Environmental Impact Assessment Study for a Proposed Chlor-alkali Plant and Associated Infrastructure at Point Lisas, Trinidad and Tobago

July 2008 - Revised January 2009

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LIST OF ACRONYMS

AC	Alternating current
API	American Petroleum Institute
ASTM	American Society for Testing Materials
BC	Brechin Castle
BMP	Best management practice
BOD	Biochemical oxygen demand
BPIP	Building Profile Input Program
CAA	Civil Aviation Authority
CARICOM	Caribbean Community
CBD	Convention on Biological Diversity
CBMS	Claxton Bay Mangrove System
CBO	Community Based Organization
CEC	Certificate of Environmental Clearance
CEP	Community Engagement Plan
CFC	Chlorofluorocarbon
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNC	Caribbean Nitrogen Company Limited
COD	Chemical oxygen demand
CPHS	Community and Public Health and Safety
CSO	Central Statistical Office
CSSP	Continuous Sample Survey of Population
DC	Direct current
DCS	Distributed control system
DESALCOTT	Desalination Company of Trinidad and Tobago Limited
DMT	Dry metric tonnes
ECU	Electrochemical unit
EH&S	Environmental health and safety
EHSM	Environmental Health and Safety Management
EIA	Environmental impact assessment
EISL	EASI Industrial Supplies Limited
EIS Ltd.	Earth Investigation Systems Limited
EM	Environmental Management
EMA	Environmental Management Authority
EPA	U.S. Environmental Protection Agency
ERP	Emergency Response Plan
ESA	Environmentally sensitive areas
ESD	Emergency Shutdown System

ESS	Environmentally sensitive species
FEED	Front-end engineering design
FIBC	Flexible intermediate bulk containers
FHWA	U.S. Federal Highway Administration
FTA	U.S. Federal Transit Authority
GIS	Geographic information systems
GPA	Global Plan of Action
GVWR	Gross vehicle weight rating
HAZID	Hazard identification
HDPE	High-density polyethylene
HEM	n-hexane extractable material
IDLH	Immediately dangerous to life and health
ITCZ	Intertropical Convergence Zone
IUCN	International Union for the Conservation of Nature
LBSA	Land Based Sources and Activities
LEED	Leadership in Energy and Environmental Design
LNG	Liquefied natural gas
MCC	Master control centre
MEEI	Ministry of Energy and Energy Industries
MPN	Most probable number
MSDS	Material Safety Data Sheets
MVA	Megavolt amp
MVR	Mechanical Vapour Recompression
NATE	No acute toxic effects
NBSAP	National Biodiversity Strategy and Action Plan
NEC	National Energy Corporation of Trinidad and Tobago Limited
NEP	National Environmental Policy
NFPA	National Fire Protection Association
NGC	Natural Gas Company
NGO	Nongovernmental organization
NIAA	No increase above ambient
OSH	Occupation Safety and Health
OSHA	Occupation Safety and Health Act
PLIPDECO	Point Lisas Port Development Company
PLSEIE	Point Lisas South and East Industrial Estate
PM	Particulate matter
PPE	Personal protective equipment
PPGPL	Phoenix Park Gas Processors Limited
ppm	Parts per million
RMS	Root mean square
Rfc	Reference concentration level

RMT	Response Management Team
ROW	Right-of-way
SIA	Social impact assessment
SMR	Southern Main Road
SPAW	Specially Protected Areas and Wildlife
SPL	Sound pressure level
SWPPP	Stormwater Pollution Prevention Plan
SWMCOL	Trinidad and Tobago Solid Waste Management Company Limited
T&TEC	Trinidad and Tobago Electricity Commission
TBD	To be determined
TCPD	Town and Country Planning Division
TEIL	Trinidad Energy Investments Limited
TO&G	Total oil and grease
TOR	Terms of Reference
TPH	Total petroleum hydrocarbons
TSP	Total suspended particulate
TSS	Total suspended solids
TSS	Trinidad and Tobago Standard
TSTT	Telecommunications Services of Trinidad and Tobago
TTEMAS	Trinidad and Tobago Emergency Mutual Aid Scheme
TTS	Trinidad and Tobago Standard
UCC	Upset Conditions Contingency
UFW	Unaccounted for Water
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	United States
USD	U.S. dollars
USEPA	Environmental Protection Agency
UTM	Universal Transverse Mercator
VOCs	Volatile organic compounds
WASA	Water and Sewerage Authority
WRA	Water Resources Agency

NON-TECHNICAL EXECUTIVE SUMMARY

OVERVIEW

CariSal Unlimited[1] (CariSal) submitted its application for a Certificate of Environmental Clearance (CEC) to the Environmental Management Authority (EMA) on December 22, 2006. The EMA has determined that the CariSal Project may have significant environmental impacts and that the application requires an Environmental Impact Assessment (EIA) in compliance with the given Terms of Reference (TOR) under Section 35 of the Environmental Management Act (2000).

CariSal proposes to establish a chlor-alkali plant for the production of calcium chloride, caustic soda, sodium hypochlorite, and hydrochloric acid with high quality distilled water as a by-product. The proposed facility would be located on 11.8 hectares (ha) of land, which CariSal would lease from the National Energy Corporation of Trinidad and Tobago Limited (NEC). The property is adjacent to the planned Point Lisas South and East Industrial Estate (PLSEIE) in Couva and the existing Point Lisas Industrial Estate managed by the Point Lisas Port Development Company (PLIPDECO). The CariSal facility would also include ex situ pipeline infrastructure and storage tanks on the existing EISL site (or alternatively, on an existing Caroni (1975) Limited tank site) and use of the Yara pier.

Prior to the commencement of the CEC application process, CariSal Unlimited conducted a due diligence evaluation of the Project's costs, feasibility, and suitability under local conditions in Trinidad and Tobago and specifically, the suitability of Couva-Point Lisas region, for the proposed venture.

This EIA submission includes evaluation and comparison of several alternatives to various Project elements on the basis of their potential environmental and social/socioeconomic impacts and in accordance with the Final TOR issued by the EMA.

The no action alternative to the proposed development would result in loss of a strategic economic opportunity for Trinidad and Tobago as a new entrant to the export markets for caustic soda, calcium chloride, and the Project's related byproducts. The opportunity for the Water and Sewerage Authority (WASA) to improve the safety of its water treatment process, while reducing cost would also be lost. The Project's direct and indirect socioeconomic impacts to the local area, specifically local and regional workers and contractors, would also be precluded by this alternative. Although local area workers and residents raised concerns about their environmental health and safety, they also simultaneously stressed the importance of ensuring that the Project-affected community/ies benefit from the Project overall, and especially the introduction of jobs to which they would have access as well as, training programs (some of which would be offered by CariSal).

[1] CariSal Unlimited officially changed its name from CariSal Limited on August 16, 2007. Any documents cited herein or appended to this EIS that contain the former name were published prior to this date.

Project and process alternatives considered broadly include the following:

- Siting – possible alternative locations for this activity;
- Design - including facility layout, technology choice that includes clean production and pollution prevention elements and choices about the intensity of development;
- Construction techniques and phasing;
- Operation and maintenance procedures;
- Process technology options – including, where feasible, use of best available and proven technologies;
- Supply options for water – such as on-site storage, water use efficiency, re-cycling and re-use;
- Energy efficiency considerations;
- Options for wastewater and solid waste treatment and management;
- A zero liquid process waste policy goal; and
- Process selection – choice of the best practicable environmental option.

In each case, CariSal selected options that would enhance the Project's efficiency, safety, and pollution prevention strategies. Through the analysis of environmental impacts, additional potential impacts were discovered and in many cases, further mitigation measures were incorporated into the Project design and description. Where impacts could not be addressed through such changes, additional monitoring was proposed and measures were developed to track and as required, reduce Project impacts to minor or insignificant levels. Mitigation measures and monitoring plans are described in Chapter 7 of this EIA report. Before and during the preparation of the EIA report (i.e., October 2006 to January 2008), a series of public engagement and disclosure activities informed the regulatory, community, NGO and industrial stakeholders in the Couva/Point Lisas area and environs that comprise the Project's Study Area (see Chapter 8). The first stakeholder meetings were held with key agencies in October and November 2006, and a broader stakeholder meeting was conducted in February 2007. A Project newsletter was begun in March 2007 and door-to-door "meet-and-greet" sessions with fenceline neighbours were started in April 2007. Two community information meetings for local residents and workers were held in July 2007. Three Focus Groups were conducted with community members and workers in nearby industry in November and December 2007. Two public engagement and disclosure meetings on the EIA study and the EIA results were held in August 2007 and January 2008, respectively.

The principal issues discussed in the meetings included how best to ensure that Project and broader industrial development benefits would inure to the local communities and requirements to have CariSal, other new companies, and agency stakeholders address specific needs of the communities. Specific community needs discussed included:

- access to adequate health care and safety facilities (the need for a local hospital with a burn unit and the opening of the new fire station);

- access to education, employment, and training (especially for those who lost their livelihoods due to the closure of Caroni (1975) Ltd.;
- concern about existing and potential industrial accidents caused by industry;
- uncontrolled industrial releases or vibration;
- availability of water supply to new industry;
- transportation and road improvement;
- flood prevention;
- facilities for youth recreation and crime prevention; and
- maintenance and development of community facilities such as playing fields, and the like.

Project-specific concerns expressed by community members included air quality, specifically emissions of chlorine, particulate matter (PM), and hydrochloric acid. At the January 2008 meeting, CariSal's results suggested that under some conditions, PM may be a concern. As a result of these concerns, CariSal re-evaluated its technology options and conducted additional air quality modeling on the basis of changes to CariSal's equipment selection and maintenance procedures for the Project in order to render PM impacts – and all foreseeable air quality emissions impacts - negligible. This EIA has been revised with these new commitments and provides the modeling results to support this conclusion. At the January 2008 meeting, community members were advised that the EIA study showed that emissions of HCl, chlorine, and other pollutants of concern are expected to be well below the established health and safety limits.

Of note is that some of the needs identified by Study Area local communities were initially addressed by the Community Public Health and Safety Plan, Emergency Response Plan, Erosion and Sediment Management Plan, and Community Engagement Plan – all described in this EIA.

The Community Engagement Plan (CEP) described in Chapter 7 would build upon these prior stakeholder engagement efforts. The CEP also would establish a baseline for continuous, transparent communication and collaboration with key stakeholders, including and of highest importance, the nearby host communities. The CEP would be designed with inputs from the community and would incorporate the information gathered and the feedback received during the initial public engagement programme. During the early stages of the Project, CariSal would develop the CEP using an "Asset-based Community Building" approach. This approach involves a shift in focus from traditional needs-based planning to working with receiver communities to build ongoing relationships and establish communication networks.

CariSal has also committed to its "Lunch and Learn" programme in Study Area schools to encourage interest in science and chemistry careers and to build local knowledge of the chlor-alkali industry and clean production/industrial greening opportunities. Through its hiring processes during construction and operations CariSal would also make a contribution to community job training efforts. CariSal has committed to giving priority to qualified or qualifiable local contractors in its procurement efforts and to provide other forms of targeted

community assistance appropriate to its budget and the Project scope, such as assistance with keeping sporting fields maintained and other community benefits.

Finally, CariSal has made provisions in its Project planning and design to supply high-quality distilled water to WASA upon commencement of the Stage 4 operating process.

SCOPE AND OBJECTIVES OF EIA STUDY

The objective of this document is to comply with the requirements of the Project TOR in order to obtain a CEC for the proposed chlor-alkali facility and associated infrastructure in Couva/Point Lisas, Trinidad. Da Costa Gwendoline, Limited and ICF International gathered and reviewed and provided feedback to the CariSal design team on the technical details of the Project as proposed, culled and evaluated baseline environmental data and assessments, historical data, and information shared during public meetings, for the Project area, and conducted an impact assessment by resource area in preparation of this EIA. The resulting EIA thus, describes baseline conditions, provides estimations of potential impacts, and offers approaches for the management of reasonably foreseeable negative impacts through monitoring and mitigation measures.

PROJECT DESCRIPTION

The CariSal facility would operate a chlor-alkali process to produce hydrogen, **chlor**ine and sodium hydroxide (an **alkali**) from brine. These three intermediate products would be processed further to produce hydrochloric acid, bleach (12 percent sodium hypochlorite solutions); caustic soda (50-percent solution in water); and calcium chloride (42-percent $CaCl_2$ solution from which 94-percent $CaCl_2$ pellets and 77-percent $CaCl_2$ flakes would be produced). Carbon dioxide would be generated during the production of $CaCl_2$ and would be partially used for future (urea or other industrial) production in proposed nearby facilities.

The first two process steps are common to the production of all products:

1. Brine Generation and Purification – from solid salt and water initially (Stage 1) and from waste brine from DESALCOTT, thereafter (Stages 2-4).
2. Membrane Cell Electrolysis – which produces hydrogen gas, chlorine gas, and sodium hydroxide as a 32-percent solution in water.

The process then splits three ways for the production of caustic soda, bleach, and (via the production of hydrochloric acid) calcium chloride. Product-strength caustic soda is produced by concentrating the 32-percent sodium hydroxide solution through evaporation of water from the solution. Bleach is produced by reacting chlorine gas with 32-percent sodium hydroxide solution. Hydrochloric acid is produced by burning chlorine gas and hydrogen gas together in a furnace. A portion is retained for sale, but the bulk is reacted with calcium carbonate (limestone) to produce 42-percent calcium chloride solution ("liquid"), which releases carbon dioxide. Product-grade calcium chloride flakes and pellets are produced by removing water from this solution.

Figure ES-1 shows a flow diagram of the overall process.

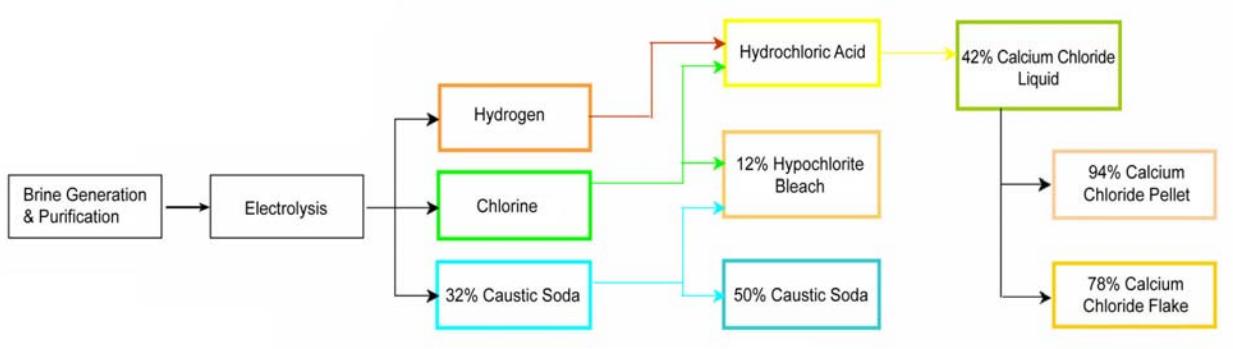

Figure ES-1. CariSal process diagram.

CariSal operations would be staged to facilitate safe and smooth start up of the plant. The plan would be to allow production to begin (using solid salt and water) while laboratory and economic evaluations into the long-term viability of using brine from DESALCOTT (a waste product of desalination) are undertaken, and because process equipment for concentrating and purifying DESALCOTT brine would not be available initially. CariSal operations would comprise four stages:

- Stage 1: Production with water from WASA and imported "pure" salt (salt containing low levels of impurity)
- Stage 2: Production with brine from DESALCOTT and imported "dirty" salt (cheaper salt containing higher levels than pure salt of impurities such as magnesium chloride, potassium chloride, calcium sulphate, and other naturally occurring salts)
- Stage 3: Production as in State 2 but with more brine from DESALCOTT and less dirty salt than in Stage 2
- Stage 4: Production with brine from DESALCOTT (but no imported solid salt) with concentration by newly commissioned mechanical vapour re-compressors.

The projected economic lifespan of the CariSal facility is envisioned to be at least 20 years, at the end of which a Decommissioning Plan would be implemented. CariSal would develop and implement in collaboration with receptor communities, a detailed plan, written near the end of the Project so that the actual state of the surrounding environment and contemporary decommissioning best practices can be accounted for (particularly, relating to equipment removal and building demolition or waste product recycling) and would be presented to the EMA for approval. However, decommissioning would have to involve the final shutdown of the production process. This shutdown would begin with the cessation of import (or generation) and purification of brine and proceed through the exhaustion of the inventories of raw materials and intermediate products, with equipment being emptied and washed once operations had ceased at each process unit.

If a new use for the plant could not be found, plant equipment would be cleaned, dismantled, and sold. Once the site is clear of all equipment and structures, the foundations would be removed and the site levelled. Building materials such as concrete and steel would be recycled to the extent possible. The remaining building materials would be disposed of as construction and demolition debris in an approved landfill.

Project Enhancements

The administrative buildings and associated facilities have been designed in accordance with "green building" and sustainable development principles such as Leadership in Energy and Environmental Design (LEED), the U.S. Green Building Council's rating system.

Parking areas would be shaded by landscape plantings and trellised green roofs, which would promote surface-water retention (see Figure 3.3-1) and absorption of ultraviolet rays. (This vegetation, along with the grove of trees to be planted on the site's northern boundary, would absorb small amounts of carbon as carbon dioxide throughout its natural life, partially mitigating the vegetation losses caused by clearing during site preparation.) Rainwater would be recycled for use in landscape irrigation. Site lighting and the electric-cart charging station would be solar powered.

Other sustainable development aspects of the project are

- Repair and reuse or utilization of existing infrastructure with excess capacity (ports, deselected Caroni (1975) Limited infrastructure (such as pipelines and tanks).
- The commissioning of a cogeneration facility during Stage 4 of the Project to make wise use of waste steam the plant generates.
- Treatment and recycling of all process and septic system water.
- No net process water discharge from the plant to surrounding areas.
- Protection of a remaining fragment of perennial wetlands.

The process itself would run a surplus of demineralised water (depending on product mix) that would be piped to WASA for distribution to industrial consumers in the vicinity.

Jobs

Construction of the primary facilities would require approximately 10 months from CEC approval. On average, 100 to 150 construction workers would be required, but at peak construction times (in the seventh and tenth months), 150 to 200 construction workers would be required. Offsite, a team of 12 construction workers would be required to build the ex situ pipelines. As many as 10 workers would be required to construct new ex situ tanks and, if the Caroni option is chosen, to repair the molasses tanks on the Caroni site.

Construction workers would be expected to work 10 hours per day, 5 days per week, with weekend work only occasionally. Workers would be hired and would live locally. No labour encampments are anticipated.

During the operations phase, the workforce would number 75 in total: around 40 technical staff (working on a 2-shift system) and roughly 35 management, support, and administrative staff working a 5-day, 40-hour week. CariSal's intent is to create a 100-percent Trinidad and Tobago-operated company.

Schedule

For the purposes of assessing impacts, this schedule may be simplified to:

- Project Design: October 2006 though October 2008
- Site Preparation and Construction: October 2008 though October 2009
- Plant Start Up: October 2009 through May 2010
- Full Plant Operations: June 2010 onwards for 20+ years
- Decommissioning: After 20+ years

KEY IMPACTS

The EIA studies the impacts of the CariSal project as it relates to humans, flora and fauna, water quality, solid wastes, soil, dust, noise, drainage, and air quality and includes a quantitative risk assessment. These impacts have been described with the following general definitions of significance:

Significant or Adverse: Project effect on resource is above established legal thresholds or at a magnitude not sustainable without substantial intervening mitigation measures.

Moderate: Project effect on resource is measurable and noticeable. Mitigation for effects is preferable in order to maintain resource quality.

Minor: Project effect on resource is measurable, but may not be noticeable. Mitigation for effects is not required to maintain resource quality.

Negligible: Project effect on resource is negligible relative to baseline conditions. No mitigation is needed.

Beneficial: Project effect to resource results in a measurable or noticeable improvement to baseline conditions. No mitigation is needed.

No Impact: Project effect does not change baseline conditions.

Unknown: Project effects are too uncertain to determine an appropriate significance level with a reasonable degree of confidence.

These terms are further qualified by their geographical extent, duration, method, and degree of confidence. For duration, permanent effects would last as long as the Project life or longer. Temporary effects would last for the duration of a specific activity (such as construction) and quickly return to baseline conditions with or without restoration/mitigation. Table ES-1 provides an overview of the impacts of each resource assuming all applicable mitigation measures are implemented.

Table ES-1. Summary Of Impacts

Resource Category	Impact (No Impact – Beneficial)	Extent (Geographical)	Duration/ Intensity	Method (Measured/ Estimated)	Degree Of Confidence (Sensitivity)
Startup and Construction					
Noise	Minor	1 ha – < 1 km^2	Temporary	Estimated	High
Vibration	Minor	1 ha – < 1 km^2	Temporary	Estimated	High
Traffic and Roads	Minor	1 – 10 km^2	Temporary	Measured	Moderate
Air Quality	Moderate	1 ha – 1 km^2	Temporary	Modelled	High
Soil Erosion	Negligible	1 ha – < 1 km^2	Temporary	Estimated	High
Solid Waste Disposal	Negligible to Minor	> 100 km^2	Temporary	Estimated	High
Drainage	Beneficial	1 ha – < 1 km^2	Temporary	Estimated	High
Water Quality/Demand	Negligible	> 100 km^2	Temporary	Measured	High
Flora and Fauna	Minor	1 ha – < 1 km^2	Permanent	Estimated	High
Health and Safety	Negligible to Minor	1 ha – < 1 km^2	Temporary	Estimated	High
Social Impact, SES	Minor to Beneficial	1 –10 km^2	Temporary	Estimated	High
Operations					
Noise	Minor	1 ha – < 1 km^2	Temporary	Estimated	Moderate
Vibration	Negligible	1 ha – < 1 km^2	Temporary	Estimated	High
Traffic and Roads	Minor	1 – 10 km^2	Temporary	Measured	Moderate
Air Quality	Minor	1 km^2 – 10 km^2	Permanent	Modelled	High
Soil Erosion	No impact	1 ha – < 1 km^2	Permanent	Estimated	High
Solid Waste Disposal	Moderate	> 100 km^2	Permanent	Measured	Moderate
Drainage	Beneficial	1 ha – < 1 km^2	Permanent	Estimated	High
Water Quality/Demand	Beneficial	> 100 km^2	Permanent	Measured	High
Flora and Fauna	Unknown[1]	1 ha – < 1 km^2	Temporary	Estimated	Low
Health and Safety	Moderate	1 ha – < 10 km^2	Temporary	Estimated	High
Social Impact, SES	Beneficial	1 – 10 km^2	Permanent	Estimated	Moderate

Table ES-1. Summary Of Impacts

Resource Category	Impact (No Impact – Beneficial)	Extent (Geographical)	Duration/ Intensity	Method (Measured/ Estimated)	Degree Of Confidence (Sensitivity)
Decommissioning					
Noise	Minor	1 ha – < 1 km^2	Temporary	Estimated	Moderate
Vibration	Minor	1 ha – < 1 km^2	Temporary	Estimated	Moderate
Traffic and Roads	Minor	1 – 10 km^2	Temporary	Measured	Moderate
Air Quality	Minor	< 1 ha	Temporary	Estimated	Moderate
Soil Erosion	Negligible	1 ha – < 1 km^2	Temporary	Estimated	High
Solid Waste Disposal	Minor	> 100 km^2	Temporary	Estimated	Moderate
Drainage	No impact	1 ha – < 1 km^2	Temporary	Estimated	High
Water Quality/Demand	Negligible	> 100 km^2	Temporary	Estimated	High
Flora and Fauna	Significant Adverse to Moderate Beneficial[2]	1 ha - < 1 km^2	Permanent	Estimated	High
Health and Safety	Negligible to Minor	1 ha – < 1 km^2	Temporary	Estimated	High
Social Impact, SES	Moderate Adverse to Beneficial	1 - 10 km^2	Temporary	Estimated	Low

[1] Flora and Fauna impacts are indicated as unknown because the likelihood of chloride toxicity to vegetation downwind of the CariSal site, resulting from $CaCl_2$ particulate deposition from the site, cannot be determined within a reasonable degree of confidence.

[2] Impacts negligible to mildly beneficial assuming recommended mitigation measures are adopted. Impacts significantly adverse if recommended mitigation measures are not adopted.

MITIGATION STRATEGIES

Where feasible, CariSal incorporated mitigation measures into the design phase completed thus far. The Project design incorporates many technologies and practices for promoting clean production, energy efficiency, and pollution prevention. These include:

- Clean Production
  - Cell membrane process,
  - Use of rainwater run-off,
  - Waste brine from a local desalination plant as raw materials (later stage), and
  - Generation of secondary raw materials such as soda ash on site.

- Energy Efficiency
  - Cell-membrane process, and
  - Co-generation plant for electricity and steam production.
- Pollution Prevention
  - Resituating brine in closed vessels,
  - Graphite anodes rather than metal,
  - Scrubbing chlorine tail-gases to produce hypochlorite, and
  - Lining the retention pond – Containment Pit 1.

CariSal has also committed to various operational measures to ensure that the impacts as stated in this EIA are not exceeded. For example, CariSal would conduct air quality and noise monitoring during different project phases to verify the modelling results that these would not exceed local or other applicable laws/thresholds. CariSal has also planned to preserve a permanent wetland located onsite and will work with nearby landowners to ensure its protection. These mitigation measures and others are described in Section 7.0. For each measure, CariSal has established performance indicators that can be used to measure the successful implementation of the mitigation measure. A summary of all mitigation measures and performance indicators can be found in Table 7.0-1.

PERMITTING REQUIREMENTS

Table ES-2 provides a list of approvals that may be required for the CariSal Unlimited Project.

Table ES-2. List of Approvals Required for the Project

Approval Type	Approving Agency	Comment
Certificate of Environmental Clearance	EMA	Would include the conduct of an EIA
Outline Planning Permission and Planning Permission	Town and Country Planning Division	Planning permission subject to the granting of a CEC
Road Permits	Traffic Management Branch, Ministry of Works and Transport, Highways Division	For routing of traffic For the transport of heavy equipment, building material and workers
Drainage Approval	Ministry of Works-Drainage Division, WASA, and Water Resources Agency (WRA)	Drainage plan Sediment and erosion control plan Surface water pollution prevention plan Permanent and temporary drains To straighten stream in northern and southern section of proposed site

Table ES-2. List of Approvals Required for the Project

Approval Type	Approving Agency	Comment
Building Design and Plant Structures	Director of Civil Aviation Occupational Safety and Health (OSH) Unit Ministry of Energy and Energy Industries Designs Engineering Department, Couva/Tabaquite/Talparo Regional Corporation Fire Services	OSH Unit, the Corporation and Fire Services building designs and plant structures for worker safety Approving storage areas for fuel
Completion Certificate	Local Health Authority of the Ministry of Health	Upon completion of building structures
Plant Operation Approval	Industrial Inspection Supervisor	Operations would be (24 hours per day, 7 days per week).
Registration Certificate	EMA	Application must be made to the EMA 45 days prior to the release
Waste Collection Permit Solid Waste License	EMA Solid Waste Management Company of Trinidad and Tobago Limited	Required under the Draft Waste Management (Solid Waste) (Collection and Disposal) Rules, 2000
Disposal System	WASA	Project would include septic system or leach field to handle domestic sewage wastes
Variance to Sound Level	EMA on the advice of the Noise Advisory Council.	Application to be made before date of the event or the activity
Emergency Response Plan/Fire Prevention	OSH Unit, Local Fire Services Department, (consultations with Trinidad and Tobago Emergency Mutual Aid Scheme (TTEMAS) including the local police)	Entire area, including roads, would be designed to have adequate safety signs, illumination, and fire extinguishers, and good housekeeping to minimize accidents
Transportation	Traffic Management and Highways Division of the Ministry of Works	Project would involve continuous transport of both raw materials and product.
WASA Outline Permission	WRA and WASA	Project would need to purchase water from DESALCOTT or WASA for start up operations Plant would generate and recycle its own process water after startup

Based on this EIA report, the residual environmental and social impacts resulting from the Project during the construction and operation phases of the chlor-alkali facility, including both its onsite and ex-situ facilities, are found to be acceptable and in compliance with relevant standards and guidelines set forth by the Trinidad and Tobago EMA and other international bodies such as the U.S. Environmental Protection Agency (EPA) and International Finance Corporation and World Bank.

Properly designed environmental and social monitoring and mitigation plans appropriate and practicable in the local context have been proposed for the construction, operation, and decommissioning phases.

The contents of this EIA document were discussed during public consultation meetings that included representatives from a wide cross-section of stakeholders, including public and private-sector organizations and residents from nearby communities in the Couva/Point Lisas area. Based on discussions with stakeholders, concerns and questions raised during the consultation have been addressed in the EIA. Potential air quality impacts were subsequently reexamined in collaboration with CariSal's engineers, and CariSal decided to purchase baghouse(s), install more efficient scrubbers, and use recent model-year front-end loaders that reduce the Project-related air quality impacts (from potential total suspended particulate and PM emissions).

These changes were incorporated in the final Project design described in Chapter 3 and in revised air contaminant dispersion modelling studies reported in Chapters 5 and 7. In conclusion, the Project addresses the need for superior quality chlor-alkali products for local and international markets and supports the economic development of the Point Lisas/Couva area communities and the nation as a whole.

Recognizing the inherent environmental and human health and safety sensitivities of the area surrounding the CariSal facility, significant safeguards have been incorporated into the Project planning, layout, design, and construction and operational phases, including detailed mitigation measures and monitoring plans. These safeguards are expected to provide continuous data on the operational/safety performance of the plant and opportunities for evaluating and reducing any residual impacts to the human and natural environment and communities and for preventing further deterioration of the receiving environment. The Project is expected to benefit local communities and help spur economic development in the Project area while contributing to the region's revitalization as it restructures its economic base.

The action items presented in Table ES-3 are based on the Project description and mitigation and monitoring described in Chapters 3 and 7, respectively, and throughout this EIA. They are summarized here as a convenient reference for CariSal Unlimited and its Project contractors, as well as any other parties interested in tracking the various stages of the Project.

Table ES-3. Selected Action Items for CariSal Personnel and Contractor Staff

Number	Action Item	Project Phase
1	Review various process/process design assumptions and requirements contained in the mitigation measures to be incorporated into the Project's final design and procurement policies and contracts, including adequate treatment capacities, scrubbers for stacks, contractor compliance with all air, traffic, and noise monitoring and mitigation.	Pre-engineering procurement and construction
2	Review HAZOP and submit to EMA/revise Quantitative Risk Assessment studies, if necessary.	Detailed design
3	Ensure that critical process systems, emergency trip systems, chlorine area monitoring, strategic control valve failure positions, and emergency power systems have been incorporated into facility design.	Detailed design
4	Submit waste-management system plan to Solid Waste Management Company of Trinidad and Tobago Limited for review and approval.	Detailed design
5	Investigate ways to use hydrogen onsite or to export it offsite to industrial neighbours and report findings to the EMA.	Detailed design
6	Notify all appropriate agencies and site neighbours before beginning work.	Pre-site preparation
7	Establish Environment and Safety (E&S) department with necessary staff such as an E&S Manager and Corporate Responsibility Officer for effective implementation of the Environmental Health and Safety Management Plan.	Pre-construction
8	Devise and implement an exterior lighting plan that would prevent light "leakage" into areas that require no light and areas with residences nearby.	Pre-construction; Construction
9	Implement Emergency Response, Spill Response, Upset Conditions Contingency, and Traffic Management Plans.	Construction
10	Inspect all structures upon completion of construction.	Construction
11	Plant perimeter trees and a stand of trees to provide a vegetated buffer zone.	After construction
12	Train contractors and employees to obtain necessary certification regarding safety performance standards.	Construction and operation
13	Provide and maintain a material certificate for each fabricated structure.	Construction and operation
14	Facilitate public consultation programmes.	Construction and operation
15	Develop and implement the Community Engagement Plan (CEP).	Construction and operation
16	Develop a more detailed Community and Public Health and Safety Plan through public consultation with local communities via the CEP.	Pre-operation
17	Update Community Engagement Plan in consultation with local community/ies every 3 to 5 years.	Operation
18	Develop and facilitate a thorough process-training programme (with qualification testing) for operators.	Operation
20	Develop and present to the EMA for approval a detailed decommissioning plan to account for the actual state of the surrounding environment and to ensure that contemporary decommissioning best practices are employed.	Pre-decommissioning
21	Develop a plan for and manage the perennial wetland as a permanent wetland nature preserve in the northwest corner of the site.	Construction, operation, decommissioning
22	Implement mitigations listed in: Community and Public Health and Safety Plan; Environmental Health and Safety Management Plan; Flora and Fauna Impact Mitigation and Monitoring Plan; Wastewater Management Plan; Water Management Plan; Water Quality Protection Plan; Waste Management Plan; Erosion and Sediment Management Plan; Noise Minimization Plan; Surface Water Pollution Prevention Plan; Greenhouse Gas Management Plan; and Decommissioning Plan.	Pre-construction, Construction, operation, decommissioning

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1.0 INTRODUCTION

1.1 AUTHORIZATION AND REPORT ORGANIZATION

This environmental impact assessment (EIA) report was prepared for the proposed development of a chlor-alkali plant in Couva/Point Lisas, Trinidad. CariSal Unlimited[1] (CariSal), the CariSal Project (or Project) developer, has submitted an application for a Certificate of Environmental Clearance (CEC), CEC1743/2006 to the Trinidad and Tobago Environmental Management Authority (EMA). The construction and operation of this chlor-alkali plant and associated infrastructure are consistent with the list of activities described in the CEC Order (2001). As such, they are Designated Activities that require approval from the EMA before performance of such activities may begin. The Project involves Activity 20: Manufacture of Goods and Products other than Petroleum Products, Petrochemicals or Petrochemical Products [(a) the establishment, modification, expansion, decommissioning or abandonment (inclusive of associated works) of a chemical manufacturing plant].

Consistent with the CEC Rules and the Environmental Management Act of 2000, the EMA has required the completion of this EIA based upon a review of the initial application. The EIA is consistent with the final Terms of Reference (TOR, see Appendix A) issued by the EMA and dated August 16, 2007.

DaCosta Gwendoline Limited (with its sub-consultants ICF International and others) was contracted by CariSal Unlimited to conduct the EIA for the proposed chlor-alkali plant. This study complies with the final TOR issued for the Project and builds upon a first-phase environmental study conducted for the Application and revised in response to the EMA's subsequent Request for Further Information. CariSal's Response document clarified the designated activity relevant to the planned development and augmented information on the Project, including changes (from the initial CEC application) in the quantities of product to be manufactured, the process and modifications to arrangements for access to port and utility infrastructure. Project changes made subsequent to the submission of the Response document are reported in, and formed the basis for the assessment contained in this EIA report.

The first-phase study included with the Response document served the purpose of a 'high-level' scoping exercise for the CEC application. The study coincided with the development of the Project's Front-End Engineering Design (FEED).

This EIA study was conducted in accordance with the requirements of the environmental laws of the Republic of Trinidad and Tobago and makes use of appropriate environmental standards and guidelines from other jurisdictions where Trinidad and Tobago legislation is silent or absent. The EIA study was conducted from September 2007 through May 2008, and this report

[1] CariSal Unlimited officially changed its name from CariSal Limited on August 16, 2007. Any documents cited herein or appended to this EIA that contain the former name were published prior to this date.

represents the results of the final impact analyses submitted to CariSal Unlimited.

After several design reviews, CariSal decided to include a cogeneration plant and the option of a reverse osmosis (desalination) unit as part of the plant utilities to address electricity and potable and raw water requirements during the operational phase of the Project. Once operational, the cogeneration unit would reduce the Project's demand for power provided by the Trinidad and Tobago Electricity Commission (T&TEC) and would improve the plant's energy efficiency. The reverse osmosis unit was included as an option to be exercised only if running the plant on waste brine from the Desalination Company of Trinidad and Tobago Limited (DESALCOTT) becomes technically infeasible. The option would be in lieu of using water provided by the Water and Sewerage Authority (WASA) - that is needed to supply residences, commercial clients and other industrial users on the existing and proposed industrial estates in Point Lisas and vicinity - for plant operations.

These and other design modifications – including use/re-use of existing port facilities and infrastructure with available slack resources – will obviate the impacts on water resources, electricity, and other environmental and social resources in the area and the impacts of constructing and operating the Project.

In addition, CariSal Unlimited conducted a series of public engagement activities and meetings starting in July 2007 with the most recent public meeting, a public consultation on the EIA results, held on January 7, 2008. Other public engagement activities are ongoing. The EIA report was revised to respond to concerns raised and comments received from the public during the January 2008 meeting.

The EIA report clearly articulates all material changes to the design of the main process units, plant capacity, or chlor-alkali processes compared to that presented in the initial CEC application document as amended in CariSal's Response to the EMA's Request for Further Information issued in January 2007. An assessment of environmental releases to the atmosphere, process effluents, and associated social and ecological risks, impacts, and mitigation plans and measures are described in the EIA pursuant to the Final TOR.

1.1.1 Study Objectives

The EIA focuses mainly on compliance with the scope of work identified in EMA's Final TOR for the Project. Specifically, the Project objectives include:

- Conducting the EIA;
- Reviewing applicability/conformance with Chlorine Institute project guidelines; and
- Reviewing applicability/conformance with Trinidad and Tobago EMA requirements and guidelines.

In developing this report, DaCosta Gwendoline and ICF sourced information contained in the following documents among others:

- CariSal Limited. 2006. Application for Certificate of Environmental Clearance (CEC 1743/2006) dated December 14, 2006;
- CariSal Limited. 2007. 100,000 Metric Tonnes NaOH per year Chlor-Alkali Plant CariSal Limited – CariSal Project: Point Lisas Industrial Estate, Couva, Trinidad and Tobago, W.I., Technical Proposal No. CAR-0607-01 – Rev. 1. Prepared by CAVS, Inc., Miami, Florida, June 26;
- CariSal Limited. 2007. Process Hazard and Environmental Risks Identification Form, CariSal Ltd., Point Lisas, Trinidad and Tobago, West Indies, Document TTK-3831-P-HAZIP-Rev.C.doc. 23 March. Prepared by Conve & Avs, Inc.;
- CariSal Limited. 2007. Response to Request for Additional Information Regarding CariSal's CEC Application (CEC 1743/2006) dated 14 December 2006, April 19;
- Relevant Trinidad and Tobago, U.S. Environmental Protection Agency (EPA), and World Bank environmental regulations and standards; and
- Environmental emissions estimates published by EPA and other comparable literature.

1.1.2 Scope of Work

The scope of work is commensurate with that of EMA's Final Project TOR and is limited to the Project design, construction, and operational data available at the time of preparation of this report.

The EIA study was completed, where feasible, with quantitative information required for impact assessment and mitigation that were available in the existing FEED documents provided by CariSal Unlimited, by baseline data collected during field reconnaissance studies, and from bench reviews of relevant and available secondary and historical information. The EIA was based on semi-quantitative and qualitative assessment of environmental or social impacts in areas where final detailed quantitative assessment information was unavailable or inaccessible.

The Project TOR requires the use of geographic information system (GIS) data and software to show locations of adjacent industrial facilities operating or planned in the Project area. CariSal Unlimited obtained and used the most recent GIS survey map of the area that was readily available from official sources (the Lands and Surveys Division). CariSal also employed the location and other relevant information for projects planned in the nearby vicinity, such as the Essar Steel Complex and the Westlake Ethylene and Polyethylene Complex, available in the EMA's National Registry at the time of study preparation. Official location information for the proposed National Energy Corporation (NEC) Point Lisas Port project was not available during the development of CariSal's air quality dispersion figures. As such, the revised Essar and Port boundaries are not reflected in these maps. A figure that combines the GIS survey map available from Lands and Surveys with a recent Google Earth image of the area is provided in Chapter 3.

1.1.3 Report Structure

This EIA report comprises ten chapters and six appendices. The rest of this introductory chapter presents the Project background, a summary description of the Project, and introduces the study team who participated in the preparation of this document. Chapter 2 presents the legislative and regulatory framework that governs this Project. It describes Trinidad and Tobago's national environmental policies and plans, environmental laws and subsidiary legislation, international and regional environmental agreements, industrial standards and guidelines, and the institutions with the statutory authority to protect the nation's environment. Chapter 3 provides a description of the Project including a justification and describes the proposed location/s and the activities entailed in construction, operations, and decommissioning. Chapter 4 presents the environmental setting at Point Lisas, including the current physical, biological, social and socioeconomic status. Significant environmental impacts of the CariSal Project, as assessed on the basis of information presented in Chapters 3, 4, Appendix C, analytical modelling and best professional judgement, are delineated in Chapter 5. Chapter 6 presents an analysis of alternatives, including facility siting, design, construction techniques and operations procedures, and options for process technology, water supply, and waste management. A presentation of the recommended monitoring and mitigation measures for impacts associated with constructing, operating, and decommissioning the plant is presented in Chapter 7. Efforts to involve agencies, the public, and nongovernmental organizations are the subject of Chapter 8. Chapter 9 lists the citations for sources of information used to supplement or substantiate the statements made in this report, including the scientific literature, government and private-sector reports, the Internet (Web sites), and other sources. Chapter 10 is a map book that provides enlarged versions of many of the key figures referenced in the main text of the EIA report.

The six appendices are the Terms of Reference (A); List of Preparers (B); Quantitative Risk Assessment (C); Records of Public and Other Stakeholder Engagement (D); Selected Data and Unpublished Documents (E); and the CariSal Unlimited Application for the Certificate of Environmental Clearance (F).

1.2 BACKGROUND

CariSal would develop its chlor-alkali plant in Point Lisas, Trinidad, on an 11.8-hectare (ha) parcel of land that the Town and Country Planning Division (TCPD) had previously designated for industrial use. The parcel is contiguous to the proposed Point Lisas South and East Industrial Estate (PLSEIE) to the east, north, and south and to the existing Point Lisas Port Development Company (PLIPDECO) Estate to the west. CariSal is a chemical company jointly owned by Guardian Energy Holdings Limited; Seneca Chemical; Denham Capital Management, an international private equity firm; Innovaone Investments of Trinidad and Tobago; TTeK Project Management Services Limited; EASI Industrial Supplies Limited (EISL); NYT, a Houston-based holding company; and a group of smaller individual investors.

The state-of-the-art chemical plant CariSal is proposing is a waste-to-retail endeavour that would transform waste brine from DESALCOTT into 125,000 metric tons (DMT) per year of calcium chloride, 100,000 DMT per year of caustic soda, and associated by-products. The 125,000 metric tons (DMT) per year of calcium chloride represents a change from the amount previously reported in CariSal's Response to the EMA's January 2007 Request for Further Information.

By-products include bleach (sodium hypochlorite), hydrochloric acid, food-grade salt, and high-quality distilled water. These products are critical inputs for the local industrial and water treatment sectors, and CariSal's proposed plant would minimize the need to import these chemicals to meet the local demand.

CariSal is dedicated to clean production and environmental and social/socioeconomic sustainability. CariSal has undertaken numerous steps to create a cutting-edge plant that would use the best available, proven technologies to minimize the release of toxics and other undesirable materials into the environment.

1.3 STUDY TEAM

The following personnel were key contributors in the development of this EIA report and the supporting baseline studies.

Name	Affiliation	Function
Karen DeGannes	DaCosta Gwendoline, Limited	Overall EIA Project Management, Data Collection, Analysis, Preparation and QAQC Review; Regulatory Relations, Social Impacts, Analysis of Alternatives, Public Engagement, Clean Production Design.
Mina Yoo	DaCosta Gwendoline, Limited	Socioeconomic Baseline Analysis
John Boyd	DaCosta Gwendoline, Limited	Trinidad and Tobago Logistics, Data Collection
Karen Fadely	ICF International	ICF Project Management, Quality Assurance/Quality Control
Penelope Kellar	ICF International	Technical Editor and Document Manager
Edward Carr	ICF International	Air Resources
James Gardiner	ICF International	Project Description
Ralph Grismala	ICF International	Drainage, Water Resources, Waste
Robert Lanza	ICF International	Risk Assessment
Laurence O'Rourke	ICF International	Transportation
Walter Palmer	ICF International	Flora and Fauna
Rishi Pragg, Sven Somair	Kaizen Environmental Services Trinidad, Limited	Baseline Air, Water, Noise Monitoring
Judy Daniel	Environmental Advisors, Inc.	Legislative and Regulatory Framework
Michael Otham, Graham White, Janice Smith	JARIC Environment Safety and Health Services Ltd.	Baseline Biological Reconnaissance Survey
Charles Allen	Earth Investigation Systems Limited	Geotechnical Survey Report
James Potter	Remote Data Concepts Caribbean Limited	GIS Mapping
Louis Bertrand	HHB & Associates	Baseline Socioeconomic Data Collection from Central Statistical Office (CSO), Focus Groups
Shaffraz A. Muhammad	Trintoplan Consultants Limited	Baseline Traffic Monitoring

2.0 LEGISLATIVE AND REGULATORY FRAMEWORK

2.1 BACKGROUND

The legal regime, within which legal liability associated with environmental impacts is determined, is contained in common law, statutory law, regulations, international environmental law, policies, and guidelines. The general trend in Trinidad and Tobago statutory environmental law is based on the principle that a person undertaking an activity that may have an environmental impact must ensure that the environmental legal risks associated with the undertaking of such activity are identified, assessed, and managed prior to the actual undertaking thereof.

In regard to the scope of the legal requirements assessment, we have identified the potential policy, legal, and institutional requirements that may arise by virtue of the nature and extent of this Project. These requirements are not unlimited but are significant to the activities proposed by the Project. The multilateral environmental agreements to which Trinidad and Tobago is party are integral to that framework and are therefore considered in relation to their applicability to the proposed Project for establishing and operating a chemical manufacturing plant.

This chapter discusses the various statutes, policies, institutional arrangements, multilateral environmental agreements, and international standards and guidelines that are relevant to Project-specific circumstances. The discussions reflect a detailed analysis of all Project activities to ensure that the Project legally complies with the EIA process and other environmental authorisation processes identified. The analysis was completed by investigating and evaluating the relevant legal requirements in the context of the environmental framework in Trinidad and Tobago. These legal requirements are based on specific statutes and, as such, do not include potential common law liability or contractual liability.

Although we have attempted to limit our discussion to provisions requiring environmental approvals, we nevertheless refer to provisions of a general nature where such general provisions have a direct consequential bearing and effect on the prospects of the Project obtaining the prescribed environmental approvals. The requirements discussed here are therefore not unlimited but are significant to the activities proposed by the Project. The elements in this discussion are as follows:

- National Policies and Plans
- Environmental Laws
- Subsidiary Legislation [under the Environmental Management Act, 2000]
- Industry standards and guidelines
- Multilateral and regional environmental agreements
- Institutions
- CariSal Unlimited Health and Safety Policy
- Summary of the approvals process

2.2 NATIONAL POLICIES AND PLANS

2.2.1 National Environmental Policy

The National Environmental Policy (2005) (NEP) is an overarching policy document made pursuant to section 18 of the Environmental Management Act No. 3 of 2000. This policy was revised after a series of public consultations in 2005 and received the approval of Cabinet and Parliament before coming into force. The Policy's primary goal is the conservation and wise use of the environment of Trinidad and Tobago to provide adequately for meeting the needs of present and future generations and enhancing the quality of life. It governs all priority aspects of environmental management in Trinidad and Tobago, including environmentally sensitive areas (ESA), coastal and marine areas, forests, wetlands, and water resources and policy with respect to specific pollutants and potentially polluting activities pertaining to waste, hazardous waste, hazardous substances and spills, and contaminated land. The Policy establishes environmental quality and performance indicators for such environmental management.

The conduct of industrial activity, if unmanaged, can compromise the future use of resources and national development objectives. To avoid such compromise, the NEP advocates for the following specific objectives:

- Prevent, reduce, or—where possible—recycle all forms of pollution to ensure adequate protection of the environment and consequently the health and well-being of humans;
- Conserve the vitality and diversity of the natural environment through conservation of ecological systems and the biodiversity within;
- Develop the carrying capacity (the assimilative capacity of the environment) of the country through national physical development and planning, the sustainable use of renewable resources, and the conservation of non-renewable resources for all decision-making on the use of the country's natural resources;
- Change attitudes and practices of citizens with a view to reducing the polluting practices of the public;
- Ensure that industry installs a certified Environmental Management System; and
- Secure the health, safety, and welfare of persons at work and provide for the protection to the public from work activities.

A key characteristic of the NEP is its reliance on EIAs as a measure to mitigate the effects of activities likely to have significant effects on the environment by virtue of their nature, size, or location. Such activities are subject to an EIA before consent is given. Broad categories to which these requirements apply are set out in the policy and include activities for establishing a chemical manufacturing plant—the subject of this assessment. The NEP specifically incorporates the "polluter pays" principle and the precautionary principle.

The NEP enlists the EMA's commitment and that of all other Governmental entities in implementing its policy and in establishing appropriate legal and institutional support for its implementation. These agencies are required to conduct their operations and programmes in

accordance with the NEP. Also included in the Policy's objectives is to empower stakeholders, including communities, to care for their own environments. Stakeholders are provided opportunities to share in managing their local resources and can participate in decision-making and creating partnerships within all levels of government. The NEP includes a general policy allowing public access to information on the environment held by public authorities for which a reasonable fee may be charged. Some requests, however, may be refused.

2.2.2 The National Physical Development Plan

The 1982 National Physical Development Plan was formulated with the goal of securing consistency and continuity in the framing and execution of a comprehensive policy for the use and development of all land in Trinidad and Tobago. The Plan, approved by Parliament in 1984, was prepared in accordance with the Town and Country Planning Act Chapter 35:01. To ensure its relevancy to changes in socioeconomic growth and development, the Plan was to have been updated every 5 years. The 1982 Plan's preamble stated that an overall view of the physical development of the country to the year 2000 was to be provided. So far this is yet to be done, raising concerns regarding the Plan's applicability to contemporary development issues. As a result it may have been superseded by other national sectoral or inter-sectoral plans and policies by implication.

The Plan takes into account and balances natural, socioeconomic, financial, land, and other material considerations. The Plan promotes consistency in matters pertaining to land use and the coordination of land use matters among public and private entities. Under the National Physical Development Plan Volume 2, the Point Lisas study area was projected as having the potential for additional built environments.

The objectives of an environmental policy the Plan contains, which are relevant to this Project, include:

- Development of a high quality of living environment and health standards in a context of effective resource development that retains the aesthetic or amenity value of landscape; and
- Contribution to economic welfare through the informed use of resources whereby the high cost of remedial infrastructure works and environmental programmes can be channelled into productive expenditure and natural opportunities for national growth are not reduced or lost through destructive activity.

The strategies for the Plan's implementation include the designation and protection of critical conservation areas to be conserved under natural cover to protect, among other things, areas in which the discharge of pollutants could lead to accumulation in off-shore areas, particularly where reefs exist. The Plan identified the protection of critical areas for soil and water conservation as the highest priority, providing for the concentration of conservation areas in regions of the country. The Plan designates the Caroni Swamp for conservation and implies the adoption of the precautionary principle with respect to other sensitive areas.

2.2.3 National Policy and Programmes on Wetland Conservation, 2002

The National Policy and Programmes on Wetland Conservation for Trinidad and Tobago, 2002 proposes several specific actions on the protection, management, and restoration of wetlands. The Policy was developed in response to the global outlook on the value of wetland areas to the conservation of species and habitat and the country's ratification of the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, 1971. This Policy instrument is valuable to the comprehensive management of wetlands. It notes that the manner in which land is used can impact significantly wetland ecosystems. It further notes that more than 50 percent of the original wetland area of Trinidad and Tobago has disappeared, and that the resources of the surviving wetlands are severely degraded through misuse and overexploitation. The Policy concludes that a clear policy is urgently needed on wetland conservation that will direct efforts toward protecting and wisely using the nation's wetland resource heritage.

The Policy proposes a Protected Wetlands Programme to promote, among other things, an integrated approach to managing resources. The approach involves the management of watersheds and catchment areas and cooperation with nongovernmental organizations (NGOs) to enhance the conservation effort. Implementation requires the preparing individual management plans for each publicly owned wetland that are compatible with the General Wetland Management Plan for Trinidad and Tobago. The policy seeks to ensure that wetlands are protected in perpetuity while their resources are used and enjoyed by the greatest possible number of people. To achieve this, the Policy identifies for preservation outstanding examples of all wetland types in Trinidad and Tobago and includes them in a system of national parks and other protected natural areas. Legislative and institutional reform is needed, however, to rationalize conflicting government policies with respect to wetlands and to identify and empower a lead agency that would implement the policy.

2.2.4 National Policy on Biodiversity

As a party to the Convention on Biological Diversity (CBD), Trinidad and Tobago has prepared a National Biodiversity Strategy and Action Plan (NBSAP). In 2001, the Cabinet passed the NBSAP, which seeks to implement certain aspects of the Convention. Like the Wetlands Policy, the NBSAP calls for establishing and implementing an appropriate legal and institutional framework to protect the country's natural resources. The first National Biodiversity Assessment Report has been completed.

The NBSAP reinforces the Convention's reliance on EIAs in promoting a system of protected areas and in designating ESAs and environmentally sensitive species (ESS). The NBSAP recognizes the need for capacity building, research, conservation, wise use of resources, education, and public awareness. Priority actions identified in the NBSAP related to protected areas and ESAs and ESSs include:

- Developing and updating legislation for conservation of protected areas, landscapes, and species, consistent with current international trends;
- Building on existing law enforcement initiatives for protecting species and ecosystems;

- Conducting regular programs to sensitize the Magistracy, Police, and Coast Guard, to the long-term effects of detrimental activities on biodiversity.

2.3 ENVIRONMENTAL LAWS

Several existing environmental laws are relevant to the Project's construction and operation of the chlor-alkali plant.

2.3.1 Environmental Management Act 2000

The Environmental Management Act, 2000, a critical part of the legislative framework for sustainably managing the natural resources of Trinidad and Tobago, adopts the precautionary principle and the polluter-pays principle. The Act contains the national environmental management policy and principles that apply throughout the Republic to the actions of all organs of State that may significantly affect the environment. Its principles serve, in part, as guidelines by reference to which any organ of State must exercise any function when taking any decision in terms of the Environmental Management Act or any other statutory provision concerning the protection of the environment.

Furthermore, the principles must guide the interpretation, administration, and implementation of the Environmental Management Act and any other law concerned with protecting and managing the environment. These principles are applicable not only to organs of State, but also to entities such as CariSal, albeit indirectly. No direct reference is made to the application of the environmental management principles to private or juristic persons; nevertheless, the Act indirectly applies through the administrative discretion that officials within various organs of State involved in protecting the environment must exercise whenever an application for approval is submitted. By regulating activities that may result in environmental pollution, the Environmental Management Act and several pieces of its subsidiary legislation are directly relevant to the Project.

EIAs are regulated under Part V sections 35 to 38 of the Act. Other important provisions relevant to EIAs are found in Part VIII section 84 (regarding the Environmental Commission); section 38 (regarding the coordination required when an activity constitutes a development requiring permission under the Town and Country Planning Act Ch. 35:01); and section 40 on appeal.

In addition to provisions regarding EIAs, the key provisions that are relevant to the Project are:

- Sec. 25 – allowing the EMA to take emergency response action when it believes a pollutant or hazardous substance will be released or a condition will present a threat to human health or the environment, including the remediation or restoration of degraded sites, containment of wastes, hazardous substances, or environmentally dangerous conditions.
- Sec. 35 – authorising the EMA to designate activities that will require a CEC. The establishment, modification, expansion, decommissioning, or abandonment (including associated works) of a chemical manufacturing plant is such a designated activity.

- Sec. 36 – authorising the EMA to issue a CEC subject to such terms and conditions as it deems appropriate, including the requirement to undertake appropriate mitigation measures;
- Sec. 47 – empowering the EMA, by virtue of subsidiary legislation, to require any person releasing pollutants or handling any hazardous substances to conduct sampling, monitoring, and record keeping;
- Sec. 52 – sanctioning the EMA to require and grant permits for the release of water pollutants subject to terms and conditions as it deems appropriate;
- Sec. 54 – establishing prohibitions against the breach of applicable water pollution standards;
- Secs. 55 – 60 – providing for the management of wastes, with sections 59 and 60 addressing matters specific to the management of hazardous waste; and
- Sec. 61 – allowing the EMA to investigate and designate circumstances where accidents and spills of pollutants or releases of pollutants of hazardous substances present a risk to human health or the environment and which must be reported to the EMA.

CariSal's Emergency Response Plan (ERP) (see Appendix E) covers all activities and operations under the control of its established Emergency Response Organization. This plan describes the steps to be taken and the procedures to be followed in the event of an emergency in the Plant or an emergency outside of the Plant that could impact the safety of the employees, fence-line communities, and the integrity of the Plant assets.

The Environmental Management Act, 2000 also incorporates mechanisms for stakeholders to participate in the development of policies and subsidiary legislation and in the EIA process. Section 28 sets out rules for public participation in developing subsidiary legislation, designating ESAs, or—where the EMA requests an EIA—in considering an application for a CEC. Failure to comply with public consultation requirements is subject to appeal to the Environmental Commission.

Additionally, the Environmental Management Act, 2000 establishes enforcement measures, such as penalties, imprisonment, license revocation, orders for remediation, and administrative civil assessments, whereby the polluter is charged a sum including costs the EMA incurs, costs of damage to the environment, and any profits gained through the breach of the law.

2.3.2 Town and Country Planning Act Chapter 35:01

The Minister responsible for town and country planning has authority to grant permission for carrying out land development. The Town and Country Planning Act delegates this function to the TCPD. Permission for developing any land must be obtained from the TCPD.

This Act provides for the orderly and progressive development of land in urban and rural areas of Trinidad and Tobago. The provisions of the Act are relevant to the Project with regard to obtaining a CEC from the EMA. When a CEC is granted, the management of the EIA process is passed to the EMA. Consistent with section 35 of the Environmental Management Act, where

development requires the express grant of planning permission, the developer should submit the CEC application directly to the TCPD. Furthermore, all government agencies, including the TCPD, are precluded from granting any permit or authorisation for any activity that is the subject of the application until the CEC is granted.

During the process in its coordinating role, the EMA collaborates with the TCPD on the proposed development's appropriateness from a planning perspective. In considering the application, the EMA determines whether the impacts of the proposed Project are significant enough to require the conduct of an EIA. TCPD and other relevant agencies contribute to the preparation of TOR for an EIA. The EMA has determined that significant environmental impacts could arise from the CariSal Project and that the application requires a CEC and an EIA.

The applicant facility would be located on a parcel that is already allocated for industrial uses. The parcel abuts the planned PLSEIE and therefore presents no conflicts with regard to its zoning.

2.3.3 Occupational Safety and Health Act (2006 as amended)

Although not specifically cited in the Terms of Reference, the Occupational Safety and Health (OSH) Act, 2004 (with 2006 Amendments) contains provisions that must be observed in the operation of a chemical manufacturing plant. The OSH Act directs all aspects of health and safety in the workplace and replaces such dated legislation as the Employment of Women (Night Work Act). An employer's responsibilities for its employees are consistent with the policy goals of the NEP and the Environmental Management Act. They are summarised as follows:

- ensuring that plant and work systems are, so far as is reasonably practicable, safe and without risks to health;
- making arrangements for, so far as is reasonably practicable, the safety and absence of risks to health in connection with the use, handling, storage, and transport of equipment, machinery, articles, and substances;
- providing adequate and suitable protective clothing or devices of an approved standard to employees;
- providing such information, instruction, training, and supervision as is necessary to ensure, so far as is reasonably practicable, the safety and health at work of its employees;
- maintaining safe conditions at the work place at all times, including providing adequate amenities and arrangements for their welfare at work;
- providing for the notification of the Chief Inspector and investigation of an accident that causes death or critical injury, an incident that may be prejudicial to the safety or health of the public or that has the potential of causing critical injury, including fire, explosion, or the release of toxic substances.

A major waste stream from the chlor-alkali plant process is the release of chlorine, a highly toxic gas. Strict precautions are therefore necessary to minimize risk to workers. According to World Bank standards, chlorine concentrations should be less than 3 milligrams per normal cubic meter

(mg/Nm^3) for process areas, including chlorine liquefaction. This standard is consistent with United States (U.S.) Occupational Safety and Health Act (OSHA) requirements and the Trinidad and Tobago Draft Air Pollution Rules. The proposed rules also set limits from stack releases to 5 mg/m^3 for chlorine and chlorinated compounds and 10 mg/Nm^3 for hydrochloric acid. The proposed rules also set fugitive source limits of 300 micrograms/m^3 over a 30-minute period.

The OSH Act provides coverage to ensure workers' safety in this regard. CariSal Unlimited's ERP also covers all activities and operations under the control of their emergency response officer. CariSal's plan describes the steps to be taken and the procedures to be followed if an emergency in the plant or an emergency outside of the plant occurs that could impact the safety of the employees, fence-line communities, and the integrity of the plant assets.

On an ongoing basis, CariSal would provide workers with the necessary personal protection gear required for operating in various areas of the site, and using such gear will compulsory. The plant workforce would be trained in the use of protective gear, handling of chemical products and acid storage cells, operation of electric safety equipment, procedures for entering enclosed areas, fire protection and prevention, emergency response, and other safety and emergency care procedures. The goal of CariSal's Environmental Health and Safety Management (EHSM) Plan is to put in place a core base of preparedness for the likely and unexpected contingencies that may arise during construction and operation.

2.3.4 Factories Ordinance

Although the OSH Act, 2006 has been proclaimed, certain parts of the Factories Ordinance still have bearing on the promotion of the health, safety, and welfare of persons employed in factories. This law makes provisions for women and young persons employed in certain occupations as two special groups.

2.3.5 Municipal Corporations Act, 1990

The Municipal Corporations Act, 1990 vets the duty to certify the compliance of structures with the building regulations and to inspect and approve all design drawings for buildings, waste water treatment systems, and onsite waste disposal systems to Regional Corporations. The Project would be located within the jurisdiction of the Couva/Tabaquite/Talparo Regional Corporation. This Corporation is therefore the approving authority for such matters.

2.3.6 Public Health Ordinance Chapter 12. No. 4 (1950 Laws)

This Ordinance contains provisions governing the maintenance of sanitary conditions and waste disposal. The Act needs to be revised and harmonised with the Environmental Management Act to avoid the potential for conflict.

2.3.7 Water and Sewerage Act Chapter 54:40 (1980 Revised)

The main legal instrument of direct relevance to the water resources of Trinidad and Tobago is the Water and Sewerage Act of 1995. This Act regulates the potable water supply and the disposal of sewage. Disposing of sewage other than by a sewer is an offence. This Act defines sewage as including "the waste of animal life other than stable manure, the draining of stable

water and liquid waste discharged from sinks, basins, baths and all other waster which has been used for domestic purposes or in industrial processes, and all waste water."

The Project would use a double compartment septic tank, aerobic treatment unit, and a disinfection unit to treat domestic sewage. The septic system would be constructed as part of the CariSal Project. The capacity of the septic system is in the design phase and is not expected to exceed 330 m^3/day. Septic tanks would be watertight to prevent subsurface leaching of contaminants into groundwater and would be emptied of sludge periodically. The septic system would not include a leach field; all treated liquid would be directed to the Containment Pit. Operation of, responsibilities for, and documentation of emptying to support good practice and surveillance would be conducted in accordance with the EHSM plans.

For its start-up operations the Project would purchase water from WASA or DESALCOTT. The Project would obtain an approval from WASA for this purpose. As an option, the CariSal Project will consider the inclusion of a small reverse osmosis plant to augment DESALCOTT's capacity. The plant would be located on DESALCOTT's property and would not require a new uptake or outfall in exercising this option.

2.3.8 Waterworks and Water Conservation Act Chapter 54:41, (1980 Revised)

In accordance with section 3(1) of this Act, the Minister or competent authority has the power to construct and carry out waterworks for any purpose set out in section 4 of the Act. These purposes include

(b) irrigation, drainage, or reclamation;

(c) the protection of lands against water; or

(e) any other purpose of a similar nature.

Whenever the competent authority considers that the natural flow of water is being or is likely to be diverted, obstructed, or impeded in any way or at any point, the authority may serve on the owner of the land on which the circumstances exist giving such directions as it deems expedient for avoiding the continuance or likelihood of the consequences. The circumstances include construction of a watercourse, drain, or outfall for water. The legislation, though dated (1944), establishes the jurisdiction as regards drainage and irrigation matters in the country.

The Act also makes it an offence for any corporate entity, their agents, or contractors to dump any logs, branches, stone, gravel, or refuse into any existing waterways during construction. These provisions are consistent with the measures established under the Litter Act aimed at preventing waste disposal and thereby provide a double measure of protection to waterways. The offence carries a fine of one thousand dollars.

2.3.9 Water Resources Management Act, 2006

This Act is the most recent enactment governing the management of water resources in Trinidad and Tobago. Significant among its objectives are the conservation of water and the maintenance of sound water quality and quantity. The Act promotes measures to reduce the potential sources

of water pollution caused, *inter alia*, hazardous waste dumps, underground fuel storage tanks, untreated sewage and industrial effluents.

2.3.10 Highways Act, 1970

In accordance with the Highways Act, 1970, any person intending to conduct works involving the breaking up, opening, tunnelling, or boring of any highways must notify the Ministry of Works or the local authority. Section 2(1) defines "highway" to mean:

> "…any road, thoroughfare, street, trail, trace or way maintainable at the public expense and dedicated to public use by way of express or implied grant or by proclamation of the President or by declaration made by the local authority or by the Minister."

During the construction and operational phases of the Project, an increase in traffic may result in congestion if adequate plans are not made to mitigate this occurrence. The Highways Division must grant approvals for vehicular traffic and must be involved in developing and approving an associated traffic plan. The Division must also approve the developments of any highway prior to their construction. For private roads constructed and used during the operational phase, the local authority is responsible for granting in accordance with the Private Streets Code Section 107 of the Highways Act.

The Drainage Division is under the authority of the Ministry of Works and Transportation. The Division must be consulted and their approval sought before drains in the Project area are developed or altered. CariSal would attempt to site the pipeline right-of-way at least 25 feet (7.6 m) from the drainage, if possible. If the pipeline must be constructed closer than 25 feet (7.6 m) to the drainage, best management practices (BMPs), such as use of silt fencing, straw waddles, staging spoils piles away from the drainage, and other BMPs would be implemented to minimize runoff and sedimentation of the drainage. No vehicle staging, cleaning, or fuelling would occur within 100 feet (30.5 m) of the drainage.

There are no naturally occurring major surface water bodies located on the Project site; however, there are minor drainages. Project construction activities could adversely affect the hydrology and surface water quality of an area by changing the drainage pattern of the site or causing soil runoff from the site leading to off-site contamination. The Project would re-route general runoff by straightening a stream at the northern section and further downstream of the proposed site. This action would avoid bottlenecks and flooding during the confluence of high tide and rainy season when the ground is already saturated. This activity would be undertaken in collaboration with the Drainage Division.

2.3.11 Oil Pollution of Territorial Waters Act Chapter 37:03

This Act renders the owner or operator of a vessel operating within the territorial waters of Trinidad and Tobago liable in the event of the discharge of oil into these waters, including operational discharges. A conviction carries a fine of ten thousand dollars and imprisonment. Though not of direct application to the proponent's activities, the provisions of this Act set the

level of diligence that CariSal is required to exercise in the selection of a vessel to conduct these operations.

2.3.12 Litter Act Chapter 30:52, 1990

Section 2 of the Litter Act defines "litter" to include any solid or liquid material or product, sand, gravel, stone, aggregate, dirt, or any other refuse from industrial or commercial activities. In accordance with section 3(1): *it is an offence punishable upon summary conviction for any person to deposit any solid or liquid material or product in any public place other than in a receptacle placed for the purpose of collecting it. Section 6 of the Act sets out a separate fine for a corporate body found guilty of the offence. The fine is two thousand dollars. The project will arrange for a qualified industrial waste services contractor to periodically collect and properly dispose at an approved site, of all solid or liquid waste materials including construction materials from the construction of on-site infrastructure, limestone inerts, and brine muds from operations.*

2.3.13 (Draft) Shipping Pollution Bill

This provision of this Bill seeks to implement, *inter alia*, the provisions of the MARPOL Convention on the prevention of pollution from the normal operational discharges of ships including garbage (Annex V). The Project would involve continuous transport of both raw materials and product. Limestone would be shipped into and finished product exported from the Savonetta Pier #4. The Project also intends to export industrial water. Notwithstanding the personal liability of any vessel owner which CariSal may engage in these operations, CariSal would be duly diligent in ensuring the integrity of any vessel that is used.

2.4 SUBSIDIARY LEGISLATION

Several pieces of subsidiary legislation are relevant to the Project and have been enacted under the Environmental Management Act, 2005. For this discussion, they are grouped under three headings according to their principal focus and are presented below.

1. CEC Application Process
   - Certificate of Environmental Clearance Rules 2001;
   - Certificate of Environmental Clearance (Fees and Charges) Regulations, 2001 (LN 91 of 2001); and
   - Certificate of Environmental Clearance (Designated Activities) Order, 2001 (LN 103 of 2001).

2. Pollution Control
   - Noise Pollution Control Rules, 2001;
   - Water Pollution Rules, 2001 (with Amendments in 2006); and
   - The Water Pollution (Fees) Regulations, 2001 as amended by the Water Pollution (Fees) (Amendment) Regulations, 2006.

3. Conservation
   - Environmentally Sensitive Areas Rules, 2001;
   - Environmentally Sensitive Species Rules, 2001; and
   - Draft Air Pollution Rules, 2005 and Waste Management (Solid Waste) (Collection and Disposal) Rules, 2000 (both of which have been prepared).

2.4.1 Certificate of Environmental Clearance Rules, 2001

These rules, made pursuant to section 26(h) of the Environmental Management Act, delegate the management of the EIA process in Trinidad and Tobago to the EMA and established the regulatory scheme for project activities that are likely to cause pollution to the environment of Trinidad and Tobago.

The categories of activities for which a CEC from the EMA is required are listed under the Certificate of Environmental Clearance (Designated Activities) Order, 2001. The activities proposed for the CariSal chlor-alkali plant, as a chemical manufacturing plant (and associated infrastructure), fall within this designation and thereby require CariSal to apply for and obtain a CEC. The Project includes construction, operation, and decommissioning of a chemical plant.

An application for a CEC contains information that would enable the EMA to determine the environmental impact of the proposed activity and to establish a management framework for these impacts. The management framework includes mitigation measures, emergency response procedures, and monitoring programmes. In this regard, the applicant is required to provide information on the following:

- the purpose and objectives of the activity;
- a description of the site and the areas the proposed activity is likely to affect;
- the size and scale of the activity, including capacity, throughput, land space and covered areas;
- a description of the activity explaining the
  - types of processes and equipment or machinery to be involved;
  - types, quantities, and sources of input materials;
  - quantities and destinations of any byproducts, including any waste;
  - modes of transportation that will be used to carry out the proposed activity and the potential effects of such transportation;
  - volume of intermediate and final products; and
  - frequency or rate of extraction with respect to the use of natural resources;
- the expected duration of the activity; and
- the proposed schedule of actions from preparatory work to start-up and operation.

Maps, plans, diagrams, photographs, charts, and other illustrative or graphic material, as appropriate, to facilitating understanding of the information presented and the nature of the site are also required.

CariSal submitted its application for a CEC to the EMA on December 22, 2006. The application was made in accordance with the CEC Rules, 2001 and with CEC (Designated Activities) Order, 2001. The Order determines that a CEC is necessary for establishing, modifying, expanding, decommissioning, or abandoning (including associated works) a chemical manufacturing plant. Upon submission, the EMA determined that significant environmental impacts could arise from the Project and that the application required a CEC and an EIA in compliance with the TOR.

The EMA prepared and submitted a Draft TOR for the EIA to CariSal on 5 July 2007 in response to which CariSal submitted comments by letter dated 31 July 2007. The response reiterated CariSal's view that an EIA was not necessary, citing that the Project represents one of the first, if not the first, modern example of the application of clean production in Trinidad and Tobago. The EMA held firm on the matter, however, and CariSal reassured its commitment to cooperate with the EMA.

In furtherance of the application and due to high public interest, Community Public Engagement Meetings were held on July 21, July 24. Three additional focus group meetings were conducted—two for community residents, held on November 3 and 7, 2007, and one for industrial neighbours, held on December 11, 2007. As required by the Final Project TOR, two Public Consultations were carried out on August 4, 2007 and January 7, 2008.

The granting of the CEC to CariSal Unlimited will signify the EMA's approval of the Project in terms of an assessment of its environmental impact, including mitigation measures in the event of emergencies and other unforeseeable events and monitoring plans to ensure compliance with all measures.

The related Certificate of Environmental Clearance (Fees and Charges) Regulations, 2001 (LN 91 of 2001) sets out the fee structure for applying for and processing CECs.

2.4.2 Noise Pollution Control Rules, 2001

The Environmental Management Act, 2000 at section 52(1) makes it an offence to emit or cause to be emitted any noise greater in volume or intensity than prescribed by the Authority in relevant rules or by any standards, conditions, or requirements under this Act. In furtherance of this enabling provision, the Noise Pollution Control Rules were established. These rules rely on a zoning mechanism to establish permissible sound limits. The Noise Zones are:

- Zone I – Industrial Areas,
- Zone II – Environmentally Sensitive Areas, and
- Zone III – The General Area.

Section 2 of the Noise Pollution Rules 2001, defines:

- Industrial Areas as "areas expressly approved for industry by a competent governmental entity."
- ESAs as a portion of the environment so designated under section 41 of the Environmental Management Act, 2000.

- General Areas as "all of Trinidad and Tobago except ESAs and industrial areas."

The proposed development falls under Zone I as it would be located within an industrial area. The First Schedule of the Noise Pollution Rules, 2001 prescribes the standards that should be maintained in industrial areas as follows:

"Anytime – The sound pressure level shall not exceed the following:

a. equivalent continuous sound pressure level of 75 dBA;

b. instantaneous unweighted peak sound pressure level of 130 dB (peak)."

The Noise Pollution Control Rules makes it an offence for any person to emit or cause to be emitted any sound that causes the sound pressure level, when measured as the equivalent continuous sound pressure level, to exceed 80 dBA during the day and 65 dBA at night. Section 7 establishes an exemption to the prescribed standard in the case of construction activity on a construction site between the hours of 7:00 a.m. and 7:00 p.m. of the same day.

2.4.3 Water Pollution Rules, 2001 (with Amendments 2006)

According to these rules, a person who intends to release from a registrable facility a water pollutant that is likely to cause harm to human health or the environment is required to submit a source application for any of the pollutants defined by Schedule 1 of the Rules to the Authority 45 days before such release. These pollutants include:

- Total suspended solids (TSS)
- Total oil and grease or n-hexane extractable material
- Ammoniacal nitrogen
- Total phosphorous (as P)
- Sulphide (as H_2S)
- Chloride (as Cl^-)
- Total residual chlorine (as Cl_2)
- Dissolved hexavalent chromium (CR^{6+})
- Total chromium (Cr)
- Dissolved iron (Fe)
- Total petroleum hydrocarbons
- Total nickel (Ni)
- Total copper (Cu)
- Total zinc (Zn)
- Total arsenic (As)
- Total cadmium (Cd)
- Total mercury (Hg)

- Total lead (Pb)
- Total cyanide (as CN^-)
- Phenolic compounds (as phenol)
- Radioactivity
- Toxicity
- Faecal coliforms
- Solid waste

Where the EMA determines a finding that the applicant is discharging a water pollutant, it issues a 3-year duration Registration Certificate to the applicant. The CariSal plant is designed to collect and use all rainwater that comes into contact with process areas to achieve a manufacturing facility with zero liquid waste; it also proposes that no wastewater be discharged from the plant during its operational phase making the need to apply for a wastewater discharge permit unlikely. The EMA does retain the power to require a person discharging a water pollutant in excess of the maximum permissible level, as cited in Second Schedule of the Rules, to apply for a permit. The permit, when granted, may contain conditions.

The rules identify parameters and substances at specific quantities, conditions, or concentrations that would be deemed to be water pollutants for island surface water, coastal nearshore, marine offshore, ESAs, and groundwater.

Table 2.4-1 lists the applicable parameters and the maximum permissible limits for discharge of water pollutants into inland surface waters.

Table 2.4-1. Maximum Permissible Limits For Discharge Into Inland Surface Waters

Parameter Unit	Maximum Permissible Limit
Temperature	35 °C
pH	6 to 9[a]
Biological Oxygen Demand	30 mg/L
Total Suspended Solids	50 mg/L
Total Phosphorus	5 mg/L

[a] Consistent with pH level recommended for chlor-alkali plants by World Bank in Industrial Pollution Prevention and Abatement Handbook, 1998

Source: Trinidad and Tobago Bureau of Standards TTS 547:1998

The EMA may vary the permit on its own initiative or an applicant may apply for a variance. The EMA must establish and maintain a register of water pollutants.

2.4.4 Environmentally Sensitive Areas Rules, 2001

The EMA, in accordance with ESA Rules sets out by Notice a framework for establishing "environmentally sensitive areas." Rule 3 establishes the standards and guidelines for designating an ESA. This includes any portion of the environment, including:

- the actual or prospective habitat of any ESSs;
- any required to be protected for the purpose of meeting the Government's international obligations under any of the International Conventions referred to in Schedule I;
- an area to which any of the Guidelines set out in Schedule II applies; and
- an area that is referred to in a written law set out in Schedule III.

Rule 5 establishes the procedure for rescission or redesignation of an ESA.

The EMA has designated the Matura National Park and the Nariva Swamp as ESAs. The Project will be constructed on an 11.8-ha lot located to the east of Southern Main Road and north of North Sea Drive within the PLSEIE and not within the environs of the designated sites.

2.4.5 Environmentally Sensitive Species Rules, 2001

The ESS Rules, 2001 were made in accordance with section 26(e) and in compliance with section 41 of the Environmental Management Act, 2000. The ESS Rules provide for the designation and regulation of species of flora and fauna within the jurisdiction of Trinidad and Tobago. Because of their unique ecological value and their endangered or protected species, Trinidad and Tobago require conservation or protection. In keeping with the NEP, the Government is committed to establishing a system of protection for ESSs. EMA has drafted a list of ESSs that includes endangered, vulnerable, and rare species of mammals, birds, reptiles, fishes, amphibians, and plants.

Schedule I lists the International Conventions to which Trinidad and Tobago is a contracting party. Schedule II contains Guidelines for Environmentally Sensitive Species. Including the species on this schedule is intended to ensure that one or more of the following general objectives are met:

- Conservation of natural resources;
- Sustainable economic and human development; and
- Logistic support, for example, environmental education and information sharing.

Schedule III lists several other written laws in which specific animals or plants are considered "environmentally sensitive." As an enforcement measure, the ESS Rules prohibit the destruction, picking, uprooting, and collecting of sensitive plants and the hunting or trade of sensitive animal species.

2.4.6 Draft Air Pollution Rules, 2005

Under the Environmental Management Act, 2000, the EMA issued Draft Air Pollution Rules, 2005. The rules define an air pollutant as any substance mentioned in the Second Schedule of the Rules that is at or exceeds the maximum permissible levels prescribed therein. Air pollutants from chimneys are distinguished from fugitive releases. The Draft Air Pollution Rules have been issued for public comment, but have not yet been promulgated.

Typically, for older chlor-alkali plants, a major waste stream would be from chlorine, a highly toxic gas that can be released through vents and seals and during transfer operations. In its design, the Project would limit concentrations to well below the standards included in the Draft Air Pollution Rules. The State of California's Office of Environmental Health Effects, which applies a standard far more stringent than federal IRIS numbers for HCl, has specified a reference concentration level (Rfc) of 9 micrograms per cubic meter ($\mu g/m^3$). This value represents an annual average concentration level at which exposure causes no adverse health effects. Screening modelling showed that the nearest resident population was exposed to a maximum annual average concentration of 0.032 $\mu g/m^3$.

2.4.7 Draft Waste Management (Solid Waste) (Collection and Disposal) Rules, 2000

These Rules are in the preliminary drafting stage. The current draft contains provisions to cover all aspects pertaining to managing and controlling discharges of solid non-hazardous wastes and liquid and solid hazardous wastes. The Rules provide for waste collection, landfill operation and closure, solid waste importation and exportation, special arrangements for particular types of waste, existing dump site detection and clean up, and contaminated land development. Under the Rules, the following are offences:

- Collecting of solid waste without a waste collection permit;
- Disposing of waste without solid waste license;
- Handling of solid waste in a manner that may cause pollution of the environment or harm to human health.

Open burning of solid waste, the importation and exportation of waste, and the disposal of certain solid waste at sea without EMA approval are also prohibited under the Rules. Construction debris would be disposed of in approved, contained areas to prevent water quality impacts from contaminated runoff and in compliance with the Draft Rules.

2.5 INDUSTRIAL STANDARDS AND GUIDELINES

2.5.1 Trinidad and Tobago Standard 547:1998 (Specification for the Effluent from Industrial Processes Discharged into the Environment), 1998

The Trinidad and Tobago Standard (TSS) 547:1998 was promulgated as a voluntary standard by the Trinidad and Tobago Bureau of Standards. The standard lists various receiving environments and permissible concentrations of specific contaminants from various sources. The standard also lists the maximum permissible limits of effluent discharge from industrial process point sources into inland surface waters.

2.5.2 Trinidad and Tobago Standard 417: 1993 (Specification for Liquid Effluent from Domestic Wastewater Treatment Plants into the Environment)

A septic system, constructed as part of the CariSal Project, would be used to treat domestic sewage. The septic system, with a capacity of up to 330 m^3/day, would include a double compartment septic tank, an aerobic treatment unit, and a disinfection unit. Septic tanks would

be watertight to prevent subsurface leaching of contaminants into groundwater and would be emptied periodically to control the final sludge. The septic system would not include a leach field; all treated liquid would be directed to the Containment Pit. Operations, responsibilities, and documentation of emptying to support good practice and surveillance would be defined through the EHSM plans and would meet the TTS 417: 1993 standard as specified.

2.5.3 Trinidad and Tobago Standard 570:2002 (Specification for the Identification of the Contents of Pipelines, Piping, Ducts and Conduits)

This standard establishes the minimum requirements for the assurance of uniform, safe, and correct identification of pipelines, piping, ducts, and conduits. A 0.10- to 0.15-meter (4- to 6-inch) natural gas pipeline would be constructed near the site to the process utility area of the project. Power lines (transmission voltage) would also be tapped off of the existing corridor to a local sub-station and from the sub-station to the various plant buildings to supply power. CariSal would also construct a pipeline from the onsite caustic soda storage tanks to the EISL site. The pipeline would be 6 inches (.15 m) in diameter and composed of carbon steel. The pipeline would be placed aboveground on sleepers, where appropriate, or buried 4 feet (1.2 m) underground with appropriate design standards based on a geotechnical investigation and international standards. Two other high density polyethylene (HDPE) pipes measuring 0.20 meters (8 inches) would be constructed from the DESALCOTT site in Point Lisas to the CariSal plant. The project would ensure compliance with the requirements of this standard in the construction of all pipelines. A minimum way leave of 6.4 meters would be maintained on either side of a pipeline to allow easy access to the pipeline for inspection and testing purposes, which applies to the property boundary of the end purchaser.

2.5.4 Trinidad and Tobago Standard 558:2001 Specifications for Motor Vehicles – Exhaust Emissions

This standard has been established as a voluntary one by the Trinidad and Tobago Bureau of Standards. It sets out the technical criteria for assessing exhaust emissions from motor vehicles. CariSal would ensure that the exhaust emissions from motor vehicles involved during the development of plant infrastructure are consistent with the permissible limits of the key pollutants based on vehicle type and class in accordance with these specifications.

2.5.5 Guidelines for Handling and Storage of Petroleum Products and Combustible Liquids

These Guidelines have been published by the Ministry of Energy and Energy Industries. Section 1.0 of the guidelines provides specifications for tanks that hold petroleum products and combustible liquids. The tanks together with all pumps, pipes, and fittings should be designed, constructed, and maintained to prevent any leakage of petroleum spirit. Given the planned plant design and given their inherent characteristics, many of the chemicals used by the CariSal facility will entail a relatively low risk of fire (combustion) or explosion. The fuel stored on site includes fuel in tanks of equipment such as trucks, excavators and the backup diesel generator tank (412 gallons or 1,559.59 litres capacity) for the plant's Emergency Power System. The backup generator stores an amount that is above the storage allowed without approval (450 litres or 100 gallons). The technical specifications and capacity of the Emergency Power System was

established subsequent to the submission of the EIA report as part of the CariSal Project refinement process. CariSal will submit an application for approval to the Ministry of Energy and Energy Industries and will include a Fire Service Report from the Fire Prevention Department of the Trinidad and Tobago Fire Service. The information presented here, therefore augments that presented in Chapter 2 of the EIA report. The storage tank will comply with all safety guidance measures required by the Ministry of Energy and Energy Industries and applicable guidelines from Responsible Care®. The storage of this amount of fuel was evaluated by CariSal's environmental review team with the result that it is not expected to pose a significant environmental or safety risk if such guidelines are followed. Any spills would be contained by the containment system required for storage approval so as not to pose a risk to water, soils, or nearby areas. The air quality analysis provided in the EIA report anticipated and considered pollutants that might be emitted by a backup generator or Emergency Power System. The amount stored would not create a significant off-site risk if an accident were to occur. CariSal will ensure that the tank has incompatible fittings with containers for other chemicals delivered to CariSal and stored on site.

2.6 MULTILATERAL AND REGIONAL ENVIRONMENTAL AGREEMENTS

The principles and philosophy of sound environmental management can be found in some 132 multilateral and regional environmental agreements. Such agreements embody the collective will of the international community to legally protect the environment. They are the key instruments available under international law for countries to work together on global environmental issues.

The range of functions and powers that are vested in the EMA make it the natural focal point for implementing these agreements. The vesting of this duty – to act as the focal point for multilateral and regional environmental agreements – appears, however, to impinge on the role of the EMA.

The enactment of national implementing legislation is required to give the force of law to environmental treaty obligations to which Trinidad and Tobago is party. The lack of such legislation was the basis of the decision rendered, for example, by the Environmental Commission against the EMA in the case of Talisman (Trinidad) Petroleum Ltd. v. The Environmental Management Authority, EA3/2003. In that case, the EMA had relied in part on the Ramsar Convention in refusing to grant a CEC to the applicant. Central to the decision of the Environmental Commission (against the EMA) was the absence of domestic legislation implementing the international Convention.

Of the large number of multilateral and regional agreements, four multilateral agreements and one legally binding regional agreement (described in the next four subsections) bear relevance to the Project.

2.6.1 Montreal Protocol on Substances that Deplete the Ozone Layer 1987

The Montreal Protocol sets targets for reducing the production and consumption of ozone-depleting substances. Parties to the Protocol committed to reducing chlorofluorocarbon (CFC)

use to 50 percent of 1986 levels by 1998 and to freeze halon consumption at 1986 levels by 1992.

Trinidad and Tobago's obligations under the Montreal Protocol are implemented through a Country Programme. The EMA manages the ozone layer protection policy in cooperation with other relevant government departments.

2.6.2 United Nations Framework Convention on Climate Change of 1992 and its Kyoto Protocol

The United Nations Framework Convention on Climate Change (UNFCCC) sets an overall framework for intergovernmental efforts to tackle the challenge climate change poses. The Convention recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. With human activity driving global warming, extreme weather events, and climate fluctuations to levels not experienced in recorded history, the Convention encourages countries to take decisive action to tackle the climate change threat. As a primary objective, the UNFCCC seeks to achieve stabilisation of greenhouse gas concentrations in the atmosphere at level that would prevent anthropogenic interference with the climate system.

UNFCCC commitments made by Trinidad and Tobago along with other parties include:

- adopting national policies to mitigate climate change by limiting anthropogenic emissions of greenhouse gases and protecting and enhancing greenhouse gas sinks and reservoirs;
- considering climate change issues in relevant social, economic, and environmental policies and actions; and
- promoting public awareness of, and education about, climate change issues.

The 1997 Kyoto Protocol is a follow-up international accord designed to set limits on global greenhouse gas emissions. The protocol furthers the Convention's objectives, principles, and institutions by providing an indicative list of mechanisms that might help mitigate climate change and promote sustainable development. These mechanisms include international emissions trading, the clean development mechanism, and joint implementation. The Protocol entered into force for Trinidad and Tobago in January 2005. Trinidad and Tobago's NEP integrates international concerns over climate by proposing to develop new and renewable energy sources where feasible (e.g., solar and wind) to decrease dependence on fossil fuels and so avoid the pollution generated by burning them.

Trinidad and Tobago's NEP integrates international concerns over climate by proposing to develop new and renewable energy sources where feasible (e.g., solar, wind) to decrease dependence on fossil fuels and so avoid the pollution generated by burning them. Cutting fossil fuel use while maintaining economic growth, however, will be a major challenge.

Carbon dioxide is a greenhouse gas, as are nitrogen oxides. Trinidad and Tobago is signatory to several international conventions and protocols (including the 1994 Kyoto Protocol) committed

to reducing manmade emissions of greenhouse gases. The implementation of the Convention's obligations by parties requires national action such as that envisaged in Trinidad and Tobago's Draft Air Pollution Rules of 2005.

2.6.3 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention), 1989

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) is the most comprehensive global environmental agreement on hazardous and other wastes. A central goal of the Basel Convention is "environmentally sound management," which aims to protect human health and the environment against adverse effects resulting from the generation, management, transboundary movement, and disposal of hazardous and other wastes.

A Compliance Committee, established on behalf of Trinidad and Tobago and on which the country served as its Vice-Chair, was established to administer the agreement. A party may make submissions to the Committee about its own or another party's compliance or implementation difficulties. The Secretariat may also make a submission when it becomes aware, through national reporting, that a party may be experiencing difficulties.

Because hazardous wastes pose such a threat to human health and the environment, adopting the waste minimisation strategies as a precautionary measure is central to the Convention. In accordance with the Convention**,** therefore**,** Trinidad and Tobago is obligated to put measures in place at the national level to minimise their production. The enactment of the Draft Solid and Hazardous Waste Management Rules and the enforcement of the TTS 547:1998 (Specification for the Effluent from Industrial Processes Discharged into the Environment) and the TTS 417:1993 (Specification for Liquid Effluent from Domestic Wastewater Treatment Plants into the Environment) standards support the country's international commitments under the Basel Convention.

2.6.4 Protocol Concerning Pollution from Land Based Sources and Activities

The Land Based Sources and Activities **(**LBSA) Protocol was established under its parent Convention for the Protection and Development of the Marine Environment for the Wider Caribbean Region, Cartagena, Colombia 1983 (commonly known as the Cartagena Convention). The LBSA Protocol is a regional mechanism assisting the United Nations Member States in the Wider Caribbean Region to meet the goals and obligations of two international agreements: the United Nations Convention on the Law of the Sea (UNCLOS) and the Global Plan of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities. The Protocol is the most significant of its kind, with the inclusion of regional effluent limitations for domestic wastewater (sewage) and requiring specific plans to address agricultural non-point sources. The LBSA Protocol, among other things, sets the stage for developing strategies to address sources of pollution; establishes priority source categories, activities, and contaminants of concern in the Wider Caribbean Region, and set timetables for achieving the limits and measures agreed to by participating parties.

The Protocol requires parties to:

- take appropriate measures to prevent or control pollution from land-based sources and activities using the best practicable means at their disposal and in accordance with their capabilities; and
- develop and implement appropriate plans, programmes, and measures for preventing, reducing or controlling pollution from land-based sources and activities on the their territories, including using the most appropriate technology and management approaches such as integrated coastal area management.

The implementation of this Protocol will result in significant improvements to the pollution control practices currently used in Trinidad and Tobago.

2.6.5 The Protocol Concerning Specially Protected Areas and Wildlife, 1990

Trinidad and Tobago is a contracting party to the Protocol for Specially Protected Areas and Wildlife (SPAW Protocol) under the Cartagena Convention. This protocol is internationally recognised as the most comprehensive treaty of its kind. The SPAW Protocol preceded other international environmental agreements in adopting an ecosystem approach to conservation. The SPAW Protocol acts as a vehicle to assist with regional implementation of the broader and more demanding global CBD.

The objective of the SPAW Protocol is to protect rare and fragile ecosystems and habitats, thereby protecting the endangered and threatened species that inhabit them. The Caribbean Regional Co-ordinating Unit pursues this objective by assisting with the establishment and proper management of protected areas, by promoting sustainable management (and use) of species to prevent their endangerment, and by assisting governments of the region in conserving their coastal ecosystems.

Rule 3 (b) covers, among other things:

(i) The Convention for the Protection of Development of Marine Environment of the Wider Caribbean Region, which entered into force in Trinidad and Tobago on October 11, 1986 (the Cartagena Convention).

(ii) The Protocol concerning SPAW to the Convention for the Protection and Development of the Marine Environment of the Water Caribbean Region, which entered into force in Trinidad and Tobago on January 18, 1990 (the SPAW Protocol).

(iii) The Convention on Wetlands (the Ramsar Convention), Iran 1971, which entered into force in Trinidad and Tobago on April 21, 1993.

(vi) Any other international legal convention relating to the environment to which Trinidad and Tobago is a party.

2.6.6 Convention on Biological Diversity, 1992

The 1992 CBD, came into force for Trinidad and Tobago in 1996. It aims to:

- conserve biological diversity for its intrinsic value,

- provide for the sustainable use of its components, and
- provide for the fair and equitable sharing of the benefits arising from the use of genetic resources.

The Biodiversity Treaty was one of two major treaties opened for signature at the United Nations Conference on Environment and Development (UNCED) in 1992. The treaty defines biodiversity as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." Parties to the Biodiversity Treaty "affirm sovereign rights over the biological resources found within their countries, while accepting responsibility for conserving biological diversity and using biological resources in a sustainable manner," according to an International Union for the Conservation of Nature (IUCN) assessment of the treaty.

In contrast to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Biodiversity Treaty sets goals rather than obligations or targets. CITES sets forth obligations that member countries must meet. For example, members must introduce a permit system for trade in certain species of wildlife, and they are allowed to export or import certain species under certain conditions. The commitments are precise and measurable. The Biodiversity Convention provides guidance on the policies necessary to achieve these goals.

The emphasis of the Biodiversity Convention is almost entirely on action at the national level. In the negotiations that produced the Convention, governments of developing countries were adamant about not wanting the structure of other conservation agreements, such as agreed lists of protected sites, or key species and habitats to be conserved. The Convention allows governments to decide how they might implement its provisions, and thus it is serves simply as a framework.

2.6.7 Convention for the Protection of Wetlands of International Importance Especially as a Waterfowl Habitat (Ramsar Convention), 1971

The International Union for the Conservation of Nature and Natural Resources initiated the 1971 Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention). Its purpose was to halt wetlands loss worldwide. The Convention promotes the conservation and use of wetlands, so they continue to operate as functioning ecosystems.

2.6.8 International Convention on the Prevention of Pollution from Ships, 1973 and Its Related Protocol of 1978 (MARPOL 73/78)

The main objective of the MARPOL Convention is to reduce to a minimum and in certain instances prohibit the operational discharge of marine pollutants from ships through the establishment of operational discharge criteria and procedures and construction and equipment standards. It is the keystone international instrument on marine environment protection. Although Trinidad and Tobago is a party to the Convention, the country has not enacted national implementing legislation to give full effect to the provisions of the Convention. Nonetheless, the Convention is of persuasive authority on matters pertaining to the pollution of Trinidad and Tobago's waters. Ships that fly the flag of Trinidad and Tobago and use its ports and coastal waters should be mindful of the requirements of the MARPOL 73/78 Convention.

2.7 INSTITUTIONS

The CariSal Project would be governed by the following key regulatory bodies:

- Ministry of Pubic Utilities and the Environment;
- Environmental Management Authority;
- Town and Country Planning Division, Ministry of Planning and Development;
- Ministry of Energy and Energy Industries;
- Couva/Tabaquite/Talparo Regional Corporation;
- Ministry of Labour and Small and Micro Enterprise Development (Occupational Health and Safety Unit);
- Ministry of Works and Transport (Drainage Division);
- WASA;
- Water Resources Agency (WRA); and
- Trinidad and Tobago Civil Aviation Authority.

2.7.1 Ministry of Planning, Housing, and the Environment

This Ministry provides the governance structure for several entities that include the:

- EMA,
- Forestry, National Parks and Wildlife,
- WASA,
- Water Resources Management Unit, and
- Solid Waste Management Company Limited (SWMCOL).

It serves an ongoing policy-making role for these agencies.

2.7.2 Environmental Management Authority

The EMA was established by the Environmental Management Act (Act No. 3 of 2000). It performs several functions, of which the most relevant to this Project are:

- developing and implementing policies and programmes for the effective management and wise use of the environment;
- coordinating environmental management functions;
- developing and establishing national environmental standards and criteria, and monitoring compliance with them;
- taking appropriate action for preventing and controlling pollution and for conserving the environment;
- achieving economic growth in accordance with sound environmental practices;
- implementing international obligations; and

- enhancing the legal, regulatory, and institutional framework for environmental management.

EMA coordinates the work of the various agencies and has enacted several pieces of subsidiary legislation.

2.7.3 Environmental Commission

The Environmental Commission is a key institution, established by section 81 of the Environmental Management Act. A specialist superior court of record to adjudicate over certain classes of legal actions under the Act, its responsibilities include ensuring compliance with environmental requirements. The Commission, under section 81(5), is vested with jurisdiction to hear appeals of decisions the EMA makes under section 36 of the Act to refuse to issue a CEC or to grant such certificates with conditions or orders for closure of facilities under section 68.

2.7.4 Town and Country Planning Division, Ministry of Planning and Development

Apart from the EMA itself, the TCPD is the most significant entity with respect to environmental planning. TCPD is the agency responsible for granting permission to develop land in Trinidad and Tobago. It discharges this responsibility in two stages: (1) outline planning and (2) granting of planning permission.

The outline planning stage focuses on ensuring that a proposed project is compatible with the land use objectives in the area for which it is planned. A grant of outline planning permission may be issued with conditions that must be satisfied before a grant of full planning permission may be obtained.

The second stage – final planning – requires the input of important project details sufficient to ensure its compatibility with all aspects of national development objectives, including environmental management objectives. Final planning permission is the legal requirement before development can begin.

TCPD planning function is also significant for two aspects of the CariSal Project:

1. As part of the CEC process established in accordance with section 35(1) of the Environmental Management Act. Under this provision where an activity requiring the issue of a CEC from the EMA also constitutes a development that requires express permission under the Town and Country Planning Act, the application for the CEC must be submitted through the entity responsible for town and country planning.

2. As part of the EIA process. In this case, the Division provides guidance to applicants or agencies, including the EMA.

2.7.5 The Ministry of Local Government/Couva/Tabaquite/Talparo Regional Corporation

The Municipal Corporations Act, 1990 vested the duty to local government bodies to:

- grant certification of structures, new or modified; and
- inspect and approve all design drawings for buildings, water reticulation systems, waste water treatment systems, and onsite solid waste disposal facilities.

The Project will undertake construction activities for which final building approval from the Couva/Tabaquite/Talparo Regional Corporation of the Ministry of Local Government must be obtained before any activity begins. In accordance with section 35(2) of the Environmental Management Act, the Corporation is prohibited from issuing this approval unless a CEC is obtained.

2.7.6 Ministry of Energy and Energy Industries

As part of its duty to coordinate the activities with other governmental entities and in the interest of integrated decision-making, the EMA consults the MEEI on matters pertaining to the preparation and review of EIAs.

2.7.7 Ministry of Labour and Small and Micro Enterprise Development (Occupational Health and Safety Unit)

This Ministry administers the OHS Act to ensure the safety of workers and the workplace. This Act is relevant to CariSal Unlimited's Emergency Response and Health and Safety Plan.

2.7.8 Ministry of Works and Transport (Traffic Management Branch, Highways and Drainage Divisions)

The focus of this Ministry relative to the Project and throughout Trinidad and Tobago is ensuring the establishment of proper drainage infrastructure and the prevention of flooding. The drainage plan would be developed in collaboration with the Ministry of Works Drainage Division. It is understood that the Ministry of Works intends to upgrade the existing water-course and final drainage plans would be developed with this in mind.

2.7.9 Water and Sewerage Authority

WASA is responsible for ensuring that the country's water resources are protected, used, developed, conserved, managed, and controlled, in a way that takes into account, among other things, the reduction and prevention of degradation, of water resources.

2.7.10 Water Resources Agency

Based on recommendations obtained from a World Bank-financed study, the WRA was established as a new independent agency. The WRA is a division of WASA in charge of managing, planning, and regulating the multi-sector use of water throughout the country, including the development of sewerage and wastewater treatment facilities. The WRA also deals with the collection, hydrological data processing, and water withdrawal licenses and concessions

for any use of water. In the context of its responsibilities toward water conservation, ensuring water quality and stormwater/drainage, the Project would collaborate with the WRA, WASA, and the Drainage Division to establish an integrated approach to water resources management issues that the Project encounters.

2.7.11 Trinidad and Tobago Civil Aviation Authority

Section 4 of the Civil Aviation Act, 2001 established the Trinidad and Tobago Civil Aviation Authority (CAA). Among the CAA's functions is maintaining an appropriate standard of safety and efficiency in the civil aviation system and regulating the civil aviation operations in Trinidad and Tobago.

As part of its authority, the CAA must ensure, to the extent practicable, that the environment is protected from any detrimental effects associated with the operation and use of aerodrome and aircraft. For this purpose, the CAA must observe the provisions of the Environmental Management Act, 2000 and any other written law.

As an example of the CAA's role in the CariSal Project, it would ensure that the release of chlorine and the cooling tower system do not pose any detrimental effects to safe aviation.

2.7.12 Ministry of Works and Transport, Maritime Division

The Maritime Division administers the government of Trinidad and Tobago's interest in shipping, safety, general and maritime, and port development matters. The Division also implements and monitors the state's obligation to maritime conventions and instruments such as the MARPOL 73/78 Convention, which focuses on the prevention of pollution from ships. The Project would engage shipping services for the transport of raw materials and product. CariSal would collaborate with the Ministry in the selection of an appropriate vessel that engages in sound environmental practice to conduct these operations.

2.8 CARISAL UNLIMITED HEALTH AND SAFETY POLICY

2.8.1 Management Plan to Mitigate Negative Impacts

CariSal is a member of the Chlorine Institute (see Appendix E) and has signed a commitment to comply with the charter and requirements of this organization. The standards and requirements of the Chorine Institute are more stringent than any published governmental standard. CariSal's Emergency Response and Health and Safety plans would be consistent with Chlorine Institute guidelines. CariSal is also a subscriber to Responsible Care.

2.9 SUMMARY OF APPROVALS REQUIRED

The following potential environmental legal obligations requiring permits, licenses, approvals, applications for exemptions, or other legal authorisations may arise by virtue of the nature and scope of this Project. Table 2.9-1 provides a list of approvals that may be required for the Project.

Table 2.9-1. List of Approvals Required for the Project

Approval Type	Approving Agency	Comment
Certificate of Environmental Clearance (CEC)	Environmental Management Authority	Would include the conduct of an EIA
Outline Planning Permission and Planning Permission Subdivision Permission	Town and Country Planning Division	Planning permission is subject to the granting of a CEC
Road permits	Traffic Management Branch/ Ministry of Works and Transport Highways Division	For routing of traffic For the transport of heavy equipment, building material and workers
Drainage Approval	Ministry of Works-Drainage Division, WASA, and Water Resources Agency (WRA)	Drainage plan Sediment and stormwater pollution prevention plan Permanent and temporary drains To straighten stream in northern and southern section of proposed site
Building Design and Plant Structures	Director of Civil Aviation Occupational Safety and Health Unit Ministry of Energy and Energy Industries Designs Engineering Department/ Couva/Tabaquite/Talparo Regional Corporation Fire Services.	OSH Unit, the Corporation and Fire Services building designs and plant structures for worker safety Approving storage areas for fuel
Completion Certificate	Local Health Authority of the Ministry of Health	Upon completion of building structures
Plant Operation Approval	Industrial Inspection Supervisor	Operations will be (24 hours per day, 7 days per week)
Registration Certificate	Environmental Management Authority	Application must be made to the EMA 45 days prior to the release
Waste collection permit Solid waste license	Environmental Management Authority Solid Waste Management Company of Trinidad and Tobago Limited	Required under the Draft Waste Management (Solid Waste) (Collection and Disposal) Rules, 2000
Approval of Disposal System	Water and Sewerage Authority	Project would includes septic system or leach field to handle domestic sewage wastes
Variance to sound level	Environmental Management Authority on the advice of the Noise Advisory Council.	Application to be made before date of the event or the activity

Table 2.9-1. List of Approvals Required for the Project

Approval Type	Approving Agency	Comment
Approval of Emergency Response Plan/Fire Prevention	The Occupational Safety and Health Unit, Local Fire Services Department, (consultations with Trinidad and Tobago Emergency Mutual Aid Scheme [TTEMAS] including the local police)	Entire area, including roads, would be designed to have adequate safety signs, illumination, fire extinguishers and good housekeeping to minimize accidents
Transportation	Traffic Management and Highways Division of the Ministry of Works	Project would involve continuous transport of both raw materials and product
WASA Outline Approval	The Water Resources Agency and the Water and Sewerage Authority	Project would need to purchase water from DESALCOTT or WASA for start up operations Plant would generate and recycle its own process water after start-up

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3.0 DESCRIPTION OF THE PROPOSED PROJECT

3.1 PROJECT OVERVIEW AND JUSTIFICATION

The CariSal venture converts fundamental substances—seawater, limestone, lime, and salt—into calcium chloride, caustic soda, sodium hypochlorite (bleach), hydrochloric acid, and a proprietary ice-melt product, ClearPath™. A total of $175 million will be invested, $170 million on the island of Trinidad, in the Republic of Trinidad and Tobago, and $5 million in three major U.S. metropolitan areas.

The CariSal business plan is based on leveraging the low-cost position of producing calcium chloride in Trinidad to provide raw material for the ClearPath™ manufacturing operation in the United States, allowing for rapid penetration of the ice-melt market by expanding CariSal's impact and reach. In addition, CariSal will use this cost position, access to deep water ports, and proximity to the Caribbean, West Africa, and Latin America to gain a dominant share of the market for 94-percent calcium chloride supplied to the oil service market in these regions.

The manufacturing cost advantage for caustic soda and chlorine derivatives is illustrated in Figure 3.1-1 below, where the blue bars represent the cash cost to produce one electrochemical unit (ECU) on the U.S. Gulf Coast. An ECU is defined as the sum of 1.0 metric ton (MT) of chlorine and 1.1 MT of caustic soda. The yellow line represents the market price of an ECU. The red line is the predicted CariSal cash cost of an ECU. Figure 3.1-1 clearly shows that the CariSal venture will be cash positive in any market scenario.

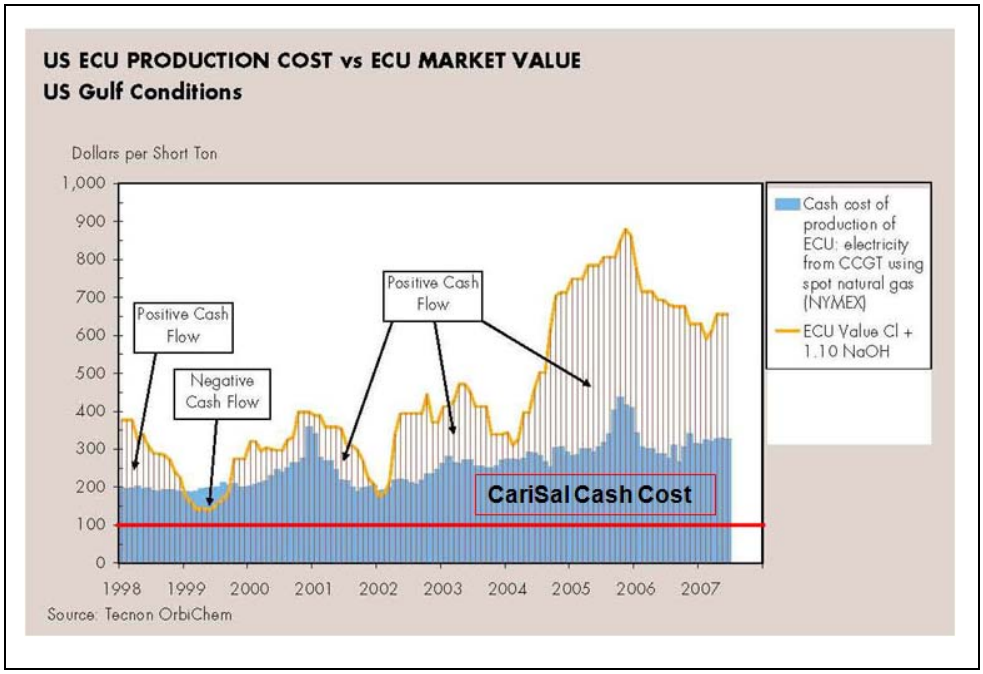

Figure 3.1-1. Manufacturing cost advantage for caustic soda and chlorine derivatives.

CariSal is a holding company organized in St. Lucia with two subsidiaries: CariSal Unlimited, located in Trinidad and CariSal LLC, located in New York State. CariSal Unlimited is building a facility to manufacture and sell caustic soda, calcium chloride, and six other byproducts. The New York-based CariSal LLC currently manufactures and sells ClearPath™. The manufacture of ClearPath™ will consume a major portion of one of the products produced in Trinidad, calcium chloride.

CariSal LLC began operation in 2006 to produce premium ice-melt, ClearPath™. ClearPath™ is a unique di-crystalline pellet formed by combining two salts, calcium chloride and sodium chloride. An early entry into this market was necessary to establish the ClearPath™ brand and provide a barrier and deterrent to other potential competitors.

Seneca Chemicals LLC, a principal shareholder, developed the proprietary ClearPath™ process to provide the most effective, environmentally friendly, and "Pet Friendly" ice-melt product. Introduced to the U.S. market in the 2006 and 2007 winter seasons, ClearPath™ is broadly accepted as evidenced by McDonalds Corporation's purchasing the product for distribution to all their north-eastern U.S. locations. Marketing during the winter of 2007 - 08 has added sales to the interest of John Deere®; Benbow a major distributor in the north-eastern United States; and Symbiot, an 800-member cooperative. The New York plant is currently producing for shipment to customers this upcoming winter season.

The CariSal business proposal is based on a multi-phase market approach. The key benefits of the venture include:

- A diverse product line to mitigate market risk associated with business cycles;
- An environmentally green project with zero liquid waste and minimum solid waste from operations;
- An existing retail presence in the U.S. ice-melt market, providing excellent corporate exposure and immediate sales for the Trinidad calcium chloride product;
- Current discussions with Ineos and others regarding long-term supply agreements for caustic soda;
- Greater than 30-percent internal rate of return and substantial cash flow under most market conditions; and
- Customer commitments (off-take agreements and letters of interest) for more than 80 percent of the production volume demonstrating a strong desire for this investment.

CariSal Unlimited, Trinidad, provides facilities for producing calcium chloride, one of the raw materials for ClearPath™, and other products based on salt. Sales of ClearPath™ in the United States are important to provide a high-margin base load for the Trinidad venture. The other major market for calcium chloride is the oil service market.

The products and annual volumes to be produced in Trinidad include:

- 125,000 DMT (dry metric tonnes) calcium chloride;
- 93,300 MT 32% caustic soda;
- 53,300 MT 12% sodium hypochlorite (bleach) solution;
- 85,200 MT hydrochloric acid (depending on product mix);
- 49,600 MT of a byproduct, carbon dioxide (CO_2), would be transported by pipeline to a nearby facility for urea production (future) or to another user of CO_2; and
- Up to 920,000 metric tonnes (MT) of demineralised water (dependent on product mix).

Trinidad is an ideal location for this capital investment for several key reasons including availability of low-cost electricity and natural gas, access to deep-sea ports, and proximity to export markets. The local market in Trinidad would generate approximately $15 million (U.S.) in annual revenue from displacement of imports, with the balance of the product slate to be exported. Trinidad is strategic for caustic soda production because of its proximity to the trading routes between the United States and Latin America and Europe and Latin America. Also, a plant in Trinidad would allow CariSal to ship to the other Caribbean Community islands duty free and at a lower cost than the competition.

The calcium chloride product is estimated to be sold as anhydrous 94-percent powder into the oil service markets and as 77-percent flake into both the oil service and North American ice-melt markets. Trinidad is a strategic location for the oil service markets because the shipping costs to these international markets would be $75–$100 per ton lower than the competition. Over the past 3 years, high energy costs, poor co-product economics, and manufacturing plant shutdowns in Europe and the United States have created a worldwide market shortage of calcium chloride. The demand for ice melting applications also has surged in the oilfield drilling industry and in Eastern European markets. As a result, the calcium chloride industry has a 200,000-MT/yr shortage in a 2,400,000-MT/yr industry. CariSal Unlimited is positioned to capitalize on these market dynamics.

The second phase of the CariSal venture requires $5 million in capital expenditures to expand the New York plant and to build two plants near Chicago and Kansas City. The investment would address the rapid expansion of the ice-melt manufacturing and distribution across the northern United States. This expansion would be accomplished by a combination of strategic acquisition and construction of new facilities. This strategy would create an additional market of 30,000 MT/yr for calcium chloride and additional margin of US $30 to $40 per MT. The initial acquisition target is a major distributor in the Chicago area.

3.2 SITE AND SURROUNDING AREA

The CariSal site would be located on an 11.8-ha parcel of land, which CariSal would lease from the National Energy Corporation of Trinidad and Tobago Limited (NEC). Currently undeveloped, this parcel is adjacent to the planned PLSEIE in Couva and is designated for industrial uses. Its geographical coordinates are 10º24’ North and 61º28’ West.

Figure 3.2-1 (see also Chapter 10) shows the vicinity and location of the proposed CariSal site and ex situ pipeline infrastructure. Beyond the northern edge of the CariSal site is undeveloped land and an adjacent gravel and cement works and, 1 kilometre (km) away, Phoenix Park Road. The CariSal site is bounded to the east by a National Gas Company (NGC) pipeline right-of-way and a Trinidad and Tobago Electricity Commission (T&TEC) transmission corridor. The 120-ha site of the proposed Westlake polyethylene production facility is adjacent to these corridors. The T&TEC reserve lands form the southern boundary of the CariSal site with the North Sea Road and NGC right-of-way corridor located farther to the south. Beyond these reserve lands and the road are the 204-ha site of the proposed Essar steel works to the southeast and the Savonetta residential estates to the south. To the west of the proposed CariSal site are the Caroni Railway right-of-way (ROW) (land owned by the NEC), Southern Main Road, and beyond them, Yara Trinidad Limited, an ammonia plant on the PLIPDECO industrial estate. Industrial Gases Limited lies to the southwest as does Phoenix Park Gas Processors Limited (PPGPL); Caribbean Nitrogen Company Limited (CNC) lies to the northwest. Northern Construction and EZYCON are to the northwest between Southern Main Road and the Caroni railway reserve. The nearest residential structure is approximately 50 m from the western facility boundary; the nearest school is to the northwest approximately 900 m away on Southern Main Road.

Figure 3.2-2 shows the layout of the proposed CariSal facilities.

3.3 CONSTRUCTION

3.3.1 Site Preparation

The site is a relatively flat to gently undulating former sugar cane field adjacent to the proposed PLSEIE. Before site preparation begins, CariSal would inspect its contractors' erosion protection measures and require compliance with its Stormwater Pollution Prevention Plan (SWPPP), which would conform to U.S. EPA guidelines and include best management practices to minimise erosion and sedimentation. Before beginning any work on site, CariSal would inform all appropriate agencies and site neighbours.

One or two civil contractors, under the direction of CariSal's project management team, would use North Sea Drive as the main access road to the site, east of Southern Main Road. This road was already partly improved by the NGC and would provide access until NEC, the site landlord, installs a permanent access road, which is expected to be constructed in 2009. The site does not require offsite laydown areas for vehicles or equipment; however, due to timing of equipment arrival and staffing requirements, CariSal has established an off-plot site for temporary offices and equipment storage pending the approval of its CEC application.

After erecting an 8-foot-high (2.4 m) chain-link fence around the site, construction subcontractors would undertake site preparation. The first stage of site preparation would be to cut and clear existing sugar cane, grass, and other vegetation requiring removal from the parts of the site on which plant and infrastructure facilities would be built—approximately 5 ha in total.

Figure 3.2-1. Vicinity and location of the proposed CariSal site and ex situ pipelines.

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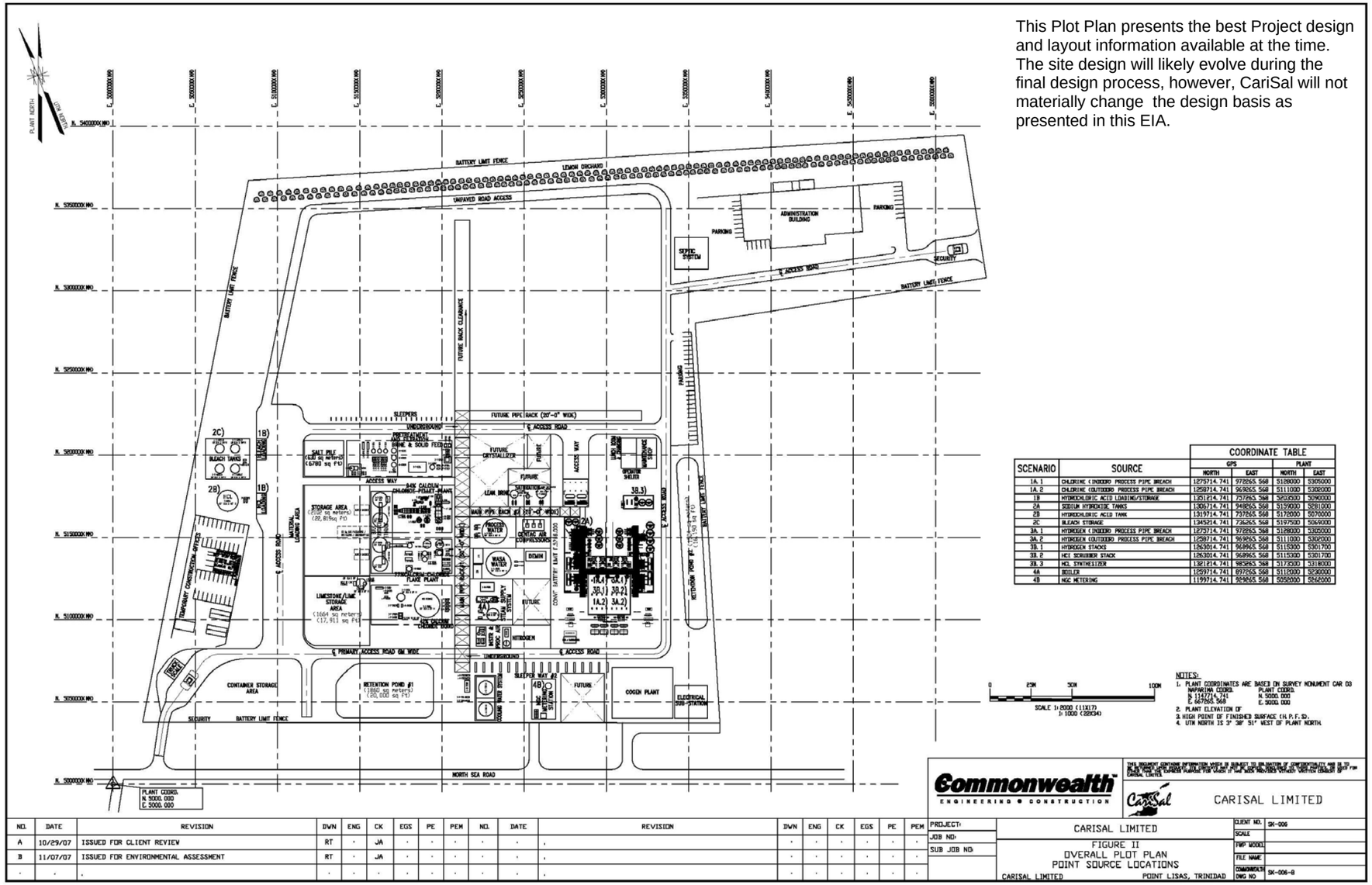
This Plot Plan presents the best Project design and layout information available at the time. The site design will likely evolve during the final design process, however, CariSal will not materially change the design basis as presented in this EIA.



SCENARIO	SOURCE	COORDINATE TABLE GPS NORTH	GPS EAST	PLANT NORTH	PLANT EAST
1A.1	CHLORINE (INDOOR) PROCESS PIPE BREACH	1275714.741	972865.568	5180000	5305000
1A.2	CHLORINE (OUTDOOR) PROCESS PIPE BREACH	1258714.741	969865.568	5111000	5302000
1B	HYDROCHLORIC ACID LOADING/STORAGE	1321214.741	757865.568	5255000	5090000
2A	SODIUM HYDROXIDE TANKS	1305714.741	948865.568	5139000	5281000
2B	HYDROCHLORIC ACID TANK	1319714.741	737865.568	5172000	5070000
2C	BLEACH STORAGE	1345214.741	732865.568	5197500	5069000
3A.1	HYDROGEN (INDOOR) PROCESS PIPE BREACH	1275714.741	972865.568	5180000	5302000
3A.2	HYDROGEN (OUTDOOR) PROCESS PIPE BREACH	1258714.741	969865.568	5111000	5302000
3B.1	HYDROGEN STACKS	1263014.741	968865.568	5115300	5301700
3B.2	HCl SCRUBBER STACK	1263014.741	968865.568	5115300	5301700
3B.3	HCl SYNTHESIZER	1321214.741	983865.568	5172000	5318000
4A	BOILER	1259714.741	897865.568	5112000	5230000
4B	NGC METERING	1199714.741	929865.568	5052000	5262000

NO.	DATE	REVISION	DWN	ENG	CK	EGS	PE	PEM	NO.	DATE	REVISION	DWN	ENG	CK	EGS	PE	PEM
A	10/29/07	ISSUED FOR CLIENT REVIEW	RT	.	JA	.	.	.	.	.	.	.	.	.	.	.	.
B	11/07/07	ISSUED FOR ENVIRONMENTAL ASSESSMENT	RT	.	JA	.	.	.	.	.	.	.	.	.	.	.	.
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Figure 3.2-2a. Detailed CariSal site plan.

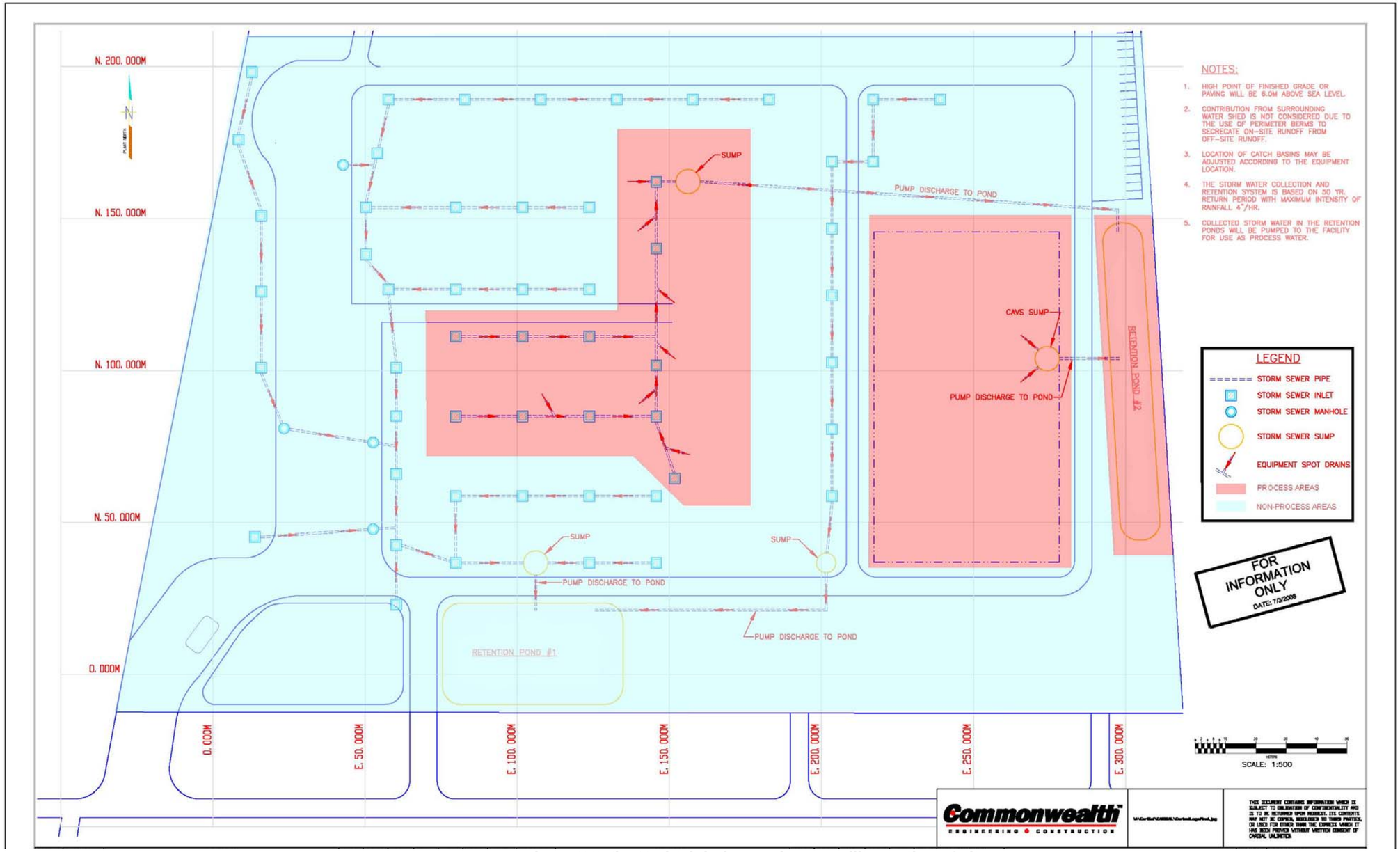

Figure 3.2-2b. CariSal drainage plan – Facility portion of site.

Trees would be left in place wherever possible. Ten-MT dump trucks would be used to haul off site any cut vegetation and spoil unsuitable for grading; an expected total of 26,500 m^3 of vegetation and spoil would be disposed of in accordance with approved methods at existing commercial landfill sites.

The second stage of site preparation would be to grub and grade this area to a level pad, and begin to excavate for the installation of foundations and water retention ponds. The current site-grading concept calls for the plant area to be 1 foot (0.3 m) above North Sea Drive, the road bordering the site on the south and to have a slope of 1/16 to 1/8 inch per foot (0.52 cm/m to 1.04 cm/m). Topsoil would be stockpiled on the undeveloped portion of the site and reused where possible. All graded or excavated materials would be used as backfill or for perimeter buffers. The perimeter roads, berms, and other earth structures would be used as protective dikes/levees to prevent run-on onto and run-off from the CariSal site. An additional 80,000 m^3 of fill would be trucked by the civil subcontractors to the site and spread with motor graders to raise the working site approximately 1 foot (0.3 m) above the road bordering the site on the south, and then compacted and readied for foundation installation. Water tenders would be used as necessary to control dust. In areas of the site requiring compacted fill, fill material would be supplemented with red sand from commercial sand pits approximately 2 miles (3.2 km) from the site or imported from a qualified supplier.

Site preparation would also include excavations necessary for the construction of two water retention ponds. Retention Pond #1 (also referred to as "the Retention Pond") would be designed to collect stormwater uncontaminated by contact with process areas. To retain sufficient rainfall based on a 50-year storm, the pond would have a surface area of 20,000 ft^2 (approximately 1,858 m^2) and a capacity of 2.0 million gallons (approximately 7,680 m^3). Retention Pond #1 would be constructed from natural materials. Double lining, impermeable interfaces, leak detection, etc., would not be necessary because the material held in this pond would not present a detrimental impact to the environment. The pond would overflow into a concrete pump basin to accommodate the sump pumps and also would incorporate an overflow weir with a sluice gate to be able to run off excess water to the natural drainage system at a controlled rate.

Retention Pond #2 (also referred to as the Containment Pit) would be either an earth-bermed structure with a Hypalon (chlorosulphonated polyethylene) or similar geomembrane liner or an engineered concrete structure. If concrete is chosen, the structure would be designed with leak stops and an underdrain to detect any leakage, and would be designed to meet the appropriate seismic requirements. It would receive any stormwater that contacts process areas of the site and which, after a period of settling, could be used as process water. Retention Pond #2 would have a surface area of 16,190 ft^2 (approximately 1,500 m^2) and a capacity of 1.6 million gallons (approximately 6,020 m^3).

The northwest corner of the site would be left undisturbed and retained as a perennial wetland and wetland buffer. Most of the remainder of the northern half of the site would remain undeveloped, except for the area near the administrative building. The final design will be coordinated with the Ministry of Works – Drainage Division to provide the most effective solution.

Temporary construction offices would be erected in the southwestern corner of the site, close to the access road. The ROW corridors for the pipelines to and from DESALCOTT (for brine and demineralised water, respectively) and the pipeline to EISL (and also, if an option is exercised to use tanks on the Caroni site across the road from EISL, a pipeline to these tanks) would also be cleared, graded, and, where necessary, excavated. These pipelines are described further in Section 3.3.2. Clearing, grading, and excavating would also be done for the pipeline that would carry carbon dioxide to Trinidad Energy Investments Limited (TEIL) or another user of CO_2, which would be built when the project is operational. However, because the pipelines would run alongside existing roads for most of their respective routes, they would not require the displacement of any major structures or physical assets. CariSal has entered negotiation with landowners along the pipeline ROW.

Site preparation is expected to take 3 months. Clearing of vegetation would begin after the CEC is received, followed by backfilling, grading, and levelling to the elevations specified in the site plan.

3.3.2 Construction of Plant and Infrastructure

Construction work would comprise all plant units and auxiliaries, roads, drainage, sewerage, and all other infrastructure within the plant boundary. In general, specification and details as to type of structures, grade of concrete, materials, etc., for all major units have been assumed to be similar to standard practice of civil works in the United States such as those approved by the American Society for Testing Materials (ASTM).

Major civil work would include completing foundations for the structural buildings, process plants, utility buildings, electrical substation, raw-material handling system, storage tanks (including ex situ tanks), and other equipment. Foundations would be on piles. Approximately 1,000 pre-stressed concrete piles [each estimated to be 60 feet (18.3 m) long and from 12 to 16 inches (30.5 cm to 40.6 cm) wide] would be installed at a target rate of 20 piles per day. All underground basement structures, such as the salt saturator, electrical underground, or water recycle sumps, in contact with earth, would have standard waterproofing treatment such as exterior drains, bitumen coatings, or low-permeability membranes.

Plant and infrastructure facilities would be installed on about 45 – 50 percent of the site area, largely on the southern half (see Figure 3.2-2). The principal units that would be installed are:

- Packaged boiler,
- Brine surge tank,
- Calcium chloride liquor storage unit,
- Calcium chloride plant,
- Calcium chloride reactions plant,
- Caustic soda tanks,
- Chlor-alkali plant,
- Cooling tower and supply and return pipelines to and from other units,

- Calcium chloride drying plant,
- Hydrogen vent stack,
- Hydrochloric acid tanks,
- Hydrogen chloride production facilities and tail-gas scrubber,
- Limestone storage area,
- Lime dust silo vent
- Process water tanks
- Miscellaneous product storage tanks
- Solid salt (sodium chloride) storage area,
- Warehouse, and
- Water tanks (water from WASA, process water, hot water).

The dryer would be purchased from a decommissioned plant in the United States and would be cleaned and certified under U.S. EPA standards before it is shipped.

The following buildings and infrastructure would also be installed during the construction phase:

- Administrative buildings,
- Control room,
- Drainage system,
- Electrical substation with a connection to offsite power lines and distribution lines across site,
- Cogeneration ("cogen") power plant,
- Emergency back-up generator,
- Fire protection systems,
- Natural-gas pipeline (from offsite pipeline in external utility corridor to onsite drying plant),
- Septic (sanitary wastewater) system, capacity 330 m^3/day, and associated pipeline from administrative building,
- Telecommunications, and
- Water retention ponds.

Most plant equipment would be purchased and transported in modular form via the Port of Point Lisas for onsite assembly and installation, whereas plant buildings would be constructed onsite.

Standards and codes of practice to carry out the civil work will comply with local or other accepted international codes such as ASTM, International Standards Organization 9001, 14001. Seismic loads and wind loads would be considered in the context of relevant Trinidad and Tobago or Caribbean statistical/meteorological data. The material for the steel structures would be consistent with American standards/ASTM. CariSal would inspect all structures once they are built. A material certificate for each fabricated structure also would be provided to and maintained by CariSal Unlimited.

A gas pipeline was recently constructed approximately 40 metres from planned pile driving activities. Said pipeline is 36 in. (91.4 cm) in diameter with a wall thickness of 0.562 in. (1.4 cm).

Based on the upper range of pile driving vibration data from the US Federal Transit Authority (FTA),[1] the resulting ground vibration level (Peak Particle Velocity) 40 metres from pile driving would be 0.126 in./sec (3.2 mm/sec). This value is below the FTA's fragile building cosmetic damage criterion of 0.20 in./sec (5.08 mm/sec). Cosmetic damage refers to hairline cracks found in plaster.

Damage criteria for a steel pipeline are orders of magnitude higher than that of conventional buildings. Acceptance criteria under various loading conditions are presented in "Guidelines for the Design of Buried Steel Pipe," American Society of Civil Engineers (July 2001). The loading conditions include forces such as earthquakes, mining, objects dropping on the pipeline, and wave propagation through the soil (e.g., pile driving, blasting). For wave propagation, the suggested acceptance criterion is a tension strain limit of 0.5 percent.

In "Blast Vibration Monitoring and Control," Charles Dowding (1984) provides methods of estimation of stress and strain on structures due to ground-borne vibration. The shearing strain on a buried gas pipeline can be calculated from

$$E_{max} = PPV/2Cs$$

Where *PPV* is the Peak Particle Velocity in the ground at the pipeline and *Cs* is the propagation velocity. Assuming a typical propagation velocity of 1232 ft/sec (375 m/sec)[2] as described by Dowding (1984), $E_{max} = 4.2 \times 10^{-6}$. In terms of a percentage tension strain, this value would be 4.2×10^{-4} percent, which is many orders of magnitude below the acceptance criterion of 0.5 percent. Therefore, damage to the pipeline due to pile driving vibration is very unlikely.

Construction activities would be scheduled to avoid or minimize impacts. Sensitive areas would be protected by means of fencing. Slopes would be stabilised by means of soil binders, straw mulch, geotextiles and mats, or polyacrylamide. Other erosion and sediment control measures would include silt fences, sediment basins, fibre rolls, hay bales, and gravel bag berms.

Construction vehicles and equipment would include a bulldozer, an excavator, a scraper box, three trucks, loaders, a compactor, a motor grader, cranes, pavers and water tenders. This equipment would operate 10 hours per day, 5 days per week over a 2-month period to complete the site filling and grading.

Site equipment would be mobilised during off-peak hours and with police escort to avert traffic disruptions, delays, hazards, and safety risks. Once onsite construction is complete, CariSal

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[1] "Transit Noise and Vibration Impact Assessment," US Federal Transit Administration (April, 1995)

[2] "Blast Vibration Monitoring and Control" Charles Dowding, (1984), p. 177

would plant perimeter trees and a lemon grove (or another local tree variety or some combination thereof) to provide a vegetated buffer zone.

The administrative buildings and associated facilities have been designed in accordance with "green building" and sustainable development principles. Buildings would make maximum use of daylight while avoiding solar (heat) gain by means of shading, exterior light shelves, overhangs, and grass roofs. Parking areas would be shaded by landscape plantings and trellised green roofs, which would promote surface-water retention (See Figure 3.3-1.). (This vegetation, along with the lemon grove, would absorb carbon as carbon dioxide throughout its natural life, mitigating the vegetation losses caused by clearing during site preparation.) Rainwater would be recycled for use in landscape irrigation. Site lighting and an electric-cart charging station would be solar powered.

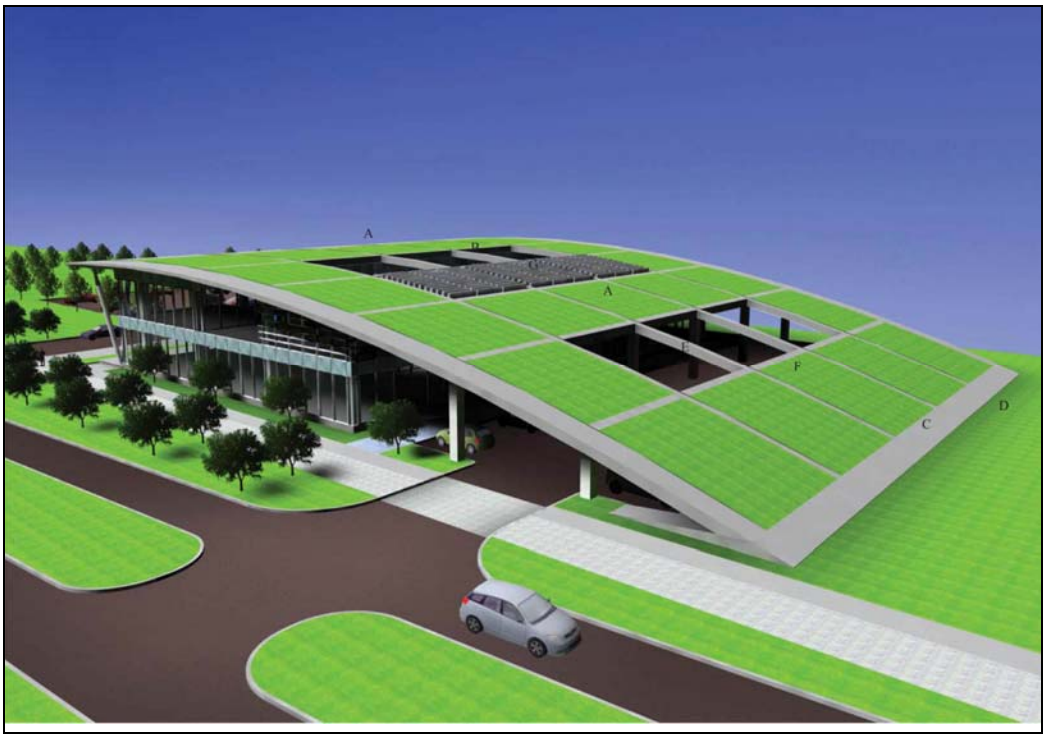


Figure 3.3-1. CariSal administrative building.

Offsite (ex situ) facilities and infrastructure would consist of the pipelines (listed in Table 3.3-1) and a caustic soda storage tank (capacity 2,488,320 gallons or 9,419 m^3) on the existing EISL site and Yara pier (which EISL would manage), as well as the (partly onsite) connections to the electricity, water, and communications grids. CariSal is also considering an option to use this tank on the EISL site for storing the 42-percent calcium chloride solution and storing the caustic soda in two existing single-walled bunded tanks (each of capacity 2,239,490 gallons or 8,477 m^3) on the Caroni site adjacent to the EISL site, until now used for the storage of molasses. This option, the "Caroni option," would entail upgrading and using an existing carbon steel pipeline (previously used for transporting molasses between the Caroni site tanks and the Yara pier), as well as the construction of a pipeline between CariSal and the Caroni site tanks.

Table 3.3-1 Offsite Pipelines

Pipeline	From/To	Diameter	Length (meters)	Constituent Material
Brine (Feed)	DESALCOTT to CariSal	20 cm (8 in.)	1,500	High density polyethylene (HDPE)
Caustic Soda (Product)	CariSal to EASI Industrial Supplies Limited (EISL)	15 cm (6 in.)	2,000	Carbon steel
Caustic Soda (Product)	EISL to Yara pier	15 cm (6 in.)	300	Carbon steel
Carbon Dioxide (Product)	CariSal to TEIL (scheduled for operation in 2011) or another user of CO_2	10 – 15 cm (4 – 6 in.)	1,750	HDPE
Natural Gas (Utility)	From the National Gas Company (NGC) pipeline alongside the site to calcium chloride fluid bed dryer	10 – 15 cm (4 – 6 in.)	50	Carbon steel
Potable Water (Utility)	From the Water and Sewerage Authority (WASA) utility line alongside the site to administrative building	10 cm (4 in.)	50	HDPE
Demineralised Water	CariSal to WASA system along the route of the brine (feed) pipeline	20 cm (8 in.)	1,500	HDPE
Should the Caroni option be chosen, the pipelines among CariSal, EISL, and the Yara pier will carry 42% calcium chloride solution, and the following two additional pipelines will be required.				
Caustic Soda (Product)	CariSal to Caroni	15 cm (6 in.)	2000 m	Carbon steel
Caustic Soda (Product)	Caroni to Yara pier (existing – pipeline to be upgraded)	15 cm (6 in.)	300 m	Carbon steel

Regarding the offsite pipelines, CariSal would undertake the necessary surveys, produce detailed ROW maps, obtain necessary excavation permits from PLIPDECO and NEC, and review pipeline construction plans with these entities and other relevant stakeholders before undertaking any pipeline installation on their properties. Pipelines would be placed aboveground on sleepers, where appropriate, or buried to a depth of 1.2 m, especially to avoid infrastructure such as roads and, in the case of the pipelines to DESALCOTT, to avoid the drainage to the north of the CariSal site.

The steps for pipeline construction are:

- Surveying the ROW,
- Locating underground utilities,
- Clearing and grading,
- Trenching (in areas where the pipeline will be buried),
- Joining of pipe lengths,
- Lowering the pipeline into position in the trench and backfilling (for buried sections),
- Positioning the pipeline onto the sleeper (for aboveground sections), and
- Clean-up and restoration of disturbed areas.

Seawater (approximately 2.5 million gallons or 9,500 m^3) would be used to test the caustic-soda storage tank at EISL and re-used for testing the caustic pipeline between the CariSal plant and EISL. Upon completion of testing, CariSal would blow the line clear back to the (still empty) storage tank for caustic soda and test for any contamination. Provided an acceptable chemical analysis for the protection of aquatic life is demonstrated, CariSal would drain the test water back to the sea. Discharge water from new pipelines is usually relatively uncontaminated and would require minimal treatment, if any. The main substances that might be of concern and require removal would be total suspended solids and possibly some metals. If contaminated, the test water would be treated and disposed of using proper procedures. Treatment systems for discharge waters from new pipelines are usually relatively simple and inexpensive (e.g., filtration and aeration). CariSal would provide a filtration and aeration system on the shore tank. CariSal would use industry standards for hydrostatic testing management, prepared by the Canadian Energy Pipeline Association and the Canadian Association of Petroleum Producers, to the extent practicable.

If the Caroni option were chosen, the same process would be followed after cleaning, repair, and integrity verification. The two tanks would be cleaned by using steam or high-pressure water, or both; the pipeline would be cleaned by circulating water through temporary hosing.

3.3.3 Labour Requirements

Construction of the primary facilities would require approximately 10 months from CEC approval. On average, 100 to 150 construction workers would be required, but at peak construction times (in the seventh and tenth months), 150 to 200 construction workers would be required. Offsite, a team of 12 construction workers would be required for construction of the ex situ pipelines. As many as 10 workers would be required to construct new ex situ tanks and, if the Caroni option is chosen, the repair of the molasses tanks on the Caroni site.

Construction workers would be expected to work 10 hours per day, 5 days per week, with weekend work only occasionally. Workers would be hired and would live locally. No labour encampments are anticipated.

3.3.4 Construction Utilities

Water for construction, such as for dust control and line testing, would be purchased from WASA and trucked to the site at a rate of 5,000 gallons (~ 19 m^3) per day. Contractors would be required to provide fuel for onsite construction equipment that would be delivered periodically to the site. Daily fuel consumption is estimated to be 1,000 to 1,500 gallons (3.8 to 5.7 m^3).

CariSal has made arrangements with T&TEC to provide temporary construction power from the power lines running adjacent to the southern site boundary. In addition, temporary telephone and Internet will be provided by Telecommunications Services of Trinidad and Tobago (TSTT).

3.3.5 Hazardous Materials Management

Hazardous materials for construction of CariSal facilities (including oils, compressed gases, cleaning products and other solvents, paints, sealers, asphalt, and pesticides) would be managed by the construction contractor in accordance with an approved management system (outlining quantities of materials used) that would be submitted to EMA for review. This management system would stipulate that, to the extent possible, excess or used hazardous materials would be returned to the vendor for recycling (for example, used oil, empty containers of compressed gases). Where returning them is not possible, the hazardous materials would be disposed of as hazardous waste in accordance with an approved waste-management system that would be submitted to the Trinidad and Tobago Solid Waste Management Company Limited (SWMCOL) for review (see Section 3.3.6).

3.3.6 Waste Management

Waste would be handled and disposed of in accordance with an approved waste-management system that would be submitted to SWMCOL for review. Hazardous waste (consisting of excess or used hazardous materials that could not be returned to vendors for recycling) would be disposed of by a qualified, experienced contractor according to SWMCOL methods at approved sites such as the Forres Park Landfill, using U.S. EPA handling and disposal methods to the extent possible.

Non-hazardous solid wastes would be disposed of by a qualified, experienced contractor according to SWMCOL methods at approved sites within the Regional Corporation of Couva, such as at Toruba. Table 3.3-2 shows the solid wastes that would be generated during the construction phase.

Contaminated water from the cleaning of the Caroni tanks and pipeline would be treated in the first instance; alternatively, it will be disposed of by a qualified, experienced contractor according to methods approved by EMA, WASA, and other relevant authorities at approved sites within the Regional Corporation of Couva or elsewhere in Trinidad. Sanitary wastewater accumulated in portable hygiene facilities would be disposed of by a qualified, experienced contractor according to methods approved by EMA, WASA, or other relevant authorities at approved sites on the island of Trinidad.

Table 3.3-2 Solid Construction Waste

Waste Material	Quantity	Disposal
Vegetation and spoil	26,500 m^3	Transported by licensed waste hauler to approved landfill if unsuitable for use as fill
Waste concrete	150 m^3	Transported by licensed waste hauler for offsite recycling or, when recycling is not possible, disposal at permitted landfill
Scrap metal	10 –15 MT	Transported by licensed waste hauler to scrap yard or sold to recyclers
Trash (paper, wood, plastics, containers, silt fencing, geotextiles)	< 2 MT/week (estimated)	Transported by licensed waste hauler for offsite recycling or, when recycling is not possible, disposal at permitted landfill
Hazardous wastes	CariSal will produce no hazardous waste during construction. Contractors are responsible for any waste from their operations.	Transported to permitted facility by licensed hazardous waste hauler

3.3.7 Air, Noise, and Light Emissions

The main construction activities that would cause temporary dust, gaseous emissions, and noise are:

- Clearing, grading and excavation, on site and along pipeline corridors,
- Onsite civil works and pipeline laying, and
- Vehicle movements.

To minimize dust, site access roads and onsite roads would be sprayed with water periodically during dry periods. Vehicles and construction equipment would undergo periodic maintenance by the contractor to ensure that exhaust emissions are minimized.

Such required maintenance would be included as a condition to the contractors' agreements with CariSal.

Maintenance would also help reduce noise levels, but noise attenuation devices, such as mufflers, would also be used. To reduce noise nuisance, as well as light pollution, construction activities would be scheduled, to the extent possible, for daylight hours. CariSal would devise and implement an exterior lighting plan, which would include, in the construction phase, "shielding" on lights to prevent "leakage" into areas that require no light as well as nearby residential areas.

3.4 OPERATIONS

3.4.1 Chlor-alkali Process Overview

The CariSal facility would operate a chlor-alkali process to produce hydrogen, **chlor**ine and sodium hydroxide (an **alkali**) from brine. These three intermediate products would be processed further to produce hydrochloric acid, bleach (12-percent sodium hypochlorite solutions); caustic soda (50-percent solution in water); and calcium chloride (42-percent $CaCl_2$ solution from which

would be produced 94-percent $CaCl_2$ pellets, 77-percent $CaCl_2$ flakes). Carbon dioxide would be generated during the production of $CaCl_2$ and would be partially used for urea production in a proposed nearby facility or by another user of CO_2.

The CariSal process is described in Section 3.4.2 and complex figures are reproduced in Chapter 10. Detailed quantities of process raw materials, intermediates, and products are provided in Section 3.4.3.

3.4.2 Process Description

CariSal operations would be staged to facilitate safe and smooth start-up of the plant. The plan would be to allow production to begin (using solid salt and water) while laboratory and economic evaluations into the long-term viability of using brine from DESALCOTT (a waste product of desalination) are undertaken, and because process equipment for concentrating and purifying DESALCOTT brine would not be available initially. CariSal operations would comprise four stages:

- Stage 1: Production with water from WASA and imported "pure" salt (salt containing low levels of impurity)
- Stage 2: Production with brine from DESALCOTT and imported "dirty" salt (cheaper salt containing higher levels than pure salt of impurities such as magnesium chloride, potassium chloride, calcium sulphate, and other naturally occurring salts)
- Stage 3: Production as in Stage 2 but with more brine from DESALCOTT and less dirty salt than in Stage 2
- Stage 4: Production with brine from DESALCOTT (but no imported solid salt) with concentration by newly commissioned mechanical vapour re-compressors

The process steps for each stage are described below.[3] In general, each stage is an extension of the preceding stage.

3.4.2.1 Stage 1 Process

Step 1: Brine Generation and Purification

Pure, solid salt, imported from a qualified supplier, is mixed with lean brine (recycled from the end of this step) and a small amount of makeup water, piped from WASA, in the salt-saturator unit (Figure 3.4-1). (At start up, the source of the water to dissolve the salt is WASA, but as the plant reaches a steady state of operations in stage 4, recycled streams provide the majority of this solvent water, and the proportion of WASA water falls to a small amount of make-up water.) This forms a saturated brine that is then pumped through a series of reaction vessels into which are added soda ash (sodium carbonate, Na_2CO_3), caustic soda (NaOH), and calcium chloride

[3] For the sake of clarity, the process steps are written in the present tense.

($CaCl_2$) to cause the impurities in the brine (arising from the salt and consisting of mainly magnesium, calcium, and sulphate, but also heavy metals such iron, aluminium and chromium) to precipitate out of solution. The precipitated solids sink to the bottom of settling vessels and are removed in a waste brine stream leaving a flow of purified brine to be fed to the electrolyser unit. The solids ("brine muds") are filtered out, dewatered, and sent to a qualified waste disposal contractor. The purified brine is sent to the lean brine tank to be recycled, along with the lean brine from the electrolyser (see Step 2 below) to the front end of this step.

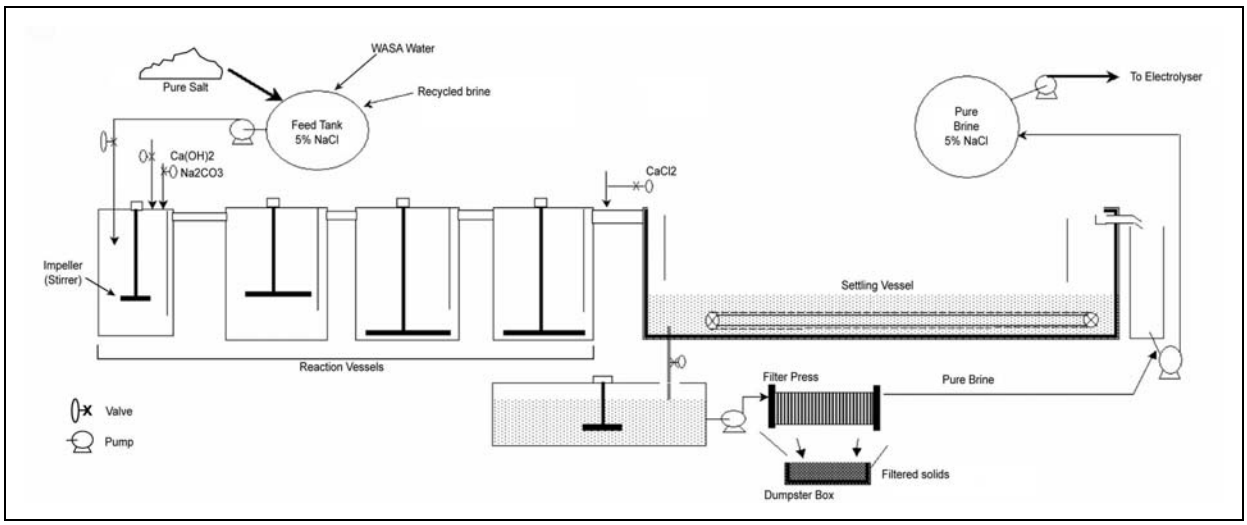


Figure 3.4-1. Brine generation and purification in Stage 1.

Initially, only one electrolyser (Step 2) and one hydrogen-chloride furnace (Step 3 of Calcium Chloride Production) will be operational (see the current schedule in Section 3.8). While this is the case, salt is added at a rate of 10 MT/hour. When the second electrolyser comes on line, salt is added at a rate of 30 MT/hour.

Step 2: Membrane Cell Electrolysis

Saturated brine enters the electrolyser unit (Figure 3.4-2), a vessel comprising 144 electrolytic cells. Each electrolytic cell consists of two chambers separated by a Bichlor™ polymer ion-Exchange membrane – the cell membrane – approximately 32 ft^2 (3 m^2) in area. One chamber contains an anode (a positively charged metal rod) and the other, a cathode (a negatively charged metal rod). The saturated brine is fed into the anode chamber where the negatively charged chloride ions present in the brine solution combine at the anode to form chlorine gas.

$2Cl^- \rightarrow Cl_2 + 2e^-$

The chlorine gas passes out of the cell to the chlorine coolers.

The positively charged sodium ions and the water molecules migrate through the cell membrane into the cathode chamber. At the cathode, water molecules split to form hydrogen gas and hydroxyl ions (OH^-), which react with the sodium ions to form sodium hydroxide.

$H_2O + 2e^- \rightarrow H_2 + OH^-$

$2OH^- + 2Na^+ \rightarrow 2NaOH$

The hydrogen gas passes out of the cell to the hydrogen coolers, and the sodium hydroxide in solution is displaced from the cell by the inflow of fresh saturated brine.

The overall chlor-alkali reaction is:

$2Na^+ + 2Cl^- + 2H_2O \rightarrow H_2 + Cl_2 + 2NaOH$

Brine in the cell is continuously replenished by fresh saturated brine. Depleted brine flows out of the cell, is treated with a mixture of hydrochloric acid, sodium bisulfite, sodium hydroxide, and air to remove any dissolved chlorine present as well as any chlorate ions (ClO_3^-) that may have been produced in the electrolytic cell. The brine is then returned to the salt saturation vessel in the previous step.

The electrolytic cell is powered by direct-current (DC) electricity, which is obtained by rectifying alternating-current (AC) electricity.

The caustic production rate is 3,900 MT/month per electrolyser.

After this step, the process splits to produce caustic soda, bleach, and calcium chloride. Quantities in the text below that describes subsequent steps are given on the basis of both electrolysers (and their associated process trains) being in operation.

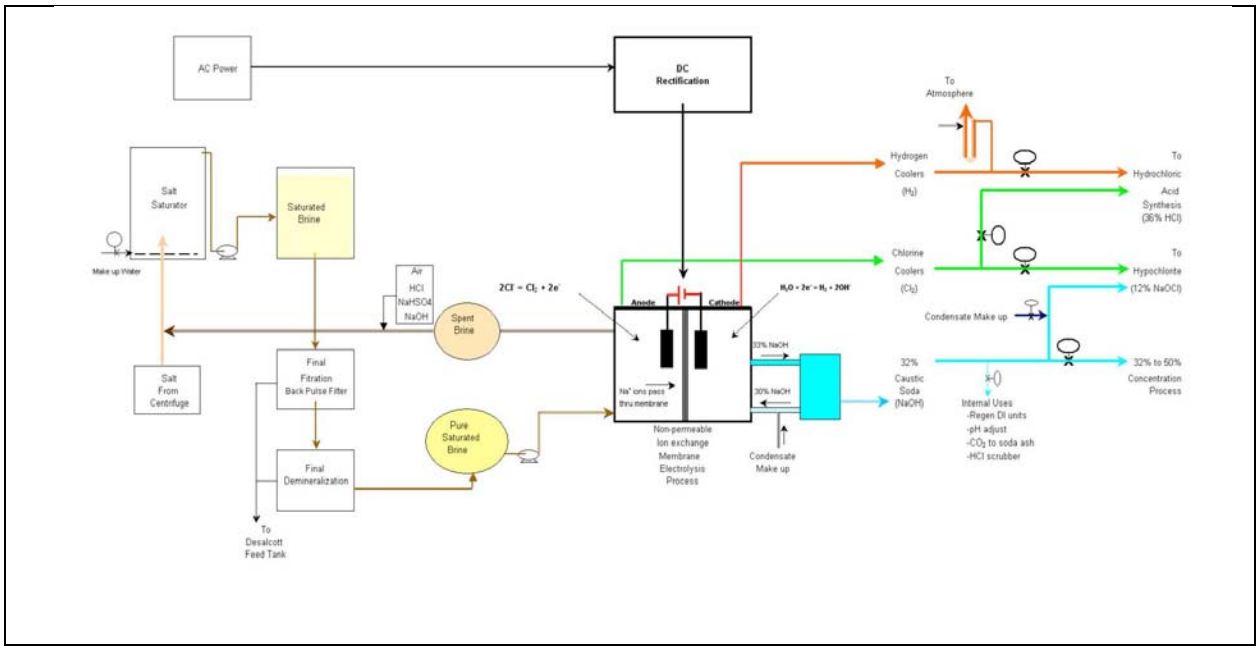


Figure 3.4-2. Membrane cell electrolysis.

Step 3 of Caustic Soda Production: Concentration

The sodium hydroxide produced in the electrolyser (Step 2) is in the form of a 32-percent solution in water. Some of this solution (2,000 kg/hr) is removed for use in the production of bleach (sodium hypochlorite, see Step 3 of Bleach Production) or to treat brine depleted through electrolysis. The remainder (17,000 kg/hr) passes through two evaporators that successively increase in concentration to 39 percent and then 50 percent (Figure 3.4-3) by removing water through evaporation. The latter solution is the end-product, caustic soda. Water removed by evaporation is condensed and sent to the WASA water tank at a flow rate approximately 13.5 m^3/hr (see Table 3.4-5).

Step 3 of Bleach Production: Generation

The 32-percent sodium hydroxide solution produced in the electrolyser (Step 2) is continuously fed into the top of a reaction tower. Chlorine gas and chlorinated air (generated by de-chlorination of depleted brine), both also produced in the electrolyser, are continuously fed into the bottom of the tower (Figure 3.4-4). The rising gases are absorbed into the falling liquid to form bleach, 12-percent sodium hypochlorite solution, which is recirculated to the top of the tower. Bleach is produced at a rate of up to 150 MT/day. This process step can absorb all chlorine produced under upset or emergency conditions.

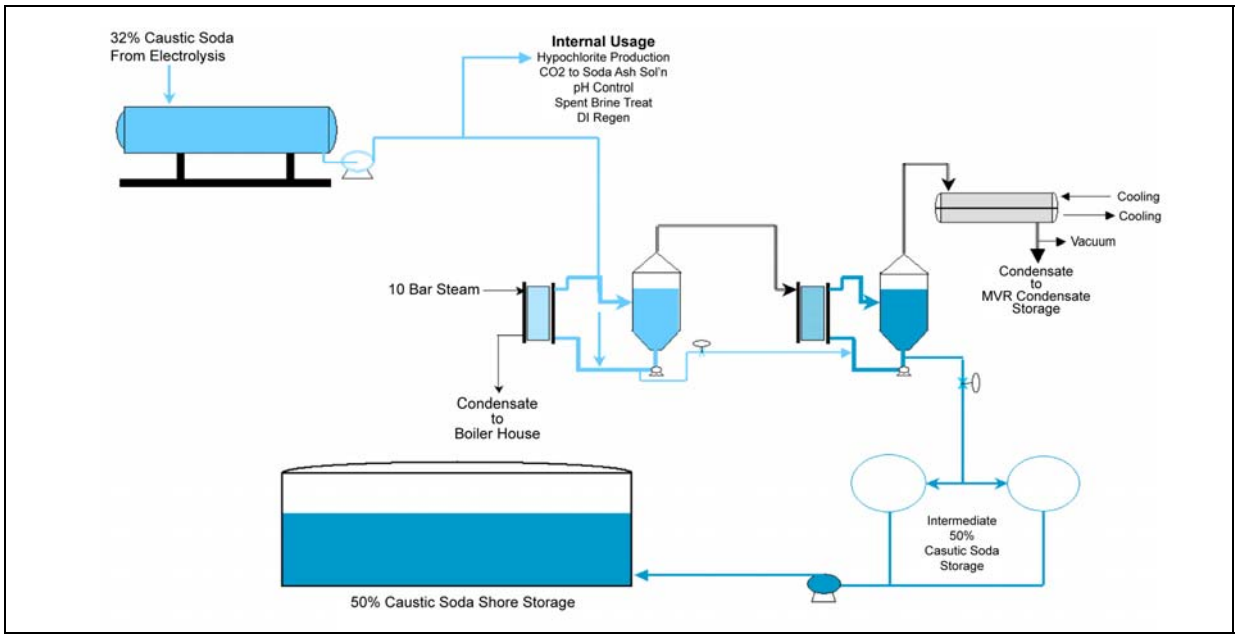


Figure 3.4-3. Concentration of 32-percent caustic soda to 50-percent caustic soda.

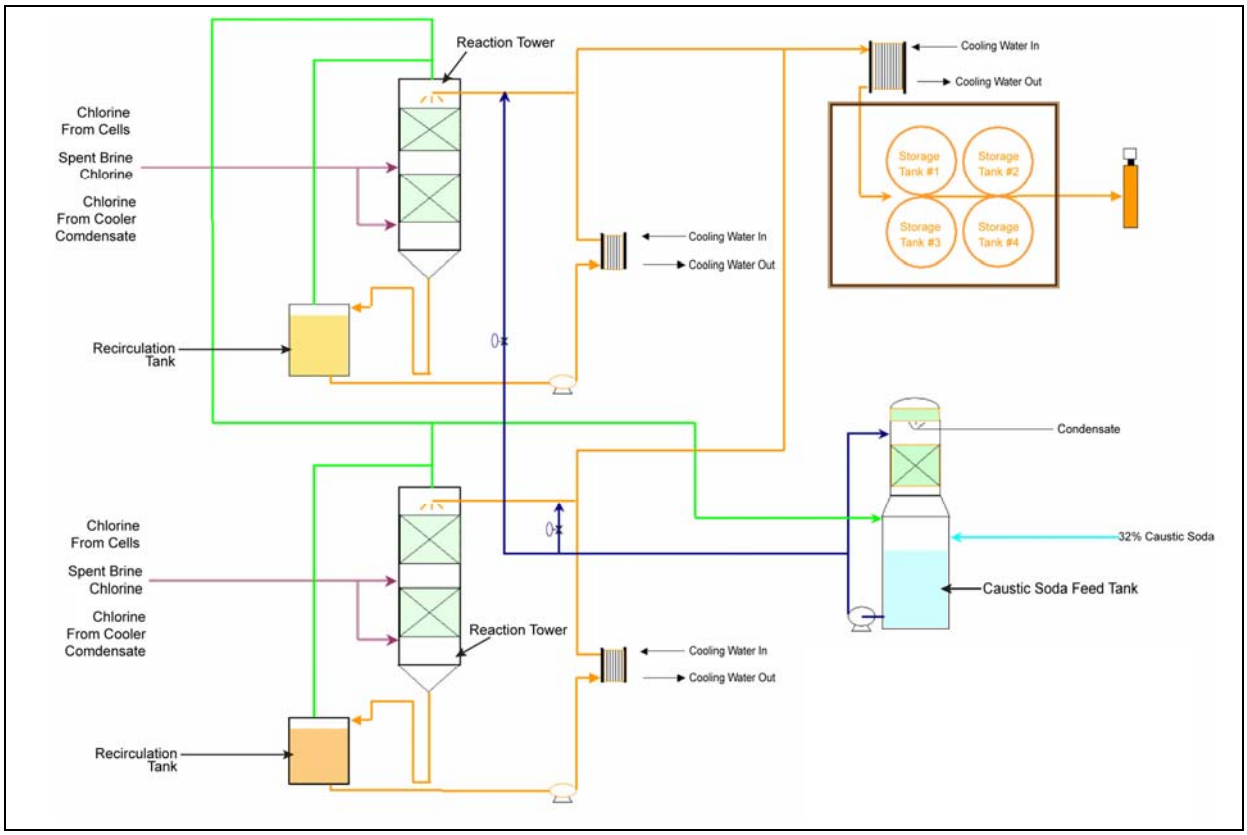


Figure 3.4-4. Generation of 12-percent sodium hypochlorite solution (bleach).

Step 3 of Calcium Chloride Production: Generation of Hydrochloric Acid

Chlorine gas and hydrogen gas from the electrolyser (Step 2) are burned together in a graphite-lined furnace (the hydrogen-chloride reactor) with a flame temperature of 2,500 degrees Celsius (ºC) (Figure 3.4-5). Hydrogen is present in a 5-percent excess concentration to ensure complete combustion of chlorine.

$Cl_2 + H_2 \rightarrow 2HCl$

The hydrogen chloride gas produced is cooled in the hydrogen-chloride reactor to 30 ºC by means of heat exchangers and is absorbed in water to form a 36-percent solution of hydrochloric acid. Some of this acid (540 kg/hour) is taken for internal use (e.g., pH control, removal of chlorate buildup in the electrolytic cell). The rest (9,660 kg/hr) is used in the production of 42-percent calcium chloride solution (Step 4). Some of the hydrochloric acid may also be sold locally and to the export market.

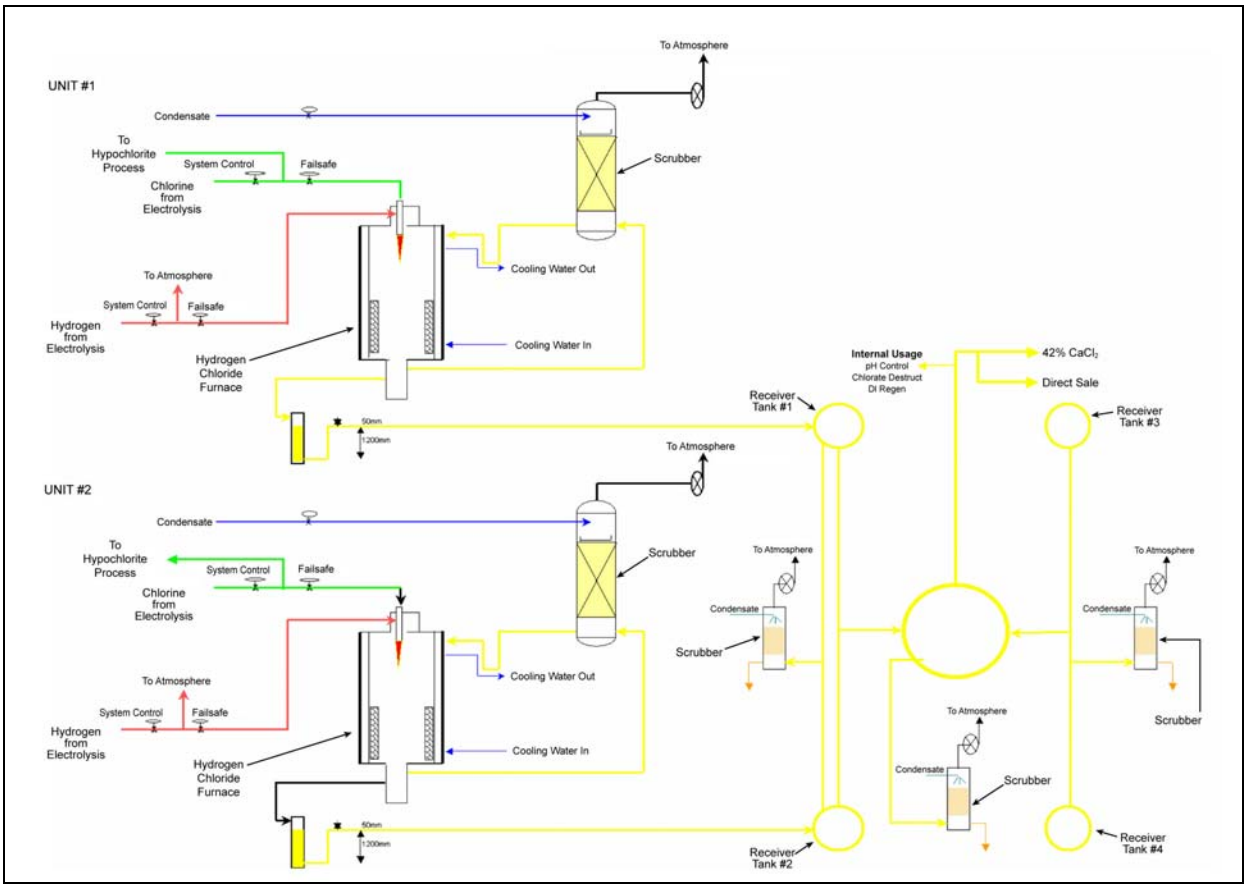


Figure 3.4-5. Generation of 36-percent hydrochloric acid.

Step 4 of Calcium Chloride Production: Generation of 42-percent $CaCl_2$ solution

Limestone (calcium carbonate, $CaCO_3$) is taken from a covered outdoor stockpile by means of hoppers and conveyors to four reaction vessels. Hydrochloric acid produced in Step 3 is pumped

up through the bottom of these reactors (Figure 3.4-6). As it rises, it "digests" the limestone to produce calcium chloride solution and carbon dioxide.

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

The acidic (pH 2 – 3) calcium chloride solution accumulates from these four reactors and is neutralised with "milk of lime" made from lime [$Ca(OH)_2$] to form a 42-percent solution of calcium chloride at pH 7 – 8. Every 16 hours the reactor vessels are cleaned to remove inert material. This material is then handled and disposed of as solid waste. Once production is established, the waste solids will be tested and if benign as expected, used or sold as fill material. The bulk of the carbon dioxide released (49,600 MT/year) is not utilised but vented to the atmosphere, although a small stream (320 MT/year) is combined with caustic soda to make soda ash, which is used to purify brine received from DESALCOTT (Step 1). When the urea plant proposed by another developer becomes operational, the carbon dioxide will be sent to that facility via pipeline. Otherwise, it will be sent to another user of CO_2. CariSal Unlimited will also continuously seek other viable, alternative uses for the carbon dioxide generated in this step of the process, as an interim measure.

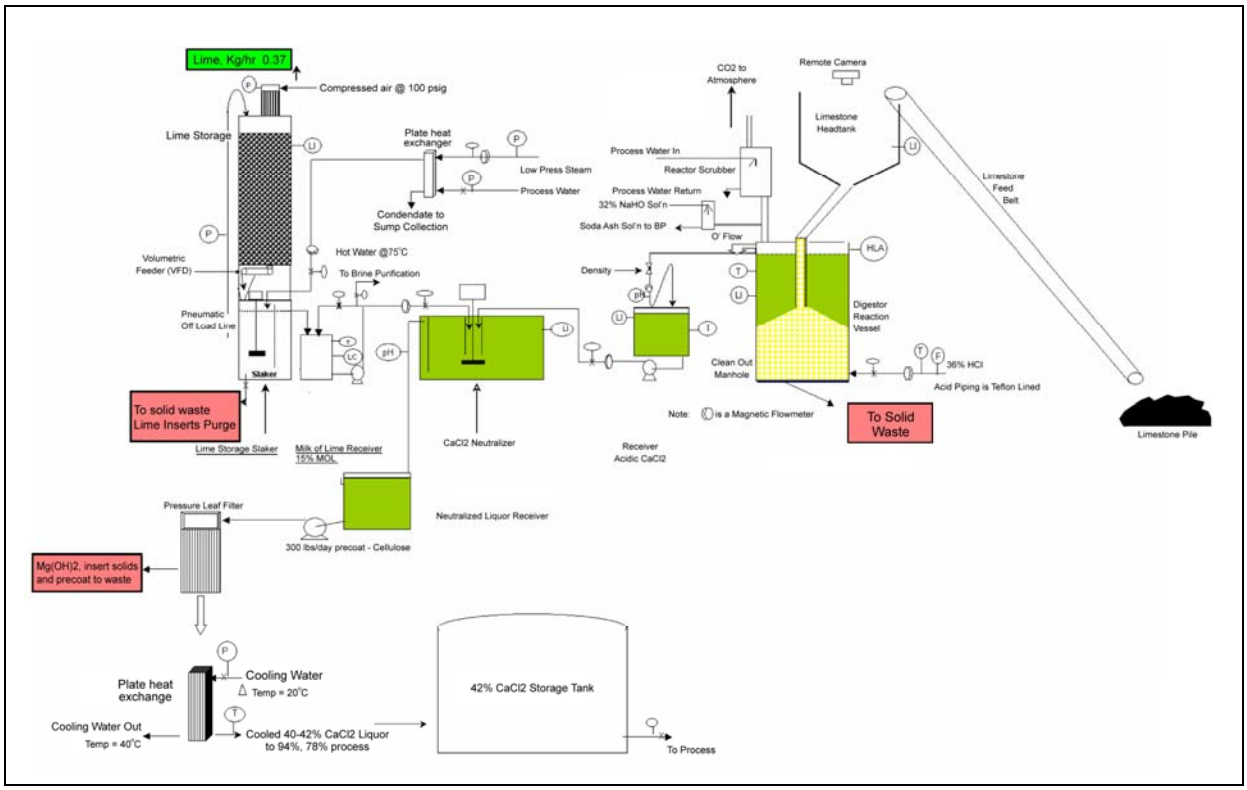


Figure 3.4-6. Generation of 42-percent calcium chloride solution.

If the Caroni option is chosen, some of the 42-percent calcium chloride solution produced will be produced for sale and export as "calcium chloride liquid" and will be piped to a tank at the EISL site for storage.

Step 5a of Calcium Chloride Production: Production of 94 percent $CaCl_2$ Pellets

The 42-percent calcium chloride solution (from Step 4) is mixed with recovered calcium chloride dust (from this step), and the resulting solution is warmed to 70 ºC and passed into a fluid bed dryer and spray system (Figure 3.4-7). The droplets formed by the sprayer coat calcium chloride spheres already present in the bed, causing them to grow and fall out of the bed once they have reached a certain size range (2 millimetres [mm] – 4 mm). These pellets are then screened, cooled, and bagged into flexible intermediate bulk containers (FIBC) and 25-kilo bags.

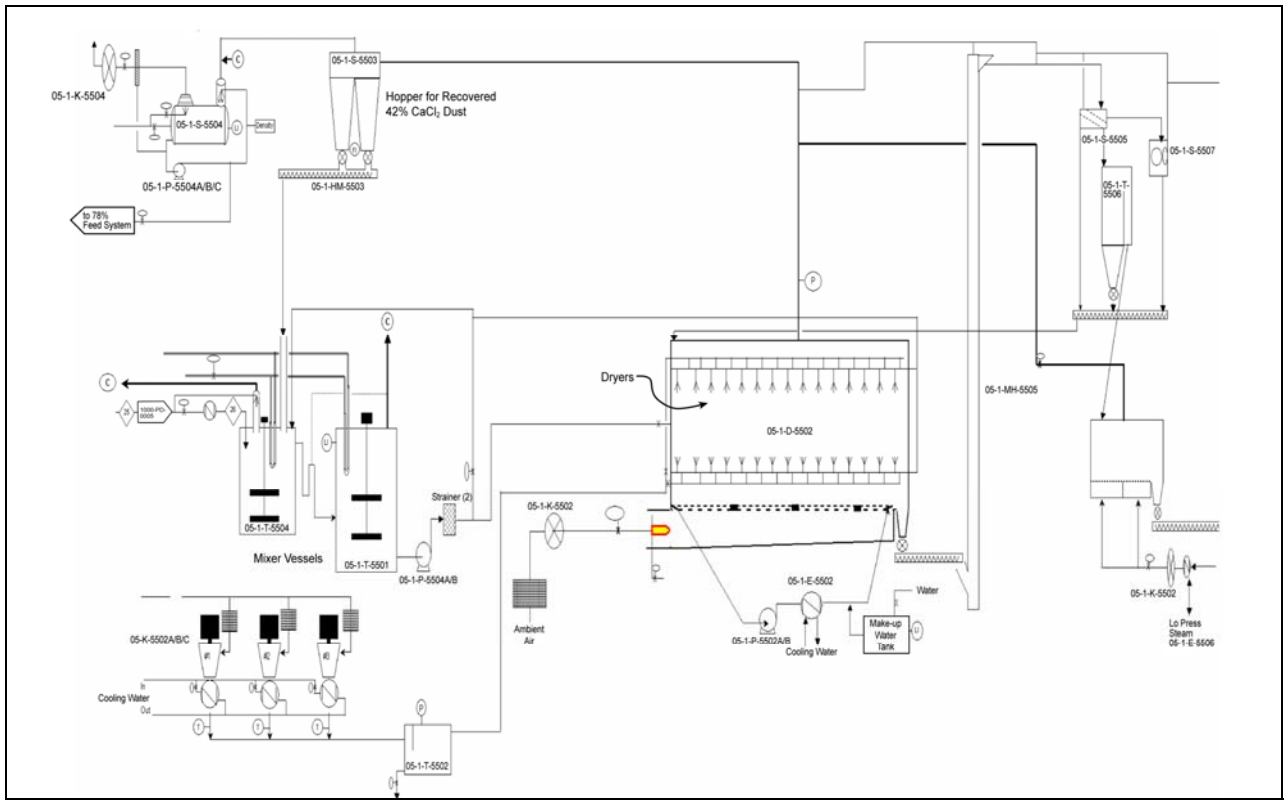


Figure 3.4-7. Production of 94-percent calcium chloride pellets.

Step 5b of Calcium Chloride Production Process: Production of 77 percent $CaCl_2$ Flakes

The 42-percent calcium chloride solution (from Step 4) is pumped to a steam-fed pre-heater/concentrator to concentrate the solution from 42 percent to 71 percent (Figure 3.4-8). The water removed (as vapour) is condensed and sent to the process water tank. The 71-percent solution is poured into a flaker—a drum with a water-cooled surface. The 71-percent solution solidifies into a thin layer when it contacts the cool drum surface. A rotating knife scrapes the thin solid layer onto conveyors that cool and dry the product, making it a 77-percent calcium chloride solid flaked product. The 77-percent flakes are bagged into FIBC and 25-kilo bags. Production of 77 percent $CaCl_2$ flakes begins once the second electrolyser unit and second HCl furnace are started up (see Section 3.8).

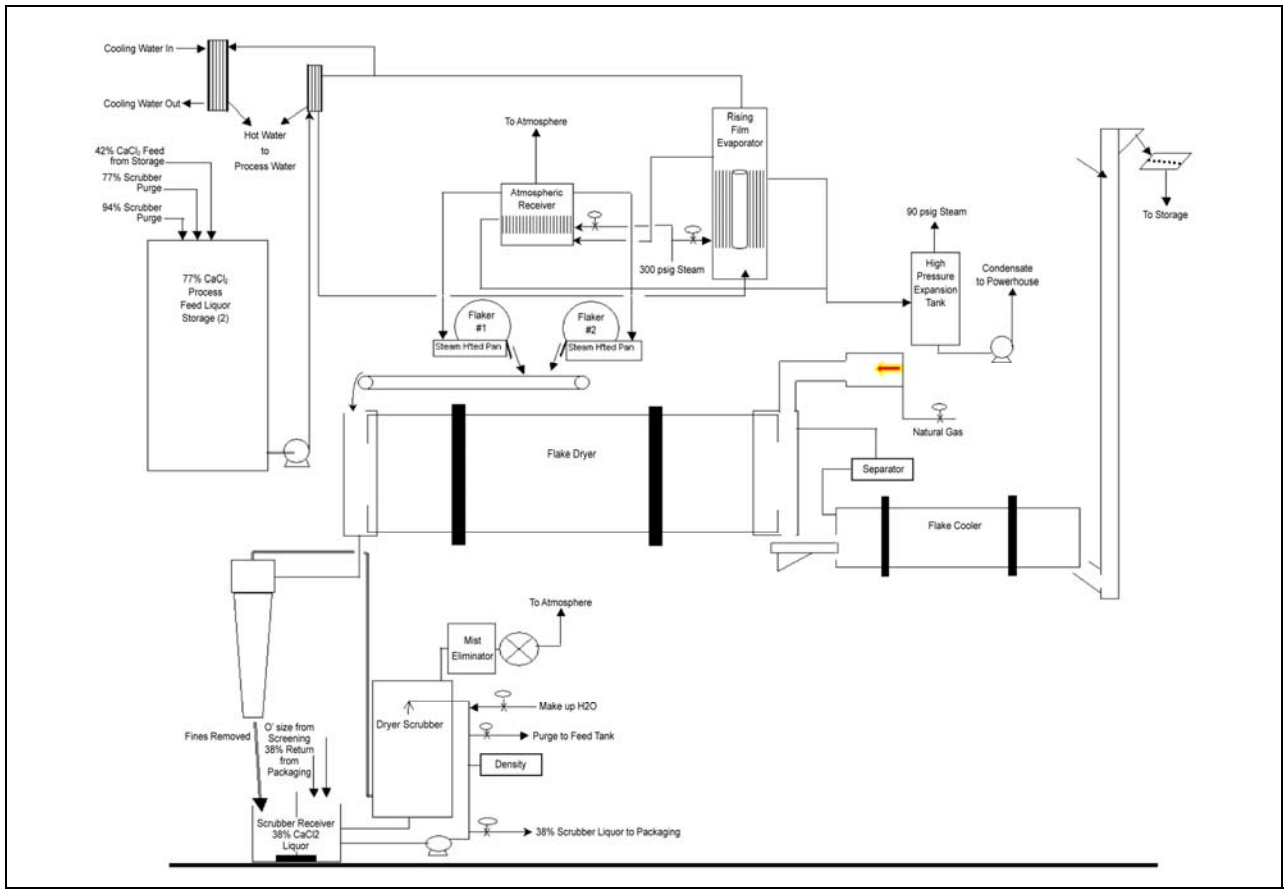


Figure 3.4-8. Production of 77-percent calcium chloride flakes.

3.4.2.2 Stage 2 Process

When the process has been demonstrated to function properly using pure salt in Stage 1, "dirty" salt (i.e., salt that is less expensive than that used in Stage 1 and contains more impurities) will be used as a raw material in the Stage 2 process. The steps of the Stage 2 process are largely the same as those for the Stage 1 process, except for the differences in Step 1, outlined below.

Step 1: Brine Generation and Purification

Approximately 20 MT/hr of "dirty" salt is mixed with brine from DESALCOTT (a 5.3-percent salt solution) and brine recycled from this step (Figure 3.4-9). The resulting brine stream is then purified as in Step 1 of Stage 1. The higher content of impurities in the dirty salt (compared to the pure salt) means that a greater quantity of brine muds (Section 3.4.7) is produced.

3.4.2.3 Stage 3 Process

In the Stage 3 process, the proportion of dirty salt is decreased (to 15 tonnes per hour) and the proportion of DESALCOTT brine increased such that demineralised water is generated by the process. This water is piped to WASA for its use. Step 1 now incorporates a salt crystalliser as follows:

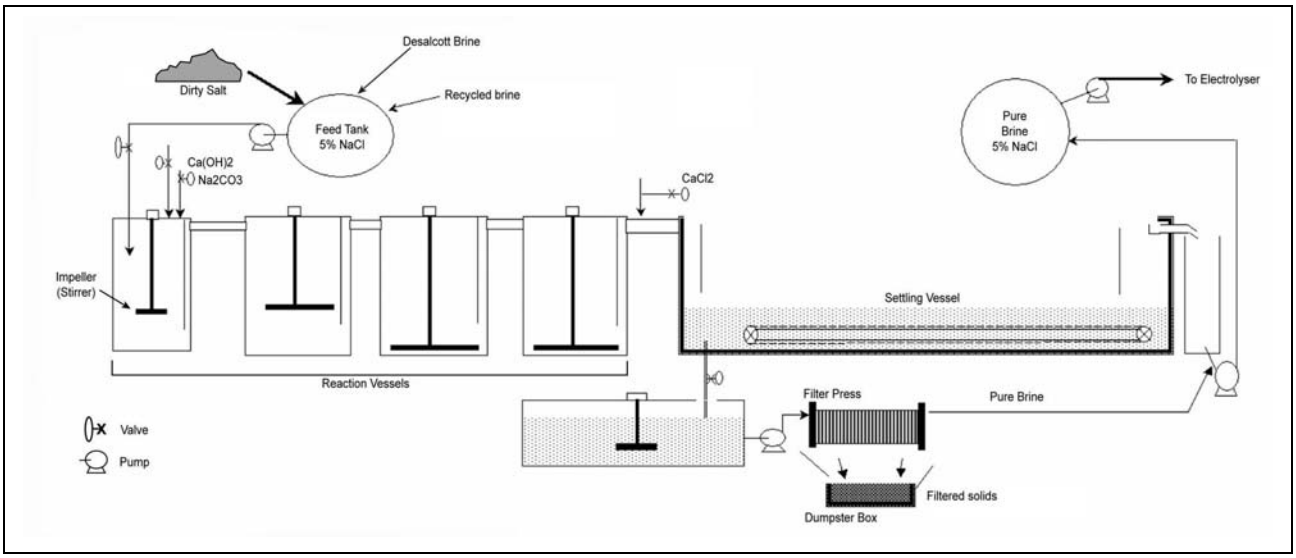


Figure 3.4-9. Brine generation and purification in Stage 2.

Step 1: Brine Generation Purification

A purified brine stream is produced as in Step 1 of Stage 2 and passed through the crystalliser to produce solid salt (Figure 3.4-10). Liquid from the crystalliser is recycled to the front of the process. The solid salt is fed to the salt saturator where it is mixed with recycled lean brine to produce saturated brine, which is then passed to the electrolyser.

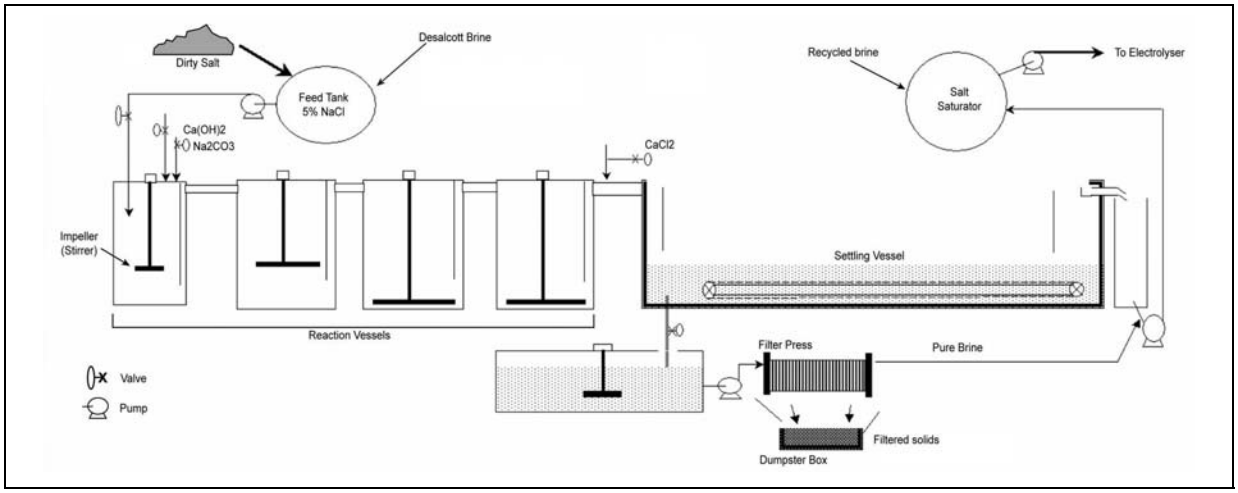


Figure 3.4-10. Brine generation and purification in Stage 3.

3.4.2.4 Stage 4 Process

In the Stage 4 process, no imported solid salt is used, only DESALCOTT brine. Concentration of the brine is performed by newly commissioned mechanical vapour recompressors (or, alternatively, by steam-driven evaporation). Step 1 is now as follows:

Step 1: Brine Generation, Purification and Concentration

The brine stream is purified as in Step 1 of Stage 3 and then steam-heated in a series of three closed mechanical vapour recompressor vessels to drive off water and thus concentrate the brine (Figure 3.4-11). The water vapour driven off from the first stage is compressed to a higher pressure and temperature using mechanical compression and used to drive the second and third stages of evaporation. Upon exiting the third-stage evaporator, the brine stream (now salt slurry)

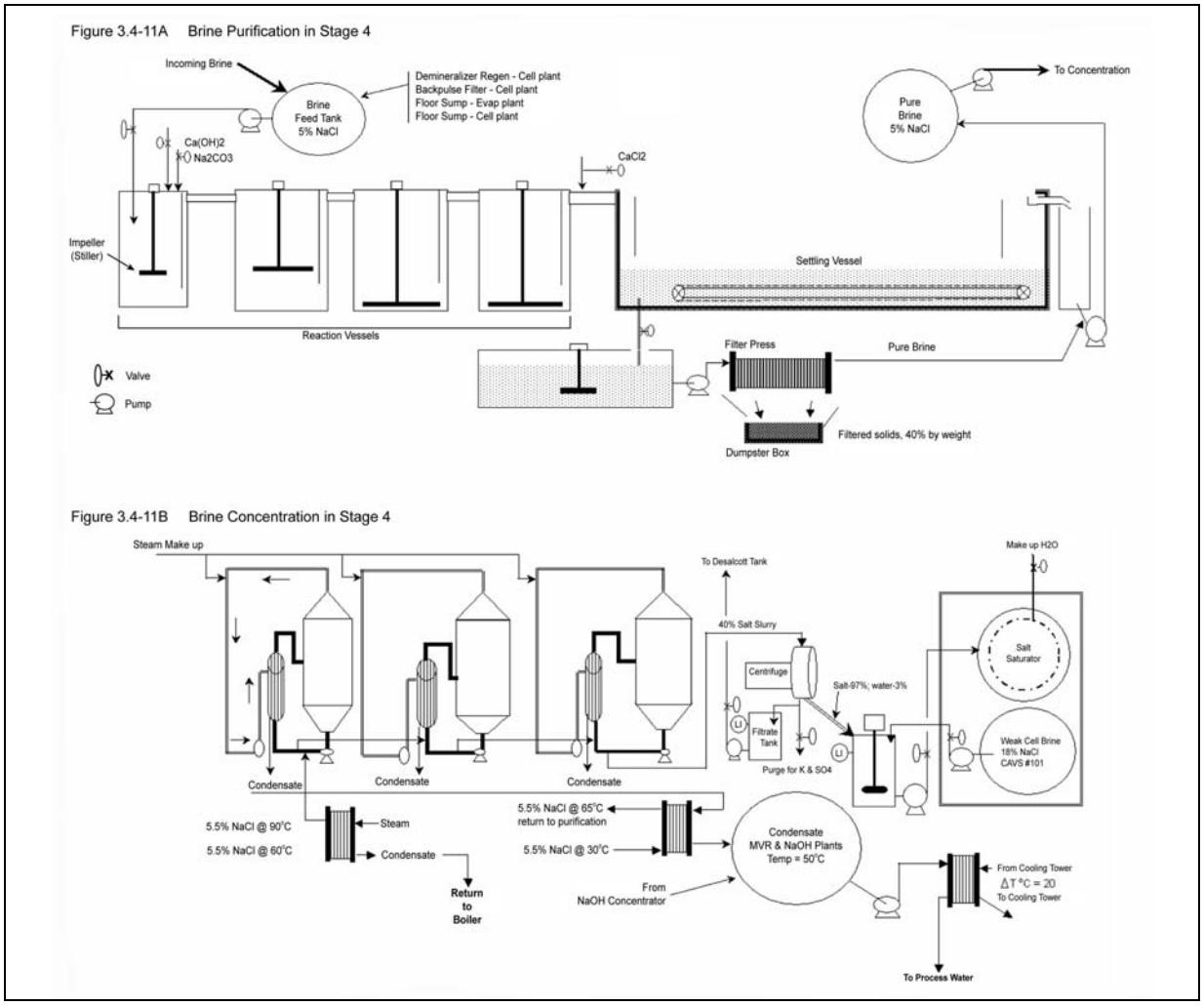


Figure 3.4-11. Brine generation, purification and concentration in Stage 4.

will be centrifuged to produce solid salt. The liquid from the slurry, "centrate" is recycled to the front of the process. The solid salt is fed into a salt saturation tank where it is mixed with recycled lean brine to produce saturated brine, which is then fed to the electrolyser.

The CariSal facility will have the following sources of CO_2:

1. Production of the 42-percent liquor from the chemical reaction of HCl and limestone, producing 49,600 MT/yr of CO_2 as a by-product.
2. Production of steam in the gas-fired boiler. The steam boiler will initially emit an estimated 76,928 MT/yr of CO_2. After CariSal installs and begins to operate the onsite cogeneration unit, waste heat from the cogeneration unit will reduce the gas requirements in the steam boiler by approximately 30 percent, and will therefore reduce the associated CO_2 emissions to an estimated 53,850 MT/yr. The cogeneration unit will supply about a third of CariSal's electrical needs. This process is more energy efficient as the combined cycle cogeneration unit produces both steam and electricity, and minimizes electric transmission losses.
3. Operation of the 77-percent dryer by burning natural gas for the production of dry flake calcium chloride, producing 2,106 MT/yr of CO_2.
4. Operation of the 94-percent dryer by burning natural gas for the production of dry calcium chloride pellets, producing 41,828 MT/yr of CO_2.

Of the total estimated CO_2 emissions of 170,400 MT/yr, 29 percent result from the chemical reaction of HCl and limestone, producing 49,600 MT/yr of highly pure CO_2 as a by-product. The highly pure CO_2 can be contained and sold as a useful product. The remaining 71%, or roughly 120,800 MT/yr, are the unavoidable end products of the combustion of natural gas used to generate steam or to operate the dryers to produce dry calcium chloride flake and pellets. There are no practical and cost effective methods to capture and purify the combustion-related CO_2 at the scale that will be produced by the CariSal plant, therefore, this CO_2 is vented to the atmosphere as in all similar combustion applications.

The highly pure CO_2 generated from the digestion of limestone with HCl would have commercial value as a marketable product. The EIA proposed transporting 100 percent of this recoverable CO_2, 49,600 MT/year, by pipeline to the proposed nearby TEIL facility for future urea production or to another user of CO_2.

CariSal has investigated alternative markets for this CO_2 in the event that the arrangements with the proposed TEIL facility do not come to fruition. For example, the KPA Group of Companies is pursuing a project which would compress CO_2 and transport it by pipeline for injection into offshore oil fields for enhanced oil recovery (EOR). The proposed project would include a compressor station located adjacent to YARA's east fence. KPA reportedly has already been granted space for the proposed CO_2 compressor station and is in negotiations to use the existing Petrotrin right-of-way for a pipeline to the southern production fields. The site for the proposed compressor station is close to CariSal's proposed caustic soda pipe line corridor to the EISL site. CariSal could easily accommodate a CO_2 line from the proposed CariSal facility to the compressor station in that same corridor as part of the CariSal Project development. No new right-of-way would be required. Other reasonably feasible alternative markets for this CO_2 would be explored by CariSal until a suitable solution can be found.

Figure 3.4-12 shows a flow diagram of the overall (Stage 4) process.

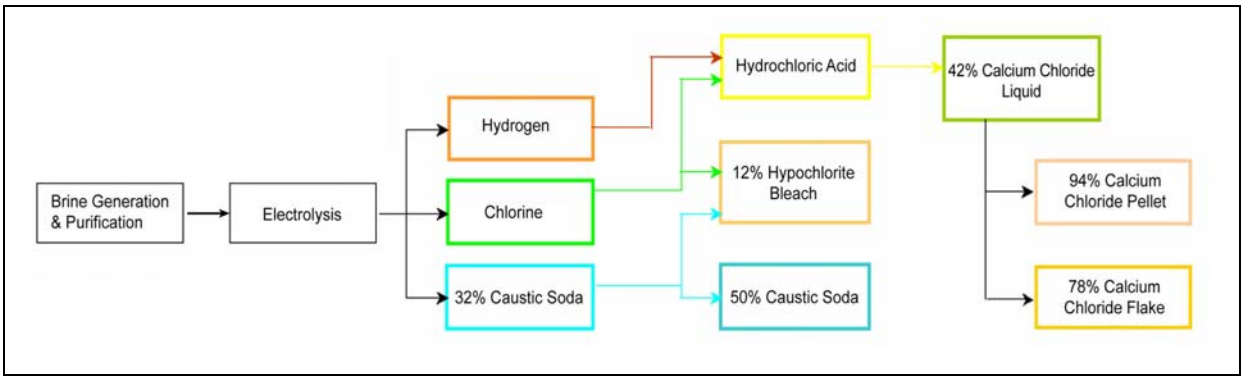


Figure 3.4-12. The CariSal chlor-alkali process.

3.4.3 Raw Materials, Intermediates and Products

Table 3.4-1 lists and quantifies the raw materials that would be brought onto the CariSal site (for consumption in the CariSal process).

Table 3.4-1. Raw Materials to Be Brought Onto the CariSal Site

Material	Hazardous	Quantity Used	Quantity Stored	Source	Transportation Method
Brine	No	Stage 1: 0 Stage 2: 23 m^3/hr Stage 3: 63 m^3/hr Stage 4: 357 m^3/hr (Salt content): Stage 1: 0 Stage 2: 10,813 MT/yr Stage 3: 27,033 MT/yr Stage 4: 168,959 MT/yr	464 m^3 of brine	DESALCOTT	Pipeline
Solid salt (shipped from Chile or other qualified suppliers)	No	Stage 1 (pure salt): 168,959 MT/yr Stage 2 (dirty salt): 158,146 MT/yr Stage 3 (dirty salt): 141,926 MT/yr Stage 4: 0	Up to 8,000 MT	Qualified Supplier	Ship to Savonetta; truck to CariSal (Option) purchase from Trinidad Chloride; truck to CariSal
Limestone (shipped from Canada)	No	All stages: 112,613 MT/yr	Up to 20,000 MT	Import	Ship to Savonetta; truck to CariSal (20 truck movements per day)
Lime (shipped from Barbados or Brazil)	Yes	21,657 MT/year	500 tonnes	Qualified Supplier	Truck

Table 3.4-1. Raw Materials to Be Brought Onto the CariSal Site

Sodium Bisulfite	Yes	33 kg/day	3,000 kg	Qualified Supplier	Truck
Sulphuric Acid	Yes	25 m^3/yr	Up to 2.3 m^3	Qualified Supplier	Truck
Microcellulose Filter Medium	No	183 MT/yr	Up to 18 MT	Qualified Supplier	Truck
Ion Exchange Resin	No	40 MT/yr	10 MT	Qualified Supplier	Truck
Activated Carbon	No	7 MT/yr	7 MT	Qualified Supplier	Truck
Potable water (used as process water)	No	Stage 1: 215.1 m^3/hr Stage 2: 192.1 m^3/hr Stage 3: 222.3 m^3/hr Stage 4: 0	2,300 m^3	WASA	Pipeline

Soda ash would be produced in the process prior to its consumption by the process and so would be classified as an intermediate (Table 3.4-2). Liquid nitrogen would be purchased and stored in a 25-m^3 cryogenic tank container in sufficient quantities to supply a continuous 5-m^3/hr flow of gaseous nitrogen to purge the catholyte tank. Table 3.4-2 lists and quantifies the intermediates that would be generated and used in the CariSal facilities.

Table 3.4-3 lists and quantifies the products that will be exported from the CariSal facility.

Table 3.4-2. Intermediates Generated By and Used In CariSal Process

Material	Hazardous?	Rate of Generation	Quantity Stored	Source	Use
32% Caustic Soda	Yes	All stages: 137,000 MT/yr	60 m^3	Electrolytic cells	Production of 50% Caustic Soda; Production of Soda Ash
Chlorine	Yes	All stages: 89,333 MT/yr	None	Electrolytic cells	Production of Hydrochloric Acid
Hydrogen	Yes	All stages: 2,516 MT/yr	None	Electrolytic cells	Production of Hydrochloric Acid
36% Hydrochloric Acid	Yes	All stages: 85,191 MT/yr	31.1 m^3	HCl Unit	Production of 42% Calcium Chloride

Table 3.4-2. Intermediates Generated By and Used In CariSal Process

Material	Hazardous?	Rate of Generation	Quantity Stored	Source	Use
42% Calcium Chloride Solution	Yes	All stages: 125,000 MT/yr	1,890 m^3	Calcium Chloride Production Unit	Production of 77% $CaCl_2$ flakes and 94% $CaCl_2$ pellets; Brine Purification
Soda Ash	Yes	Stage 1: 187 MT/yr Stage 2: 457 MT/yr Stage 3: 1,365 MT/yr Stage 4: 7,016 MT/yr	10 MT	Calcium Chloride Production Unit	Brine purification

Table 3.4-3. Products Generated at, and Exported from CariSal Facility

Product	Hazardous?	Quantity Exported	Quantity Stored	Destination	Transportation Method
Caustic Soda	Yes	All stages: 93,319 MT/yr	307 m^3 onsite; 9419 m^3 at EISL site	EISL	Pipeline
Calcium Chloride Flakes	Yes	All stages: 60,000 MT/yr	300 tonnes	Export	Truck, Ship
Calcium Chloride Pellets	Yes	All stages: 65,000 MT/yr	300 tonnes	Export	Truck, Ship
Carbon Dioxide (after 2011)	No	All stages: 49,600 MT/yr (from a total of 170,400 MT/yr)	None	TEIL or another user of CO_2	Pipeline
Bleach (12% solution)	Yes	All stages: 53,343 MT/yr	682 m^3	Local markets and export	Truck, Ship
Hydrochloric Acid (36% solution)	Yes	All stages: 1,280 MT/yr	1515 m^3	Local markets and export	Truck, Ship
Demineralised Water	No	Stage 1: 0 Stage 2: 0 Stage 3: up to 360,000 MT/yr (dependent on product mix) Stage 4: up to 920,000 MT/yr (dependent on product mix)	None	WASA	Pipeline

If the Caroni option is chosen, an unquantified portion of the 42-percent calcium chloride solution produced will be produced for sale and export as "calcium chloride liquid" and be piped to a tank at the EISL site for storage. If suitability tests allow, certain non-hazardous, solid, process wastes would be sold as road stabilizer rather than landfilled (Table 3.4-4). These secondary products are limestone inerts, lime inerts, and magnesium hydroxide from lime (from Step 4 of Calcium Chloride Production).

Table 3.4-4. Potential Products from Non-hazardous Solid Waste

Product	Quantity Exported	Destination	Transportation Method
Limestone Inerts, Dry Basis (Magnesium Carbonate and Silica)	All stages: 649 MT/yr	Local markets	Truck
Lime Inerts, Dry Basis	Stage 1: 100 MT/yr Stage 2: 219 MT/yr Stage 3: 146 MT/yr Stage 4: 500 MT/yr	Local markets	Truck
Magnesium Hydroxide from Lime, Dry Basis	All stages: 69 MT/yr	Local markets	Truck

The surface on which stockpiled solids would be stored would be concrete. Soluble solids would be stored in covered areas (e.g., salt) or containers (e.g., calcium chloride).

3.4.4 Workforce

During the operations phase, the workforce would number 75 in total: around 40 technical staff (working on a two-shift system) and around 35 management, support, and administrative staff working a 5-day, 40-hour week. CariSal's intent is to create a 100-percent Trinidad and Tobago-operated company.

3.4.5 Water

No abstraction of water would occur at the site. During Stages 1 through 3, the principal source of process, utility, and potable water will be approximately 220 m^3/hr of potable water supplied by WASA from the water main running alongside Southern main Road, near the CariSal site. In Stage 3, the brine stream from DESALCOTT would come online. In Stage 4, the brine stream from DESALCOTT would become the major source of process and utility water through the recycling of water removed during brine concentration.

Other, smaller, sources would include collected rainwater run-off from process areas and undeveloped areas of the site. This run-off would be collected in the Containment Pit or the clean water Retention Pond. These retention areas would be sized to contain 50-year storms.

The process itself would be running a surplus of demineralised water (depending on product mix) that would be piped to WASA for distribution to industrial consumers in the vicinity.

Table 3.4-5 shows the water balance of the CariSal facility.

Table 3.4-5. CariSal Water Balance

Water Sources in m^3/hr	Stage 1	Stage 2	Stage 3	Stage 4
Dikes and Roof Area Rainfall	4.9	4.9	4.9	4.9
Sanitary, Drinking, and Safety – WASA	4.1	4.1	4.1	4.1
Potable Water from WASA	219.2	219.2	222.3	0.0
Waste Brine from DESALCOTT	0.0	0.0	63.0	357.0
Excess Water Returned to WASA	0.0	0.0	-60.0	-153.2
CariSal Water Usage	-224.0	-224.0	-234.2	-212.8
Total	**0.0**	**0.0**	**0.0**	**0.0**

Table 3.4-6 shows water usages within the CariSal facility.

Table 3.4-6. Breakdown of CariSal Water Usage

Water Usages in m^3/hr	Stage 1	Stage 2	Stage 3	Stage 4
Calcium Chloride Plant (seals)	5.0	5.0	5.0	5.0
Process Water Makeup	5.1	5.1	5.1	5.1
Sodium Hydroxide Condensate	-13.5	-13.5	-13.5	-13.5
Sanitary, Drinking and Safety	4.1	4.1	4.1	4.1
Cooling Tower Makeup	159.1	159.1	159.1*	131.0*
Chlor-alkali Plant	62.6	62.6	62.6	62.6
Boiler Feed Makeup	1.6	1.6	11.8	13.2
Potassium Control Purge	0.0	0.0	0.0	5.2
Total	**224.0**	**224.0**	**234.2**	**212.8**

If steam evaporation were adopted instead of mechanical vapour recompression, cooling tower makeup would rise to 190.9 m^3/hr in Stage 3 and 157.2 m^3/hr in Stage 4, and so the quantity of excess water produced and exported to WASA would be commensurately lower: 28.3 m^3/hr in Stage 3 instead of 60.0 m^3/hr and 127.0 m^3/hr in State 4 instead of 153.2 m^3/hr.

The firewater system would be fed by the WASA water tank, which would be 600,000 gallons (2,271 m^3) in capacity.

3.4.6 Other Utilities

Electricity would be provided by a connection to the T&TEC grid. Consumption would be on the order of 24 megavolt amp-years (MVA-Years) for Stage 1 and 43 MVA-Years for the other stages. A cogeneration plant (consisting of three 7.5-MW gas-fired units) would be used as alternate power in Stage 4 (see Section 3.8).

Natural gas for the steam boiler would be supplied through a pipeline spur from the NGC pipeline that runs along the southern boundary of the site. Consumption would be approximately 4,500 million standard cubic feet (127.4 million m^3) per day in Stages 1 through 3, and approximately 7,300 million standard cubic feet (206.7 million m^3) per day in Stage 4, when the mechanical vapour compressors would be commissioned. Steam production would rise from 32,537 kg/hr in Stages 1 and 2 to 53,987 kg/hr in Stage 3 to 66,231 kg/hr in Stage 4.

Under normal operations, 5 m^3/hr nitrogen (gaseous) would be used for purging the catholyte tank. Under startup or shutdown (planned or unplanned), 100 m^3/hr nitrogen would be required. Liquid nitrogen would be stored in a 25-m^3 capacity tank.

Approximately 1,200 m^3/hr compressed air would be produced by air compressors throughout Stages 1 to 4 inclusive.

3.4.7 Waste Management

Waste would be handled and disposed of in accordance with a waste-management system of the kind described in Section 3.3.6. Table 3.4-7 characterizes the solid wastes that would be generated during operation of the CariSal Project.

There would be no liquid wastes. Sanitary wastewater would be fed (0.38 m^3/hr) to an aerobic treatment unit and disinfection unit (of capacity 330 m^3/day) with the treated discharge directed to the Containment Pit.

Table 3.4-7. Solid Waste Generated During Operations Phase

Solid Wastes	Quantity (MT/ year)				Fate
	Stage 1	Stage 2	Stage 3	Stage 4	
Typical Business Waste (Paper, Wood, etc.)	0.3 – 0.5	0.3 – 0.5	0.3 – 0.5	0.3 – 0.5	Stored in proper waste containers and regularly removed to an authorised waste management facility for recycling or landfilling
Limestone Inerts, Dry Basis (Magnesium Carbonate and Silica Removed During the Digestion Process)	649	649	649	649	Will be tested, then sold as a road stabiliser or sent to a qualified landfill
Lime Inerts, Dry Basis	100	219	146	500	Will be tested, sold as a road stabiliser or sent to a qualified landfill
Magnesium Hydroxide from Lime, Dry Basis	69	69	69	69	Will be sold as a road stabiliser or sent to a qualified landfill
Brine Muds, Dry Basis (Impurities Precipitated During Brine Purification)	461	3,500	7,000	48,356	Collected, tested, dewatered, and disposed of by an appropriately qualified and experienced contractor in a suitable landfill

Table 3.4-7. Solid Waste Generated During Operations Phase

Solid Wastes	Quantity (MT/ year)				Fate
Cooling Tower Blowdown	328 – 529	328 – 529	328 – 529	328 – 529	Tested; hauled to an appropriate waste disposal site by a qualified solid and industrial waste contractor
Settled Solids in Containment Pit and Sand Traps, Dry Basis	2.0	2.0	2.0	2.0	Periodically dredged, tested, and removed by a qualified solid and industrial waste contractor
Settled Solids in Retention Pond and Sand Traps, Dry Basis	2.4	2.4	2.4	2.4	Sediments will be tested regularly and removed about every 2 to 5 years; removed sediment will be disposed of by a qualified industrial waste management contractor or if appropriate per environmental standards, reapplied on site
Spent Microcellulose Filter Medium	50	183	183	183	Will be tested, then sent to an approved landfill
Spent Ion Exchange Resin	10	40	40	40	Will be tested, then sent to an approved landfill
Spent Activated Carbon	7	7	7	7	Will be tested, then sent to an approved landfill

In addition to the wastes disposed of annually in Table 3.4-6, every 7 to 10 years, the polymer membranes from the electrolysers are removed, washed free of all chemicals (wash water going to the Containment Pit), and disposed of in an approved landfill. The total weight of all the membranes replaced at one time would be approximately 500 kg.

3.4.8 Hazardous Materials

Substances posing a safety hazard that would be used, produced, or stored at the facility are chlorine gas; hydrogen gas; caustic soda (solutions ranging in concentration from 32 percent to 50 percent); bleach (12-percent solution); and hydrochloric acid (36-percent solution). The Quantitative Risk Assessment for this development is located in Appendix C and Attachment 4 of Appendix C. Both the unmitigated risk and the mitigated risk resulting from engineering and procedural controls are found within the Quantitative Risk Assessment.

3.4.8.1 Chlorine (Cl_2)

Chlorine gas would be generated in the electrolysers when brine is electrolysed into chlorine gas, hydrogen gas, and sodium hydroxide (Step 3). At the CariSal Unlimited facility, chlorine gas would be present in the electrolysers (47 lbs or 21.4 kg in each of two units, for a total of 94 lbs or 42.8 kg) and the piping from the cells to the hydrogen-chloride production units, estimated to be approximately 104 lbs or 47 kg, for an estimated total system inventory of approximately 198 lbs or 90 kg at any time.

Chlorine would not be handled by employees or stored or otherwise allowed to accumulate in the plant. Approximately 1.5 g/hr (0.0034 pounds/hr) of chlorine gas would be emitted from the process via the caustic scrubbers into the atmosphere, where it would dissipate. Workers would not be exposed to concentrations of chlorine gas above the recommended thresholds (i.e., per OSHA). CariSal would also develop its environmental health and safety management plan in compliance with the Trinidad and Tobago Occupational Safety and Health Act 2004 and 2006 Amendment with regard to ensuring workplace safety.

3.4.8.2 Hydrogen (H_2)

Hydrogen gas would be generated in the electrolysers when brine is electrolysed into chlorine gas, hydrogen gas, and sodium hydroxide (Step 3). At the CariSal Unlimited facility, hydrogen gas would be present in the electrolysers (1.3 lbs or 0.6 kg in each of two units, for a total of 2.6 lbs or 1.2 kg). It would also be present in the piping from the cells to the hydrogen-chloride production units and to the hydrogen vent stack via the hydrogen-chloride scrubber, estimated to be approximately 6 lbs or 2.8 kg. The estimated total system inventory would be 5.6 lbs or 2.6 kg at any time.

Hydrogen would not be handled by employees or stored or otherwise allowed to accumulate in the plant. Approximately 27 kg/hr (60 pounds/hr) of hydrogen gas would be emitted from the process via the hydrogen vent stack and via the hydrogen-chloride scrubber into the atmosphere, where it would dissipate.

3.4.8.2 Caustic soda (NaOH solution)

Including the proposed shore tank at the EISL site or the two retrofitted tanks at the Caroni facility, caustic soda would be stored in six or seven bunded tanks. The tank design would include pressure/vacuum relief valves at the top, in accordance with the relevant American Petroleum Institute (API) standard for atmospheric pressure storage, allowing the caustic soda tanks to be naturally aspirated. These tanks are:

- Receiver tank: 10 ft by 27 ft (3.05 m by 8.23 m) and holding 15,854 gal (60.0 m^3),
- Four intermediate storage tanks: each 12 ft in diameter by 24 ft tall (3.66 m by 7.32 m) and holding 81,000 gal (307 m^3) each, and
- Either EISL facility storage tank: 84 ft in diameter and 60 ft tall (25.6 m by 18.3 m), capacity 2,488,320 gals (9,419 m^3)
- Or two retrofitted tanks at Caroni site, each 84 ft in diameter and 54 ft tall (25.6 m by 16.5 m), capacity 2,239,490 gal (8,477 m^3)

The receiver tank would be used to store (intermediate) 32-percent caustic soda; the other tanks would be used to store (product) 50-percent caustic soda. The amount of caustic soda product stored would be 2,569,000 gal (9,726 m^3), but total caustic soda storage capacity would be approximately 2,828,000 gal (10,710 m^3) with the EISL option or 4,819,000 gal (18,240 m^3) with the EISL option.

3.4.8.3 Bleach [sodium hypochlorite (NaOCl) solution]

Before storing, the product would be cooled to enable storage at ambient temperatures, thus avoiding the necessity of a scrubbed vent. Bleach would be contained in six bunded tanks:

- Two receiver tanks: each 5 ft in diameter by 24 ft tall (1.52 m by 7.32 m) with a resulting maximum capacity of 3,526 gal (13.35 m^3) each; and
- Four storage tanks with a capacity of 45,000 gal (170.3 m^3) each, which is the maximum volume generated from four days of production.

Total bleach storage would be approximately 183,000 gal (692 m^3); total storage capacity would be approximately 187,000 gal (708 m^3).

3.4.8.4 Hydrochloric acid (HCl)

Hydrochloric acid would be stored in six bunded tanks:

- One internal storage tank 10 ft in diameter by 14 ft tall (3.05 m by 4.26 m) holding 5,878 gal (22.2 m^3) of hydrochloric acid;
- Four hydrochloric acid receivers, each 12 ft in diameter by 24 ft tall (3.66 m by 7.32 m) holding 20,312 gal (76.9 m^3); and
- One product storage tank 42 ft in diameter by 40 ft tall (12.8 m by 12.2 m) holding 400,000 gal (1,514 m^3).

Total hydrochloric acid storage would be approximately 408,400 gal (1,546 m^3); total storage capacity would be 489,393 gal (1,853 m^3).

3.4.8.5 Sodium Bisulfite ($NaHSO_3$)

Sodium bisulfite in 25-kg bags would be delivered to the facility by truck about 4 times per year, with each delivery consisting of 3 pallets of 40 bags each for storage in the warehouse. Workers wearing appropriate PPE in accordance with the MSDS would manually add about 33 kg of sodium bisulfite per day to a batching hopper with water from which the solution would be automatically metered into the spent brine stream.

3.4.9 Air, Noise, and Light Emissions

Emissions of gases and dust to the atmosphere during the operations phase are summarized in Table 3.4-8.

Table 3.4-8. Gaseous And Dust Emissions During Operations Phase (including the Cogeneration facility)

Substance Emitted	Source	Rate of Emission
Carbon dioxide	Calcium chloride production	170,400 MT/year (118,260 MT/year from Cogen facility)
Chlorine gas	Chlor-alkali electrolysis	14 kg/year

Table 3.4-8. Gaseous And Dust Emissions During Operations Phase (including the Cogeneration facility)

Substance Emitted	Source	Rate of Emission
Hydrogen gas	Chlor-alkali electrolysis via hydrogen vent stack and via the HCL scrubber	238 MT/year
Gaseous hydrochloric acid	Scrubbers on hydrochloric acid production unit	0.024 MT/year
Calcium chloride (size smaller than 44 micrometers, µm)	Fugitive, from drying and packaging operations	10.3 MT/year
Water vapour	Processing of calcium chloride liquor	324,000 MT/year
Nitrogen oxides	Exhaust gases from 94% $CaCl_2$ and 77% $CaCl_2$ dryer	141.9 MT/year (97.7 MT/year from Cogen facility)
Carbon monoxide	Exhaust gases from 94% $CaCl_2$ and 77% $CaCl_2$ dryer	62.1 MT/year (25.0 MT/year from Cogen facility)
Sulphur dioxide	Exhaust gases from 94% $CaCl_2$ and 77% $CaCl_2$ dryer	1.307 MT/year (1.04 MT/year from Cogen facility)
Lime dust	Calcium chloride production	0.00013 MT/year
Particulate	Cogen Facility	2.02 MT/year

CariSal's process design would allow for reductions in carbon dioxide from what would otherwise be produced, primarily, by exporting 49,600 MT/year to TEIL (or another user of CO_2) by pipeline (from 2011) and, secondarily, by planting a grove of about 948 trees in the northern part of the site.

Noise levels within the plant would be less than or equal to 85 decibels, except next to the hydrogen chloride furnace, the fans in the 94-percent $CaCl_2$ pellet production unit, and the evaporator circulating pump in the brine concentration unit. The size of the motors on these pumps and fans would be 600 horsepower and 1,000 horsepower (447 kW and 746 kW), respectively.

Light pollution would be minimised during the operations phase by means of an exterior lighting plan, which would be devised during the design phase. Elements of this plan may include shielding for lights, so that the light would be directed toward the intended areas and light leakage into surrounding areas would be minimised, and a ban on up-lighting from outdoor light fixtures.

3.4.10 Maintenance

An in-house maintenance crew, comprising mechanical, electrical, and instrumentation disciplines, would undertake periodic inspections and day-to-day minor maintenance, such as lubrication of mechanical equipment or tuning of control instruments. In-house maintenance crews would also undertake scheduled maintenance shutdowns of process units and repair or replacement of equipment items, for example, the replacement every 7 to 10 years of the cell membranes.

3.4.11 Safety and Emergency

CariSal's safety philosophy comprises the following elements:

- Inherently safe process design,
- Strategically placed instrumentation
- On-going operator training/testing,
- Safety interlocks,
- Physical and mechanical safety devices, and
- Emergency systems.

Contractors as well as employees would be required to undergo training to obtain necessary certification regarding safety performance standards.

Critical process systems, emergency trip systems, chlorine area monitoring, strategic control valve failure positions, and emergency power systems have been incorporated into the CariSal facility design to make the process inherently safe.

Instrumentation would be provided at key locations in the process to enable operators to monitor critical plant parameters. A thorough process-training programme (with qualification testing) would ensure that operators have the knowledge to use this process information to avoid unsafe operating conditions.

A safety-and-interlock system would continuously monitor all critical operating parameters and take corrective action before hazardous conditions could develop. Typical interlock actions would be the shutdown of pumps, fans, and other plant equipment; the opening or closing of control valves; and initiation of process purge streams. Before the interlock action took place, an alarm would sound on the distributed control system (DCS) warning the operator that the process parameter had deviated from the normal operating range.

Safety devices such as liquid seals and dikes would provide backup if the process were to develop a hazardous condition. Dike or containment walls and sumps have been designed to avoid the mixing of incompatible chemicals.

Safety showers would be located at strategic locations throughout the plants. The safety showers would be equipped with local flashing lights and remote indication in the DCS, activated on use of the shower.

Portable fire extinguishers also would be provided in the plants. Carbon dioxide extinguishers would be provided in the control room and master control centre (MCC) room to extinguish any electrical fires. In addition, a firewater ring line would be provided. A firewater pump and firewater jockey pump would deliver water to the firewater stations and to the sprinkler systems in the buildings.

Hazardous-gas monitors for chlorine, hydrogen, and hypochlorite would be located at strategic locations throughout the plant. These locations include the HCl synthesis area, brine dechlorination area, and cell room as shown in Figure 3.4-13. Additionally, one hypochlorite monitor will be added to the design and placed in an appropriate location.

Critical instruments would be hard-wired to a separate panel. These instruments would provide continuing operation during an emergency, for example, loss of main electrical power or DCS.

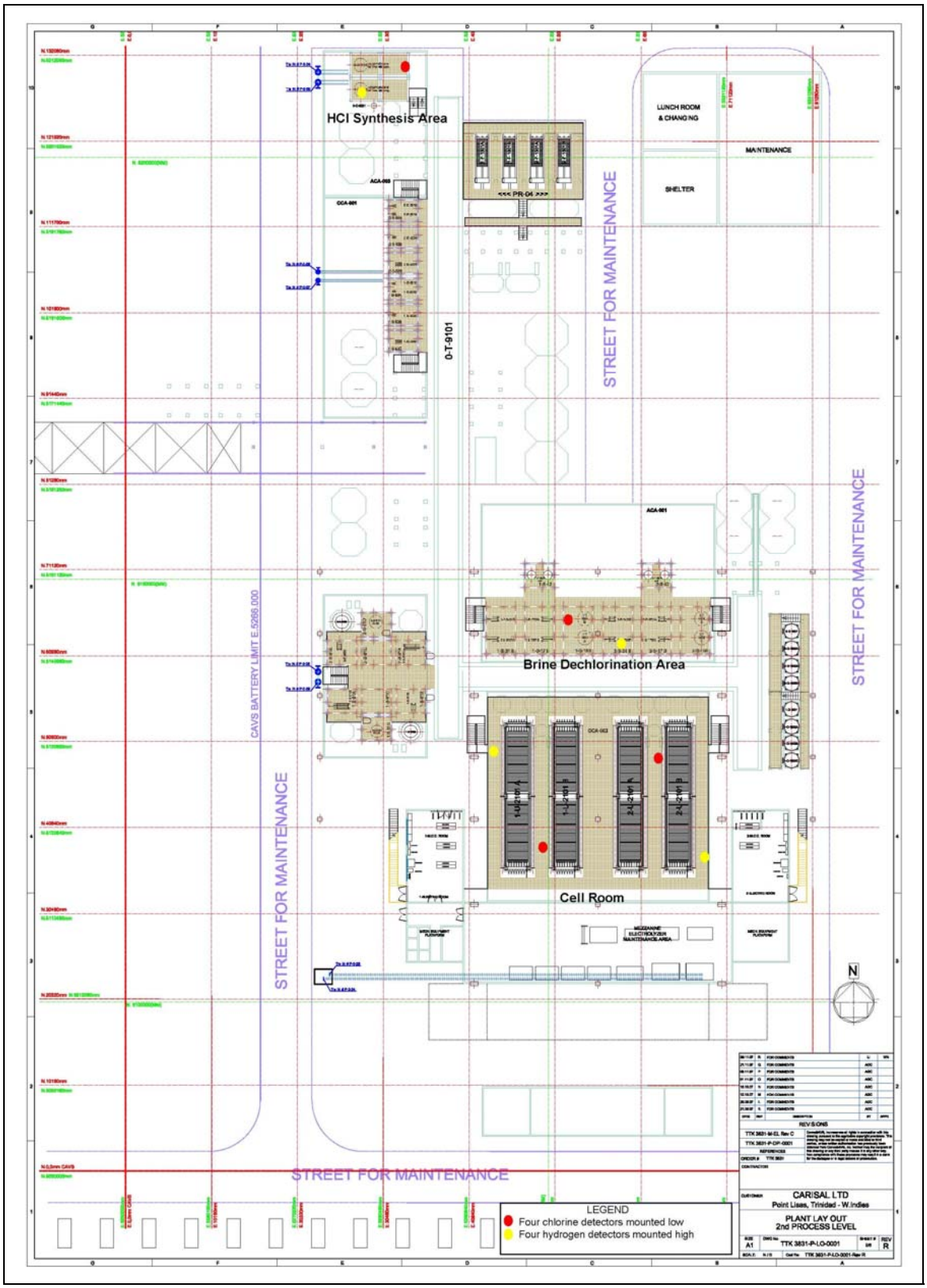


Figure 3.4-13. Locations of hazardous-gas monitors.

3.5 DECOMMISSIONING PHASE

The lifespan of the CariSal facility is envisioned to be at least 20 years, at the end of which a decommissioning plan would be implemented. A detailed plan would be written near the end of the CariSal Project so that the actual state of the surrounding environment and contemporary decommissioning best practices can be accounted for (particularly, relating to equipment removal and building demolition) and would be presented to the EMA for approval. However, decommissioning would have to involve the final shutdown of the production process, which is expected to follow the procedure described below.

Shutdown would begin with the cessation of import of brine from DESALCOTT and the shutdown of the brine purification process. The purification unit would be emptied and washed until the chloride concentration in the wash water has decreased to less than 250 parts per million (ppm) (250 mg/L). The wash water would be discharged to the Containment Pit (Pond #2), the contents of which would be consumed as makeup to the calcium chloride processes. The vessels, pipe work, and other process equipment comprising the purification unit would be open to the atmosphere to promote draining (to the Containment Pit). All solids would be discharged through the settlers and filter. The filter cake would be tested and sent to an approved landfill.

Next would be to stop the concentration of brine to salt. Once the evaporative processes involved in that process step have been shut down, the process equipment (mechanical vapour recompressors, centrifuge, etc.) would be washed until the chloride concentration in the wash water has fallen to less than 250 ppm (250 mg/L). The wash water would be discharged to the Containment Pit, the contents of which would be consumed as makeup to the calcium chloride processes. The equipment used in this process step would be opened to the atmosphere to promote draining.

The reconfigured plant would be operated to exhaust the salt, lime/limestone inventories, and water inventory in the Containment Pit. All usable salt remaining on site would be consumed in accordance with a published schedule.

When the salt inventory is depleted to zero, the electrolysis facility would be shut down, purged of all gases, and cleaned to remove soluble salts. The cells and associated equipment would be opened to the atmosphere to promote draining to the Containment Pit. Wash water would be discharged to the Containment Pit. Production of sodium hypochlorite would be shut down once all chlorine has been discharged from the electrolysis facility. Residual inventory of bleach would be sold to a zero inventory. Process equipment would be washed and opened to the atmosphere to promote draining to the Containment Pit. Cell membranes would be disposed of as when replaced during operations (Section 3.4.7).

Once hypochlorite production had been shut down, remaining inventory of 32-percent caustic would be concentrated to 50-percent caustic soda, which would be sold to a zero inventory. The pipeline for exporting caustic soda to EISL would be flushed to the Containment Pit and shut down.

The inventory of hydrochloric acid would be used to consume the entire onsite inventory of usable limestone/lime. (Any lime/limestone deemed unusable would be sold or disposed of in an environmentally acceptable manner.) Any hydrochloric acid remaining after this step has been completed would be sold. The calcium chloride processes would be continued, to consume as much as possible of the Containment Pit inventory while producing calcium chloride solution of the highest strength attainable, which may be lower than the 42 percent in the operations phase. This residual solution would be used to produce as much as possible of the 77-percent calcium chloride flake.

The 94-percent calcium chloride production unit would be shut down and washed to remove all products. Wash water would be fed to the 77-percent flake unit, if its calcium chloride concentration is high enough, or to the Containment Pit, if not.

When all 42-percent calcium chloride solution had been consumed, the contents of the boiler, cooling towers, and process water tanks would be emptied into the Containment Pit. The remaining fluids in the plant will be the calcium chloride solution (greater than 30 percent) in the scrubber system [which holds about 20,000 gallons (76 m^3)], the water in the Containment Pit (which would have a minimal chloride content), and the water in the Retention Pond (which would be simply rainwater). The residual calcium chloride solution from the scrubber could be applied to local dirt roads for dust control and base stabilization. It would also be suitable for use as a concrete additive promoting early setting. The residual fluids in the Retention Pond and the Containment Pit could be discharged to local waterways if of suitable quality and if this action were in accord with regulations in place at the time of plant shutdown. If such discharge were not permitted, the waters would be trucked to a suitable disposal facility. It is estimated that the Containment Pit inventory would be no more than 1.6 million gallons (6,020 m^3) of less than 1-percent chloride strength, the equivalent of approximately 270 tanker truck loads. Retention Pond volume would be a function of rainfall at the time of shutdown, but at a maximum would be 2.0 million gallons (7,680 m^3), the equivalent of approximately 330 tanker truck loads. The volume of retention pond water requiring disposal could be reduced through natural evaporation, especially in the dry season.

If a new use for the plant could not be found, plant equipment would be cleaned, dismantled, and sold. Once the site is clear of all equipment and structures, the foundations would be removed and the site levelled. Geomembrane pond linings would be transported by licensed waste hauler for offsite recycling or, when recycling is not possible, disposal at permitted landfill. Building materials such as concrete and steel would be recycled to the extent possible. The remaining building materials would be disposed of as construction and demolition debris in an approved landfill.

3.6 SCHEDULING

Table 3.6-1 shows CariSal's current project schedule from October 2006, when FEED was initiated to full commercial operations.

Table 3.6-1. CariSal Project Schedule

Milestones	Date
Initiate FEED	October 1, 2006
Submit CEC Application	December 15, 2006
Complete FEED for Chlor-alkali Unit	August 1, 2007
Complete FEED for Balance of Plant	June 1, 2008
Detailed Design	October 1, 2007 to December 31, 2008
Mobilise to Trinidad and Tobago	October 1, 2008
Anticipated Date for CEC	September 21, 2008
Start Date for Site Work	October 15, 2008 (Week 0)
Phase I	
Receive First Module	Week 8
Mechanical Construction	Week 11
Receive Electrolysers	Week 12
Start Date for Commissioning	Week 33
Calcium Chloride and 94% Dryer Operational	Week 50
First Chlor-alkali Unit Operational	Week 51
Phase II	
Second Chlor-alkali Unit Operational	Week 60
77% Flake Unit Operational	Week 60 or earlier
Co-generation Unit Operational	Week 64
Brine Purification Unit Operational[a]	TBD
Salt Crystallisation Unit Operational	TBD
Full Operation on DESALCOTT Brine	TBD

[a] Dependent on viability analysis.

For the purposes of assessing impacts, this schedule may be simplified to:

- Project Design: October 2006 though October 2008
- Site Preparation and Construction: October 2008 though October 2009
- Plant Start-Up: October 2009 through May 2010
- Full Plant Operations: June 2010 onward for 20+ years
- Decommissioning: After 20+ years

4.0 DESCRIPTION OF THE ENVIRONMENT

This chapter provides a description of the natural environmental setting at Point Lisas with respect to the current physical, biological, and socioeconomic environments. These descriptions are based on bench reviews of available historical information, field reconnaissance and surveys, monitoring and measurements taken on or in the vicinity of the Project site, review and analysis of updated Census data, focus group interviews and other information gathering meetings with communities and a wide range of other stakeholders.

4.1 STUDY AREA

The Terms of Reference (TOR) stipulate that the study area be determined by the extent of the direct and indirect impacts on the physical, biological, and social environments. For direct impacts, the spatial boundaries of the study areas vary depending on which environmental component is being assessed. For this reason, the specific study area for each component is defined at the beginning of each corresponding subsection, below. Table 4.1-1 summarizes the definition of each study area. For indirect impacts, a wider study area was identified that encompasses all locations within a 5-kilometre (km) radius of the Project site (see Figure 4.1-1).

Table 4.1-1. Definition of Study Area for Environmental Components Assessed in the EIA

Component (Section)	Study Area
Physical Environment (4.3)	**Areas within 5 km of Project site and its ex situ facilities and as defined in the impact analysis for each resource area**
Climate	**National, Point Lisas area, Project site**
Geology and Soils	**Point Lisas area within 5 km of Project site, Point Lisas Port Development Company, Project site**
Topography	**LNG River basin and alluvial plains, Project site**
Air Quality	**Point Lisas area, Point Lisas Port Development Company, Project site**
Noise	**Ambient conditions within 300 m of Project site**
Aquatic Environment	**Surface waters within and adjacent to Project site, groundwater within Project site**
Flora and Fauna (4.4)	**Point Lisas area within 5 km of the Project site, Point Lisas Port Development Company, Project site**
Socioeconomic (4.5)	**Communities within approximately 3 km of Project site and Couva /Tabaquite/Talparo Regional Corporation**
Land Use	**Communities within approximately 3 km of Project site and Couva /Tabaquite/Talparo Regional Corporation**
Demographics	**Communities within approximately 3 km of Project site and Couva /Tabaquite/Talparo Regional Corporation with data available from CSO**
Employment	**Communities within approximately 3 km of Project site and Couva /Tabaquite/Talparo Regional Corporation with data available from CSO**
Services and Utilities	**Couva /Point Lisas region and transmission/distribution districts within Couva /Tabaquite /Talparo Regional Corporation; (for Solid Waste – study area extended to landfill areas between Port of Spain**

Table 4.1-1. Definition of Study Area for Environmental Components Assessed in the EIA

Component (Section)	Study Area
	and Port of Fernando)

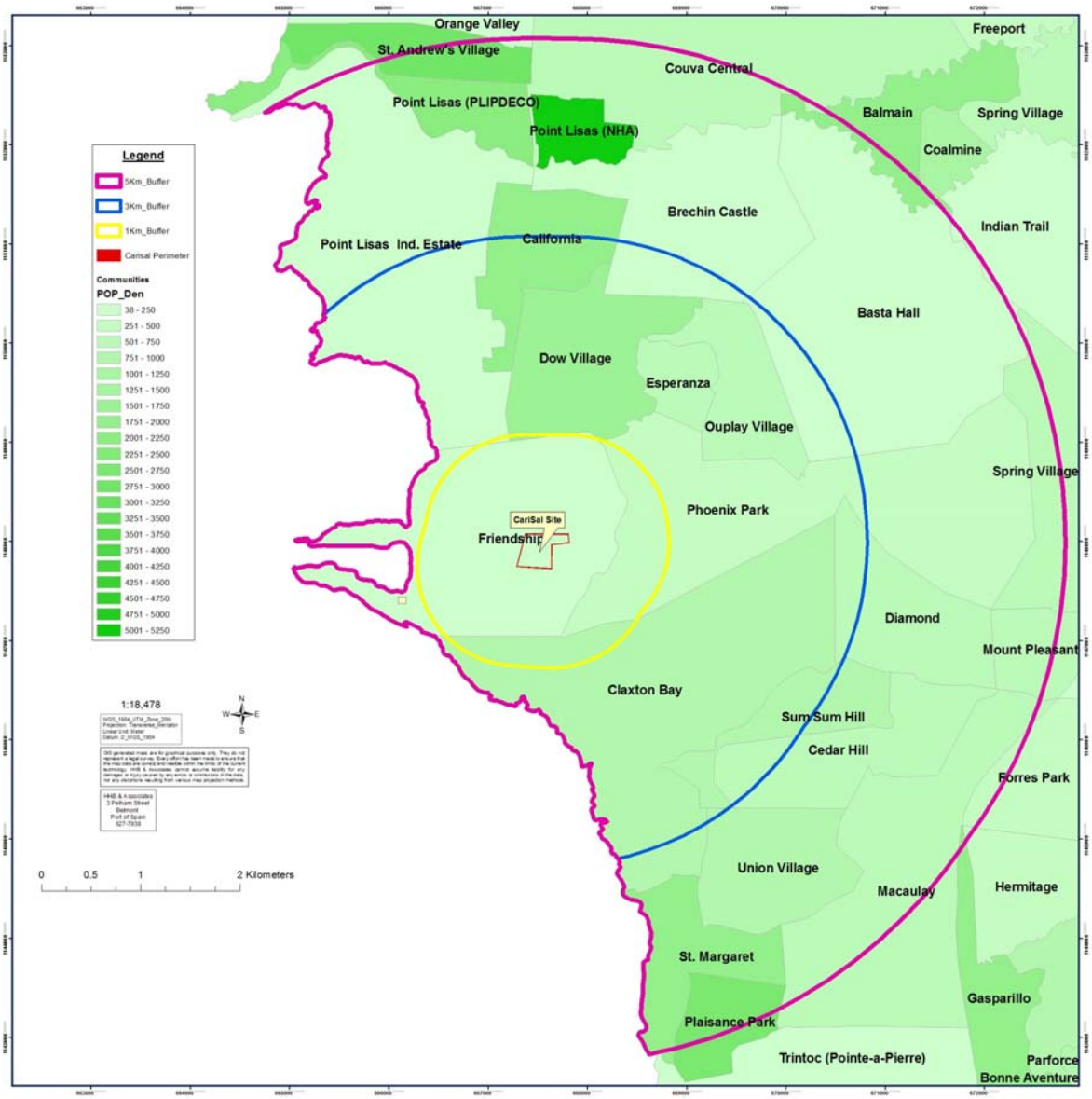
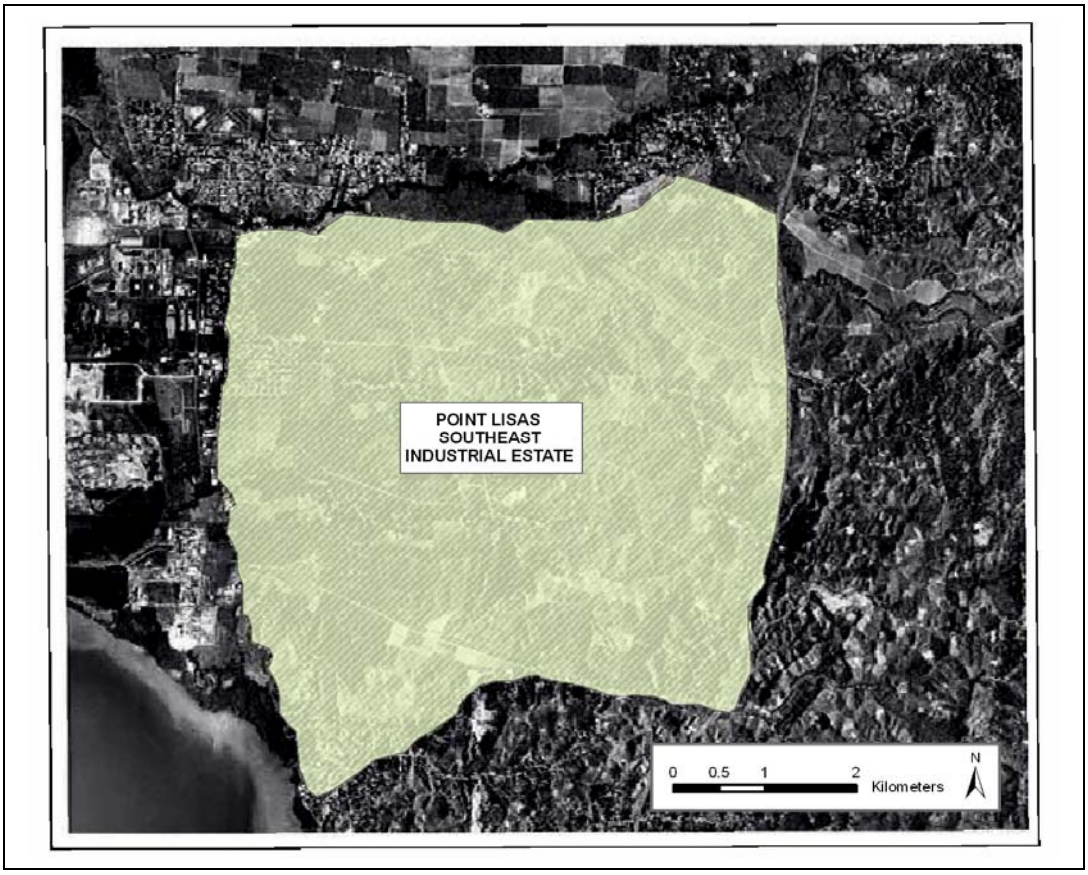


Figure 4.1-1. CariSal Project site and 5-km radius showing population density.

Historically, the Project site was used for the intensive monoculture of sugar cane and intermittent settlements developed around the sugar industry. Since the 1970s, land use within the wider Couva area has gradually changed from agriculture to industrial and residential uses. Today, the predominant land uses within the 5-km area around the proposed plant site include agriculture, heavy and light industry, and some residential; the area is generally built-up (Ministry of Agriculture 1994).

Heavy industry is the dominant economic activity in the immediate study area. The CariSal site is located adjacent to the proposed PLSEIE. Using the area for industry became a feasible economical alternative when 90 percent of the land for the proposed industrial expansion came out of sugarcane cultivation. The 1,725-ha PLSEIE is bounded on the north by Rivulet Road, on the east by the Solomon Hochoy Highway, on the south by Cedar Hill Road, and on the west by Southern Main Road. The Project site would be located along the western margin of PLSEIE (Figure 4.1-2). Nearby industrial facilities include:



Source: NEC, http://www.nec.co.tt/html/NECestates.htm#

Figure 4.1-2. Point Lisas South and East Industrial Estate (PLSEIE).

- Two ammonia plants (Yara Trinidad Ltd and CNC Ammonia);
- A producer of aerosols (Aerosol Gas);
- A chlorine-producing plant (ANSA McAl Ltd);
- A concrete and aggregate batch plant (Northern Construction);
- A fertilizer-producing plant (National Agro Ltd);
- A plant producing industrial gases, including oxygen, acetylene and hydrogen (Industrial Gases Ltd);
- A natural gas plant (PPGPL);

- The Petrotrin (Gas) Compressor Station;
- Two methanol plants (Titan Methanol and Atlas Methanol); and
- A producer of food-grade salt (Trinidad Salt).

Several small support and downstream industries also occupy this area along the eastern perimeter of the PLIPDECO Industrial Estate. The proposed Essar steelworks and Westlake polyethylene plant would also be built near the CariSal site (Section 4.2).

Three major communities lie to the south: Phoenix Park Village to the east, Savonetta Estates and Claxton Bay, further south along Southern Main Road. The communities of Dow, California, and Esperanza are also found within the wider study area. Houses, schools, and commercial areas are located along Phoenix Park Road and Southern Main Road. The nearest structure is approximately 50 m from the facility's western boundary, and the nearest school (a small kindergarten) is approximately 900 m away to the northwest, on Southern Main Road, south of Phoenix Park Road. The nearest residents are believed to be approximately 50 m away from the western boundary of the site. The general Project area has a relatively high ambient noise level because it is industrial (see Section 4.3.5). Rivulet Road to the north is the site of many commercial buildings, and a few bars and restaurants.

The site is located between two river systems: the LNG River to the south and the Brechin Castle River to the north. Other river systems within the 5-km study area include the Soledad River to the south, and the Savonetta River, Couva River, and Rivulet River to the north. The LNG River discharges into the Claxton Bay Wetland System, a 50- to 100-ha mangrove system southwest of the Project site.

The underlying geology in the Project area is generally over-consolidated alluvial deposits consisting of grey and occasionally mottled red/brown clays and silt intermixed and inter-bedded with sands, gravels, and beds of sea shells. The Project site is within a region of Trinidad characterized as having dystric planosol soils (FAO 1998). Planosols are soils with bleached, temporarily water-saturated topsoil on slowly permeable subsoil. The predominant soil types are sandy clays interspersed with clayey soils. The soil type in the area has only a slight potential for erosion (Hardy 1974).

4.2 PROJECT LOCATION

The CariSal Unlimited chlor-alkali plant would be sited in the Phoenix Park district of the Ward of Couva on the west coast of Trinidad (Figure 4.2-1). The Project would be constructed on an L-shaped lot, measuring approximately 11.8 ha. The site is located on an agricultural plot of land previously used for sugar cane cultivation, which is Plot 4A of the New Industrial Estate in Couva. The southwest point of the proposed CariSal site boundary is located at Universal Transverse Mercator (UTM) coordinates 1147714.741 N and 667266.668 E.

The proposed site is located on land that is relatively flat to gently undulating, with a general slope from east to west; the central and northern portions are the lowest elevation. No residential areas are within the 11.8-ha property proposed for the plant site (see Figure 4.2-2 in Chapter 10). No structures are currently on the site, nor is there any evidence of previous structures on the

site. Overhead electrical power lines run just beyond the southern boundary of the site. No lakes or major waterbodies occur on the Project site. A small drainage ditch runs across the northern section of the site and a wetland area is present along the site's western edge.

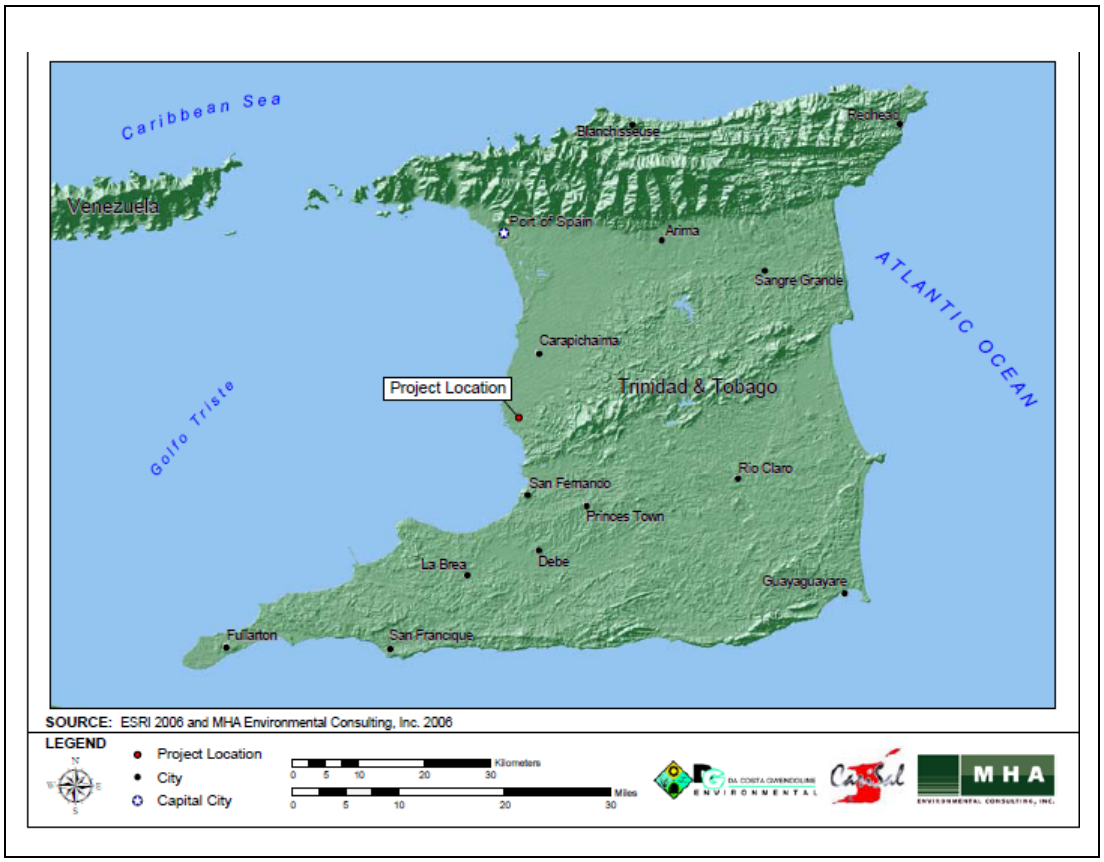


Figure 4.2-1. General location for proposed CariSal Project.

The proposed CariSal site would be bounded on the north by a drainage channel and undeveloped land and a segment of the proposed PLSEIE. To the east are an NGC pipeline right- ROW and a T&TEC transmission corridor. The 120-hectare site of the proposed Westlake polyethylene production facility is adjacent to these corridors.

The T&TEC reserve lands form the southern boundary of the CariSal site with the North Sea Road and NGC ROW corridor located further to the south. Beyond these lands and the road are the 204-ha site of the proposed Essar steelworks to the southeast and the Savonetta residential estates to the south. To the west of the proposed CariSal site are the Caroni Railway ROW, land owned by the NEC, Southern Main Road, and beyond them, Yara Trinidad Limited, an ammonia plant on the PLIPDECO estate. Industrial Gases Limited lies to the southwest as does PPGPL; CNC lies to the northwest. Northern Construction and EZYCON also lie to the northwest between Southern Main Road and the Caroni Railway reserve.

4.3 PHYSICAL ENVIRONMENT

The physical environment is characterized in terms of climate, geology and soils, topography, air quality, noise, and water quality.

4.3.1 Climate

In general, the climate and meteorology of the Caribbean Region including Trinidad and Tobago is described as Tropical Marine (Macpherson 1982), which is characterized by the uniformity of its high temperature throughout the year. Data from national sources were used to develop a general description of the climate, and when available, more localized data were used. Climate is described in terms of wind flow, rainfall, temperature and relative humidity, and tropical storms and hurricanes.

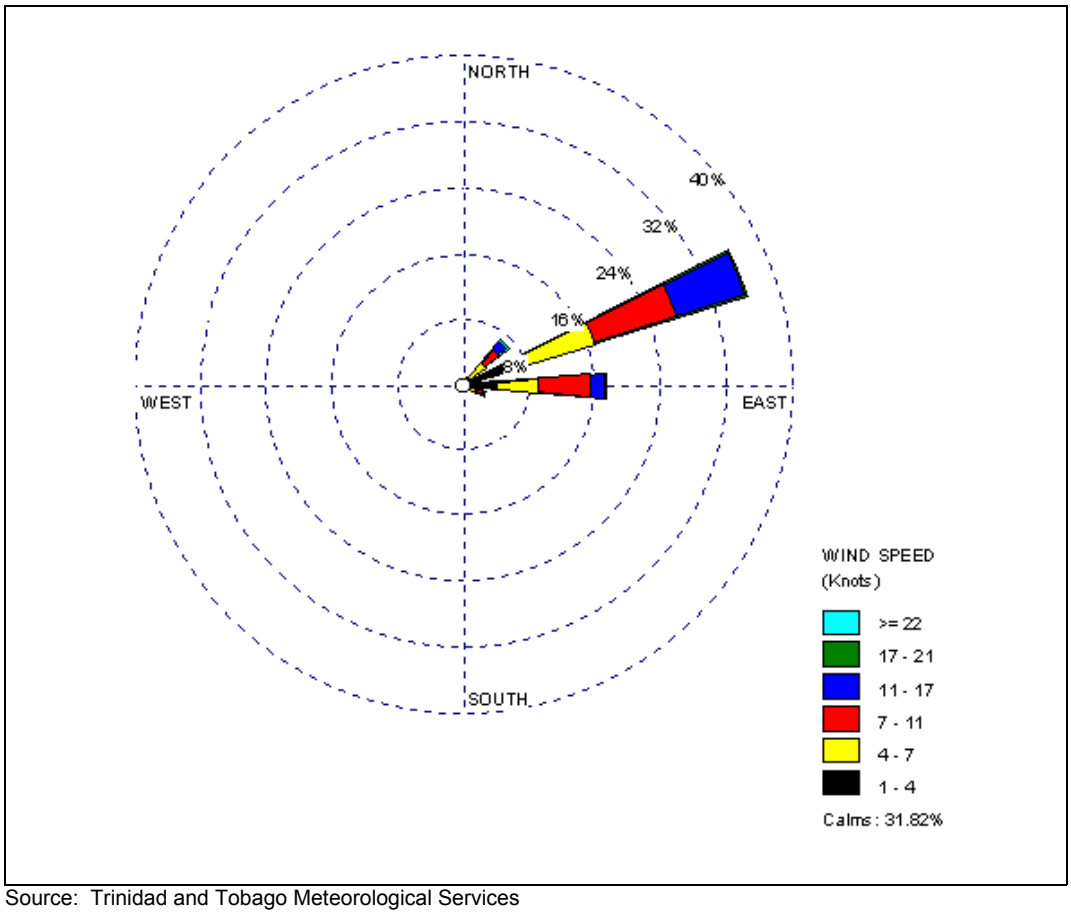
4.3.1.1 Wind

Although a long period of wind data is not available for Point Lisas, data from the Piarco International Airport allow for general characterizations of the wind flow pattern for Trinidad. Data collected at Piarco International Airport show that overall wind speeds in Trinidad typically range from calm[1] to 10.3 metres per second (m/s) during both the dry and wet seasons. Wind speed tends to vary seasonally, with higher speeds observed more frequently during the dry season. Calm conditions are recorded at Piarco about a quarter of the time during the dry season and more than a third of the time during the wet season. Easterly/north-easterly winds are common about a third of the time in the dry season. In the wet season, easterly winds dominate (approximately 24 percent of the time). The wind rose for Piarco International Airport for 1995 to 2004 is shown in Figure 4.3-1.

For most of the year, the northeast trade winds influence Trinidad and Tobago. However, from August through October, the southeast trade winds predominate over the southern portion of the island of Trinidad as the Intertropical Convergence Zone (ITCZ) moves north. This more southeasterly wind flow pattern is evident in the wind data collected for the Caroni Research Station at Waterloo, located approximately 7 km to the northwest of the proposed site location (Tables 4.3-1 and 4.3-2). Although these data were collected only during May to December 1993 and January to April 1994, they can be used to delineate the expected wind flow pattern at the Project site given its close proximity.

More recent data are available from the Trinidad and Tobago EMA's air quality and meteorological monitoring station in Point Lisas. The station is located about 4.1 km north-northwest of the Project location and is the most representative, recent data for the Project site. Average wind roses at Point Lisas are shown in Figure 4.3-2 and 4.3-3 for the 2005-2006 wet season and dry season, respectively. The Waterloo and EMA stations show the same consistent wind pattern. However, unlike at Piarco, both of these stations show a pronounced southeasterly wind component. Calm winds occur only about 6 percent of the time because of the lower threshold wind speed (0.5 m/s) instrumentation used by EMA.

[1] Calm – wind speeds less than 0.5 m/s



Source: Trinidad and Tobago Meteorological Services

Figure 4.3-1. Wind rose at Piarco Airport, 1995 to 2004.

Table 4.3-1. Wet Season (May – December 1993) Wind Data (%) at Waterloo Research Station

SPEED (km/h)	Direction (degrees)													
	345-15	15-45	45-75	75-105	105-135	135-165	165-195	195-225	225-255	255-285	285-315	315-345	Calm	Overall %
<0.1	-	-	-	-	-	-	-	-	-	-	-	-	44.70	44.70
0.1-4.8	0.00	0.18	2.39	4.44	1.74	0.18	0.08	0.10	0.03	0.03	0.00	0.03	-	9.18
4.8-8.0	0.00	0.05	1.66	2.85	1.30	0.26	0.03	0.05	0.00	0.16	0.05	0.00	-	6.41
8.0-16.0	0.00	0.10	2.78	7.06	4.15	1.12	0.23	0.18	0.13	0.44	0.26	0.13	-	16.58
16.0-24.0	0.03	0.03	1.74	7.50	5.99	0.62	0.13	0.08	0.08	0.05	0.00	0.05	-	16.29
>24.0	0.00	0.00	0.78	4.41	1.25	0.21	0.03	0.00	0.00	0.00	0.03	0.00	-	6.69
Waterloo %	0.03	0.36	9.35	26.26	14.43	2.39	0.50	0.41	0.24	0.68	0.34	0.21	44.70	99.85
Piarco %	0.26	0.66	11.87	43.96	6.88	0.64	0.21	0.13	0.22	0.25	0.16	0.15	32.85	98.24

Source: Trinidad and Tobago Meteorological Services

Table 4.3-2. Dry Season (January – April 1994) Wind Data (%)
at Waterloo Research Station

SPEED (km/h)	Direction (degrees)													
	345-15	15-45	45-75	75-105	105-135	135-165	165-195	195-225	225-255	255-285	285-315	315-345	Calm	Overall %
<0.1	-	-	-	-	-	-	-	-	-	-	-	-	37.82	37.82
0.1-4.8	0.00	0.11	1.29	5.97	2.48	0.62	0.06	0.00	0.06	0.00	0.00	0.00	-	10.58
4.8-8.0	0.00	0.11	0.51	2.93	1.46	0.06	0.00	0.00	0.00	0.00	0.00	0.00	-	5.06
8.0-16.0	0.00	0.00	0.96	6.42	3.04	0.23	0.06	0.06	0.11	0.00	0.06	0.06	-	10.97
16.0-24.0	0.00	0.00	0.84	9.45	7.20	0.00	0.06	0.00	0.06	0.06	0.00	0.00	-	17.67
>24.0	0.00	0.00	0.11	7.65	9.68	0.00	0.00	0.00	0.00	0.11	0.00	0.00	-	17.56
Waterloo %	0.00	0.22	3.17	32.42	23.86	0.91	0.18	0.06	0.17	0.23	0.06	0.06	37.82	99.66
Piarco %	0.18	0.55	14.56	56.71	3.63	0.14	0.04	0.01	0.01	0.02	0.04	0.03	23.05	98.97

Source: Trinidad and Tobago Meteorological Services

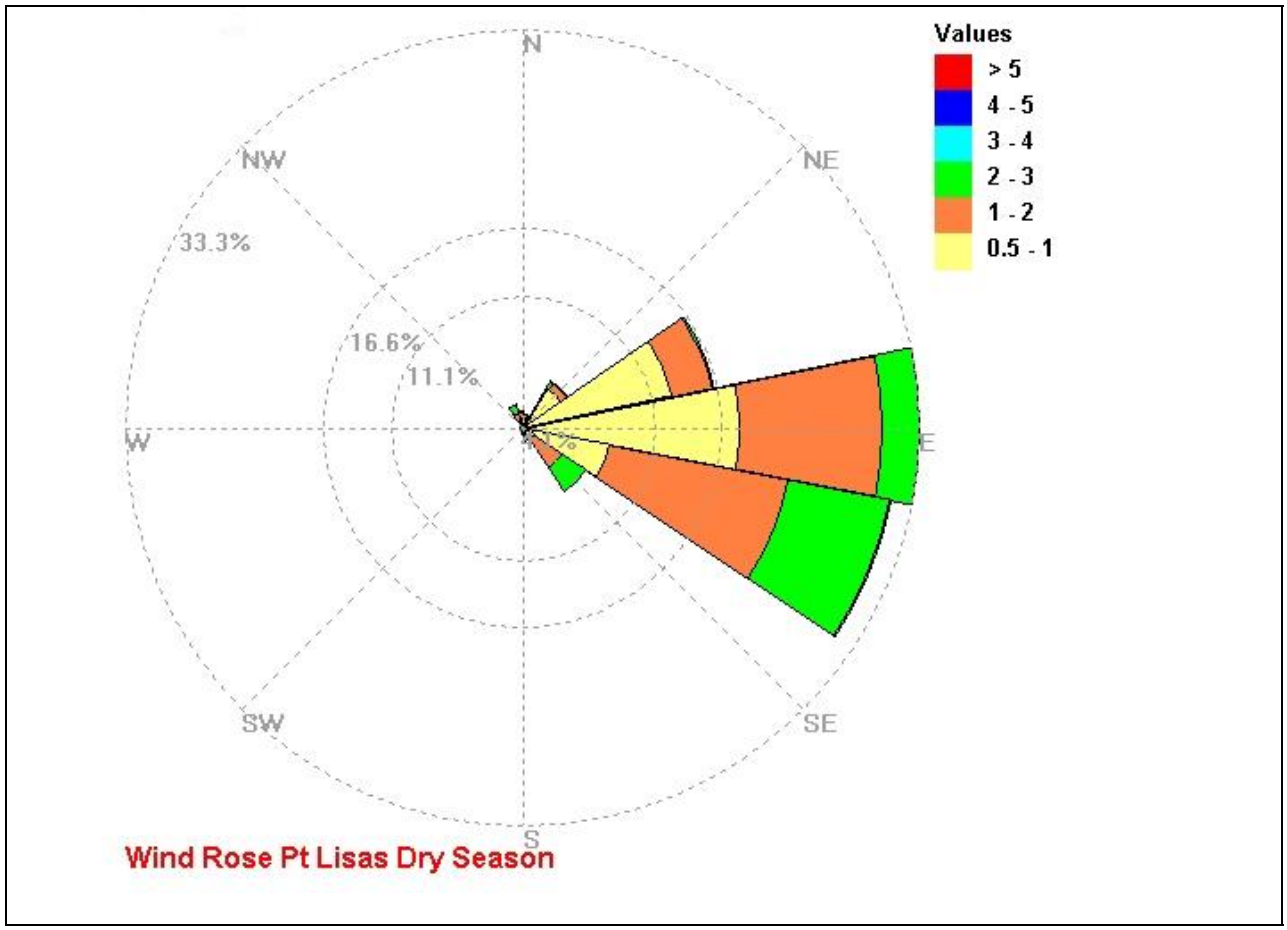


Figure 4.3-2. Average wind rose (m/s) at the EMA monitoring station at Point Lisas for 2005–2006 dry season.

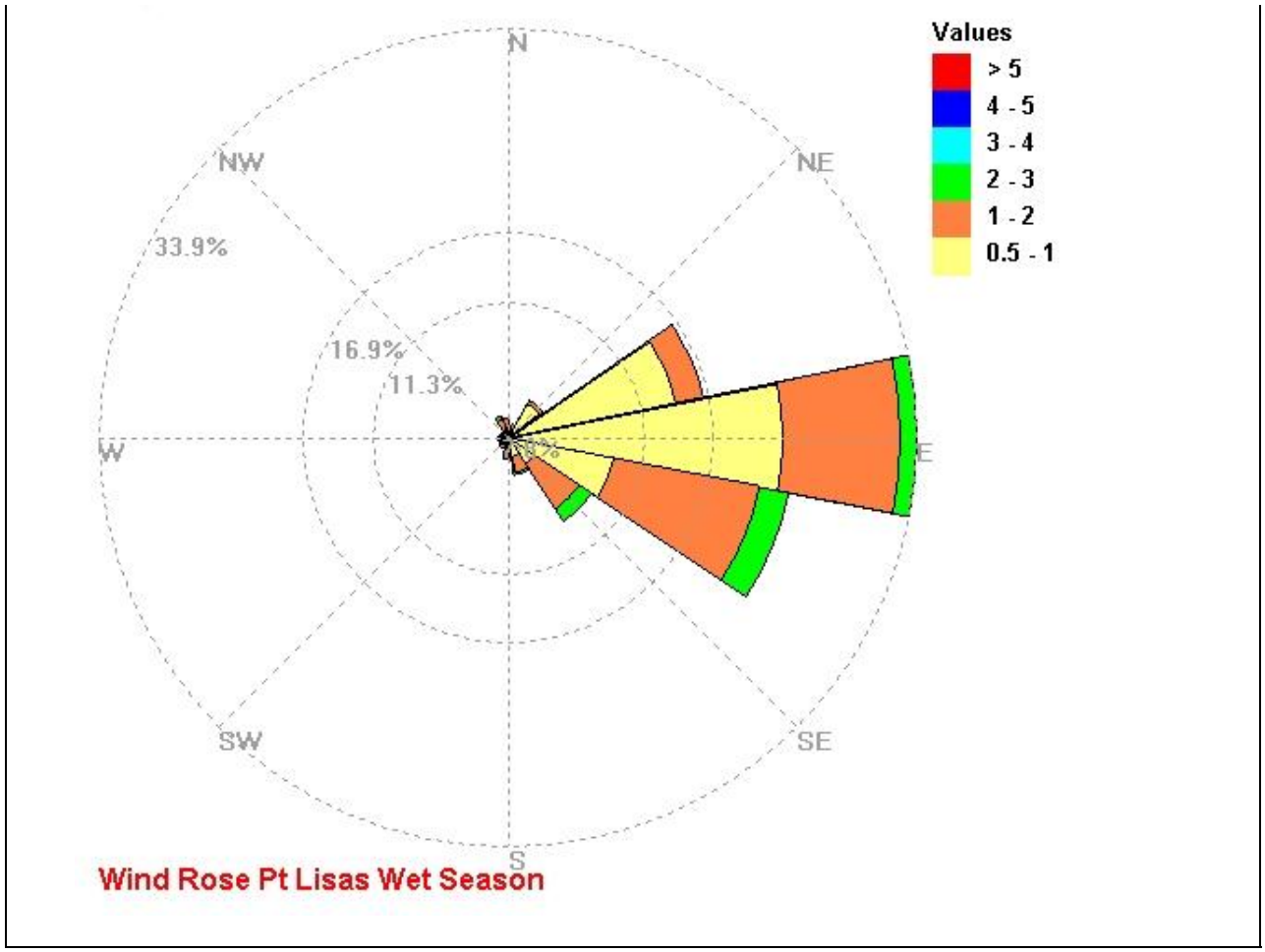


Figure 4.3-3. Average wind rose at the EMA monitoring station at Point Lisa's for the 2005–2006 wet season.

Meteorological data were collected at the project site during the air quality monitoring period from October 26 to December 2, 2007. CariSal acquired the EMA wind data for this same time period, however during the early part of the period the EMA meteorological monitoring system was down. Beginning November 4, 2007 hour 18, the EMA data recommenced operations. A total of 692 hours was available for a comparison between the CariSal wind data and the EMA wind data. The mean wind speed (0.9 m/s) over the period was the same for both EMA and for the Project site. However, the speed distribution was different with EMA having 88 percent of all wind speeds less than 2.0 m/s while the Project site had only 70 percent. Wind directions also showed some small differences with the EMA site having a prevailing wind direction from the east or east southeast about 67 percent of all hours, while the Project site had prevailing winds from the east-northeast or northeast about 37 percent of all hours. These differences are likely due to differences in the monitoring heights (3 m for CariSal and 10-m for EMA) along with the 4.1 km difference in location.

4.3.1.2 Rainfall

Rainfall patterns in Trinidad are seasonal due to the annual north to south migrations of the ITCZ. There is a pronounced dry season from January to May and a wet season from June to December. A secondary dry season or Petit Careme occurs during September and October. Although it may rain during the dry season, the wet season accounts for approximately 70 – 80 percent of annual rainfall (FAO, 2000). The mean annual rainfall for Trinidad is 2,200 mm. There is considerable variation, as seen in Figure 4.3-4 (see also Chapter 10). The Northern Range averages 3,500 mm annually while the off-shore islands of the northwest peninsula and the southwest peninsula average 1,300 mm (Bryce, 2005).

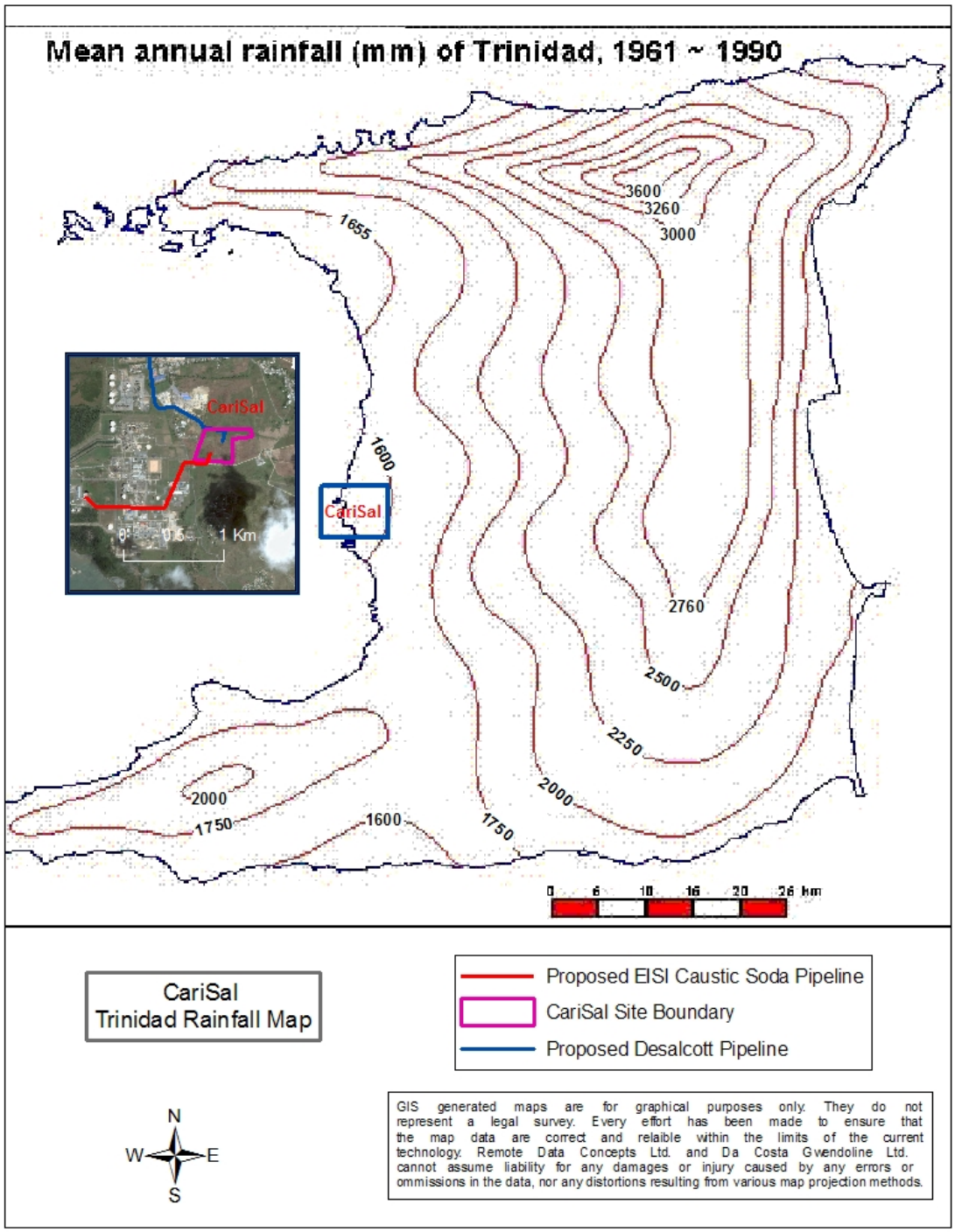
The nearest representative rainfall data available from the Trinidad and Tobago WASA-WRA are for Phoenix Park, located about 1 km northeast of the Project site. The rainfall data at Phoenix Park were collected from 1999 to 2003. Table 4.3-3 shows that the driest month based on monthly average rainfall is February with an average rainfall amount of only 27 mm, while the wettest month is August with an average monthly rainfall of 201 mm. The wettest year during 1993 through 2003 was 2002 with 1,831 mm of rainfall; 2001 was the driest year with 1,360.5 mm of rainfall.

Recent precipitation data available from the EMA site located 4.1 km north northwest of the Project site recorded similar levels of rainfall, 1,722 mm in 2005 and 1,652 mm in 2006.

Table 4.3-3. Monthly Rainfall Data (mm) for Phoenix Park Recording Station (1999 – 2003)

Month	1999	2000	2001	2002	2003	Monthly Average
January	136	74	25	144	38	83
February	60	27	24	9	14	27
March	48.5	81	1	77	3	42
April	87	82	9	178	NA	89
May	5	114	40	87	59.5	61
June	214.5	169	91	156	195.5	165
July	112.5	120	201.5	210	NA	161
August	240	223	217.5	125	NA	201
September	162	88	160	119	NA	132
October	231	168	167.5	236	NA	200
November	199	286.5	273	408	NA	191
December	211	71.5	151	82	NA	128
Yearly Total	1,706.5	1,504	1,360.5	1,831	NA	

Source: Trinidad and Tobago Water and Sewer Authority, Water Resources Agency.



Source: Meteorological Services Division – Piarco International Airport

Figure 4.3-4. Trinidad annual rainfall.

4.3.1.3 Air Temperature and Relative Humidity

Long-term temperature data are not available for the Project area, so data from the Piarco Airport were used to describe seasonal temperature variations (Table 4.3-4). Average monthly temperature for the period 1999 to July 2004 ranged from 26.6 °C in February to 28.5 °C in September. The dry season experiences the largest diurnal changes in temperature primarily because of the minimal cloud cover occurring during that time period. The air temperature data available from the EMA monitoring site for 2005 and 2006 (Figure 4.3-5) recorded mean annual temperature of 26.9 °C, which is slightly lower than the mean annual temperature at Piarco of 27.7 °C. This difference likely results from the site's closer proximity to the ocean and resulting coastal effects; similar effects are likely to occur at the Project site.

Table 4.3-4. Mean Monthly Temperatures Recorded at Piarco

Month	Mean Max Temp.	Mean Min. Temp.	Mean Temp.
January	31.3	22.1	26.7
February	31.4	21.8	26.6
March	32.3	22.5	27.4
April	32.8	23.8	28.3
May	32.1	24.5	28.3
June	31.5	24.1	27.8
July	31.9	23.7	27.8
August	32.6	24.0	28.3
September	33.0	24.0	28.5
October	32.6	23.9	28.3
November	31.9	23.7	27.8
December	31.2	23.0	27.1

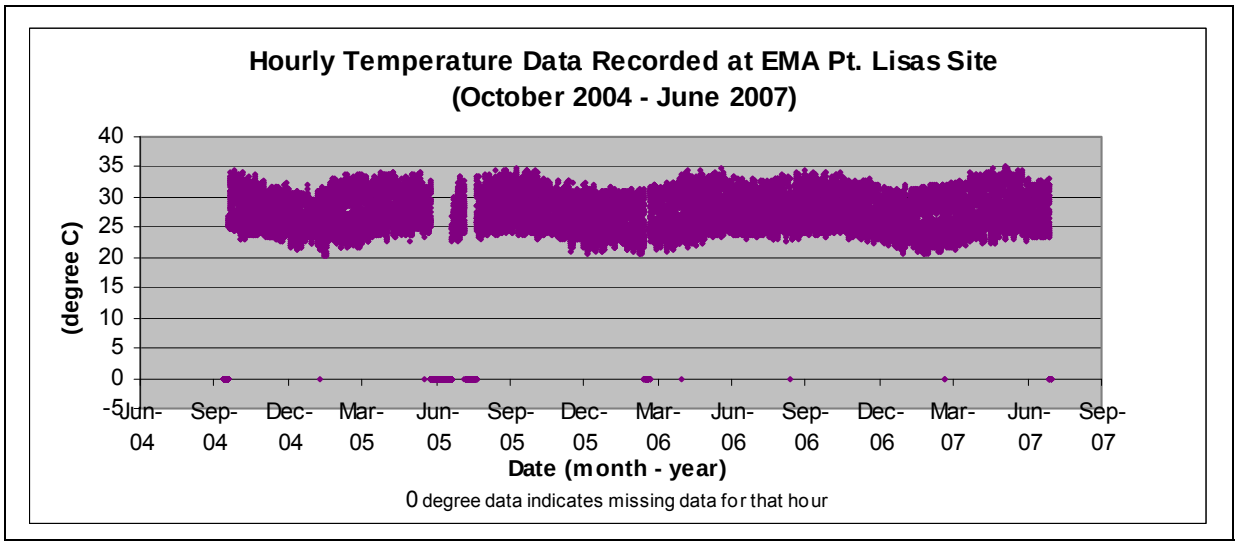


Figure 4.3-5. Hourly temperature data recorded at EMA Point Lisas site.

4.3.1.4 Relative Humidity

Based on data for 1989 to July 2004 from Piarco (Table 4.3-5), the highest average monthly relative humidity was recorded for the month of November (82 percent), while the lowest was recorded during March (73 percent). As expected, the highest humidity occurs during the wet season. The annual mean relative humidity is 78 percent, which is slightly lower than the 2-year average (2005–2006) 81-percent relative humidity recorded at the EMA's Point Lisas monitoring station. The difference in the two observations likely stems from the EMA site's closer coastal proximity. The Project site is most likely similar to the EMA site.

Table 4.3-5. Mean Monthly Relative Humidity Recorded at Piarco (1999 – 2004)

Month	Mean Monthly Relative Humidity (%)
January	77
February	75
March	73
April	75
May	78
June	80
July	79
August	80
September	79
October	80
November	82
December	80

4.3.1.5 Tropical Storms and Hurricanes

The Point Lisas area and Trinidad and Tobago as a whole periodically experiences extreme weather events. These events are associated with tropical storms and or hurricanes[2] that can produce extremely strong winds or heavy rainfall amounts or both. From 1970 to 2006, the paths of 17 tropical storms have passed close to Trinidad[3] (NOAA 2007). Two tropical storms, Fran and Alma, have passed over the island in recent history and caused significant damage (U.S. Department of State, 2007). In September 2004, rain associated with Hurricane Ivan caused severe flooding in St. Helena, Piarco, Caparo, and Kelley. These villages are located well north of the proposed Project site.

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[2] Hurricanes are tropical storms with sustained winds in excess of 119 km/h as defined by the National Emergency Management Agency of Trinidad and Tobago.

[3] Close refers to passing through the geographical area bounded by Latitudes 10EN to 12EN and Longitudes 69EW to 62EW.

4.3.2 Geology and Soils

The geology and soils section of the report is presented in the following categories:

- Regional and national geology
- Site geology
- Soil types and distribution
- Geotechnical investigations
- Regional tectonic setting

4.3.2.1 Regional and National Geology

The topography of Trinidad is dominated by the Northern, Central, and Southern mountain ranges and their surrounding river terraces and coastal flats. The mountain ranges originated about 100 million years ago from tectonic movements at the end of the Cretaceous period that caused folding of submarine strata. These folds initially formed three distinct islands, but subsequent deposition of sands, clays, and some limestone, followed by uplift during the Tertiary period (50 to 25 million years ago), joined the islands into one. Further uplift and the development of river terraces in the Recent Period (the last 10,000 years) gave Trinidad its present character (SENES Consultants Ltd. and EPAS Consultants Ltd. 2006).

4.3.2.2 Site Geology

The proposed site for CariSal's chlor-alkali plant lies adjacent to the PLSEIE. The site is located within the Caroni Syncline, in the south-western corner of the Northern Basin, between the coast and the base of the western Central Range. The deeper, older deposits from the late Andean (Pliocene) period are thicker and more compact than the more recent Holocene-age, over-consolidated, estuarine sediments that are softer in character and between 9 m and 15 m thick (SENES Consultants Ltd. and EPAS Consultants Ltd. 2006).

The CariSal site lies in the area where the geological strata transition from the recent alluvial deposits to the Pleistocene era Talparo Formation. The Talparo Formation comprises a series of clays and sands deposited in marine and brackish environments that is subdivided into Sum Sum Sands, Chin Chin clays, and Caparo Clays. These strata are overlain with Quaternary river, swamp, and coastal sediments. The Chin Chin clay formation outcrops approximately 400 m east of the Project site. The Sum Sum Sand formation outcrops about 2 km east of the Project site and dips in a western to north-western direction. The Sum Sum Sands form a major freshwater aquifer that ranges in thickness from approximately 60 m in the area of the outcrop to 240 m in the Point Lisas area. Beneath the Project site, the top of the Sum Sum Sands aquifer is estimated to be several hundred metres below ground level. The overlying alluvial sediments consist of deep hydromorphic soils with restricted drainage (EIS Ltd. 2007, Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP 2007)**.**

4.3.2.3 Soil Types and Distribution

The general area of the CariSal chlor-alkali plant Project site has been described as having surface soils of the Freeport Series, Savonetta Series, and the Talparo series (Figure 4.3-6, see also Chapter 10). (Eco Engineering Consultants Ltd. 2005). The soils in the region are predominantly over-consolidated alluvial deposits consisting of grey and occasionally mottled red/brown clays and silt intermixed and inter-bedded with sands, gravels and beds of sea shells. Soil series agricultural descriptions are presented in the following subsections, verbatim as they appear in the Environmental Impact Assessment Study for Proposed Steel Complex of Essar Group at Point Lisas, Trinidad and Tobago (SENES Consultants Ltd. and EPAS Consultants Ltd. 2006)

4.3.2.3.1 Talparo Series

The Talparo Series can be described as a Land Capability Class V soil,[4] which is fairly good land for forests, tree crops, grazing and buildings, depending on the slope. The Talparo Series contains heavy clays, with greater than 60 percent clay fraction located below the top three inches. The series is classified as a soil of the intermediate uplands with restricted internal drainage. This series is moderately acidic and is well supplied with nitrogen, phosphorus, and potassium. The series may also contain gypsum, which can bind phosphorus, in its profile. Sodium and magnesium content increases with depth. Forest, sugar cane, lastro, and bamboo dominate the environments in which the Talparo Series occurs, but small areas of cocoa, mixed crops, citrus, pastures, and teak are also supported.

4.3.2.3.2 Freeport Series

The Freeport Series can be described as a Land Capability Class III Soil, which is good land that requires moderate to intensive conservation and management practices. The series contains clays having less than 50 percent clay fraction. This series becomes progressively lighter in texture as the amount of sand in the sub-soil increases. It can be classified as a deep alluvial soil with restricted internal drainage. Lastro dominates the Freeport Series.

4.3.2.3.3 Savonetta Series

The Savonetta Series can be described as Land Capability Class V soil, which is considered fairly good land for forests, tree crops, grazing, and buildings, depending on its slope. This series consists of heavy clays containing more than 60 percent clay fraction. Soils in this series have impeded drainage, which results in flooding during the rainy season. Overall, the soils are slightly acidic, with strongly acidic lower horizons.

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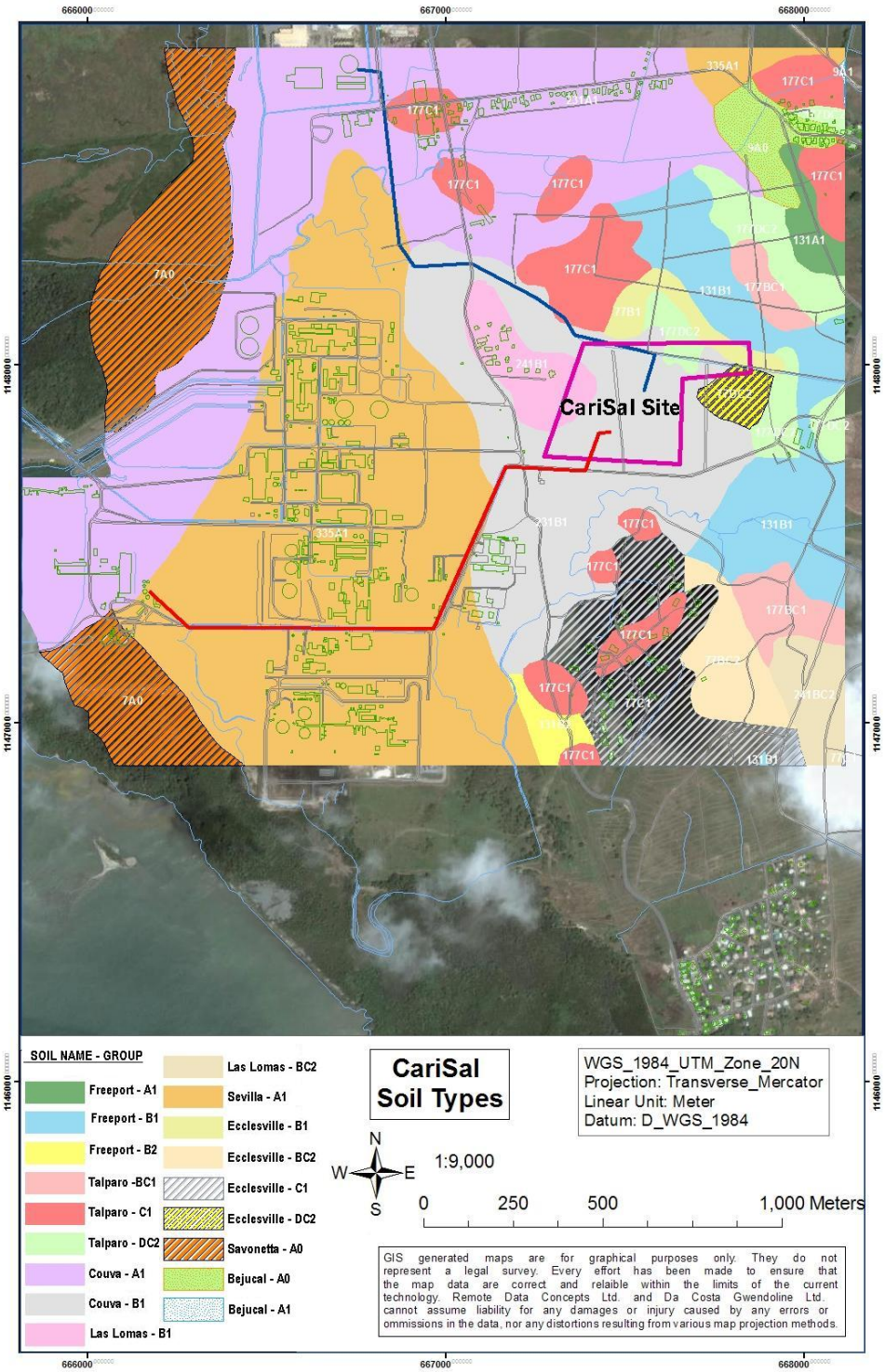
[4] The framework of the Trinidad and Tobago Land Capability Survey Protocol (Hardy 1974) classifies lands within seven Classes with Class I being lands best suited to agriculture and Class VII characterizing lands best suited to Forestry and Environmental Protection.



Source: Trinidad and Tobago, Ministry of Agriculture

Figure 4.3-6. Soil types and distribution.

Table 4.3-6 provides summary pedological and engineering information on the predominant soil types within or adjacent to the Project site.

Table 4.3-6. Soil Types, Pedological Classifications, and Engineering Properties

Soil Code	Series	USDA Class (Subgroup)	FAO Class	Bulk Density in T/m³	Field Capacity in % Water Content by Weight
177	Talparo	Aquentic Chromuderts	Eutric Vertisol	1.15	36
231	Couva	Typic Tropaqualfs	Gleyic Lixisol	1.36	24
241	Las Lomas	Orthoxic Tropudults	Plinthic Acrisol	1.25	28

Source: FAO (2005)

The soil in the study area was analyzed to determine the presence and concentrations of any existing contaminants. Because the proposed Project site and surrounding areas were historically used for sugarcane cultivation (some land adjacent to the site has been allocated for residential purposes), any contaminants present would be expected to be related to the prior use of agricultural chemicals including fertilizers during sugarcane cultivation and small scale animal husbandry. In 2006, SENES and EPAS Consultants Ltd. gathered primary soil and sediment data from the Essar Steel study area (Table 4.3-7). Table 4.3-7 compares the reported soil concentrations against three widely recognized international soil screening criteria – the Canadian standards for petroleum hydrocarbons in soil, the Dutch intervention values for soil remediation, and the U.S. EPA Region 9 preliminary remediation goals. The chart in Figure 4.3-7 shows the data from additional sediment samples from the LNG River. With the exception of arsenic, the levels within the study area were less than the most restrictive of the three screening levels for all parameters measured. The maximum arsenic level in the LNG River sediment samples, 5.6 milligrams per kilograms (mg/kg), exceeds the U.S. EPA Region 9 PRG of 1.6 mg/kg, but equals only about 10 percent of the Dutch intervention level of 55 mg/kg.

4.3.2.4 CariSal Site Investigations

CariSal Unlimited commissioned EIS Ltd. to conduct a geotechnical investigation of the main Project site, Plot 4A adjacent to the proposed PLSEIE. EIS Ltd. performed a desktop study, executed a field program, and performed laboratory testing. The field program included a visual survey of the site and sampling from 16 boreholes ranging from 24 m to 31 m deep between May 17 and June 9, 2007. The laboratory program included soil classification, water content, Atterberg limit, grain size analysis, strength testing, and consolidation testing.

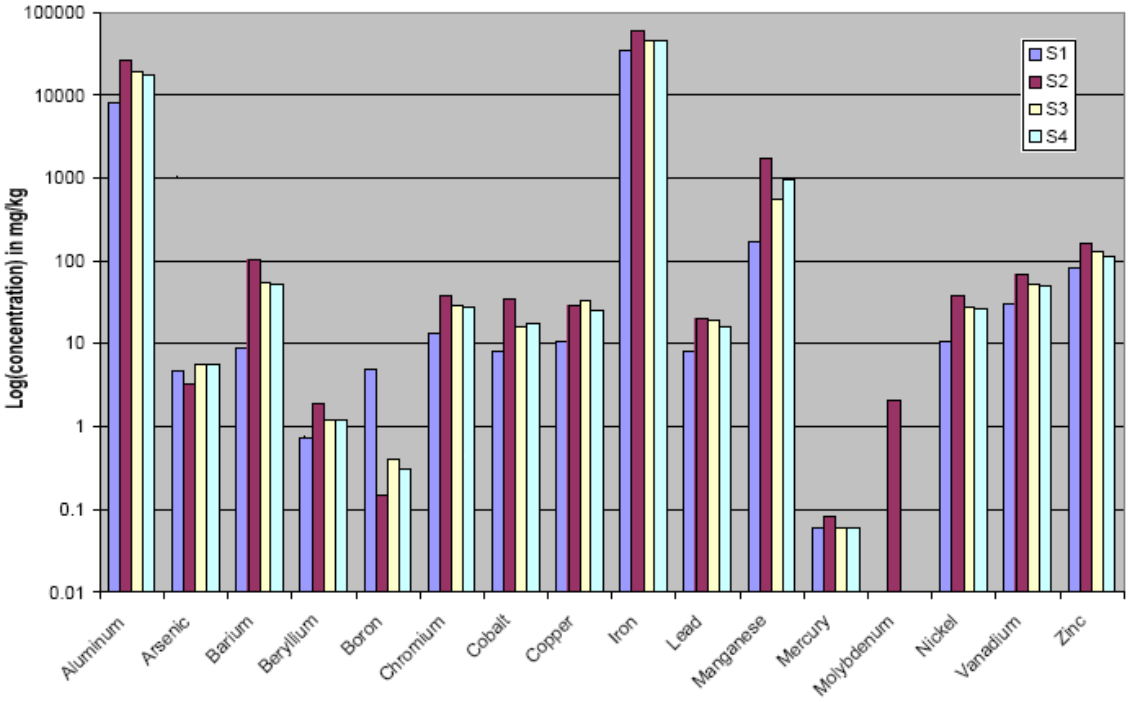
Table 4.3-7. Soil and Sediment Samples Monitored in the Study Area (2006)

Parameter	Sediment 01 LNG Stream (Near North West Essar Site Boundary)	Sediment 02 LNG Stream (Near North East Essar Site Boundary)	Soil 03 (North West Essar Site Boundary)	Soil 04 (Within Essar Site)	Screening Level[a]
Approx. Distance from CariSal Site, m	360	1,970	590	1,180	
Total Petroleum Hydrocarbons mg/Kg	118.84	146.74	76.34	62.42	≥ 260[b]

Table 4.3-7. Soil and Sediment Samples Monitored in the Study Area (2006)

Parameter	Sediment 01 LNG Stream (Near North West Essar Site Boundary)	Sediment 02 LNG Stream (Near North East Essar Site Boundary)	Soil 03 (North West Essar Site Boundary)	Soil 04 (Within Essar Site)	Screening Level[a]
Mercury mg/Kg	0.524	0.953	1.041	0.243	10[c]
Aluminium mg/Kg	970.117	1662.830	3301.617	2659.395	100,000[d]
Chromium mg/Kg	13.957	21.789	37.956	20.955	38[d]
Lead mg/Kg	64.658	79.734	63.701	55.624	530[c]
Cadmium mg/Kg	1.892	1.538	1.578	1.015	8[d]
Zinc mg/Kg	154.957	203.556	257.502	174.583	720[c]
Iron mg/Kg	6111.371	6627.873	6597.173	5761.561	100,000[d]
Copper mg/Kg	22.728	16.938	21.805	12.482	190[c]
Nickel mg/Kg	19.627	30.734	36.647	20.324	130[d]

Source for measured concentrations: SENES Consultants Limited and EPAS Consultants Limited 2006
[a] The listed Screening Level equals the most restrictive value from the three screening guidelines below.
[b] Tier 1 numerical levels for petroleum hydrocarbons for industrial land use range from 260 to 3300 mg/kg depending on soil grain size and equivalent normal straight-chain hydrocarbon (nC) boiling point ranges, (Canadian Council of Ministers of the Environment 2008).
[c] Intervention value from VROM (2000).
[d] Preliminary remediation goals for industrial soil (U.S. EPA 2004)



Source: Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting LP. (2007)

Figure 4.3-7. Sediment Sample Results from the LNG River

Significant findings from the geotechnical investigation (EIS Ltd. 2007) are as follows:

- At the time of the investigation, which took place at the end of the dry season and the beginning of the rainy season, the groundwater level was between 0 and 2.4 m below ground surface. EIS Ltd. recommended designing the plant under the assumption that ground water level is at the ground surface.
- Soil samples consisted primarily of light brown to brown and gray sandy silty clays, with fines content generally greater than 80 percent.
- Wood fragments and other organic material were found to a depth of 14 m, suggesting the presence of an old swamp.
- Field and laboratory data suggest normally consolidated, highly compressible soils.
- Surface soils over some areas of the site have high shrink-swell potential, resulting in deep desiccation cracking during the dry season (see Figure 4.3-12), below).
- The geotechnical report presents foundation and soil improvement recommendations, but without supporting calculations.
- Predicted settlements for shallow foundations with applied loads of 50 kN/m^2 are on the order of 0.3 m.
- Predicted allowable pile capacities for pile lengths of 18 m (~60 ft) equal 600 kN to 800 kN, depending on pile type.

4.3.2.5 Regional Tectonic Setting

Trinidad is located on the Circum-Caribbean Tectonic Belt, which has produced several earthquakes in magnitudes exceeding 7.0 since 1900. The most recent was a 7.3 magnitude earthquake that occurred off the north coast of the island of Martinique on November 29, 2007 and was felt throughout the Caribbean region, including Trinidad and Tobago. The intensity on the island of Trinidad was estimated at below 5.0. On December 12th, 2007, the Bamboo Settlement, Santa Cruz, Maraval, Port of Spain and St. Helena regions of Trinidad experienced another earthquake. The University of the West Indies Seismic Research Unit reported the preliminary location of the event at 10.70°N 62.41°W, approximately 110km west of Port of Spain, with a depth of 94km and magnitude of 4.1.[5] The island presents a greater-than-moderate earthquake risk.

Given the higher rate of physical and industrial development in Trinidad and Tobago, the risks posed by earthquakes have also grown, necessitating that extra care be taken in facility design to minimize the potential harm from earthquakes (EcoEngineering Consultants Ltd., 2006).

[5] See http://www.uwiseismic.com/ accessed on December 17, 2007.

The geotechnical study (EIS Ltd. 2007) reports maximum expected ground accelerations from seismic events to be between 0.275 g and 0.300 g (for a 2 percent probability of exceedance in 50 years and periods of T= 0.2 sec and T=1 sec).

4.3.3 Topography

The study area lies in the alluvial plain between the foothills of the Central Range and the coast of the Gulf of Paria. From west to east, the relatively flat areas near the coast give way to gently undulating terrain and then to more steeply defined hills and terraces. Ground elevations increase from sea level along the coast to above 60 m above sea level about 5 km inland.[6]

The Project site is located approximately 1 km east of the coast on relatively flat to gently undulating land. The site has a general downward slope from east to west with the central and northern portions being lower. The topographic survey for this site indicates that the ground surface elevation over the site varies between 4.5 m and 7 m above mean sea level. The portion of land bounded by the northern and western boundaries is lowest, with standing water in this area even during the dry season (EIS Ltd. 2007). A slight depression occurs in the Northeastern corner, and a large depression is present in the centre of the site that runs north to south. Figure 4.3-8 (see also Chapter 10) shows the topographic contours of the proposed site.

4.3.4 Air Quality

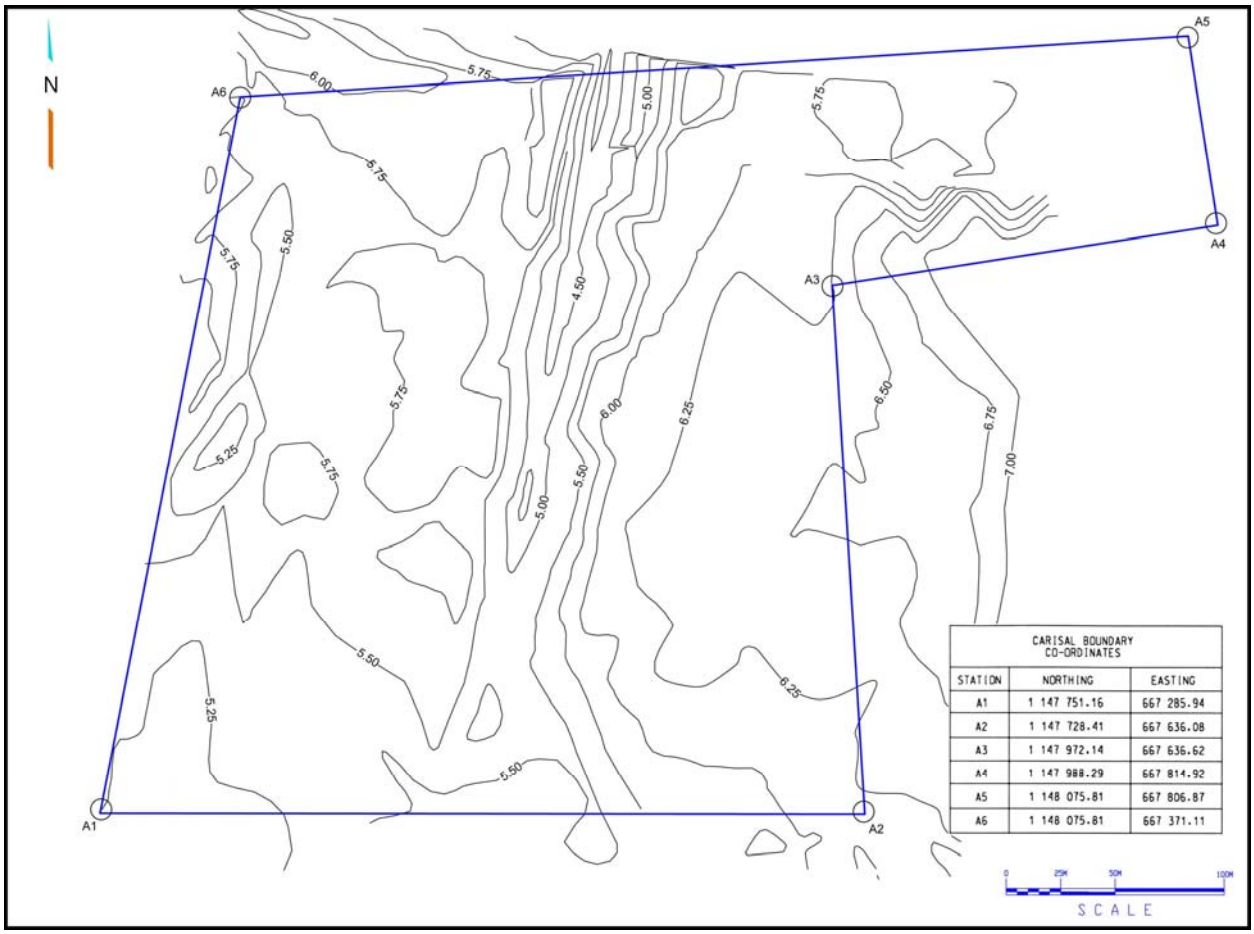
4.3.4.1 Introduction

Air emissions during construction and operation will affect ambient air quality in the Project area. Dust, particulate matter, and gaseous emissions can influence air quality. Ambient air quality would have a direct effect on workers at the site and on the surrounding communities and industries located downwind of the site.

Sources of air emissions within the study area that are likely to contribute to the ambient air quality of the region are:

- Industries in the existing PLIPDECO located downwind and close to the western and southern boundaries of the site. Industries located near the site include ammonia and urea manufacture, an iron and steel plant that will be under construction, a proposed polyethylene facility, power, and methanol manufacture.
- Vehicles using the roads bordering the site, such as Southern Main Road. These roads provide access to the existing industries and the highway, and thus experience heavy traffic consisting of all types of vehicles. These vehicles are potential sources of volatile organic compounds (VOCs), nitrogen oxides (NO_x), sulphur oxides (SO_x), and particulate.
- Aerial spraying of sugarcane fields with insecticides.
- Windblown dust from fields and unpaved roads.

[6] Source: Topographic map prepared by HHB & Associates, Belmont, Port of Spain.



Source: ABT Engineers & Constructors Limited, Drawing No. CS-000-00100-000

Figure 4.3-8. CariSal site topographic map

4.3.4.2 Ambient Air Quality Measurement

The EMA has collected the best available long-term ambient air quality data in the vicinity of the Project, that is, the PLIPDECO area. This EMA monitoring station is located about 4.1 km north-northwest of the Project site. CariSal has obtained and summarized these data below. In addition, CariSal conducted onsite ambient air monitoring for roughly a one-month period from late October 2007 to December 2, 2007 for these same pollutants monitored by EMA and others that the proposed plant would emit. Together, these data establish the current ambient background concentration levels in the vicinity of the Project. The other air pollutants that were monitored include total suspended particulate (TSP), particulate matter with a mean mass diameter less than 2.5 microns (µm, or $PM_{2.5}$), hydrogen chloride (HCl) gas, and chlorine (Cl_2) gas.

The EMA's monitoring effort began in October 2004 at the Point Lisas Industrial Estate, which at the time comprised a mix of petrochemical and steel plants, medium-sized manufacturers, and smaller service companies. Ambient air measurements monitored at the site include carbon monoxide (CO), sulphur dioxide (SO_2), ground-level ozone (O_3), nitrogen dioxide (NO_2), and meteorological parameters. Monitoring for particulate matter with a mean mass diameter less than 10 µm (PM_{10}) began in March 2006. Data provided by EMA have been reported through early July 2007 and for October 30 through December 2, 2007.

The EMA data were reviewed and analyzed to determine how they compare with the proposed Trinidad Air Pollution Rules. The review and assessment revealed the following issues with the data.

4.3.4.2.1 CO Measurements

1. Before October 5, 2005, the baseline trend of values was constantly negative during three periods, before the instrument was reset. These three periods were: October 1, 2004 through February 13, 2005, February 14 through April 26, 2005, and April 27 through October 5, 2005. This type of error is common with laser measurements that do not account for degradation of the initial beam due to aging. Thus these data were corrected by determining the long-term average slope (negative, in these cases) of the raw values in each period and subtracting the trend from the raw measurements.

2. During the period from December 11, 2005 at 1500 hours through January 14, 2006 at 1600 hours apparent problems with the instrumentation were noted, possibly due to the instrument's being offline. Reported values were constantly small and negative during this period and were corrected at the end of the period. These values were removed from the analysis.

4.3.4.2.2 PM_{10} Measurements

A calibration problem appears to have developed because the values increased toward the end of the data period and increased very rapidly during late June and early July 2007. A root cause for these increases could not be clearly identified in conversation with EMA staff, nor could we determine the period where the error clearly begins. Contact with the manufacturer suggested that the flow rate output should be checked and also recommended brushing to remove accumulated PM from the primary deposition area in the inlet. Based on the widely fluctuating hour-to hour PM_{10} values measured for the period, the data for June 24, 2007 at 2000 hours through June 6, 2007 at 0100 hours and June 30, 2007 at 2100 hours through July 7, 2007 at 0300 hours were therefore removed from the analysis.

4.3.4.2.3 NO_2 Measurement

NO_2 measurements showed little variation in hour to hour measurements with the exception of one hour on August 4, 2006 at 1100 hours when a 1-hour concentration of 157.4 micrograms per cubic metre (µg/m^3) was reported. The hours preceding and following were only 1 and 37 µg/m^3 and the second highest 1-hour value over this 2.5-year monitoring period was only 37.4 µg/m^3.

This single hour jump in measurement is unusual and likely to be the result of contamination or possibly instrument malfunction and was removed from the analysis.

All of the remaining air quality data provided, collected, and reported by EMA were used for the analysis. A comparison of EMA's monitored values with the proposed Trinidad and Tobago Air Pollution Rules is shown in Table 4.3-8. Maximum measured values are compared with the permissible levels; the relative fraction of the permissible level is summarized. Most values are less than half of the draft permissible levels prescribed in the draft Air Pollution Rules. Three concentrations were more than half of the permissible values. The maximum 1-hour observed CO concentration was half the permissible level, while the annual average PM_{10} concentration was slightly more than half at 52 percent of the permissible value. The single pollutant that exceeded the permissible level by a wide margin was the 24-hour PM_{10} concentration. The maximum observed 24-hour PM_{10} concentration was more than twice the permissible level; the permissible level for this parameter was exceeded in at least seven 24-hour periods over the 16-month monitoring period.

CariSal Unlimited collected onsite ambient air monitoring data over a 30-day period starting on October 25, 2007 (except for CO which began on November 2). Table 4.3-9 shows the results and compares them with Trinidad Permissible Levels. No exceedances of permissible levels were observed during the monitoring period. The highest fractions of the permissible levels were for the 24-hour PM_{10} and TSP concentrations.

To determine the appropriateness of the EMA data for use as background concentration in the impact analysis, CariSal acquired the EMA air quality data for the same time period as the CariSal on-site monitoring. However, during the early part of the monitored period, the EMA air quality monitoring system was not operational. Beginning November 4, 2007 hour 18, the EMA data recommenced operations. A total of 692 hours was available for a comparison between the CariSal air quality data and the EMA air quality data. The pollutants available for comparison include CO, NO_2, and PM_{10} (SO_2 comparison is not meaningful as there were no values above

Table 4.3-8. Summary of Air Quality Measurements from EMA's Point Lisas Monitoring Site (2004 – 2007)

Air Pollutant	Averaging Period	Permissible Level	Observed Concentration			Percentage of Permissible Level		
			Maximum Observed	3-Year Average Maximum Short-term	Annual Average	Maximum Observed	3-Year Average Maximum Short-term	Annual Average
Units		µg/m³	µg/m³	µg/m³	µg/m³	%	%	%
Total Suspended Particulate	24-hour	150	NM	NM	NM			
PM_{10}	24-hour	75	154.4	116.4	N/A	206%	155%	
PM_{10}	Annual	50	29.0	N/A	25.8	58%		52%
$PM_{2.5}$	24-hour	65	NM	NM	NM			
$PM_{2.5}$	Annual	15	NM	NM	NM			

Table 4.3-8. Summary of Air Quality Measurements from EMA's Point Lisas Monitoring Site (2004 – 2007)

Air Pollutant	Averaging Period	Permissible Level	Observed Concentration			Percentage of Permissible Level		
			Maximum Observed	3-Year Average Maximum Short-term	Annual Average	Maximum Observed	3-Year Average Maximum Short-term	Annual Average
Units		µg/m³	µg/m³	µg/m³	µg/m³	%	%	%
Hydrogen Chloride (HCl)	30-minute	100	NM	NM	NM			
Chlorine (Cl_2)	30-minute	300	NM	NM	NM			
Nitrogen Dioxide (NO_2)	1-hour	200	69.6	64.1	N/A	35%	32%	
Nitrogen Dioxide (NO_2)	Annual	40	10.2	N/A	9.4	26%		24%
Carbon Monoxide (CO)	1-hour	30,000	15,100	11,900	N/A	50%	40%	
Carbon Monoxide (CO)	8-hour	10,000	2,440	2,030	N/A	24%	20%	
Sulphur Dioxide (SO_2)	24-hour	125	56.0	44.0	N/A	45%	35%	
Sulphur Dioxide (SO_2)	Annual	50	7.33	N/A	5.0	15%		10%

Notes:
The EMA's Air Quality Monitoring for pollutants began in October 2004 with the exception of PM_{10}, which began in March 2006.
N/A - Not Applicable
NM - Not Monitored

Table 4.3-9. Background Air Quality Measured at the CariSal Site[a]

Air Pollutant	Averaging Period	Trinidad Draft Rules (2005) Permissible Level	On-Site Monitoring		Percentage of Permissible Level
			Maximum Observed	Period Average	
Units		µg/m[c]	µg/m[c]	µg/m[c]	Percent
Total Suspended Particulate	24-hour	150	89.0	N/A	59%
PM_{10}	24-hour	75	60.1	N/A	80%
PM_{10}	Annual	50	N/A	24.4	49%
$PM_{2.5}$	24-hour	65	20.8	N/A	32%
$PM_{2.5}$	Annual	15	N/A	7.9	53%
Units		µg/m³	µg/m³	µg/m³	Percent
Hydrogen Chloride (HCl)	30-minute	100	8.6[b,c]	N/A	9%
Chlorine (Cl_2)	30-minute	300	17.4[3]	N/A	6%
Nitrogen Dioxide (NO_2)	1-hour	200	71.4	N/A	36%
Nitrogen Dioxide (NO_2)	Annual	40	N/A	15.8	39%
Carbon Monoxide (CO)	1-hour	30,000	416	N/A	<1%

Table 4.3-9. Background Air Quality Measured at the CariSal Site[a]

Air Pollutant	Averaging Period	Trinidad Draft Rules (2005) Permissible Level	On-Site Monitoring		Percentage of Permissible Level
			Maximum Observed	Period Average	
Units		µg/m[c]	µg/m[c]	µg/m[c]	Percent
Carbon Monoxide (CO)	8-hour	10,000	141	N/A	<1%
Sulphur Dioxide (SO_2)	24-hour	125	6.5[d]	N/A	<1%
Sulphur Dioxide (SO_2)	Annual	50	N/A	6.5[d]	<1%

[a] Air quality monitoring data at the CariSal collected over a 30-day period starting late October 2007
[b] Based on 1/2 the minimum detection limit of 4 ppb for 24 hours with the integrated measurement scaled by 1/0.4 (= 2.5) based on U.S. EPA 1992 pp. 4–16
[c] 1/5 power law relationship applied to estimate peak 30-min from 1-hour observed concentration
[d] 1/2 the minimum detection limit of 5 ppb
N/A – Not Applicable

the detection limit recorded at the CariSal site). The mean 1-hour NO_2, 1-hour CO, and 24-hour PM_{10} concentrations at the EMA site were 6.2 ppb, 0.25 ppm and 23.2 µg/m^3, respectively. The mean NO_2, CO and PM_{10} concentrations at the CariSal site were 10.2 ppb, 0.10 ppm and 25.9 µg/m^3, respectively. The higher CO values for the EMA site is likely caused by higher concentrations of light-duty gasoline vehicles in the vicinity of the EMA site, while the higher mean NO_2 at the CariSal site may be due to influences of the nearby NGC pipeline construction activity that occurred during the monitoring period. Both the CO and NO_2 concentrations are small fractions of the Trinidad and Tobago permissible values. The mean 24-hour PM_{10} values as shown in Figure 4.3-9 are not well correlated when paired in time, suggesting that the two sites may be influenced by different PM_{10} emission sources; however, maximum 24-hour PM_{10} concentrations observed over this 3-week period were close at 65.3 µg/m^3 at EMA and 60.1 µg/m^3 at CariSal. This daily difference in PM_{10} concentration suggests that the CariSal PM_{10} data should be used as the background concentration because the EMA site is likely influenced by other PM_{10} sources and is not representative of the CariSal site. The CariSal data demonstrate that the current ambient air quality concentrations in the vicinity of the Project are below all of the permissible air quality levels provided in the draft Air Pollution Rules, except for the 24-hour PM_{10} concentration levels. Sections 5.1, 5.6, and 5.9 provide detailed discussion of air quality impacts.

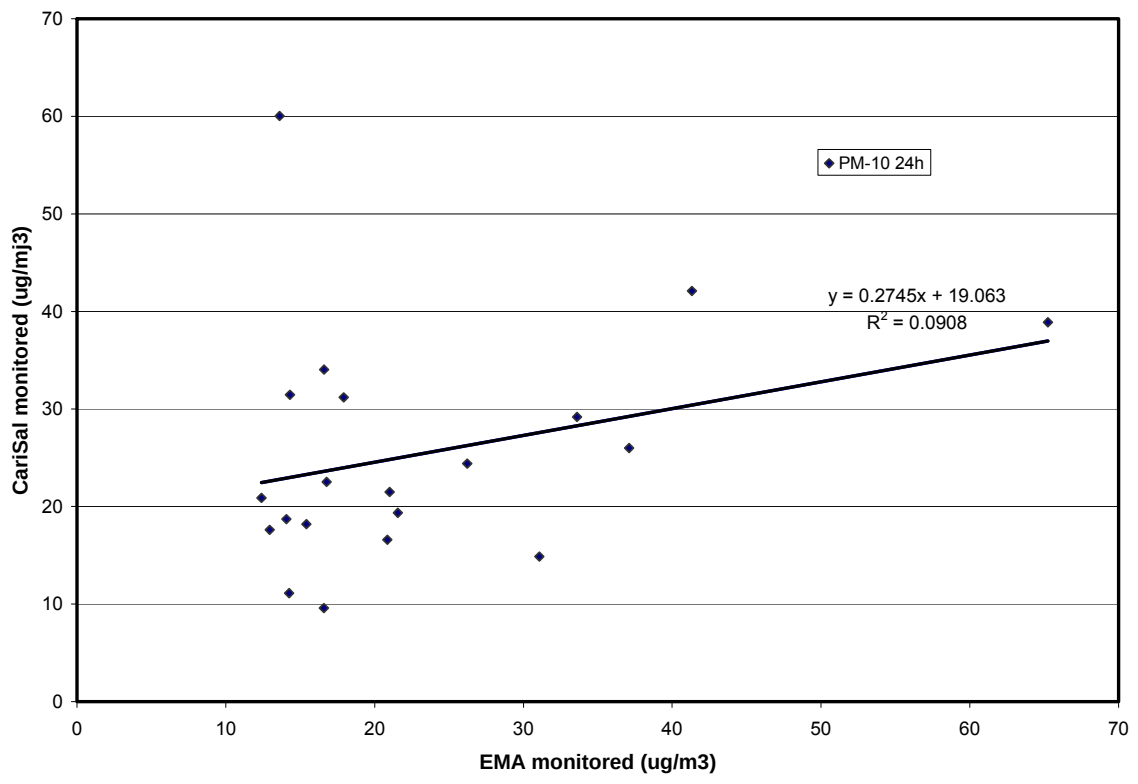


Figure 4.3-9. Comparison of EMA and CariSal site 24-hour PM_{10} concentrations (November 5 – 27, 2000).

4.3.5 Noise

This section describes the baseline noise conditions in the environment on and surrounding the CariSal site. Noise conditions were defined through a measurement programme conducted in July 2007. Historical data on noise measurements made in 1999, 2005, and 2006 were compiled to provide additional information on noise conditions in the vicinity of the site.

4.3.5.1 Noise Criteria

The EMA has established standards for allowable noise levels (Laws of Trinidad and Tobago, Environmental Management, Chapter 35:05, Noise Pollution Control Rules 2001, First Schedule – Prescribed Standards), which are briefly described in Section 2.4.2 and listed in Table 4.3-10. Noise levels in the Project area were compared to these standards for the impact assessment in Section 5.

Table 4.3-10. EMA Noise Standards

Time of Day	Zone I: Industrial Areas		Zone II: Environmentally Sensitive Areas		Zone III: General Areas[a]	
	Continuous (dBA)	Instantaneous (dB)	Continuous (dBA)	Instantaneous (dB)	Continuous (dBA)	Instantaneous (dB)
Any Time	75	130				
Day 8:00am-8:00pm			• Not exceeding 3 dBA above background, and • Not exceeding 60 dBA.	120	• Not exceeding 5 dBA above background, and • Not exceeding 80 dBA.	120
Night 8:00pm-8:00am			• Not exceeding 3 dBA above background, and • Not exceeding 60 dBA	115	• Not exceeding 5 dBA above background, and • Not exceeding 65 dBA	115

[a] Zone III (General Areas) includes residences.
Source: EMA Noise Pollution Control Rules (2001)

4.3.5.2 July 2007 Ambient Noise Monitoring Programme

4.3.5.2.1 Measurement Locations

CariSal commissioned Kaizen Environmental Services (Trinidad) Limited (Kaizen) to conduct environmental sound pressure level (SPL) (or noise) monitoring at the fence line. Kaizen conducted noise monitoring at two locations on the CariSal site, the North Field Location and the South Field Location (Figure 4.3-10, see also Chapter 10).

4.3.5.2.2 Instrumentation and Calibration

Quest Model 2900 Integrating/Data logging sound level meters were used to conduct the noise measurements. The Quest Model 2900 provides General Purpose Type 2 accuracy and complies with applicable portions of Type 2, ANSI S1.43-1997, IEC60651-1979, IEC60804-1985, PTB, and CE Mark. This meter incorporates an internal data logger, allowing the user to store one or more sound studies in the field for later printing or uploading to a computer. The instruments were configured to log data at 30-minute intervals. The Quest Model 2900 complies with the specifications of the EMA Noise Pollution Control Rules 2001. Table 4.3-11 lists the parameter settings used in the measurements.

The microphone must be calibrated to ensure accurate readings. The microphone was calibrated before each recording session for complete records and data integrity. The microphone was calibrated using the Quest QC-10 Calibrator (114 decibels [dB] at 1000 hertz [Hz] output), which is the manufacturer-certified kit.

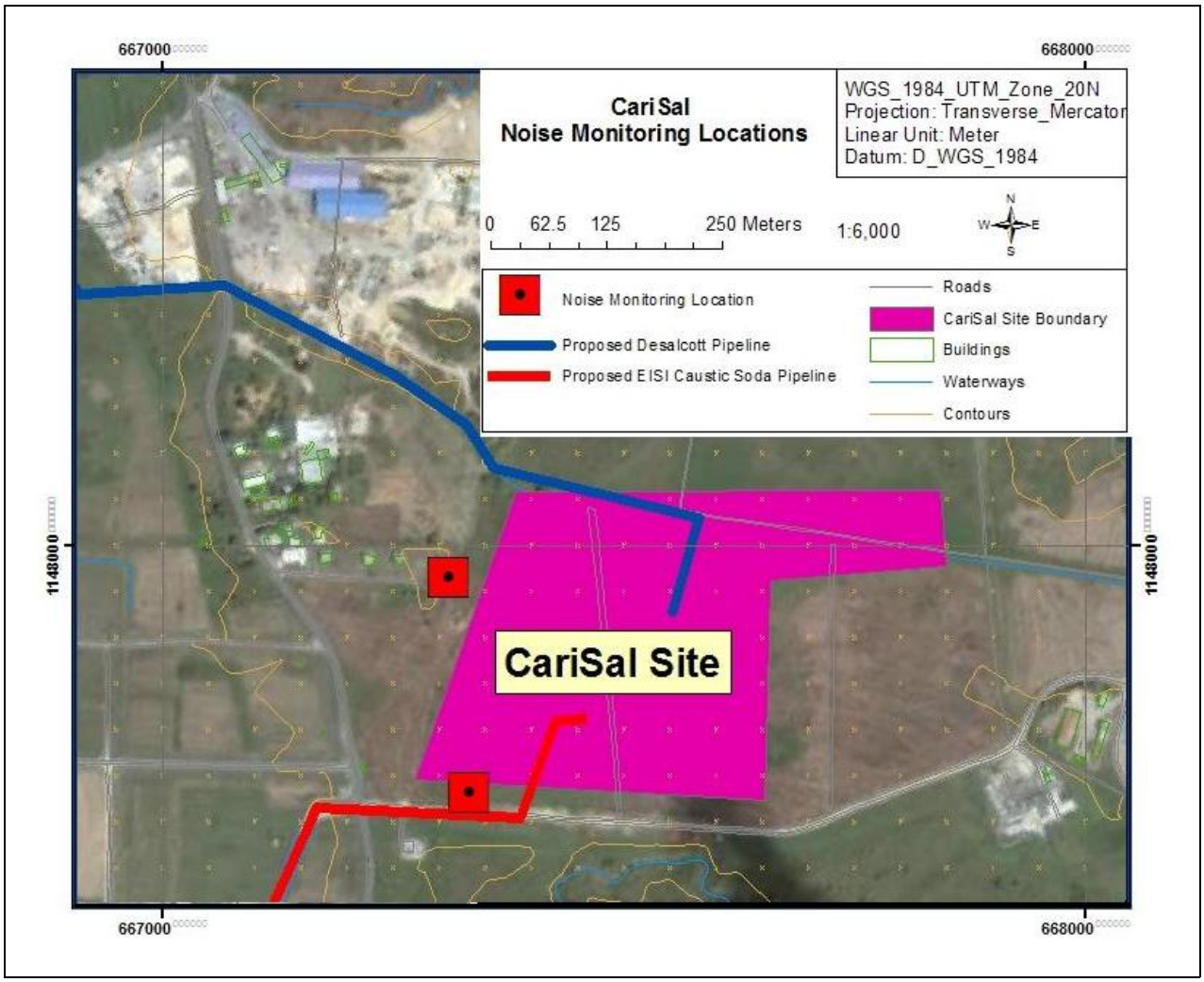


Figure 4.3-10. Noise monitoring locations, July 2007.

Table 4.3-11. Noise Measurement Parameters for July 2007 Program

Parameter	Units	Exchange Rate	Response	Frequency Characteristic
Equivalent Continuous Sound Pressure Level (L_{eq})	**dBA**	**3 dB**	**"Fast"**	**A-weighted**
Instantaneous Unweighted Peak Sound Pressure Level (L_{peak})	**dB (peak)**	**3 dB**	**"Peak"**	**Linear**

For determination of the L_{eq} and L_{peak} parameters, measurements were made in accordance with the Noise Pollution Control Rules 2001, Second Schedule – Measurement of Sound Pressure Levels. Noise was monitored for approximately 24 hours at each location. A windscreen was used to prevent measurement errors caused by wind blowing across the microphone. The monitoring was conducted during normal plant operating conditions at the nearby industrial

facilities. Thus, the measured noise levels are considered representative of conditions in the area.

4.3.5.2.3 July 2007 Monitoring Results

Table 4.3-12 provides the results of the July 2007 noise measurement programme. The results show that the environmental noise levels on the CariSal site during the July 2007 measurement period were in compliance with the applicable standards.

Table 4.3-12. July 2007 Noise Measurement Results

Location No.	Location Description	Date	Start Time	Stop Time	L_{eq} (dBA)	L_{peak} (dB)
1	**North Field Location: Residence 50 m west of site boundary, off Southern Main Road. Nearest residence to site.**	**July 27–28, 2007**	**9:06 am**	**9:15 am**	**53.8**	**109.2**
2	**South Field Location: At southern boundary of site, northeast of NGC Phoenix Park Intermediate Station.**	**July 27–28, 2007**	**9:02 am**	**9:08 am**	**51.1**	**106.3**
EMA Standard for Zone 1, Industrial Areas					**75**	**130**

Source: Kaizen Environmental Services (Trinidad) Limited 2007.

4.3.5.3 Historical Noise Monitoring Data

Historical noise data were compiled from three previous noise monitoring studies in the area near the CariSal site. The studies were conducted in 2006, 2005, and 1999. The results are summarized below, with the most recent data presented first, for the monitoring locations that are relevant to the CariSal site.

4.3.5.3.1 February 2006 Noise Measurements

A baseline environmental noise survey of the study area was conducted by EPAS Consultants Ltd. in February 2006 as part of the *Environmental Impact Assessment Study for the Proposed Steel Complex of Essar Group at Point Lisas, Trinidad and Tobago* (the Essar EIA). A Quest Model 2900 integrating/logging sound level meter was used for the measurements. Table 4.3-13 presents a summary of the monitored data. The monitored noise levels were reported to be below the EMA noise L_{eq} standards of 75 dBA for industrial areas (Zone I), and 80 dBA in daytime and 65 dBA in nighttime for the general area (Zone III).

4.3.5.3.2 1999 and 2005 Noise Measurements

Noise surveys were also conducted in the study area in 1999 and 2005 and are reported here as historical measurement data. Table 4.3-14 presents a summary of the 1999 and 2005 monitored data, and monitoring locations are shown in Figure 4.3-11 (see also Chapter 10). Noise levels for 2005 at each location were monitored for approximately 24-hour periods. No data are available regarding the duration of monitoring periods in 1999.

Table 4.3-13. February 2006 Noise Measurement Results

Location No.	Location Description	Monitoring Period	L_{eq} (dBA)	L_{90}[a] (dB)	Max.[b] (dB)	Min. (dB)
	Upwind of Savonetta Estates	**2/2/06 5:20 pm – 2/3/06 5:13 pm**	**61.7**	**61.6**	**82.3**	**61.6**
	Sum-Sum Hill	**2/6/06 12:51 pm – 2/7/06 12:51 pm**	**61.7**	**61.6**	**82.1**	**61.6**
EMA Standard for Zone 1, Industrial Areas			**75**		**130**	
EMA Standard for Zone 3, General Areas (day/night)			**80/65**		**120/115**	

[a] L90 indicates the sound level that was exceeded 90% of the time.

[b] The reported "Maximum" levels are assumed to correspond to L_{peak}.

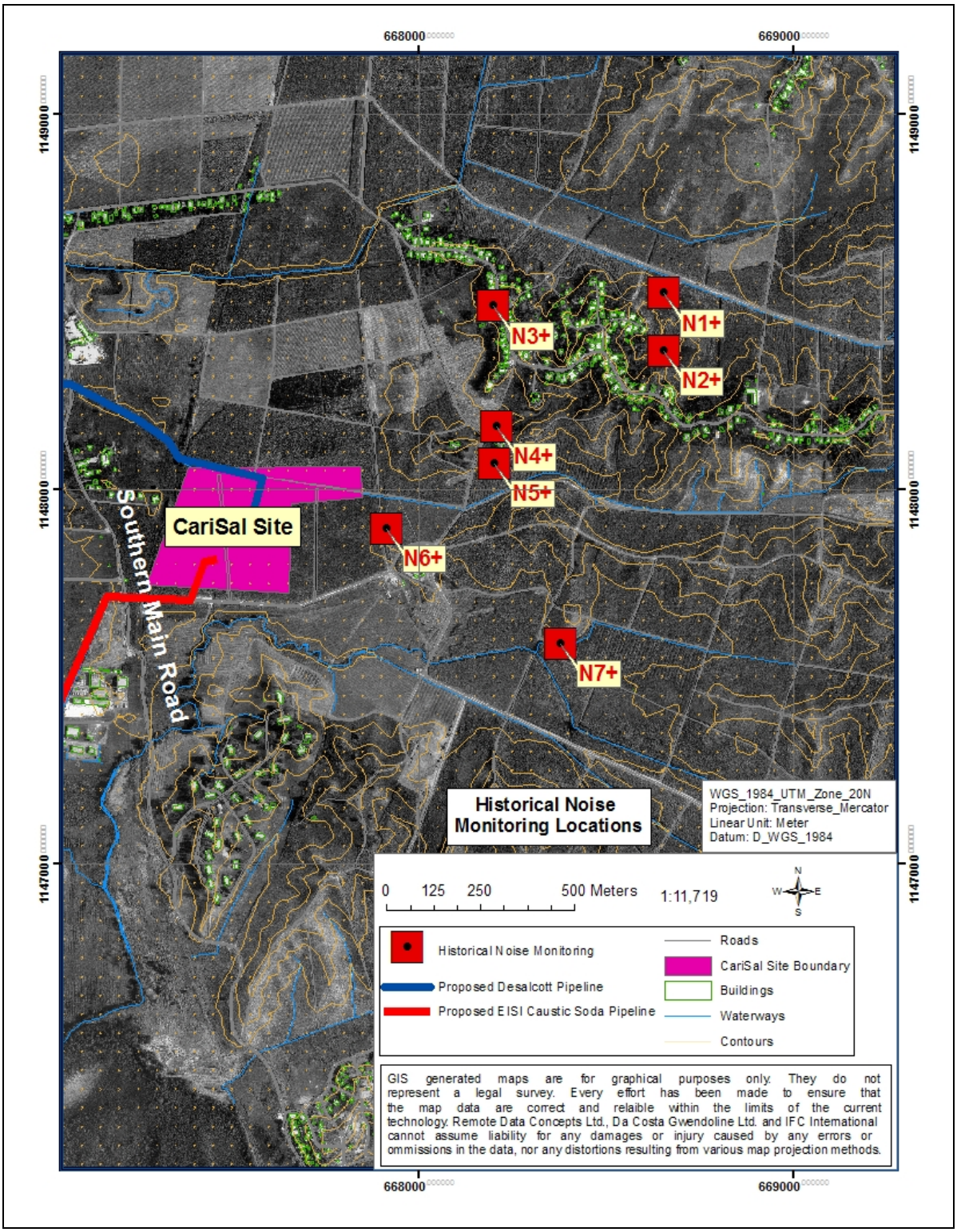
Source: SENES Consultants Limited and EPAS Consultants Limited, 2006

Table 4.3-14. 1999 and 2005 Noise Measurement Results

Location	Location Description	Year	Daytime		Nighttime	
			L_{eq} (dBA)	L_{peak} (dB)	L_{eq} (dBA)	L_{peak} (dB)
A	**Along Southern Main Road, at Hydro Agri (now Yara Trinidad) Customs Residence**	**1999**	**61.9**		**59**	
B	**Hydro Agri Housing Establishment**	**1999**	**51.9**		**76.3**	
C	**Residence in Claxton Bay area**	**1999**	**60.9**		**55.7**	
3	**Opposite Mosque in Phoenix Park**	**2005**	**62.4**	**108.6**	**60.8**	**104.6**
EMA Standard for Zone I, Industrial Areas			**75**	**130**	**75**	**130**
EMA Standard for Zone III, General Areas			**80**	**120**	**65**	**115**

Source: EcoEngineering Consultants Ltd. 2005

Most values were in compliance with the noise standards. The nighttime L_{eq} of 76.3 dBA as measured in 1999 at Location B exceeds the Zone III standard of 65 dBA. The Essar EIA does not provide further information on any conditions that might have accounted for this noise level during the measurement period. However, as residential areas generally are quieter at night, the measured value of 76.3 dBA may not be representative of conditions at Location B. In general, the noise levels appeared to be highest in locations closest to the more heavily travelled roads, indicating that road transportation was the primary cause of higher noise levels.



Source: Adapted from EcoEngineering Consultants Ltd. 2005

Figure 4.3-11. Historic noise levels in the study area.

4.3.5.4 Summary of Noise Environment of CariSal Site

Based on the measurement data reported above, the following conclusions may be drawn concerning the ambient noise environment of the area surrounding the CariSal site.

- The measured peak and average noise levels in the area around the CariSal site comply with the applicable Zone I and Zone III standards except for one instance that was measured in 1999. However, this single instance of apparent noncompliance may not be representative of the area.
- The EMA defines background noise levels (Noise Pollution Control Rules 2001, Rule 2) as the composite of sounds generated by all natural sources as well as those generated by activities that comprise the ordinary living conditions of an area. Based on the measured data presented, background noise levels (as L_{eq}) in the area around the CariSal site appear to range from 51.1 dBA to 62.4 dBA.

4.3.6 Aquatic Environment

4.3.6.1 Surface Hydrology and Drainage

No major drainages exist on the Project site itself. A minor drainage traverses the northern boundary of the site, originating from the hills to the east-southeast. The BC river lies about 500 m north of the site boundary flows west through the industrial estate. The LNG River lies approximately 100 m south of the site and discharges to the Gulf of Paria through a mangrove area on the western side of Southern Main Road.

No naturally occurring large ponds or reservoirs are located within the Project site. Wetland (comprising perennial and annual marshland) areas have been identified along the northern and western segments of the site (EIS, Ltd. 2007).

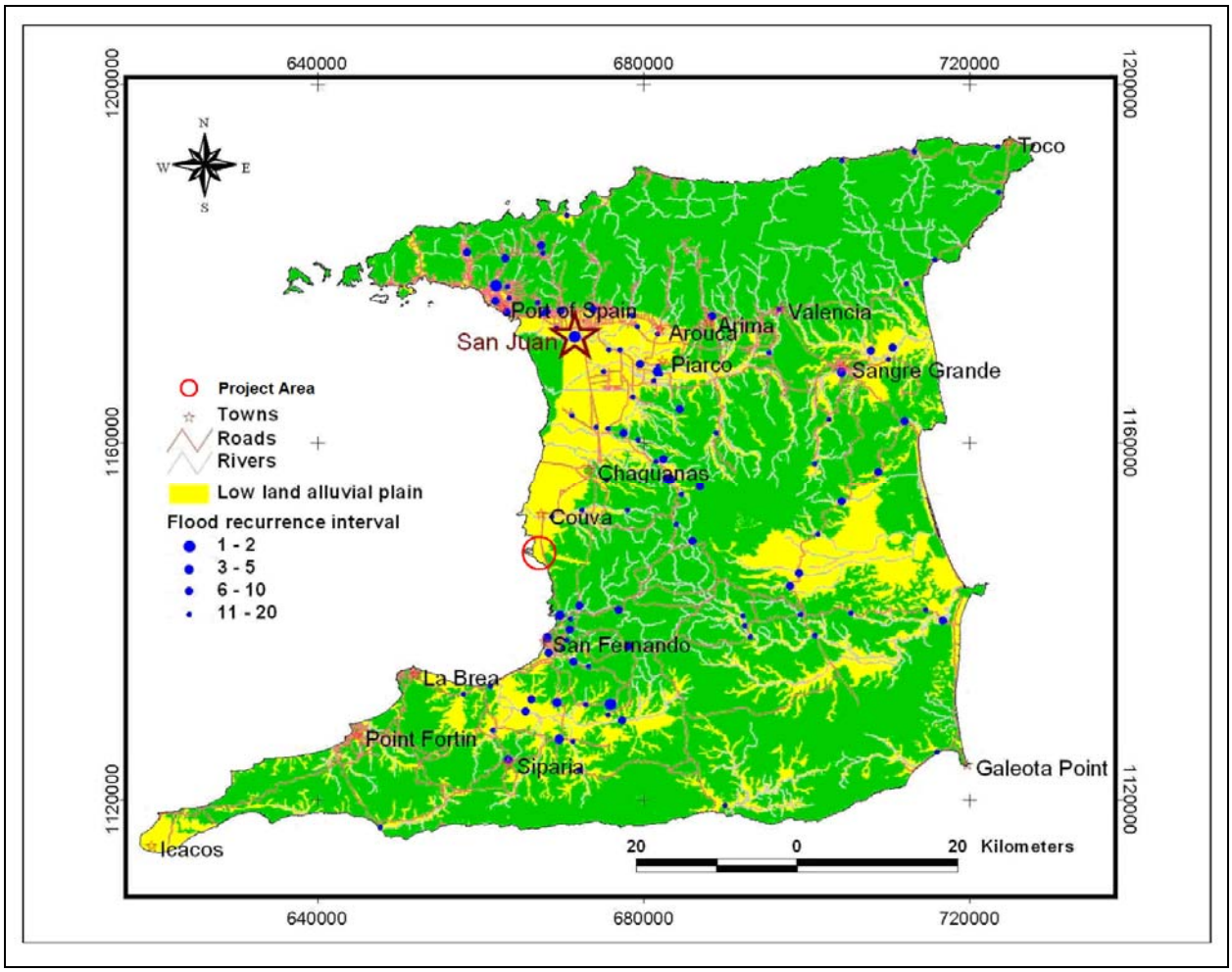
Severe island-wide flooding occurred in Trinidad in 1981, 1984, 1985, 1986, and 1988, with regional and local flooding occurring nearly every year. In the past 20 years, more than 100 locations on the island have been flooded (FAO 2005). Low land alluvial plains along coastal plains and in riverine areas are most vulnerable to flooding, especially areas of low elevation and little topographic relief. The map in Figure 4.3-12 identifies low land alluvial plains (Canisius and Nancy 2007). The proposed CariSal site lies within such a low land alluvial plain, as indicated in the figure.

Flooding is generally caused by periods of high intensity rainfall, especially during the rainy season when groundwater levels are already high and detention basins and natural storage areas are full. The rate of excess runoff exceeds the capacity of the drainage system and water accumulates in low lying areas.

In 2003, Trinidad and Tobago was working on the development of pilot projects for flood early warnings systems in three communities near the Project site: Caparo (17 km NE), Caroni (26 km N), and Oropouche (20 km SE) (CDERA 2003).

The Ministry of Works and Transport, Drainage Division identifies the area around the project site as a flood-prone area. Recent flooding has been reported in the lower reaches of the LNG River, west of Southern Main Road just before it enters the coastal mangrove. The NEC indicated that it plans to improve the flow channel of the LNG River as part of a port development project to reduce flooding of these low-lying areas between the CariSal site and the Bay. This NEC Port Project involves the reclamation of 250 ha of land for the establishment of a port, causeway, turning basin and navigation channel at Point Lisas.

The proposed CariSal site itself lies within a low land alluvial plain, as indicated in Figure 4.3-12. The low topographic relief combined with a high natural groundwater table and soils with restricted drainage capabilities combine to make the site susceptible to flooding. The site had been partially protected from flooding from the LNG River to the south by slightly higher ground elevations along the NGC's utility right of way. Recent earthmoving associated with the construction of the new NGC pipeline has lowered the ground elevation in the area, removing the former protective barrier.



Source: Adapted from Canisius and Nancy (2007)

Figure 4.3-12. Flood-prone areas and flood locations in Trinidad.

Two proposed projects, the Westlake ethylene and polyethylene complex and the Essar steel complex, are both located upstream of the Project site along the LNG River. The levelling and paving associated with the change from agricultural to industrial land use at these sites threaten to increase the runoff and the peak flows in the LNG River, and to exacerbate the downstream flooding hazards, without appropriate drainage plans in place. The Westlake site covers 120 Ha and the Essar site covers 204 ha

The drainage channel that runs along the northern portion of the Project site reportedly backs up during high flows from Southern Main Road to the Project site. The inadequate channel capacity is attributed to restrictions in and near the culvert under Southern Main Road. Figures 4.3-13 and 4.3-14 show the northern drainage channel in the vicinity of Southern Main Road.

Measurements taken in the northern drainage channel on 16 November 2007 indicated a flow rate of approximately 0.010 m^3/hr at about 300 m east of the western boundary of the Project site and a flow rate of about 0.080 m^3/hr at Southern Main Road. On the day the measurements were taken, flow from the east was interrupted by construction within the NGC ROW, so most or all of the flow represented runoff or seepage from the land adjacent to the channel.

Source: Grismala (2007)

Figure 4.3-13. Northern drainage channel approaching Southern Main Road from the East.

Source: Grismala (2007)

Figure 4.3-14. Northern drainage channel exiting under west side of Southern Main Road.

4.3.6.2 Groundwater Resources

Information on the hydrogeology of the Project site was obtained from the Hydrogeological Map of Trinidad (1989) published by the Water Resources Agency. The Sum Sum Sands Compartment is the primary aquifer, which outcrops in this area as the Sum Sum outcrop and Durham Sands outcrop. The Sum Sum Sands Compartment dips sharply downward in a westerly to north-westerly direction toward the Gulf of Paria. This aquifer is a sheet or blanket type sand aquifer, which consists of clean well-sorted fluvial and tidal shoreface fine to medium sands of excellent quality. The major users of the aquifer system are Trinidad Cement Limited, Petrotrin, and Yara.

The aquifer productivity within the Study Area can be described as medium to high, with the specific capacity of wells between 1 and 4 cubic metres per minute per hour ($m^3/h/m$). This includes an area with intensive groundwater exploitation and some areas have significant natural replenishment to the groundwater several km east of the site where the Sum Sum Sands outcrops.

4.3.6.3 Ambient Water Quality

Surface water quality sampling was conducted within the study area of the proposed plant to determine the baseline ambient surface water quality to baseline conditions. Samples were taken on May 30, 2007 at the five locations listed in Table 4.3-15 and shown in Figure 4.3-15 (see also Chapter 10). No significant precipitation occurred during or within one week prior to the sampling event within or in the vicinity of the Project area.

Table 4.3-15. Surface Water Sampling Locations, May 30, 2007

Loc. No.	Description	UTM Coordinates[a]
1	**Along the LNG River, south of proposed plant site**	**E 0667743 N 1147850**
2	**Drain along western boundary of site, north of road along southern boundary**	**E 0667443 N 1147900**
3	**Southern drain along North Sea Road, near turn off to PPGPL**	**E 0666975 N 1147445**
4	**Drain east of CNC**	**E 0667021 N 1148687**
5	**Drain along southern boundary of DESALCOTT**	**E 0666943 N 1148901**

[a] Accuracy of coordinate is approximately 10 feet or 3.0 m (depending on availability of satellites and cloud cover).

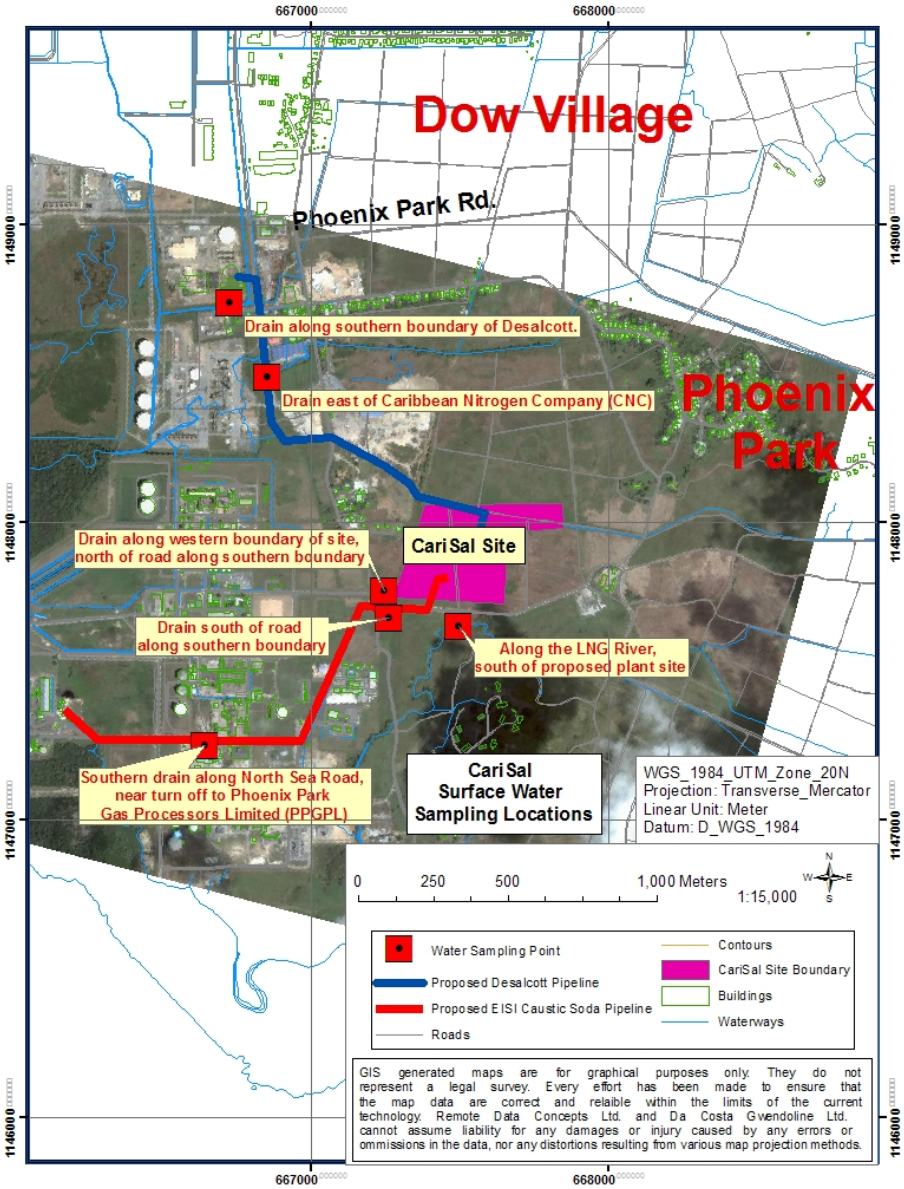


Figure 4.3-15. Surface water monitoring locations.

Table 4.3-16 presents the analytical results of the surface water samples collected. Trinidad and Tobago has no established guidelines for surface water quality, so the criteria stipulated in the following laws and guidelines are included for comparison:

- Water Pollution Rules, 2001
- TTS 547: 1998 (Specification for Effluent from industrial Processes Discharged into the Environment)

Table 4.3-16. Results of Surface Water Analysis, May 30, 2007

		Sample Location							
Parameter	Units	1	2	3	4	5	Water Pollution Rules[a]	TTS 547:1998[a]	Historical Results[b]
pH @ 25 °C		7.34	6.48	8.62	7.36	6.18	6 – 9	6 - 9	6.1 – 7.0
Temperature	°Celsius	31.1	29.7	33.4	29.7	29.9	35	35	22.79 – 29.31
Dissolved Oxygen	mg/L	3.10	0.59	4.38	3.10	1.02	>4	NQ	4.4 - 9.1
Biochemical Oxygen Demand (BOD)	mg/L	<6.0	7.43	6.47	< 6.0	85.78	30	30	6.51 – 16.35
Chemical Oxygen Demand (COD)	mg/L	40	27	27	22	106.0	250	250	NA
Total Suspended Solids	mg/L	< 2	38.0	29.6	20.0	805.0	50	50	6.9 - 28
Oil and Grease	mg/L	18.3	< 1.6	4.0	1.8	5.8	10	10	0.107 – 0.444
Total Petroleum Hydrocarbons	mg/L	<1.6	< 1.6	3.2	1.3	1.8	25	25	NA
Ammonia-N	mg/L	0.31	0.45	2.05	0.70	2.13	10	10	NA
Wat-phosphorus (as phosphate)	mg/L (as phosphate)	0.30	4.40	0.17	0.25	3.20	5	5	0.158 – 0.4215
Sulphide (H_2S)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	1	1	NA
Chloride	mg/L	53.88	32.61	53.88	46.79	68.06	250	250	NA
Hexavalent Chromium (Cr^{6+})	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.1	0.1	NA
Dissolved Iron	mg/L	0.258	0.539	0.038	0.106	1.17	3.5	3.5	615.2 – 1472.0
Total Nickel (Ni)	mg/L	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	0.5	0.5	23.0 – 38.1
Total Copper (Cu)	mg/L	< 0.006	0.018	0.016	< 0.006	0.008	0.5	0.5	8.3 – 12.8
Total Zinc (Zn)	mg/L	0.053	0.085	0.059	0.043	0.248	2	2	73.2 – 217.8
Total Arsenic (As)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.1	0.1	NA
Total Cadmium (Cd)	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	0.1	0.1	1.5 – 2.2
Total Mercury (Hg)	mg/L	< 0.00004	< 0.00004	< 0.00004	< 0.00004	0.00089	0.01	0.01	BDL
Total Lead (Pb)	mg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.1	0.1	25.4 – 31.4
Cyanide	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.1	0.1	NA

Table 4.3-16. Results of Surface Water Analysis, May 30, 2007

		Sample Location							
Parameter	Units	1	2	3	4	5	Water Pollution Rules[a]	TTS 547:1998[a]	Historical Results[b]
Phenol Total	mg/L	0.015	0.010	0.006	0.012	0.005	0.5	0.5	NA
Acute Toxicity (LC_{50})	ppm	NATE	NATE	NATE	NATE	563,000	NATE	NQ	NA
Faecal Coliform (MPN mtd)	MPN/ 100 mL	> 1600	240	900	900	> 1600	400	400	500 – ≥ 16000
Total chromium (Cr)	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.5	0.5	1.25 – 61.4

Note: Exceedances shown in **shaded bold type**
[a] Guideline for discharge to Inland Surface Water
[b] Information Sources from the EIA for Proposed Steel Complex of Essar Group at Point Lisas
LC_{50} = lethal concentration, 50 percent
MPN = most probable number
NATE = No Acute Toxic Effects
NQ = Not Quoted
NA = Not Available

CariSal also conducted surface water quality sampling to collect baseline data during the wet season. Samples were collected on July 19 and 30 of 2007 at six locations chosen to represent watercourses crossing or in the vicinity of the Project facilities. Table 4.3-17 presents a description of the sampling locations.

Table 4.3-17. Surface Water Sampling Locations for July 17 and 30, 2007 Sampling

Loc. No.	Description	UTM Coordinates[a]
1	Along the LNG River, south of proposed plant site	0667743 1147850
2	Drain along western boundary of site, north of road along southern boundary	0667443 1147900
3	Southern drain along North Sea Road, near turn off to PPGPL	0666975 1147445
4	Drain east of CNC	0667021 1148687
5	Drain along southern boundary of DESALCOTT	0666943 1148901
6	Drain south of road on southern boundary of site, near the Phoenix Park Intermediate Station	0667443 1147895

[a] Accuracy of coordinate is approximately 10 feet or 3.0 m (depending on availability of satellites and cloud cover). UTM coordinates are based on World Geodetic System Datum.

Tables 4.3-18 and 4.3-19 present the results of the analysis on the samples collected. The criteria stipulated for the tables are identical to that of Table 4.3-16.

Table 4.3-18. Results of Surface Water Analysis Conducted on July 19, 2007

Parameter	Units	Sample Location 1	Sample Location 2	Sample Location 3	Sample Location 4	Sample Location 5	Sample Location 6	Water Pollution Rules*	TTS 547:1998[a]	Historical Results[b]
pH @ 25 °C		6.41	6.66	10.03	7.46	7.22	6.68	6 – 9	6 - 9	6.1 – 7.0
Temperature	Degrees Celsius	24.2	25.6	25.7	25.5	25.3	25.5	35	35	22.79 – 29.31
Dissolved Oxygen	mg/L	1.17	3.48	3.73	3.82	3.75	2.42	< 4	NQ	4.4 - 9.1
Biochemical Oxygen Demand (BOD)	mg/L	<6	<6	18.36	<6	<6	<6	30	30	6.51 – 16.35
Chemical Oxygen Demand (COD)	mg/L	18	36	32	22	27	24	250	250	NA
Total Suspended Solids	mg/L	1660.0	2.0	42.0	110.0	10.0	12.0	50	50	6.9 - 28
Oil and Grease	mg/L	<1.6	4.8	2.1	<1.6	<1.6	4.3	10	10	0.107 – 0.444
Total Petroleum Hydrocarbons	mg/L	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	25	25	NA
Ammonia-N	mg/L	0.53	0.51	0.88	0.48	0.67	0.38	10	10	NA
Wat-phosphorus (as phosphate)	mg/L (as phosphate)	0.34	0.50	0.32	0.64	0.48	0.44	5	5	0.158 – 0.4215
Sulphide (H_2S)	mg/L	<0.010	<0.010	0.157	<0.010	<0.010	<0.010	1	1	NA
Chloride	mg/L	25.52	25.52	25.52	11.34	25.52	25.52	250	250	NA
Hexavalent Chromium (Cr^{6+})	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	0.1	NA
Dissolved Iron	mg/L	1.17	3.53	0.484	2.08	0.910	3.29	3.5	3.5	615.2 – 1472.0
Total Nickel (Ni)	mg/L	0.081	<0.006	<0.006	0.015	<0.006	<0.006	0.5	0.5	23.0 – 38.1
Total Copper (Cu)	mg/L	0.063	0.012	0.011	0.017	0.010	0.007	0.5	0.5	8.3 – 12.8
Total Zinc (Zn)	mg/L	0.441	0.059	0.094	0.212	0.102	0.105	2	2	73.2 – 217.8
Total Arsenic (As)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.1	0.1	NA

Table 4.3-18. Results of Surface Water Analysis Conducted on July 19, 2007

Parameter	Units	Sample Location 1	Sample Location 2	Sample Location 3	Sample Location 4	Sample Location 5	Sample Location 6	Water Pollution Rules*	TTS 547:1998[a]	Historical Results[b]
Total Cadmium (Cd)	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.1	0.1	1.5 – 2.2
Total Mercury (Hg)	mg/L	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	0.01	0.01	BDL
Total Lead (Pb)	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.1	0.1	25.4 – 31.4
Cyanide	mg/L	<0.010	<0.010	0.014	<0.010	<0.010	<0.010	0.1	0.1	NA
Phenol Total	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.5	0.5	NA
Acute Toxicity (LC_{50})	Ppm	**750,000.0**	**175,000.0**	**625,000.0**	NATE	NATE	**250,000.0**	NATE	NQ	NA
Faecal Coliform (MPN mtd)	MPN/100mL	**>1600**	**>1600**	**900**	**>1600**	**>1600**	**900**	400	400	500- ->= 16000
Total Chromium (Cr)	mg/L	0.031	<0.005	<0.005	<0.005	<0.005	<0.005	0.5	0.5	1.25 – 61.4

Note: Exceedances shown in **shaded bold type**

[a] Guideline for discharge to Inland Surface Water

[b] Information Sources from the EIA for Proposed Steel Complex of Essar Group at Point Lisas

LC_{50} = lethal concentration, 50 percent

MPN = most probable number

NATE = No Acute Toxic Effects

NQ = Not Quoted

Table 4.3-19. Results of Surface Water Analysis Conducted on July 30, 2007

Parameter	Units	Sample Location 1	Sample Location 2	Sample Location 3	Sample Location 4	Sample Location 5	Sample Location 6	Water Pollution Rules[a]	TTS 547:1998[a]	Historical Results[b]
pH @ 25 °C		7.17	6.87	7.78	6.78	7.05	6.87	6 – 9	6 - 9	6.1 – 7.0
Temperature	Degrees Celsius	29.0	27.5	30.5	27.6	32.5	27.5	35	35	22.79 – 29.31
Dissolved Oxygen	mg/L	4.99	0.8	3.5	5.01	1.54	0.8	< 4	NQ	4.4 - 9.1
Biochemical Oxygen Demand (BOD)	mg/L	< 6	< 6	<6	< 6	> 16.74	<6	30	30	6.51 – 16.35
Chemical Oxygen Demand (COD)	mg/L	23	27	26	31.0	77	27	250	250	NA
Total Suspended Solids	mg/L	53.0	28.0	5.0	5.0	58.0	28.0	50	50	6.9 - 28
Oil and Grease	mg/L	< 1.6	< 1.6	<1.6	< 1.6	< 1.6	<1.6	10	10	0.107 – 0.444
Total Petroleum Hydrocarbons	mg/L	< 1.6	< 1.6	<1.6	< 1.6	< 1.6	<1.6	25	25	NA
Ammonia-N	mg/L	0.09	0.34	0.42	0.13	0.17	0.34	10	10	NA
Wat-phosphorus (as phosphate)	mg/L (as phosphate)	0.25	0.51	0.34	0.31	< 0.01	0.51	5	5	0.158 – 0.4215
Sulphide (H_2S)	mg/L	< 0.01	< 0.01	<0.01	< 0.01	< 0.01	<0.01	1	1	NA
Chloride	mg/L	36.87	22.69	79.41	29.78	58.14	22.69	250	250	NA
Hexavalent Chromium (Cr^{6+})	mg/L	< 0.01	< 0.01	<0.01	< 0.01	< 0.01	<0.01	0.1	0.1	NA
Dissolved Iron	mg/L	1.12	1.18	0.134	0.361	0.316	1.18	3.5	3.5	615.2 – 1472.0
Total Nickel (Ni)	mg/L	< 0.006	< 0.006	<0.006	< 0.006	< 0.006	<0.006	0.5	0.5	23.0 – 38.1
Total Copper (Cu)	mg/L	< 0.006	< 0.006	<0.006	0.028	< 0.006	<0.006	0.5	0.5	8.3 – 12.8
Total Zinc (Zn)	mg/L	0.102	0.113	0.126	0.111	< 0.095	0.113	2	2	73.2 – 217.8
Total Arsenic (As)	mg/L	< 0.02	< 0.02	<0.02	< 0.02	< 0.02	<0.02	0.1	0.1	NA
Total Cadmium (Cd)	mg/L	< 0.003	< 0.003	<0.003	< 0.003	< 0.003	<0.003	0.1	0.1	1.5 – 2.2
Total mercury (Hg)	mg/L	< 0.00004	< 0.00006	0.00005	0.00007	0.00015	0.00006	0.01	0.01	BDL
Total Lead (Pb)	mg/L	< 0.03	< 0.03	<0.03	< 0.03	< 0.03	<0.03	0.1	0.1	25.4 – 31.4
Cyanide	mg/L	< 0.01	< 0.01	<0.01	< 0.01	< 0.01	<0.01	0.1	0.1	NA
Phenol Total	mg/L	0.053	0.021	0.027	0.013	0.013	0.021	0.5	0.5	NA
Acute Toxicity (LC_{50})	ppm	NATE	NATE	NATE	NATE	NATE	NATE	NATE	NQ	NA
Faecal Coliform (MPN mtd)	MPN/100mL	> 1600	240	900	1600	> 1600	240	400	400	500-≥16000
Total Chromium (Cr)	mg/L	< 0.005	< 0.005	<0.005	< 0.005	< 0.005	<0.005	0.5	0.5	1.25 – 61.4

Note: Exceedances shown in **shaded bold type**
[a] Guideline for discharge to Inland Surface Water
[b] Information Sources from the EIA for Proposed Steel Complex of Essar Group at Point Lisas
LC_{50} = lethal concentration, 50 percent
MPN = most probable number
NATE = No Acute Toxic Effects
NQ = Not Quoted

Kaizen also conducted baseline groundwater quality monitoring at the Project site. Samples were taken in two groundwater monitoring wells located as shown in Table 4.3-20 and in Figure 4.3-16.

Table 4.3-20. Groundwater Sampling Locations

Loc. No.	Description	UTM Coordinates
1	**South East Corner of Project Site**	**E 0667737 N 1147898**
2	**South West Corner of Project Site**	**E 0667656 N 1147917**

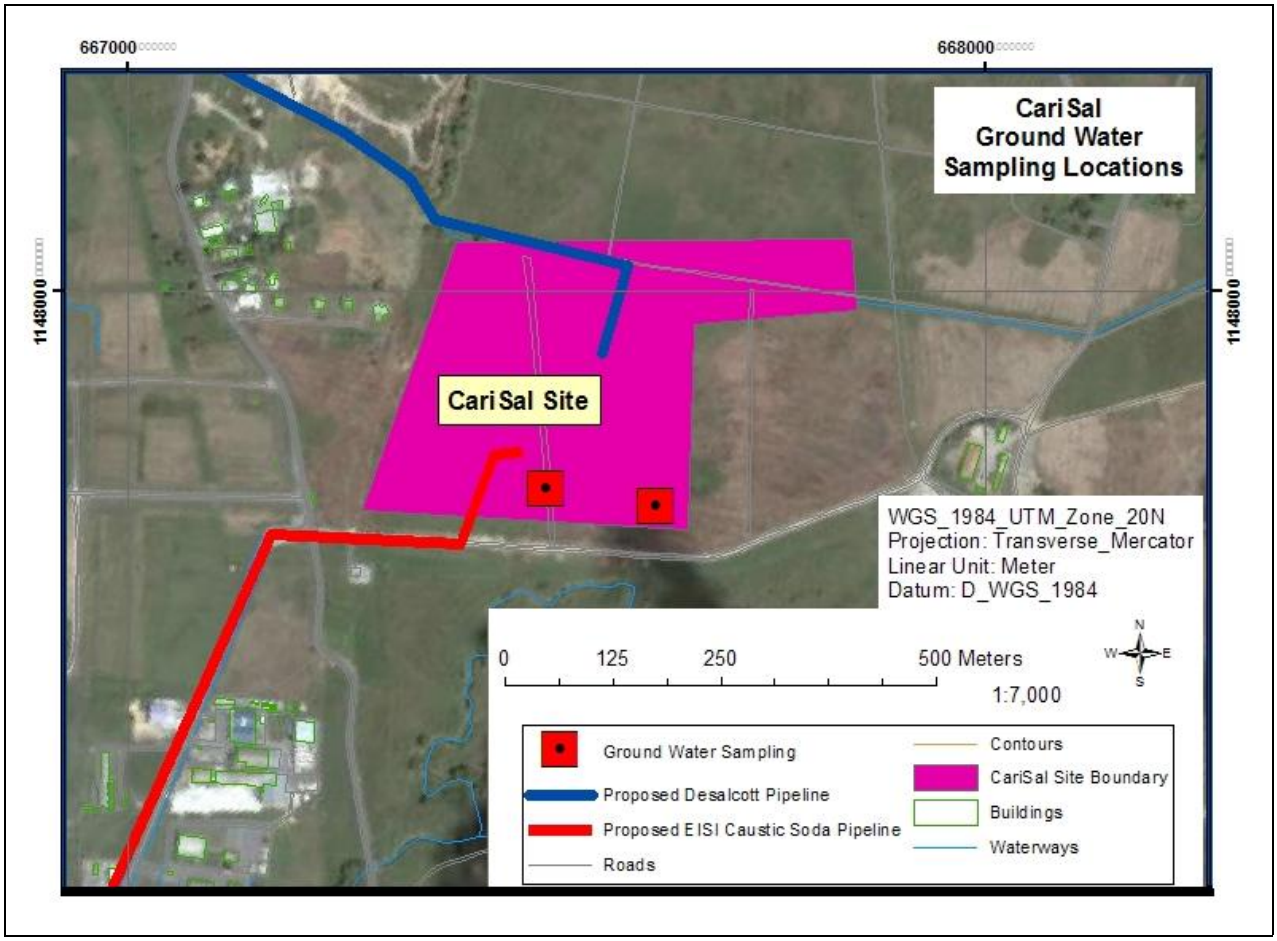


Figure 4.3-16. CariSal groundwater sampling locations.

Well 1 was sampled on July 16, 2007 and on July 19, 2007. Well 2 was sampled on July 16, 2007 and on July 26, 2007. Tables 4.3-21 and 4.3-22 present the analytical results of the groundwater samples collected. The results are compared against three sets of criteria. Trinidad and Tobago have no current standards for ambient groundwater quality, but the Water Pollution Rules, 2001 specify acceptable criteria for discharge into groundwater. The table also compares the results against the criteria in TTS 417:1993, Specification for the Liquid Effluent from

Domestic Wastewater Treatment Plants into the Environment, and TTS 547:1998, Specification for the Effluent from Industrial Processes Discharged into the Environment.

Table 4.3-21. Results of Well 1 Groundwater Analysis

Parameter	Units	16 Jul 07	19 Jul 07	Method 1 [a] 9 Oct 07	Method 2 [b] 10 Oct 07	Water Pollution Rules[c]	TTS 417:1993 [d]	TTS 547:1998 [e]
pH @ 25 °C		6.66	6.7	NT	7.09	6 – 9	6 – 9	6 – 9
Temperature	Degrees Celsius	27.5	25.5	NT	30.45	NIAA	NQ	NIAA
Conductivity	µS/cm	NT	NT	NT	1199.0	NQ	NQ	NQ
Dissolved Oxygen	mg/L	2.23	2.31	NT	NT	> 4	NQ	NQ
Biochemical Oxygen Demand (BOD)	mg/L	45.3	< 6	< 6	< 6.0	10	nil	10
Chemical Oxygen Demand (COD)	mg/L	43	7	NT	NT	60	NQ	60
Total Suspended Solids	mg/L	3,800.00	2,340.0	4660.0	1376.7	15	Nil	15
Oil and Grease	mg/L	3.9	< 1.6	NT	NT	NR	NQ	NR
Ammonia-N	mg/L	0.64	0.86	0.15	0.22	0.1	NQ	0.01
Wat-phosphorus (as phosphate)	mg/L	0.17	0.18	0.14	0.25	0.1	NQ	0.1
Sulphide (H_2S)	mg/L	< 0.01	< 0.01	NT	NT	0.2	NQ	0.2
Chloride	mg/L	< 0.15	571.45	NT	NT	NIAA	NQ	250
Residual Chloride	mg/L	**	< 0.5	NT	NT	0.2	Nil	0.2
Hexavalent Chromium (Cr^{6+})	mg/L	< 0.01	< 0.01	NT	NT	0.01	NQ	0.1
Total Chromium (Cr)	mg/L	< 0.005	< 0.005	NT	NT	0.1	NQ	0.1
Dissolved Iron	mg/L	1.58	1.14	11.0	0.006	1	NQ	1
Total Petroleum Hydrocarbons	mg/L	<1.6	< 1.6	NT	NT	NR	NQ	NQ
Total Nickel (Ni)	mg/L	< 0.006	0.038	NT	NT	0.5	NQ	0.5
Total Copper (Cu)	mg/L	0.031	0.051	0.048	0.033	0.01	NQ	0.01
Total Zinc (Zn)	mg/L	0.186	0.281	0.715	0.134	0.1	NQ	0.1
Total Arsenic (As)	mg/L	< 0.02	< 0.02	NT	NT	0.01	NQ	0.05
Total Cadmium (Cd)	mg/L	< 0.003	< 0.003	NT	NT	0.01	NQ	0.01
Total Mercury (Hg)	mg/L	< 0.00004	< 0.00004	NT	NT	0.005	NQ	0.005
Total Lead (Pb)	mg/L	< 0.03	< 0.03	0.08	< 0.03	0.05	NQ	0.05
Cyanide	mg/L	< 0.010	< 0.010	NT	NT	0.01	NQ	0.01

Table 4.3-21. Results of Well 1 Groundwater Analysis

Parameter	Units	16 Jul 07	19 Jul 07	Method 1 [a] 9 Oct 07	Method 2 [b] 10 Oct 07	Water Pollution Rules[c]	TTS 417:1993 [d]	TTS 547:1998 [e]
Phenol Total	mg/L	< 0.003	<0.003	NT	NT	0.1	NQ	0.1
Acute Toxicity (LC_{50})	ppm	625,000	643,000	NATE	NATE	NATE	NQ	NQ
Faecal Coliform (MPN mtd)	MPN/100mL	> 1600	> 1600	> 1600	300	100	Nil	100
Depth to Groundwater	m	1.20						
Depth of Piezometer	m	2.80						

Note: Exceedances shown in **shaded bold type**

[a] Method 1: Bottom loading bailer

[b] Method 2: Low flow sampling pump. Sampled after measured pH, temperature and conductivity stabilised

[c] The Environmental Management Act, 2000, The Water Pollution Rules, 2001, as amended 2006

[d] TTS 417:1993 Specification for the Liquid Effluent from Domestic Wastewater Treatment Plants into the Environment

[e] TTS 547:1998 Specification for the Effluent from Industrial Processes Discharged into the Environment

µS/cm = microSiemens per centimetre
LC_{50} = lethal concentration, 50 percent
MPN = most probable number
NT = not tested
NATE = No Acute Toxic Effects
NQ = Not Quoted
NIAA = No Increase Above Ambient
Sources: Kaizen Environmental Services Limited (August 2007) and (November 2007)

Table 4.3-22. Results of Well 2 Groundwater Analysis

Parameter	Units	16 Jul 07	26 Jul 07	Method 1 [a] 9 Oct 07	Method 2 [b] 10 Oct 07	Water Pollution Rules[c]	TTS 417:1993 [d]	TTS 547:1998 [e]
pH @ 25 °C		6.75	6.83	NT	7.01	6 - 9	6 - 9	6 – 9
Temperature	Degrees Celsius	27.3	28.1	NT	30.3	NIAA[f]	NQ	NIAA
Conductivity	µS/cm	NT	NT	NT	2.12	NQ	NQ	NQ
Dissolved Oxygen	mg/L	2.3	2.55	NT	NT	> 4	NQ	NQ
Biochemical Oxygen Demand (BOD)	mg/L	> 88.56	> 111.00	< 6.0	< 6.0	10	nil	10
Chemical Oxygen Demand (COD)	mg/L	52	27	NT	NT	60	NQ	60
Total Suspended Solids	mg/L	5,010.00	2,224.00	3210.0	1220.0	15	Nil	15
Oil and Grease	mg/L	3.8	< 1.6	NT	NT	NR	NQ	NR
Ammonia-N	mg/L	0.58	0.41	0.30	0.25	0.1	NQ	0.01
Wat-phosphorus (as phosphate)	mg/L	0.14	< 0.01	0.08	0.25	0.1	NQ	0.1
Sulphide (H_2S)	mg/L	< 0.01	< 0.01	NT	NT	0.2	NQ	0.2

Table 4.3-22. Results of Well 2 Groundwater Analysis

Parameter	Units	16 Jul 07	26 Jul 07	Method 1 [a] 9 Oct 07	Method 2 [b] 10 Oct 07	Water Pollution Rules[c]	TTS 417:1993 [d]	TTS 547:1998 [e]
Chloride	mg/L	< 0.15	256.66	NT	NT	NIAA	NQ	250
Residual Chloride	mg/L	**	<0.5	NT	NT	0.2	Nil	0.2
Hexavalent Chromium (Cr^{6+})	mg/L	< 0.01	< 0.01	NT	NT	0.01	NQ	0.1
Total Chromium (Cr)	mg/L	< 0.005	< 0.005	NT	NT	0.1	NQ	0.1
Dissolved Iron	mg/L	5.3	< 0.003	5.31	3.36	1	NQ	1
Total Petroleum Hydrocarbons	mg/L	< 1.6	< 1.6	NT	NT	NR	NQ	NQ
Total Nickel (Ni)	mg/L	0.07	0.154	NT	NT	0.5	NQ	0.5
Total Copper (Cu)	mg/L	0.086	0.129	0.031	0.036	0.01	NQ	0.01
Total Zinc (Zn)	mg/L	0.476	1	0.410	0.149	0.1	NQ	0.1
Total Arsenic (As)	mg/L	< 0.02	< 0.02	NT	NT	0.01	NQ	0.05
Total Cadmium (Cd)	mg/L	< 0.003	< 0.003	NT	NT	0.01	NQ	0.01
Total Mercury (Hg)	mg/L	< 0.00004	< 0.00004	NT	NT	0.005	NQ	0.005
Total Lead (Pb)	mg/L	< 0.03	0.017	.05	< 0.03	0.05	NQ	0.05
Cyanide	mg/L	< 0.010	< 0.010	NT	NT	0.01	NQ	0.01
Phenol Total	mg/L	< 0.003	< 0.003	NT	NT	0.1	NQ	0.1
Acute Toxicity (LC_{50})	ppm	509,000	NATE	NATE	NATE	NATE	NQ	NQ
Faecal Coliform (MPN mtd)	MPN/100mL	900	>1600	300	900	100	Nil	100
Depth to Groundwater	m	1.19						
Depth of Piezometer	m	3.53						

Note: Exceedances shown in **shaded bold type**
[a] Method 1: Bottom loading bailer
[b] Method 2: Low flow sampling pump. Sampled after measured pH, temperature and conductivity stabilised
[c] The Environmental Management Act, 2000, The Water Pollution Rules, 2001, as amended 2006
[d] TTS 417:1993 Specification for the Liquid Effluent from Domestic Wastewater Treatment Plants into the Environment
[e] TTS 547:1998 Specification for the Effluent from Industrial Processes Discharged into the Environment
µS/cm = microSiemens per centimetre
LC_{50} = lethal concentration, 50 percent
MPN = most probable number
NT = not tested
NATE = No Acute Toxic Effects
NQ = Not Quoted
NIAA = No Increase Above Ambient
Sources: Kaizen Environmental Services Limited (August 2007) and (November 2007)

The results of the groundwater analyses showed ambient values higher than the discharge criteria for total suspended solids (TSS), ammonia, water-soluble phosphorus, iron, copper, zinc, and faecal coliform. Both wells had exceedances of oil and grease on July 16, 2007 only and

exceedances of chloride only during the second sampling round later in July. Ammonia and phosphorus are common elements of fertilizer; their presence should not be unexpected in agricultural areas such as the former Caroni sugar cane fields of which the Project site is comprised. The TSS values are unusually high for groundwater, and could bias the values for metals in an upward direction. The ambient faecal coliform values are generally an order of magnitude higher than the discharge criteria. The most likely explanation for the high faecal coliform values is a combination of the past and current use of the land for the grazing of cows and goats combined with the high shrink-swell potential of the surface soils and the shallow groundwater table. The photograph in Figure 4.3-17, taken near the end of the dry season, shows desiccation cracks greater than 75 mm wide and up to 1 m deep. The cracks provide a ready pathway for runoff and material from animal waste to reach the groundwater table and, as the cracks close during the rainy season, to trap any such material in the soil matrix as the groundwater level inevitably rises.

Source: EIS Ltd. 2007

Figure 4.3-17. Shrinkage cracks in surface soils.

Because of the elevated TSS results, the wells were re-sampled using two different methods on October 9 and 10, 2007. In Method 1 the wells, which had been undisturbed since the second July sampling event, were sampled by slowly lowering a bottom-filling bailer into the wells. The water was visibly clearer at the top of the bailer than at the bottom. In Method 2, the well was purged with a continuous low flow rate sampling pump until the temperature, pH, and conductivity stabilized, and then the sample was collected from the pumped stream. The TSS values were significantly lower using Method 2, but still about two orders of magnitude above the discharge criteria. The high TSS values may indicate that surface flow or lateral flow is moving through as yet incompletely sealed desiccation cracks and suspending clay particles in these channels and in the wells. It is unlikely that the groundwater TSS values are high within

the soil matrix below the depth of desiccation because the small pore sizes within the alluvial clays would prevent the movement of suspended particles.

4.4 BIOLOGICAL ENVIRONMENT

4.4.1 Vegetation

This section briefly describes the vegetation of the area that was present before sugar cane plantations were dominant and places emphasis on those that are the dominant vegetation on and near the Project site today. The description is based on historical and more recent surveys conducted in the Project area and in a wider (5-km radius) study area in 2005, 2006, and 2007.

4.4.1.1 Historic Vegetation

Before the sugar cane industry developed, seasonal evergreen forests and mangrove woodlands were the dominant vegetation communities along the west coast of Trinidad (Marshall 1939, Beard 1946). Historically, four primary types of vegetation communities were present:

1. forest communities,
2. mangrove woodlands,
3. coastal thickets/littoral woodlands, and
4. freshwater and saline marsh communities.

However, between 1966 and 1981, these vegetation communities were replaced by agricultural, industrial, and social development activities including:

- Cultivation of sugar cane plantations on the eastern border adjacent to Southern Main Road;
- Development of residential communities associated with the growth of sugar cane cultivation and industry along Southern Main Road on the east; and
- Installation of supporting infrastructure, including roadways, utility conduits, and recreational and social service (health, education, etc.) facilities.

4.4.1.2 Current Vegetation

4.4.1.2.1 Project Site

During site visits between October 29 and November 12, 2007, JARIC Environmental Safety and Health Services Ltd. (JARIC EHS) completed a Biological Reconnaissance of the CariSal Point Lisas Development (for the full report, see Appendix E).

Sixty-one plant species were recorded on the CariSal main development site (Figure 4.4-1), and 81 species on the pipeline ROW (Figure 4.4-2). The difference in numbers of species reflects the greater diversity of habitats crossed by the ROW and the greater variety of management regimes (from abandoned plots to regularly mown savannahs). Extrapolation using the Michaelis Menten asymptotic method (Colwell 2006) resulted in 76 species likely to be present on the main site,

which indicates that the present survey recorded 80 percent of all species on the main site. The same extrapolation method showed that 120 species are likely to be present on the pipeline ROW, indicating the current survey recorded 68 percent of all species.

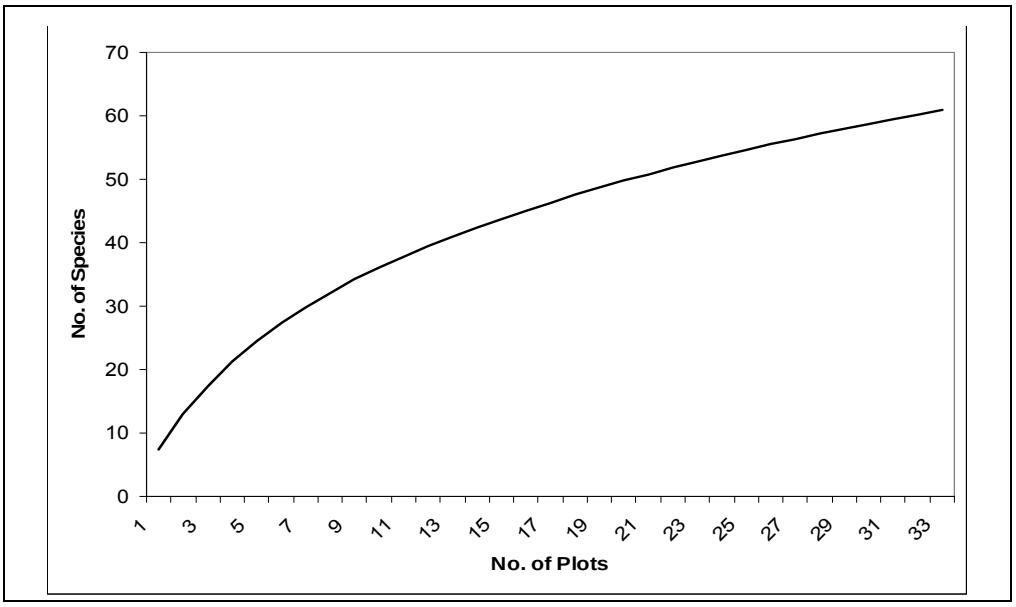


Figure 4.4-1. Main site species accumulation curve.

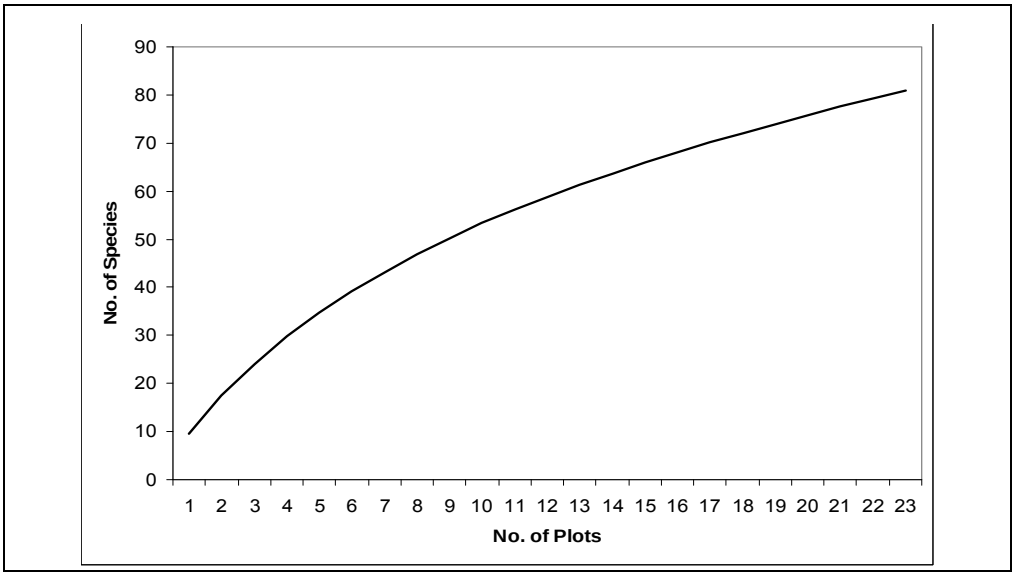


Figure 4.4-2. Rights-of-way species accumulation curve.

The vegetation of the main site was classified into four communities based on species composition:

1. permanent freshwater marsh;
2. annual freshwater marsh;

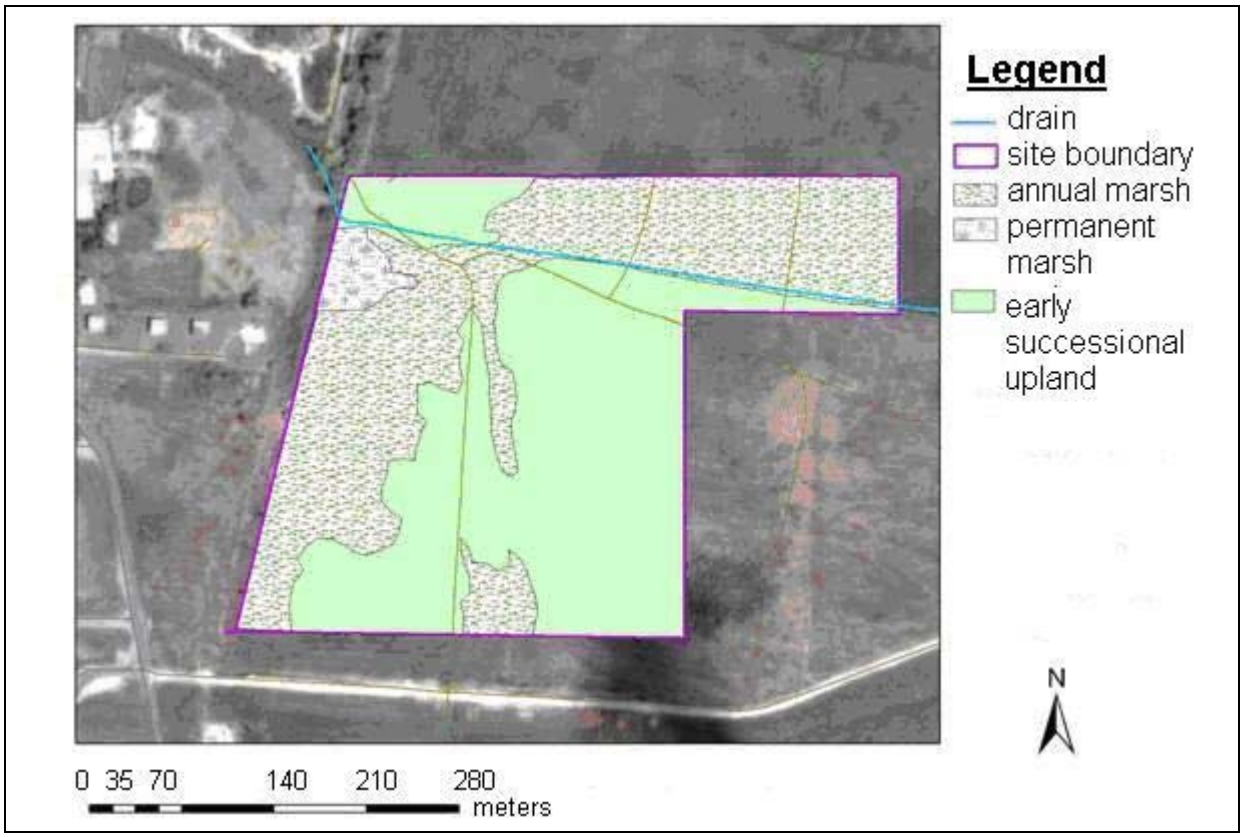
3. early successional stage upland.; and
4. early successional upland – bamboo dominated.

The distinguishing species of the vegetation communities are presented in Table 4.4-1. The permanent marsh community is characterized by hydrophytes such as cascadoux grass (*Leersia hexandra*) and the tall Marantaceae *Thalia* sp. This marsh is likely to provide a habitat for the economically and culturally important fish Cascadura (*Hoplosternum littorale*). The native cascadoux grass (*Leersia hexandra*) is also an important food source for wetland birds in the southern United States and may be an important resource for neotropical migrants. The annual (or seasonal) freshwater marsh fringes the permanently inundated marsh and is dominated by the grasses *Urochloa mutica* (para grass, a native of Africa) and *Fimbristylis meliacea* and the Ongaraceae species *Ludwigia erecta* and *Ludwigia sp*. Para grass is an introduced plant used extensively as cattle fodder. *Ludwigia erecta* is a native plant species that has no recorded economic importance except as a weed on crop lands such as rice. However, because of its dominance in the wetland environment, it is likely ecologically important (probably as a food source).

Table 4.4-1. Characteristic Species of Vegetation Communities

Permanent Swamp	Frequency (%)	Annual Swamp	Frequency (%)	Upland Early Successional	Frequency (%)
Leersia hexandra	100	*Urochloa mutica*	82	*Fimbristylis meliacea*	75
Torulinium odoratum	50	*Ludwigia erecta*	64	*Ischaemum rugosum*	65
Thalia	50	*Fimbristylis meliacea*	64	*Rottboelia sp*	50
Sphenochlea	50	*Ludwigia sp.*	55	*Aechynomene sensitiva*	40
Ludwigia erecta	50	*Pueraria phaseoloides*	45	*Paspalum fasciculatum*	35
		Sphenochlea sp.	36	*Solanum jamaicense*	30
		Ischaemum rugosum	36	*Panicum maximum*	30
		Caperonia palustris	36	*Hyptis sp.*	30

On June 2, 2008, JARIC EHS submitted a Plot of Wetland Boundary Report for the CariSal Point Lisas Development, further refining the locations of vegetation communities in the Project site based on global positioning plots taken during a second site survey conducted in May 2008 (Figure 4.4-3).



Source: JARIC EHS, 2008

Figure 4.4-3. CariSal Site Vegetative Communities.

This freshwater marsh (Figure 4.4-4) remnant may be the remains of a once more extensive system or it may be a small "exotic" ecosystem not normally found in the area. Evidence points to the former as a freshwater marsh positioned immediately behind a mangrove wetland much like the Nariva, Los Blanquizales, and even Caroni swamps. If so, then its ecological importance may be considerable because it is one of the few habitats of this type remaining in the area. Wetlands to the west of the site are mainly mangrove or brackish swamp types; this marsh was the only freshwater marsh sighted in the survey.

The perennial and annual marsh vegetation communities on the Project site meet the broad definition of a wetland community as given by the National Wetlands Committee (2002). They are permanently or seasonally inundated and have soils that become anaerobic and promote hydrophytes. Herbaceous species of plants dominate and therefore they can be considered marsh communities (Figure 4.4-5). The communities provide economic benefits in terms of fodder and potential fish extraction. They may also act as filters and flood control for runoff along the main ravine cutting across the northern segment of the Project site from the east. The marshes provide ecological benefits for plants and animals, possibly including Neotropical migrant bird species. They may also act as a refuge or food supply for animals with a more restricted distribution in the dry season.

Source: DGE 2007

Figure 4.4-4. Freshwater marsh on neighbour's property beyond western site boundary.

Source: Grismala 2007

Figure 4.4-5. Marsh vegetation, from project site looking west.

The present characteristics and ecological services of the perennial and annual marsh areas on the Project site appear to be dependent on topographical and hydrological features outside of the Project site boundaries. Although hydrological studies were not carried out, it appears that the marsh areas extend across the western and northern borders of the Project site onto adjacent property. Topographical features such as earth embankments or raised areas, which are

important in preserving the permanent wetland by impeding water flow and allowing it to collect to form the wetland, may be located outside of the Project property. The area to the north and northeast of the Project site appears to be extensively flooded in the wet season and probably inputs a substantial amount of water into the wetland on the Project site. Water flow from the main ravine cutting across the northern segment of the Project site from the east also appears to be critical to maintaining the integrity of the permanent marsh area. This ravine appears to receive drainage from areas within and outside of the Project site, to the east. Hydrological studies would be required to confirm this observation.[7]

The early successional stage upland communities and the pipeline ROW communities are dominated by common weedy species and do not, per se, represent substantive economic or ecological value. However, these communities may be important in supporting plants and animals in neighbouring wetland communities by providing food and retaining soil moisture.

None of the floral species identified in the Project area are considered rare or endangered.

4.4.1.2.2 5-km Study Area

The larger study area is characterized by wetland and riparian habitats, and maintained grassy lawns associated with residential and industrial development. Field reconnaissance completed in 2006 by NGC identified riparian vegetation along the nearby Brechin Castle River, located approximately 500 m north of the Project site. Flora observed along the Brechin Castle River were typical of roadside vegetation comprising grasses like razor grass (*Paspalum virgatum*), a few cultivated crop species like sugarcane, and some trees such as coconut (*Cocus nucifera*), immortel (*Erythrina spp.*), java plum (*Syzygium cumini*), and hogplum (*Spondias mombin)*. Most of the riparian vegetation observed was typical of disturbed habitats that may result from the close proximity of the river to urban settlements (particularly housing) and small areas of agricultural land. Along the banks of the LNG River support larger trees and small shrubs that could withstand harsh environmental conditions and direct exposure to the elements. Bankside vegetation include razor grass (*Paspalum virgatum*), bamboo (*Bambusa spp.*), swamp immortelle (*Erythrina fusca*), hog plum (*Spondias mombin*), and bois cano (*Cecropia peltata*). In areas where a riparian community was visible, angelin (*Andira inermis*), water immortelle (*Erythrina fusca*), manjak (*Cordia collococca*), and bamboo (*Bambusa vulgaris*) dominated the tree cover. These trees were found in clusters with each cluster representing a distinct habitat type (SENES Consultants Limited and EPAS Consultants Limited 2006).

Planted fruit trees or introduced ornamentals commonly dominate floral communities that border urban areas. The residential areas that border the sugarcane fields approximately 1 km east of the Project site contain scattered trees such as mango (*Mangifera indica*), chataigne (*Artocarpus altilis*), coconut (*Cocos nucifera*), chennette (*Meliococcus bijugatus*), and the native palm gru-gru bouef (*Acrocomia aculeate*). The buildings and scattered houses within the now abandoned Caroni Limited properties are surrounded by trees such as royal palm (*Roystonea oleracea*) and

[7] Biological Reconnaissance of the CariSal Point Lisas Development; JARIC EHS (see Appendix E), and conversation with Dr. Mike Oatham, Biologist, JARIC EHS, 6/9/08.

samaan (*Samanea saman*), together with fruit trees, such as coconut (*Cocos nucifera*), pommecythere (*Spondias cytherea*), and paw paw (*Carica papaya*). Several industrial tenants dominate the area to the west of the proposed site. Floral communities are limited to manicured lawns at such facilities.

Southwest of the Project site is a well developed mangrove woodland and an associated marsh community approximately 1.26 km^2 in area. As part of the Claxton Bay Mangrove System (CBMS), red mangrove (*Rhizophora mangle*) dominate the seaward boundary with mixed stands black (*Avicennia germinans*) and white mangroves (*Laguncularia racemosa*) dominating the landward section just west of Southern Main Road. A marsh community lies just east of the edge of the mangrove forest. The area, approximately 1km west of the Project site, is subjected to tidal fluctuations and freshwater from the LNG River. Spikerush (*Eleocharis spp.*) is the predominant plant species observed within this community. In apparently less waterlogged areas, species such as the mangrove fern (*Acrostium aureum*), grasses (*Paspalum spp.*), and sedges such as *Cyperus haspan, Kyllinga bervifolia*, and *Typha domigensis* were noted (SENES Consultants Ltd. and EPAS Consultants Ltd., 2006). Where freshwater dominates, the marshes are dominated by the species *Cyperus articulatus* with a substantial interspersing of *Eleocharis mutata*. These individuals create a homogenous low vegetation structure less than 0.5 m tall.

Of the plant species observed during these surveys of the wider study area, none are considered rare or endangered.

4.4.2 Fauna

This section describes the fauna in the Project area based on Biological Reconnaissance Surveys JARIC EHS completed between October 29 and November 12, 2007. During the first visit, assessing the bird and mammal fauna and identifying locations at which fish and amphibians may be present were the focus. Birds and other diurnal vertebrates were surveyed by slowly walking along the site perimeter and recording all species observed within or flying above the site. The path followed and time taken for conducting the survey are presented in Table 2 of the Biological Reconnaissance Report (see Appendix E). Where possible, individuals counted in one sector were not re-counted if they were observed in the next sector.

4.4.2.1 Avifauna

4.4.2.1.1 Project Site

The site is highly disturbed and, with the exception of seven species, the bird species observed are considered common or abundant. The uncommon species include Wilson's snipe (*Gallinago delicate)*, green-rumped parrotlet (*Forpus passerinus)*, white-tailed goldenthroat (*Polytmus guainumbi)*, bran-coloured flycatcher (*Myiophobus fasciatus)*, masked yellowthroat (*Geothlypis aequinoctialis*), saffron finch (*Sicalis flaveola*) and common waxbill (*Estrilda astrild*). The white-tailed goldenthroat breeds in Trinidad during the wet season and disperses to mainland South America during the non-breeding period. This species depends on flooded savannah conditions and is typically seen in the Waller Field and Aripo Savannah areas and along the edges of Nariva Swamp, Caroni Swamp and Oropuche Lagoon. The conditions available at the site appear to be suitable for this species. The common waxbill is not native to South America. It is a common cagebird of African origin that was first observed in Orange Grove in 1987

(White 1988). Since this time the population has naturalised and appears to be spreading. The species had been recorded previously from the Brechin Castle area, but this site represents the most south-westerly sighting of the species in Trinidad. The saffron finch is a comparatively localized species. It is often trapped as a cagebird but the population in the Point Lisas area appears to be surviving, probably in part due to large expanses of regularly mown grasses and comparatively restricted access to trappers.

Five species of shorebirds and two warblers that migrate from North America and over winter in Trinidad were observed at the Project site. These include Wilson's snipe, spotted sandpiper (*Actitis macularia*), lesser yellowlegs (*Tringa flavipes*), solitary sandpiper (*Tringa solitaria*), semipalmated sandpiper (*Calidris pusilla*), yellow warbler (*Dendroica petechia*), and northern waterthrush (*Seiurus noveboracensis*). The shorebirds were observed feeding in small patches of soil exposed as a result of pipe-laying exercises. A wide variety of shorebirds may feed at the site if vegetation is cleared. Two species, the little blue heron (*Egretta caerulea*) and snowy egret (*Egretta thula*) are local resident species whose numbers are augmented seasonally by visiting birds.

For a complete list of avifaunal species observed during visits to the Project site, see Table 4 of the Biological Reconnaissance Report (see Appendix E).

4.4.2.1.2 5-km Study Area

Avifaunal surveys conducted within the within the wider study area by Eco-Engineering identified the presence of white-winged swallow (*Tachycineta albiventer*), crested oropendola (*Psarocolius decumanus*), and the northern waterthrush (*Seirus noveboracensis*).

The nearby mangrove and marsh reeds are likely to provide habitat for a variety of other avifauna, which are relatively common throughout Trinidad's wetlands. These include great egrets (*Casmeroduis albus*), little blue herons (*Egretta caerula*), cattle egrets (*Bubulcus ibis*), wattled jacanas (*Jacana jacana*), pied water-tyrants (*Fluvicola pica*), white-headed marsh tyrants (*Arundinicola leucocephala*), yellow-chinned spinetails (*Certhiaxis cinnamomea*), plovers (*species unidentified*), and unidentified species of sandpipers (Bacon 1970, Cuffy 1999).

4.4.2.2 Other Terrestrial Fauna

4.4.2.2.1 Project Site

Five amphibian species were observed and three more species probably inhabit the site as they have been collected under similar conditions at Waterloo. These species are all common and widespread in Trinidad. The reptiles observed are limited to four species including the spectacled caiman (*Caiman crocodilus*) and iguana (*Iguana iguana*). Reptiles are likely to be greatly underestimated unless extensive surveys are conducted.

The observations of mammals are limited to those of area residents, including comparatively well known pest species and the introduced small Indian mongoose (*Herpestes auropunctatus*). Mongoose can exploit such areas, where it scavenges and feeds on domestic chickens, lizards, and snakes. Although the mongoose is the more conspicuous member of this type of environment, another mammal likely to be encountered in the Project area is the nocturnal black-

eared opossum or manicou (*Didelphis marsupialis*). Historically, this native species was considered vermin on the Cocoa estates and could be hunted at any time. The manicou is now considered acceptable wild game and is hunted for food on the island.

Several species of dragonflies were observed but not identified. Butterflies were very uncommon. No other large insects were apparent.

Table 4.4-2 presents a full list of non-avian fauna observed during visits to the Project site.

Table 4.4-2. Non-avian Fauna Observed During Site Visits

Group	Family	Species	Notes
Gastropoda (Snails)	Ampullariidae	*Pomacea glauca*, river conch	Observed along watercourse
		Marisa cornuarietis, ram's horn snail	Observed along watercourse
Decapoda (Crabs)	Trichodactyliidae	*Trichodactylus dentatus*, crab	Single specimen observed
Pisces (Fish)	Callichthyidae	*Hoplosternum littorale*, Cascadura	Signs of Cascadura present
	Characidae	*Astyanax bimaculatus,* Two-spot sardine	Abundant in watercourse
	Cichlidae	*Cichlasoma taenia,* brown coscorob	Present in watercourse
	Erythrinidae	*Hoplias malabaricus*, guabine	Not observed but reported by adjacent resident.
	Poeciliidae	*Poecilia reticulata,* guppy	Abundant in watercourse
	Rivulidae	*Rivulus hartii*, jumping guabine	Not observed but likely to be present
	Synbranchidae	*Synbranchus marmoratus*, zangee	Not observed but likely to be present
Anura (Frogs)	Bufonidae	*Bufo beebei*	Not observed but likely to be present
		Bufo Marinus, crapeau	One individual heard
	Hylidae	*Hyla crepitans*, flying frog	Not observed but likely to be present
		Hyla geographica, flying frog	Tadpoles observed in watercourse
		Hyla microcephala misera	Abundant along watercourse
		Phrynohyas venulosa	Not observed but likely to be present
		Scinax rubra, Savannah Frog	Scattered throughout site
	Leptodactylidae	*Loptodactylus fuscus,*	One individual heard
		Loptodactylus validus	Scattered throughout site
		Physalaemus pustulosus	Abundant throughout site

Table 4.4-2. Non-avian Fauna Observed During Site Visits

Group	Family	Species	Notes
	Microhylidae	*Elachistocleis ovalis*	A few individuals heard
	Pseudidae	*Pseudis paradoxa caribensis,* paradoxyl frog	Not observed but likely to be present
Crocodylia (Crocodiles)	Alligatoridae	*Caiman crocodilus crocodilus,* spectacled caiman	Observed along watercourse
Squmata (Lizards)	Gekkonidae	*Gonatodes vittatus vittatus,* streak lizard	One individual observed at site
	Iguanidae	*Anolis aeneus*	One observed along ROW
		Iguana iguana, iguana	One observed along ROW
Mammalia (Mammals)	Didelphidae	*Didelphis marsupialis,* black-eared opossum	Reported by adjacent resident
	Muridae	*Rattus norvegicus*, wharf rat	Reported by adjacent resident
	Muridae	*Mus musculus*, house mouse	Reported by adjacent resident
	Viverridae	*Herpestes auropunctatus*, small Indian mongoose	Observed by watchman at adjacent site

4.4.2.2.2 5-km Study Area

Several species of mammals are known to be present within mangrove areas in Trinidad. Mammals such as the silky anteater (*Cyclopes didactylus*) or "poor-me-one" are conspicuous members of the Caroni Bird Sanctuary and surrounding areas. Mammals such as the crab-eating raccoon (*Procyon cancrivorus*) and neo-tropical otter (*Lutra langicaudis*) known as the "river dog" or "chien d'eau" are likely to occur in larger wetlands but are very secretive (Rapid Environmental Assessments (2003) Limited and Sage Environmental Consulting, LP. 2007).

4.4.2.3 Aquatic Fauna

4.4.2.3.1 Project Site

During site visits conducted by JARIC EHS, fish were sampled with a dip net (30 cm in diameter) at the northwest point of the Project site where a small drainage canal exits the site. A resident farmer, adjacent to the site was questioned on the presence of fish and mammals. The farmer mentioned that a pond just northwest of the site was once stocked with Cascadura, but during floods the fish escaped to the surrounding waterways.

Amphibians were surveyed during the second visit. Representative areas of the site were visited and species identified by their characteristic vocalisation. The ROW for the planned pipeline was followed and the general habitat and fauna observed were noted.

Five species of fish were recorded and at least two additional species are likely to inhabit the site (see Table 4.4-2). These species are all common and widespread south of the Northern Range.

The Cascadura observed in the north-eastern area of the site may occur naturally or may have escaped from the fish pond adjacent to the site. The flooded portion of the site will provide a small area of habitat in which the Cascadura are likely to nest.

Non-vertebrate macrofauna observed during these site visits were limited to one crab and two molluscs.

4.4.2.3.2 5-km Study Area

The LNG River is a tidal river situated less than 1 km south of the Project site that is directly influenced by the sea. Surveys in 1981 observed that the composition and distribution of fauna in the river are significantly influenced by seasonality, tidal fluctuations, and gradients of salinity along its course (IMA 1981). Additional observations made in 1981 suggested that the diversity of aquatic fauna is greater in the wet season primarily because of changes in water depth along the river's course.

During November 2006, surveys of the fish and decapods within the LNG River system were conducted for the completion of the Westlake EIA (Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007). These surveys included seining at sites along the LNG River and unnamed channels that may have been artificial.

The prevalent fish species observed included two-spotted sardine (*Astyanax bimaculatus*), guabine (*Hoplias malabaricus*), and *Dormitator maculates*. The upstream locations within the LNG River and its tributaries supported freshwater fishes, such as *Hoplias malabaricus, g*oby (*Dormitator maculates*), two-spotted sardine (*Astyanax bimaculatus*), brown coscorob (*Cichlasoma taenia*), blue coscorob (*Aquidens pulcher*), *s*wordtail sardine (*Corynopoma riisei*), swamp guppies (*Poecilia reticulate*), and *Micropoecilia picta*.

Most fish collected at the mouth of the river and segments of the tidally influenced lower course belonged to the species *Selanaspis herzbergii* of the family Achiridae. Snook (*Centropomus ensiferus*) and croaker (*Stellifer sp*.) (both important food species), the four-eyed fish (*Anableps anableps*), and flatfish (*Achirus lineatus*) were also identified. One unique species observed hiding in crevices of the tangled mangrove roots and caught at the river mouth was the soap fish (*Rypticus randalli*). Soap fish are typically considered a reef species.

Although none of the fish species observed in the LNG River can be considered rare or threatened on a global scale, there is constant regional pressure in Trinidad from invasive species such as colonizers and newly introduced exotic species that threaten to out-compete or replace native species. Pollution and habitat degradation increase the threat as they make habitats more conducive to generalist species, which often favours invasive species.

Nineteen species of crustaceans in eleven families representing two orders were collected or observed in the LNG River during the November 2006 surveys. All crustacean species collected have been previously recorded for Trinidad waters. None is known to be particularly rare (Rapid Environmental Assessments (2003) Limited and Sage Environmental Consulting, LP. 2007).

The most abundant macroinvertbrate taxa observed throughout the LNG River area were chironomids (midges) and thiarid snails. In some segments of the LNG River, thiarids appeared to be quite prevalent with large populations recorded. The Malayan trumpet snail (*Melanoides tuberculata)*, is invasive and was introduced to local streams from the ornamental pet trade. The snail feeds mainly on detritus and algae and can be found in large colonies in many rivers of Trinidad.

The density of Mangrove oysters (*Crassostrea rhizophorae*) is high in the wetland downstream of the Westlake site. The survey reported that oysters covered all submerged portions of mangrove roots. Two species of mussels, Yellow mussel *(Brachidontes modiolus*) and scorched mussel *(Brachidontes exustus*), formed colonies on the submerged red mangrove roots within the 5km study area. Because these mussels are a food source for crabs they are an integral part of the complex mangrove food web. Young specimens of Green lip mussel *(Perna viridis*) were noted on submerged tree trunks. Evidence of the Antillean razor shell *(Solen obliquus)* was observed, however no live specimens were collected (Rapid Environmental Assessments (2003) Limited and Sage Environmental Consulting, LP. 2007).

4.4.3 Identification of Commercially Important Flora or Fauna

Some of the intertidal species observed are considered resources for bioharvesting. Oyster consumption, for instance, is a popular recreational activity. Harvested oysters are gathered in "crocus" bags and sold as delicacies to oyster vendors **(**Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007**).**

The blue crab (*Cardisoma guanhumi)* is a commercially important species observed in the wetland system. This burrow-dwelling species, which resides on land and is associated with riparian areas containing mangroves or strand vegetation, is also considered a delicacy and is harvested seasonally **(**Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007**).** The Cascadura (*Hoplosternum littorale*) is another popular, edible wetland species. This economically and culturally important fish has a special significance in Trinidad's folklore; according to local legend, those who eat the Cascadura will return to Trinidad to end their days (Allsopp 1996).

The permanent marsh community within the Project area is characterized by hydrophytes such as Cascadoux grass (*Leersia hexandra*) and the tall Marantaceae *Thalia* sp. These marshy ecosystems are likely to provide habitat for the Cascadura (JARIC Environment Safety and Health Services Ltd. 2007**).**

4.4.4 Identification of Sensitive Species in the Area

None of the species observed within the immediate project area are considered endangered, threatened, or rare in Trinidad under the Conservation of Wildlife Bill of 2003, but the green-rumped parrotlet, spectacled caiman, and iguana are listed in Schedule 1 of the Bill as species that require a harvesting license. None of the species observed are listed as Environmentally Sensitive Species, nor are any of them listed in the 2003 International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. Several of the species observed, including the yellow-headed carcacara (*Milvago chimachima*), green-rumped parrotlet,

white-tailed goldenthroat (*Polytmus guainumbi*), spectacled caiman, and iguana are listed under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). These species are not particularly threatened but they are listed under Appendix II of CITES because they can be confused with species that *are* threatened by international trade.

At present three species are designated in Trinidad and Tobago as Environmentally Sensitive Species (ESS) rules pursuant to section 26(e): (1) the white-tailed sabrewing hummingbird (*Campylopterus ensipennis)*, (2) Trinidad piping guan or pawi (*Pipile pipile)*; and (3) West Indian manatee (*Trichechus manatus)*. The manatee is found only in Nariva Swamp, roughly 40 km east of the Project site. The white-tailed sabrewing hummingbird is found on Tobago. The pawi has become scarce and is now concentrated in the forests around Aripo and Toco, in the north-eastern and northern regions of Trinidad. On the basis of the biological reconnaissance of the broader Project area reported by SENES Consultants Limited and EPAS Consultants Limited (2006) and the biological reconnaissance survey of the CariSal Project site conducted by JARIC EHS in 2007, there is no evidence that these species are located within the immediate Project area or within the 5-km study area (S). The Project site is not within the known ranges of Trinidad and Tobago's Environmentally Sensitive Species.

4.5 SOCIOECONOMIC ANALYSIS OF COMMUNITIES NEAR THE PROPOSED CARISAL PROJECT

4.5.1 Introduction

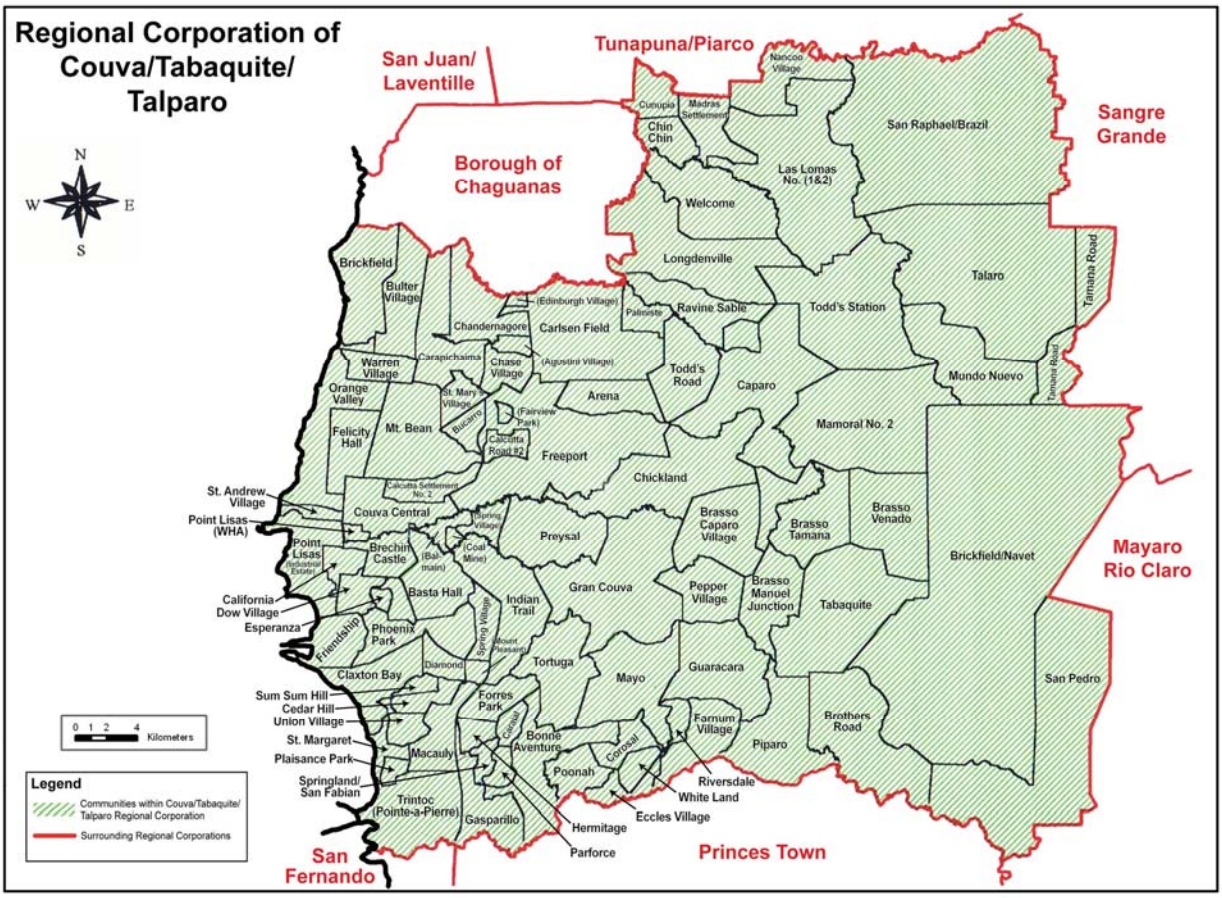
This section presents a socioeconomic assessment of the Study Area – Diamond Village, Dow Village, Savonetta Village, Phoenix Park, California, Pranz Gardens and Esperanza. These settlements represent the communities proximate to the proposed chlor-alkali plant that may be impacted by its construction and operational activities (Figure 4.5-1, also in Chapter 10). The socioeconomic assessment can be broadly classified into seven categories:

1. Land use
2. Population demographics
3. Economic status
4. Labour market characteristics
5. Services and utilities
6. Community attitudes toward the Project
7. Existing and planned activities in the Study Area

Analyses for the first four categories were based on data from the 2000 Census, which the Central Statistical Office (CSO) of Trinidad and Tobago conducted. For the evaluation of the labour market and the economic status of the area, the Continuous Sample Survey of Population (CSSP)[8] employment surveys, which are conducted every two weeks by the CSO, were utilized.

[8] The Continuous Sample Survey of Population is the Nation's Premier Household *Probability Sample* Survey primarily designed as a vehicle to obtain information on employment, unemployment and other labour force characteristics of the population as a whole or various subgroups of the population. It is also used as an *omnibus*

While all of the communities defined above are included in the Study Area category for the analysis, in some instances, community- or village-level data are presented based on their availability from the CSO. For example, the CSO did not report data for Pranz Gardens as a specific enumeration district (ED) but included it as part of other EDs, possibly due to its size in during the Census 2000. Data for the project-affected communities including Pranz Gardens and other small villages are however, included in information presented for the Study Area category, as a whole. Additionally, because the CSSP is a sample and not a census, not all villages/areas are included in the CSO's update for any given year.[9]



Source: Central Statistical Office

Figure 4.5-1. Communities surrounding the CariSal facility comprising the Study Area for the socioeconomic assessment.

survey for mounting myriad, high-profile social and economic investigations by social scientists in both the public and private sectors, and national and international researchers. Source: CSO 2006.

[9] CSO information was obtained by HHB and Associates during the months of October and November 2007. Confirmation of the CSO's reporting on and availability of data for specific Study Area communities was garnered in conversations with CSO staff in November 2007 and on January 31, 2008.

Secondary data from the CSO, reviews of historical records, and previous studies and interviews with representatives from the community formed the basis for assessing existing services and utilities.

Analyses of attitudes toward the proposed plant were based on focus groups and in-depth interviews with community members – opinion leaders, residents, and employees of the potentially impacted areas. The goal was to identify citizens' concerns regarding the development of the proposed plant, specifically, and industrialization development efforts, in general. Focus group and interview topics included positive expectations of the proposed plant, as well as possible negative impacts on the community and the environment. Potential community involvement in efforts to enhance community safety was also discussed.

Finally, to assess the existing and planned activities in the Study Area, a focus group was conducted with local industry experts and key informants. The data from these focus groups informed and augmented field surveys on the frequency and intensity of vehicular traffic in the Study Area (actual and projected), drainage and flood control, emissions, and construction and operations schedules of each proposed facility.

All focus groups included discussions of the community's challenges and needs and opportunities for collaboration between CariSal and the potentially impacted community and community organizations.

4.5.2 Land Use

Land in the Couva/Point Lisas area is witnessing a significant transformation from agriculture to industrial and residential uses, much like that which occurred before, when the construction of the first industrial estate, PLIPDECO, began in the 1970s. The Government [through its recent ownership transition of the former Caroni (1975) Limited],[10] is the single largest landowner in the region. Both the Government and the private sector are actively involved in the growth and development of industry and residential uses in the area. Before the PLIPDECO was created, marking the shift from predominantly agricultural to industrial uses, sugarcane cultivation and large areas of mangrove wetlands and fresh water marshes dominated the area. McShine-Mutunhu (1986) observed the extent of the mangroves to be on the order of some 445 ha.

Some parts of the region had experienced a long history of agricultural development, such as Savonetta, which, was originally called *Savanetta, a* Spanish word meaning "small savannah." What is today known as Savonetta Village was once a prime and established agricultural district when the British arrived in Trinidad during the late Eighteenth Century (Trinidad and Tobago Secretariat for the Implementation of Spanish 2005).

In more recent years, during the operation of Caroni (1975) Limited, the nationalized sugar industry accounted for approximately 95 percent of the agriculture in the region. With the closure of Caroni, large scale sugarcane cultivation, previously foundational to the national economy, was abandoned (Rapid Environmental Assessments (2003) Limited and SAGE

[10] Caroni (1975) Limited lands were transferred to the NEC for the development of the proposed PLSEIE.

Environmental Consulting, LP 2007). The closure of the old sugar manufacturing industry gave way to new industrial development that is currently being observed in the region.

Today, the western reaches of the Greater Couva/Point Lisas area are largely industrial supporting major ports such as the Savonetta Pier #4, a multi-user facility that is significant to the regional and national economy. The most currently available land use map from official sources is included in Chapter 10 as Figure 4.2-2. PLIPDECO and the broader area also encompass methanol and ammonia production, power generation, the production of metals (iron and steel) and desalinized water, as well as various support services for heavy industry and manufacturing. Together, these industries occupy approximately 13.3 square kilometres (sq km) of land, in addition to the area along the eastern boundary of PLIPDECO. The eastern reaches of the region still remain largely agricultural; however, this baseline may change with the proposed additions of the PLSEIE and Port. The Essar Steel Caribbean Limited facility and NGC 36-inch Pipeline are in the construction phase, and other projects are currently in the CEC application process including the Westlake Ethylene and Polyethylene Complex, the PLSEIE, and the NEC's Port Project.

The population centres of relevance to this study and their areas are:

- Diamond – 1.8 sq km
- Dow Village – 2.12 sq km
- Esperanza – 0.55 sq km
- Phoenix Park – 5.65 sq km
- Savonetta – current data unavailable
- Pranz Gardens – current data unavailable
- California – current data unavailable

4.5.2.1 Land and Dwelling Ownership

This subsection presents basic descriptive statistics on land and home ownership and findings on the quality of housing located in the Study Area.

In Census year 2000, the Study Area was characterized by a predominance of land owners over renters[11] That is, far more individuals owned the land on which their dwellings were located (57.2 percent) compared with those who rented (18.2 percent) or leased (11.4 percent) their homes (see Table 4.5-1). A very small percentage (1.3 percent) inhabited rent-free accommodations while 9.8 percent of the Study Area population was characterized as "squatters." Significant differences in land ownership were observed across the settlements in the Study Area. For example, an examination of dwelling ownership characteristics show that Dow Village had the highest proportion of land owners (81.6 percent) while the lowest proportion occurred in Esperanza (22.9 percent), where the popular form of tenancy government

[11] Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. (2007) arrived at a similar conclusion. Census 2000 data reported in these tables were confirmed with the CSO by HHB and Associates in October and November 2007.

rentals. The proportion of individuals who reported "squatting" as their primary form of tenancy was highest in the Diamond (21.5 percent) and Phoenix Park (17.9 percent) communities.

Table 4.5-1. Land Tenancy in Study Area, by Community, 2000 (%)

Tenancy	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Own	51.8	81.6	22.9	25.1
Rent (Private)	2.1	2.3	0	9.0
Rent (Government)	19.5	5.5	67.1	15.3
Lease (Private)	0.0	0.5	0.0	25.1
Rent-free	4.1	1.0	0.0	0.6
Lease (Government)	0.5	6.9	0.0	1.4
Squat	21.5	1.2	10.0	17.9
Other	0.0	0.3	0.0	3.2
Don't know	0.0	0.0	0.0	1.7
Not reported	0.5	0.7	0.0	0.6
Total	**195**	**597**	**70**	**346**

Source: CSO 2000

Table 4.5-2 and Figure 4.5-2 show that in 2000, in *land* tenancy, the Study Area is distinguished from the national level by its greater proportion of land owners; 57.2 percent compared to 53 percent, respectively. Conversely, but consistent with the previous finding, only 18.2 percent of Study Area residents reported renting the land, compared to 21.1 percent nationally. Of the remainder, 11.4 percent of the Study Area population reported Government and private leasehold arrangements, compared to 10.8 percent of the national population.

Table 4.5-2. Land Tenancy in Study Area, 2000 (%)

Tenancy	Study Area	National
Own	57.2	53.0
Rent (Private)	4.1	18.1
Rent (Government)	14.1	3.0
Lease (Private)	7.5	2.8
Lease (Government)	3.9	8.0
Rent-free	1.3	4.6
Squat	9.8	8.2
Other	1.1	0.6
Don't know	0.5	0.6
Not reported	0.5	1.1
Total	**1,208**	**228,996**

Source: CSO 2000

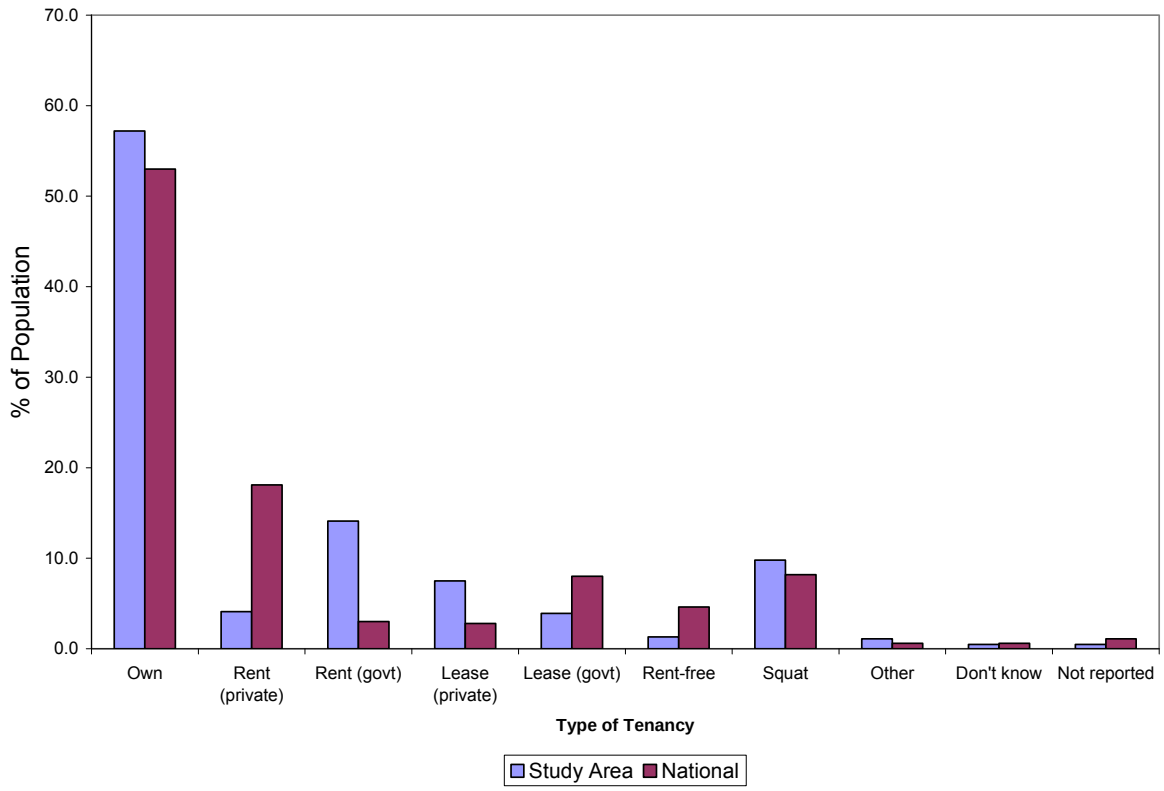


Figure 4.5-2. Land tenancy (Study Area vs. National), 2000 (%).

Observations are similar when the Study Area *dwelling* tenancy is compared to national dwelling tenancy for 2000. Table 4.5-3 and Figure 4.5-3 show that more people owned their homes in the Study Area than at the national level. A notable observation is that the extent of squatting was far greater in the Study Area than at the national level, unlike the slight difference observed for land tenancy.

Table 4.5-3. Dwelling Tenancy in Study Area, 2000 (%)

Tenancy	Study Area	National
Own	80.1	76.1
Rent (Private)	6.5	13.2
Rent (Government)	0.1	2.0
Lease (Private)	0.2	0.2
Lease (Government)	0.0	0.4
Rent-free	9.3	6.6
Squat	2.8	0.5
Other	0.6	0.4
Don't know	0.3	0.1
Not reported	1.1	0.5
Total	**1509**	**300,844**

Source: CSO 2000

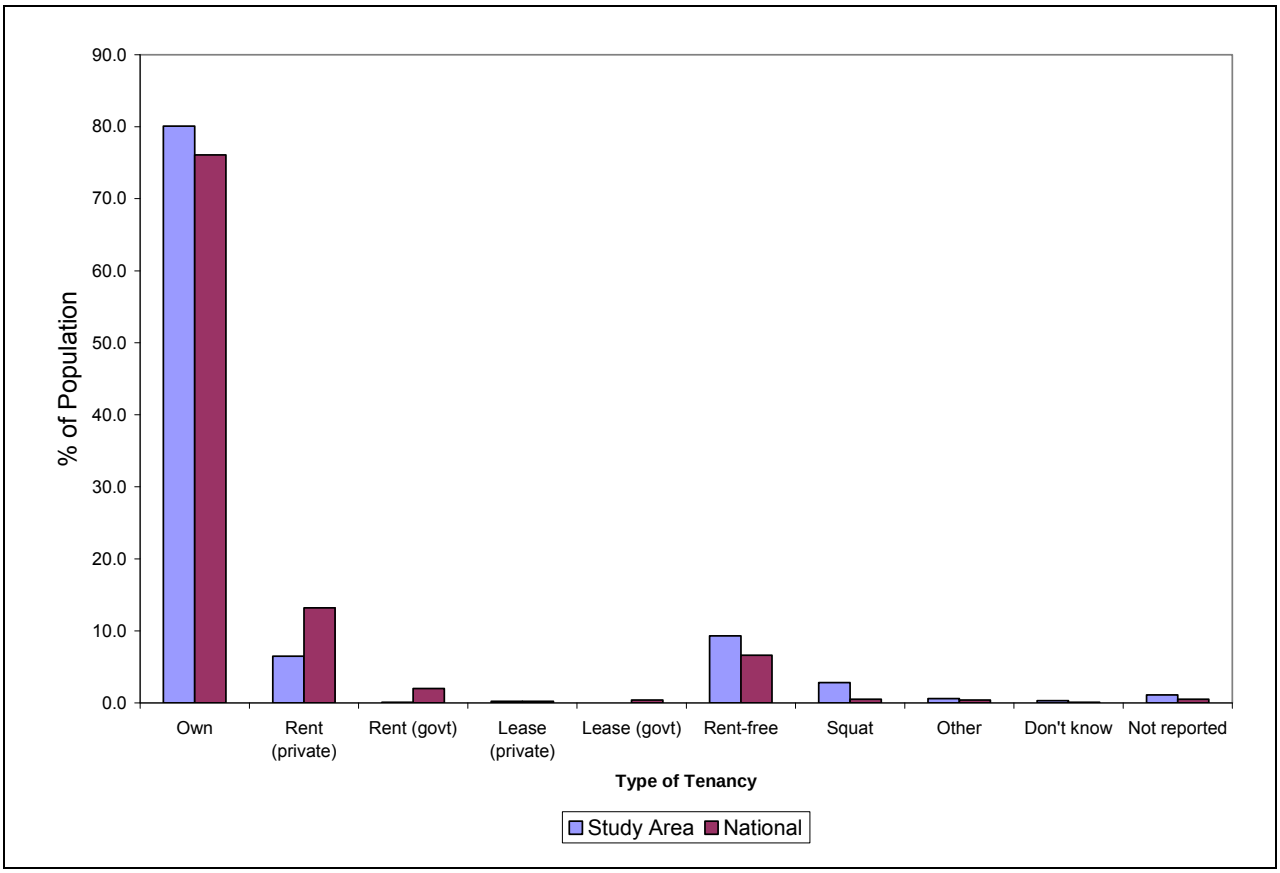


Figure 4.5-3. Dwelling tenancy (Study Area vs. National), 2000 (%).

Table 4.5-4 indicates dwelling ownership also varies among the communities. In Phoenix Park, 91.8 percent own their homes but only 25.1 percent own the land on which the dwellings stand. In Esperanza, 83.3 percent owned their homes, and 22.9 percent owned the land that the dwellings occupy.

Updated data for the year 2006 were obtained from the CSO's CSSP. Because the CSSP is a sample and not a census, not all villages/areas are included in the update for any given year.

Table 4.5-4. Dwelling Tenancy in Study Area, by Community, 2000 (%)

Tenancy	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Own	83.3	73.3	83.3	91.8
Rent (Private)	1.3	9.7	4.8	3.2
Rent (Government)	0.0	0.1	0.0	0.0
Lease (Private)	0.0	0.4	0.0	0.0
Lease (Government)			0.0	0.0

Table 4.5-4. Dwelling Tenancy in Study Area, by Community, 2000 (%)

Tenancy	Community			
Rent-free	15.4	11.1	10.7	1.6
Squat	0.0	4.9	1.2	0.5
Other	0.0	0.2	0.0	1.9
Don't know	0.0	0.0	0.0	1.0
Not reported	0.0	0.2	0.0	0.0
Total	**234**	**814**	**84**	**377**

Source: CSO 2000

Table 4.5-5 shows that rates of ownership have been declining over time, falling from 80.1 percent in 2000 to 75.0 percent in 2006. Over the same period, rental as a form of tenure increased sharply from 6.5 percent in 2000 to 15.4 percent in 2006.

Table 4.5-5. Dwelling Tenancy in Study Area 2000 – 2006 (%)

Tenancy	2000		2006	
	Study Area	Nation	Study Area	Nation
Own	80.1	76.1	75.0	67.1
Rent (Private)	6.5	13.2	15.4	10.7
Rent (Government)	0.1	2.0		0.9
Lease (Private)	0.2	0.2	5.8	
Lease (Government)	0	0.4		
Rent-free	9.3	6.6	3.8	8.4
Squat	2.8	0.5		0.3
Other	0.6	0.4		0.1
Don't know	0.3	0.1		
Not reported	1.1	0.5	5.8	12.4
Total				

Source: CSO 2000

4.5.2.2 Housing Quality

The Study Area exhibited characteristics of high quality with modern amenities housing as defined by the type of construction material used (Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007). As indicated in Table 4.5-6, by far, the largest percentage of homes (78.5 percent) were made of brick and concrete (a modern standard), exceeding by 14.2 percent the national rate of 64.3 percent. Homes constructed from wood (considered the lowest standard) in the Study Area are fewer (5.1 percent) and amount to

less than half of the comparable national rate. Across all of the Study Area villages, towns and settlements, the quality of housing was consistently high (i.e., built using brick and concrete).

Table 4.5-6. Construction Materials Used in Dwellings in Study Area, 2000 (%)

Material	Study Area	National
Brick/Concrete	78.5	64.3
Wood/Concrete	14.4	20.7
Wood/Galvanize	1.9	2.2
Wood	5.1	12.1
Wattle/Adobe/Tapia	0.0	0.5
Other	0.0	0.1
Not reported	0.1	0.1
Total	**1,509**	**225,613**

Source: CSO 2000

The data for 2006 (Table 4.5-7 and Figure 4.5-4) suggest that the Study Area experienced a slight increase in housing standards from 2000 with houses made from brick and concrete increasing from 78.5 to 79 percent. Houses made of wood and concrete decreased from 14.4 to 14 percent. Table 4.5-8 indicates that Diamond Village had the poorest housing quality in 2000.

Table 4.5-7. Construction Materials Used in Dwellings in Study Area, 2000 – 2006 (%)

Material	Study Area	National
Brick/Concrete	79	63
Wood/Concrete	14	25
Wood/Galvanize	2	
Wood	5	10
Wattle/Adobe/Tapia	0.0	
Other	0.0	
Not reported	0.0	2

Source: CSO 2006

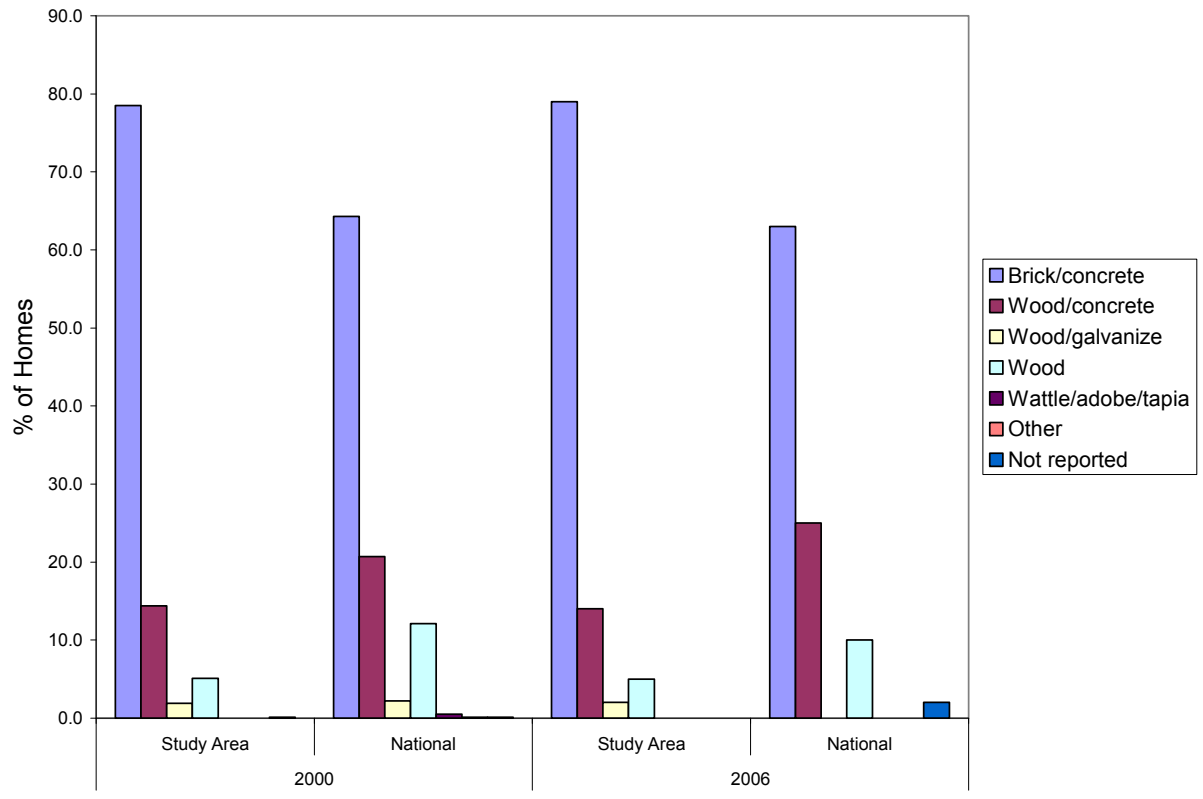


Figure 4.5-4. Construction materials used, 2000-2006 (%).

Table 4.5-8. Construction Materials Used in Dwellings in Study Area, by Community, 2000 (%)

Material	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Brick/Concrete	67.5	87.8	83.3	78.5
Wood/Concrete	23.9	10.1	3.6	14.4
Wood/Galvanize	2.1	0.4	9.5	1.9
Wood	6.4	1.5	3.6	5.1
Wattle/Adobe/Tapia	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0
Not reported	0.0	0.2	0.0	0.1
Total	**234**	**814**	**84**	**377**

Source: CSO 2000

In 2006 a large percentage of homes in the Study Area (65.4 percent) pit latrines still comprise the predominant type of sanitary facilities employed. Pit latrines were highest in Diamond and Phoenix Park (Table 4.5-9).

Table 4.5-9. Type of Toilet Facilities, by Community, 2006 (%)

Toilet Facility	Percentage Distribution			
	Dow Village	Diamond	Phoenix Park	Total
Pit	51.9	100.0	73.7	65.4
WC not linked to sewer	44.4	0.0	26.3	32.7
Not stated	3.7	0.0	0.0	1.9
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO 2006

The type of toilet/sanitary facilities available is one of the most sensitive of indicators of economic development in the local context. The Study Area has a very high rate of pits, which tend to be common in rural agricultural areas across the nation.

4.5.3 Demographics

4.5.3.1 Population

A very small fraction of Trinidad's 1.2 million people inhabited the Study Area with a population of 5,962 (0.4 percent of national population) in 2000[12] Esperanza is the least populated community, with a population of only 315 people (Table 4.5-10). Dow Village, reported a population of 3,300 individuals and is the most populated, comprising 55.3 percent of the population of the Study Area.

Table 4.5-10. Population of Study Area, 2000 (%)

Community	Population	% of Study Area
Diamond	891	14.9
Dow Village	3,300	55.3
Esperanza	315	5.3
Phoenix Park (incl. Windsor)	1,456	24.4
Total	**5,962**	**100**
National	**1,262,366**	

Source: CSO 2000

[12] See footnote 11.

Population data for 2006 (Table 4.5-11 and Figure 4.5-5) indicate that Diamond Village, the least developed of the villages in the Study Area, experienced an 11.4 percent decline in population from 891 persons in 2000 to 789 in 2006, At the same time, Dow Village and Phoenix Park experienced population growth of 28.2 percent and 42.4 percent. CSSP data for Esperanza were not available for 2006.

Table 4.5-11. Population of Study Area, 2000 – 2006

Community	Population, 2000	Population, 2006
Diamond	891	789
Dow Village	3,300	4,232
Esperanza	315	NA
Phoenix Park (incl. Windsor)	1,456	2,074
Total	**5,962**	**7,095**

Source: CSO 2006

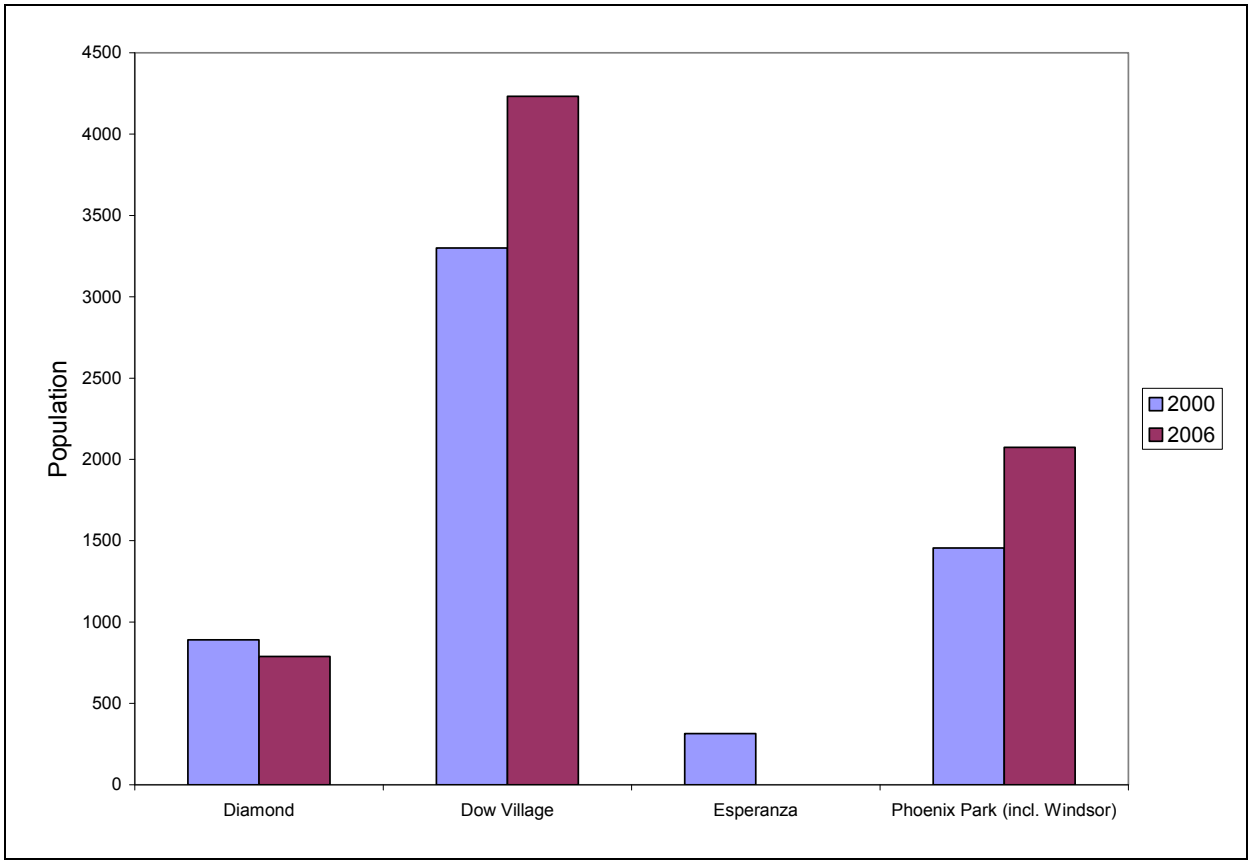


Figure 4.5-5. Population of Study Area by community, 2000-2006 (%).

4.5.3.2 Age

In 2000, the age structure of the Study Area population was comparable to the nation as a whole (Table 4.5-12) (Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007).[13] Persons under age 30 comprised roughly 53 percent of the population. The 30 – 64 age group accounted for 41.6 percent and the 65+ age group, 5.4 percent, respectively. Study Area communities exhibited smaller proportions of individuals in both 0-14 and 65+ age groupings (the young and the elderly) and had a slightly higher number of young adults and adult (working age) persons.

Table 4.5-12. Age Distribution in Study Area, 2000 (%)

Age Group	Study Area	National
0 – 14	23.0	25.3
15 – 24	21.1	19.8
25 – 29	8.9	7.6
30 – 44	23.1	22.6
45 – 64	18.5	17.5
65 +	5.4	7.1
Total	**5,962**	**1,262,366**

Source: CSO 2000

Some differences in age structure were evident among the various settlements that comprise the Study Area (Table 4.5-13). For example, Diamond had the smallest proportion of individuals in the 45 – 64 age group at 14.3 percent of the population while Dow Village had the largest number of 45-64 year old persons in the region at 20.7 percent. The 15 – 24 age group comprised only 13.6 percent of Esperanza's population but represented greater than 21 percent of the populations in the other communities.

Table 4.5-13. Age Distribution in Study Area, by Community, 2000 (%)

Age Group	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
0 – 14	26.3	20.9	28.2	24.7
15 – 24	22.3	21.2	13.6	21.7
25 – 29	8.0	9.1	13.0	7.9
30 – 44	21.7	23.1	21.6	24.5
45 – 64	14.3	20.7	18.4	16.1
65 +	7.4	5.0	5.1	5.1
Total	**891**	**3,300**	**315**	**1,456**

Source: CSO 2000

[13] See footnote 11.

Age structure data for the Study Area in 2006 (Table 4.5-14 and Figure 4.5-6) suggests a decline in the population of persons under 24 years, from roughly 44 percent in 2000 to 38 percent in 2006. This decline is almost certainly due to out-migration of young people seeking better life opportunities as reported in the focus groups (see Section 5.1.4). The dependency ratio in the Study Area, consequently, probably would have risen because the percentage of persons over 65 has almost doubled from about 5 percent to nearly 10 percent.

Table 4.5-14. Age Structure of the Study Area Population, 2000 – 2006

Age Group	Study Area, 2000	Study Area, 2006
0-14	23.0	18.2
15-24	21.1	19.7
25-29	8.9	7.6
30-44	23.1	21.2
45-64	18.5	23.7
65+	5.4	9.6

Source: CSO 2000, 2006

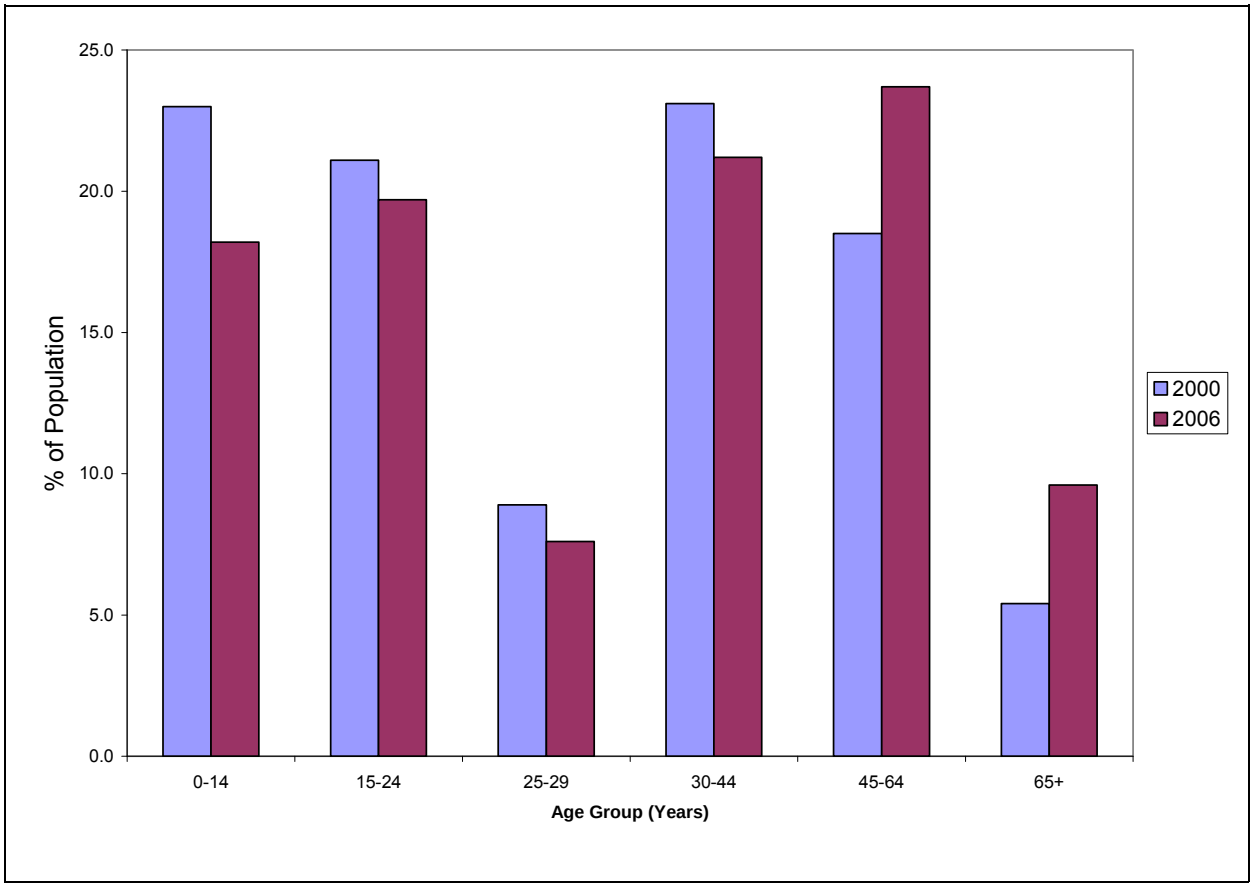


Figure 4.5-6. Age structure of Study Area, 2000-2006 (%).

4.5.4 Race/Ethnicity

The racial composition of the Study Area differed significantly from the national in 2000. As Table 4.5-15 and Figure 4.5-7 show, the Study Area was predominantly Indian (78.3 percent) followed by African (13.7 percent). At the national level these two groups comprise 40.0 percent and 37.5 percent, respectively; a considerably smaller difference of only 2.5 percent. Fewer persons report their race and ethnicity as mixed in the Study Area (7.7 percent) compared to the 20.5 percent who report mixed heritage at the national level.

Table 4.5-15. Racial/Ethnic Composition of Study Area, 2000 (%)

Race/Ethnicity	Study Area	National
African	13.7	37.5
Indian	78.3	40.0
Mixed	7.7	20.5
Other	0.0	1.2
Not reported	0.3	0.7
Total	**5,962**	**1,114,772**

Source: CSO 2000

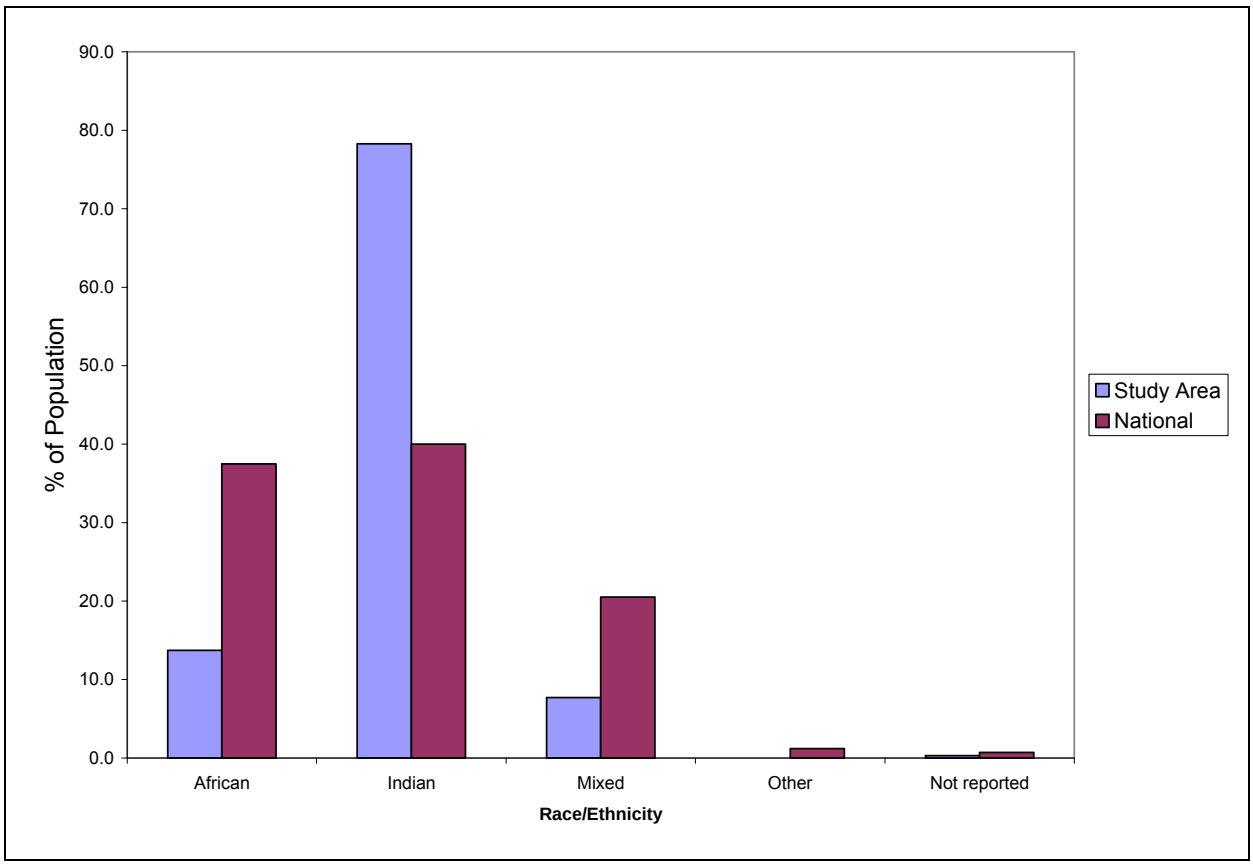


Figure 4.5-7. Racial/ethnic composition (Study Area vs. National), 2000 (%).

The differences in the racial/ethnic composition across the four communities (Table 4.5-16) were also significant in 2000. Diamond mirrors the national composition most closely, having the highest percentage of Africans and mixed individuals in the Study Area (38.4 percent and 16.6 percent respectively). In contrast, those reporting race and ethnicity as Indian comprised 83.3% to almost 86% of the populations in Dow Village, Esperanza, and Phoenix Park, while those reporting as Africans represented lower percentages of the populations in the same three communities (10.1 percent, 2.2 percent, and 9.3 percent, respectively).

Table 4.5-16. Racial/Ethnic Composition of Study Area, by Community, 2000 (%)

Race/Ethnicity	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
African	38.4	10.1	2.2	9.3
Indian	45.0	83.3	84.8	85.8
Mixed	16.6	6.0	12.7	4.8
Other		0.1	0.3	
Not reported		0.5		0.1
Total	**891**	**3,300**	**315**	**1,456**

Source: CSO 2000

A comparison of the racial/ethnic composition of the Study Area communities in 2000 versus 2006 (Table 4.5-17) shows a decline in the African population from 13.7 percent to 9.6 percent. At least part of the reason for this decline is explained by the general population decline in Diamond, which has the highest African population of all Study Area communities.

Table 4.5-17. Racial/Ethnic Composition of the Study Area, 2000 – 2006

Race/Ethnicity	Study Area, 2000	Study Area, 2006
African	13.7	9.6
Indian	78.3	86.9
Mixed	7.7	3.5
Other	0	0
Not reported	0.3	

Source: CSO 2006

4.5.5 Religion

Given the positive correlation between race and religion in Trinidad and Tobago, it is not surprising that the distribution of religious groups in the Study Area also differs from the national distribution. While Christianity is the largest religion nationally (50.4 percent of the population), the largest religion in the Study Area (Table 4.5-18 and Figure 4.5-8) is Hindu (49.5 percent, compared with 22.5 percent nationally), followed by Christianity (20.4 percent

compared with 50.4 percent nationally) and Muslims (11.9 percent compared with 5.8 percent nationally).[14]

Table 4.5-18. Religious Composition in Study Area, 2000 (%)

Religion	Study Area	National
Baptist	5.2	7.2
Christian	20.4	50.4
Hindu	49.5	22.5
Muslim	11.9	5.8
Other	12.0	10.8
None	0.4	1.9
Not reported	0.6	1.4
Total	**5,962**	**1,114,772**

Source: CSO 2006

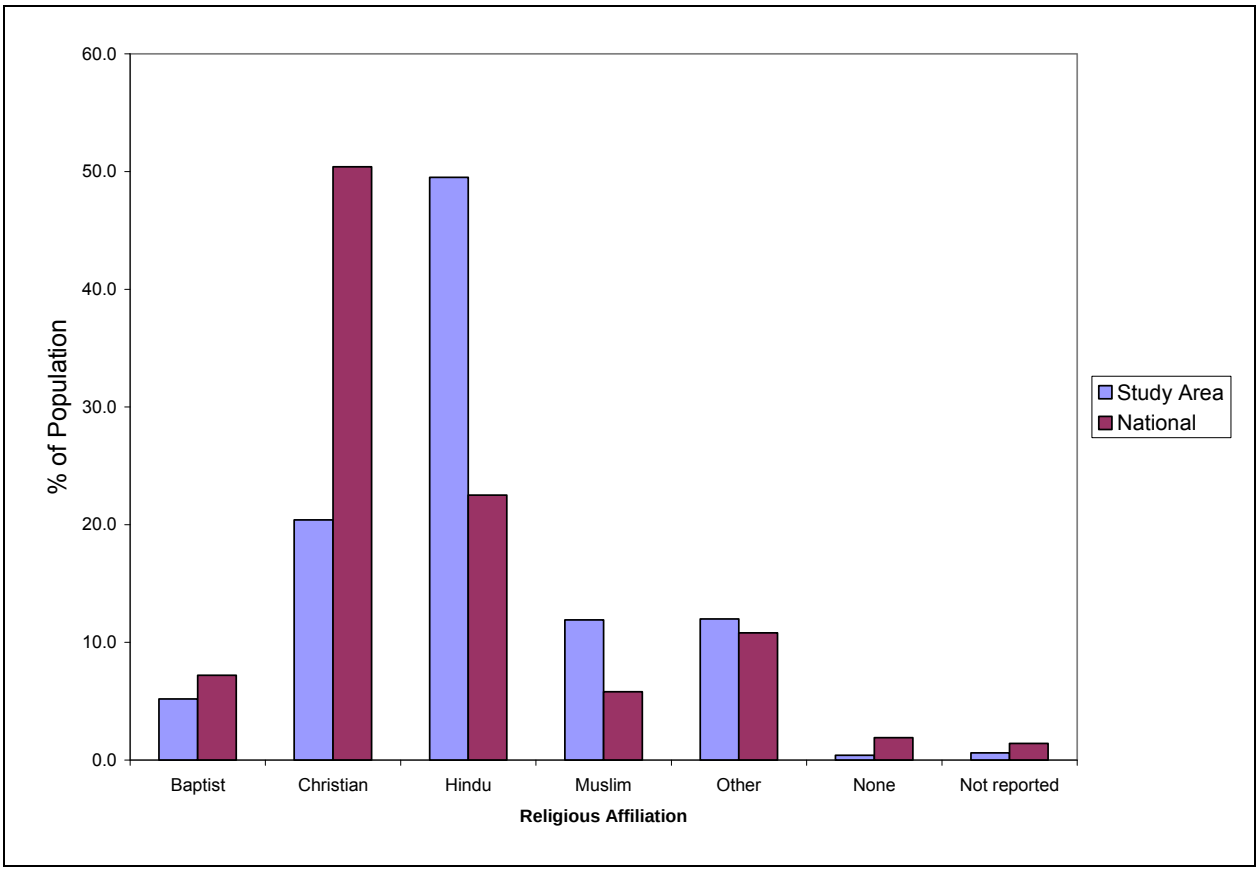


Figure 4.5-8. Religious composition (Study Area vs. National), 2000 (%).

[14] See footnote 11.

Religious preference as reported in the 2000 Census, was unevenly distributed across the four communities (Table 4.5-19) and strongly influenced by each community's distribution of race/ethnicity. For example, in Dow Village, Esperanza, and Phoenix Park, with high Indian populations, Hindu is the most common religion (51.3 percent, 75.6 percent, and 55.3 percent, respectively). In Diamond however, Christians are the majority (26.7 percent), followed closely by Hindus (24.2 percent) and Baptists (23.9 percent). The Baptist religion is relatively uncommon in Dow, Esperanza, and Phoenix Park.

Table 4.5-19. Religious Composition in Study Area, by Community, 2000 (%)

Religion	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Baptist	23.9	2.4	0.3	1.3
Christian	26.7	19.6	15.8	17.6
Hindu	24.2	51.3	75.6	55.3
Muslim	11.3	13.0	6.9	12.4
Other	11.6	12.7	1.3	13.2
None	1.2	0.2		0.1
Not reported	1.0	0.8		0.1
Total	**891**	**3,300**	**315**	**1,456**

Source: CSO 2000

4.5.6 Economic Status of Area

The current economic status of the Study Area is critical for establishing the baseline economic conditions that will affect and be impacted by the proposed Project. This section examines industry and income characteristics of the Study Area based upon the readily available data.

4.5.6.1 Industry Characteristics

Although service industries provide most of the national employment opportunities (64.7 percent), the Study Area in 2000 depended on the services sector far less frequently (41.4 percent, Table 4.5-20)[15] Instead, residents of the Study Area relied far more on agriculture (27.1 percent) for their livelihoods when compared to the nation as a whole where agriculture comprises one of the smallest employment sectors, providing jobs for only 7.5 percent of the population. Manufacturing was the third largest industry sector in the Study Area, providing 17.3 percent of employment, followed by the construction (10.8 percent) and petroleum/gas (2.2 percent) sectors. (See Figure 4.5-9.)

[15] See footnote 11.

Table 4.5-20. Employment by Type of Industry in Study Area, 2000 (%)

Industry	Study Area	National
Agriculture	27.1	7.5
Petroleum/Gas	2.2	2.9
Mining/Quarrying		0.2
Manufacturing	17.3	10.3
Construction	10.8	11.6
Services	41.4	64.7
Not reported	1.2	2.8
Total	**2288**	**424,428**

Source: CSO 2000

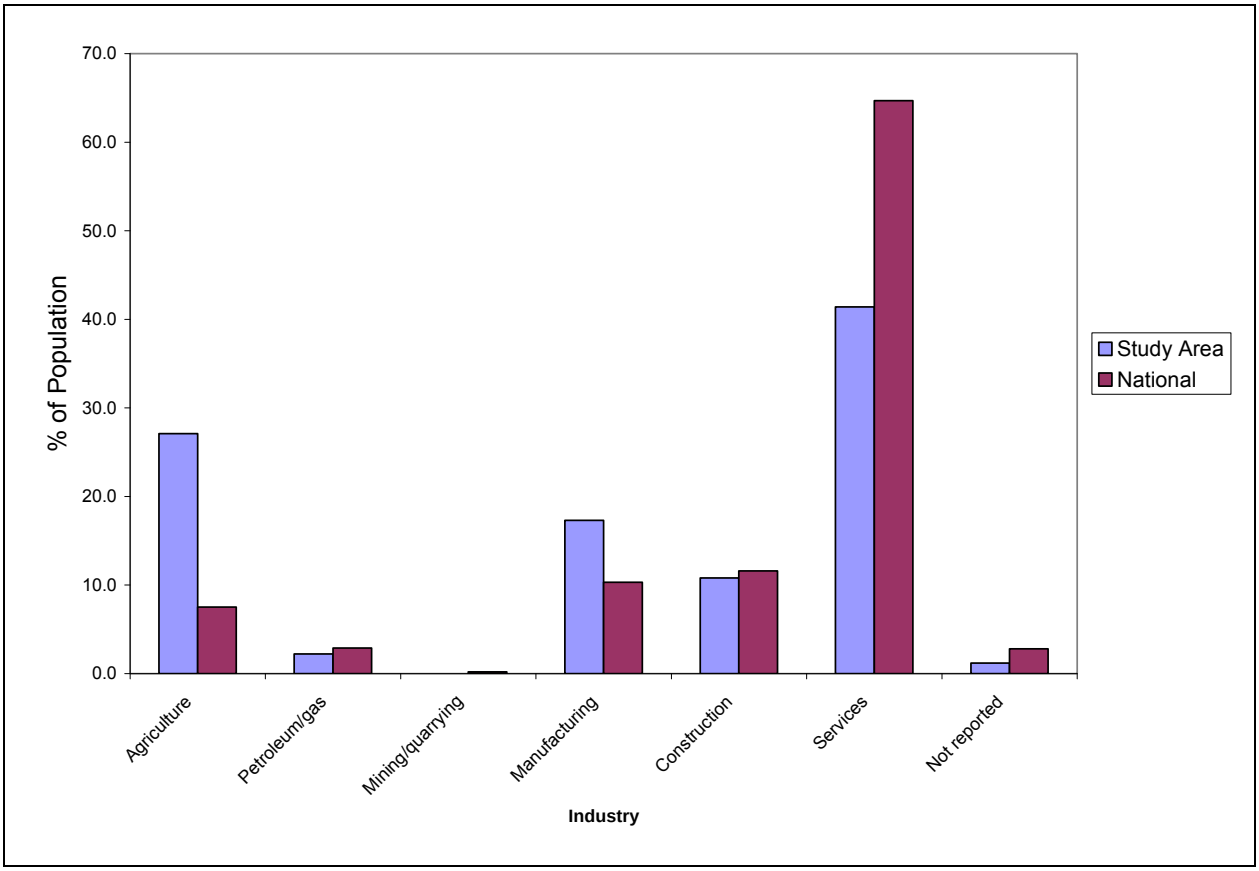


Figure 4.5-9. Employment by Type of Industry (Study Area vs. National), 2000 (%).

The distribution of industry sectors was highly variable among the Study Area communities (Table 4.5-21). Esperanza relied on agriculture to provide 52.5 percent of its employment,

although this number is expected to decline significantly given the recent closing of Caroni (1975) Limited. In contrast, agriculture comprised only 14.7 percent of employment in Diamond. Other notable differences include the relative significance of the manufacturing sector in Diamond, Dow Village, and Phoenix Park (15.7 percent, 17.2 percent and 21.2 percent respectively) to that in Esperanza (4.8 percent). The petroleum/gas sector is significant in Diamond and Dow Village (8.6 percent for each), but not in Esperanza and Phoenix Park (1.0 percent and 0.8 percent, respectively).

Table 4.5-21. Employment in Study Area, by Industry and Community, 2000 (%)

Industry	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Agriculture	14.7	29.5	52.5	22.4
Petroleum/Gas	8.6	8.6	1.0	0.8
Mining/Quarrying	-	-	-	-
Manufacturing	15.7	17.2	4.8	21.2
Construction	18.4	8.6	6.9	12.8
Services	41.2	42.7	32.7	40
Not reported	2.0	1.0	1.7	1.7
Total	**299**	**1341**	**116**	**532**

Source: CSO 2000

Table 4.5-22 shows a detailed industry classification for communities in the Study Area (excluding Esperanza) for 2006.

Table 4.5-22. Percentage Distribution of Employment by Industry, 2006 (%)

Industry Class	Percentage Distribution			Total
	Dow Village	Diamond	Phoenix Park	
Sugar Cultivation and Manufacturing	3.7	0.0	0.0	2.4
Petroleum and Gas, including Production, Refining, and Service Contractors	0.0	0.0	4.3	1.2
Other Manufacturing, excluding Sugar and Oil	16.3	14.6	26.2	18.8
Construction	14.6	28.3	21.7	17.7
Wholesale and Retail Trade, Restaurants and Hotels	29.0	0.0	21.9	24.7
Transportation, Storage, and Communication	3.6	0.0	0.0	2.4
Finance, Insurance, Real Estate, and Business Services	7.3	14.1	0.0	5.9
Community, Social, and Personal Services	25.5	42.9	25.8	27.1
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO 2006

In 2006, the largest sources of employment were the community, social and personal service sector (27.1 percent of all Study Area employment) and the wholesale and retail trade, restaurants and hotels sector (24.7 percent)., followed by the manufacturing sector (18.8 percent, excluding sugar and oil) and construction (17.7 percent). The financial, real estate and business services sector employed 5.9 percent of the population, while the transportation, storage and communication sector and the sugar cultivation sectors each employed 2.4 percent. The smallest employment sector was in petroleum and gas production and refinement (1.2 percent).

4.5.6.2 Occupation Characteristics

On the national level as a whole, Trinidad and Tobago has experienced employment growth over the past decade. However, the fastest growing employment sectors have not necessarily provided the highest quality jobs that often require skilled labour.[16] Census year 2000 data for the Study Area show a predominance of occupations that were low paying (i.e., jobs in elementary occupations, plant and machinery operations and assembly, crafts, and clerical services, which collectively make up 72.7 percent of all employment). That proportion climbs to 82 percent, when the services and sales sectors are included (Table 4.5-23). The high-status, better-paying professions (legislators, officials, managers, technicians, and professionals) comprised only 13.7 percent of all occupations, considerably lower than nationally (20.1 percent). In each of the lowest skill occupations (elementary education, plant and machine operators/assemblers, crafts), the Study Area communities demonstrate proportions that are greater than the nation as a whole (see Figure 4.5-10.)

Table 4.5-23. Occupations in Study Area, 2000 (%)

Occupation	Study Area	National
Legislator, Senior Official, Manager	4.8	6.6
Professional	1.8	4.1
Technicians, Associate Professionals	7.1	9.4
Clerical	10.9	11.8
Service, Sales	9.3	14
Agriculture, Forestry, Fishery, Hunting	0.4	3.4
Crafts	19.4	17.1
Plant/Machinery Operators, Assemblers	13.6	8.6
Elementary Occupations	28.8	21.1
Not reported	4.0	3.9
Total	**2,451**	**468,237**

Source: CSO 2000

[16] See footnote 11.

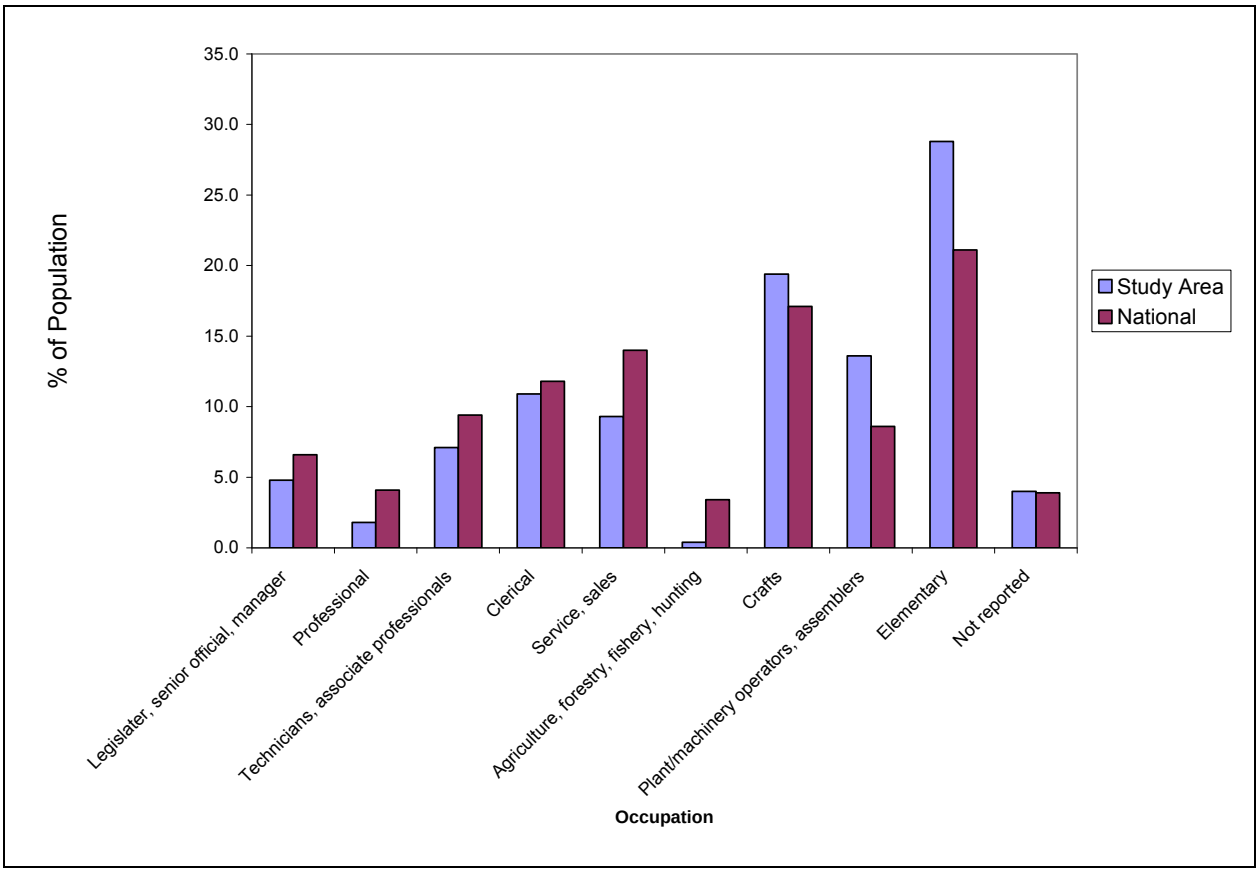


Figure 4.5-10. Occupations (Study Area vs. National), 2000 (%).

Among the communities (Table 4.5-24) that comprise the Study Area, some key differences were observed in the dominant types of occupation. For example, the elementary education occupation was most common in Esperanza (46.3 percent) and Phoenix Park (36.1 percent) and least common in Dow Village (24.2 percent). Similarly, in Diamond, occupations based on crafts comprised 29 percent of all occupations, but were much lower in Dow Village (17.5 percent) and Phoenix Park (17.4 percent). High-paying jobs were found most frequently in Dow Village (15.2 percent) and Diamond (14.2 percent) and less frequently in Phoenix Park (11.2 percent) and Esperanza (4.8 percent).

Table 4.5-24. Occupations in Study Area, by Community, 2000 (%)

Occupation	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Legislator, Senior Official, Manager	5.1 (5.2)	5.3 (5.4)	3.2 (3.3)	3.5
Professional	1.7	2.2	0.8	1.0 (1.1)
Technicians, Associate Professionals	7.4 (7.5)	7.7	0.8	6.7
Clerical	6.9	12.1	3.2 (3.2)	11.8
Service, Sales	6.6	11.4 (11.5)	7.3	6.2
Agriculture, Forestry, Fishery, Hunting	0.6	0.3	1.6	0.2
Crafts	29.0	17.5 (17.6)	21.1	17.4 (17.6)
Plant/Machinery Operators, Assemblers	8.0	14.8	10.6	14.8

Table 4.5-24. Occupations in Study Area, by Community, 2000 (%)

Occupation	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Elementary Occupations	29.0	24.2	46.3	36.1 (36.2)
Not reported	5.4 (5.5)	4.2	4.8 (4.9)	2.1
Total	**348**	**1,413**	**123**	**567**

Source: CSO 2000

Table 4.5-25 shows comparative CSSP data for 2006 (see Figure 4.5-11).

Table 4.5-25. Comparative Occupational Distribution, 2000 versus 2006

Occupation	Study Area, 2000 (%)	Study Area, 2006 (%)
Legislator, Senior Official, Manager	4.8 (5)	7.0
Professional	1.8 (2)	2.4
Technicians, Associate Professionals	7.1 (7)	8.3
Clerical	10.8 (11)	9.4
Service, Sales	9.3 (9)	14.2
Agriculture, Forestry, Fishery, Hunting	0.3 (0)	
Crafts	19.3 (19)	28.1
Plant/Machinery Operators, Assemblers	13.6 (14)	8.3
Elementary Occupations	28.7 (29)	22.3
Not Reported	3.9 (4)	

Source: CSO 2000, 2006

The data suggest that the Study Area economy is one in transition with increased employment in the higher paying occupations (from 13.7 percent to 17.7 percent) over the six-year period. While clerical sector jobs declined, there were marked increases in the number of persons employed in service and sales, with the biggest jump (45.5%) in crafts. The proportion of elementary occupations fell from 28.7 percent in 2000 to 22.3 percent in 2006 as did the percent of persons employed in plant and machinery operations.

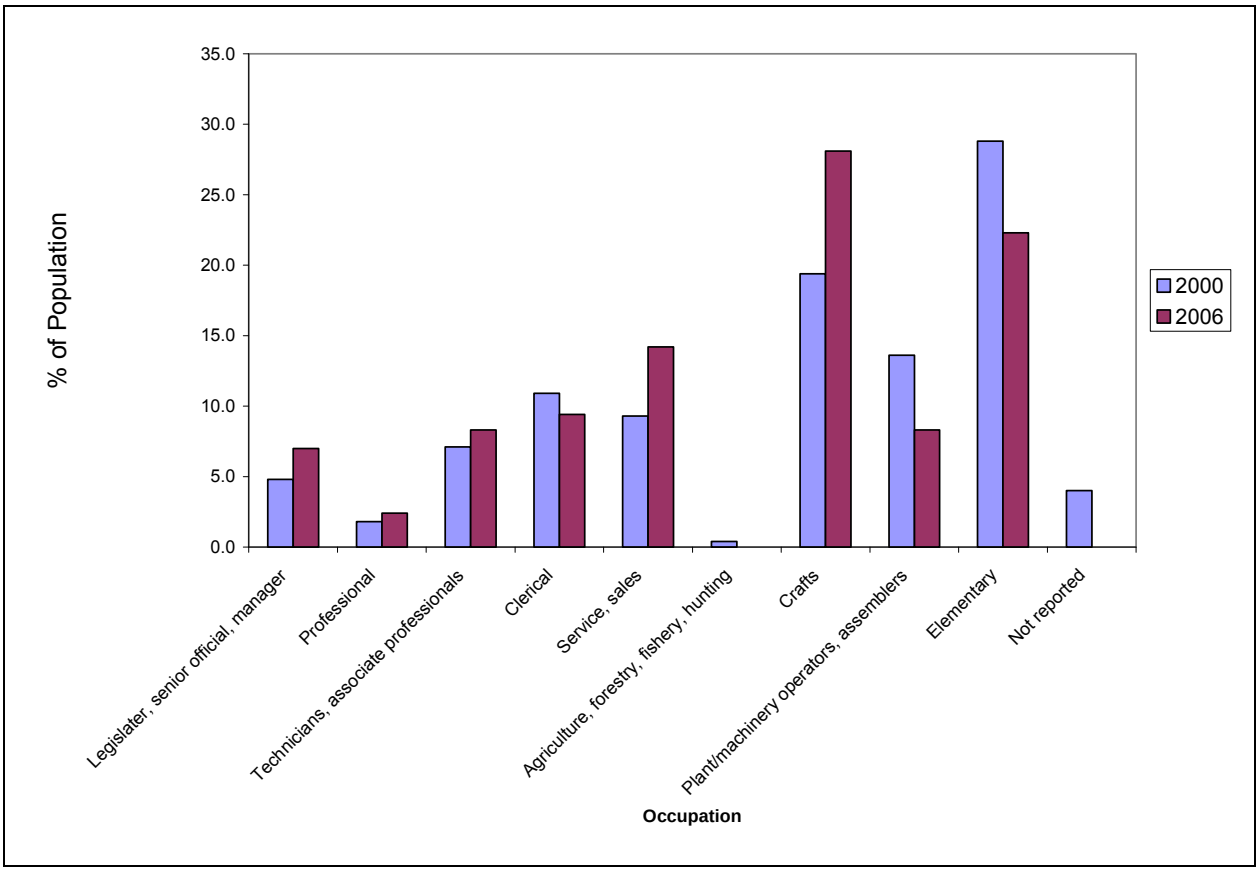


Figure 4.5-11. Occupations in Study Area, 2000-2006 (%.)

4.5.6.3 Income and Income Distribution

The Census 2000 income levels reported for the Study Area were generally low largely but followed the national trend. Table 4.5-26 shows only 12.5 percent of the Study Area population earned a monthly income of over TT$4000. The majority (82.4 percent) of Study Area workers earned less than $4000 per month compared to 68.9 percent of the nation's workers. Of this group, the largest concentration (44.6 percent) of incomes was in the $500 - $1,999/month income range for the Study Area compared to 35.5 percent for the nation as a whole. While almost 11 percent of workers earn less than $500/month at the level, a slightly smaller proportion of Study Area workers earned incomes in this category. Nevertheless, it is clear that Study Area workers are more likely to be employed in lower –paying jobs. Study Area workers were also less likely to possess jobs at the highest pay scales – 2.5 percent of Study Area workers earned greater than $8000/month compared to 3.8 percent for the nation. However, the gap between the SA and nation is much smaller at these income levels (a 1.3 percent difference) compared to the gap that exists at the lowest pay levels (13.5 percent). Given the area's level of industrialization compared to that of the nation, this degree of variance might be unexpected but it is not surprising when understood in the context of the types of jobs prevalent in the Study Area (See Figure 4.5-11 above). (The remaining 5 percent represents missing data for the Study Area). At the lowest end of the income distribution, 7.7 percent of the Study Area population earned less than TT$500 per month, compared to the national figure of 10.8 percent. (See Figure 4.5-12.)

Table 4.5-26. Monthly Income (TT$) in Study Area, 2000 (%)

Income	Study Area	National
< 500	7.7	10.8
500 – 1,999	44.6	35.5
2,000 – 3,999	30.1	22.6
4,000 – 5,999	8	9.0
6,000 – 7,999	2	2.8
8,000 – 9,999	0.9	1.3
> 10,000	1.6	2.5
Not reported	5	15.6
Total	**2,288**	**424,428**

Source: CSO 2000

A comparison of the Study Area workers shows that income levels are uniformly depressed for the majority of workers, across all of the communities (see Table 4.5-27). More than 10 percent of Dow Villagers reported incomes below $500 per month in 2000 followed by Diamond at over 6 percent. The communities reported low percentages of members in the highest income bracket, with the largest proportion observed in Phoenix Park at 2.1 percent.

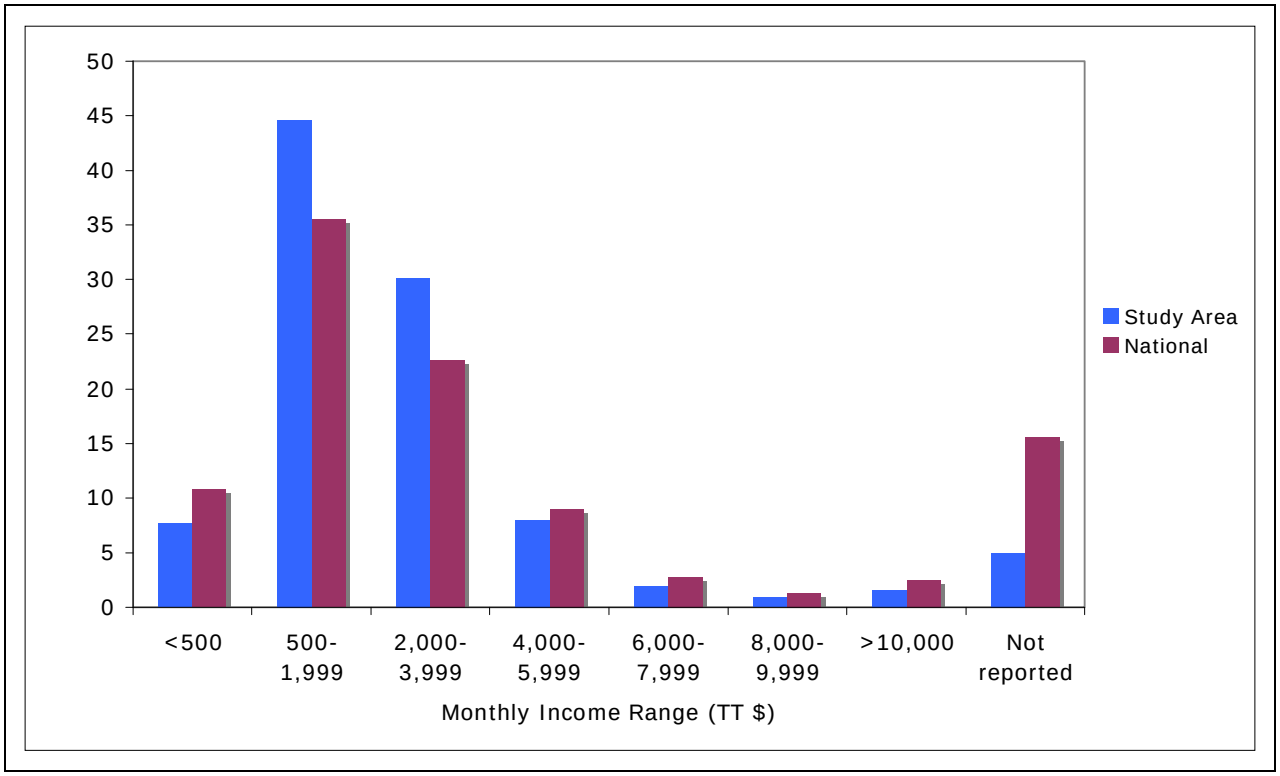


Figure 4.5-12. Income Distribution (Study Area vs. National), 2000 (%).

Table 4.5-27. Monthly Income (TT$) in Study Area, by Community, 2000 (%)

Income	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
< 500	6.4	10.3	3.4	3.0
500 – 1,999	39.2	41.6	50.9	53.6
2,000 – 3,999	28.1	31.8	36.2	26
4,000 – 5,999	13.7	7.5	5.1	6.8
6,000 – 7,999	2	1.3	1.8	3.8
8,000 – 9,999	1.7	.7	.9	.9
> 10,000	1.6	1.4	.9	2.1
Not reported	7.4	5.3	.9	3.9
Total	**299**	**1,341**	**116**	**532**

Source: CSO 2000

Table 4.5-28 shows employment in the Study Area (excluding Esperanza) by type of enterprise for 2006. CSSP (2006) data were not available for Esperanza.

Table 4.5-28. Percentage Distribution of Employment by Enterprise, 2006 (%)

Employment by Type of Enterprise	Percentage Distribution			Total
	Dow Village	Diamond	Phoenix Park	
Government State Enterprises	3.7	0.0	4.3	3.5
Central and Local Government	3.7	0.0	12.9	5.8
Private Enterprise	63.7	85.4	69.8	67.1
Unpaid Worker	1.8	0.0	0.0	1.2
Own Account Worker	21.8	14.6	13.0	18.8
Employer	5.4	0.0	13.0	3.5
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO 2006

Most people in the Study Area (67.1 percent) work in private enterprise with 9.3 percent employed in state enterprises or central/local government. Almost 19 percent are self-employed and 3.5 percent are employers.

4.5.7 Labour Market and Skills

The low income levels of the Study Area described in the previous section are matched by low levels of education and training across the communities. This condition underscores the critical need to educate and train the population if socioeconomic development is to occur. Based on the Census 2000, the largest fraction of the population in each community comprised those whose highest level of education is primary school (ranging from 42.1 percent to 49.7 percent across the communities), while a smaller subset had attended secondary school (ranging from 33 percent to

41.7 percent)[17] Only the smallest proportion (ranging from 0.8 percent to 2.2 percent) had attended university (less than the already low 3.4 percent, nationally), despite the opportunity for free tertiary education and the existence of a major university in the Study Area (see Table 4.5-29).

Table 4.5-29. Educational Attainment in Study Area, by Community, 2000 (%)

Attainment	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
None	2.0	2.3	5.7	1.8
Nursery/Kind.	2.0	3.8	3.5	1.6
Primary	49.7	42.1	44.1	46.0
Secondary	33.0	41.7	35.9	36.7
University	0.8(7)	2.2(74)	0.9(3)	1.5(22)
Other	5.4	1.6	_	2.8
Not Applicable	6.3	5.4	6.6	5.3
Not stated	0.6	0.8	3.1	4.1
Total	**890**	**3,300**	**315**	**1,456**

Source: CSO 2000

Adding to this picture of the labour market, most of the population had never successfully taken an examination (between 62.3 percent and 74.4 percent), and only a very small percentage has attained full ordinary certificates in secondary school (between 0.7 percent and 7.5 percent) or earned a degree (between 0.3 percent and 1.1 percent, substantially lower than the national figure of 2.2 percent). (See Table 4.5-30.) The growing mismatch between educational attainment, the availability of skilled labour and the planned growth in industrial jobs that require a range of skilled labour is becoming readily apparent, particularly for those workers who are attempting to transition from agricultural jobs to those created by newer forms of industry.

Table 4.5-30. Highest Examination Passed in Study Area, by Community, 2000(%)

Examination	**Community**			
	Diamond	Dow Village	Esperanza	Phoenix Park
None	72.2	62.3	74.4	72.0
School Leaving	5.0	4.9	1.5	2.5
CXC Basic	1.5	0.8	19.1	1.0
CXC Gen./Os(1-4)	10.2	15.7	1.5	12.1
Full certificate	5.2	7.5	0.7	6.6

[17] See footnote 11.

Table 4.5-30. Highest Examination Passed in Study Area, by Community, 2000(%)

Examination	Community			
Advanced (1-2)	0.1	0.8	---	0.4
Advanced 3+	0.8	1.5	---	1.1
Diploma	2.3	2.8	0.7	0.9
Degree	0.5(4)	1.1(34)	0.3(1)	0.5(7)
Other	0.1	0.4	0.3	0.9
Not stated	1.8	1.9	1.1	1.6
Total	**810**	**3,017**	**266**	**1,292**

Source: CSO 2000

More importantly, for the proposed Project, only a small percentage of the population has acquired specialized job training (between 9.3 percent and 36 percent in the Study Area, compared with the national level of 34.6 percent), and a large fraction has never obtained specialized job training at all (between 55.4 percent and 87.6 percent in the Study Area, compared with the national level of 60.9 percent).

Table 4.5-31 shows the situation in 2000.

Table 4.5-31. Special Job Training in Study Area, by Community, 2000 (%)

Training	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Yes	36.0	26.6	9.3	24.6
No	55.4	68.4	87.6	74.5
Don't know	0.3	0.1	-	0.3
Not stated	8.2	4.8	3.1	0.4
Total	655	2,610	226	1096

Source: CSO 2000

In the Study Area as a whole, 18.7 percent had attended secondary school but had passed no subjects, with an additional 3.5 percent who had passed no subjects in secondary school but had obtained additional training. 2.5 percent had attended secondary school and had passed at least one subject, while 30.9 percent had only some form of primary school training and 15.2 percent had received only kindergarten or no education.

Table 4.5-32 shows the situation in 2006.

Table 4.5-32. Education by Community, 2006 (%)

Educational Level Completed	Percentage Distribution			Total
	Dow Village	Diamond	Phoenix Park	
None/Kindergarten	14.4	13.8	17.3	15.2
Primary Less than Std. 5	5.1	27.3	8.6	8.6
Primary Greater than Std. 4	21.3	22.5	24.2	22.3
Primary with Training	10.2	4.5	10.3	9.6
Secondary with No Subjects	21.2	9.0	17.2	18.7
Secondary 1 – 4 Subjects	1.7	4.6	3.4	2.5
Secondary 5 or More Subjects	4.2	4.6	1.8	3.5
Secondary No Subjects with Training	3.4	0.0	5.1	3.5
Secondary 1 – 4 Subjects with Training	10.1	9.1	5.2	8.6
Secondary 5 or More Subjects with Training	5.0	4.6	3.5	4.5
University with No Degree	0.9	0.0	0.0	0.5
Diploma/Certificate	0.0	0.0	3.5	1.0
University Degree	2.6	0.0	0.0	1.5
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO 2006

4.5.8 Existing and Planned Activities in EIA Study Area

The major land use activities in the Project area include agriculture, heavy and light industry and manufacturing. As reflected in the 2006 CSSP employment data provided in Section 4.5.8.1 above, the Point Lisas Estate and the broader Study Area have seen growth of the commercial service sector, especially in construction.

The PLIPDECO estate is the hub for a number of satellite industries that are located in the rapidly industrializing Point Lisas area.

Sugar cane cultivation continues to be an important regional activity on the Caroni (1975) Limited lands that are currently the responsibility of the Estate Management and Business Development Company and other small-scale agriculture-based projects.

Within the immediate vicinity of the proposed Project, there is an ammonia plant, two NGC valve stations, a T&TEC transmission line right of way, an NGC gas pipeline right of way, a bus stop along the Southern Main Road (SMR) at the corner of North Sea Drive and the old Caroni Railroad ROW. There are residences beyond the utility rights of way farther to the south, to the east and beyond the Caroni Railroad ROW on the western battery limit of the site. Immediately beyond the western site boundary, before the Southern Main Road, there are lands that are part of the proposed NEC PLSEIE. Northern Construction and EZYCON are to the northwest between Southern Main Road and the Caroni railway reserve. Farther west, across the Southern Main Road there is a cluster of industrial facilities including ammonia plants, EISL, a sugar factory and a gas processing concern. Travelling north along the SMR there are residences, a

construction company, DESALCOTT, food processors, a small family owned hotel and repair shop, and other small-scale commercial and industrial activities.

To the south of the Project site, there is the existing NGC ROW that is currently undergoing expansion, the LNG River, lands that are being cleared for the construction of a steel plant and the Savonetta Estates. An ethylene complex is also proposed for a site due southeast of the CariSal Project.

The NEC's proposed development of the PLSEIE is to the east, north and south of the proposed CariSal site. A new port facility that will service the proposed PLSEIE is also proposed to the southwest of the CariSal site (NEC's Port Project), in the Gulf of Paria between Claxton Bay and Goodrich Bay. CEC applications have been submitted for both the PLSEIE and the Port Project.

4.5.9 Resource Users

CariSal's community outreach and public engagement efforts were in part aimed at obtaining information on the use of the Project site and ex situ facilities by nearby neighbours, community members/organizations and other stakeholders. During several field visits, small flocks of goats and a kine of cows were observed grazing on the Project site. These animals very likely belong to neighbouring farmers. CariSal will post notices at the site or will otherwise make reasonable attempts to notify the owner/s of these livestock in advance of commencement of any site clearing, construction work, or other activities that can cause harm to their animals.

Fishing is a common recreational (and commercial) activity in the coastal areas of Trinidad and Tobago. Goodrich Bay, a relatively large, mangrove lined and well protected bay, is a popular recreational fishing location for locals and other users of the broader Project Study Area[18]. It is accessed via North Sea Drive (west).

Goodrich Bay comprises the larger marine environment in which the Yara Pier that is currently used by EISL (for caustic soda imports) and by the former Caroni (1975) Limited (or its remaining sugar and molasses exports) is all located. Yara Limited uses this pier for its ammonia business while the Immigration Division of the Trinidad and Tobago Ministry of National Security has a seaport office in this location. Notwithstanding these current uses, the Bay is noted by fisher-folk for not having heavy shipping traffic and being "in its natural state"[19].

Caustic soda will be stored at and exported through the EISL facilities and Yara pier located at Goodrich Bay, due west of the Project site. CariSal's proposed use and any necessary repair of the existing nearby EISL and Caroni facilities (caustic soda and CaCl solution shore-tanks and pipelines) are not expected to adversely impact or permanently limit the ability of current resource users in engaging in their usual activities in Goodrich Bay and the nearby environs. Hydrostatic testing of pipelines and shore tanks will be conducted as described in Section 5.3.2.

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[18] Small groups of two or three men have been observed fishing in the Goodrich Bay during site reconnaissance events. Goodrich Bay is also listed among the popular fishing areas in Trinidad (Outdoors Trinidad 2007).

[19] Id.

There will be no net increase in shipping traffic in Goodrich Bay due to CariSal's proposed activities. Rather than importing caustic soda for local use in Trinidad, EISL will *export* caustic soda generated by CariSal in the same number of annual shipments.

CariSal's port storage and docking needs for limestone will not be handled at the Yara Pier in Goodrich Bay but through a commercial agreement with PLIPDECO for use of Savonetta Pier 4, an existing public, multi-user port facility in Point Lisas.

Installation of CariSal infrastructure at the EISL/Yara docking facility/pier will not entail the reclamation of land, cutting or dredging of marine areas. Similarly, it will not require any new construction in mangroves nor cause permanent and adverse impacts to the mangrove systems (see Sections 5.2.2 and 5.3.1).

The Project does not include any activities associated with the establishment, modification, expansion, decommissioning or abandonment of marinas, piers, slipways, jetties or other coastal features. There is also no need for modification associated with dry-docking, ship repair or construction.

4.5.10 Community Attitudes to Proposed Project

Community residents were chiefly concerned about the potential hazardous health impact of emissions, noises, and additional lighting from the proposed plant. Overall, however, community participants showed a great deal of interest in and anticipation for the CariSal Project.

Many residents expressed interest in collaborating with CariSal to create an environment that is favourable to both the Community and the Company. Participants identified groups that should be targeted for future endeavours including the "Friends of Phoenix Park" and the "All Fours" card-playing group, also located in Phoenix Park. CariSal expressed a commitment to continue efforts to identify groups and individuals that can act as key liaisons between the Company and the Community.

CariSal's representative expressed concern about the dearth of skilled labour in the area. Community participants acknowledged this concern and indicated a willingness to partake in CariSal or other company/government agency training programs if employment opportunities were to follow.

Residents of the Study Area presented the following information and suggestions for consideration:

- There is no hospital in the area. The nearest health centers are at Couva, California, and Claxton Bay.
- Any hospital that would be built in the vicinity of the industrial estate/s would need to include a well-equipped and well-staffed burn unit.
- An existing sewer plant in the area is emitting a strong, offensive smell.

- In Dow Village, testimony was given of a strong intermittent smell of ammonia in the vicinity, which led one focus group attendee to experience dizziness when pregnant with her first child.
- The rainy season and westerly winds aggravate the impact and effect of what community members described as "hazardous ammonia odours." The problem was especially of concern in the Savonetta area.
- Frequent venting from a facility on the industrial estate impacted adversely on dwellings in Savonetta, causing windows in the houses to shake – that is, the venting reportedly caused vibration.
- Both community focus groups brought up the infamous "Bhopal" incident with its highly publicized sequel involving Union Carbide. The groups expressed fear regarding the possibility of repeating this type of scenario with regard to the proposed CariSal facility.
- Participants of the focus groups also voiced concern regarding ambient temperature increases that they are reportedly experiencing in the area. Cricketers and others having long exposure to the sun observed that temperatures seemed to be hotter while playing at Dow than at other venues such as Chaguanas. This phenomenon was attributed to operations at PLIPDECO.
- Participants felt that while the area was above the national employment average partly due to the existence of PLIPDECO, quality jobs generally remained outside the reach of villagers due to qualifications criteria. This experience is especially true for workers from Dow Village compared in Phoenix Park or Savonetta. Education and training were identified as the solution to the problem.
- Crime, drug use, and alcoholism are social problems on the rise, in part associated with the transition of Caroni (1975), the actual and anticipated loss of livelihoods, community infrastructure, and social support systems – especially for youth. Some participants stated that the Dow Village Rural Development Group, formed to tackle social issues, should be given more support by existing and proposed businesses.
- Residents of Pierre Street indicated that their 16 residences still do not have access to electricity services.
- In the event of an industrial accident, the area was considered to be very vulnerable because of its narrow and bad roads, poor access to public transportation, and limited evacuation arrangements.
- The groups were concerned about the handling of bleach at the CariSal plant. This concern was based on the personal knowledge of group members about persons who had lost fingernails and suffered damage to their hands by using bleach manufactured by the a local estate operation.

Industrial Focus Group participants (9) expressed concerns about increased flooding due to land clearing, traffic congestion and dust during construction, possible declining availability of power and industrial power supply to meet new demands, drainage, and impaired emergency response

capabilities. Their concerns were not specific to CariSal, but were focused on the overall industrial expansion of the area. This group identified the following pre-existing coordinating mechanisms, codes, and bodies that could be useful for addressing the identified concerns for everyone's (including the community's) mutual benefit:

- Trinidad & Tobago Emergency Mutual Aid Scheme (TTEMAS)
- Emergency Response Plan for Savonetta Piers
- ISPS - International Ship and Port Facility Security Code
- CAER - Community Awareness Emergency Response
- PLEA - Point Lisas Energy Association

Overall, community members in the focus groups showed great interest in the economic and social development of the broader area, emphasized the need for basic services to be augmented, and expressed a strong desire that the communities benefit from employment or contracting opportunities that may become available at CariSal or other new and proposed industries on the existing and proposed estates. The community also exhibited strong concern for their safety due to the risks associated with activities on the estate and the need for redress of their perceived environmental problems, such as facilities that generate odours, vibration, and excess heat. For detailed discussion of the modelled risk assessment and social impacts of the Project, see Appendix C and Sections 5.1.3 and 5.1.5.

4.5.11 Services and Utilities

4.5.11.1 Electricity and Telecommunications

The vast majority of homes in the Study Area (94 percent, compared with the national figure of 91.3 percent) have electricity (Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007). Some disparities are evident across the communities, however, with the lowest percentage of electricity use in Esperanza (84.3 percent) and the highest in Diamond and Phoenix Park (99.4 percent and 99.3 percent respectively). Small but substantial percentages in Esperanza and Dow Village (10.8 percent and 6.4 percent, respectively) rely on kerosene.

Despite the wide availability of electricity in the Study Area, use of the Internet and computers is low, with only 6.6 percent of the population accessing the Internet and only 11.8 percent having possession of a computer. Most of the population owns and uses a telephone (67.1 percent) and television set (87.8 percent), and 34.2 percent uses cable television. Across the communities, Phoenix Park had the highest levels of these telecommunications with little variation across the remaining three communities.

4.5.11.2 Water

Census 2000 data show that between 60.2 percent and 99.4 percent of the Study Area has direct access to the public water supply (Table 4.5-33). These figures, except for that for Esperanza, are higher than the national percentage of 60.5 percent (Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007).

Table 4.5-33. Water Supply in Study Area, by Community, 2000(%)

Water Supply	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Public Piped Into Dwelling	99.4	75.8	60.2	95.3
Public Piped Into Yard	0.0	4.7	6.0	3.3
Private Piped into Dwelling	0.0	1.6	0.0	0.3
Private Catchment	0.0	5.0	14.6	0.0
Public Standpipe	0.0	8.2	14.6	0.7
Truck Norne	0.0	0.7	0.0	0.0
Spring/River	0.0	2.7	2.4	0.0
Other	0.0	0.7	0.0	0.0
Not Stated	0.0	0.6	2.4	0.3
Total	**174**	**697**	**83**	**298**

Source: CSO 2000

In 2000, the Study Area (73.4 percent) enjoyed a higher proportion of continuous supply of water than nationally (54.3 percent) as shown in Table 4.5-34.

Table 4.5-34. Water Supply in Study Area, by Frequency, 2000 (%)

Tenancy	Study Area	National
Continuous	73.4	54.3
> 3 Times	22.1	29.4
Twice	1.3	7.6
< 2 Times	0.8	6.3
Not at All	0.2	0.9
Other	0.1	0.5
Not Stated	1.9	1.0
Total	**1,154**	**303,871**

Source: CSO 2000

There is, however, a great deal of variation in the level of service/frequency of water supply among the Study Area communities. For instance, while 97.9 percent of Phoenix Park accessed a continuous supply of water in 2000, only 5.2 percent of Diamond enjoyed a comparable level of service (Table 4.5-35). In Esperanza and Dow Village, the proportions of the community receiving continuous water supply service were 88.0 percent and 79.1 percent, respectively.

Table 4.5-35. Water Supply in Study Area, by Community, 2000(%)

Frequency	Community			
	Diamond	Dow Village	Esperanza	Phoenix Park
Continuous	5.2	79.1	88.0	97.9
> 3 Times	94.8	14.2	1.5	0.7
Twice	0.0	1.9	1.5	0.7
< 2 Times	0.0	1.3	3.0	0.0
Not at All	0.0	0.5	0.0	0.0
Other	0.0	0.0	3.0	0.0
Not Stated	0.0	2.9	3.0	0.7
Total	**173**	**618**	**67**	**296**

Source: CSO 2000

Although access to a continuous supply of water is high for most of the communities, 41.7 percent of the Study Area still rely upon water tanks; however, this proportion is lower than the national figure of 64.4 percent water tank ownership.

Diamond had the highest proportion of water tank ownership in the Study Area, at 67.8 percent (Table 4.5-36). Homes that do not direct access to the public water supply depend on community street pipes or stand-pipes and yard taps.

Table 4.5-36. Water Tanks in Study Area, by Community, 2000 (%)

Community	Percent
Diamond	67.8
Dow Village	38.6
Esperanza	32.5
Phoenix Park	36.2
Study Area	41.7
Nationally	64.4

Source: CSO 2000

The 2006 CSSP provided disaggregated drinking water source information for three of the Study Area communities. These data indicate overall increases in the proportions of community residents receiving pipe-borne drinking water directly into their dwellings. The most significant improvement in the level of service among the three communities for which the data were reported was in Diamond Village (Table 4.5-37). While the level of service variables reported differ between the 2000 Census and the CSSP, they nevertheless indicate the likelihood of substantially improved water supply services in Diamond over the period – a change from 5.2

percent of households receiving continuous water supply in 2000 to 66.7 percent of households receiving drinking water from the public supply (WASA) piped directly to the dwelling.

Table 4.5-37. Drinking Water Source, by Community 2006 (%)

Water Supply	Percentage Distribution			Total
	Dow Village	Diamond	Phoenix Park	
Public Piped Into Dwelling	88.9	66.7	94.7	88.5
Public Piped Into Yard	0.0	16.7	0.0	1.9
Private Catchment Not Piped	0.0	16.7	5.3	3.8
Public Standpipe	7.4	0.0	0.0	3.8
Not Stated	3.7	0.0	0.0	1.9
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: CSO 2006

4.5.11.3 Waste Disposal

Waste pick-up from the study area by the Couva/Tabaquite/Talparo Regional Corporation service is scheduled three days a week (Monday, Wednesday, and Friday). The waste is deposited at the Forres Park Landfill.

4.5.11.4 Services

Couva and Chaguanas house the police and fire stations in the Study Area. The Point Lisas Industrial Estate operates its own estate police service, and a modern fire station is being added on Southern Main Road at the entry way to Phoenix Park.

Couva also hosts the main medical service, the Couva District Health Facility. Operating under the South West Regional Health Authority, the facility operates 24 hours, seven days per week and can handle urgent care needs. Although other medical organizations are nearby, such as the San Fernando General Hospital and the Claxton Bay Health Centre, accommodating the growing industrialization in the Study Area may require improvements in the efficiency and capacity of the hospitals.

4.6 TRANSPORTATION

4.6.1 Traffic Flow

Traffic counts were conducted from August 12 through August 17, 2007 on Southern Main Road at Point Lisas. Traffic volumes also were measured on Pacific Avenue for the same days. Additional traffic counts were conducted on Southern Main Road between September 15 and September 22, 2007.

4.6.1.1 Southern Main Road

Southern Main Road is a single-lane paved road. Peak traffic flows typically occur in the morning between 6:30 and 7:30 and in the late afternoon between 3:30 and 5:00.

Daily traffic flows for Southern Main Road in August 2007 averaged 7,085 northbound vehicles and 7,369 southbound vehicles. Average volumes in September were similar, with 6,951 northbound vehicles and 7,528 southbound vehicles. The peak hourly traffic for northbound traffic was 793 vehicles, occurring between 6:30 and 7:30 a.m. The peak hour for traffic in the southbound direction was 664 vehicles, occurring between 3:45 and 4:45 in the afternoon. Afternoon peaks for each day varied between 3:30 and 5:00.

4.6.1.2 Pacific Avenue

Pacific Avenue is a single-lane paved road. The daily average traffic flows for Pacific Avenue were 2,392 vehicles in the northbound direction and 2,459 vehicles in the southbound direction. The peak hourly volume, 534 vehicles, occurred in the northbound direction between 6:30 and 7:30 a.m. Southbound hourly traffic volumes peaked with 426 vehicles between 3:30 and 4:30 p.m.

4.7 AESTHETIC AND RECREATIONAL VALUE

The landscape surrounding the Project site is a relatively flat and typical of coastal areas, with the topography sloping from the east to the west in a series of undulating ridges. The Project site itself is primarily flat with a slight depression toward the north-eastern corner. There is also a central depression, which runs southward and covers approximately half the site. The Project would be sited in an area that contains or is near anthropogenic activities such as sugar cane cultivation, commercial and industrial activity, roads, and residential housing. The viewshed currently includes other industrial structures, such as gas processing plants, storage tanks, piers, docks, and other pipelines. Additional industrial facilities are anticipated because the general area is intended to be developed as an industrial area.

In the vicinity of, and adjacent to, the proposed site, the dominant vegetation type is sugar cane and a variety of other grasses in open, unoccupied lands. Vegetation is generally small and low, although some taller shrubs and trees are located in relatively small, irregular patches, in mangroves approximately 1 – 2 km southwest of the proposed site, and in riparian areas. Vegetation is generally green in colour, and in agricultural areas, brown soil dominates much of the groundcover. Several rivers surrounding the proposed site are bordered by taller riparian vegetation (see Section 4.4). For example, the LNG River is located less than 1 km south of the Project site and the BC River is located north of the Project site.

Approximately 1 – 2 km west of the proposed site is the Gulf of Paria. Between the site and Gulf, where the proposed pipeline and storage tank facilities would be located, are industrial buildings, large storage tanks, and open unused land with low-lying vegetation, such as grasses. Along the coastline are large piers, ports, beaches, and mangroves. Within the Gulf of Paria are multiple ports, which include various above-water structures, such as large piers, above-ground pipelines, and often large ships.

Key observation points would include roads, residential zones, and commercial areas surrounding the proposed site. North of the site are areas with residential and commercial developments including residential buildings, schools, religious establishments, community centres, and playgrounds. The closest residential area is Phoenix Park, which is located north of the proposed site. This community extends from the intersection of Southern Main Road and Phoenix Park Road and follows a line along the Phoenix Park Road in an easterly direction. A few commercial buildings are near Southern Main Road, while the eastern portion of the community is primarily residential. Several roads, which link commercial and residential areas, are adjacent to and surround the proposed site.

No recreational grounds are located within the vicinity of the proposed site. Approximately six sport grounds are located 1 – 3 km north of the Project site, including the Macaulay Park Recreation Ground, Dow Village Recreation Ground, Inshad Ali Promenade, Couva Recreational Ground, and two others. Information contained in this section was derived from a review of historical source documents and physical reconnaissance of the project and broader study area.

4.8 ARCHAEOLOGICAL AND HISTORICAL SITES

No known archaeological or historic sites are located within the Project site boundaries, proposed rights of way or the immediate vicinity of the project and thus, the Project will have no adverse impacts to archaeological or historical sites.

The TCPD as well as residents, Project site neighbours, and opinion leaders, were consulted on this and other issues during stakeholder meetings held over the period from late October 2006 to early December 2007. Discussions with a neighbour of the proposed plant, the NEC and the TCPD confirmed the existence of the Caroni Railroad right of way which runs in a north-south direction, outside the western boundary of the proposed Project site.

A bench review of historical records and other recent environmental studies completed in the area revealed the existence of archaeological and historic sites within the broader Study Area including historical sites that were recorded as located within the Savonetta Housing Development, a community south of the proposed Project site (SENES Consultants Ltd. and EPAS Consultants Ltd. 2006, Rapid Environmental Assessments Limited and SAGE Environmental Consulting, LP. 2007, and EcoEngineering Consultants Limited. 2006). The historic site reportedly consists of two sets of cannon emplacements (coastal gun artillery according to a map displayed at the Military Museum), two underground bunkers associated with the cannon emplacements, and two magazine bunkers.

5.0 ENVIRONMENTAL IMPACT ASSESSMENT

The major objectives of an environmental impact assessment study are to

- predict (by direct measurement or estimation) the extent of potential project impacts;
- identify and assess the significance of likely changes to baseline conditions,
- disclose such information to decision-makers and the public; and
- recommend plans to monitor or mitigate detrimental changes.

As illustrated in the impact ratings table below, environmental (and related social and socioeconomic) impacts associated with a project could range from non-existent or negative to beneficial. The geographical extent and duration of impacts are also important considerations and can influence whether the impacts are direct or indirect, local or regional, and reversible or irreversible. In some cases where the scientific or community information available about a potential resource impact is uncertain or unavailable, the impact result may be unknown or not determined in the context of the scope of the given study.

The following sections describe the impacts of the proposed CariSal Project as it relates to humans, flora and fauna, water quality, solid wastes, soil, dust, noise, drainage, and air quality. Each section briefly describes the methodology used to assess impacts and describes impacts with the following general definitions of significance:

Significant or Adverse: Project effect on resource is above established legal thresholds or at a magnitude not sustainable without substantial intervening mitigation measures.

Moderate: Project effect on resource is measurable and noticeable. Mitigation for effects is preferable to maintain resource quality.

Minor: Project effect on resource is measurable, but may not be noticeable. Mitigation for effects is not required to maintain resource quality.

Negligible: Project effect on resource is negligible relative to baseline conditions. No mitigation is needed.

Beneficial: Project effect on resource results in a measurable or noticeable improvement to baseline conditions. No mitigation is needed.

No Impact: Project effect does not change baseline conditions.

Unknown: Project effects are too uncertain to determine an appropriate significance level with a reasonable degree of confidence.

These terms are further qualified by their geographical extent, duration, method, and degree of confidence. For duration, permanent effects would last as long as the Project life or longer. Temporary effects would last for the duration of a specific activity (such as construction) and quickly return to baseline conditions with or without restoration/mitigation. A summary of impacts of the CariSal Project is provided in Section 5.10.

5.1 HUMAN IMPACTS

5.1.1 Community Health Implications

The EIA study found that community members would not be adversely impacted by CariSal's operations and that with mitigation measures in place, community members would not be adversely impacted during construction. Community members could be exposed to additional emissions of particulate matter (PM) and other pollutants derived from construction and operational processes related to the CariSal Project, but these would remain below permissible levels contained in the Trinidad and Tobago Draft Air Pollution Rules (Republic of Trinidad and Tobago 2005).

The implications for community health were evaluated quantitatively by estimating emissions to air from operational and construction processes, assessing maximum offsite air concentrations using dispersion modelling, and comparing the estimated air concentrations with permissible levels of air pollutants as specified in Trinidad and Tobago's Draft Air Pollution Rules (Republic of Trinidad and Tobago 2005). Emissions during start-up processes are estimated to be substantially less than those generated during routine operations. Therefore, start-up emissions were not modelled; see Section 5.9.4.

The approach used to examine the potential for community-scale health implications had two steps. First, the maximum offsite ambient air concentration due to emissions associated with CariSal were added to the maximum measured background concentration for each pollutant expected from the plant. Then, this total concentration was then compared to the appropriate permissible level to estimate the percentage contribution of the Project to the maximum permissible level. The locations of residences also were considered in determining the implications for community health. Methods used to evaluate air quality effects are described in Section 5.9.

5.1.1.1 Construction

Offsite ambient air concentrations of PM and gas-phase air pollutants were modelled for CariSal during construction. The 24-hour concentrations of total suspended particulate (TSP) and particulate matter with effective diameter less than 10 micrometers (PM_{10}) that might result from construction emissions are estimated to exceed permissible levels when considered in combination with <u>maximum</u> offsite background concentrations. Elevated levels of PM are associated with respiratory and other human health problems. The 1-hour concentration of nitrogen dioxide (NO_2) also is estimated to exceed the permissible level when considered in combination with maximum offsite background concentrations. Exposure to NO_2 can cause eye, nose, and throat irritation and can impair lung function in young children (U.S. EPA 1995). Of note, however, is that the total combined (Project plus background) concentration of PM

estimated for CariSal's construction emissions and background is only marginally above permissible levels (i.e., within about 10 percent).

The short-term duration of the construction activity (approximately 2 months), combined with the fact that residences are not located at the fence line, make it unlikely that the off-site concentration would exceed permissible levels. Further, the mitigation measures described in Section 7.2 would greatly reduce the possibility of an off-site exceedance. These measures include: (1) monitoring ambient air quality in real time, (2) reducing the daily construction activity level by extending the construction period, and (3) using newer construction equipment. The net impact after taking these measures into consideration is that it is highly unlikely that nearby communities would have health effects associated with CariSal's construction activities.

5.1.1.2 Operation

Offsite concentrations of PM resulting from CariSal-generated emissions under normal operations are estimated to never exceed permissible levels for several size categories and averaging periods, even in combination with the maximum ambient background concentrations. Human health effects associated with inhalation of PM include impaired respiratory function, aggravated asthma, impacts on heart function, and other problems (U.S. EPA 2002). The potential for and severity of health effects are related to particle size, with smaller particles posing the greatest problems. See Table 5.9-10 for a detailed assessment of the air quality impacts from CariSal operations.

Gas-phase air pollutants, including hydrogen chloride, chlorine, NO_2, carbon monoxide (CO), sulphur dioxide (SO_2), and hydrogen, are also estimated to be emitted during normal operations. In no case are the emissions from the facility estimated to exceed permissible levels, and in most cases the CariSal contribution is a small fraction of the permissible level. Consequently, no adverse community health effects are expected from emissions of these pollutants. Table 5.9-10 provides a detailed assessment of the air quality impacts from CariSal operations.

5.1.2 Cumulative Health Effects

For the cumulative modelling analysis, all CariSal sources in normal operation were modelled together with the sources of emissions from the Essar Caribbean Limited Steel Complex (Essar) and the proposed Westlake Trinidad Unlimited Ethylene and Polyethylene Manufacturing Complex. The modelling included all pollutants that the Essar and Westlake facilities propose to emit (that are also expected to be released by CariSal) these pollutants include TSP, PM_{10}, $PM_{2.5}$, SO_2, nitrogen oxides (NO_x), and CO. Not explicitly included in the modelling analysis were the emissions from the proposed Port at Claxton Bay North, as well as the 55-m-wide port access corridor proposed for development to Southern Main Road, which would service import and export materials to the Essar facility. This activity was not quantified in the CEC application and related documents for the Port available at the time of this writing and hence is not available for modelling. However, because of the distance (greater than 3 kilometres) and direction (south and west of the proposed CariSal location) and the Port's location off-shore, the emissions from the Port construction, operation, and access road are not anticipated to have important impacts on air quality in the vicinity of the CariSal facility. Similarly, available documentation on the PLSEIE CEC application did not develop a quantitative estimate of the increase in air emissions from

increased vehicle activity associated with the proposed estate project, but the proponents note that a small quantity of emissions should be effectively dispersed by the prevailing winds and that traffic would be routed away from existing residential areas. A complete description of the air dispersion modelling analyses for cumulative impacts is presented in Section 5.9.6.6.2.

Offsite cumulative concentrations of PM resulting under normal operations are estimated to be below the permissible levels and exposure to PM is expected to be similar to or only slightly higher than those estimated for the CariSal only impact analysis. In no case are the emissions of gas-phase air pollutants emitted from CariSal during normal operations estimated to exceed permissible levels, and in most cases the CariSal contribution is a small fraction of the permissible level. Consequently, no adverse cumulative health effects are expected.

5.1.3 Occupational Health and Safety Impacts

5.1.3.1 Construction Phase

Construction workers would be exposed to potential hazards associated with fugitive dust and combustion emissions, noise, and also to physical hazards normally associated with industrial construction sites of this kind. CariSal would implement a health and safety plan for construction activities, and all construction activities would be conducted in accordance with the Trinidad and Tobago Occupational Safety and Health Act (OSHA) or with U.S. or World Bank OSHA requirements where the Trinidad and Tobago statute is silent.

5.1.3.1.1 Noise Exposure

Well-maintained equipment with noise attenuating technologies (such as mufflers) would be used during construction. Construction activity would be limited primarily to daytime hours, to minimise nuisance to residents to the north, east, and west. Workers would use hearing protection (e.g., earplugs/muffs) for work activities performed near high noise generating equipment. Construction contractors would be required to provide construction personnel with protection against the effects of noise when measured sound levels exceed 80 decibels (dBA) for a time-weighted average over an 8-hour work day. CariSal would need to prepare an assessment of potential noise exposure from operating equipment after operations begin, using noise monitoring devices, to assess whether workers could be exposed to noise levels exceeding the 80-dBA threshold.

5.1.3.1.2 Air Emissions Exposure

Air emissions during the construction phase would consist of mainly fugitive particulate emissions from earth-moving activity, dust entrainment due to movement of construction equipment on roads, and exhaust emissions from construction vehicles and equipment.

Major construction activities responsible for dust and gaseous emissions would include:

- Excavation and earth work for site levelling and preparation
- Civil work at the site
- Vehicles transporting building materials to the site
- Excavation for pipelines

The sizes of suspended particulates emitted during construction activities are generally larger than those from fuel burning and other process emissions and thus would settle within short distances from the construction site. Therefore, impacts would be restricted to areas close to the construction activities. The dust/gaseous emissions would be temporary (approximately 8 weeks as opposed to permanent or ongoing (i.e., the impacts would occur only during the construction phase, and then primarily during the site preparation activities. Plant erection activities would not likely contribute significantly to dust generation. Occupational exposure to fugitive dust emissions would be expected to be low during the construction phase, if dust mitigation measures are implemented. Dust mitigation would be necessary only when soil moisture is low. Use of personal protective equipment (e.g., dust masks and other respiratory protection) by construction workers would be mandated as needed to minimise worker exposure to fugitive dust.

Onsite approach roads and internal site roads would be periodically water-sprayed using dedicated water trucks during periods of low soil moisture. Water (approximately 5,000 to 8,000 gallons per day, or 18.92 to 30.28 m^3 for 45 days) for this purpose would be purchased from WASA by the construction subcontractors. Spoils piles would be covered to prevent fugitive emissions, as would all aggregate storage piles. Construction contractors would be supervised to ensure that they are using well-maintained transport equipment and vehicles. If hired on contract, such requirements would be added as explicit performance terms of the contract.

5.1.3.1.3 Hazardous Materials Exposure

Construction workers could be exposed to potential hazards associated with use of hazardous materials (e.g., solvents) on the construction site. Construction contractors and CariSal personnel would be required to minimise the use of hazardous materials during site construction. When practical, non-hazardous, rather than hazardous, materials would be used. For every initial delivery of a chemical or fuel to the Project site, CariSal would require construction contractors to ensure that a current manufacturer's Material Safety Data Sheet (MSDS) accompanies the delivery. Construction contractors would be required to retain the current MSDS on the construction site and make it available to onsite personnel upon request. CariSal would also require that construction contractors and CariSal personnel required to work with hazardous materials are trained in the hazards associated with exposure and mitigation measures to avoid adverse effects to the environment and to avoid occupational exposure and protect personnel safety. A copy of each MSDS shall also be provided to the CariSal Health Safety and Environment Coordinator for the construction operation.

5.1.3.1.4 Physical Hazards

CariSal would establish a "Work Permit" system by which CariSal personnel and contractor personnel would conduct a safety hazard analysis prior to issuance of a work permit and initiation of work. CariSal would conduct audits of CariSal personnel and contractor activities, and violations of safety procedures could result in a "Stop Work Order." CariSal would develop a detailed Construction Worker Health and Safety Plan and Site Environment, Health, and Safety (EH&S) Plan, and CariSal would require all construction contractors to be pre-qualified and to submit a Health and Safety Plan for CariSal approval before initiation of onsite work.

Construction contractors would be required to have a trained, certified, qualified Safety Coordinator onsite at all times to support construction activities. All personnel on the construction site would be required, prior to the start of construction, to complete health, safety, and environment training as required by CariSal. CariSal would exercise management oversight for all construction activities through a designated health, safety, and environment representative who would have complete authority to enforce compliance with all safety and environmental rules and laws or to cease construction activity for non compliance. The onsite CariSal health, safety, and environment representative would conduct weekly safety meetings to advise employees of progress made, where improvements are needed, and where hazards may occur in the future. Logs of the meetings would be maintained by the CariSal EH&S officer or the Managing Director. Daily safety meetings would be held for all construction personnel prior to starting daily work.

Consistent with CariSal policies, good construction practices would be employed throughout the construction phase. These practices would include restricted work zones, daily safety meetings, and trenching and excavation safety procedures to prevent cave-ins. All personnel would also be required to wear appropriate personal protective equipment (PPE), such as hard hats, steel tip boots, safety glasses, and welding shades.

CariSal has a zero/no accident target for all construction activities. CariSal and each construction contractor would develop a detailed first-aid emergency medical treatment plan for the construction phase. Medical services would be available to all onsite personnel through an onsite first-aid facility employing a Project nurse. Certain personnel would be designated as members of the construction site emergency response team and would receive training in procedures for administering first aid and cardiopulmonary resuscitation. If an injury that necessitates offsite treatment occurs, CariSal has established relationships with offsite medical facilities for the ambulance or air evacuation and treatment of injured persons.

5.1.3.2 Operations Phase

Occupational hazards associated with the operations phase would include occupational exposure to fugitive dust and combustion source air emissions, toxic air releases, noise, and physical hazards including fires and explosions. CariSal would provide training to all onsite operation staff in preparation for, prevention of, and response to operational hazards. Hazard areas on the facility grounds would be clearly identified on a site development map to be developed by CariSal for the construction phase with proper labels and posters, and the entire CariSal plant workforce would be trained to recognise danger signs. The map should be posted in locations where all contractors and personnel can access it. Through the CariSal Environmental Health and Safety Management (EHSM) Plan, all workers and contractors would be trained and receive orientation on the proper procedures to be followed before entering hazardous areas.

CariSal would design its EHSM Plan to achieve continuous improvement in efficiency, security, and performance using a risk-based approach to: identify, assess, and address vulnerabilities; prevent or mitigate incidents; enhance training and response capabilities; and maintain and improve relationships with key stakeholders. The EHSM Plan and the facility would be subjected to regular periodic verification by a licensed, independent third party.

CariSal would provide workers with the necessary PPE required for operating in various areas of the site and the use of such equipment would be compulsory. The plant workforce would be trained in the use of protective gear; handling of chemical raw materials, intermediates, and products and acid storage cells; use of electric safety equipment; and procedures for entering enclosed areas, fire protection and prevention, emergency response, and other safety and emergency care procedures. The goal of the EHSM Plan and training would be to establish a core base of preparedness for the unlikely and unexpected contingencies that may arise during construction and operation.

CariSal would assign a dedicated staff member or office with oversight and management responsibility for ensuring environmental, health, and safety compliance, and implementation of the EHSM Plan during the construction and operation phases of the Project. This officer or another CariSal appointee also would serve as a community liaison to address social issues and relations with the local communities. CariSal would also develop and implement a Site Emergency Response Plan (ERP) and a Community and Public Health Communication and Safety Plan for site operations. Elements of the Site ERP are summarized in the Upset Conditions Plan.

Practices and procedures for protecting workers from physical hazards would be implemented during the operations phase in a similar manner to the construction phase. Work permit programs, worker training, and other occupational safety programs would be implemented through the EHSM Plan to minimise worker exposure to physical hazards and potential accidents.

Process safety systems, discussed in Section 2.4 of the Risk Assessment (see Appendix C), would be implemented to minimise the potential for worker exposure to hazardous materials. Hazardous-gas monitors would be located at strategic locations throughout the plant to minimise the potential for exposure to accidental releases of chlorine and sodium hypochlorite. Operators would be required to wear PPE, including escape respirators, and safety gear to protect against chemical exposure. Self-contained breathing apparatus and chlorine masks would be located at the entrances to the cell room, hypochlorite unit, and other locations for use in emergency situations. EHS maps showing the locations of such equipment should be posted in areas where they can be readily accessed by staff and should be addressed during worker and contractor safety training. Safety showers would be located at strategic locations throughout the plants. The safety showers would be equipped with lights consistent with industry standards and remote indication in the distributed control system (DCS) room, activated upon use of the shower.

CariSal contractors and all visitors to the CariSal facility would be provided with health and safety training as a condition of entry. Contractors would be required to follow health and safety procedures applicable to their specific work location. Visitors to the CariSal facility generally would not be permitted to enter areas of the facility (e.g., the cell room) where PPE would be required. Any visitors for which such entry is required would be provided and trained in the use of PPE specific to the areas of entry prior to entry.

CariSal would conduct onsite operations in accordance with OSHA, and would limit occupational exposure to regulatory standards for exposure to hazardous materials (e.g., chlorine) releases (e.g., standards summarized in Risk Assessment Table 1.5-5.). CariSal would

limit worker exposure to noise to below regulatory standards either through equipment design and operation standards or implementation of a worker hearing protection program. In some areas of the CariSal plant reducing the noise level to within acceptable regulatory limits may not be technologically feasible, even after noise mitigation measures through equipment selection or design are implemented. Plant personnel working in these areas would be required to wear hearing protection such as ear mufflers, and the amount of time workers occupy these areas may also be limited. CariSal would prepare and implement a noise monitoring program and hearing protection program as part of the EHSM plan for plant operations.

Portable fire extinguishers would be provided in areas of the plant including production areas. Carbon dioxide extinguishers would be provided in the control room and master control centre (MCC) room to extinguish any electrical fires. A firewater ring line would be provided. A firewater pump and firewater jockey pump would deliver water to the firewater stations and to the sprinkler systems in the buildings.

For fire protection CariSal would have a raw water tank of a minimum capacity of 1,817 cubic meters [(m^3) (480,000 gallons (gal)], designed to National Fire Protection Association (NFPA) standards or the equivalent of 4 hours of continuous water for fire fighting, at a minimum rate of 456 m^3/hour [2,000 gallons per minute (gpm)]. The system would be backed up by a potable water supply from WASA and would include a 6-inch (0.15-m) diameter fire ring with strategically located hydrants, and an electric-driven pump and diesel-driven spare pump taking suction from the tank, along with a jockey pump that would maintain a pre-set system pressure continuously. Additional support would be provided by the Fire Services stationed about 200 metres from the plant and also by the Trinidad and Tobago Emergency Mutual Aid Scheme (TTEMAS) that includes the local police and fire services. CariSal would coordinate with the local fire department to implement fire prevention systems early in the Project development process. All liquid storage facilities would be equipped with secondary containment systems to prevent fires or the release of hazardous materials to the environment. (See Section 4.3 of the Risk Assessment in Appendix C.)

5.1.3.2.1 Detailed Environment, Health, and Safety Management Plan

CariSal would develop a detailed EHSM Program for site construction before initiating construction activities. The EHSM Program would include a detailed EHSM Plan for facility operations that would take place before onsite operations begin. The principal goals of the EHSM Program would be to assist CariSal in:

- Achieving compliance with all Trinidad and Tobago Rules and Regulations, including OSHA, public and occupational exposure standards for air emissions and hazardous materials, and other applicable rules and regulations;
- Achieving compliance with regulatory standards and conformity with standard practices and procedures for production and handling of hazardous materials;
- Achieving conformity with standard practices and procedures established by the Chlorine Institute and other standards organizations for operating chlor-alkali plants;

- Maintaining the goal of an injury- and illness-free work environment for employees, contractors, and visitors by developing and implementing standardized environment, health, and safety processes and procedures;
- Providing for continuous improvement of process safety and reliability, minimizing potential losses from property damage and business interruption;
- Promoting plant personnel skills and capabilities development through direct employee involvement in the CariSal EHSM program; and
- Conducting systematic EHSM compliance audits, developing and reviewing the facility corrective action plans, and validating corrective action plans.

CariSal anticipates that the detailed EHSM Plan for site operations will include the following elements:

1. EHSM Policy Statement
2. Plant Personnel Safety Orientation Procedure (new employee and refresher)
3. Contractor/Visitor Safety Orientation Procedure
4. Plant Personnel ESHM Training Program
5. Contractor ESHM Training Program
6. Contractor Pre-qualification and Selection
7. Incident Reporting (includes injury and incident/spill/release notification)
8. Permit to Work (including lock-out/tag-outs, hot work, elevated work, line breaking, confined space entry, electrical safety, transfer of operating control)
9. Control of Hazardous Energy
10. Confined Space Entry Permits
11. Workplace Environmental Controls (housekeeping, accident prevention, signage, etc.)
12. Access to Medical and First Aid
13. Management of Change
14. Process Safety Management
15. Pre-start-up Safety Review
16. Mechanical Integrity Program
17. Training Programs and Frequency
18. Walking and Working Surfaces (ladders, stairs, scaffolds)
19. Occupational Health (ventilation systems, noise areas and control)
20. Compressed Gases and Air
21. Hand and Portable Tools (inspection, guarding, use)
22. Welding, cutting, brazing (training, review for these certified workers)
23. Electrical Safety (general instruction, specific training for areas exceeding 440 Volts)
24. Means of Egress (emergency evacuation plans, fire protection plans)
25. Powered Platforms (training for platforms, man-lifts, etc.)
26. Hazardous Materials (training for handling chlorine, hydrogen, hydrochloric acid, sodium hydroxide, sodium hypochlorite, calcium chloride, sodium bisulfite, and other materials)

27. Personal Protective Equipment (instructions for eye/face, gloves, head, feet, specific instruction for respiratory protection, escape equipment, noise, electrical)
28. Fire Protection
29. Material Handling and Storage (specialist training for hoists, chains, slings)
30. Machinery and Machine Guarding
31. Toxic and Hazardous Substances (hazard communication, MSDSs)
32. Fire Codes and Electrical Codes (general instruction for all employees)
33. Hearing Conservation
34. Stormwater Pollution Prevention
35. Waste and Wastewater Management
36. Facility Emergency Response Plan
37. Transportation Safety

5.1.3.3 Decommissioning Phase

The lifespan of the CariSal Project is expected to be 20 or more years. At the end of the Project's lifespan, decommissioning would occur. During decommissioning, tanks and site equipment would be removed. The potential public and occupational (worker) impacts of decommissioning would be similar to those of construction. A decommissioning plan would be developed by CariSal and reviewed by the Emergency Management Authority (EMA) and other relevant authorities. Decommissioning would result in air, noise, and dust emissions and potential worker exposure. Truck trips for workers and for removing materials for recycling and disposal would occur. Occupational impacts could also include potential contamination and subsequent worker exposure from accidental spills such as from tank removal. Other occupational hazards associated with decommissioning are anticipated to be similar to hazards associated with construction and operations phases as described above. Mitigation measures would be included during decommissioning to minimise exposure to occupational hazards. The CariSal Facility EHSM Plan, worker health and safety plan, emergency response plan, and other plans would be applied to the decommissioning phase of the Project as they would be applied to the construction and operations phases of the Project.

5.1.4 Social Impacts

Social impact assessment (SIA) has been defined as

"[T]he process of analysing (predicting, evaluating and reflecting) and managing the intended and unintended consequences on the human environment of planned interventions (policies, programs, plans and projects) and any social change processes invoked by those interventions so as to bring about a more sustainable and equitable biophysical and human environment (Vanclay 2002, U.S. DOC et al 1994)."

Impact assessment, therefore, promotes community development and empowerment, builds capacity, and develops social capital (social networks and trust) (IAIA 2003). It also necessarily pays particular attention to the *differential distribution of impacts among different groups in a society* and the *impact burden experienced by vulnerable groups* in communities (IAIA 2003).

This section presents an assessment of the social, cultural, and socioeconomic effects linked to the biophysical changes caused by the Project and suggests necessary mitigation and management plans for addressing potential Project impacts. The analysis examines a reasonably foreseeable range of intended and unintended consequences of the Project using the impact rating criteria articulated at the beginning of this chapter.

5.1.4.1 Methodology

Social impacts were assessed by examining a standard set of SIA criteria tailored to the local situation in Trinidad and Tobago and those relevant to the CariSal Project. Census 2000 and 2006 Enumeration District data available from the Trinidad and Tobago Central Statistical Office (CSO) were analysed for this assessment. Social scoping and community assets and needs mapping were also completed through focus groups, stakeholder interviews, and feedback at public meetings. These activities generated qualitative information used for assessing the social impacts of the Project. The Study Area for SIA purposes was the Point Lisas area and nearby communities as defined in Section 4.5.

The SIA was also tailored specifically to the scope of the proposed CariSal development and the TOR for this EIA. For this assessment, social impacts were conceptualised as changes to one or more of the attributes presented in Table 5.1-1.

Table 5.1-1. Attributes Examined in the Social Impact Assessment for the CariSal Project

Attribute	Definition
People's way of life	How they live, work, play, and interact with one another on a day-to-day basis
Culture	Their shared beliefs, customs, values, and language or dialect
Community	Its cohesion, stability, character, services, and facilities
Political systems	The extent to which people are able to participate in decisions that affect their lives, the level of democratisation that is taking place and the resources provided for this purpose
Biophysical environment / food security / sense of safety and security	The quality of the air and water people use; the availability and quality of the food they eat; the level of hazard or risk, dust, and noise they are exposed to; the adequacy of sanitation, their physical safety; and their access to and control over resources
Health and well-being	Health is defined as a state of complete physical, mental, social and spiritual well-being and not merely the absence of disease or infirmity
Personal and property rights	Whether people are economically affected or experience personal disadvantage, which may include a violation of their civil liberties
Fears and aspirations	Perceptions about their safety, their fears about the future of their community, and their aspirations for their future and the future of their children

5.1.4.1.1 Social Impact Assessment Criteria

The criteria for determining the significance of impacts in the SIA for the CariSal Project are defined in Table 5.1.-2. Four impact ratings were assigned: negligible, minor, moderate, and major/adverse.

5.1.4.1.2 Baseline Conditions - A Qualitative Summary

Residents, workers, and other community members self-described the way of life, culture, and communities in the Study Area as largely shaped by agriculture, sport, religion, the local labour movement, and the transition from agricultural land uses and an agrarian way of life to industrial growth and development.

Table 5.1-2. SIA-Specific Criteria for Determining the Significance of Impacts[a]

Impact Rating	Definition
Negligible	Of short duration and affecting a small group of persons, or that occurs in a localized area, similar to small random changes due to extraneous irregularities. No measurable effect on the population of the whole.
Minor	Short-term or affecting a specific group of persons in a small area, but not affecting the integrity of the entire group.
Moderate	Of medium-term duration, namely one or two generations, or that affects a moderate portion of the population without affecting the integrity of the entire population.
Major/Adverse	Lasting several generations, or affecting a population with sufficient intensity to cause a change in economic, physical, cultural, psychological, or sociological well-being in long-established activity patterns that would not return to pre-Project levels or patterns within several generations.

[a]The definitions of the *no impact, unknown,* and *beneficial* ratings are the same as those provided in Section 5.0.

Overall, the Study Area population grew between 2000 and 2006. This growth was uneven however, given that Diamond Village experienced a decline while Dow and Phoenix Park grew rapidly. The age-structure data for the Study Area in 2006 suggests a decline in the population of persons under 24 years, from roughly 44 percent in 2000 to 38 percent in 2006. This decline is almost certainly due to out-migration of young people seeking better life opportunities as reported in the focus groups.

Tertiary educational opportunities are improving in the area with the expansion of the University of Trinidad and Tobago system. However, overall education levels remain low with the most completing elementary school. Employment is also centred in lower paying occupations and thus, overall income levels remain low relative to that of the nation. Also, of note is that most employment (67 percent) is in private enterprise.

The growing disparity – among low educational attainment, resulting high levels of unskilled or semi-skilled labour, and planned growth in industrial jobs that require a range of skilled, technical labour – is becoming more pronounced. This disparity is particularly evident for those workers who are attempting to switch from agricultural jobs to those created by new types of industry. The review of secondary population data and focus group discussion results indicate a need for improvements in job-training for adults who previously worked in agriculture to prepare them to work in the new industrial economy or in new agribusiness jobs that can make use of

their current skills. The results also emphasize the need to increase the proportions of the population who are able to successfully complete secondary education in preparation for college or for entry-level technical/industrial posts.

The healthcare services available in the immediate Study Area are minimal, and would require significant upgrades to accommodate the degree and density of existing and proposed industrial development and the potential associated safety risks they pose to nearby communities and residents. Similar conclusions can de drawn for key infrastructure such as road networks and traffic safety infrastructure such as traffic lights and stop signs, as well as sewer and drainage networks to avoid flash floods.

Land in the area remained under sugar cane cultivation for several years under Caroni (1975) Limited, which employed – and provided important community services for – many residents. The closure of Caroni in 2003 and the ongoing transition of its labour force and lands were reported as major features of community life by focus group respondents and participants at the public meetings. Some raised concerns about land tenure issues associated with the separation packages offered to former Caroni workers during the closure process as they await opportunities to lease 2-acre parcels of the remaining Caroni lands for agricultural cultivation. In the context of the NEC's plans to develop the proposed PLSEIE on some of these lands, community residents and other stakeholders have raised salient questions about land use, zoning, and land redistribution, and especially the execution of leases promised to former Caroni workers.

Focus groups and other participants indicated that Caroni's closure has not only triggered land tenure issues, but has led to a broader unravelling of the social fabric of their communities by changing the underlying social structure – both formal and informal – including reduced access to resources for the support of community and cultural activities; changes in the structure of social arrangements and networks; out-migration of youth; loss of employment for an aging population of workers whose primary work experience is based on agriculture (and specifically, sugar cane cultivation); reduced access to resources that support or maintain physical community infrastructure (such as the maintenance of community playgrounds or points of cultural importance); and a loss of physical, economic, and psychosocial security.

Apart from the issues associated with the Caroni transition, however, the members of these communities self-described their rich and diverse cultural heritage as an important community asset, including their longstanding practice of religious traditions.

> *… a village in Trinidad on the edge of the Caroni plain, the wide central plain … to which indentured cane cutters were brought after emancipation…..this Saturday afternoon Ramleela, the epic dramatization of the Hindu epic the Ramayana, was going to be performed, and the costumed actors from the village were assembling on a field strung with different-coloured flags, like a new gas station, and beautiful Indian boys in red and black were aiming arrows haphazardly into the afternoon light. Low blue mountains on the horizon, bright grass, clouds that would gather colour before the light went….*

> *The performance was like a dialect, a branch of its original language, an abridgement of it, but not a distortion or even a reduction of its epic scale. Here in Trinidad I had discovered that one of the greatest epics of the world was seasonally performed, not with that desperate resignation of preserving a culture, but with an openness of belief that was as steady as the wind bending the cane lances of the Caroni plain.*
>
> From: ***The Antilles: Fragments of Epic Memory.*** Derek Walcott Nobel Prize Acceptance Speech, December 7, 1992.

Derek Walcott was writing about the village of Felicity, but it could easily have been about Dow Village where the Ramleela ceremony has been celebrated for the past 127 years. In their identification of other community assets, focus group participants noted that the Caldrac Club has existed for 61 years and is a centre for social activities for a diverse collection of residents and community participants.

There are temples, churches, mosques and masjids, tassa bands, and steel pan orchestras in the Study Area. Many cultural organizations exist. It is home to schools run by the State, the Presbyterians, and the Muslims. All are testimony to a region steeped in rich tradition in this relatively small but diverse geographical area.

Football and cricket are popular sporting activities that link industrial firms to host communities, youth to adults, non-resident workers to residents, and also provide recreation and after-school diversion. Table-tennis, chess, All-Fours, draughts, and martial arts are some of the other recreational pursuits described by community members. Hilton Phillips Drive was named after one of Trinidad and Tobago's most successful and best-known cyclists – a local hero.

Of equal importance perhaps are the tensions that stem from the historical social inequities and present-day contrasts among the various groups and villages that comprise the Study Area, as evidenced by a comparison of, for instance, Dow and Savonetta Villages. The former was highly dependent on the recently demised sugar cane estates and largely lacks the financial resources or educational certification necessary to fully exploit available socioeconomic opportunity in the growing industrial economy; the latter consists of relatively more affluent heirs to the prosperity of the past and current industrial booms.

Members of all these communities, nevertheless, uniformly and repeatedly pointed to the need for improved access to basic infrastructure such as the maintenance of public and estate roads, access to electricity and potable water, a sound sewer system, the need for adequate hospital facilities with a well-equipped burn unit in the Couva/Point Lisas area, the need for training and meaningful living-wage employment in the new industries, a stake in the jobs and prosperity that the proposed new industrial estate would engender, and a need for safety and security with regard to both crime and industrial accidents or routine industrial releases that may threaten community health.

There appears to be a broad consensus among a cross-section of community residents, workers, business owners, industrial neighbours, and others stakeholders about what is needed to improve community conditions. However, there seems to be no clear and readily accessible mechanisms

and processes, including clearly defined authorities, modes of communication, and resources for coordinating and delivering the desired (and much needed) changes/improvements.

5.1.4.1.3 Project-specific Social Impacts

The baseline conditions summarized in Chapter 4 (section 4.5.2 through 4.5.9) and section 5.1.4.1.2 provide the social milieu in which the Project would be embedded. The social impacts of the Project for the purposes of the EIA, however, must be understood in the context of the likelihood that the Project would change the existing or baseline social conditions present in the Study Area. The assessment focuses on social impacts that result from the Project's changes to the biophysical environment and opportunity structures. Many of the most important aspects of social impacts involve not only the biophysical changes that affect human health, safety, and environment but the meanings, perceptions, or social significance of these changes as understood by members of the potentially impacted communities (Vanclay 2004). Consequently, the baseline conditions as self-described by community members – the closure of Caroni (1975) Limited and the perceptions and fears about land tenure and livelihoods, loss of physical, economic, and psychosocial security, concerns about personal safety with regard to industrial pollution or emergencies – must also form the context in which Project social impacts are to be interpreted. Even negligible Project specific impacts can be magnified by these underlying social conditions if both (a) resource specific Project mitigations, and/or (b) social mitigations (including on-going, meaningful public engagement between communities and the Project's management/staff) are not carried out effectively, and would be, in that scenario, potentially detrimental to both the Project and communities alike.

The Project is not expected to produce significant negative or adverse social, cultural, or socioeconomic impacts to its fence-line neighbours or the broader Point Lisas study area communities. No adverse impacts to archaeological resources are expected. Resource users of the Project site, that is, the plant site and its ex situ facilities would not be adversely impacted during initial start up, construction, the various stages of operation, and decommissioning.

The identified activities that are likely to result in negligible to minor impacts during construction and operations include increased dust levels (especially during construction); potential health and safety risks to village residents; increased levels of environmental releases including air, noise and solid wastes; and, in the event of emergency scenarios, the potential for hazardous waste releases, accidental releases of hazardous substances, and fire and explosion risk to workers' and community safety with the resulting increase in demand for limited medical and fire services. Overall, the social impacts of the Project are expected to be minor to beneficial during the construction phase. Social impacts are expected to be beneficial during the operations phase, if mitigation measures described for both biophysical and social resources are effectively and consistently implemented. Decommissioning impacts are expected to range from moderately adverse to beneficial depending upon the specific social, socioeconomic, and ecological/environmental health conditions that inhere at the time of plant closure or transition. See section 5.1.4.5 for a more detailed discussion of decommissioning phase impacts. See also Table 5.10-1 below.

5.1.4.1 Local Employment and Training

The Project would provide a moderate socioeconomic benefit to the Project-affected community and to the broader regional communities by providing roughly 200 construction jobs and about 75 permanent positions during operation stages, in addition to the multiplier effects of these jobs and the overall Project operation.[1] Labour encampments or re-settlement of residents or business concerns would be unnecessary.

5.1.4.1 Construction

Contractors as well as employees would be required to undergo training to obtain necessary certification regarding safety performance standards. CariSal would require its subcontractors to provide their workers with safety training prior to commencing any site work and would also provide training to its staff members, contractors, and visitors to the site as part of its EHS programme. Such requirements, when institutionalised through contractual arrangements, become inducements for greater levels of education and training among local labour suppliers and workers. The Project would employ and train approximately 200 workers, with first preference given to locals, during the course of its construction phase. The Project is expected to have beneficial social effects on local employment and training during construction by providing a source of income, on-the-job training with relevance to other industries, and the potential for improved sources of livelihood.

5.1.4.1.2 Operations

About 75 permanent jobs would be created by the CariSal Project (40 technical and 35 administrative). Preference in hiring also would be given to potentially qualified or qualifiable employees from the Study Area. Critical process systems, emergency trip systems, chlorine area monitoring, strategic control valve failure positions, and emergency power systems have been incorporated into the CariSal facility design to make the process inherently safe. A thorough process-training programme (with qualifications testing) would ensure that operators are knowledgeable in how to use this process information to avoid unsafe operating conditions. Such training would introduce local workers to a set of highly specialized skills in a work environment that constitutes a state-of-the art industrial (chlor-alkali) facility.

CariSal has also planned a Lunch and Learn programme for implementation in Study Area schools and has obtained the approval of the Ministry of Education. The Lunch and Learn programme would introduce children to careers in the chlor-alkali and related industries; it would augment the science education curriculum by creating new applications of science and technology aimed at environmental monitoring, protection, and remediation through clean production and building design. Schools that participate in the programme also would likely receive resource support from CariSal. By targeting its training programmes to both community school children and adult workers, the Project may modestly improve the capacity of the current

[1] A numeric calculation of the multiplier effects is noted here because the information required for calculating a reasonable, simple output multiplier for the region was not readily available and the quantification task for the multiplier is outside the scope of the EIA as defined by the Project TOR. The analysis assumes that the multiplier is nevertheless greater than 1 because the Project is expected to increase aggregate demand for goods and services in the study area and regionally.

and future local labour force. The employment and training-related social impacts of the Project are predicted to be permanent and beneficial.

5.1.4.2 Infrastructure, Services and Utilities, Social Services, Resource Usage, and Impacts on Overall Availability to Other Users

5.1.4.2.1 Construction

CariSal's construction activities would increase road traffic by roughly 40 vehicles per day and could add to congestion on the section of Southern Main Road near the plant site. Traffic along the Southern Main Road and Pacific Avenue also may be disrupted during the construction of the pipeline ROW and the delivery of large pieces of plant equipment and construction machinery. As noted in Section 7.7.1, no significant, adverse impacts to water availability and demand during the Project's construction phase are projected, and coincident social impacts also are expected to be negligible. CariSal has received Outline permission from WASA for its water requirements during all Project phases and is in the process of completing agreements with T&TEC for electric power supply. There is potential for a negligible and temporary increase in demand for social (medical) services in the event of accidents on the construction site. Proper implementation of the mitigations described in Section 7.2.1.2 would help minimize public and on-site physical hazards.

Goodrich Bay fisher-folk would experience a temporary disruption of fishing and disturbance due to temporary construction activity, noise, and the discharge of hydrostatic testing water during the construction phase. Livestock farmers in the nearby area who currently use the CariSal plant site for grazing their animals would be displaced.

Social impacts (changes in worker or community way of life, biophysical environment, safety, health and well being) associated with the Project's demands on infrastructure, utilities, social services and resources available to others are expected to be negligible and temporary during construction.

5.1.4.2.2 Operations

During Stages 1 through 3, the principal process, utility, and potable water will be supplied by WASA through its water main near the CariSal site. In Stage 3, the brine stream from DESALCOTT would come online, and in Stage 4, the brine stream from DESALCOTT would become the major source of process and utility water through the recycling of water removed during brine concentration. Excess distilled water produced during the Stage 4 process would be tested and returned to WASA for its use.

Electricity would be provided by a connection to the T&TEC grid. CariSal's electricity consumption would be augmented by a gas-fired cogeneration plant in Stage 4 (see Section 3.8).

Natural gas for the steam boiler would be supplied through a pipeline spur from NGC. During several stakeholder meetings with CariSal during 2007, both T&TEC and NGC confirmed the availability of electricity and natural gas supplies for the Project and supplier agreements are currently being finalized. No resource availability shortages are anticipated. CariSal has also elected to use equipment with high-energy efficiency ratings in its facility design. Road

infrastructure is expected to be improved by NEC, thus expanding the capacity of existing road networks. Social impacts to utility services, infrastructure, and resource availability due to Project operations are expected to range between negligible and beneficial.

5.1.4.3 Nearby Industries and Sustainable Economic Activity

5.1.4.3.1 Construction

Social impacts associated with nearby industries during construction include disruptions in traffic patterns for roughly 8 to 12 months resulting from an increase in the number of people working at the proposed plant site and along the pipeline ROW and the number of vehicles accessing the site via the Southern Main Road and Pacific Avenue. Increased dust and noise levels also would impact the working conditions for employees at industries neighbouring the CariSal Project site. During the industry focus group, workers at industrial facilities near the Project site expressed concerns about the increased traffic congestion and dust and increased potential for flooding associated with the construction of the CariSal facility and the new PLSEIE. Mitigations described in Sections 7.2.1.1, 7.10, and 7.12, properly implemented, would minimize the CariSal-induced effects of such impacts. These changes in work life are expected to be temporary and thus, negligible. The Project would create short-term demand for construction materials, workers, suppliers of other related services (such as portable latrines, trucking, and food concessions) from primarily local providers of such goods and services. The socioeconomic effects of the Project in the construction phase would be temporary and beneficial to nearby and regional industries and businesses.

5.1.4.3.2 Operations

CariSal would develop long-term contracts with nearby industries such as EISL for export of its caustic soda product, DESALCOTT for the supply of waste brine, Yara for access to its pier in Goodrich Bay, and other neighbouring firms that may be suppliers of inputs needed for its operations or that may be potential consumers of its by-products. By-products would include CO_2, CaCl to be used for dust control, and limestone inerts that could be used for road fill (once tested to confirm the absence of toxic impurities). CariSal's production of caustic soda would create a local supplier for this product, leading to opportunities for import substitution of a key input for nearby industries in Point Lisas and the oil and gas industry throughout South Trinidad. The Project's production of sodium hypochlorite also presents WASA with an opportunity to improve the safety of its water purification operations by replacing stored chlorine with liquid bleach. In Stage 4, the Project would produce distilled water - as a by-product of purifying waste brine from DESALCOTT - that would be returned to WASA. The development of a Leadership in Energy and Environmental Design (LEED)-certified administration building (Sections 3.3.2 and 7.1.1.5) and the clean production (zero liquid discharge) design of the plant would be among the earliest demonstrable examples of how such innovations can be implemented in Trinidad and Tobago. Together, these and other initiatives described in the Project Description (Chapter 3) and the mitigations plans described in Chapter 7 (water quality monitoring, water recycling, and the Wetland Reserve) foster sustainable economic activity that is potentially of great benefit to neighbouring industry, the region, and the nation. These beneficial Project effects would last for the duration of the Project and are considered permanent.

5.1.4.3.3 Decommissioning

Social impacts associated with decommissioning of the facility are difficult to predict with great certainty given that the event involves action in the distant future (20+ years from plant start up) and knowing what the particular circumstances surrounding the event might entail is virtually impossible. In the broadest sense, however, anticipated social impacts would be associated with the loss of employment (direct and indirect) at the plant, and the creation of temporary (approximately 10 – 12 months) employment opportunities associated with facility closure and site clean up and restoration or facility re-use. Depending on the circumstances at that time, decommissioning may also create moderate adverse social effects in a scenario where Trinidad and Tobago or the region is experiencing broader economic decline. In an alternative scenario, Project decommissioning could present an opportunity to restore the site to agricultural use. Absent detailed knowledge and understanding of future conditions, however, assessing whether such opportunities would be beneficial with a high degree of confidence is difficult.

What is knowable from the extant theoretical literature and case studies, in the areas of environmental and social impact assessment and public involvement, is that public involvement is crucial to a successful plant decommissioning process. Use of extensive, well-crafted (with communities and experts) and executed participation strategies before and during the final adoption stages is more likely to lead to publicly acceptable decommissioning plans. The social impacts of decommissioning – as measured by community acceptability – are even more beneficial in cases where the Project proponents have actively, over the life cycle of the Project, built effective relationships where the affected communities accept the given technology and risks associated with the Project and would be negatively impacted by closure. Effective public participation and engagement were also found to be facilitated by transparency in the decision-making process, thereby fostering communities' confidence in the process itself. Timely (as early as possible) provision of sufficient information to community groups and stakeholders was also found to facilitate on-going public participation by creating opportunities for better understanding of complex issues, minimising mistrust and facilitating productive dialogue, mutual learning (by Project managers/workers and community members) and creative problem solving. These findings are consistent with best practice in the respective fields.[2]

Potential social impacts resulting from decommissioning may range from moderate adverse to beneficial. Mitigation measures for social impacts are informed by these best practices and are described in Section 7.4.

Table 5.1-3 presents an overview of the CariSal Project's social impact assessment results.

Table 5.1-3. Results of Social Impact Assessment – CariSal Project

Criterion	Definition	Project Impact
Way of Life, Culture, Community, and Political Structure	How community members live, work, play and interact with one another on a day-to-day basis	Beneficial (jobs, training, etc.)
Culture	Shared beliefs, customs, values and language or dialect	No impact to Beneficial (experience with *green* companies, sound public participation practice and community partnerships)
Community	1. Cohesion 2. Stability 3. Character 4. Services and facilities	No impact No impact Minor (visual/aesthetic) Negligible to Minor (traffic, noise, dust and air emissions during construction)
Political systems	1. Extent to which people are able to participate in decisions that affect their lives, 2. Level of democratisation that is taking place and the resources provided for this purpose	No impact to Beneficial (sound public participation practice) No impact to Beneficial (indirect effect of community capacity building via sound public engagement practice)
Biophysical environment / food security / sense of safety & security	1. Quality of the a) air b) water people use 2. Availability and quality of the food 3. Level of hazard or risk 4. Dust and noise exposure 5. Adequacy of sanitation 6. Physical safety 7. Access to and control over resources	Negligible to Minor (during construction) Negligible (operations) Negligible (construction) to Beneficial (operations – Stage 4) No impact Negligible/Minor Minor No impact Negligible/Minor No impact/Negligible
Health and well-being	Health - defined as a state of complete physical, mental, social, and spiritual well-being and not merely the absence of disease or infirmity	Negligible (air quality, noise and traffic during construction, safety during operation) to Beneficial (training, jobs, community capacity building)
Personal and property rights	Whether people are economically affected or experience personal disadvantage which may include a violation of their civil liberties	No impact to Beneficial
Fears and aspirations	1. Perceptions about their safety, 2. Fears about the future of their community 3. Aspirations for their future and the future of their children	Minor (associated with baseline conditions and potential for emergencies, given baseline, e.g., lack of Hospital with Burn Unit) Minor (associated with baseline conditions) Beneficial (training and education, Community Management Plan activities)

5.1.5 Potential for Increased Dangers

The potential for increased dangers to the offsite population from operation of the CariSal facility is associated with the potential for accidental releases of hazardous materials, including chlorine, hydrochloric acid, and sodium hypochlorite from onsite process equipment and offsite

transportation equipment, and with the potential for accidental releases of natural gas resulting in fire or explosion. Accidental release modelling was conducted for the risk assessment for onsite and offsite accidental release scenarios for hazardous materials and natural gas. The risk associated with each scenario was assessed based on the severity (consequences) of a release and the probability (frequency) of a release. Quantitative consequence modelling was conducted for the scenarios listed in Table 5.1-4.

Table 5.1-4. Accident Scenarios for which Quantitative Modelling was Conducted

No.	Scenario	Type	Event Frequency
1.	*Onsite hazardous material (gaseous) release*		
1.a.1	Chlorine [indoor] process pipe breach	Cl_2 release	$1x10^{-6}$
1.a.2	Chlorine [outdoor] process pipe breach	Cl_2 release	$1x10^{-6}$
1.a.3	Chlorine [outdoor] process pipe breach [seismic event]	Cl_2 release	$1x10^{-6}$
1.b	Intermixing of hypochlorite with HCl	Cl_2 release	$1x10^{-7}$
2.	*Onsite hazardous material (liquid) release*		
2.b	Vessel Failure: Onsite HCl storage tank	HCl spill	$1x10^{-6}$
2.c	Vessel Failure: Onsite hypochlorite storage tank	bleach spill	$1x10^{-6}$
3.	*Flammable gas release (dispersion)*		
3.a.1	Hydrogen [indoor] process pipe breach	H_2 release	$1x10^{-6}$
3.a.2	Hydrogen [outdoor] process pipe breach	H_2 release	$1x10^{-6}$
3.a.3	Hydrogen [outdoor] process pipe breach [seismic event]	H_2 release	$1x10^{-6}$
3.b.	Hydrogen vent stack release/HCl scrubber stack release	H_2 release	$1x10^{-6}$
4.	*Flammable gas release (deflagration)*		
4.a	Onsite natural gas deflagration	CH_4 release	$1x10^{-6}$
4.b	Offsite natural gas deflagration	CH_4 release	$1x10^{-6}$
6.	*Offsite transportation hazardous material release*		
6.a	Hydrochloric acid: 4,000-gallon tank truck accident	HCl spill	$3x10^{-7}$
6.b	Hypochlorite: 4,000-gallon tank truck accident	bleach spill	$3x10^{-7}$

Source: CariSal Limited 2007. [HAZID].

Event frequencies (probabilities) for each event in Table 5.1-4 are taken from the Process Hazard and Environmental Risks (HAZID) document. The scenarios in Table 5.1-4 are quantitatively modelled in the risk assessment to assess the potential for impacts to the offsite population. The potential dangers section highlights potential dangers to the offsite population. Worker (occupational) impacts are described in Section 5.1.3.

Modelling of onsite flammable gas releases of hydrogen and natural gas did not indicate a potential for danger to the offsite population. Modelling of offsite flammable gas releases of natural gas from the tie-in with the natural gas utility pipeline indicated a potential for explosion (Release Scenario 4.b). The modelled radius of effect of a natural gas explosion resulting from a natural gas leak from the tie-in and subsequent ignition is approximately 300 metres from the point of ignition; at 300 metres from the point of ignition buildings could be destroyed. At 311 metres from the point of ignition there is the potential for serious injury to persons. These distances of impact extend beyond the CariSal site boundary. Impacts from Release Scenario 4.b

are depicted in Figure 5.2-14a in the Quantitative Risk Assessment for this environmental impact assessment (EIA) (see Appendix C).

Modelling of onsite accidental releases of chlorine from process equipment indicated the potential for exceedance of the immediately dangerous to life and health (IDLH) concentration for chlorine of 10 parts per million (ppm) at offsite locations. Modelling indicates that, for an outdoor release of chlorine gas from onsite process equipment (Release Scenario 1.a.2), the IDLH concentration would be exceeded at 1,500 metres (1.5 kilometres) from the point of release on the CariSal plant site. Such a release could affect the offsite residential population and offsite industrial plant workers, depending on wind direction at the time of a release. For the prevailing wind direction from the east (wind direction 90 degrees), approximately 165 persons reside within the area of impact. Modelling indicates that, for an outdoor release of chlorine gas from onsite process equipment affected by a seismic event (Release Scenario 1.a.3, which is assumed to affect both process lines), the IDLH concentration for chlorine would be exceeded at 1,800 meters (1.8 kilometres) from the point of release on the CariSal site. Impacts from Release Scenario 6.a are depicted in Figure 5.2-15a in the Quantitative Risk Assessment (see Appendix C).

Modelling of accidental releases of hydrochloric acid from onsite storage tanks indicated the potential for exceedance of the IDLH concentration for hydrogen chloride gas of 50 ppm at offsite locations. A spill of hydrochloric acid into the storage tank secondary containment system could release hydrogen chloride gas to the atmosphere. Modelling indicates that for a spill of the entire contents of the 400,000-gallon (gal) (1,514 m^3) hydrochloric acid storage tank capacity (Release Scenario 2.b), the IDLH concentration for hydrogen chloride gas would be exceeded at 2,500 metres (2.5 km) from the point of release on the CariSal plant site. Such a release could affect the offsite residential population and offsite industrial plant workers depending on the wind direction at the time of a release. For the prevailing wind direction from the east (wind direction 90 degrees) approximately 157 persons reside within the area of impact. Impacts from Release Scenario 2.b are depicted in Figure 5.2-12a in the Quantitative Risk Assessment (see Appendix C).

Modelling of accidental releases of liquid bleach from onsite storage tanks indicated the potential for exceedance of the IDLH concentration for hydrogen chloride gas of 50 ppm at offsite locations. Vapour pressure data for sodium hypochlorite solutions were obtained from page 6 of the Sodium Hypochlorite Manual (Chlorine Institute Pamphlet 96, Edition 3) for use in modelling accidental releases. Liquid spills of bleach into the storage tank secondary containment system or onto pavement could release chlorine monoxide gas to the atmosphere under certain conditions, including the presence of metals that could catalyze a chemical decomposition reaction. Metal catalysts are not likely to be present to interact with or decompose the bleach, and therefore generation of chlorine monoxide during a spill event is very unlikely to occur. The accidental release scenarios for liquid bleach spills are based on chlorine monoxide release in order to provide a conservative assessment.

The IDLH for hydrogen chloride gas is used as a surrogate for chlorine monoxide gas, for which there is no established IDLH concentration. Modelling indicates that for a spill of the entire bleach storage tank capacity into the secondary containment system (Release Scenario 2.c), the

IDLH concentration for hydrogen chloride gas would be exceeded at 720 metres from the point of release on the CariSal plant site. Such a release could affect the offsite residential population and offsite industrial plant workers depending on the wind direction at the time of a release. For the prevailing wind direction from the east (wind direction 90 degrees) approximately 18 persons reside within the area of impact. Impacts from Release Scenario 2.c are depicted in Figure 5.2-13a in the Quantitative Risk Assessment.

Hydrochloric acid solution would be transported from the CariSal site to local customers and exported in totes, drums, or isotainers. The transportation route is shown in Figure 5.1-1 (see also Chapter 10). Liquid spills of hydrochloric acid could release hydrogen chloride gas to the atmosphere. Modelling of offsite releases of liquid hydrochloric acid from transportation accidents indicates that the IDLH concentration for hydrogen chloride gas of 50 ppm would be exceeded at 3,300 metres (3.3 km) from the point of release. An offsite transportation accident could occur at any point along the transportation route from the CariSal plant to the Desalination Company of Trinidad and Tobago Limited (DESALCOTT) plant. Assuming that a transportation accident takes place in the vicinity of the DESALCOTT plant and 100 percent of the hydrochloric acid in the 4,000-gallon (1,51.4-m^3) capacity truck is released (Release Scenario 6.a), 145 persons would be located within the area of impact to the west of the point of release, including residents and industrial workers. Impacts from Release Scenario 6.a are depicted in Figure 5.2-15a in the Quantitative Risk Assessment.

Sodium hypochlorite (bleach) solution would be transported from the CariSal site to Savonetta Pier #4 in tank trucks. Liquid spills of bleach could release chlorine monoxide gas to the atmosphere if a spill occurs. The IDLH for hydrogen chloride gas is used as a surrogate for chlorine monoxide gas, for which there is no established IDLH concentration. Modelling of offsite releases from liquid bleach from transportation accidents indicates that the IDLH concentration for hydrogen chloride gas of 50 ppm would be exceeded at 1,500 metres (1.5 km) from the point of release. An offsite transportation accident could occur at any point along the transportation route from the CariSal plant to Savonetta Pier #4. Assuming that a transportation accident takes place in the vicinity of the Universal Foods facility and 100 percent of the liquid bleach in the tank truck is released (Release Scenario 6.b), 115 persons would be located within the area of impact to the west of the point of release, including residents and industrial workers. Impacts from Release Scenario 6.b are depicted in Figure 5.2-17a in the Quantitative Risk Assessment. The point was selected because it is adjacent to several industrial facilities and close to a population centre.

5.1.6 Impact on Traffic and Travel Times

This section evaluates the traffic impacts of the proposed construction and operation of the CariSal chlor-alkali plant. The impact of decommissioning the facility would be smaller than operating the facility, and therefore these traffic impacts are not considered separately. This analysis examines the impact of forecast traffic generated by the proposed action. The primary impact considered in this section is the effect of vehicle trips generated by the construction and operation of the facility on the level of service provided by surrounding roadways.

Figure 5.1-1. Transportation Route

5.1.6.1 Methodology

The roadways most affected by the construction and operation of the plant are Southern Main Road and Pacific Avenue. Employees, construction workers, and freight trucks entering the site would use these roads for access. Traffic volume impacts would likely be the greatest on roadway segments that provide direct access to the site.

Our analysis is also focused on peak-hour traffic impacts. Measuring the effect of traffic impacts that occur during the peak hours of the day provides an upper bound on the likely impacts that would be experienced by roadway users.

5.1.6.2 Current Volumes

Traffic counts were conducted from August 12 through August 17 on Southern Main Road at Point Lisas. Traffic volumes were also measured on Pacific Avenue at Point Lisas for these days. Additional traffic counts were conducted on Southern Main Road between September 15 and September 22. The traffic counts provide 15-minute volumes, by vehicle class and roadway direction.

Peak northbound Pacific Avenue volumes occurred between 6:30 a.m. and 7:30 a.m. during weekdays. Peak hourly volumes for southbound traffic occurred between 3:30 p.m. and 4:30 p.m. for weekday traffic.

The highest hourly volumes occurred on Southern Main Road between 6:30 a.m. and 7:30 a.m. for northbound traffic. Peak volumes for southbound traffic were less uniform, occurring in the morning between 6:45 and 8:15 and in the afternoon between 3:45 and 4:45. Table 5.1-5 shows the peak daily and hourly traffic volumes for Pacific Avenue and Southern Main Road.

Table 5.1-5. Peak Daily and Hourly Traffic Volume by Roadway and Direction

	Peak Daily Traffic	Peak Hourly Traffic	Typical Peak Hour
Pacific Avenue – Northbound	2,562	534	6:30 a.m. – 7:30 a.m.
Pacific Avenue – Southbound	2,654	426	3:30 p.m. – 4:30 p.m.
Southern Main Road – Northbound	7,245	793	6:15 a.m. – 7:15 a.m.
Southern Main Road – Southbound	7,447	664	Varies

5.1.6.3 Forecast Traffic

Table 5.1-6 below shows forecast traffic impacts for construction and operations of the facility. CariSal Unlimited anticipates that construction activities would generate no more than five trips per hour for the delivery of materials (DaCosta Gwendoline, Ltd. & MHA Inc. 2007). As many as 200 construction workers would commute to the site during the Project's peak months of construction. The facility operation would require approximately 75 employees. Our analysis assumes that most of these employees would drive to the site in personal vehicles, generating

two trips per day per employee. In addition, 200 on-road truck trips per day would be generated by the plant, of which no more than 9 would occur during the peak hour.

Table 5.1-6. Forecast Traffic Impacts from Construction and Operations

Trip Type	Total Trips	Peak Hour Trips
Construction		
Materials	NA	5
Workers	200	200
Total	NA	205
Operations		
Materials	200	9
Workers	150	75
Total	350	84

Traffic impacts from construction would increase current traffic volumes during the peak hour between 13 percent and 24 percent. These increases would be temporary and would dissipate as facility construction is completed in the latter half of 2009. This increase would create a minor negative traffic impact. The change would be temporary and major street traffic flow would maintain an intersection level of service of B or better, which is considered free flowing.

Traffic from operations would have a smaller, but lasting impact on roadway congestion. Workers commuting to and from the site would add 150 trips. Including the freight movements generated by the facility, a total of 84 vehicle trips would occur during the peak hour of traffic.

5.1.6.4 Assessment of Significance

To assess the significance of traffic impacts, baseline traffic forecasts for the no-action alternative are compared to forecasts that include traffic from the facility. Baseline traffic forecasts include additional traffic generated by the operation of other new facilities (the Essar Integrated Steel Plant and Westlake Ethylene and Polyethylene Complex) that are being constructed or planned nearby and will be operational by 2012. The significance of the impact can be determined by the extent to which the level of service would be changed by the addition of traffic from the CariSal facility. Table 5.1-7 shows forecast baseline no-action alternative traffic volumes and the traffic volume increases that the operation of the CariSal plant would cause.

Our analysis assumes that half of the peak-hour trips generated by the operation of the Westlake and Essar facilities would affect traffic levels in front of the CariSal Plant. This assumption is conservative, as volumes are likely to be lower than this due to alternative routes available to access these facilities.

Traffic from the CariSal plant would increase future traffic volumes between 4.3 and 7.0 percent. Based on modelling conducted with McTrans Software, these increases would not significantly affect the level of service that the Southern Main Road or Pacific Avenue provide. Major street traffic flow would maintain an intersection level of service of B or better, which is considered free flowing. Therefore, traffic would create a minor negative impact.

Table 5.1-7. Incremental Traffic Increase from No-Action Alternative 2012 Baseline

Affected Roadway	Current Peak Hour Traffic Volume	2012 New Facility Operations	2012 Peak Hour Baseline Volume	CariSal Peak Hour Traffic Impacts	CariSal Percent Traffic Increase (%)
Pacific Avenue – N.	534	175	709	42	5.9
Pacific Avenue – S.	426	175	601	42	7.0
Southern Main Road – N.	793	175	968	42	4.3
Southern Main Road – S.	664	175	839	42	5.0

The construction of the Westlake facility would require thousands of workers. If a substantial fraction of these workers use Southern Main Road to access the job site, the current level of service the road provides would be reduced. The incremental impact of the CariSal facility would be even smaller relative to these impacts, and would not likely further and measurably lower the level of service the road provides.

There may also be forthcoming proposals to construct the Point Lisas South/East Industrial Estate and to build a Port at Claxton Bay North. If these facilities are built, they may create additional temporary traffic impacts during the construction phase. As a mitigation measure for these developments, there may be a proposal to widen Southern Main Road, which could have a positive impact on traffic flow in the future. The traffic volumes associated with the operation of these developments are not yet known or quantifiable within a reasonable degree of precision or certainty, since the tenant facilities will need to obtain separate licenses to operate, and they have not yet applied for these licenses.

If the Point Lisas South/East Industrial Estate and the Port at Claxton Bay North are built, they may create additional temporary traffic impacts during construction. As a mitigation measure for these developments, there is a proposal to widen the Southern Main Road, which could have a positive impact on traffic flow in the future. The traffic volumes associated with the operation of these developments are not yet known, since the tenant facilities will need to obtain separate licenses to operate, and they have not yet applied for these licenses.

Several traffic mitigation measures are proposed in section 7 to minimise peak-hour traffic impacts.

5.2 FLORA AND FAUNA

5.2.1 Summary of Impacts

Relatively few significant impacts on flora and fauna are anticipated from the construction, operation, or decommissioning of the CariSal plant. This is primarily because most of the vegetative communities on the proposed plant site and pipeline right-of-ways (ROW) have been highly disturbed or completely converted from the natural state by prior human activity. As described in Section 4.4, the Project site and much of the pipeline ROWs are a former sugar cane field and the vegetative communities in the upland areas comprise early succession plant species

having minimal ecological sensitivity or economic or cultural value. Conversion of the upland parts of the Project site would have minimal impact on flora and fauna.

However, nearly half of the site lies within an annual marsh (wetland) area, and a small perennial wetland area is located near the north-western corner of the property. This perennial wetland area and the surrounding annual wetland area are believed to be important ecologically, inasmuch as they appear to be the sole, small surviving remnant of a once larger freshwater marsh system. The remaining perennial wetland provides several ecological services and benefits. Elimination of this wetland, or compromise of its integrity, would constitute a significant environmental impact of the Project.

No sensitive, endangered, or threatened species were found on the Project site or pipeline ROWs. Seven uncommon species of birds, however, are present. The cascadura (*Hoplosternum littorale*) is present in the perennial wetland area. This fish species is very popular in Trinidad and Tobago and has a special significance in the country's folklore (De Souza 1998). It is therefore culturally and economically important. Elimination or conversion of this wetland area would have negative impacts on most of the uncommon bird species observed on the site and on the cascadura.

5.2.2 Construction

Site preparation would entail clearing most of the existing vegetation in the areas where plant facilities, roads and parking lots, and administrative buildings will be located. Most of the northern half of the site (except for the administrative building area) would remain undeveloped, and present vegetation would remain largely undisturbed. Vegetation would also be cleared along the pipeline ROWs. Parts of the Project site are early successional stage upland and early successional upland (bamboo dominated) vegetative communities (see map in Section 4.4). The upland communities and the pipeline ROW communities are highly disturbed and dominated by common weed species that are not inherently of much economic or ecological value. However, these ecosystems may be important in supporting plants and animals in neighbouring wetland communities by providing food and retaining soil moisture. No endangered flora or fauna species have been identified in these upland communities. The clearing and site preparation in these areas are therefore expected to have minor or negligible impacts on natural habitat.

Roughly half the Project site is either annual or perennial marshland. Annual (or seasonal) marshland extends in a crescent along the western and northern borders of the site (see vegetative community map in Section 4.4). A small area [approximately 2,500 – 3,000 square meters (m^2)] at the northern end of the western boundary is perennial marshland. This freshwater marsh remnant may be the remains of a once more extensive system that occupied an area immediately behind a mangrove wetland. If so, this remnant wetland may have considerable ecological importance, as little habitat of this type remains in the area. Wetlands to the west of the site are principally mangrove or brackish swamp types.

The annual and perennial wetland areas provide many ecological services. The permanent marsh community provides habitat for the economically and culturally important cascadura, which was present during site surveys. The wetland vegetation is also an important food source for wetland birds and may be an important resource for Neotropical migrants. The dominant grasses present

in the annual freshwater marsh are likely to be important food sources for birds and other wildlife. Several species of uncommon birds have been identified in these marsh areas.

The wetland communities provide economic benefits in terms of fodder provision and probably fish extraction. They probably also serve as filters and flood control for runoff along the main ravine cutting across the northern part of the Project site from the east. Draining or filling these wetlands likely would increase flooding risks to receiving environments farther to the west. Filling would also reduce the overall capacity of the associated floodplain and contribute to increased flood risks offsite.

The wetland areas provide important stormwater filtering and flow attenuation services. Eliminating the wetlands would exaggerate the peaks and lows of rainwater flow from the upland areas east of the wetlands to the receiving environments west and north of the site, thereby potentially affecting the flow regimes of receiving streams. In the absence of the wetland areas, peak stormwater flows would likely carry more silt, soluble salts, and nutrients into the receiving environments.

Loss of the wetlands as a result of site preparation would therefore be a significant negative environmental impact of the CariSal Project. CariSal's proposed site development would avoid these areas to the extent possible. CariSal plans to preserve the entire perennial wetland area, and a surrounding buffer of annual wetland and upland area. It is recommended that these areas be preserved in their present state (see Chapter 7 of this EIA).

As noted in Chapter 4, the integrity of the perennial wetland on the Project site appears to rely not only on surrounding features on the Project site, but also on topographical and hydrological features on adjacent properties. In particular, these include areas to the north and east that appear to drain toward and provide essential water to the perennial wetland, and areas to the west and northwest that may be the location of the geological structures that impede water flow and allow it to collect to form the wetland.[3] Hence, the effort to preserve this wetland must include conservation measures on surrounding properties. CariSal should commit to working with landowners of surrounding properties to preserve the integrity of the perennial wetland on the Project site (see Chapter 7 of this EIA).

Soils eroded from the Project site during site preparation could be deposited in the wetland areas and the intermittent stream on the northern edge of the property, and could be carried to the LNG River downstream. Siltation or sedimentation of these wetlands and waterbodies could negatively affect aquatic habitats.

This potential impact can be mitigated by (1) implementing standard erosion control mitigation measures on all areas subject to site preparation activities (as outlined in Section 7.2); and (2) preserving key onsite wetlands and uplands in their current states as described above. These measures include: preserving existing vegetation where possible; using silt screens and barriers, mulching, and quickly revegetating bare soils, especially on slopes; and constructing sediment

[3] Biological Reconnaissance of the CariSal Point Lisas Development, JARIC EHS (see Appendix E), and conversation with Dr. Mike Oatham, Biologist, JARIC EHS, 6/9/08

basins. Any sedimentation impacts to wetland or surface water quality (assuming implementation of mitigation measures) are expected to be localized and short-lived. This impact is therefore deemed to be minor.

The configuration and hydrologic flow of the small intermittent stream (drainage bed) on the northern edge of the Project site may be altered by site preparation for, and construction of, the brine and hypochlorite pipelines between CariSal and DESALCOTT. Changes to stream habitat could result. Due to the small and intermittent nature of this stream, this impact is deemed to be minor.

Flow regimes down-gradient of the Project site would be affected by draining or filling the perennial wetland and by converting the annual wetland areas. The result could be exaggerated peaks and lows in water flow rates, increased flood risk, and degradation of aquatic habitat. These impacts could be mitigated by preserving the perennial wetland in its current state as proposed above.

Wildlife would be largely eliminated from the areas of the Project site where plant facilities, roads and parking lots, and administration buildings would be located (i.e., in the proposed site construction areas). Wildlife diversity would be reduced on pipeline ROWs due to site preparation and construction activities. If the annual and perennial wetland areas of the site are drained or filled, wildlife also would be largely eliminated from these areas. As outlined in Section 4.4, the proposed site construction areas are highly disturbed, and with the exception of seven species, the bird species observed are widespread in suitable habitat in Trinidad and considered common or abundant. Of the seven uncommon bird species observed on the site, most use wetland habitat. Impacts to these species could be mitigated by preserving the perennial wetland area, and a portion of the adjacent annual wetland area and upland area as proposed above. The uncommon bird species using the upland habitat on the site would be negatively affected by the conversion of habitat within the proposed site construction areas to industrial use. This impact is deemed minor to insignificant because (1) although these bird species are locally uncommon, they are not endangered or threatened species, and are not therefore a highly sensitive resource; and (2) the upland habitat on site is not unique. Ample, similar habitat to support these bird species is available nearby. Some upland area on the Project site itself (in the northern part of the site where no construction is planned) would be left in its current state and would continue to provide upland habitat.

Changes in aquatic habitats brought about by siltation and sedimentation and hydrologic flow alteration, and especially by the filling/draining of the perennial and annual marsh areas on the Project site, could result in the loss of aquatic species diversity in the affected aquatic habitats. The perennial wetland near the northwest corner of the site and the connecting waterbodies down-gradient of this wetland are habitat for the cascadura and a number of other fish, amphibian, and reptile species, including the spectacled caiman, which were observed on the site.

Draining or filling of the perennial wetland area and conversion of the annual wetland area would have a significant negative impact on these species. This impact would be largely mitigated by preserving the perennial wetland and creating a buffer of annual wetland area and upland area onsite, as planned by CariSal.

During plant construction, CariSal would drive approximately 1,000 piles, a process requiring up to 6 months. During this period, pile driving would be continuous, with several piles being driven at one time. The associated noise and vibration would likely disturb wildlife and could cause birds and other more mobile species to avoid the area. Noise disturbance could affect normal feeding and reproductive patterns, resulting in reduced population sizes and overall abundance. This impact on wildlife cannot be quantified or assessed in detail. However, given the relatively low baseline species diversity, the absence of highly sensitive faunal species and the presence of few sensitive species, and given that wildlife could be expected to recover from this impact relatively quickly once pile driving is completed, this impact is deemed to be of minor significance.

While site development of the CariSal site alone is expected to have relatively minor impacts on flora and fauna (assuming preservation of the permanent wetland and buffer area on site), the cumulative effects of this development combined with other projects in the area such as the proposed Westlake facility, the proposed Essar facility, and the development of the Point Lisas South and East Industrial Estate, could result in more significant impacts to flora and fauna.

Development of the CariSal site alone would not result in the loss of a significant portion of any unique ecological communities (again assuming preservation of the permanent wetland and buffer on site). However, land clearing, alteration of drainage patterns, and project development over a much larger area in the vicinity of the CariSal site would present the potential for significant habitat loss, and possibly for substantial reduction or elimination of unique ecological communities (the likelihood of substantial reduction in unique ecological communities resulting from the combined development of all of these proposed projects cannot be determined with available data). Alteration of vegetation and drainage patterns on land and water courses adjacent to the CariSal site also could potentially affect water levels and ecological viability of the permanent wetland on the CariSal site.

Identification of all ecological communities within a large area or region, and planning for the preservation of viable samples of each ecological community type, requires a regional planning effort. The combined plans for development over a large area in the vicinity of the CariSal plant indicate the need for regional conservation planning.

Such a planning effort is beyond the capabilities and responsibilities of CariSal alone. However, CariSal can and should:

- bring to the attention of responsible government authorities the need for regional conservation planning
- cooperate with and contribute to such a planning effort.

5.2.3 Operation Impacts

The CariSal plant is projected to release substantial amounts of calcium chloride during calcium chloride packaging. The deposition of these particulates onsite and in the surrounding areas could alter soil and surface water chemistry and affect flora and fauna.

Projections indicate that most calcium chloride dust the plant emits would settle on the Project site, primarily to the west or west-northwest of the emission points. A small portion of the dust emitted would settle beyond plant boundaries, again primarily to the west and west-northwest of the emission points (see Section 5.9 for details). Deposited calcium chloride would be suspended and dissolved by rainwater during rain events and would be transported in runoff. The maximum annual average chloride concentration in runoff would be 50 milligrams per litre (mg/L). The U.S. Environmental Protection Agency (EPA) water quality criterion for the protection of aquatic flora and fauna is 230 mg/L. Runoff from the plant site is therefore not expected to pose a threat to aquatic flora and fauna due to chloride content. This impact could be mitigated by the capture of all runoff generated on the property, and the prevention of unmanaged runoff from the site to the wetland or other down-gradient areas.

The potential for calcium chloride to cause corrosion as a result of dust corrosion on metals was estimated with a conservative theoretical calculation. The calculation:

- assumes a worst-case calcium chloride deposition rate of 4 grams per square metre (gm per m^2) per year at the facility boundary as determined by dispersion modelling (equivalent to 3.0×10^{-3} moles per m^2 per month);
- assumes that calcium chloride is deposited on pure iron (with no protection provided by paint or zinc in galvanized steel, for example);
- assumes that iron undergoes oxidation to ferrous form (divalent) rather than ferric form (trivalent), thereby considering a worst case;
- assumes that the reaction of chlorine provides maximum number of electrons, representing a worst case;
- ignores thermodynamic restrictions (in reality, thermodynamics and mass transfer restrictions would reduce the rate of corrosion);
- ignores side reactions (in reality side reactions would likely reduce the rate of corrosion).

Considering the chemical reactions with iron, it can be determined stoichiometrically, that one mole of chlorine (accepting 12 moles of electrons) will lead to the corrosion of six moles of iron. Therefore, a calcium chloride deposition rate of 3.0×10^{-3} moles per m^2 per month could lead to an iron conversion rate of 1.8×10^{-2} moles per m^2 per month. Given that the density of iron is 143.3 mol m^3, the rate of iron corrosion can be estimated to be 1.26×10^{-3} metres per month. At this rate, it would take approximately 8 months for one millimetre of bare iron to corrode.

This calculation is highly simplified and conservative. In reality, the corrosion chemistry would be considerably more complex and considerably slower than that indicated above because:

- Dispersion modelling was conservative. The calcium chloride deposition rate at the facility boundary is likely to be lower than that predicted.
- Calcium chloride may react with other compounds in the environment, thereby reducing the actual dust load.

- The calculation assumes constant deposition and corrosion, with no dust being removed by rain.
- Corrosion would be inhibited by thermodynamics (activation energies, reactivities).

Although simplified and conservative, the above calculation demonstrates that corrosion attributable to calcium chloride dust deposition would be small at the plant boundary. At both Southern Main Road and the nearest residence, dust deposition would be about half; thus corrosion rates would be about half of those found at the facility boundary.

Calcium chloride would be deposited over a limited area outside the plant boundaries particularly to the west and would result in the introduction of chloride to soils and plants. Low levels of chloride in soils are beneficial to plants, but excess chloride can result in chloride toxicity. Symptoms of chloride toxicity include reduced plant growth; decreased leaf size; chlorosis (yellow leaves due to a lack of chlorophyll); necrosis (tissue death); excessive leaf fall; and the inhibition of nitrate and phosphorous uptake. Chloride can also accumulate in soil and plant tissue under certain conditions.

The fate of chloride in soils, and the effect of soil chloride on plants, is highly dependent on an array of factors including: soil chemistry and the presence/concentrations of a number of other ions and nutrients; soil physical properties; soil moisture; temperature; plant species; variety of plants within species; insolation; and other factors. Because chloride effects on plants are so sensitive to multiple factors, the impact of $CaCl_2$ deposition on soils and vegetation beyond the CariSal plant boundary (if any) cannot be predicted with any degree of confidence. It is recommended that the areas receiving $CaCl_2$ deposition be monitored for signs of chloride accumulation in soil and chloride toxicity in plants. It is further recommended that a contingency plan be developed, to be adopted in the event that monitoring indicates an unacceptable level of chloride toxicity in vegetation beyond site boundaries.

5.2.4 Decommissioning

The impact of decommissioning on flora sand fauna could range from significantly negative to mildly beneficial, depending on the ultimate disposition of the plant and site.

A key issue with respect to decommissioning would be whether the wetland and upland area preserved under the above-recommended mitigation measure would continue to be preserved upon decommissioning of the site. It is recommended that CariSal make arrangements for permanent preservation of the wetland and upland areas preserved during the construction and operations phase. This could be done by handing the preserved wetland and upland area over to a nongovernmental organization or to the Government so that it can become a protected area open to the public, and/or developing a trust fund that would fund basic reserve area management functions on an ongoing basis (See Chapter 7).

If the wetland and upland area preserved during the construction and operations phase were allowed to be damaged, filled or developed upon decommissioning of the CariSal plant, this would constitute a significant negative impact on flora and fauna associated with decommissioning.

However, if arrangements are made to preserve these wetland and upland areas permanently after decommissioning, then decommissioning would have a negligible to mildly beneficial impact on flora and fauna:

- if another use is found for the plant, and it is sold and put back into operation for a new purpose, then impacts on flora and fauna associated with decommissioning would be negligible; or
- if the plant is demolished, debris is removed, and the site is graded, planted, and allowed to revert to natural cover, then impacts on flora and fauna could be mildly beneficial in that the revegetated site could serve as habitat for wildlife. Under this scenario, it is recommended that only species of plants native to Trinidad be used for revegetation of the site. Introduction of exotic plant species could potentially have negative impacts on native flora and fauna, although these impacts can be easily avoided through the use of native species.

During decommissioning, all liquid and solid waste materials will be handled in an approved manner, which should preclude significant impacts on the environment or on flora and fauna. Residual liquids from the Retention Pond and the Containment Pit may be discharged to local waterways if of suitable quality and if this action were in accord with regulations in place at the time of plant shutdown. It can be assumed that adherence to environmental regulations would prevent any such discharge from causing significant impact on aquatic flora and fauna in the receiving water bodies.

Overall, then, potential impacts of decommissioning on flora and fauna range from significantly negative to mildly beneficial, depending on whether the mitigation measure of permanent preservation of the preserved wetland and upland area is adopted, and depending on ultimate disposition of the plant and site.

5.3 WATER QUALITY

The CariSal Project would generate both adverse and beneficial impacts to water quality. The Project would consume both DESALCOTT waste brine and WASA potable water, and return demineralised water to WASA. The consumption of waste brine improves the quality of the water in the Gulf of Paria by reducing the salinity of discharged water. The adverse consumption of potable water in Stages 1, 2, and 3 of the Project are at least partially offset by the beneficial production of excess demineralised water in Stages 3 and 4. Development of the Project site would reduce the area currently covered by wetlands.

5.3.1 Impact of Outfall Water

The Project would not require a process water outfall from the CariSal plant. In fact, the CariSal plant would reduce the discharge of waste brine from the DESALCOTT desalination plant in Stages 2, 3 and 4 of operation. DESALCOTT waste brine is currently discharged through DESALCOTT's outfall, which connects to the marine outfall from Yara Trinidad Limited – formally Hydro Agri – (Caribbean Environmental Health Institute, 2006). The EIS for the DESALCOTT plant (including addenda) determined that the salinity of the combined effluent

would not exceed 40 grams per litre (g/L) more than 20 metres from the outfall discharge point, that the impacts on marine organisms are not significant up to a salinity of 40 g/L, and that salinity concentrations in the range of 40 to 50 g/L would not adversely affect adjacent mangrove communities (EcoEngineering Consultants Limited. 2000, Republic of Trinidad and Tobago 2000). The salinity of the combined outfall discharge is about 42 g/L. The background salinity of the Gulf of Paria, the receiving body of water, varies from 10 g/L to 36 g/L, primarily due to seasonal variations in the outflow from the Orinoco River into the gulf (Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007). The reduction in outfall salinity from operation of the CariSal plant would have an insignificant beneficial impact on the marine environment.

Table 5.3-1, below, details the volumes and salinities of the Yara discharge alone, the DESALCOTT discharge alone, and the combined discharge. The data are presented both for the normal Yara operating condition of three plants running, and for the maintenance or shutdown condition of only two Yara plants running.

Table 5.3-1. Volumes and Salinities of Yara Discharge, DESALCOTT Discharge, and Combined Discharge

	Flow Rate in gpm	Salinity[a] (TDS) in g/L
Yara Trinidad Ltd., 3 plants	180,000	36.058
Yara Trinidad Ltd., 2 plants	115,000	36.058
DESALCOTT input	54,000	36.300
DESALCOTT discharge	19,980	97.799
DESALCOTT and 3 Yara plants	199,980	42.226
DESALCOTT and 2 Yara plants	134,980	45.197

a Dry season, worst-case scenario

No impacts related to outfall water during the construction phase are anticipated.

5.3.2 Impact on Water Requirements

5.3.2.1 Construction Phase

During the construction phase, CariSal would purchase potable water from WASA for dust control, soil compaction, and line testing at the rate of approximately 19 cubic metres per day (m^3/day) for 180 days (3,420 m^3, total volume). The WASA water tank and the process water tank within the CariSal site with a combined 4,540-m^3 capacity would require a one time fill-up. This potable water requirement does not represent a significant impact.

CariSal would either build a new tank on the EISL property or use the two former molasses tanks for the storage of caustic. If the molasses tanks are used, CariSal may build a new tank on the EISL property for the storage of liquid calcium chloride. Approximately 10,000 m^3 of seawater would be used for hydrostatic testing of each tank and for pressure testing the associated pipelines connecting to the CariSal plant and to the Yara pier. The water could be reused to test more than one tank. Following testing, CariSal would analyze the water for any chemical contamination and, if it meets the discharge requirements of the Trinidad and Tobago Water

Pollution Rules and other relevant rules or guidelines, discharge it into the sea (Gulf of Paria). This seawater water requirement does not represent a significant impact.

If the former molasses tanks are used, the tank cleaning contractor would need additional water, probably potable, for high-pressure water or steam cleaning of the tanks and the pipeline to the Yara pier. Wastewater from the cleaning, which would contain some concentration of sugar, would be tested and disposed of in accordance with applicable requirements, either by discharging it or by trucking it to a licensed water treatment facility. This potable water requirement does not represent a significant impact.

5.3.2.2 Operational Phase

During operation, water for the Project processes would be obtained from WASA or derived from DESALCOTT's waste brine. In addition, during all stages of operation CariSal would use about 4.1 m^3/hr of potable water from WASA for drinking water, sanitary, and safety shower systems. No groundwater pumping is proposed. To the extent available, rainwater and runoff collected in the Containment Pit and retention pond would be used to offset the demands of water from WASA.

In operation Stages 1, 2, and 3, CariSal would obtain approximately 200 m^3/hr of potable water from WASA for process purposes. In Stages 2 and 3, increasing amounts of DESALCOTT waste brine would be piped to the CariSal facility and would displace some portion of the potable water that otherwise would be required for the process. WASA has granted Outline Approval to CariSal and confirms that WASA would be able to provide the water required for the Project.

In Stage 4, when the mechanical vapour recompression (MVR) unit becomes operational, CariSal would no longer need potable water from WASA for process purposes. Waste brine from DESALCOTT would provide the feed for both water and salt. The process would generate a 153-m^3/hr surplus of demineralised water to be made available to WASA for industrial consumers in the vicinity.

The DESALCOTT plant has a capacity of more than 5,600 m^3/hr of demineralised water, which reportedly can be expanded to over 8,300 m^3/hr. During meetings with CariSal staff and consultants in November 2007, DESALCOTT indicated that it plans to expand its current capacity. Under the terms of the Water Sale Agreement, WASA purchases approximately 4,000 m^3/hr of water from DESALCOTT (Regulated Industries Commission 2005). The DESALCOTT desalination plant was built to provide water to the Point Lisas Industrial Estate, which previously had been served by the Caroni Water Treatment Plant (Rodriguez 2007). WASA has divided its service area into five supply classes. The Point Lisas area is served by a Class One Supply, which is defined as receiving water at all times. If the DESALCOTT supply is interrupted, WASA can supply Point Lisas from its Caroni Water Treatment Plant, which has a capacity of 14,000 m^3/hr. The maximum requirement of the CariSal plant would be about 200 m^3/hr – roughly about 3.5 percent of DESALCOTT's current production capacity. In Stage 4, CariSal would generate an amount of excess water equivalent to 2.7 percent of DESALCOTT's current production capacity by utilising a fraction of DESALCOTT's waste brine stream.

Some of WASA's service areas experience water supply problems, especially in the dry season. Based on WASA data, total annual water demand reached 501 million m^3 in 2007. The total demand included 280 million m^3 for residential, commercial, industrial, and institutional consumption, and 221 million m^3 in Unaccounted for Water (UFW) losses due to leaks, illegal connections, and unmetered water. These amounts are equivalent to an average of 32,000 m^3/hr consumption and an average of 25,000 m^3/hr UFW loss. WASA's annual water production of 402 million m^3 equates to 46,000 m^3/hr. CariSal's water requirements in Stages 1, 2, and 3 would equal about 0.4 percent of WASA's water production. (Rodriguez 2007). Additionally, according to the 2000 Census, most residents of the Study Area for the Project receive a continuous, pipe-bourne water supply from WASA (98 percent of households in Phoenix Park, 88 percent in Esperanza, and 79.1 percent in Dow Village). Diamond Village exhibited (markedly) the fewest households with a supply of continuous pipe-bourne water (5.2 percent) with 94.8 percent of households reporting receiving water more than 3 times per week.

The potable water requirements in Stages 1, 2, and 3 represent a minor irreversible impact on the consumption of WASA's potable water production. Because Stage 4 is anticipated to begin within approximately 2 years after plant start up (depending on equipment delivery schedules), this impact would be temporary. If the start of Stage 4 were delayed, CariSal would require an additional reverse osmosis unit to be constructed at DESALCOTT as outlined in section 7.7.2.

CariSal would conduct additional environmental studies on the effects of this unit in the unlikely event it is necessary. During Stage 4, the surplus demineralised water that the plant would produce represents a minor beneficial impact on the region's water supply.

Water demands from other proposed projects in the area and from future projects on the proposed industrial estate would increase the demands on the WASA water supply. If the cumulative water demands exceeded the ability of WASA to supply the industrial facilities and other needs while CariSal was operating in Stages 1, 2, or 3, and if CariSal exhausted the water supply in its retention ponds, then CariSal would suffer a temporary but irreversible impact in lost production. In Stage 4, CariSal production is not dependent on WASA's water supply and would, in fact, help to mitigate such a cumulative impact by generating excess demineralized water.

5.3.2.3 Decommissioning Phase

During the decommissioning phase, CariSal would require water for dust control; rinsing of facility vessels, pipelines, and paved areas; and perhaps irrigation of new ground cover or plantings. To the extent possible, water retained in Retention Pond No. 1 would be used for these purposes.

No significant, adverse, water-requirement impacts requiring mitigation are anticipated during the decommissioning phase.

5.3.3 Impacts of Discharged Cooling Water

No liquid cooling water would be discharged to any inland or marine environment. The design of the CariSal plant calls for cooling water to pass through the cooling tower system at the rate of

approximately 5,700 m^3/hr. Most (98 percent) of the water would be recycled, but approximately 122 m^3/hr would be lost to evaporation and 12 m^3/hr would be lost as cooling tower drift. Given the predominant pattern of wind from the east and the proposed location of the cooling towers, most of the cooling tower drift would precipitate on property within the CariSal parcel. The maximum estimated precipitation of 860 millimetres per year (mm/year) would occur near the east end of Retention Pond #1. The maximum offsite precipitation is expected to be less than 7 percent of the average annual rainfall. Offsite precipitation from the cooling tower drift is not expected to produce any significant negative impacts, and may have a minor beneficial impact during the dry season.

5.3.4 Impacts on Surface Water Quality

No naturally occurring major surface waterbodies are located on the Project site. However, a small perennial wetland of about 0.3 ha and about 5 ha of annual wetland and upland area is located in the northwest corner of the site. A drainage channel crosses the northern portion of the site. Project construction activities could adversely affect the hydrology and surface water quality of the area by:

- Changes in the drainage pattern of the site
- Wetlands degradation or destruction
- Improper disposition of construction debris, leading to offsite contamination of water resources
- Soil runoff from the site, leading to offsite contamination of water resources
- Blockage, through sedimentation, of drainage channels crossed during pipeline construction.

5.3.4.1 Construction Phase

To preserve the wetland areas, the north half of the site, except for the administration building area, will remain undeveloped. The perennial wetland will be undisturbed except for the installation of a perimeter fence. Minor construction activity on the remainder of the northern half of the site may include relocating the northern drainage channel and planting trees.

No equipment would be fuelled or maintained within 100 feet (30.5 m) of drainages. No construction debris would be disposed of on or adjacent to the site. All waste construction materials would be transported to the Forres Park Landfill or other suitable disposal location to avoid any significant adverse impacts to surface water quality.

Construction operations for the plant facilities and pipelines would use the erosion control best management practices (BMPs) incorporated in the Stormwater Pollution Prevention Plan (SWPPP) to minimise the release of sediment-laden runoff and to prevent significant adverse impacts from the runoff of turbid waters. Although no significant impacts are expected, extremely heavy rainfall events could contribute additional silt loading to the LNG River or to the northern drainage channels, even with proper erosion control measures in place.

5.3.4.2 Operational Phase

During operation, surface water quality could be adversely affected by waste/chemical spills, runoff from material stockpiles, discharge of inadequately treated process-area runoff, discharge of runoff in areas with inadequate erosion control, failure of a retention pond, leakage from a storage tank or pipeline, or precipitation of airborne chemicals from plant emissions.

Because the project design incorporates engineered features and management policies to minimise or prevent uncontrolled releases, adverse impacts to surface water are not expected to be significant. All process areas would have containment structures, surface drains, and sumps to direct runoff to the Containment Pit; no process area runoff would be discharged into surface waters. Any small waste or chemical spills would be contained and cleaned up to prevent the spread or discharge of contaminants. Retention ponds would be engineered to contain the 50-year precipitation event, and would have adequate spillways to prevent overtopping. All storage tanks would have secondary containment. Pipelines would have systems to monitor for pressure or fluid loss and automatic shutoff valves to minimise the duration and volume of any release in the event of a pipeline rupture.

Calcium chloride deposition within the plant area from drying and packaging operations would be washed off by precipitation and carried to the Containment Pit. Deposition would also occur in undeveloped areas surrounding the plant and may be carried to the Retention Pond or ponds by means of surface runoff. The estimated deposition rate would produce runoff from the roofs, and potentially from natural ground, with annual average chloride concentrations of approximately 50 mg/L, which is well below the 250-mg/L maximum threshold for discharge to inland surface waters (Republic of Trinidad and Tobago 2006, Trinidad and Tobago Bureau of Standards 1998). Surface water impacts both within the CariSal site and offsite from chloride deposition are expected to be insignificant.

5.3.4.3 Decommissioning Phase

During decommissioning, the site drainage systems, perimeter protection systems, and retention ponds would remain in place until after the plant was disassembled, the site cleared, and vegetation was re-established. In the final stages of decommissioning, the residual fluids in Retention Pond No. 1 and the Containment Pit would be discharged to local waterways if of suitable quality and if this action were in accord with regulations in place at the time of plant shutdown. If such discharge were not permitted, the waters would be trucked to a suitable disposal facility.

It is estimated that the Containment Pit inventory would be no more than 550,000 gallons (2,082 m^3). Retention Pond volume would be a function of rainfall at the time of shutdown, but at a maximum would be 600,000 gallons (2,271 m^3). The volume of water requiring disposal could be reduced through natural evaporation, especially in the dry season. No significant water quality impacts are expected from the one-time discharge or disposal of this water.

5.3.5 Impacts on Groundwater Quality

Groundwater resource quality could potentially be adversely affected if there were infiltration of contaminated surface water runoff from the site, the introduction of incompatible waste into the

septic system, leakage from the retention ponds, leakage from storage tanks, infiltration beneath material stockpiles, or infiltration of chemicals from atmospheric deposition. CariSal has engineered protective features and would institute management policies to minimise or prevent adverse impacts to groundwater resources. Because runoff from all industrial areas would be directed to channels, drains, or sumps that discharge to the Containment Pit, groundwater impacts from runoff are not expected to be significant. Furthermore, the naturally occurring clayey alluvial soils restrict infiltration and the movement of groundwater. The only useful local aquifer, the Sum Sum Sands, lies well below the depth of any potential Project impacts.

All storage tanks would be bunded and designed to meet the appropriate seismic requirements. Any catastrophic failure of a tank would be handled in accordance with the Emergency Response Plan. The septic tank would connect to and receive water only from sanitary facilities within the plant and the administrative building, and not from any process areas. The septic tank would not be attached to a leach field, but would discharge to a treatment system whose effluent would discharge to the Containment Pit. Material stockpiles would be placed on concrete pads to prevent infiltration of any runoff into the ground. The Containment Pit, which would be either an earth-bermed structure with a Hypalon® (chlorosulphonated polyethylene) lining or similar geomembrane liner or an engineered concrete structure. If the concrete structure is chosen, the structure would be designed with leak stops and an underdrain to detect any leakage, and would be designed to meet the appropriate seismic requirements. Retention Pond No. 1, which would contain only clean runoff, would be an engineered earth structure with a compacted base of low permeability natural soils. Infiltration from the retention pond or ponds would not adversely impact groundwater quality.

Some of the calcium chloride deposition dissolved by precipitation in the undeveloped areas could infiltrate into the groundwater. The annual average chloride concentration would be the same as for surface water runoff, 50 mg/L, which is well below the 250-mg/L maximum threshold for industrial discharge to groundwater (Trinidad and Tobago Bureau of Standards 1998) and below the No Increase Above Ambient threshold in the Water Pollution Rules (Republic of Trinidad and Tobago 2006). Groundwater impacts from chloride deposition are expected to be insignificant.

Aquifer recharge affected by the CariSal site is not expected to be significant. The naturally occurring soils have high clay content and a low infiltration rate. Neither the sanitary system nor runoff from process areas would infiltrate into groundwater. There may be a small amount of infiltration of clean water from within the retention pond or ponds. Recharge in undeveloped areas on the north half of the site would be unaffected. No groundwater would be extracted on the Project site.

5.4 SOLID WASTE

5.4.1 Construction Phase

During site preparation, approximately 5 to 6 ha of land on the southern half of the site would be stripped of existing vegetation, which consists primarily of past remnants of sugarcane cultivation. On the north half of the site, additional areas would be stripped for construction of the perimeter access road and the administrative building, and for regrading to improve drainage.

Some wetland areas would remain undisturbed to the extent possible. Based on descriptions of current flora, recent photographs in the geotechnical report (EIS Ltd. 2007), and inspection of the Project site, typical ground cover consists of mid-height and tall grasses, with some shrubs and small trees. Assuming an estimated average of 50 kilograms of material per square meter of cleared land, and a total disturbed area of up to 10 ha, site clearance would generate on the order of 5,000 MT of vegetative waste. The CEC application states that cleared vegetation would be disposed of at an authorised waste facility such as the Forres Park Sanitary Landfill, one of the three major landfill sites Trinidad and Tobago Solid Waste Management Company Limited (SWMCOL), a state owned entity, manages.

The primary solid waste impact during the construction phase of the Project would be the burdening of available landfill capacity with vegetative waste. The vegetative waste would be generated in a short time period, possibly in the span of several weeks. The Forres Park Sanitary Landfill currently accepts about 500 MT/day of waste. SWMCOL has stated that accepting an additional 170 MT/day of waste would be no problem (Scott 2007). As of 2004, the area of the Forres Park Sanitary Landfill was 8 ha. A 63-ha site adjacent to the landfill has been designated for expansion but approvals had not yet been granted as of 2004 (Dillion Consulting 2004).

Additional solid waste generated during the construction phase would likely include construction debris such as wood, metal, concrete, plastics, and paper. According to CariSal, solid waste disposal would take place at approved solid waste sites within the Regional Corporation of Couva/Point Lisas and be undertaken by a contractor qualified to handle industrial wastes (CariSal Limited 2007). Due to proximity and available capacity, the probable destination of construction-phase waste would be the Forres Park Sanitary Landfill. Any hazardous wastes generated during construction would be managed by the construction contractor in accordance with an approved management system. The generation and management of additional construction solid waste and hazardous waste are not expected to cause significant impacts.

Clearing land for other proposed projects in the area such as the Westlake facility, the Essar facility, the development of the PLSEIE, and the NEC Port expansion would lead to the generation of considerably more waste biomass. The proposed industrial estate, in particular, has a proposed development area of 1400 ha compared to the 11.8-ha CariSal parcel. If disposed at the Forres Park landfill, the cumulative 500,000 to 600,000 MT of vegetation waste would consume a large volume of valuable landfill airspace. Depending on the length of time over which land clearing would be distributed, the daily flow of material to the landfill could overwhelm the landfill's operational capacity. Under the current proposed schedules for CariSal, the proposed Port and the PLSEIE, CariSal would complete site clearing activities before clearing begins for the estate development. Site clearing for some of the other, smaller projects could overlap with the CariSal clearing schedule. Other options for managing the waste include burning or composting. Burning would have adverse air quality impacts. Composting would require the temporary set-aside of perhaps 10 percent of the cleared land area and additional fuel and labour costs.

5.4.2 Operations Phase

As indicated in Table 3.4-6, the operations phase would generate solid wastes in the form of business waste; limestone inerts; lime inerts; magnesium hydroxide; brine muds; cooling tower

blowdown solids; settled solids in the containment pit, retention pond(s) and sand traps; and spent membranes.

CariSal estimates that during plant operations, approximately 300 to 500 kg/year of business waste such as paper and wood would be generated. The paper waste would be recycled to the extent practicable or landfilled at an authorized waste management facility.

The limestone inert waste may be useable as daily cover at the receiving landfill, yielding some value. Once the inerts are confirmed to be non-hazardous, CariSal's intent is to sell the limestone inerts for construction road fill. Until the limestone inerts are available to verify quality and purity, the material would be disposed of by a qualified solid and industrial waste hauler. Current estimates suggest that the plant would produce approximately 650 MT/year of limestone inerts, which would be the equivalent of 1 or 2 truckloads weekly.

On a dry basis, the CariSal facility would generate between 460 and 48,356 MT/year of solid waste (depending on the operational stage) from the brine muds. Provided that a chemical analysis of the material shows that it meets SWMCOL's acceptance requirements and that CariSal dewaters the material to a water content that produces a stable material, SWMCOL would accept the waste at the Forres Park Sanitary Landfill. Belt filter presses can reduce the water content of mineral sludges to about 30%. If the characteristics of the dried brine muds do not meet SWMCOL's acceptance criteria, CariSal would need to reduce the water content by aeration, evaporation, or drying.

The brine muds consist of the mineral impurities found in salt and in seawater. The brine mud solids are expected to consist of approximately 46.8 % sulphate, 39.6% magnesium and 13.4% calcium, with the remaining 0.4% a variety of metals and sulphate. Table 5.4-1 details the expected composition of the brine solids, and compares the concentrations to the Dutch soil screening levels.[4] For all parameters for which Dutch soil screening levels exist, the expected concentrations of the constituents within the brine mud solids are well below the Dutch action levels.

SWMCOL would determine the acceptability of disposal at the Forres Park Sanitary Landfill as Special Waste based on CariSal's analysis of the actual brine mud solids. In addition to prior approval, disposal of Special Waste could be subject to special conditions imposed by SWMCOL. Although the brine mud solids are expected to meet SWMCOL's acceptance criteria, if they did not then CariSal would need to either treat the waste to meet the criteria or find an alternate disposal site, possibly outside of Trinidad and Tobago.

SWMCOL has indicated that it has the capacity to handle the anticipated volume. Because the brine muds consist of the mineral impurities found in salt and in seawater, chemical acceptance should be no issue. Acceptance of the quantities of waste generated in Stage 4 would have a permanent, irreversible, moderate, or significant impact on the landfill's remaining available

[4] The Dutch soil screening guidelines present numerical screening levels and are one of the most widely recognized soil remediation standards in Europe and the United States.

space. The potential use of some or all of this material as daily cover would produce an offsetting beneficial impact.

Similarly, solids from cooling tower blowdown would consist of mineral impurities found in potable water, so chemical acceptance at Forres Park Sanitary Landfill should pose no problem. The estimated quantity of less than 530 MT per year would not significantly impact the landfill's ability to handle the waste and would not consume significant landfill volume.

Table 5.4-1. Constituents and Concentrations in Disposable Brine Mud Solids

Constituent	Concentration in mg/kg	New Dutch List Action Level in mg/kg
Calcium	134,000	N/A
Magnesium	396,000	N/A
Strontium	1.690	N/A
Aluminium	14.6	N/A
Iron	9.96	N/A
Barium	1.89	625
Silica	0.00	N/A
Nickel	39.8	210
Copper	21.4	190
Cadmium	5.13	12
Mercury	0.00	10
Lead	1.74	530
Chromium	55.9	380
Sulphate	468,000	N/A

The remaining solid wastes would be produced in comparatively low volumes and consist of relatively inert materials, so no significant impacts are expected.

Other than the consumption of available landfill capacity, negative environmental impacts from the disposal of solid waste are not expected to be significant. All solid waste intended for offsite disposal would either be used as a beneficial material or handled by a qualified waste contractor and disposed of in a controlled landfill. Furthermore, offsite disposal of solid wastes generated by the Project would create economic benefits for waste haulers.

5.4.3 Decommissioning Phase

If a new use for the plant cannot be found, plant equipment would be cleaned, dismantled, and sold. Structures would be sold or demolished. Once the site is clear of all equipment and structures, the foundations would be removed and the site levelled. Any materials that are not sold would be segregated for disposition. Scrap metal, glass, plastic, and other recyclable materials would be recycled to the extent possible. Concrete structures would be demolished, and the concrete crushed for reuse as aggregate. Steel rebar would be separated and recycled. Asphalt would be crushed and recycled for new asphalt or aggregate. Electronic equipment that cannot be sold would be separated and disposed of as e-waste. The materials remaining would be disposed of in an approved landfill.

5.5 SOIL

5.5.1 Construction Phase

During the construction phase, many activities would involve soil excavation or earthmoving. The major planned activities include:

- Stripping surface vegetation and exposing the underlying soil
- Raising the Project area approximately 1.2 metres
- Grading the site to enhance drainage
- Constructing earth berms for one or more retention ponds
- Excavating for foundations
- Excavating for underground pipelines or utilities
- Compacting soil
- Constructing roads and parking areas
- Grading the site for landscaping.

Earthmoving activities could disrupt existing drainage channels, create or destroy ponding areas, and expose soil to wind and water erosion. The disturbance of drainage paths and ponding areas could concentrate flows and increase the rate of soil loss.

Stripping site vegetation and adding compacted fill to the site would contribute to higher rates of erosion. The site grading plan calls for raising the Project area by backfilling with approximately 80,000 m^3 of compacted soil. Exposed soil during backfill operations is more susceptible to erosion, but grading of working areas to promote controlled drainage would reduce surface flow velocities. Construction operations for the plant facilities and pipelines would use the erosion control BMPs incorporated in the SWPPP to minimise erosion during construction. Some erosion should be expected onsite, but the impacts are expected to be minor if proper procedures are followed.

Stripping site vegetation also could lead to a loss of topsoil, either directly in the disposal process or through increased erosion. Topsoil would be stockpiled and reused where possible, although there would still be a significant local impact in the area.

Excavation for foundations and any underground portions of utilities or pipelines could entail the risk of excavation collapse, with subsequent dangers of entrapment, crushing, or death if workers are within the excavation at the time. These dangers would be increased at the Project site due to the high natural groundwater level. Best construction practices and international trench safety regulations[5] restrict the entry of personnel into excavations unless the excavations are either structurally braced or meet strict geometric requirements for stability. The OSHA of 2004 also imposes a general duty on employers to ensure employee safety. No significant worker safety impacts are expected if proper procedures are followed.

[5] For example, U.S. OSHA Excavation Safety Rules, 29 CFR 1926 Subpart P

5.5.2 Operations Phase

None of the planned activities in the operations phase would involve significant earthmoving or alterations of site soils.

5.5.3 Decommissioning Phase

The erosion and sediment control impacts expected during decommissioning would be similar in type to but lesser in magnitude than those expected during construction. The required sediment and erosion control measures would be similar to those used during the construction phase. Any areas of soil exposed would be covered with topsoil and revegetated. With the erosion and sediment control features in place and with implementation of the SWPPP, the expected soil impacts from erosion during decommissioning would be minor.

5.6 DUST IMPACTS

This section of the EIA assesses the dust impacts associated with the construction and operation of the proposed chlor-alkali facility. During construction, dust is generated due to wind action on loosened soil caused by the passage of vehicles and earth moving equipment. During operation of the chlor-alkali facility, dust is generated from the packing of calcium chloride and from the drying and cooling operations. These processes also generate TSP with mean mass diameter of about 44 microns (µm) or smaller, as well as smaller inhalable particles. The discussion on TSP and smaller particles is presented in Section 5.9. Tables 5.6-1 and 5.6-2 summarise the dust-related emissions during the construction and operation of the facility.

5.6.1 Construction

During construction dust is generated as the result of soil disturbance activities that occur during site preparation (grubbing, grading, and trenching) activities. Because the dust particles are relatively large, they would settle within a short distance of the disturbance activity. For the very smallest dust particles under the highest wind speed conditions [10 meters per second (m/s)], the gravitational settling rate (1 metre in 37 seconds) of dust resuspended to a height of 3 metres due to earth movement activity could result in a maximum travel distance of about 1000 metres. However, many of the particles are much larger (75 – 100 µm) and would be deposited within a hundred metres of the site. Under typical wind speeds (5 m/s or less) and lower heights of soil disturbance, nearly all dust settles within the first 100 metres.

To minimise offsite impacts, approach roads and internal site roads would be periodically sprayed with water using dedicated water trucks during periods of low soil moisture (e.g., the dry season). Construction contractors would be supervised to ensure that they are aware of this requirement and such requirements would be added as explicit performance terms of the contract. Therefore, impacts would be restricted to the close vicinity of the Project site, of short duration (a few months), and limited primarily to the period during site preparation. Plant erection activities would generate only limited amounts of dust—primarily from vehicle traffic. Dust impacts would be fully minimised following completion of construction activities through revegetation of the Project site.

Table 5.6-1. CariSal Daily Average Dust and TSP Emissions During Construction for the Chlor-alkali Plant in Point Lisas

Process	Daily Average Emission Rate (kg/day)		
	Particulate Matter		
	Dust (> 44 (µm)	TSP (< 44 (µm)	Total Mass
Bulldozers	6.23	5.35	11.58
Excavators	6.23	5.16	11.39
Scraper boxes	0.83	1.38	2.21
Trucks (fill)	0.17	1.14	1.31
Compactors	6.23	4.81	11.04
Motor graders	6.23	4.85	11.08
Water tender	0.24	0.89	1.13
Total	**26.18**	**23.60**	**49.72**

Table 5.6-2. Maximum Annual Operational Dust Emissions for the Chlor-alkali Plant in Point Lisas

Process	Annual Average Emission Rate (MT/yr)		
	Particulate Matter		
	Dust (> 44 (µm)	TSP (< 44 (µm)	Total Mass
Packing $CaCl_2$	1.35	1.30	2.65
94% Dryer	2.72	5.05	7.77
77% Dryer/Cooler	2.33	3.97	6.30
Total	**6.40**	**10.32**	**16.72**

To quantify the impact during site preparation CariSal, as part of the air quality modelling effort (see Section 5.9), modelled dust emissions from construction with the resulting offsite dust concentration and deposition quantified. Figures 5.6-1 and 5.6-2 (see Chapter 10 and Appendix E) show the location of the maximum 24-h offsite dust concentration and deposition during construction. Only a small fraction (10 percent) of the construction-generated dust would remain within the facility boundary.

5.6.2 Operations

During the operation of the chlor-alkali facility, calcium chloride dust would be generated from the packing of product and from the drying and cooling operations. The dust emissions are those vented to the atmosphere after scrubbing (see Section 5.9.2.1.3 for details on the emission control technology).

To quantify the operational impacts, CariSal modelled these dust emissions as part of the predictive air quality analysis effort (see Section 5.9) with the resulting offsite dust concentration and deposition quantified. Appendix E has two figures which show the location of the annual average maximum offsite dust concentration and deposition during operation. The modelled annual average maximum offsite dust concentration is located along the CariSal western property line about 75 meters north of the south-western corner of the CariSal property with a maximum concentration of 48 $\mu g/m^3$. In general these large size dust particles are a nuisance and not a public health issue. That said, the level of maximum concentration is well below the Trinidad and Tobago proposed TSP permissible level of 150 $\mu g/m^3$ which is an air quality threshold aimed at smaller size particles that are considered to be more injurious to human health as they can travel deeper into the lungs. The maximum modelled annual average deposition of 4 g/m^2 is also located at the fence line, about 50 meters north of the maximum offsite dust concentration. The impacts of these deposits on the environment are discussed in Section 5.2.3 (Operational Impacts on Flora and Fauna).

5.7 NOISE

This section describes the anticipated noise impacts in the environment surrounding the CariSal facilities.

5.7.1 Noise Impact Assessment Methodology

5.7.1.1 Construction

5.7.1.1.1 Construction Equipment

Construction activity would produce temporary noise impacts from heavy equipment and vehicles needed to prepare the site and construct the plant, related utilities, and buildings. Noise produced by construction equipment would occur with varying intensity and duration during the various phases of construction. The degree of noise impact during construction would be a function of the amount and types of equipment being used, and the distances between the construction equipment and noise-sensitive areas. Because of the different phases of construction and the large Project area, no single location would experience construction noise impacts for the entire duration of construction.

Construction noise impacts were assessed by defining several representative scenarios of onsite construction activity, assigning a typical "fleet" of equipment and vehicles to each scenario, and calculating the noise level (L_{eq}) at the nearest residence. The EMA noise rules (see Section 4.3.5) specifically exempt construction equipment operating during daytime hours; thus, the calculated noise levels were not compared to specific numerical criteria but were assessed with respect to potential for annoyance or nuisance impacts.

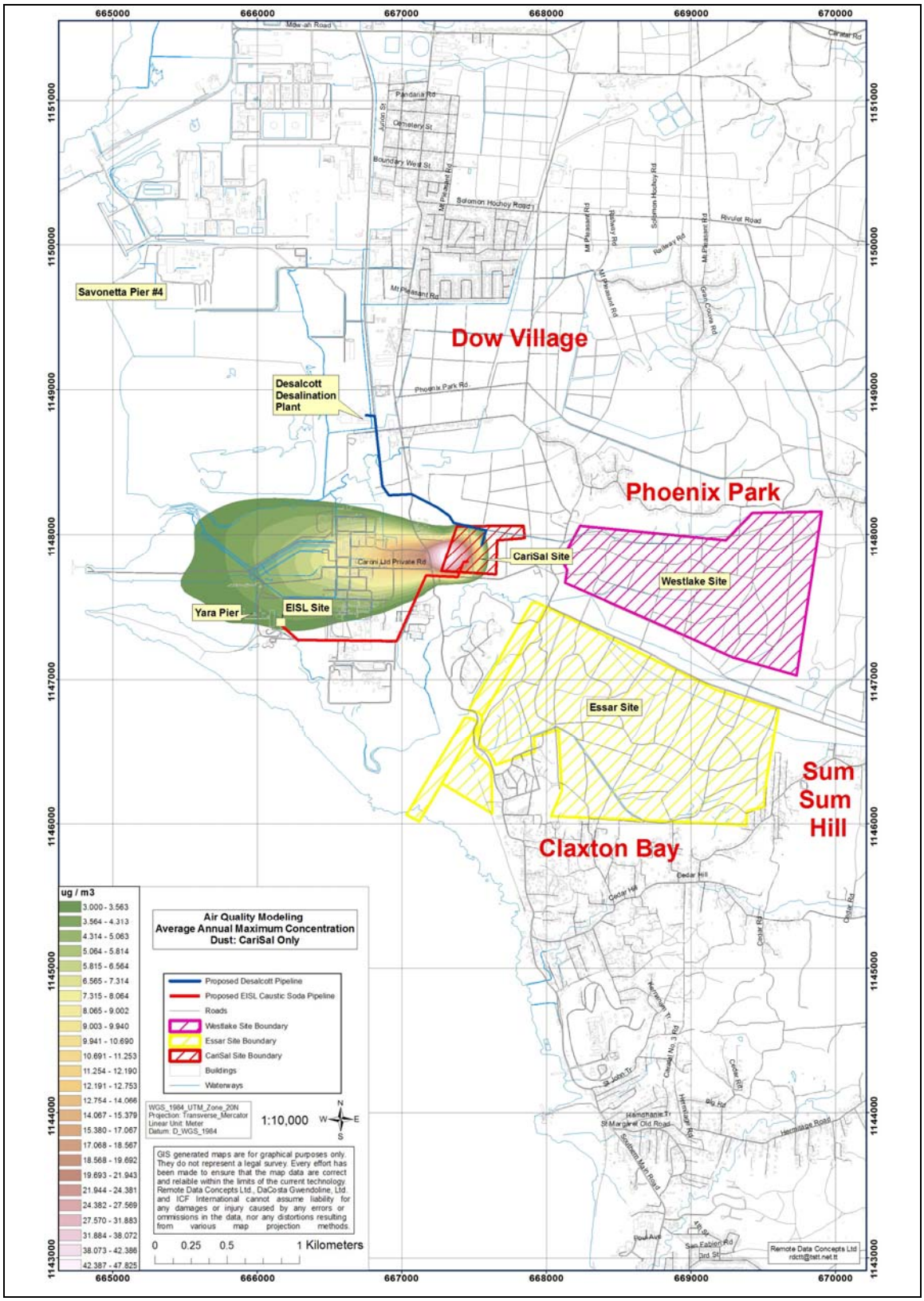

Figure 5.6-1. Average Annual Maximum Concentration of Dust.

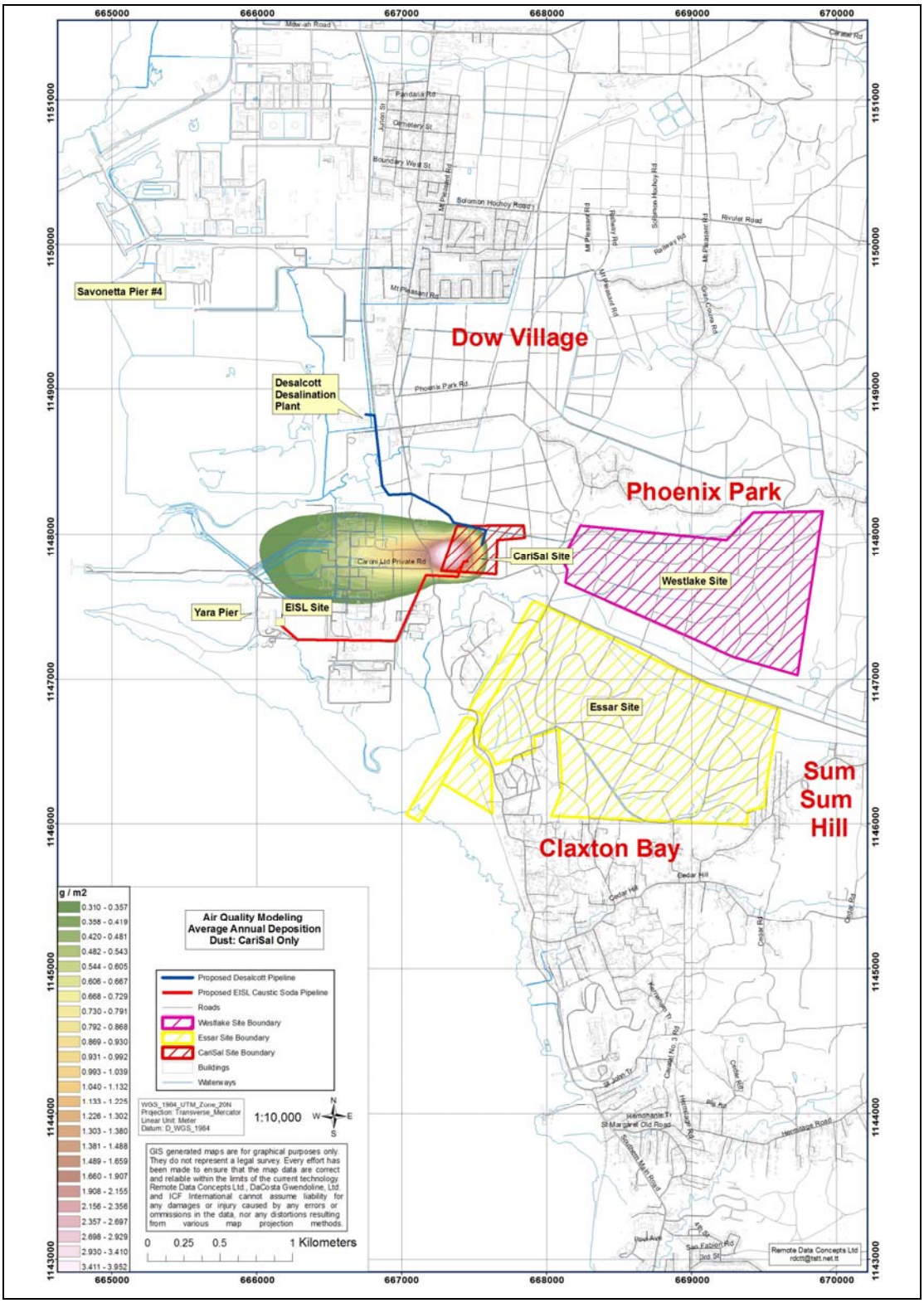

Figure 5.6-2. Average Annual Deposition of Dust.

The noise levels from construction were calculated by the method used in the U.S. Federal Highway Administration (FHWA) Roadway Construction Noise Model (US FHWA 2006). This model contains a database of reference noise levels for various types of equipment typically used in site preparation, facility erection, and other construction and demolition processes for roadways and industrial facilities. Table 5.7-1 lists the reference noise levels for several representative types of construction equipment that are likely to be used during construction of the Project. These reference levels were used for the construction noise calculations. The reference levels are expressed as the maximum measured noise levels (L_{max}). The model calculates the equivalent average noise levels (L_{eq}) by adjusting the L_{max} by the acoustical usage factor, which expresses the percentage of time that the unit is running at its noisiest level (full throttle).

Table 5.7-1. Noise Emission Reference Levels and Usage Factors

Equipment Description	Acoustical Usage Factor (%)	L_{max} (dB) Measured at 50 ft (15 m)	L_{eq} (dBA) at 50 ft (15 m) Based on L_{max} and Usage Factor
Compactor (ground)	20	83	76
Concrete Mixer Truck	40	79	75
Concrete Pump Truck	20	81	74
Crane	16	81	73
Dozer	40	82	78
Dump Truck	40	76	72
Excavator	40	81	77
Flat Bed Truck	40	74	70
Generator	50	81	78
Man Lift	20	75	68
Paver	50	77	74
Pickup Truck	40	75	71
Scraper	40	84	80
Welder/Torch	40	74	70

Source: U.S. FHWA 2006. (Table 1 in printed user guide, same as Table 9.1 in online page)

The Roadway Construction Noise Model assumes that the ground between the source and the impact location (or receptor) is hard or paved. Hard or paved ground tends to reflect sound and, accordingly, results in higher noise levels at receptors. Soft or vegetated ground is less reflective and results in lower noise levels at receptors. The model's noise propagation calculation was adjusted for soft ground conditions to account for the vegetated character of the Project site vicinity and to assess the potential impacts more accurately.

Noise levels during construction were assessed at the nearest noise-sensitive receptors to the Project site, all of which are residences, as described in Table 5.7-2.

Table 5.7-2. Sensitive Receptors Used in Construction Noise Analysis

No.	Land Use and Location	Approx. Distance from Centre of Site (metre)	Approx. Distance from Nearest Site Boundary (metre)
1	Residence west of site and east of Southern Main Road. Nearest sensitive receptor to site boundary.	210	50
2	Residence, nearest sensitive receptor south of site.	420	250
3	Residence off North Sea Road, east of site and north of the NGC and Caroni facilities. Nearest sensitive receptor east of site.	570	180
4	Residence along Phoenix Park Road. Residences in this neighbourhood are the nearest sensitive receptors north of site.	860	600

The total noise level (as L_{eq}) at a receptor is the combination of the construction noise and the ambient background noise. The calculated construction noise levels at each receptor were combined with background noise levels taken from the noise monitoring data presented in Section 4.3.5. The total noise levels were assessed with respect to potential for annoyance or nuisance impacts. The instantaneous maximum noise level (L_{max}) tends to be determined by the maximum noise level from the single loudest piece of equipment. For this assessment the L_{max} from the loudest piece of equipment in each scenario, irrespective of background levels, was used to calculate L_{max} at each receptor.

5.7.1.1.2 Pile Driving

Substantial pile driving activity is anticipated during the construction of the plant, which could cause noise and vibration impacts. Noise and vibration levels were estimated according to established procedures (FTA 1995). Assuming nearly continuous pile driving (20 piles per day) during daylight hours (8 a.m. to 6 p.m.), soft ground attenuation, and mapped pile driving locations (drawing dated November 29, 2007), resulting noise and vibration levels were estimated. Nearby residences to the west of the plant would be approximately 100 metres from pile-driving activity associated with bleach and HCL loading structures. On the east side of the plant, residences would be as close as 300 metres from pile driving associated with construction of the administration building.

The National Gas Company (NGC) pipeline would be approximately 40 metres from pile driving activities. Ground-borne vibration levels at this distance would be below the FTA cosmetic damage level for fragile historic buildings (0.20 inches/second or 5 mm/second). Vibration damage thresholds for steel pipe structures would be at least an order-of-magnitude higher than this value; therefore, no damage to the pipeline is expected.

5.7.1.2 Operation

Noise levels due to operation of the plant were modelled by using established relationships among horsepower, fan speed, size, configuration, and noise level for pumps, compressors, front-end loaders, and cooling towers. Table 5.7-3 shows the resulting estimated sound power levels

for equipment and processes within the plant area. Noise contours were developed from the areas where the noise generating equipment would operate. EMA noise standards, shown in Table 5.7-4, require continuous night time noise levels to not exceed 65 dBA.

Table 5.7-3. Estimated Sound Power Level for Plant Equipment

Equipment	Horsepower	Sound Power Level (dB)
Marley Cooling Tower (2)	150	117
Front End Loader (2)	213	123
Pumps (6)	200	92
Bleach Loading Pumps (2)	50	91
HCl Pumps (2)	50	91
Circulating Pumps (2)	200	92
Water Pumps (2)	100	91

Table 5.7-4. EMA Noise Standards

Time of Day	Zone I: Industrial Areas		Zone II: Environmentally Sensitive Areas		Zone III: General Areas[a]	
	Continuous (dBA)	Instantaneous (dB)	Continuous (dBA)	Instantaneous (dB)	Continuous (dBA)	Instantaneous (dB)
Any time	75	130				
Day 8:00 a.m. - 8:00 p.m.			— Not exceeding 3 dBA above background, and — Not exceeding 60 dBA.	120	— Not exceeding 5 dBA above background, and — Not exceeding 80 dBA.	120
Night 8:00 p.m. - 8:00 a.m.			— Not exceeding 3 dBA above background, and — Not exceeding 60 dBA.	115	— Not exceeding 5 dBA above background, and — Not exceeding 65 dBA.	115

[a] Zone III (General Areas) includes residences.

Source: EMA 2001.

5.7.2 Noise Analysis Results

5.7.2.1 Construction

5.7.2.1.1 Construction Equipment

Construction noise could impact residents located in close proximity to the site boundaries. The nearest residence is approximately 50 metres from the western boundary of the site. Noise from onsite construction would be temporary, but could cause annoyance when noisy equipment is being operated near the site boundaries opposite the closest residences.

For each of the four receptors nearest the site, the calculated total noise levels for each activity scenario were compared. At each receptor two scenarios were selected:

- The scenario that resulted in the highest noise levels, due to the maximum number of pieces of equipment operating near the site boundary nearest the receptor; and
- A more typical scenario involving the average number of pieces of equipment operating at representative locations (modelled at the centre of the site).

In general the modelled noise levels from site preparation were greater than those from plant and building erection, all other factors held equal. Table 5.7-5 presents the results of the construction noise analysis.

Table 5.7-5. Estimated Construction Noise Levels at Sensitive Receptors

Rec. No.	Scenario Type	Construction Activity: Description, Assumed No. of Units, Duration of Phase	Construction Activity: Locations for Scenario	Noise Levels (dBA except L_{max})			
				L_{eq} Bkgnd.[a]	L_{eq} Constr.	L_{eq} Total	L_{max} Constr.[b]
1 (West)	Maximum	Site preparation, 9 machines/trucks, 2 months	Western site boundary and cooling tower area opposite nearest residence	53.8	76	76	76
	Typical	Site preparation, 5 machines/trucks, 2 months	Entire site (modelled at centre)	53.8	71	71	75
2 (South)	Maximum	Site preparation, 9 machines/trucks, 2 months	Pond and Cogen Plant areas	53.8	62	63	63
	Typical	Cogen Plant erection 6 machines/trucks, 3-4 months	Pond and Cogen Plant areas	53.8	56	58	58
3 (East)	Maximum	Site preparation, 9 machines/trucks, 2 months	Administration Building area	62.4	65	67	67
	Typical	Administration Building erection, 6 machines/trucks, 5 months	Administration Building area	62.4	55	63	63
4 (North)	Maximum	Site preparation, 9 machines/trucks, 2 months	Northern site boundary	62.4	55	63	63
	Typical	Site preparation, 5 machines/trucks, 2 months	Entire site (modelled at centre)	62.4	50	63	63

[a] Basis for assumed background levels (see Section 4.3.5)
[b] The L_{max} of the loudest machine when estimated at the receptor is less than the total L_{eq}. The actual L_{max} from the construction activity would be similar to the L_{eq}
Receptors 1 and 2 – July 2007 monitoring program, "North Field Location."
Receptors 3 and 4 – 2005 monitoring program, location #3 "Opposite Mosque in Phoenix Park."

Project construction noise levels would be noticeable at the nearest residences and may cause annoyance at times. Construction noise levels would result in no adverse environmental or health impacts.

Pipeline construction would temporarily increase noise levels adjacent to roadways in which the pipeline is being installed. The total noise levels adjacent to these roadways would vary with the levels of vehicle traffic, as well as pipeline construction.

5.7.2.1.2 Pile Driving

Pile driving noise levels would be below Federal Transit Administration's (FTA) construction noise 8-hr L_{eq} criterion of 80 dBA during the day, and therefore would not comprise an impact (Table 5.7-6). However, pile driving noise levels could be above FTA's 30-day average criterion of 75 dBA for the residences to the west. It is assumed that pile driving at the bleach and HCl loading structures would not require 30 days, and therefore the 30-day criterion would not be violated.

Table 5.7-6. Estimated Noise and Vibration Levels Due To Pile Driving

Receptor Location	Distance to Pile Driving (meter)	L_{eq} (dBA)	Vibration PPV (in./sec)	Vibration RMS (VdB re: 1 µin./sec)
Nearest residence to the west	106	79	0.029	89
Nearest residence to the east	300	67	0.006	80

Vibration levels would be below FTA's damage criterion of 0.20 inches/second (5 mm/second) for fragile buildings and therefore would not comprise a vibration impact. Vibration levels on a root-mean-square (RMS) basis, which corresponds with human annoyance (peak particle velocity corresponds with building damage), would be readily perceptible (above 65 VdB), but would not be a significant impact because of the temporary nature of construction.

5.7.2.1.3 Motor Vehicle Traffic

Section 5.1.7.3 describes the increase of traffic by construction worker automobiles and material delivery trucks on nearby roads during peak months of construction. Traffic impacts from construction would increase current traffic volumes during the peak hour between 13 percent and 24 percent. A 24-percent increase in volume would result in an increase of 0.8 dB in traffic noise. Because the human ear normally cannot discern an increase of less than about 3 dB except under laboratory conditions, an increase of 0.8 dB in traffic noise would not be noticeable. Accordingly, construction-related traffic would not result in noise impacts.

5.7.2.2 Operation

5.7.2.2.1 Plant Operation

During normal plant operation, certain equipment such as the front-end loaders and cooling towers tend to dominate the shape and location of the noise contours (Figure 5.7-1). This analysis indicates that operational noise levels greater than 65 dBA would essentially be contained within the plant area. The measured ambient noise level at the residences to the west

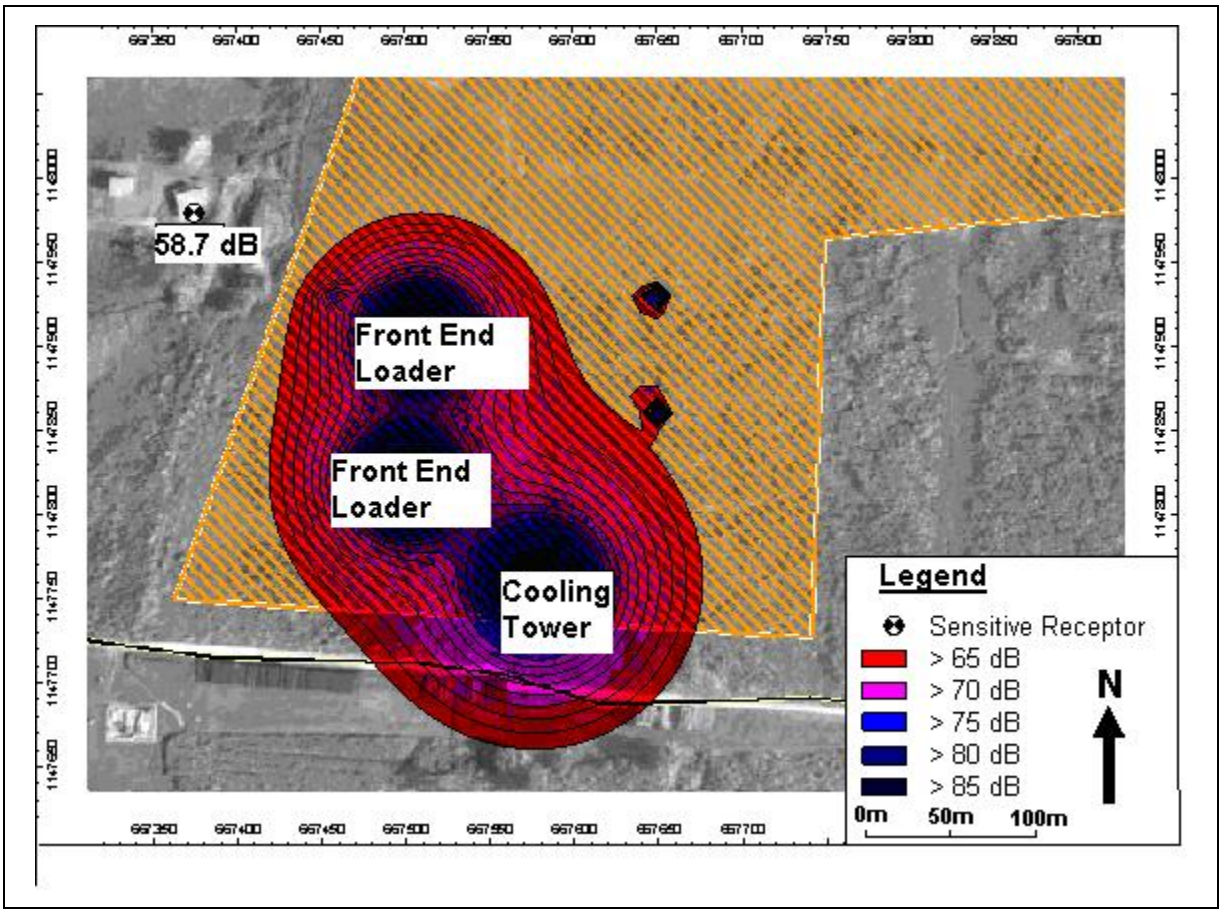

Figure 5.7-1. Plant operation noise contours.

of the plant is 51 dBA, and estimated plant noise would be 58.7 dBA, which would be approximately 8 dBA greater than the ambient noise level at this location. This exceedance is greater than the allowed 5-dBA exceedance by EMA and therefore would constitute a noise impact. Two types of noise impacts are possible: an "absolute" noise impact where noise levels would exceed a specified absolute noise standard (e.g., 65 dBA), or a "relative" noise impact where noise levels would exceed the ambient noise level by a specified amount (e.g., 5 dBA). A relative noise impact is a measure of the increased audibility of a potentially intrusive environmental noise source.

5.7.2.2.2 Motor Vehicle Traffic

The traffic associated with Project operation would increase existing traffic volumes by less than 8 percent. This increase in volume would result in a noise increase of less than 1 dB. Because the human ear normally cannot discern an increase of less than about 3 dB except under laboratory conditions, these noise increases would not be noticeable. Accordingly, vehicle traffic associated with Project operation would not result in noise impacts.

5.7.3 Cumulative Impacts - Noise

Two projects proposed in the general vicinity of CariSal, the Port at Claxston Bay North, and the PLSEIE, in conjunction with the CariSal Project could cause cumulative noise impacts at sensitive receptor locations near CariSal. Noise caused by dredging activities at the Port Project would be approximately 2.1 km from CariSal. No major noise sources are expected for the PLSEIE Project, approximately 300 m from the CariSal property. Since the noise produced by dredging activities would be required to be lower than that allowed for worker hearing conservation, noise levels would drop to ambient noise levels or below at a relatively short distance from the dredging site. While such noise might be audible at sensitive receptors near CariSal, the cumulative increase in noise level would be negligible.

Secondary noise effects caused by these projects would also include increased truck traffic along southern main road, which is located near sensitive receptors near CariSal. In addition, temporary construction noise caused by the widening of southern main road (with construction activity occurring approximately 830 m from CariSal) and construction of the NGC pipeline might be audible at sensitive receptors. Because of the masking effects of the existing ambient sound environment, the distances from noise sources to sensitive receptors, overall noise level of sources, as well as the sporadic nature of these activities, it is unlikely that secondary noise effects would cause any long term cumulative noise impacts.

In addition, EMA noise standards evaluate noise impacts on the basis of the difference between CariSal noise and ambient noise levels. Depending on the timing of these other projects, any increase in noise caused by these projects could be considered as part of the ambient noise environment, thus reducing potential noise impacts caused by CariSal activities.

5.8 DRAINAGE

To avoid a moderate to significant risk of flooding, the CariSal design incorporates engineering measures to isolate it from surface water run-on. The LNG River has a 1,480-ha drainage basin, and in times of sustained and heavy rainfall the valley floods, and water backs up from the west at least as far as Southern Main Road (Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007). The drainage channel to the north of the site occasionally backs up from Southern Main Road to the CariSal property. The Project would make a beneficial impact by reducing the amount of runoff from the CariSal property. Because the CariSal property constitutes less than 1 percent of the LNG River drainage basin, the beneficial impact would be minor. Additional drainage analysis was requested by the EMA and appears in Appendix G.

5.8.1 Construction Phase

The Project would alter the drainage patterns on the Project parcel in many ways. Site preparation activities such as vegetation stripping, raising the site elevation, and grading to enhance drainage would modify local watershed boundaries, eliminate existing flow channels, and create new flow paths. Temporary drainages would be created during construction to divert stormwater away from cleared areas. An SWPPP would be prepared for the site and would

include all sediment and erosion BMPs recommended by the U.S. EPA or included in CariSal's Response Document to EMA (DaCosta Gwendoline Limited & MHA, Inc. 2007).

No construction across drainages would occur during periods of rainfall. Construction in drainage beds would be completed as quickly as possible. Creek beds and banks would be protected by using soil stabilization techniques, temporary retention basins, and drainage diversion structures to reduce siltation due to runoff. Stockpiles of topsoil would be placed outside of drainage areas and within the designated pipeline right of way. A sediment and storm water management plan (the SWPPP) would be developed and implemented before any major earthwork is undertaken. The designs would include the installation of both permanent and temporary drains, complete with silt traps.

Although CariSal's responsibility does not extend to correcting the existing drainage problems within the estate, CariSal's drainage plan would be developed in collaboration with the Ministry of Works, Drainage Division. The Ministry of Works intends to upgrade the existing water-course of the LNG River, and CariSal's drainage plan would be developed with the Drainage Division's plan to straighten the LNG River east of Southern Main Road. CariSal has discussed with NEC ways to coordinate efforts to improve the drainage of the north drainage channel.

Construction-phase drainage impacts from the CariSal site are expected to be insignificant if the SWPPP is properly implemented. Depending on the rainfall frequency and intensity during the early site preparation activities, moderate drainage impacts to the CariSal site may result. Note that this Project-related impact does not imply an increased chance of flooding, but greater consequences to the site if flooding were to occur. Once the perimeter road base has been built to its design elevation, drainage impacts to the site should be beneficial due to the reduced risk of onsite flooding.

5.8.2 Operational Phase

The construction of roofed areas, paved areas, and concrete slabs in the plant area would decrease infiltration and increase runoff, but most of this runoff would be collected in the Containment Pit. Except for the undeveloped northern half of the site and *de minimis* areas around the site perimeter outside of the perimeter roads, runoff from all other site areas would drain into the retention pond or ponds.

Operation-phase drainage impacts from the CariSal site are expected to be beneficial by reducing runoff into the LNG River and the northern drainage channel, but minor because of the small size of the CariSal parcel. Operation-phase drainage impacts to the CariSal site are expected to be beneficial and significant by reducing the risk of site flooding.

Other projects in the area such as the proposed Westlake facility, the proposed Essar facility, and the development of the Point Lisas South and East Industrial Estate could contribute to cumulative drainage impacts. The anticipated effects of the removal of vegetation, compaction of soil, and the construction of roofed and paved areas include an increase in the rate and magnitude of surface runoff, increased erosion of river banks, increased turbidity and sedimentation of receiving waters, and flooding. The proposed Westlake drainage plan calls for stormwater runoff to be diverted to the LNG River at a maximum rate of 42.3 m3/sec during the design storm

(Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007). Wastewater and stormwater from the Essar site would also be discharged into the LNG River. At this time, information regarding the drainage plans for the proposed estate development is not known.

The Ministry of Works & Transport, Drainage Division requires that the peak flow from site discharge from runoff following development does not exceed the pre-development peak flow. Nevertheless, even if this condition is met on all of the parcels proposed for development, the post-development average flow could be higher than the pre-development flow due to the reduction in infiltration and the increase in total runoff. The increased flow in the area drainages and rivers could lead to more bank erosion and higher normal water flows and levels. The higher water levels could reduce the remaining available floodplain capacity during peak flow events and contribute to more frequent or higher level flooding. If runoff from any of the parcels under development contains soil particles, sediment build-up in the drainage channels could reduce the drainage capacity and contribute to more severe flooding.

Since the CariSal site would be developed to prevent any surface water run-on or runoff (except for the undeveloped northern half of the site and *de minimis* areas around the site perimeter), the development of the CariSal site would not contribute to these flows and would, in fact, have a marginally beneficial impact by preventing the runoff which currently occurs from the site. The analyses presented in Attachment 1 demonstrate the decrease in runoff from the site to both the northerly and southerly areas. The proposed project also would result in a net increase in the floodplain capacity for both drainage areas. The wetland areas would remain largely undisturbed physically, would receive similar amounts of runoff from the site per square meter of wetlands, and would remain hydrologically connected to the northern drainage channel.

Increased flows from other properties may induce flooding on the CariSal site, but only in the undeveloped wetlands areas. CariSal proposes isolating the plant area of the site hydraulically from the surrounding areas by constructing a system of perimeter berms and elevated roads to prevent any offsite run-on from flooding the site and to prevent any runoff from the plant area from discharging into surface water bodies. The net effect of capturing and storing all precipitation onsite would reduce the potential for downstream flooding in both the northern drainage channel and the LNG River to the south.

5.8.3 Decommissioning Phase

During decommissioning, the perimeter dikes and retention ponds would remain in place until most of the land had been restored to its final grades and revegetated. Finally, the perimeter dikes and retention ponds would be removed or breached to restore distributed runoff.

No adverse drainage impacts during or after the decommissioning phase, compared to the initial conditions, are expected.

5.9 AIR QUALITY IMPACTS

This section of the EIA assesses the air quality impacts of the proposed chlor-alkali facility. The methodology presented here is used to assess the construction and operation of the facility over

the proposed 20-year life span of the facility. Impacts are presented and discussed relative to the Trinidad and Tobago air quality permissible levels as documented in the draft *Trinidad Air Rules* (Republic of Trinidad and Tobago. 2005).

5.9.1 Location and Land Use

The proposed plant would occupy an approximately 11.8-ha lot of land bounded on the north by parcel 4A of the proposed East and South Point Lisas Industrial Estate operated by NEC, on the east by an NGC pipeline corridor and a T&TEC corridor, on the west by Southern Main Road and the existing Point Lisas Industrial Estate operated by PLIPDECO, on the south by North Sea Road with the proposed Essar Steel plant farther southwest, and the proposed Westlake ethylene complex to the southeast.

The nearest meteorological station that measures wind hourly is EMA's aerometric monitoring unit located at PLIPDECO car park in the Point Lisas Industrial Estate about 4.1 kilometres north of the CariSal site. The next nearest wind monitoring station is located at Piarco International Airport about 28 kilometres to the northeast of the Project.

The proposed site is zoned for industrial development and has gently rolling flat terrain. A map of the immediate area is shown in Figure 3.2-2 in Chapter 3.

Land use surrounding the meteorological observation site is used to characterize the development of the boundary layer for dispersion characterization as the meteorological site is intimately linked with the surface characteristics and the observed meteorological values.

Land use within a 3-km radius surrounding the meteorological observation site is used to characterize the land use for air quality modelling purposes. The EMA monitoring site, located at 666,978 meters Easting, 1,151,815 meters Northing was used in conjunction with GoogleEarth™ to estimate the surrounding area land use. For air quality modelling, land use is characterized as one or more of the following types: water (fresh and sea), deciduous forest, swamp, cultivated land, grassland, urban, or desert shrub land. Five sectors were identified for the 3-km radius. Table 5.9-1 shows the sector boundaries and the distribution of land use within each sector. The air quality model requires values for three parameters to estimate boundary layer development and other dispersion parameters: surface albedo (surface reflectivity); Bowen ratio (ratio of sensible heat to latent heat); and surface roughness. Relationships between land-use and these three parameters are available for the model but have a seasonal dependency. However, these seasonal dependencies were developed for mid-latitude locations. To best estimate the wet/dry seasonal variation of Trinidad's tropical climate, each month of the year was assigned to either mid-latitude summer or autumn, depending on which phase of the dry/wet season the month most likely represents, with wet-season months (July through December) most similar to mid-latitude summer and dry-season months (February through May) most similar to mid-latitude autumn. January and June were characterized as transitional months.

Table 5.9-1. Land-use Characterization within a 3-km Radius of Meteorological Monitoring Site

Sector	Degrees from North		Percent of Sector Covered					
	Minimum Angle	Maximum Angle	Water (fresh and sea) (%)	Deciduous Forest (%)	Swamp (%)	Cultivated Land (%)	Grassland (%)	Urban (%)
1	333	86		5		45		50
2	86	140		10		60	20%	10
3	140	215				33		67
4	215	250	25			8		67
5	250	333	34		33	17		17

5.9.2 Operational Emissions

5.9.2.1 Source Information

Emissions from the proposed chlor-alkali plant were estimated assuming that the plant would be operated continuously—24 hours a day, 7 days a week, 365 days per year.[6] Thus, the emission rates for both the short term (g/s) and the long-term (MT/yr) are the same.

The proposed plant would have the following emission source components:

- three natural gas-fired 7.5-megawatt Solar Taurus 70 (T-10301) co-generation or equivalent industrial gas turbine generators
- 94-percent calcium chloride fluidized bed dryer (two-stage scrubbing system)
- 77-percent calcium chloride dryer and cooler (two-stage scrubbing system)
- hydrogen chloride plant (with Cl_2 scrubber)
- hydrogen chloride intermediate storage tanks (with HCl scrubber)
- calcium chloride storage tanks
- storage and packing of calcium chloride (with scrubber)
- lime dust silo vent (with bag house)
- diesel-fired fire pump (maximum size of 150 hp)
- two cooling towers

The major physical structures of the current plant design are:

[6] The plant is anticipated to operate 350 days per year, with shut downs occurring only for emergency repairs. Routine maintenance can be performed without interrupting operation of the plant. Thus the assumption of continuous operation is conservative.

- 42-percent calcium chloride liquid processing tanks (one 18,000-gal receiver and one 500,000-gal storage)
- Caustic soda storage tank (four 81,000-gal and one 15,000-gal)
- 12-percent sodium hypochlorite storage tanks (four 45,000-gal and two 7,000-gal)
- Brine and solid feed tanks (26 tanks with a total capacity of 500,000 gal)
- HCl tanks (four 20,000-gal receivers, one 400,000-gal storage)
- Feed (NaCl) tanks (one 377,000-gal, one 100,000-gal, two 63,000-gal)
- Process water tank (one 600,000-gal)
- WASA water tank (one 600,000-gal)
- Chlor-alkali plant
- Maintenance building
- Warehouse
- Administration building
- Cooling tower (two cells)
- Gas-fired turbine generators (cogeneration plant)
- Electrical substation building
- Salt shed and lime bin
- Limestone storage pile

The plot plan for the facility, which identifies its major structures and layout, is shown in Chapter 3, Figure 3.2-2. The effect of building downwash also has been incorporated into the modelling using direction-specific building-downwash parameters calculated using the U.S. EPA Building Profile Input Program (BPIP), Version 95086, based on the facility layout and building, tanks, and other structures heights.

5.9.2.1.1 Stack Information

The facility's stack parameter information (stack height, flow rate, exit temperature) are shown in Table 5.9-2. Four calcium chloride storage tanks, vented to the atmosphere, are included.

Table 5.9-2. Maximum Annual Operational Stack Parameters and Locations for the CariSal Facility Point Lisas

Emission Point Point Sources	UTM Easting (metres)	UTM Northing (metres)	Stack Height (metres)	Exit Temp. (deg C)	Actual Volumetric Flow Rate (m^3/s)
Chlorine scrubber train 1	667,545	1,147,840	22.9	39	0.17
Chlorine scrubbers train 2	667,591	1,147,840	22.9	39	0.17
HCl scrubber	667,579	1,147,887	10.7	40	0.24
Electrolysis (Hydrogen excess) No. 1	667,561	1,147,834	10	87	0.075
Electrolysis (Hydrogen excess) No. 2	667,574	1,147,834	10	87	0.075
Packing $CaCl_2$	667,415	1,147,846	12.2	40	0.58
94% Dryer	667,455	1,147,873	32	40	49.6

Table 5.9-2. Maximum Annual Operational Stack Parameters and Locations for the CariSal Facility Point Lisas

Emission Point	UTM	UTM	Stack Height	Exit Temp.	Actual Volumetric
77% Dryer/Cooler	667,450	1,147,847	30.5	60	4.72
Cogen (3 CH_4 fired @ 7.5 MW ea)	667,586	1,147,771	15	517	52.5
Cooling tower	667,493	1,147,774	11.7	36	0.036
Cooling tower	667,493	1,147,761	11.7	36	0.036
Lime dust silo vent	667,416	1,147,837	12.2	40	0.48
Volume Sources	**UTM Easting (meters)**	**UTM Northing (metres)**	**Release Height (metres)**	**Initial Width (metres)**	**Initial Length (metres)**
Diesel-fired firewater pump	667,558	1,147,905	3.0	1.0	1.0
Backup generators	667,609	1,147,779	3.0	1.0	1.0
$CaCl_2$ storage tank No. 1	667,429	1,147,888	8.6	1.0	1.0
$CaCl_2$ storage tank No. 2	667.429	1,147,876	8.6	1.0	1.0
$CaCl_2$ storage tank No. 3	667,429	1,147,848	8.6	1.0	1.0
$CaCl_2$ storage tank No. 4	667,429	1,147,836	8.6	1.0	1.0

5.9.2.1.2 Operational Emissions

Table 5.9-3 shows the maximum emission rates for the stationary emission sources plus the mobile source emissions associated with plant operations, which include pickup of product and deliveries of salt, lime and limestone, commuter emissions, and in-plant activity. Storage tank emissions are principally due to evaporation through a single vent.

Table 5.9-3. CariSal Annual Average Emissions (MT/yr) Summary

Description	Dust	TSP	PM_{10}	$PM_{2.5}$	HCl	Cl_2	H_2	NO_x	CO	SO_2
Point Sources										
Chlorine Scrubbers Train 1	0.00	0.00	0.00	0.00	0.00	0.0070	0.00	0.00	0.00	0.00
Chlorine Scrubbers Train 2	0.00	0.00	0.00	0.00	0.00	0.0070	0.00	0.00	0.00	0.00
HCl Scrubber	0.00	0.00	0.00	0.00	0.024	0.00	117.00	0.00	0.00	0.00
Electrolysis (Hydrogen Excess) Unit 1	0.00	0.00	0.00	0.00	0.00	0.00	60.50	0.00	0.00	0.00
Electrolysis (Hydrogen Excess) Unit 2	0.00	0.00	0.00	0.00	0.00	0.00	60.50	0.00	0.00	0.00
Packing $CaCl_2$	1.35	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94% Dryer	2.72	5.05	0.52	0.40	0.00	0.00	0.00	43.00	36.10	0.26
77% Dryer/Cooler	2.33	3.97	0.36	0.20	0.00	0.00	0.00	1.20	1.00	0.01

Table 5.9-3. CariSal Annual Average Emissions (MT/yr) Summary

Description	Dust	TSP	PM_{10}	$PM_{2.5}$	HCl	Cl_2	H_2	NO_x	CO	SO_2
Cogen (3 CH_4 fired @ 7.5 MW each)	0.00	2.02	2.02	2.02	0.00	0.00	0.00	97.70	25.00	1.04
Cooling Tower Unit One	0.00	0.00	0.002	0.001	0.00	0.00	0.00	0.00	0.00	0.00
Cooling Tower Unit Two	0.00	0.00	0.002	0.001	0.00	0.00	0.00	0.00	0.00	0.00
Lime Dust Silo Vent	0.00	0.000134	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Summary of Point Sources	6.4	12.34	2.904	2.622	0.024	0.014	238.00	141.9	62.1	1.31
Mobile Sources										
Inbound/Outbound Material Trucks	0.649	0.470	0.067	0.019	0.000	0.000	0.00	0.105	0.056	0.015
Employee Commuter Vehicles	0.035	0.026	0.003	0.000	0.000	0.000	0.00	0.012	0.175	0.000
In-plant Vehicle Activity	0.000	0.025	0.024	0.023	0.000	0.000	0.00	0.318	0.153	0.027
Summary of Mobile Sources	0.684	0.521	0.093	0.042	0.000	0.000	0.00	0.435	0.384	0.042
Stationary Sources										
$CaCl_2$ Storage Tank # 1	0.0004	0.0008	0.0001	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000
$CaCl_2$ Storage Tank # 2	0.0004	0.0008	0.0001	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000
$CaCl_2$ Storage Tank # 3	0.0004	0.0008	0.0001	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000
$CaCl_2$ Storage Tank # 4	0.0004	0.0008	0.0001	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000
Diesel-fired Firewater Pump	0.0000	0.0009	0.0009	0.0009	0.0000	0.0000	0.0000	0.000	0.000	0.000
Backup Generators	0.0000	0.0451	0.0451	0.0435	0.0000	0.0000	0.0000	0.563	0.324	0.047
Summary of Stationary Sources	0.002	0.049	0.046	0.045	0.0000	0.0000	0.0000	0.563	0.324	0.047
Grand Total (All Sources)	7.09	12.96	3.09	2.75	0.024	0.014	238	143.46	63.13	1.45

The facility would collect three types of materials to be stored in storage piles: lime would be received as pebble lime by truck and stored in covered bins; limestone would be received as 2-inch by 4-inch (5-cm by 10 cm) rock and stored in an open pile of up to 20,000 MT; and salt (NaCl) would be stored in a covered shed containing up to 8,000 MT. Because these sources would either be housed (lime and salt) or received as amalgamated material (limestone), emissions to the ambient air are not expected to occur and are not included in the air dispersion modelling analysis.

The motor vehicle emissions are based on the average number of vehicles (plant personnel of two shifts of 60 people and an additional weekday staff of 15 personnel along with the routine delivery of materials and pickup of product) accessing the site daily. Truck deliveries assumed the continuation of the current 1500-ppm sulphur content diesel. Truck pickup and delivery were assumed to travel twice the length of the longest loading area(s). Also included are the onsite emissions from the dump trucks, front-end loaders, and forklifts that would operate to move solid waste, packaging of calcium chloride, container handling, and moving product from the salt, lime, and limestone piles. Emission factors as used in the USEPA NONROAD model (Exhaust and Crankcase Emission Factors for NONROAD Engine Modelling—Compression-Ignition, Report No. NR-009C, 2004) were used based on typical horsepower rating of equipment and assuming typical U.S. fleet average age distribution and deterioration rates except for the front-end loaders which will meet or exceed EPA Tier 1 emission standards.

5.9.2.1.3 Emissions Controls

The chlor-alkali facility would use the best control technology to reduce emissions to the environment. This technology would include scrubbers to reduce emissions of chlorine and HCl, as well as the wet calcium chloride emissions from the dryer and cooling operations. To reduce emissions from the packaging and the handling of lime dust, bag house technology would be used. Finally, emissions from the co-generation unit would use clean natural gas and operate at high load levels to achieve maximum thermal efficiency, which increases overall efficiency and effectively reduces emissions. Details about the control technology for each process are provided below.

Dryer and Cooler Units

The 94-percent scrubbing system would use a two stage scrubbing system. In the first stage a Sulzer designed Fluid Bed Spray Dryer is used which includes a 98.5% efficient wet scrubber that reduces CaCl2 emissions to 5.44 kg/hr (12 lbs/hr). This emission rate is lowered further by using a second scrubber equivalent in performance to a Ducon dynamic wet scrubber. The Ducon scrubber reduces emissions to an overall removal efficiency of 99.82%. This approach using two scrubbers - one to reduce the gross amount of contaminant and a second to capture the fine particles remaining is an effective means of pollution control with a high degree of operational integrity. The 77-percent cooler/dryer system is similar to the 94-percent dryer in that a cyclone removes the bulk of calcium chloride captured in the dryer-cooler and the air scrubber receives the reduced calcium chloride content. Air discharged from both the 77 percent cooler and dryer are vented through a single scrubber system equivalent in performance to a Ducon dynamic wet scrubber. Emissions are again reduced to a removal efficiency of approximately 99.75%.

Lime Dust Bag House and Packing

Lime dust emissions would come from the pneumatic unloading of truck shipments. The lime is used to neutralize the 42-percent calcium chloride solution prior to drying. The bag house design would employ best available technology achieving 99.99 percent removal. The technology would likely use a pressure blow back bag house with capture characteristics of BHA Tex (or another comparable manufacturer) with similar bag material efficiency with rerouting the discharge point to dust system reducing dust exposure.

For the material handling package area, a Ducon dynamic wet scrubber will be used to control dust emissions. The Ducon system provides an overall collection efficiency of 99.5 percent.

Hydrogen Chloride Scrubber

The HCl tail gas scrubber would likely use the SGL CARBON design that operates by having hydrogen and chlorine gases fed into a burner. The gases flow into two concentric tubes, with chlorine flowing through the inner burner tube and hydrogen through the annulus between the inner and outer burner tubes. The gases are mixed in the burner and react to produce HCl gas. Only high-performance materials (impregnated graphite) contact the HCl gas or acid. The flow of hydrogen is carefully monitored at a constant excess of 5 – 15 percent compared to the stoichiometric balance (operates with an automatic ratio control Cl_2/H_2) to ensure that the vent gas contains no chlorine. The HCl is cooled in the combustion chamber and reaches the film absorber where it is absorbed in absorption water to form hydrochloric acid. The concentration of the hydrochloric acid is monitored and adjusted to a constant concentration by automatic control of the absorption water supply rate. The weak residual gas (containing excess hydrogen and some HCl) leaves the absorber and is fed into the bottom of the scrubber. It passes through the scrubber counter-currently to the flow of the absorption water, which is fed to the top of the scrubber where hydrogen and small amounts of HCl gases are vented to the atmosphere.

Chlorine Scrubber

The chlorine scrubber would be constructed with titanium to provide high reliability and availability of the absorption system to remove chlorine gas through absorption to a maximum of 0.5 ppm. All pumps used as part of the system would be made from titanium. Cooling of the reactors would be by means of titanium plate heat exchangers using cooling water.

Cogeneration Unit

A cogeneration cycle consists of a gas turbine with a heat recovery steam generator. A cogeneration unit operates most efficiently to reduce NO_x and CO emissions when it is operated at high thermal efficiency. CariSal would operate the unit at 80- to 100-percent load during routine operations of the facility. The unit would comply with ISO 2314 for combined-cycle power plants.

5.9.3 Construction Emissions

Initial construction of the chlor-alkali facility would occur over 11 months with initial site grubbing, filling, and grading occurring during the first two months. Initial construction activities would consist of site preparation, which would include cutting of the sugarcane and grasses and grubbing the area that would be occupied by the plant facilities. About 45 percent of the site vegetative cover would need to be cleared; this area would cover approximately 5 ha. Filling and grading work would also be required to raise the process area and to promote drainage. The site would require an estimated 80,000 m^3 of fill, or about 40,000 m^3 of fill each month. The equipment type, quantity, and rate per day and per month used to complete this activity are shown in Table 5.9-4.

Table 5.9-4. Equipment Associated with Site Preparation Activities for the CariSal Chlor-alkali Plant in Point Lisas

Equipment	Quantity	Earth Moved Per Day (m^3/day)	Earth Moved Per Month (m^3/month)
Bulldozers	1	1,500	30,000
Excavators	1	2,000	40,000
Scraper Boxes	1	5,000	100,000
Trucks (fill)	3	2,000	
Compactors	1		
Motor graders	1		
Water tender	1		
Total			**170,000**

Emissions estimates have been developed based on the above construction equipment assuming the equipment is fuelled with diesel having 1500 ppm sulphur. The equipment is to be operated on a 10-h workday schedule, 5 days per week. This operating information was used in combination with the horsepower rating assuming typical U.S. fleet average-age distribution and deterioration rate for construction equipment to estimate emissions during the site-excavation period. The onsite bulldozer, excavator, and motor grader will meet or exceed U.S. EPA Tier 2 non-road internal combustion engine emission standards. Emission factors were developed based on the U.S. EPA NONROAD2004 model (Exhaust and Crankcase Emission Factors for NONROAD Engine Modelling – Compression-Ignition, Report No. NR-009C, 2004). Fugitive emissions from earth-movement activity are included in the analysis based on soil disturbance emission factors as reported in U.S. EPA AP-42, Chapter 13.2, "Fugitive Dust Sources." As shown in Table 5.9-4, CariSal would employ the standard best practices of watering trucks (water tender) to minimise fugitive dust emissions. For the on-road trucks (dump trucks), emissions were estimated based on the gross vehicle weight rating (GVWR), average daily mileage travelled while at the facility and average travel speed. Table 5.9-5 summarizes the average daily emissions during site preparation activities. Emissions estimates were not developed for the post-site preparation period as the earth movement activity should be substantially lower and onsite motor vehicle activity would be less than during the site-preparation period.

Table 5.9-5. CariSal Annual Average Daily Emissions (kg/day) During Site Preparation Activities for the CariSal Chlor-alkali Plant in Point Lisas

Description	Dust	TSP	PM_{10}	$PM_{2.5}$	NO_x	CO	SO_2
Exhaust							
Bulldozers	0.00	0.75	0.72	0.51	12.74	11.16	1.61
Excavators	0.00	0.56	0.54	0.39	10.13	7.26	1.21

Scraper Boxes	0.00	0.77	0.74	0.71	8.80	4.01	0.75
Trucks (fill)	0.00	1.01	0.97	0.93	14.75	8.01	2.21
Compactors	0.00	0.21	0.20	0.20	1.34	1.24	0.12
Motor Graders	0.00	0.25	0.24	0.17	4.11	2.86	0.53
Water Tender	0.00	0.71	0.69	0.66	8.18	3.72	0.69
Summary of Exhaust Sources	0.00	4.26	4.09	3.57	60.05	38.25	7.12
Fugitive Dust (Earth Movement Activities)							
Bulldozers	6.23	4.60	0.67	0.35	0.00	0.00	0.00
Excavators	6.23	4.60	0.67	0.35	0.00	0.00	0.00
Scraper Boxes	0.83	0.62	0.09	0.05	0.00	0.00	0.00
Trucks (fill)	0.17	0.14	0.04	0.01	0.00	0.00	0.00
Compactors	16.23	4.60	0.67	0.35	0.00	0.00	0.00
Motor Graders	6.23	4.60	0.67	0.35	0.00	0.00	0.00
Water Tender	0.24	0.18	0.03	0.00	0.00	0.00	0.00
Summary of Fugitive Dust Sources	26.18	19.34	2.85	1.44	0.00	0.00	0.00
Grand Total (All Sources)	**26.18**	**23.60**	**6.94**	**5.01**	**60.05**	**38.25**	**7.12**

5.9.4 Start-up Emissions

Based on engineering design of the facility, emissions from start up of the chlor-alkali facility are substantially less than those generated during routine operation. Thus the emissions during the operation of the facility represent the highest emission rate estimate and the potential for highest ambient concentrations. Therefore, no modelling of the start-up emissions was performed.

5.9.5 Regulatory Review Criteria

5.9.5.1 Standards and Criteria Levels

The proposed chlor-alkali facility would be a source of hydrochloride (HCl), chlorine (Cl_2) nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO) emissions, as well as particulate matter of all sizes. Particulate matter can be characterized as TSP, as well as the fraction considered "inhalable" particles (PM_{10}) and the portion consisting of fine particles ($PM_{2.5}$).

Table 5.9-6 shows the modelling averaging periods and levels of ambient air concentrations to which the modelling results would be compared. For the purposes of the air quality impact assessment, all averaging periods are based on maximum emission rates and predicted concentrations for all averaging periods would be compared to the applicable ambient air quality standard.

Table 5.9-6. Summary of the Applicable Trinidad Permissible Levels from the 2005 Trinidad and Tobago (Draft) Air Pollution Rules

Air Pollutant	Averaging Period	Permissible Level (µg/m³)
Total Suspended Particulate	24-hour	150
PM_{10}	24-hour	75
PM_{10}	Annual	50
$PM_{2.5}$	24-hour	65
$PM_{2.5}$	Annual	15
Hydrogen Chloride	30-minute	100
Chlorine	30-minute	300
Nitrogen Dioxide (NO_2)	1-hour	200
Nitrogen Dioxide (NO_2)	Annual	40
Carbon Monoxide	1-hour	30,000
Carbon Monoxide	8-hour	10,000
Sulphur Dioxide	24-hour	125
Sulphur Dioxide	Annual	50

For estimating the 30-min HCl and Cl_2 concentration from the 1-hour concentration, CariSal used the 1/5 power law relationship based on estimates made by the Turner Workbook (Turner 1994). This relationship provides a reasonable upper-bound estimate for the shorter-term averaging period from the 1-hour concentrations modelled. This can be expressed as:

$$X_{0.5} = X_1 (0.5/1.0)^{-0.2}$$

where the subscript 0.5 is the half-hour time period and 1 is the 1-hour time period, and X is the concentration.

5.9.6 Air Quality Analysis

5.9.6.1 Dispersion Modelling

5.9.6.1.1 Model Settings

For the operational and start-up air quality analysis, the U.S. EPA AERMOD (Version 07026) model is proposed. This latest version of U.S. EPA's air quality models has undergone extensive model testing and evaluation[7] in recent years and represents the best air quality modelling approach for this size facility. This state-of-the-science Gaussian dispersion model developed by U.S. EPA is aimed at short-range (< 50-km) dispersion from stationary industrial sources and was designed as a replacement to U.S. EPA's ISC3 model. AERMOD is U.S. EPA's recommended air quality model for near-field (< 50-km) impact assessments. Relative to ISC3, AERMOD contains new or improved algorithms for:

- dispersion in both the convective and stable boundary layers;
- plume rise and buoyancy;
- plume penetration into elevated inversions;
- computation of vertical profiles of wind, turbulence, and temperature, via the American Meteorological Society (AMS)/U.S. EPA Regulatory Model (AERMOD) meteorological preprocessor, AERMET;
- the treatment of receptors on all types of terrain;
- the treatment of building wake effects using the improved Plume Rise Model Enhancements (PRIME) wake effects modelling algorithm;
- an improved approach for characterizing the fundamental boundary layer parameters; and
- the treatment of plume meander and most recently the inclusion of the state-of–the-science wet and dry deposition model.

Initial consideration was given to the California Gaussian Puff (CALPUFF) air quality modelling system if long-range transport and recirculation were at issue for the CariSal facility, but because of the relatively low stacks (< 33 meters) and limited initial plume rise, maximum concentrations are likely found within 5 kilometres of the facility. Preliminary screening of the CariSal facility confirmed the use of a near-field model such as AERMOD because maximum concentrations were all found within a few kilometres of the facility. Also important for this analysis was the use of the state-of-the-science building wake effects algorithm (PRIME), which is available in AERMOD, but not in CALPUFF. AERMOD also includes state-of-the-science wet and dry deposition algorithms for characterizing near-field ambient air quality concentrations as well as an up to date algorithm for plume meander – important during low wind speed conditions. Thus AERMOD was the preferred modelling choice for the air quality impact analysis.

[7] USEPA has posted a number of papers on the model's capability and performance relative to more than a dozen field studies including conditions during low wind speed periods. These are available for download and review at http://www.epa.gov/scram001/dispersion_prefrec.htm#aermod

AERMOD was applied using 2 years of nearby representative onsite meteorological data from the EMA's Point Lisas monitoring site for 2005 and 2006. The monitoring site is located 4.1 kilometres north of the CariSal site. The AERMET preprocessor model was used to develop the meteorological dataset for use with the AERMOD. Meteorological data information on cloud cover was used from Piarco International Airport (because these data are not collected by the EMA) and to supplement the onsite data when missing.

AERMOD was run with the following options:

- U.S. EPA regulatory default options (include calm processing[8])
- Direction-specific building downwash
- Missing meteorological data processing
- Direction-specific dispersion processing (land-use based)
- In lieu of in-stack emissions tests, conservative assumptions were:
  - a 0.75 NO_2-to-NO_x ratio for annual NO_2 (U.S. EPA Guideline on Air Quality Models, Appendix W)[9]
  - a 0.10 NO_2-to-NO_x ratio for short-term (1-hour) conversion (5 percent in stack and 5 percent within hour of release)

AERMOD has two methods for estimating dry deposition: Method 1 and Method 2. Method 1 is used if a significant fraction (greater than 10 percent, approximately) of the total particulate mass has a diameter of 10 µm or larger, which is the situation for CariSal. Thus Method 1 was used in the air quality analysis. Wet deposition was also modelled using the hourly rainfall information available from EMA's meteorological monitoring site.

5.9.6.2 Meteorological Data

The AERMOD meteorological preprocessor (AERMET) version 06341 was used to process the Point Lisas data (hourly wind speed, direction, temperature, and rainfall) and the Piarco cloud cover and upper-air data for use in AERMOD. AERMET uses the upper-air data to determine the convective mixing height (an estimate of the potential daytime mixing height). The convective mixing height is determined from the surface temperature and the vertical variation in the potential temperature as observed from the morning sounding.

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[8] The AERMOD model calculates period and annual averages by summing the total number of hourly concentrations in the period and dividing by the number of hours (minus calm hours). This is referred to as calms processing. A calm hour is defined as an hourly average wind speed in which the winds average less than 0.5 m/s. During these conditions the measurement precision of wind speed and wind direction is not reliable; therefore, the calms processing routine sets concentrations to zero for calm hours, and short term averages are calculated by skipping results for that hour. For example, if 24 hours of data are run for a pollutant concentration, in which hour 14 is a calm hour, a simple average would result in a lower concentration due to the inclusion of the calm hour's zero value. However, calms processing, excludes the zero concentration from the calm hour resulting in a more reliable concentration. The Point Lisas meteorological data has 4.0% in 2005, and 1.4% in 2006, of the hourly wind speed data in which wind speeds are less than 0.5 m/s.

[9] Unless the available ozone limits the conversion of NOx to NO_2 in which case the ozone concentration would be equal to the NO_2 concentration

5.9.6.3 Ambient Conditions

Background air quality concentrations from the nearby EMA Point Lisas monitoring site were used to develop background concentration records for particulate matter (PM_{10}, SO_2, CO, and NO_2). In addition, CariSal conducted onsite ambient monitoring for these same pollutants, plus TSP, $PM_{2.5}$, as well as for HCl and Cl_2, over a 1-month period starting in late October 2007. The higher combination of the EMA data and these onsite data were used to establish the existing maximum background ambient air quality concentrations levels at the CariSal site location. Table 5.9-7 summarizes the current background based on the results from these two datasets. Only the 24-hour PM_{10} data show problems with meeting the permissible level.

Table 5.9-7. Background Air Quality at the CariSal Site Based on Measurements from EMA's Point Lisa's Monitoring Site and Onsite Monitoring

Air Pollutant	Averaging Period	Trinidad Draft Rules (2005) Permissible Level		EMA Monitored Concentration[a]		On-Site Monitoring[b]		Max Back-ground
				Max Obs.	Annual Average	Max Obs.	Period Average	
Units			µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Total Suspended Particulate	24-hour		150	NM	NM	89.0	N/A	89.0
PM_{10}	24-hour		75	154.4	N/A	60.1	N/A	154.4
PM_{10}	Annual		50	N/A	25.8	N/A	24.4	25.8
$PM_{2.5}$	24-hour		65	NM	NM	20.8	N/A	20.8
$PM_{2.5}$	Annual		15	NM	NM	N/A	7.9	7.9
Units		µg/m³	ppb	ppb	ppb	ppb	ppb	ppb
Hydrogen Chloride (HCl)	30-min	100	67	NM	NM	5.8[c,d]	N/A	5.8
Chlorine (Cl_2)	30-min	300	103	NM	NM	6.0[d]	N/A	6.0
Nitrogen Dioxide (NO_2)	1-hour	200	106	37	N/A	38	N/A	38
Nitrogen Dioxide (NO_2)	Annual	40	21.0	N/A	5.0	N/A	8.4	8.4
Carbon Monoxide (CO)	1-hour	30,000	26,196	13,200	N/A	363	N/A	13,200
Carbon Monoxide (CO)	8-hour	10,000	8,732	2,130	N/A	123	N/A	2,130
Sulphur Dioxide (SO_2)	24-hour	125	48	21.4	----	2.5[e]	N/A	21.4
Sulphur Dioxide (SO_2)	Annual	50	19	----	2.0	N/A	2.5[e]	2.5

Notes:
[a] Air quality Monitoring for EMA data started in October 2004 except for PM_{10}, which began in March 2006.
[b] Air quality was monitored at CariSal over a 30-day period during October and November 2007.
[c] Based on ½ the minimum detection limit of 4 ppb for 24 hours, then scaled by 1/0.4 (= 2.5) based on U.S. EPA 1992.
[d] 1/5 power law relationship applied to estimate peak 30-min from 1-hour observed concentration
[e] 1/2 the minimum detection limit of 5 ppb
N/A - Not Applicable
NM - Not Monitored

5.9.6.4 Receptors

Based on screening modelling, maximum impacts were identified to occur within 5 kilometres of the proposed facility. To capture the maximum concentration, the following receptor grid was used in the AERMOD modelling:

- Receptors were placed at 50-m intervals around the property boundary (fence line)
- A 100-m inner grid extending to 1 kilometres around the facility boundary
- A 250-m outer grid around the 1-km grid extending to 5 km

Figure 5.9-1 illustrates the layout of the fence line and inner and outer receptor grids used in the air quality modelling assessment. In addition to the gridded receptors, sensitive receptors were included in the air quality modelling. The locations of these sensitive receptors are shown in Figure 5.9-2 (see also Chapter 10).

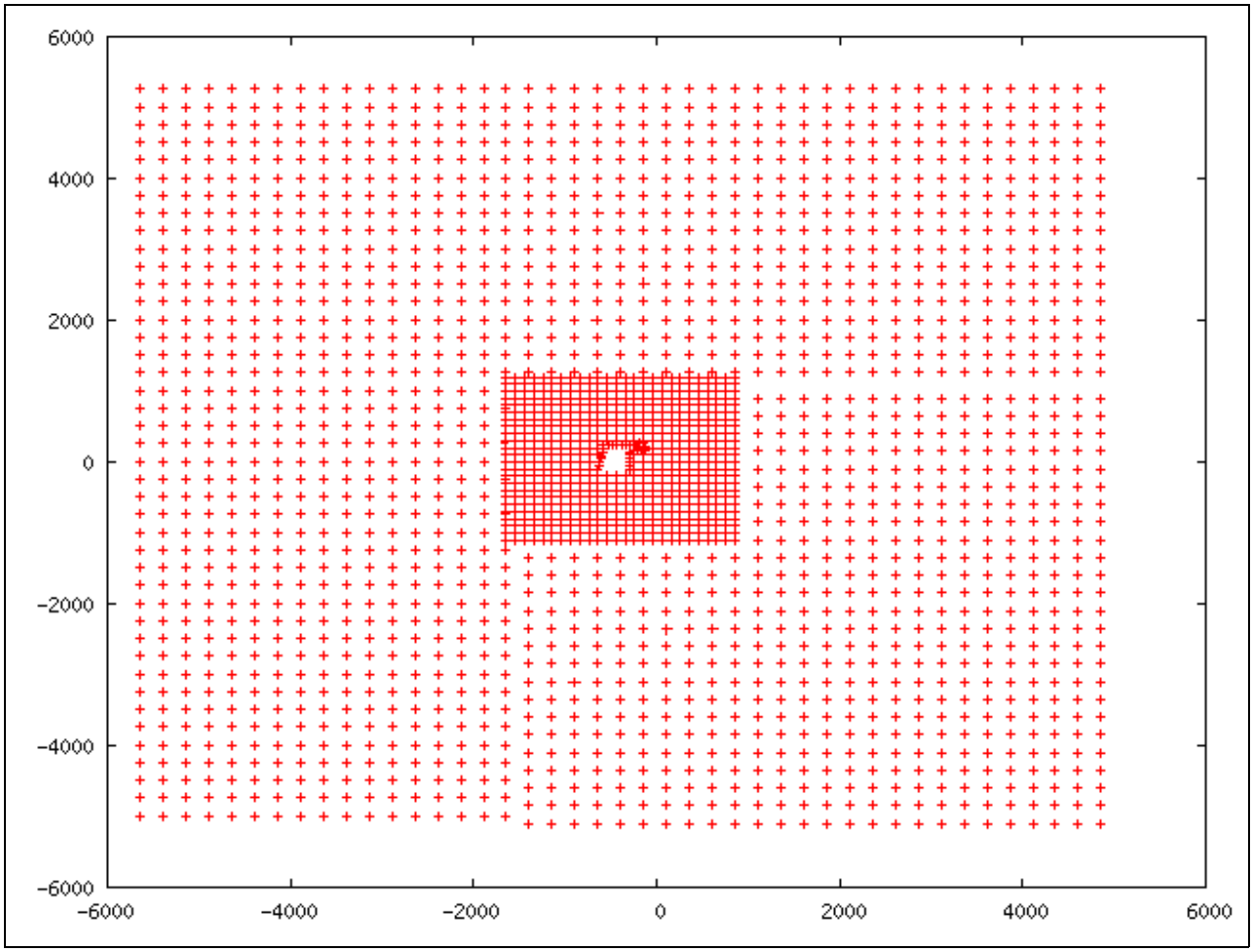

Figure 5.9-1. Air quality modelling receptor grid.

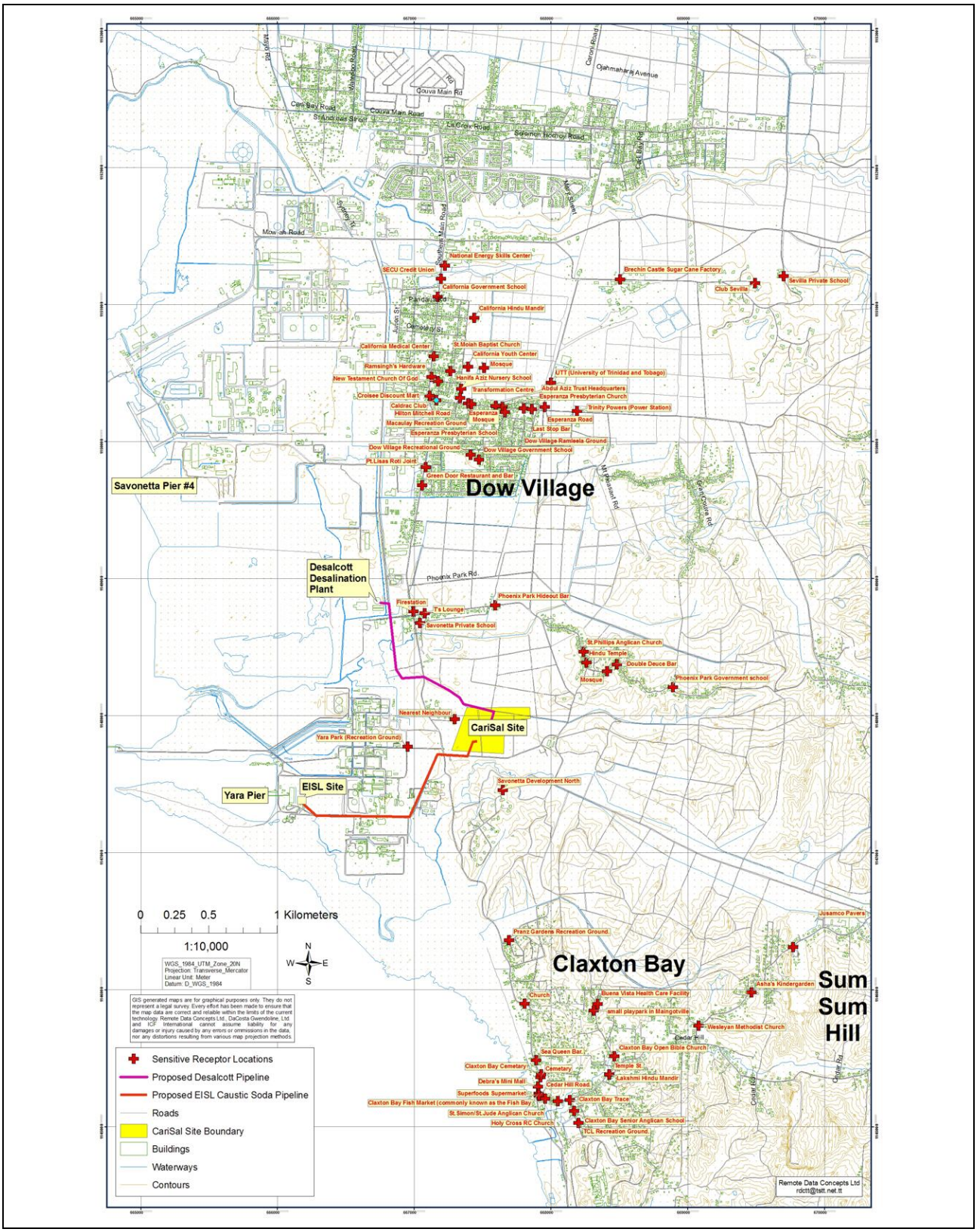

Figure 5.9-2. Sensitive receptor locations in the vicinity of the CariSal Project.

5.9.6.5 Impact Assessment

5.9.6.5.1 Routine Impact and Cumulative Impact Assessment

Air quality modelling for the proposed CariSal facility was performed with the AERMOD air quality model, using emissions based on routine operation of the plant. In addition to the CariSal emissions, air quality modelling for the two proposed facilities, Essar Steel and Westlake, were modelled using their emission rates (as identified in their respective EIAs) to determine the overall impact. Tables 5.9-8 and 5.9-9 show the emission rates used in the modelling for the Westlake[10] and Essar[11] facilities.

Potential emissions from the development of industrial estate for Point Lisas South and East as well as from the proposed port facilities at Point Lisas South and East were also considered for the cumulative analysis.

Table 5.9-8. Westlake Annual Average Emissions (MT/y) Summary

Description	Coordinates (metre)		Emissions				
	UTM E	UTM N	TSP/PM_{10}	SO_2	NO_x	CO	$PM_{2.5}$
Furnace	669,392.9	1,147,475.0	4.70	0.00	161.88	126.89	3.48
Furnace	669,392.9	1,147,459.7	4.70	0.00	161.88	126.89	3.48
Furnace	669,392.9	1,147,443.2	4.70	0.00	161.88	126.89	3.48
Furnace	669,392.9	1,147,427.2	4.70	0.00	161.88	126.89	3.48
Furnace	669,392.9	1,147,411.4	4.70	0.00	161.88	126.89	3.48
Spin Dryer	668,584.9	1,147,618.3	0.60	0.00	0.00	0.00	0.44
Extruder Feed Collection	668,589.2	1,147,635.0	0.01	0.00	0.00	0.00	0.01
Pellet Surge Hopper	668,524.1	1,147,558.0	0.60	0.00	0.00	0.00	0.44
Virgin Powder Bin	668,658.6	1,147,671.6	0.01	0.00	0.00	0.00	0.01
Activator Knockout Pot Vent Filter	668,757.9	1,147,838.6	0.01	0.00	0.00	0.00	0.01
Catalyst Charge Line Vent Filter	668,778.0	1,147,836.1	0.01	0.00	0.00	0.00	0.01
Pellet Dryer Exhaust	668,573.1	1,147,748.4	0.00	0.00	0.00	0.00	0.00
Extruder/Additives Vent Filter	668,588.0	1,147,783.9	0.01	0.00	0.00	0.00	0.01
Catalyst Activator Heater	668,770.6	1,147,762.4	0.32	0.00	1.59	3.62	0.24

[10] Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007. Westlake Trinidad Unlimited, *EIA for the Proposed Ethylene and Polyethylene Complex, Point Lisas*

[11] SENES Consultants Limited and EPAS Consultants Limited. *Environmental Impact Assessment Study for Proposed Steel Complex at Pt. Lisas, Trinidad and Tobago,* February, 2006

Table 5.9-8. Westlake Annual Average Emissions (MT/y) Summary

Description	Coordinates (metre)		Emissions				
	UTM E	UTM N	TSP/PM_{10}	SO_2	NO_x	CO	$PM_{2.5}$
Pellet Surge Hopper	668,521.7	1,147,719.6	0.60	0.00	0.00	0.00	0.44
Boiler A	669,404.2	1,147,562.3	0.75	0.00	6.42	1.88	0.56
Boiler B	669,404.2	1,147,542.8	0.75	0.00	6.42	1.88	0.56
Boiler C	669,404.2	1,147,523.3	0.75	0.00	6.42	1.88	0.56
Cooling Tower	668,939.8	1,147,390.0	26.54	0.00	0.00	0.00	19.54
Emergency Generator	669,054.9	1,147,287.0	0.04	0.00	0.59	0.13	0.03
Diesel Firewater Pump	669,005.3	1,147,306.3	0.05	0.00	0.73	0.26	0.04
Spent Caustic Incinerator	669,387.2	1,147,394.8	12.00	7.90	59.40	7.90	8.88
Misc. Loading	668,598.2	1,147,493.9	0.00	0.00	0.00	0.00	0.00
Low Pressure Flare	669,459.4	1,147,208.6	0.00	0.00	14.93	53.69	0.00
High Pressure Flare	669,425.5	1,147,305.4	0.00	0.00	0.06	5.86	0.00
Utility Area Flare	669,392.3	1,147,208.6	0.00	0.00	4.44	24.13	0.00
Process Flare for Ethylene Plant	669,425.5	1,147,145.4	0.00	0.00	46.44	388.99	0.00
Fugitive Emissions							
Ethylene Plant Fugitive Emissions	669,275.4	1,147,482.3	0.00	0.00	0.00	0.00	0.00
Gas Phase PE Plant Fugitive Emissions	668,646.6	1,147,635.9	0.00	0.00	0.00	0.00	0.00
Slurry PE Plant Fugitive Emissions	668,612.2	1,147,765.0	0.00	0.00	0.00	0.00	0.00
Polyethylene Bagging Operations	668,315.1	1,147,825.3	0.22	0.00	0.00	0.00	0.16
Warehouse Fugitive Dust Emissions	668,388.3	1,147,750.0	0.09	0.00	0.00	0.00	0.07
Summary			69.09	7.90	976.12	1,130.31	51.13

Table 5.9-9. Essar Annual Average (MT/y) Emissions Summary

Description	Coordinates (metre)		Emissions					
	UTM E	UTM N	TSP	PM_{10}	SO_2	NO_x	CO	$PM_{2.5}$
PDCS1 Process Dust Collection System – I	668,251.4	1,146,808.0	6.0	5.4	0.0	0.0	600.8	4.0
PDCS2 Process Dust Collection System – II	668,228.5	1,146,819.0	7.3	6.3	0.0	0.0	600.8	4.7
PDCS3 Process Dust Collection System – III	668,293.3	1,146,902.0	6.3	5.7	0.0	0.0	600.8	4.2

Table 5.9-9. Essar Annual Average (MT/y) Emissions Summary

Description	Coordinates (metre)		Emissions					
	UTM E	UTM N	TSP	PM_{10}	SO_2	NO_x	CO	$PM_{2.5}$
PDCS4 Process Dust Collection System – IV	668,271.4	1,146,912.0	6.3	5.7	0.0	0.0	600.8	4.2
RC1 Recuperator – I	668,150.7	1,146,836.0	9.1	4.7	0.0	630.7	4,204.7	3.5
RC2 Recuperator – II	668,189.6	1,146,961.0	8.2	4.1	0.0	630.7	4,204.7	3.0
EAF1 Electric Arc Furnace	668,417.0	1,146,740.0	49.8	41.3	0.0	0.0	3,003.5	30.5
L1 Lime – I	668,622.5	1,146,748.0	43.8	24.0	0.0	151.4	1,001.3	17.7
L2 Lime – II	668,642.5	1,146,739.0	43.8	24.0	0.0	151.4	1,001.3	17.7
RHF1 Reheating Furnace – I	668,758.2	1,146,512.0	15.5	12.9	34.7	901.9	6,007.0	9.5
RHF2 Reheating Furnace – II	668,804.1	1,146,492.0	16.7	13.9	37.8	901.9	6,007.0	10.2
EAF2 Boiler – EAF	668,386.1	1,146,678.0	0.9	0.6	0.0	59.9	400.5	0.5
FE1 Feed End	668,005.0	1,147,246.0	6.9	3.5	0.0	0.0	182.0	2.6
DE1 Discharge End	668,517.8	1,147,184.0	71.9	36.0	0.0	0.0	2,223.6	26.5
HLS Hearth Layer Separation	668,113.8	1,147,379.0	14.5	7.3	0.0	0.0	406.5	5.4
AG Additive Grinding	668,026.0	1,147,208.0	20.8	10.4	0.0	0.0	528.2	7.7
IS Indurating Section	668,210.5	1,147,244.0	816.2	408.1	2135.0	2803.6	18,654.5	301.2
Material Handling								
Iron Ore[a]	667,880.3	1,147,180.7	0.084	0.042	0.0	0.0	0.0	0.013
Iron Ore[a]	667,910.3	1,147,161.7	0.084	0.042	0.0	0.0	0.0	0.013
Petcoke, Bentonite, Coal	667,947.2	1,147,139.8	1.7	0.84	0.0	0.0	0.0	0.3
Limestone, Dolomite	667,994.1	1,147,115.8	0.003	0.003	0.0	0.0	0.0	0.001
Ferro-Alloys	668,036.0	1,147,091.0	0.098	0.047	0.0	0.0	0.0	0.01
Summary			**1,146**	**614**	**2,208**	**6,232**	**50,228**	**453**

[a] This includes implementation of full mitigation measures identified by Essar for controlling fugitive emissions from the iron ore storage piles as identified in their EIA mitigation plans. We have assumed that this will be achieved through application of water on non-rainy days plus either a surfactant or other chemical binder or a 4-sided enclosure with wall heights equal to or greater than the height of the pile. Additionally, to demonstrate modelling results to be compliant with the CEC issued by EMA (CEC1248/2005) for the Essar facility, which on page 6 identifies that air quality permissible levels must be met at the plant battery limit (fence line), we reduced PM emissions from the iron ore storage piles by additional 95%.

5.9.6.5.2 Construction

In addition to routine operations, emissions during the construction period were modelled to assess the impacts on nearby air quality during the construction of the chlor-alkali facility. Both short-term and long-term emissions impacts were evaluated.

5.9.6.6 Air Quality Modelling Results

5.9.6.6.1 CariSal Only – Normal Operations

AERMOD calculates the concentration for each receptor and for each source. The results of the air dispersion modelling analyses for CariSal only are summarized in Table 5.9-10 comparing the maximum model concentration plus background with the permissible levels. Maximum concentration plots plus background for the same averaging period as the permissible levels for locations outside the CariSal plant boundary are presented in Appendix E. These results show the maximum concentration plus background at each receptor location. The Appendix also includes the impacts from the deposition of dust emissions (for a discussion on dust impacts, see Section 5.6).

The upper half of Table 5.9-10 shows that the cumulative particulate matter concentrations from all sources (including the background concentration) will not exceed the permissible air quality levels in the Trinidad and Tobago Draft Air Pollution Rules under any routine circumstances. The 24-hour TSP approaches the highest fraction of the permissible level at 95% when background is included. The locations of the maximum offsite concentrations are shown in Appendix E.[12]

The lower half of Table 5.9-10 shows the maximum concentrations for each gas-phase air pollutant that would be routinely emitted from the chlor-alkali facility. To determine the 1-hour NO_2 concentrations for the construction, operation, and cumulative modelling analysis, the ozone-limiting approach was used. Nearby hourly ozone data are readily available and the approach represents a conservative, but not overly conservative model. The ozone limiting approach uses hourly ozone data from EMA's Point Lisas monitoring station. The AERMOD model uses all of the NO_x emissions as input to AERMOD and then applies the default assumption that 10 percent of the initial NO_x is emitted as NO_2. The model then applies the ozone-limiting method, which converts the available NO to NO_2 based on the available hourly ozone concentration to drive this chemical conversion process.

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[12] The modelling results for the longer term averages (24-hour and longer) presented in Appendix E show higher concentrations to the west of the CariSal facility. This is principally a result of the prevailing wind direction in Point Lisas from the east-northeast to southeast, which occurs on average for 83 percent of all hours. The 1-hour concentration plots shown for CO and NO_2 show a more distributed pattern with high concentrations in all directions; however, high peak (1-hour) concentrations are a result of the combination of wind direction and atmospheric stability – the latter controls the amount of horizontal and vertical mixing of the pollutants, which leads to a maximum concentration pattern that is not perfectly circular but has a more preferential direction in the downwind direction.

As Table 5.9-10 shows, in no case do the emissions from the facility exceed the permissible levels; in most cases the CariSal contribution is a small fraction of the permissible level. The highest fraction of the permissible level is for annual average NO_2, which reaches 96 percent of the permissible level when background is included. The routine emissions of hydrogen chloride (HCl) and chlorine gas (Cl_2) are well below the permissible levels, with each having maximum concentrations less than 0.5 ppb, which when added to the maximum monitored background concentration are less than 9 and 6 percent of the permissible level, respectively. The hydrogen gas routinely vented to the atmosphere has a maximum offsite concentration of 81,600 ppb, which is less then 0.2 percent of

Table 5.9-10. Maximum Air Quality Modelling Impact for CariSal Only During Routine Operations

Pollutant	Averaging Period	Maximum Offsite Concentration	Maximum Background Concentration	Total Concentration	Permissible Level	Percentage of Permissible Level
Units		**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**%**
TSP	24-hour	53.9	89	142.9	150	95
PM_{10}	24-hour	7.1	60.1[a]	67.2	75	90
PM_{10}	Annual	4.5	25.8	30.3	50	61
$PM_{2.5}$	24-hour	8.7	20.8	29.5	65	45
$PM_{2.5}$	Annual	5.2	7.9	13.1	15	87
Units		**ppb**	**ppb**	**ppb**	**ppb**	**%**
Hydrogen Chloride	30-minute	0.34	5.8	6.1	67	9
Chlorine	30-minute	0.16	6	6.2	103	6
Nitrogen Dioxide	1-hour	85.8	14.4	100.2[b]	106	95
Nitrogen Dioxide	Annual	11.8[c]	8.4	20.2	21	96
Carbon Monoxide	1-hour	109	13,200	13,309	26,200	51
Carbon Monoxide	8-hour	92	2,130	2,222	8,730	25
Sulphur Dioxide	24-hour	4.1	21.4	26	48	53
Sulphur Dioxide	Annual	2.9	2.5	5	19	28
Hydrogen	1-hour	81,600	0	81,600	40,000,000[d]	0.2

[a] The CariSal-monitored PM_{10} value was used, as it is more likely representative of the site background concentration; if EMA background concentration from the PLIPDECO (154 µg/m³) is used, then the total concentration would be 161.1 µg/m³.

[b] This is the combined highest concentration of the 1-hour NO_2 background paired with contemporaneous maximum offsite concentration.

[c] Available ozone limits the amount of NO_x converted to NO_2 to the annual average ozone concentration (11.8 ppb).

[d] Lower Explosive Limit (LEL) for hydrogen gas = 4 % by volume

the lower explosive limit of 4 percent (40,000,000 ppb). The locations of the maximum concentrations are shown in Appendix E and are located either just to the west of the facility between the Southern Main Road and the western property line of the CariSal facility or just to the south of North Sea Drive.

5.9.6.6.2 Cumulative Impact Analysis

For the cumulative modelling analysis, all CariSal sources in normal operation were modelled collectively with the emission sources from the Essar and the Westlake complexes. Not explicitly included in the modelling analysis were the emissions from the proposed Port at Claxton Bay North which is expected to include marine ship emissions, cargo loading and unloading activity and operational support activities as well the 55-m-wide port access corridor proposed for development to the Southern Main road which would service import and export materials to the Essar facility. This activity was not included as specific quantitative information is not yet available, however because of the distance and off-shore southerly location of the Port operations the emissions from the Port and access road are not anticipated to have important impacts to air quality in the vicinity of the CariSal facility. Similarly, to date, the Point Lisas South and East Industrial estate study is unavailable for review and thus, a quantitative estimate of the increase in operational air emissions associated with increased vehicle activity or new facilities is also unavailable. Facility impacts are left to each facility e.g., Westlake and Essar, to include as the estate is developed. Thus, emissions from motor vehicle activity from operation of the industrial estate were concluded to be small, as well as not available, and not included in the quantitative cumulative analysis.

The cumulative modelling analysis includes all pollutants from CariSal plus all air emission from Essar and Westlake which includes TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_x, and CO. The results of the air dispersion modelling analyses for cumulative impact are summarized in Table 5.9-11, which compares the maximum model concentration plus background with the permissible levels for locations outside the CariSal property. Spatial plots of maximum cumulative concentration plus background for the same averaging period as the permissible levels for offsite or outside the CariSal plant boundary are presented in Appendix E. These results show that the maximum cumulative concentration plus background is below the permissible air quality levels.

Table 5.9-11 shows that particulate matter ($PM_{2.5}$, PM_{10} and TSP) plus background concentrations are below the permissible air quality levels. It should be noted that Westlake also conducted air quality modelling for PM_{10} and TSP with different results than reported.[13] Some of the differences between these two studies are most likely attributable to the following:

Table 5.9-11. Cumulative Air Quality Modelling for CariSal, Essar, and Westlake During Routine Operations

[13] Westlake modelling included emissions for both Westlake and Essar facilities and found higher concentrations than Essar, which they attributed to the use of different air quality models and different meteorological years (2003 vs. 2004). Both studies, however, relied on meteorological data from Piarco.

Pollutant	Averaging Period	Maximum Offsite Concentration	Maximum Background Concentration	Total Concentration	Permissible Level	Percentage of Permissible Level
Units		**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**%**
TSP	24-hour	58.7	89	147.7	150	98
PM_{10}	24-hour	14.7	60.1[a]	74.8	75	99.7
PM_{10}	Annual	11.7	25.8	37.5	50	75
$PM_{2.5}$	24-hour	10.5	20.8	31.3	65	48
$PM_{2.5}$	Annual	6.8	7.9	14.7	15	98
	Units	**ppb**	**ppb**	**ppb**	**ppb**	**%**
Hydrogen Chloride	30-minute	0.34	5.8	6.1	67	9
Chlorine	30-minute	0.16	6	6.2	103	6
Nitrogen Dioxide	1-hour	85.9	14.4	100.3[b]	106	95
Nitrogen Dioxide	Annual	11.8[c]	8.4	20.2	21	96
Carbon Monoxide	1-hour	2,800	13,200	16,000	26,200	61
Carbon Monoxide	8-hour	1,980	2,130	4,110	8,730	47
Sulphur Dioxide	24-hour	14	21.4	35.4	48	74
Sulphur Dioxide	Annual	3.7	2.5	6.2	19	33
Hydrogen Gas	1-hour	81,600	0	81,600	40,000,000[d]	0.2

[a] The CariSal monitored PM_{10} value was used as it is more likely representative of the site background concentration; if EMA background concentration from the PLIPDECO (154 µg/m³) were used, the total concentration would be 168.7 µg/m³.

[b] This is the combined highest concentration of the 1-hour NO_2 background paired with contemporaneous maximum offsite concentration.

[c] Available ozone limits the amount of NO_x converted to NO_2 to the annual average ozone concentration (11.8 ppb).

[d] Lower Explosive Limit (LEL) for hydrogen gas = 4 percent by volume

- Essar and Westlake modelling was performed using PIARCO meteorological data using a different meteorological year. The predominant wind direction for PIARCO meteorological data is from the east and east-northeast with very few hours with east-southeast or southeast wind. The EMA meteorological data used in this study have

1. Many more hours with east-southeast and southeast winds, which results in somewhat shorter travel distances to the nearest off-property receptor for most Essar emission sources, and
2. The Essar emission sources are oriented along an east-southeast line, which favours the accumulation of emissions, leading to higher concentrations.

- Essar used the ISC3ST while Westlake used the CALPUFF model for their air quality modelling study. The particle deposition algorithm in AERMOD differs from that in ISC3, which may explain some of the differences in results.

The lower half of Table 5.9-11 shows the maximum concentrations for each gas-phase air pollutant that is routinely emitted from the chlor-alkali facility. In no case do the emissions from the facility exceed the permissible levels and, in many cases, CariSal is a small contributor to the permissible level. The highest proportions of the permissible levels attributable to CariSal are for the 1-hour and annual average NO_2, which are 95 and 96 percent of the permissible level, respectively, when background is included. The 1- and 8-hour CO values, as well as the 24-hour SO_2 maximum concentrations, are associated primarily with Essar emissions, while the maximum off-site concentration for the annual average SO_2 is associated primarily with CariSal emissions. No changes are seen relative to the CariSal-only impacts for hydrogen chloride, chlorine gas, and hydrogen, as neither Westlake nor Essar emits these pollutants. The locations of the maximum concentrations are presented in Appendix E; they range from just outside the western property line of the CariSal facility to 3 kilometres northeast of the CariSal site. All cumulative maximum concentrations are below the permissible levels. The 1-hour and annual NO_2 concentration maximums are found just south of the CariSal property, with the 1-hour maximum representing a combination of emissions from CariSal, Essar, and Westlake. The 8-hour CO and 24-hour SO_2 maximums are found on the Essar property and are associated with emissions from Essar only. The 1-hour CO cumulative maximum is found about 1 kilometre northeast of the CariSal site, but is well below the permissible level. In general, Essar's air quality modelling reported similar concentration levels for CO, SO_2, and NO_2 as those found in CariSal's modelling. Although some differences are evident, they likely result from the use of different meteorology (the CariSal model uses EMA meteorological data for 2005 and 2006) and AERMOD.

5.9.6.6.3 Construction

AERMOD calculates the concentration for each receptor and for each source. The results of the air dispersion modelling analyses for CariSal during construction are summarized in Table 5.9-12 comparing the maximum model concentration plus background with the permissible levels. Maximum concentration plots plus background for the same averaging period as the permissible levels for locations outside the CariSal plant boundary are presented in Appendix E. These results show the maximum concentration plus background at each receptor location.

Table 5.9-12 shows that the maximum 24-hour TSP and the 24-hour PM_{10} concentrations could exceed permissible levels in the Trinidad and Tobago Draft Air Pollution Rules (Republic of Trinidad and Tobago. 2005) if they were to occur when ambient background concentrations are

also high and that no mitigation measures were applied. Modelling results show that the potential numbers of days on which this could occur is less than a dozen days per year[14] during the

Table 5.9-12. Maximum Air Quality Modelling Impact for CariSal Only During Construction

Pollutant	Averaging Period	Maximum Off-Site Concentration	Maximum Background Concentration	Total Concentration	Permissible Level	Percentage of Permissible Level
Units		**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**%**
TSP	24-hour	79.1	89	168.1	150	112
PM_{10}	24-hour	22.4	60.1[a]	82.5	75	110
PM_{10}	Annual[b]	8.1	25.8	33.9	50	68
$PM_{2.5}$	24-hour	17.0	20.8	37.8	65	58
$PM_{2.5}$	Annual[b]	6.1	7.9	14.0	15	93
Units		**ppb**	**ppb**	**ppb**	**ppb**	**%**
Nitrogen Dioxide	1-hour	100.5	38	138.5	106	131
Nitrogen Dioxide	Annual[b]	11.8[c]	8.4	20.2	21	96
Carbon Monoxide	1-hour	479	13,200	13,679	26,200	52
Carbon Monoxide	8-hour	174	2,130	2,304	8,730	26
Sulphur Dioxide	24-hour	14.3	21.4	35.7	48	74
Sulphur Dioxide	Annual[b]	5.2	2.5	7.7	19	41

[a] Here the CariSal monitored PM_{10} value was used as it is more likely representative of the site background concentration; if EMA background concentration from the PLIPDECO (154 µg/m³) is used, then the total concentration would be 218.6 µg/m³.
[b] Maximum off-site concentration is the period average of two months
[c] Available ozone limits the amount of NO_x converted to NO_2 to the annual average ozone concentration (11.8 ppb)

construction phase of the Project and absent appropriate mitigation measures. The 1-hour NO_2 concentration could exceed the permissible levels with zero background concentration in the absence of any appropriate mitigation measures. Again, modelling results suggest that exceedances could potentially occur for up to 2% of the hours in a year[15]. All other air pollutants emitted during construction in combination with maximum background concentration would be below the air quality permissible levels. The maximum concentrations for the 24-hour TSP and PM_{10} are located to the northwest of the facility in close proximity to the nearest residence (customs officer housing). However, the concentration is not exceeded at the nearest

[14] These days can generally be characterized as days with daily average wind speeds which are low (< few meters per second) and can be found at any time throughout the year,

[15] These hours can generally be characterized as occurring in the afternoon period from September through January with wind speeds less than 1 meter per second and the wind coming from the east, south east.

residence. The area over which the maximum predicted 24-hour PM_{10} and TSP concentrations may exceed the permissible level extends only 20 metres northwest and 100 meters along CariSal's western boundary. The maximum concentration for 1-hour NO_2 also located near the same location. The area, over which the predicted 1-hour NO_2 concentration may exceed the permissible level, in the absence of appropriate mitigation measures, extends only 30 metres northwest, 100 metres south, and 50 metres north of CariSal's western boundary. The locations of the maximum concentrations for all air pollutants emitted during construction are shown in Appendix E; in all cases the maximum concentration is within 100 meters of the western property line of the CariSal facility. It should be noted that this construction activity level, and the resulting emissions, are projected to occur over a 2-month period and the meteorological conditions favourable for maximum concentrations may not occur during this period. Several mitigation measures have been developed to ensure that no violations of the permissible levels occur during construction these include: (1) real-time ambient air quality monitoring for PM_{10}, TSP and NO_2, (2) reducing the daily construction activity level by extending the construction period if needed (delay construction during adverse conditions) and (3) use of newer construction equipment thereby reducing emissions of NO_2 and particulate matter.

The real-time ambient monitoring program would monitor both NO_2 and ozone during the construction period to avoid a situation where high ozone concentration coupled with "fresh" NO_x emissions[16] from construction activity in combination with high background NO_2 concentration could lead to an exceedance of the 1-hour NO_2 permissible level. This real-time monitoring would take place in the prevailing downwind fenceline location (western property boundary), where modelling has shown as the only area where potential exceedances may occur. If real-time ambient monitoring were to indicate that the combined ozone and NO_2 concentration exceeds 75 percent of the NO_2 standard (i.e.,150 $\mu g/m^3$), onsite construction activity would be reduced or suspended until levels drop below the 75 percent threshold level. Implementation of this program would then avoid any periods where a possible exceedance could occur. This program, along with the other mitigation measures stated above, would result in lower daily average emissions and a reduced chance for the permissible levels to be exceeded. Table 5.9-13 shows the maximum concentrations based on the mitigations listed above.

Table 5.9-13. Maximum Air Quality Modelling Impact for CariSal Only During Construction with Mitigation

Pollutant	Averaging Period	Maximum Off-Site Concentration	Maximum Background Concentration	Total Concentration	Permissible Level	Percentage of Permissible Level
Units		**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**%**
TSP	24-hour	49.2	89	138.2	150	92
PM_{10}	24-hour	14.2	60.1[a]	74.3	75	99
PM_{10}	Annual[b]	8.1	25.8	33.9	50	68
$PM_{2.5}$	24-hour	17.0	20.8	37.8	65	58
$PM_{2.5}$	Annual[b]	6.1	7.9	14.0	15	93
Units		**ppb**	**ppb**	**ppb**	**ppb**	**%**

[16] Available ambient ozone would convert fresh NO emissions to NO_2

Table 5.9-13. Maximum Air Quality Modelling Impact for CariSal Only During Construction with Mitigation

Pollutant	Averaging Period	Maximum Off-Site Concentration	Maximum Background Concentration	Total Concentration	Permissible Level	Percentage of Permissible Level
Nitrogen Dioxide	1-hour	41.5	38	79.5[d]	106	75
Nitrogen Dioxide	Annual[b]	11.8[c]	8.4	20.2	21	96
Carbon Monoxide	1-hour	479	13,200	13,679	26,200	52
Carbon Monoxide	8-hour	174	2,130	2,304	8,730	26
Sulphur Dioxide	24-hour	14.3	21.4	35.7	48	74
Sulphur Dioxide	Annual[b]	5.2	2.5	7.7	19	41

[a] Here the CariSal monitored PM_{10} value was used as it is more likely representative of the site background concentration; if EMA background concentration from the PLIPDECO (154 µg/m^3) is used, then the total concentration would be 218.6 µg/m^3.
[b] Maximum off-site concentration is the period average of two months
[c] Available ozone limits the amount of NO_x converted to NO_2 to the annual average ozone concentration (11.8 ppb)
[d] This result reflects implementation of the real-time NO_2 and ozone ambient monitoring program during the construction period.

At any point during operation or construction, there is a potential for nearby residents to smell air pollutants from the CariSal facility. This potential was assessed by comparing maximum off-site ambient air quality concentrations with odour threshold values. Table 5.9-14 provides a comparison between the maximum offsite ambient air concentrations of gas-phase pollutants and odour threshold values. The maximum offsite concentrations are the maximum short-term concentrations possible during operation (including cumulative) and construction of the facility. Table 5.9-13 shows that, even with the highest background concentration in combination with the highest offsite concentrations, CariSal's maximum short-term ambient air concentration levels do not exceed the odour threshold levels for any air contaminant. The odour thresholds used in this comparison are based on either the American Industrial Hygiene Association (1989)[17] or the threshold developed by the Netherlands Centraal Instituut voor Voedingsonderzoek (CIVO) TNO (1977, 1982).[18]

[17] TRC Environmental Consultants and American Industrial Hygiene Association. 1989. *Odor Thresholds for Chemicals with Established Occupational Health Standards*. Fairfax, VA: American Industrial Hygiene Association.
[18] Gemert, L.J. Van and A.H. Nettenbreijer. *Compilation of Odor Threshold Values in Air and Water*. CIVO-TNO, Netherlands (1977).
Gemert, L.J. Van. *Compilation of Odor Threshold Values in Air, Supplement IV*, CIVO-TNO, Zeist, Netherlands (1982).

Table 5.9-14. Maximum Ambient Air Quality Impacts of Gas Phase Pollutants During Construction or Operation of CariSal Project in Comparison with Odour Threshold Levels

Pollutant Units	Averaging Period	Maximum Off-Site Concentration	Maximum Background Concentration	Total (ppb)	Odour Threshold Level[a]	Percentage of Odour Threshold
Hydrogen Chloride	30-minute	0.34	5.8	6.1	770	0.8
Chlorine	30-minute	0.16	6	6.2	50	12
NO_2	1-hour	130.4	38	168.4	186	91
CO	1-hour	2,800	13,200	16,000	74,000,000	0.022
SO_2	1-hour	35	53.5	88.5	708	13
Hydrogen Gas	1-hour	81,600	0	81,600	None	0.0

Source: TRC Environmental Consultants and American Industrial Hygiene Association. 1989. *Odor Thresholds for Chemicals with Established Occupational Health Standards*. Fairfax, VA: American Industrial Hygiene Association.

5.9.6.7 Impacts of Cooling Water Discharge on Ambient Air and Ground Deposition

As discussed in Section 5.3.3, the design of the CariSal plant calls for cooling water to pass through the cooling tower system at a rate of 5,700 m^3/hr. Most of the water would be recycled, but approximately 12.3 m^3/hr of water would be lost as cooling tower drift (water vapour that leaves the cooling tower and is discharge to the ambient air in the form of water droplets). Makeup of this cooling tower water is potable water and salts discharged through the water vapour are not an issue. However, given the prevailing easterly wind direction, the potential exists for the water vapour to precipitate as rainfall in the area immediate west of the cooling towers. Thus CariSal examined this potential impact of the cooling towers' potential for water droplet deposition (i.e., rainfall).

CariSal calculated the cooling tower drift deposition to ground using information on the typical cooling tower drift droplet size spectrum (see Table 5.9-15) to determine droplet deposition rate based on the cooling tower height and average wind speed (1.3 m/s) and average atmospheric stability (neutral or D stability). CariSal modelled the droplet lateral dispersion assuming that the water vapour plume of 12.3 m^3/hr would disperse in a Gaussian distribution and that most (95 percent) of the water vapour would be found within ± 2 standard deviations of the plume centreline. Precipitation rates were then calculated for each mass fraction size category assuming uniform precipitation rate within each size fraction. Modelling results showed that the maximum deposition (rainfall rate) occurred at a distance of 31.7 meters downwind with a maximum precipitation rate of 3,100 mm/year if the wind direction remains constant. The two most prevailing wind directions are from the east and east-southeast, which occur about 28 percent of the time for each direction. Thus the upper bound for rainfall in any one sector is estimated at 860 mm/year or about 51 percent of the annual average rainfall rate. This maximum rainfall rate would be within the CariSal property near the east end of Retention Pond #1. The maximum offsite concentration would be adjacent to the western boundary property line and

would average about 110 mm/year or about 6.8 percent of the annual average rainfall amount. This additional rainfall would not add significantly to current annual average rainfall total of about 1,690 mm/year.

Table 5.9-15. Cooling Tower Drift Drop Size Spectrum[a], Terminal Velocity and Average Travel Distance from Cellular Type Drift Eliminators

Percent of Total Mass	Droplet Size Diameter (µm)	Terminal Velocity[b] (m/s)	Travel Distance[c] (meters)
0.20	> 525	1.1	13.8
0.80	275 – 525	0.8	19.0
4.0	230 – 275	0.48	31.7
5.0	170 – 230	0.37	41.1
10	115 – 170	0.24	63.4
20	65 – 115	0.13	117.0
20	35 – 65	0.043	353.7
20	15 – 35	infinite	infinite
20	< 15	infinite	infinite

Notes:
[a] Based on a presentation from Marley Cooling Technologies (Lindahl 2002) of reported size distributions.
[b] Terminal velocity (V_t) based on formula given by Atlas et al. (1973):
$V_t = 4.323*(D/2-15)*10^{-3}$ valid for droplets between 30 < diameter (D) < 600 (µm). Droplets less than 30 µm do not deposit.
[c] Travel distance based on average wind speed (1.3 m/s) from EMA's 2005 and 2006 meteorological data at Point Lisa's and cooling tower height of 11.7 metres and the calculated terminal velocity

5.9.6.7 Worst Case Routine Air Quality impact for Savonetta Village

Prevailing meteorological conditions will routinely transport CariSal emissions to the west of the facility. Air quality modelling was performed using hourly meteorological data and results presented in Section 5.9.6.6, while these results contain the worst case impacts we present here modelling results for a single 24-hour period in which the prevailing wind conditions were favourable for high concentrations to occur in the nearby community of Savonetta Village which is located to the south-southeast of CariSal. A review of 2 years of the Point Lisas meteorological data identified that the highest 24-hour concentrations would occur on a day similar to July 13, 2005. On this date, winds from the northwest (blowing towards the south-southeast) prevailed during most of the day. From 8 am until midnight hourly wind direction was between westerly and north westerly with an average speed of 2.1 m/s and a vector average direction of 326 degrees. During the early morning hours winds were from the east at an average speed of 0.6 m/s.

Modelling results for 24-hour PM_{10} impact from CariSal are presented in Appendix E along with the maximum background concentration of 60.1 µg/m^3. These results show that the maximum impact from CariSal only during this worst-case time period would increase the maximum concentration to 64.3 µg/m^3. In no location is the 24-hour PM_{10} permissible level of 75 µg/m^3

exceeded and the maximum increase at any location within Savonetta Village is less than 1 $\mu g/m^3$. Similarly, other air pollutants show little to no increase over background concentrations with no period exceeding the air quality permissible levels. Emissions from Essar and Westlake would contribute little to nothing to ambient concentrations over Savonetta Village during the 8 am to midnight time period on this day due to the prevailing northwest wind direction.

5.10 SUMMARY OF IMPACTS

Table 5.10-1 provides a summary of the impacts and mitigation measures discussed in the previous sections and in Section 7.

Table 5.10-1. Summary Of Impacts

Resource Category	Impact (No Impact – Beneficial)	Extent (Geographical)	Duration/ Intensity	Method (Measured/ Estimated)	Degree Of Confidence (Sensitivity)
Start Up and Construction					
Noise	Minor	1 ha - < 1 km^2	Temporary	Estimated	High
Vibration	Minor	1 ha - < 1 km^2	Temporary	Estimated	High
Traffic and Roads	Minor	1 - 10 km^2	Temporary	Measured	Moderate
Air Quality	Moderate	1 ha - 1 km^2	Temporary	Modelled	High
Soil Erosion	Negligible	1 ha - < 1 km^2	Temporary	Estimated	High
Solid Waste Disposal	Negligible to Minor	> 100 km^2	Temporary	Estimated	High
Drainage	Beneficial	1 ha - < 1 km^2	Temporary	Estimated	High
Water Quality/Demand	Negligible	> 100 km^2	Temporary	Measured	High
Flora and Fauna	Minor	1 ha - < 1 km^2	Permanent	Estimated	High
Health and Safety	Negligible to Minor	1 ha - < 1 km^2	Temporary	Estimated	High
Social Impact, SES	Minor to Beneficial	1 -10 km^2	Temporary	Estimated	High
Operations					
Noise	Minor	1 ha - < 1 km^2	Temporary	Estimated	Moderate
Vibration	Negligible	1 ha - < 1 km^2	Temporary	Estimated	High
Traffic and Roads	Minor	1 – 10 km^2	Temporary	Measured	Moderate
Air Quality	Minor	1 km^2 - 10 km^2	Permanent	Modelled	High
Soil Erosion	No impact	1 ha - < 1km^2	Permanent	Estimated	High
Solid Waste Disposal	Moderate	> 100 km^2	Permanent	Measured	Moderate
Drainage	Beneficial	1 ha - < 1 km^2	Permanent	Estimated	High
Water Quality/Demand	Beneficial	> 100 km^2	Permanent	Measured	High
Flora and Fauna	Unknown[1]	1 ha - < 1 km^2	Temporary	Estimated	Low
Health and Safety	Moderate	1 ha - < 10 km^2	Temporary	Estimated	High
Social Impact, SES	Beneficial	1 -10 km^2	Permanent	Estimated	Moderate

Table 5.10-1. Summary Of Impacts

Resource Category	Impact (No Impact – Beneficial)	Extent (Geographical)	Duration/ Intensity	Method (Measured/ Estimated)	Degree Of Confidence (Sensitivity)
Decommissioning					
Noise	Minor	1 ha – < 1 km^2	Temporary	Estimated	Moderate
Vibration	Minor	1 ha – < 1 km^2	Temporary	Estimated	Moderate
Traffic and Roads	Minor	1 - 10 km^2	Temporary	Measured	Moderate
Air Quality	Minor	< 1 ha	Temporary	Estimated	Moderate
Soil Erosion	Negligible	1 ha - < 1km^2	Temporary	Estimated	High
Solid Waste Disposal	Minor	> 100 km^2	Temporary	Estimated	Moderate
Drainage	No impact	1 ha - < 1 km^2	Temporary	Estimated	High
Water Quality/Demand	Negligible	> 100 km^2	Temporary	Estimated	High
Flora and Fauna	Significant Adverse to Moderate Beneficial[2]	1 ha - < 1 km^2	Permanent	Estimated	High
Health and Safety	Negligible to Minor	1 ha - < 1 km^2	Temporary	Estimated	High
Social Impact, SES	Moderate Adverse to Beneficial	1 - 10 km^2	Temporary	Estimated	Low

[1] Flora and Fauna impacts are indicated as unknown because the likelihood of chloride toxicity to vegetation downwind of the CariSal site, resulting from $CaCl_2$ particulate deposition from the site, cannot be determined within a reasonable degree of confidence.

[2] Impacts negligible to mildly beneficial assuming recommended mitigation measures are adopted. Impacts significantly adverse if recommended mitigation measures are not adopted.

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6.0 ANALYSIS OF ALTERNATIVES

6.1 INTRODUCTION

This chapter presents an assessment of the site selection, technology, process design, construction methodology and techniques for optimizing operations and maintenance procedures, infrastructure, and resource acquisition alternatives that CariSal Unlimited considered for attaining its project development goals.

6.1.1 Rationale

The consideration of alternatives to a proposed project is a requirement of EIAs in many jurisdictions and is a core element of the EIA process and methodology. The Trinidad and Tobago environmental management regime is no exception: Applicants must identify and appropriately evaluate project alternatives as part of the process.

The process for analysing alternatives is designed to incorporate environmental considerations into all stages of project and development planning. Ideally, this approach begins with strategic environmental assessment to analyse broad alternatives within a sector or geographic region. When such a framework is absent, as is the case in Trinidad and Tobago, the key alternatives are examined as part of a project-specific EIA as addressed in this chapter.

In many cases, certain alternatives will have been foreclosed by the overall project approach undertaken and earlier stages of decision-making. Retroactive analysis of alternatives is not considered good practice unless the circumstances deem it necessary, for example, when a proposal is well advanced but has a potentially significant impact on the environment or involves the relocation of large numbers of people.

The relative impact of each alternative is compared against the baseline environment (with and without the project) to select a preferred alternative, including taking no action. Election of the no action alternative does not necessarily correspond to the maintaining of baseline conditions, however, because changes may result from other actions.

In the sections below, alternatives are evaluated and compared on the basis of their potential environmental and social/socioeconomic impacts, costs, feasibility, and suitability under local conditions in Trinidad and Tobago and specifically, the Couva-Point Lisas region, in accordance with the Final TOR issued to CariSal.

6.1.2 Environmental Management Authority Requirements

The Final TOR issued by the EMA requires a description of the reasonable alternatives considered for achieving CariSal's major Project objectives. The TOR also requires that the analysis of alternatives consider the choices made regarding the Project's location, the design of manufacturing operations, technology options, and the election of appropriate approaches, methods and techniques for optimizing operations and planned maintenance procedures. The TOR specifically requests an assessment of the items listed below and a discussion that

elaborates the reasoning and strategies adopted that resulted in the selection of the preferred Project option compared to a no action baseline and other relevant alternatives.

The no action alternative is evaluated to demonstrate potential changes in baseline environmental conditions in the absence of the CariSal Project including, but not limited to, the following:

- Siting – possible alternative locations for this activity;
- Design, including facility layout and intensity of development;
- Construction techniques and phasing (see Chapter 3);
- Operation and maintenance procedures (see Chapters 3 and 7);
- Process technology options in terms of use of best available technology (see Chapters 3 and 7);
- Supply and use efficiency options for water in terms of on-site storage, recycling, and other factors;
- Options for wastewater and solid waste treatment and management; and
- Process selection in terms of the best practicable environmental option (see Chapter 7).

6.2 APPROACH TO THE ANALYSIS OF ALTERNATIVES

The consideration of alternatives is likely to be most effective when the EIA is undertaken early in the project cycle. CariSal embraced the preferred practice by fostering collaboration between its environmental review and engineering design consulting teams early in the scoping process when alternatives to the Project could be formulated. By comparing the various alternatives identified through this collaboration, the best methods for achieving project objectives while minimizing environmental impacts and risk could be determined. This process also provides opportunities to identify more creatively the most environmentally friendly or best practicable environmental options.

6.2.1 Range of Alternatives Considered

Types and ranges of alternatives considered include:

- **Demand alternatives** – using cogeneration (in Stage 4) to improve the energy safety and efficiency of the plant.
- **Input or supply alternatives** – with the completion of Project Stages 2, 3, and 4, CariSal would introduce a waste brine stream from DESALCOTT to minimise the need to obtain water required for the chlor-alkali operation from WASA's potable supply resources. Several suppliers were canvassed to locate the purest limestone to reduce the quantity of reaction mud produced by the process.
- **Project activity alternatives** – several alternatives were investigated for the piling activity that would occur during plant construction. The soil conditions and

limited availability of piling equipment, contractors, tools, and techniques on the island restrict the options available for this activity.

- **Location alternatives** – For the entire proposal as well as for various project components, several potential locations were evaluated before selecting Trinidad and the proposed Project site in Point Lisas. Trinidad was chosen because of its strategic location relative to the potential customer base and the attractive energy pricing. Alternative configurations of major plant components were studied with regard to protecting public health and the environment while simultaneously optimizing operations (e.g., moving cooling towers, the entire chlor-alkali facility, and the ponds to areas of the site where they would be farthest from nearby residences.

- **Process alternatives** – Mechanical vapour recompression, among the most efficient use of energy for evaporation, is the technology that would be used for concentrating waste brine. Mechanical vapour recompression was proposed as a design alternative to multiple-effect evaporation for the DESALCOTT brine concentrator. This technology, along with the cell membrane process, would substantially improve the plant's energy efficiency.

- **Start up approach** – The Project would be phased to minimize the risk of an environmental or health and safety incident during startup and to provide an opportunity to prove the brine purification process, and test and quantify waste solids products, one step at a time. The Project design calls for the dryer off-gas filtration system to be replaced so that particulate emissions are reduced and all water streams are recycled to achieve a "zero" process waste water discharge.

- **Use of best available technologies** – The proposed chlor-alkali plant would incorporate state-of-the-art cell membrane—not diaphragm or mercury membrane—technology. The industry has largely phased out the use of mercury membrane technology in the United States and Europe. The cell membrane would be nameplate rated and would use CONVE equipment. The Project would also use high efficiency scrubbers to minimize air emissions from the plant. The Containment Pit would be either an earth-bermed structure with a geomembrane liner or an engineered concrete structure to minimize the risk of groundwater contamination from process water. If the concrete option is chosen, the structure would be designed with leak stops and an underdrain to detect any leakage, and would be designed to meet the appropriate seismic requirements.

- **Scheduling alternatives** – The Project would be phased, in part, to allow time for the introduction of greener alternatives, which require large upfront capital investments, including the ability to use the waste brine stream from DESALCOTT and to develop the cogeneration plant. Cogeneration has a higher overall efficiency than conventional utility systems, typically 85 percent versus 58 percent. This efficient use of fuel would reduce the forecast emissions of greenhouse gases by approximately 30 percent.

Stakeholder input (through meetings with stakeholders, community outreach efforts, and focus groups) was actively sought to inform the generation and analysis of viable alternatives.

As is customary for EIA studies, CariSal's preferred alternative was considered in greater detail than others.

6.2.2 Background on the Site Selection Process

CariSal is a chemical company jointly owned by Guardian Energy Holdings Limited; Seneca Chemical; Denham Capital Management, an international private equity firm; Innovaone Investments of Trinidad and Tobago; TTeK Project Management Services Limited, Easi Industrial Supplies Limited (EISL); NYT, a Houston-based holding company; and a group of smaller individual investors. Before Trinidad and Tobago was selected, several worldwide locations were considered. The culmination of this process was to select the current location in Point Lisas. The INEOS chlor-alkali technology chosen is the latest and best available for the production of caustic soda and hydrochloric acid. The technologies for waste brine purification and calcium chloride production are owned by CariSal (Seneca) and are proprietary. This section presents an overview of the alternatives that were investigated to achieve the objectives of the business including:

- Local government approval
- Logistics
- Environmental
- Cost of production

A summary of the selection process is provided below.

Calcium Chloride – Key Factors for Success	
	Degree of Importance
Low-cost Energy	** ** ** **
Access to Natural Gas	** ** ** **
Low-cost Raw Material	** ** **
Access to Market	** ** **
Close to Port	** ** **
Strong Investment Environment	** ** **
Strong Management	** ** **
Stable Government	** **

6.3 FACILITY SITING

Seneca conducted a thorough location evaluation process that included possible production sites in the Middle East, Russia, China, the United Kingdom and Western Europe, and the United States. The key success factors for the business are given in the table above. Although the calcium chloride process does not use a significant quantity of natural gas, energy is an important contributor to the total manufacturing cost. Raw materials, limestone and salt, are readily available in most parts of the world, but the price of these inputs is also important to establishing a competitive cost structure. Next to manufacturing cost, access to a deep-water port and the market are critical to satisfying customer supply requirements. Finally, a strong economy and investment climate and a stable government are preferred. The two locations with the highest ranking in this evaluation were the Middle East (Qatar) and Trinidad and Tobago.

The evaluation team visited both locations to discuss possible development with key agencies and investment firms. Important to the selection of Trinidad and Tobago were discussions with

Guardian Holdings, the NEC, DESALCOTT, and several members of the South Trinidad Chamber of Industry and Commerce.

In DESALCOTT, Seneca found a source of low-cost raw material, the waste brine from the reverse osmosis process presently being discharged to the sea. Discussions with NEC and TTEC revealed a favourable access to natural gas and electrical power. Further conversations with potential investment partners solidified Trinidad and Tobago as the location of choice.

Calcium Chloride – Benchmarking Trinidad

	1	2	3	4	5	
Middle East						
Lack substantial raw material						4.0
Trinidad						
Need raw material analysis						4.0
Russia						
Unstable Government						3.0
China						
Lacks natural gas						2.0
UK/Western Europe						
High energy costs						2.5
United States						
High Energy Costs						2.5

The current site in Point Lisas was preferred over a site in LaBrea for its proximity to DESALCOTT and deep water port facilities that are important to movement of raw material and finished products and for access to utilities including electrical power, natural gas and water. The preferred site in Point Lisas was previously zoned for industrial use; it is currently an abandoned sugarcane field that was part of Caroni (1975) Limited. No displacement of population would result, and no sensitive flora or fauna were observed on the site.

6.4 DESIGN AND TECHNOLOGY

The Project is designed to convert DESALCOTT waste brine into a high purity salt through several steps of purification and concentration. In this process, other valuable salts are produced, such as magnesium hydroxide, calcium sulphate and potassium chloride. Seneca Chemical owns proprietary technology for the separation of salts to produce pure sodium chloride. Concentration would be achieved by MVR followed by multi-effect evaporation to achieve an energy efficiency factor approaching six times single effect.

The salt (sodium chloride) is dissolved to produce a saturated solution feed to a chlor-alkali process. INEOS membrane technology was chosen for its high energy efficiency, safety of operation, and minimum impact on the environment. Relocation of an idled chlorine production facility was considered and rejected due to reliability concerns.

Seneca also owns proprietary technology for the production of calcium chloride from hydrochloric acid and limestone. The chlor-alkali and calcium chloride processes offer several synergies, the most important being the ability to recycle and reprocess all water streams allowing for design of a manufacturing procedure that can achieve zero liquid process waste.

The INEOS membrane technology is noted among the best available and is similar to the DuPont fluorocarbon membrane. Relative to other membrane manufactures, it is characterized as simple to maintain. The INEOS Chlor technology was selected after comparing it with that of other major chlor-alkali manufacturers such as Asahi Kasei and Uhde. Mercury (due to potential for environmental contamination) and diaphragm (due to asbestos and other concerns) membranes were ruled out as technology options early in the design process and were not included in any of the comparisons, because of the environmental, public health, and efficiency problems that have been associated with their use.

Technology refinements also were implemented during various phases of the actual plant design process. Changes were made to both the "front-end" (brine purification and concentration) and "back-end" (calcium chloride production) of the CariSal plant. An example of front-end redesign includes the introduction of a back pulse filter in the brine purification process, which has the advantage of making a dryer solid waste (brine mud) that is easier to handle for disposal, per the Trinidad and Tobago Solid Waste Management Company Limited requirements (see Chapter 7). Introduction of the back-pulse filters was driven by designing for no liquid back wash (see Section 6.6). Another example, a cooling tower filter, was also introduced to separate blow-down liquids (water and airborne particulate) for recycling.

6.5 CONSTRUCTION TECHNIQUES AND PHASING

Various construction techniques and Project phasing alternatives were considered for the CariSal development, including:

- Full Modularization of the process would fabricate all process buildings outside of Trinidad and only utilize Trinidad labour for the assembly. This option did not prove to be practical for the entire site.
- "Stick built" is normal construction, where all the equipment and materials are shipped to the construction site and the plants are assembled from the ground up. This option resulted in a 24-month construction schedule, higher construction risk exposure due to the extended duration, traffic, and additional construction emissions.
- Sequential construction (site prep, followed by piling, then civil, structural – each craft discipline applied to the entire site) results in the longest construction schedule (30 months) and did not meet the business requirements.
- Concurrent construction allows for a shorter schedule by overlapping certain craft activities, and

- A blend of Modular, Stick Built, and Concurrent.

The CariSal engineering and construction team selected the blend of Modular, Stick Built and Concurrent as the practical alternative for construction that would result in the shortest, practical construction schedule and have the lowest impact on the environment. In this plan, the chlor-alkali plant is being fabricated in Mexico to reduce the peak labour requirement as well as shorten the construction schedule and reduce environmental impacts due to on-site construction activity. Concurrent with module fabrication, Trinidad contractors would be preparing the site, installing piling, piling caps, and foundations. Once the foundations are complete, the process modules would be received and placed directly on their respective foundations. Several of the utility systems would also be purchased as skid-mounted units to minimize field assembly:

- Boiler
- De-ionized water unit
- Boiler feed water pumps
- Motor Control Centre
- Pipe racks

Construction Approach	Construction Duration (months)	Investment Impact vs. Base $(000)	Average Construction Manpower	Peak Construction Manpower
Full Modular	12	(7,500)	100-150	180
Stick Built	24	22,500	100-150	300
Sequential	30	37,500	100-150	450
Concurrent	18	7,500	100-150	250
Blended (Base in EIA)	15	0	100-150	220

Source: eProject Management, Project Consultants

Construction would begin with site preparation for the entire site followed by piling for the chlor-alkali facility a combination of auger and driven piling will be utilized to facilitate schedule and also utilize the auger pile capacity available (auger pile installation creates less noise pollution). Upon completion of the piling in the chlor-alkali area, the foundations for the chlor-alkali plant would be installed. Concurrently piling would continue for the remainder of the site. Followed by foundations and structure for the calcium chloride reaction and drying areas.

Once the foundations are complete for the chlor-alkali unit, the modules would be received and placed on the foundations. The 94-percent calcium chloride pellet dryer facility would be "stick built" concurrently with the associated utility skids being received and installed.

Coincident with this effort would be construction of the salt receiving and brine saturation process, package boiler, compressed air facilities, nitrogen facility, natural gas, electrical utility, and water systems. The water systems would include potable water, sanitary water, demineralised water, and firewater.

Commissioning of the utilities systems and one chlor-alkali unit will begin concurrently with the erection and installation of the 77-percent flake process. The flake unit and the second chlor-

alkali unit will come on stream approximately three months after successful commissioning of unit one.

This alternative, the phased, concurrent construction approach using modular components, was chosen to result in minimizing construction delays, a shorter overall construction period, lowest craft density and therefore safer working conditions and reduced construction related, vehicle traffic, noise, and emissions.

6.6 OPERATION AND MAINTENANCE PROCEDURES

Alternative plant operation procedures considered included:

- the classic process-by-process chemical plant operator functioning in a minimally instrumental mode;
- a design based on a process-by-process operator with distributed control system oversight and programmable logic controller (PLC)-based automation of all processes aided, where necessary, with laboratory analysis of process parameters; and
- the preferred alternative of equipping the plant for essentially full automation. Plant processes would be instrumented to complement this decision. Operators would be trained in the complete process to ensure that the automation value is maximized.

As noted above, plant operation essentially would be fully automated. The operation of each unit would be controlled by way of PLCs. Plant operations have been designed to be readily adaptable to automation, and the necessary data points are instrumented allowing their values to be reported to a central computing site. In this central area, incoming data would be analyzed according to set points, and changes are automatically made to control the process. A trained process operator would oversee the computer activities to ensure that performance is according to preset criteria. Additionally, data points for chemical levels would be monitored by in-plant laboratory analysis and process operators would be able to adjust and optimize process parameters to again achieve desired performance criteria set by CariSal management. The collective impact of automation and 24/7 laboratory monitoring of the process is a proactive rather than reactive environment that provides desired production levels with a minimum of unscheduled intervention or breakdown. An active operator-training program would further support the production activities. Operators would be trained initially by equipment manufacturer-supplied trainers (CONVE & AVS, INEOS); later, the trained, experienced operators would train new operators. CariSal is also actively pursuing two experienced chlor-alkali personnel to participate in commissioning, startup, and training of permanent CariSal operators and management.

Maintenance procedures alternatives considered by CariSal include:

- onsite mechanical forces handling all site maintenance requirements;
- contract maintenance forces handling all site maintenance requirements; and

- a blend of both.

CariSal has opted for a blend of both approaches and would have a trained onsite maintenance work force that would handle the specialized nature of the facility.

Maintenance would be handled on a predictive and preventative, scheduled basis rather than on a break-down or unscheduled basis. The scheduling would be derived from equipment vendors and CariSal's experience to achieve 95-percent onstream time for the chlor- alkali, 83 percent uptime for the 94-percent pellet dryer, and a 92-percent uptime for the 77-percent flake dryer. Operators would be trained to lubricate equipment on a suitable schedule.

CariSal personnel would be trained by equipment vendors, educational institutions, apprenticeships, and on-the-job experience rather than solely by on-the-job experience.

An onsite maintenance force would be employed to provide day-to-day maintenance of plant equipment. The intent is to have the workforce be fully trained and equipped. Maintenance procedures would be employed in accordance with manufacturers' recommendations.

Proper operation and maintenance of the membrane cell is necessary to achieve desired production and membrane longevity. Breakdown maintenance can result in poor performance due to insufficient process control as well as environmental incidents resulting from uncontrolled process upsets. This breakdown maintenance approach was thus rejected on the basis of safety, environmental risk, performance, and cost.

The preferred option of a predictive and preventative maintenance regime offers the best opportunity to achieve the facility's maximum output in a safe and effective manner and at the lowest, long-term cost. Maintenance technicians would be trained in their specific disciplines to be effective and productive. Training would be provided by vendors, educational opportunity, apprentice programs, and on-the-job experience.

Maintenance activity would be centred on day-to-day repairs against expected failure periods, inspection techniques to foresee potential faults, timely lubrication schedules, and scheduled, annual outages to service otherwise unavailable equipment. The operations group would be trained in basic lubrication needs, tools and methods, as well as trouble spot diagnosis. At times when site maintenance needs exceed the in-place CariSal maintenance force, on-call, appropriately trained and certified, outside contractors would be utilized. These on-call contractors would first be evaluated and then selected based on their ability to safely and productively complete the projects assigned to them in compliance with the facility's established performance and maintenance standards.

CariSal's contract with CONVE & AVS, the suppliers of the chlor-alkali plant, would include complete onsite support until all performance guarantees are demonstrated. The performance of the hydrogen chloride scrubbers would be included in the performance guarantees for the chlor-alkali plant.

CariSal Unlimited also became a member of the Chlorine Institute to support its planned environmental health and safety goals, and as a resource for access to training for local staff.

Membership will ensure that CariSal remains abreast of changing industry standards, regulatory requirements, tools, methods, technology enhancements, and techniques.

6.7 PROCESS TECHNOLOGY OPTIONS

Four alternative methodologies were considered for the preparation of a purified and saturated salt solution that is the feedstock for the (chlor-alkali) electrolysis process. All four alternatives have been adopted as the staged approach described in Chapter 3.

The electrolysis process can be performed using mercury cell technology where elemental mercury serves as the cathode; diaphragm cell technology where a 1+ percent caustic soda is produced across asbestos-covered diaphragms and the membrane cell process where a low salt caustic soda is produced without mercury or asbestos. The membrane process was chosen.

Synthesizing hydrochloric acid by burning hydrogen and chlorine was the only technology possible following the electrolysis process.

The 94-percent calcium chloride pellets can be produced in fluid bed dryers, spray dryers, and fluidized bed spray dryers. A fluidized bed dryer was chosen as it is a proven technology with the desired product sizing and density.

The 77-percent calcium chloride flake product can be manufactured using flaker wheels following concentration to a molten state. A similar particle can be made by using a spray dryer to produce a fine particle that is compacted using hydraulic force into a flake-like particle. Due to the additional processing associated with the compacting activity, this approach was rejected.

Production and sales of intermediate products such as hypochlorite, hydrogen chloride, and 42-percent calcium chloride support plant safety and the continued operation of the electrolysis process.

The process technology for the four stages in the CariSal facility is robust, proven, and among the best available for the specified production requirements. In Stage 1 of the brine preparation process, a simple carbonate-hydroxide-calcium chloride brine-purification process is lab-monitored and fully automated to achieve a brine of very high purity required for electrolytic cell operation. The impurity removal is high and the solids separation technology (back-pulse filtration) captures sub-micron particles. This approach is augmented by gravity separation due to the much higher solids content in later brine preparation stages. Stage 4 offers the opportunity to capture and sell magnesium hydroxide, calcium sulphate, and potassium chloride.

The chlor-alkali process is performed using a membrane electrolytic cell that produces an essentially sodium chloride-free caustic soda, together with hydrogen and chlorine. The process alternatives are:

- diaphragm cells that use an asbestos blanket in its cell and produces caustic soda with 1+ percent sodium chloride; and

- mercury cells that use elemental mercury as the cathode. The caustic soda produced is low in sodium chloride but can emit mercury to the environment.

The electrolytic process, the preferred alternative, has a chlorine bleach operation that also serves as an environmental capture point for all chlorine being produced during a system upset. As described in Chapter 3 (Step 3 of bleach production), if an upset occurs, the plant automatically shuts down and diverts to the bleach system. Auxiliary power (via backup generator and later the cogeneration plant) would be provided to ensure performance if power is lost.

The choice of product mix is driven by environmental health and safety concerns as much as it is by economic opportunity. As such, the proposed product lines have the mutually reinforcing benefits of minimising the risk of chlorine contamination by producing sodium hypochlorite.

Hydrochloric acid is made directly from gaseous chlorine and hydrogen removing the need to liquefy the chlorine. This process has the desired effect of reducing the amount of chlorine present in the plant and eliminating the drying and liquefaction operations that typically are part of chlor-alkali plants.

The burning of hydrogen and chlorine occurs in a water-cooled furnace in a fully automated operation. Hydrogen that is produced with the chlorine is vented to the atmosphere in these circumstances. The chlorine stream produced defaults to the bleach (hypochlorite) system; the hydrogen defaults to the atmosphere during any plant upset that affects these streams. Exit gas scrubbers on the absorbing tower prevent uncontrolled emissions.

The Project would neither store nor transfer chlorine, reducing the number of emissions sources and the likelihood of contamination.

Calcium chloride is produced from reacting high purity limestone and hydrochloric acid. The initially acidic liquid is neutralized with lime solution to produce a 40+ percent calcium chloride liquid. The process is used worldwide for production of calcium chloride and represents a growing segment of that market. The process is fully automated. Insoluble sand-like material in the limestone and lime is separated from the calcium chloride liquid and discarded from the process. It is stored, and once tested to confirm purity, is intended for later use as roadbed material, fill, or similar uses. It would be a readily compacted and the small amount of calcium chloride in it would further enhance its compactibility. The dry products are 94-percent calcium chloride pellet and a 77-percent calcium chloride flake. Both operations are chosen to serve specific markets. The pellet is a concentrated form of calcium chloride that can be readily transported anywhere in the world for use in oil-well production tasks and as a pure calcium source for many products such as Kevlar®, Nomex®, food preparation, and preservation.

The chosen fluid bed drying is best suited to achieving the desired spherical particle shape in a productive process, readily automated and supportive of the zero discharge philosophy. The 77 percent flake material is suited to the ice melting opportunities available in the Northeastern United States. It is also useful as a dust palliative and road base stabilizer in environments where humidity is above 50 percent.

The process chosen evaporates the 42-percent calcium chloride starting liquor mixed with the purges from the pellet process and the environmental scrubbers. The vapour driven off during evaporation is condensed for reuse as process water, offsetting need for WASA water.

Emissions scrubbers would be the best available for reducing particulate emissions. Waste reuse and water reuse minimize the facility's ecological footprint.

Product packaging would be semi-automated. An employee would place empty bags on a packager and they would be automatically filled. Twenty-five-kg bags would be palletized using a robot designed for this task. The automated palletizing robot is a unique approach to palletizing that prevents employee exposure to the repetitive motion of bag movement with its resultant repetitive motion-type injuries.

Computer process control optimizes what a process can produce. This process control is designed to detect a shortfall situation and initiate reaction sooner and more correctly than an operator can.

Collectively, the Project's preferred operations tools, techniques, and methodologies combine tested technologies with some of the most modern technologies in use today.

6.8 WATER SUPPLY OPTIONS

Water supply alternatives examined included:

- Direct connection to a WASA water main for total facility supply,
- A pipeline from DESALCOTT carrying water for total facility supply,
- Direct connection to WASA for partial process water supply, evaporation or condensation of DESALCOTT brine to produce water and sell excess production, and
- Direct connection to WASA water with total requirement offset by rainwater collection and internal recycling.

WASA would initially supply water for Stage 1 operation of the Project. In all stages, the facility would reuse rainwater captured in ponds and in process condensates normally discarded to offset demand for WASA water. This approach is consistent with CariSal's zero liquid process waste discharge operating philosophy, and it minimises draw on the public water supply. As the Project moves through Stages 2, 3, and 4, WASA water use would be reduced. Water use would be replaced by reverse osmosis effluent from the DESALCOTT plant operation in an increasing quantity in each of these stages. In Stage 4, the purchase and use of solid salt would be fully replaced by complete conversion to DESALCOTT effluent with a subsequent production of pure water, 50 percent higher than in-plant demand.

This hybrid, staged approach is the preferred option and presents opportunities for greater environmental, consumption reduction/supply augmentation, cost and societal benefits than

either of the first two alternatives or the selection of any one of the four, in the absence of a staged approach.

Under the preferred design option developed to date, firewater would be stored onsite in a tank (as described in Chapter 3 and represented on the proposed Project plot plan). Water would also be stored in two surface water impoundments as presented in Chapter 3.

Abstraction of water was not considered a viable option for meeting the Project's water demands.

The preferred option is designed to maximise water use efficiency in the facility's operation. Other sources of water would include collected rainwater run-off from process areas and undeveloped areas of the site. The site would be designed to enable process area run-off to be collected in the Containment Pit, and for clean water run-off to be directed to the Retention Pond. These retention areas would be sized to contain 50-year storms. The preferred design would also optimise the protection of the perennial wetland on the undeveloped northern section of the site, the reduction of flooding during periods of heavy rains in the western section of the site and in neighbouring sites immediately west of the Project, and would promote maintenance of the floodplain for the drainage channel that runs along the northern battery limit of the Project site.

The production process would yield a surplus of demineralised water (depending on product mix) in Stage 4 that would be piped to WASA for distribution to industrial consumers in the vicinity.

CariSal has also chosen to treat and reuse its sanitary system water by substituting a septic system for an activated sludge process (via the aerobic treatment unit) with ultraviolet treatment and recycling.

6.9 WASTE TREATMENT AND MANAGEMENT OPTIONS

Nine solid waste treatment options were evaluated:

1. Landfill all solid waste as generated
2. Test and recover/reuse process solid waste as road base or berm material, landfill wastes that do not support this reuse
3. Modify processes to recover wastes as sellable products
4. Landfill office waste, construction waste, and maintenance wastes
5. Recycle maintenance solvents, waste oils
6. Recover carbon dioxide as soda ash
7. Sell carbon dioxide to area consumers
8. Design plant to a zero liquid process discharge standard
9. Process sanitary waste water to allow complete reuse

Process solid waste would be generated from brine purification, limestone inerts, lime inerts, and the cooling tower blowdown. These solids would comprise calcium carbonate, magnesium hydroxide, calcium sulphate, and clays, and would be extracted from their respective processes by plate and frame filters resulting in relatively high solids content. Both the brine muds from the purification process and the lime and limestone inerts from the calcium chloride production process would first be tested for purity. If they are shown to be adequately pure, they would then be mixed and further tested for appropriateness as a road base material, day cover at landfills and/or berming material in an attempt to reuse rather than landfill the solids. The selection of high quality raw materials by CariSal would also minimize the quantities of solids generated.

Liquid waste would be reused within the process to effect the zero liquid discharge philosophy. This includes on-site treatment and recycling of sanitary wastewater.

Other types of waste would be minimised to the extent possible using recognized techniques such as, recycling, composting, and reuse. CariSal would implement Items 2 through 9 of the waste minimisation and management alternatives listed above.

The status quo practice and alternative to the options described above would include simply sending all waste solids to landfills with a likely negative impact on limited landfill capacity in Trinidad – absent expansion of such capacity or development of other strategies for solid waste minimization and management.

6.10 BEST PRACTICABLE ENVIRONMENTAL OPTION

A range of best practicable environmental options was assessed in the design and environmental review of the proposed facility. These options include clean production, close-looped processes for managing process waters such as testing, recycling, and reuse; energy efficiency; pollution prevention; green building principles applied to the administration building; and safety features for chlor-alkali plants recommended by the World Bank and Chlorine Institute. The selection of best practicable environmental options includes ongoing efforts to reduce the Project's physical and ecological footprint.

CariSal's proposed waste-to-retail Project would be an early attempt at implementing the principles of clean production in Trinidad and Tobago, particularly when its Stage 4 production process is realized. By utilising a clean production, closed-loop approach (for liquid process wastes), CariSal proposes a facility that would incorporate proven pollution prevention techniques and best available technologies for the manufacturing process. Compared to the other design, process, construction, and operation methods considered, and with mitigations in place, the selected facility design options would reduce the routine release of toxic and other environmentally harmful compounds into the environment.

Cleaner production has been shown to produce more environmentally advantageous environmental health and safety outcomes than traditional end-of-pipe industrial design and environmental regulation. Cleaner production allows for the use of general management systems and specific environmental management tools such as process controls, continuous monitoring and reporting, and data and audits to support environmental compliance.

Some of the environmentally beneficial options selected by CariSal include:

- Use of a three-stage purification process to convert waste brine from DESALCOTT to calcium chloride and caustic soda, sellable products that benefit the local market. The process water produced would be treated and recycled in the CariSal production process.
- Prioritises environmental considerations—potentially negative impacts are being identified and addressed at the design phase.
- Has as its goal a zero liquid process-waste policy.
- Cleans and utilises DESALCOTT waste brine for use in CariSal's production process, and exports demineralised water produced by the process to local industry as distilled water to WASA (Stage 4);
- Utilises rainwater runoff from the process and site buildings;
- Local manufacture of reliable quantities of hypochlorite would allow WASA to substitute sodium hypochlorite for imported chlorine that is currently stored at its water treatment facilities;
- Uses the best available (cell membrane) technologies for the chlor-alkali production process, resulting in reduced waste streams and greater energy efficiency compared to other chlor-alkali plants in the United States, Europe, and South America; and
- Evaluates and practices the latest, most locally practicable methods of carbon dioxide mitigation, including off-setting, manufacture of soda ash for internal consumption, and implementation of green and cool-roof technologies on office and support buildings.

6.10.1 Energy Efficiency

A natural gas-fired cogeneration unit would provide supplemental electricity to the CariSal calcium chloride plant (during its Stage 4 operation, see Section 3.4.6). The cogeneration plant would consist of three gas turbines, coupled to three generators each producing 7.5 MW electrical power. The exhaust gases would be sent to a heat recovery boiler to produce high-pressure steam; approximately 32,537 kg/hr in Stages 1 and 2 to 53,987 kg/hr in Stage 3 and 66,231 kg/hr in Stage 4. This steam would displace steam required from the plant's natural gas boiler.

The efficient cogeneration plant would use significantly less fuel than separate heating and electric power plants. Cogeneration has higher overall efficiency than conventional utility systems, typically 85 percent versus 58 percent. This efficient use of fuel would reduce the forecast emissions of greenhouse gases (those associated with the steam and electricity production) by approximately 30 percent, which would reduce the plant's total GHG emissions by about 16 percent.

Energy efficiency has also been taken into consideration when designing the process itself. The cell membrane process is more energy efficient than earlier types of chlor-alkali processes, such as mercury cell and diaphragm cell.

6.10.2 Pollution Prevention

CariSal would implement pollution prevention techniques recognized by the U.S. EPA and the Chlorine Institute, including the recovery and recycling or sale of production byproducts and the filtering, compaction, and proper disposal of brine mud.

The Project's conceptual design includes the following pollution prevention measures, which include several recommended by the World Bank for chlor-alkali plants (including cell membrane plants):

- Use metal rather than graphite anodes to reduce lead and chlorinated organics;
- Re-saturate brine in closed vessels to reduce the generation of salt sprays;
- Reduce the amount of process wastewater through capture, condensation, and uses of the resulting water vapour;
- Scrub chlorine tail gases to reduce chlorine discharges and to produce hypochlorite;
- Recycle condensates and process water to the brine system, if possible;
- Recycle brine wastes, if possible;
- Include closed re-saturation;
- Provide for a process water retention pond (the Containment Pit) that would be either a geomembrane-lined earth-bermed structure or an engineered concrete structure with leak stops and an underdrain and designed to meet the appropriate seismic requirements;
- Subject to test results, sell limestone inerts, lime inerts, and magnesium hydroxide inerts from lime as road stabilizer.

Other pollution prevention measures to be implemented by the Project include:

- Adding scrubbers to calcium chloride dryers to achieve 99.82-percent efficiency;
- Modifying dust collection equipment to accept high-efficiency cloth media having 99.99-percent efficiency;
- Programming the central control system to automatically shut down and secure processes having high environmental downsides; and
- Identifying, via HAZOP and other techniques, remaining potential process shortfalls and redesigning processes to eliminate them.

As recommended in Chapter 7, air emissions from the calcium chloride drying operations would be retrofitted with high-efficiency liquid scrubbers capable of meeting necessary emission

standards for overall amount discharged and particulate matter that is 2.5 microns in size and greater. Emissions from the lime handling systems would use a 1-micron mesh-size capture cloth in the pressure blowback dust control systems.

Carbon dioxide generated from the reaction of limestone and hydrochloric acid would be reused to prepare soda ash solution in the early stage of brine purification. All available alternatives to reduce greenhouse gases would be explored and reasonable efforts undertaken.

6.10.3 Plant Footprint and Buffer Zones

A series of raw materials, plot plan configurations and designs, and transportation and construction techniques were identified and evaluated to achieve the goal of reducing the goal of the Project's footprint. In its initial Certificate of Environmental Clearance application, CariSal proposed the use of *planned* port facilities and other infrastructure in the Point Lisas area. Early in the application process, however, this alternative was re-evaluated, and a decision was made to identify slack resources or unused capacity at local ports. CariSal explored a series of options that would involve the cleanup, rehabilitation and reuse of existing infrastructure in the area, such as the caustic soda pipelines at the EISL facility and the selection of the Point Lisas Port Development Company ports—in particular, Savonetta Pier No.4—for bringing in raw materials. The use of existing the Caroni (1975) Limited infrastructure was also investigated, including the use of the two molasses shore tanks described in Chapter 3. Some of these efforts to utilise existing facilities are still underway while others have proven impracticable. The preferred option of the Project is nevertheless to use an existing caustic handler, EISL, and the Yara Pier.

Project components were also rearranged on the site plot plans to reduce receptor exposure levels in the air and noise resource areas. The cooling towers were moved from the western side of the site to reduce Project-related noise, and retention ponds were reconfigured to optimize water use and drainage while mitigating flooding that is part of the baseline environmental profile of the immediate vicinity of the plant. The Project was designed to use roughly half the site for industrial facilities, while leaving the northern section of the parcel in its natural state and protecting the perennial wetland found there.

Compared to industrial sites in the vicinity, the proposed CariSal site is far smaller in land area. Given the limited availability of land, the relative small scale and contained nature of the Project, and the already highly industrialized setting to the north and west, a 9-metre (m) perimeter boundary is proposed for the Project; however, the plot is designed to include a minimum buffer of 40 m from any process unit. The location of the site at the boundaries of the Natural Gas Corporation, Trinidad and Tobago Electricity Commission, and Caroni Railroad rights-of-way may also support a smaller buffer zone.

6.10.4 Green-Building and Sustainable Design Principles

The administrative buildings and associated facilities have been designed in accordance with "green building" and LEED sustainable design principles (see Section 3.3.2). Buildings would make maximum use of daylight while avoiding solar (heat) gain by means of shading, exterior light shelves, overhangs, and grass roofs. Parking areas would be shaded by landscape plantings and trellised green roofs, which would reduce heat-island impact and promote surface-

water retention. (This vegetation, along with the grove of local tree species, would absorb carbon as carbon dioxide throughout its natural life cycle, mitigating the vegetation losses caused by clearing during site preparation.) Rainwater would be recycled for use in landscape irrigation. Site lighting and electric-cart charging stations would be solar powered.

6.11 NO ACTION OPTION

Under the no action alterative, the chlor-alkali project proposed by CariSal Unlimited would not be built in this location. As suggested in Section 6.1, evaluation of the no action option compares the relative impact of each alternative against the baseline environment (with and without the Project) to select a preferred alternative, including taking no action. Choosing the no action alternative does not necessarily correspond to the maintaining of baseline conditions, however, because changes may result from other actions. That no adverse impacts to the natural, biophysical, and human environments are foreseeable is true, if the Project were not constructed and if no other future development with comparable or worse potential impacts occur at the site. For example, because the site has already been approved for industrial use by the Town and Country Planning Division, other industrial uses may be sited there. Inquiries with the lessor of the 11.8-ha site suggested, however, that at present, no known alternative activities are planned for the site. If the site remains undeveloped, the environmental status quo would inure in the short to mid-term.

The no action alternative, however, would result in loss of a strategic economic opportunity for Trinidad and Tobago as a new entrant to the export markets for caustic soda, calcium chloride, and the Project's related by-products. The opportunity for WASA to improve the safety of its water treatment process, while reducing cost (by substituting imported chlorine that is then stored onsite with domestically produced hypochlorite) would be lost. The Project's direct and indirect socioeconomic impacts to the local area, specifically local and regional workers and contractors, would also be precluded by this alternative. Although local area workers and residents have raised concerns about their environmental health and safety, they also simultaneously stressed the need for the community to benefit from the introduction of jobs to which they would have access and to training programs (some of which would be offered by CariSal).

Given that any negative impacts to humans and the environment can be successfully mitigated by implementing the recommendations stated in Chapter 7, the no action alternative is not considered to be a preferred option in these circumstances.

7.0 MITIGATION, MONITORING, AND MANAGEMENT PLANS

This chapter reviews the mitigation, monitoring, and management plans that address the impacts of the CariSal Project. Table 7.0-1 summarizes the impacts, the specific resource mitigation measures, time frame, and responsible authorities that are described in the following sections. Two levels of Project mitigation are described: (1) those that are to be addressed by the various plans that CariSal has developed or should develop and (2) the specific measures delineated in Table 7.0-1. Both levels are necessary for the Project to realize a well coordinated and effective mitigation, monitoring, and management programme.

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
Design and Operations Principles	Use a clean production, closed-loop approach	Verify that this measure is incorporated into CariSal's detailed design	Throughout operation	CariSal
	Employ proven pollution prevention measures	Verify that these measures are incorporated into CariSal's detailed design and its preventative maintenance plan	Throughout operation	CariSal
	Use best available technologies for the manufacturing process		Throughout operation	CariSal
	Employ a natural gas-fired cogeneration unit to provide supplemental electricity to the calcium chloride plant		Throughout operation	CariSal
	Use mechanical vapour recompression as a replacement for multiple-effect evaporation for the brine concentrator		Throughout operation	CariSal
	Design and build administrative facilities in accordance with "green building" and sustainable design principles		Prior to operation	CariSal
	Utilise the 238 MT/yr of hydrogen currently planned to be vented under the current design	Verify that this measure is incorporated into CariSal's detailed design	Throughout operation	CariSal
Traffic and Transportation	Issue advisories and public announcements to inform residents of construction activities and transportation of pipeline materials	Verify that public announcements have been issued	Throughout construction	CariSal/ Contractors
	Comply with the Highways Act and Motor Vehicle and Road Traffic Act	Citations issued	Throughout construction	CariSal/ Contractors
	Consult with the Police Service in the affected areas	Verify that the Police Service has been consulted	Throughout construction	CariSal/ Contractors

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Widen areas near the site approach	Roadway level of service	Throughout construction	CariSal/ Contractors
	Define and utilise best hours of material transport	Percent of trucks moving during peak hours/roadway level of service	Throughout construction and operation	CariSal/ Contractors
Physical Hazards to the Public	Prohibit public access to the Project site and to pipeline rights-of-way	Control and monitoring of access; no unauthorized persons achieve access	Throughout construction, operation, and decommissioning	CariSal
	Train contractors and visitors to the CariSal site in appropriate health and safety measures and supply them with personal protective equipment appropriate to the areas of the plant they access and the activities they undertake; develop a Decommissioning Plan	Training measured by measuring rate of occupational incidents; evaluation as to cause of incidents; evaluation of compliance with site personal protective equipment program	Throughout construction, operation, and decommissioning	CariSal
Hazardous Materials Exposure	In the event of a toxic substance release, control room personnel activate the plant emergency shutdown system and notify local communities downwind and advise them to remain indoors until the release is controlled; develop a Decommissioning Plan	Emergency shutdown activates effectively in 100 percent of incidents; local communities notified in a timely manner; community takes actions directed by the notification to limit exposure potential	Throughout operations and decommissioning	CariSal
Emergency Response	Provide safety training for hazardous materials truck drivers	Document that hazmat truck drivers are properly trained	Throughout operations and decommissioning	CariSal (or hazmat driver contractors)
	Ensure routes of hazardous materials are specified	Measurements of traffic movements	Throughout operations and decommissioning	CariSal (or hazmat driver contractors)
	Clearly define offsite emergency response procedures to transportation incidents	Measured compliance with offsite emergency response procedures if necessary	Throughout operations and decommissioning	CariSal (or hazmat driver contractors)
Dust and Particulate Matter	Construction contractors supervised to ensure that they are using well-maintained transport equipment and vehicles	Requirements added to all contracts as explicit performance terms	During construction	Oversight by CariSal and site civil contractors
	Pave primary plant roads to minimize dust emissions from vehicular traffic	Document date on which plant roads were paved and the amount of paving material used in the process	Early in construction	Oversight by CariSal and site civil contractors

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Cover all aggregate storage piles	Document acquisition of storage pile covers and instructions in operating procedures for covering storage piles	During construction	Site civil contractors
	Spray onsite approach roads and internal site roads with water using dedicated water trucks during periods of low soil moisture	Document date on which plant roads were watered and amount of water applied	During construction	Oversight by CariSal and site civil contractors
	Clear only the area(s) needed for construction	Document area(s) worked on a weekly basis on a site map; document activity in each area worked	Throughout construction	CariSal
	Cover dump trucks and other vehicles carrying construction material to prevent spillage	Document that material leaving site is covered and secured prior to departure; have records available for review	Throughout construction	Oversight by CariSal and site civil contractors
	Cover all construction material storage piles and water as appropriate to minimize generation of dust	Document acquisition of storage pile covers and instructions in operating procedures for covering storage piles; document that piles are covered at end of each day's activity	Throughout construction	Oversight by CariSal and site civil contractors
	Track-out control – downwash trucks (especially tyres) prior to departure from site	Document procedures for wash down and equipment used; document daily volume of water used and number of vehicles washed	Throughout construction	Oversight by CariSal and site civil contractors
	Thoroughly train operations personnel on proper operation of scrubber and bag house air pollution control equipment	Document training records for plant employees which cover operation and maintenance of scrubbers and bag house equipment; review and inspect training material	Prior to and throughout operations	CariSal Safety and Environmental Officer
	Use advanced process control technology and modern operator interfaces to monitor and control operation of scrubbers and bag house equipment, including the 94-percent dryer, 77-percent dryer and cooler, lime dust bag house, hydrogen chloride scrubber, and chlorine scrubber	Document procurement and installation of scrubber and bag house along with metering equipment; document real-time monitoring of process flow and exhaust rates	Throughout operations	CariSal
	Implement formal preventative maintenance program for scrubbers and bag house	Document and maintain records of quarterly checks on preventative maintenance procedures	Prior to and throughout operations	CariSal

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Discourage vehicle and equipment idling	Confirmation of posted signs on property and at load and unload points requiring equipment shutdown after 3 minutes of idling	Throughout construction, operations, and decommissioning	CariSal Safety and Environmental Officer
	Implement a real-time fence line air monitoring program for particulate matter	Procure equipment for real-time monitoring; document method for reporting readings in real time; identify course of action if exceedance occurs; provide written report of any incidents	Prior to operations	CariSal
Wastewater Management	Direct disinfected effluent from the sanitary system to the Containment Pit and reuse it as process water	Verify the implementation of the design elements; confirm attainment of treatment system performance criteria; document proper septic waste disposal and inspections of the plant drainage system	Throughout operations	CariSal
	Incorporate into terms of agreement with the septic system cleanup contractor the prohibition of uncontrolled, illegal emptying or dumping of sludge into the environment	Include contract clause requiring discharge only at licensed facility. Require verification of receipt at licensed facility prior to payment of contractor.	Throughout operations	Contractor with CariSal oversight
	Direct all rainwater that contacts process or storage areas to the Containment Pit and recycle it through the process makeup water system	Verify the implementation of the design elements; document inspections of the plant drainage system.	Throughout operations	CariSal
	Direct all rainwater that contacts non-process areas to the Retention Pond for use as cooling tower makeup water	Verify the implementation of the design elements; document inspections of the plant drainage system and inspection of the Retention Pond	Throughout operations	CariSal
	Discharge any residual water in the retention ponds to local waterways if testing confirms that the water meets the discharge criteria and such discharge is in accord with regulations in place at time of decommissioning	Document the chemical testing of any water intended for discharge, confirm that any water discharged complies with discharge requirements, and maintain a record of the date, time, volume, and water quality results of all discharges	During decommissioning	CariSal
Gaseous Emissions	Use well-maintained vehicles and equipment	Operating records and maintenance logs	Throughout construction, operations, and decommissioning	CariSal and civil contractors

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Verify the installation and functionality of vehicle-equipped emission controls	Check Ministry of Works and Transportation records on vehicle safety; check and document that emissions control devices have not been removed or tampered with	Throughout construction, operations, and decommissioning	CariSal and civil contractors
	Require onsite contractors to perform vehicle inspections and maintain their internal combustion engines	Check Ministry of Works and Transportation records on vehicle safety inspection	Throughout construction, operations, and decommissioning	CariSal
	Optimize the efficient use of equipment and vehicles through management practices such as idle minimization	Document that management practices are included in written contract with civil contractor	Throughout construction, operations, and decommissioning	CariSal and civil contractors
Noise	Fit all vehicle and construction equipment with exhaust silencers	Records of physical condition of mufflers and replacements if necessary	Throughout construction, operations, and decommissioning	CariSal and construction contractors
	Require damaged silencers to be promptly replaced		Throughout construction	CariSal and construction contractors
	Ensure that all construction equipment adheres to noise standards of the (Trinidad & Tobago Noise Pollution Rules)	Documentation that equipment is operating in compliance	Throughout construction	CariSal and construction contractors
	Install noise shields or barriers on construction equipment such as portable power generators	Verification that barriers break the line-of-sight from noise source to listener	Throughout construction	CariSal and construction contractors
	Reduce noise at the source by providing acoustic lagging for the equipment, select and design low-noise equipment, and effect operation and maintenance to keep noise levels low on relevant equipment; develop a Decommissioning Plan	Check conditions of equipment; equipment repaired or replaced as necessary; management practices in place to minimize noise	Throughout construction, operations, and decommissioning	CariSal
	Fit air-powered equipment with pneumatic exhaust silencers	Check physical condition of silencer and replace if necessary	Throughout construction, operations, and decommissioning	CariSal
	Evaluate feasibility of upgrading windows and doors (for nearest residence/s) with acoustical replacement windows and doors to reduce front loader or cooling tower noise, if monitoring demonstrates that the standard is exceeded	Confirm by noise measurements that sound insulation or noise barriers achieve a 5- to 10-dBA noise reduction	During operations	CariSal

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Evaluate feasibility of noise barriers to shield front loader or cooling tower noise	Confirm by noise measurements that sound insulation or noise barriers achieve a 5- to 10-dBA noise reduction	During operations	CariSal
Flora and Fauna	Perennial wetland area in the northwest corner of the CariSal site, along with a buffer of annual wetland and upland area surrounding the perennial wetland, would be protected and left in as close to its current state as possible	Establishment of Wetland Reserve Area with clear borders; no physical alteration to topography, vegetation, or water bodies within the Wetland Reserve Area or contamination with silt from the construction site during construction; no introduction of contaminated runoff from the plant site or other impacts on Wetland Reserve Area during operation; no significant loss of species diversity or abundance within the perennial wetland area as compared to baseline conditions described in the Biological Reconnaissance Report	Throughout construction and operations	CariSal site planners and site preparation contractors
	Set aside wetland areas on site permanently as a Wetland Reserve Area and carry out active management and monitoring activities to preserve the ecological values *Alternatively, if the above should prove to be impractical, suitable, off-site property is to be restored (if necessary), developed, and maintained as a permanent Wetland Reserve Area*	Establishment of a Wetland Reserve Management team within the CariSal organization; establishment of staff positions and job descriptions to include Wetland Reserve management and monitoring activities; development of a monitoring regime and reporting and recordkeeping system	Throughout construction and operations	CariSal EHS team and contracted Biologist/Wetland Reserve Manager
	Contract with a qualified biologist or wetland expert to provide supervision prior to and during construction, and ensure construction activities minimize adverse impacts to the wetland, to preserve ecological values of the wetland	Contract in place with qualified biologist/wetland specialist; budget available for periodic assessment and supervision activity by contracted expert; maintenance of periodic expert reports on the state of the wetland and actions needed to protect it	Prior to and throughout construction	CariSal EHS team, and contracted Biologist/Wetland Specialist

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Contract with a qualified watershed hydrologist to carry out a hydrological study of the surrounding area (including areas beyond the Project site) to identify drainage areas and other features critical to the integrity of the perennial wetland area on the Project site	Hydrological report documenting a hydrological study of the surrounding area (including areas beyond the Project site) and identifying all hydrological, topographical. and other features critical to the integrity of the perennial wetland area	Prior to the start of construction	CariSal EHS team with adjacent property owner/s, and contracted hydrological specialist
	Work closely with EMA and property owners of adjacent properties to ensure that the offsite features critical to the integrity of the perennial wetland on the CariSal site will be conserved by adjacent property owners	Record of communication with EMA and adjacent property owners regarding conservation of the perennial wetland. Written agreements with adjacent property owners to preserve features critical to the integrity of the perennial wetland on the CariSal site. Program in place by EMA to preserve the wetland and offsite features critical to wetland integrity	Prior to development of adjacent properties	CariSal EHS team, EMA, adjacent property owners.
	Ensure that all potentially contaminated runoff from the plant site is collected and routed to the Containment Pit, and cannot flow into the Wetland Reserve Area	Periodic monitoring data on record indicating no significant increase in contaminants; corrective action plan in place to be activated if necessary	Prior to and throughout operations	CariSal EHS team
	Monitor soil and plants in calcium chloride deposition areas for chloride accumulation and chloride toxicity	Baseline and periodic monitoring data; recorded results of visual monitoring	Prior to and throughout operations	CariSal EHS team and contracted soil/plant monitoring contractors
	Develop contingency plan to be adopted if biological monitoring indicates a significant and unacceptable level of chloride toxicity to vegetation outside plant boundaries	Contingency plan in place to reduce calcium chloride releases beyond the plant boundaries if action levels are reached	Prior to operations	CariSal EHS team
	Hand over the Wetland Reserve Area to a nongovernmental organization or to the Government so that it can become a protected area open to the public; develop a Decommissioning Plan	Clear plan for sustainable management of the Wetland Reserve Area, with budgetary resources in place	Planning prior to decommissioning Hand over upon decommissioning	CariSal EHS team and participating NGO or governmental agency

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Develop a trust fund that would fund basic reserve area management functions on an ongoing basis as part of the Decommissioning Plan	Identification and acquisition of resources needed for trust fund and foundation	Prior to decommissioning	CariSal management
Drainage	Construct permanent elements of drainage management system in a sequenced fashion to control drainage from construction areas and completed areas, and direct it to the Containment Pit and Retention Pond	Include sequence of construction for drainage works in Surface Water Pollution Prevention Plan or in contractor's work plan and monitor for compliance	Throughout construction	Contractor with CariSal oversight
	Construct perimeter dikes and retention ponds to control construction runoff	Documentation of reviews and monitoring contractor's schedule for compliance	Early in construction	Contractor with CariSal oversight
	Construct dedicated stormwater drains throughout the developed areas	Review engineering design calculations for adequacy of stormwater system; documented verification that construction complies with the design	Early in construction	Contractor with CariSal oversight
	Maintain perimeter dikes and retention ponds until most land has been restored to its final grades and revegetated as part of the Decommissioning Plan	Include sequence of removal of drainage works in Surface Water Pollution Prevention Plan or in contractor's decommissioning plan and monitor for compliance	Throughout decommissioning	Contractor with CariSal oversight
	Schedule construction to minimize the proportion of soil area exposed all at once, especially during the rainy season	Include sequence of clearing, excavation, backfill, and grading activities in contractor's work plan and monitor for compliance; base acceptable exposed soil area on the effectiveness of runoff control measures; impose limits on the contractor preventing work in new areas if necessary	Prior to and throughout construction	Contractor with CariSal oversight
	Avoid construction across drainages during periods of rain	Documented requirement that the contractor is required to submit weather data and the schedule to obtain a permit from CariSal prior to performing construction across drainages and that the contractor is to develop a contingency plan if rain develops or the schedule is exceeded.	Throughout construction	Contractor with CariSal oversight

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Complete construction in drainage channels as quickly as possible	Documented requirement that the contractor is to develop a schedule prior to performing construction across each drainage and monitor for compliance	Throughout construction	Contractor with CariSal oversight
	Inspect, repair, and fortify all runoff control measures if necessary before any forecast precipitation or pause in construction activities, including weekends	Documented requirement that the contractor is to certify that each erosion control measure has been inspected, repaired, and fortified if necessary before any forecast precipitation or pause in construction activities	Throughout construction	Contractor with CariSal oversight
	Make work crew available to inspect, maintain, and repair runoff control measures during all storm events, including nights and weekends	Contractual requirement to make a work crew available to inspect, maintain, and repair runoff control measures during all storm events, including nights and weekends	Throughout construction	Contractor with CariSal oversight
	Use gravel-bag check dams or similar measures to reduce water velocity and to direct runoff to drainage channels	Visually inspect site periodically to identify areas requiring velocity reduction or redirection of flows	Throughout construction	Contractor with CariSal oversight
	Site pipeline rights-of-way at least 25 feet from drainages	Review engineering drawings to verify that pipeline rights-of-way remain at least 25 feet from drainages except at crossings; verify that construction complies with the design	Prior to construction	Contractor with CariSal oversight
Soils and Erosion	Use soil binders and polyacrylamides to prevent erosion or to stabilize soil until new vegetation becomes established, when necessary	Include compliance with the mitigation as a contractual requirement for the contractor, subject to CariSal compliance and inspections	Throughout construction	Contractor with CariSal oversight
	Contour soil surfaces to promote sheet flow and to prevent concentrated flow	Require contractor to grade soil surfaces to promote sheet flow and monitor for compliance.	Early in construction	Contractor with CariSal oversight
	Use geotextiles and mats as necessary to protect erosion-prone areas from damage	Specify locations of erosion control measures in Surface Water Pollution Prevention Plan or contractor work plan and monitor for compliance	Throughout construction	Contractor with CariSal oversight
	Seed and sod as soon as possible in areas where construction is otherwise complete	Documentation that seeding or sodding is completed in applicable areas within one month (dry season) and within one week (rainy season)	Throughout construction	Contractor with CariSal oversight

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Use permeable berms, hay bales, silt fences, or other sediment controls as necessary to detain and filter sediment-laden runoff	Specify locations of sediment controls in Surface Water Pollution Prevention Plan or contractor work plan and monitor runoff for compliance	Early in and throughout construction	Contractor with CariSal oversight
	Stockpile and reuse topsoil where possible	Developed topsoil reuse plan and monitor for compliance	Throughout construction	Contractor with CariSal oversight
	Maintain vegetation in all areas not containing industrial facilities, buildings, or roads; prohibit large areas of bare soil	Restrict land clearing to required areas only and monitor contractor for compliance	Throughout operations	Contractor with CariSal oversight
	Remove and periodically dispose of sediment that accumulates in sediment traps or the retention pond using a qualified industrial waste management contractor	Documented inspection and cleaning of sediment traps at least weekly and after rainfall events	Throughout construction and operations	Contractor with CariSal oversight
Water	Recycle cooling tower water, process water, and sanitary system wastewater	Incorporated into plant design; confirm compliance with design	Throughout operations	CariSal
	Collect runoff from the site in the Containment Pit and Retention Pond for use as cooling tower and process water makeup	Incorporated into plant design; confirm compliance with design	Throughout operations	CariSal
	Pump portable toilets provided for the construction crews regularly and dispose of waste at a wastewater treatment plant	Requirement that contractor complies with record keeping, certification of periodic pumping and documentation of proper disposal	Throughout construction	Contractor with CariSal oversight
	Segregate construction debris in waste containers or within contained areas to prevent water quality impacts due to contaminated runoff	Requirement that contractor define debris areas in construction work plan and monitor for compliance	Throughout construction	Contractor with CariSal oversight
	Discharge any residual water in the retention ponds to local waterways if testing confirms that the water meets the discharge criteria and such discharge is in accord with regulations in place as part of the Decommissioning Plan	Document the chemical testing of water and document confirmation that each test result meets discharge criteria prior to discharge	During decommissioning	CariSal
Waste Management	Instruct the contractor to reuse and recycle materials and waste to the extent practicable to minimize the generation of waste requiring disposal or treatment	Documented requirement that contractor reuses and recycles materials to the extent practicable in Waste Management Plan submitted to CariSal	Prior to construction	CariSal

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Segregate demolition debris and residual materials that are not sold for disposition as part of the Decommissioning Plan	Documented requirement that contractor include material segregation in decommissioning work plan	Throughout decommissioning	CariSal
	Recycle scrap metal, glass, plastic, concrete, asphalt, and other recyclable materials to the extent possible as part of the Decommissioning Plan	Document goals for material recycling during decommissioning planning; document materials recycled and materials landfilled (nature, quantity, date/s and location/s).	Throughout decommissioning	CariSal
Social and Socio-economic Impacts	Develop and implement in collaboration with receptor communities, a Community Engagement Plan and (upon the advent of a plant closure decision,) a Decommissioning Plan. Coordinate all other safety, environmental mitigation and health plans via the CEP.	Creation of the CEP in collaboration with a diversity of receptor communities and stakeholders; demonstrable acceptance of the CEP by community members and CariSal; evidence of on-going community engagement and information sharing – clear statements of goals, benchmarks and strategies, improved community knowledge of the operation (measurable against baseline), durable Company-Community relationships; a member of CariSal's Response Management Team would actively participate in the development of the CEP and be involved in its on-going implementation.	Throughout start up, construction, operations and decommissioning	CariSal
Greenhouse Gas Emissions	Ensure that equipment is operated in a fuel-efficient manner and minimize periods of idling	Signs posted on property indicating idling restriction; documentation of idling restriction in contract with civil contractor; training provided and documented in civil contract identifying the use of well maintained equipment	Throughout construction, operations, and decommissioning	Instruct: CariSal Implement: Contractor with CariSal oversight
	Use low greenhouse gas-emitting diesel fuel rather than gasoline where practical	Identify in civil contract the preferred use of low emitting diesel fired equipment	Throughout construction, operations, and decommissioning	Contractor with CariSal oversight
	Maintain and check equipment periodically to ensure fuel-efficient operation	Document date and records of independent third party equipment inspection which documents equipment status	Throughout construction, operations, and decommissioning	Contractor with CariSal oversight
	CariSal will seek to negotiate agreements with industrial users of CariSal's captured excess CO_2 emissions	Document efforts or that agreements have been reached with CO2 buyers	Prior to and throughout operations	CariSal

Table 7.0-1. Recommended Mitigation Measures

Impact Addressed	Mitigation Measure	Performance Indicator	Timetable	Responsible Party(ies)
	Plant local tree or shrub species on site to reduce emissions	Document purchase and planting of trees or shrubs prior to facility operation; identify total number planted and estimate amount of CO_2 sequestering	Prior to operations	CariSal

7.1 DESIGN AND OPERATION PRINCIPLES

7.1.1 Measures Envisioned by CariSal

Cell-membrane chlor-alkali plants are considered among the most environmentally friendly technologies in the inorganic chemicals production industry by authorities such as the U.S. EPA, the Chlorine Institute, and the Global Partnership for Mercury Reduction in the Chlor-Alkali Sector (a United Nations Environment Programme body), among others (U.S. EPA 1995, Kent 1993).

CariSal is committed to the principles and practice of environmental and economic sustainability. Toward that end, the Project would be designed to incorporate many of the technologies and practices recognised for promoting clean production, energy efficiency, and pollution prevention (including waste minimisation). The Project would also have the benefits of a compact facility footprint and a green administration building.

The performance of this mitigation would be measured by verifying that the technologies and practices are incorporated into CariSal's Detailed Design and Preventative Maintenance Plan.

7.1.1.1 Clean Production

CariSal's proposed waste-to-retail Project would be one of the earliest attempted examples of clean production in Trinidad and Tobago when its Stage 4 production process is realized. By utilising a clean-production, closed-loop approach, CariSal has designed a state-of-the-art facility that would employ proven pollution prevention, use best available technologies for the manufacturing process, and reduce the routine release of toxic and other environmentally harmful compounds into the environment.

Cleaner production has been shown to produce more environmentally advantageous environmental health and safety outcomes than traditional end-of-pipe industrial design and environmental regulation (e.g., Frondel et al. 2004). Cleaner production allows for the use of general management systems and specific environmental management tools such as process controls, continuous monitoring and reporting, and data and audits to support environmental compliance.

The CariSal plant would be among the first modern examples of green or clean production in Trinidad and Tobago by a heavy industrial client in that its process design:

- Uses a three-stage purification process to convert waste brine from DESALCOTT to calcium chloride. The process water produced would be treated and recycled in the CariSal production process.
- Prioritises environmental considerations—potentially negative impacts are identified and addressed at the design phase.
- Has as its goal a zero-waste policy.
- Cleans DESALCOTT waste brine for use in CariSal's production process, and exports demineralised water produced by the process to WASA as distilled water to WASA (Stage 4).
- Utilises rainwater runoff from the process and site buildings.
- Uses the best available (cell membrane) technologies for the chlor-alkali production process, resulting in reduced waste streams and greater energy efficiency compared to older chlor-alkali plants in the United States, Europe, and South America.

- Evaluates and practices the most locally practicable methods of carbon dioxide mitigation including off-setting, manufacture of soda ash for internal consumption, and implementation of green and cool-roof technologies on office and support buildings and has as a continued goal to identify and implement strategies for reducing CO_2 emissions.

The choice of product mix is driven by environmental health and safety concerns as much as it is by economic opportunity. As such, the proposed product lines have the mutually reinforcing benefits of minimising the risk of chlorine contamination by producing sodium hypochlorite, which in turn allows WASA to substitute sodium hypochlorite for imported chlorine. The plant's total caustic soda capacity has been pre-sold with a 10-year take-and-pay contract with a major consumer of caustic.

7.1.1.2 Energy Efficiency

A natural gas-fired cogeneration unit would provide supplemental electricity to the CariSal calcium chloride plant (during its Stage 4 operation, see Section 3.4.6). The cogeneration plant would consist of three gas turbines, coupled to three generators, each producing 7.5 MW electrical power or similar arrangement. The exhaust gases would be sent to a heat recovery boiler to produce approximately 36,287.3 kilograms per hour (kg/hr) (or 80,000 pounds per hour) of high-pressure steam. This steam would displace steam required from the plant's natural gas boiler.

The cogeneration process, also known as combined heat and power, is the simultaneous production of electricity and useful heat from the same fuel or energy source, resulting in little waste heat. Heat from burning natural gas would run turbines that generate electricity for the electrolysis plant. The remaining heat then would produce steam that would be used in the process for salt crystallisation. The highly efficient cogeneration plant would use significantly less fuel than separate heating and electric power plants. Cogeneration has higher overall efficiency than conventional utility systems, typically 85 percent versus 58 percent. This

efficient use of fuel would reduce the forecast emissions of CO_2, a greenhouse gas (GHG), by approximately 30 percent to 53,850 MT/yr. This would result in a reduction of the overall CO_2 emissions association with the entire CariSal Facility by about 16 percent.

Energy efficiency has also been taken into consideration when designing the process itself. The cell membrane process is more energy efficient than earlier types of chlor-alkali processes, such as mercury cell and diaphragm cell. The CariSal process design team also recommended the use of mechanical vapour recompression as a replacement for multiple-effect evaporation for the DESALCOTT brine concentrator to improve energy efficiency. This technology and selection of a cell membrane process would substantially improve the plant's energy efficiency.

7.1.1.3 Pollution Prevention

Many of the Project design elements have been driven by CariSal's desire to develop a project with minimal environmental and social impacts and one that fully embraces, to the extent economically practicable, the principles of pollution prevention. CariSal would implement pollution prevention techniques recognized by the U.S. EPA and Chlorine Institute, including the recovery and recycling or sale of production by-products and the filtering, compaction, and proper disposal of brine mud.

The Project's conceptual design process includes measures that implement the following pollution prevention recommendations from the World Bank for chlor-alkali plants (including cell membrane plants):

- Use metal rather than graphite anodes to reduce lead and chlorinated organics;
- Re-saturate brine in closed vessels to reduce the generation of salt sprays;
- Reduce the amount of process wastewater through capture, condensation, and re-use of the resulting water vapour;
- Scrub chlorine tail gases to reduce chlorine discharges and to produce sodium hypochlorite;
- Recycle condensates and process water to the brine system, where possible;
- Recycle brine wastes, if feasible;
- Include closed-loop re-saturation;
- Provide for a process water retention pond (the Containment Pit) that would be either a geomembrane-lined, earth-bermed structure or an engineered concrete structure with leak stops and an underdrain and designed to meet the appropriate seismic requirements; and
- Subject to test results, sell limestone inerts, lime inerts, and magnesium hydroxide inerts from lime as road stabilizer.

As mentioned in the list above, World Bank guidelines recommend treatment options that include installing caustic scrubber systems to control chlorine emissions from condensers. CariSal has adopted in its designs caustic scrubbers to control emissions and would recycle

chlorides produced within its facility. The Project would neither store nor transfer chlorine, reducing the number of emissions sources and the likelihood of contamination.

7.1.1.4 Plant Footprint

Compared to existing and known proposed industrial sites in the vicinity, the CariSal site is far smaller in land area. Given the limited availability of land, the relative small scale and contained nature of the CariSal Project, and the already highly industrialized setting to the north and west, a 9-metre (m) perimeter boundary is proposed for the Project. The plot is, however, designed to include minimum buffer of 40 m from any process unit. CariSal's very deliberate efforts to design a relatively environmentally benign process and facility that relies on best available technologies and its location at the boundaries of the Natural Gas Corporation, Trinidad and Tobago Electricity Commission, and Caroni Railroad right-of-way (ROW), also supports a smaller buffer zone.

7.1.1.5 Green-Building Principles

The administrative buildings and associated facilities have been designed in accordance with "green building" and LEED sustainable design principles (see Section 3.3.2). Buildings would make maximum use of daylight while avoiding solar (heat) gain by means of shading, exterior light shelves, overhangs, and grass roofs. Parking areas would be shaded by landscape plantings and trellised green roofs, which would reduce heat-island impact and promote surface-water retention. (This vegetation, along with the tree plantation, would absorb carbon as carbon dioxide throughout its natural life cycle, mitigating the vegetation losses caused by clearing during site preparation.) Rainwater would be recycled for use in landscape irrigation. Site lighting and electric-cart charging stations would be solar powered.

7.1.2. Additional Mitigation Measures

The CariSal process, as currently envisioned, would vent 238 metric tons (MT) of hydrogen gas from the facility annually. Hydrogen has several uses, principally in ammonia production and in oil refining. It is also used in removing oxygen impurities from industrial gases (e.g., argon), in hydrogenating animal fats and vegetable oils, and in cooling generators in large power plants. Hydrogen is also a fuel of high-energy density (per unit mass), with a net calorific value (lower heating value) around 2.5 times that of natural gas.

The 238 MT/yr of hydrogen gas estimated to be vented is not trivial. To ensure continued adherence to concepts of clean production and energy efficiency that it has embraced, CariSal should investigate ways of using hydrogen onsite or exporting it offsite to industrial neighbours, such as Industrial Gases Limited, and report its findings to the EMA. A simple and efficient way of utilising the hydrogen would be to use it on site to raise steam required as a utility, as has been done at other chlor-alkali plants, such as the Coogee Chemicals chlor-alkali plant in Western Australia (www.coogee.com.au/op_chlor.html). Utilising the 238 MT in this way could create a potential savings of more than 600 MT of natural gas – thus reducing carbon dioxide emissions by approximately 1600 MT/yr. To implement this measure, CariSal must first identify an efficient method to clean the hydrogen gas to keep HCl gas out of the boiler combustion chamber.

7.2 COMMUNITY AND PUBLIC HEALTH AND SAFETY PLAN

The Community and Public Health and Safety (CPHS) Plan was developed based on the specific activities anticipated for construction, operation, and decommissioning of the CariSal facility. Such hazards may include exposure to toxic gas releases, air emissions, noise, physical hazards (including fires and explosions), and traffic and transportation hazards. The Plan does not address occupational hazards or onsite response to and mitigation of process upset conditions; such incidents are discussed in the Upset Conditions Contingency (UCC) Plan (discussed in Section 7.14) and CariSal's Emergency Response Plan. The CPHS Plan also does not address onsite response to and mitigation of onsite or offsite liquid spills associated with vessel failure or pipeline or transportation accidents; such incidents are addressed in the Spill and Air Emissions Reporting Plan (discussed in Section 7.9). The three sections of the CPHS Plan address three aspects of CariSal Plant operation: Facility Construction and Initial Start up, Facility Operations, and Facility Decommissioning.

7.2.1 Construction Phase

7.2.1.1 Public Hazards

Public hazards associated with construction of the CariSal facility would be associated primarily with potential traffic impacts due to transporting construction workers and materials to and from the plant site over public roads. The public could also be exposed to noise and fugitive dust associated with the operation of construction equipment on the CariSal site.

7.2.1.1.1 Construction Traffic and Transportation

Site construction would require the transport of construction workers and materials to and from the site and the operation of heavy construction equipment. Construction equipment operating on the site would include trucks, loaders, dozers, excavators and compactors, cranes, pavers, and various other types of heavy equipment. During site preparation work, all equipment would remain on site, minimizing hazards associated with moving heavy equipment over public roads. Road permits could be required for oversized equipment that might be transported from the port to the Project site.

During the peak plant construction phase, about 40 vehicles per day and at most 5 vehicles per hour are expected to visit the site including CariSal and contractor staff and supply vehicles carrying steel, equipment, and building materials. These vehicles are expected to run locally between Point Lisas and Port of Spain. Vehicles would use roads such as the Solomon Hochoy Highway, Rivulet Road, Phoenix Park Road, Southern Main Road, and North Sea Drive.

CariSal expects to construct pipelines to and from the DESALCOTT facility and the EASI Industrial Supplies Limited facility with no adverse impacts to Southern Main Road. Borings or other construction techniques such as horizontal directional drilling would be used to install the pipelines under the road, thereby avoiding interference with traffic. If trenching in a road (e.g., driveways) is required, it would be completed during off-peak hours and then reclaimed or covered with a temporary steel plate to avoid traffic interruptions.

Road safety along public roads would be achieved by:

- Issuing advisories and public announcements to inform residents of construction activities and transportation of pipeline materials;
- Complying with the Highways Act and Motor Vehicle and Road Traffic Act; and
- Consulting with the Point Lisas Port Development Company and the Police Service in the affected areas.

CariSal would implement traffic mitigation measures, which would include erecting traffic warning signs, widening areas near the site approach, and determining the most appropriate hours for transporting material as feasible, in coordination with the Ministry of Works and Transport. Flaggers may be used if necessary to protect construction workers and the public and to direct traffic during pipeline construction adjacent to Southern Main Road.

The performance of this mitigation measure would be indicated through verification and documentation (or both) that announcements, citations and consultations have been issued in a timely manner, as well as through measurements of traffic movements.

7.2.1.2 Physical Hazards

Potential public exposure to onsite physical hazards associated with the construction phase would be mitigated by prohibiting public access to the site; construction areas for pipeline rights-of-way also would be controlled to prohibit public access during construction activities. Access to the construction site would be restricted, and security guards would be on watch at all times. Because members of the public would not be permitted in the construction zone, they would not be exposed to hazards associated with the operation of heavy equipment.

The performance of this mitigation would be measured by the number of unauthorized individuals gaining access to the Project site throughout all phases of construction, operations, and decommissioning. The mitigation would be considered successful if no unauthorized individuals gain access.

7.2.1.3 Air Emissions

Air emissions during the construction phase would consist primarily of fugitive particulate emissions from earth-moving activity, dust entrainment due to movement of construction equipment on roads, and exhaust emissions from construction vehicles and equipment. Major construction-related activities that generate dust and gaseous emissions are:

- Excavation and earth work for site levelling and preparation
- Civil work at the site
- Vehicle transport of building materials to the site
- Excavation for pipelines

Suspended particulate emitted during construction activities is generally larger than that from fuel burning and other processes and thus would settle out close to the construction site. Therefore, impacts would be restricted to areas close to the construction activities. The

dust/gaseous emissions would be temporary and would occur mainly during site preparation. Plant erection activities would not likely contribute significantly to dust generation. A minor impact on ambient air quality therefore is expected during the construction phase if dust mitigation measures are not implemented. Dust mitigation would be necessary only when soil moisture is low.

Onsite approach roads and internal site roads would be sprayed with water periodically using dedicated water trucks during periods of low soil moisture. Water [approximately 5,000 to 8,000 gallons (or 18.93 to 30.28 m^3) per day for 45 days] for this purpose would be purchased from WASA by the construction subcontractors. This mitigation would be measured through documentation of dates on which plant roads were watered and the amount of water applied.

Spoils piles would be covered to prevent fugitive emissions. All aggregate storage piles would be covered. For both storage and spoils piles, CariSal would document their acquisition of pile covers and instructions in operating procedures for covering piles.

Construction contractors would be supervised to ensure that they are using well-maintained transport equipment and vehicles. Such requirements would be added to all contracts as explicit performance terms.

7.2.1.4 Noise Exposure

During the construction phase, noise generation is expected from the operation of construction equipment and vehicles. Typical noise levels at approximately 15 m (Bolt et al. 1971) for construction work using standard construction equipment are:

- Clearing: 83 dBA
- Excavation: 88 dBA
- Paving: 79 dBA

Noise could impact nearby residents located in close proximity to the site boundaries. The nearest occupied structure is approximately 50 m from the site boundary. The nearest residents are approximately 50 m from the western boundary of the site. Construction noise would be temporary, but could be disturbing. Pipeline construction would temporarily increase noise levels next to the nearby roadways. Well-maintained equipment with noise-attenuating technologies (such as mufflers) would be used during construction. Construction activity would be limited primarily to daytime hours, between 8 a.m. and 8 p.m. to minimize nuisance on nearby residential areas to the north, east, and west. Some limited activities, such as pouring concrete, may require construction activity to extend beyond daylight hours.

Maintenance would also help reduce noise levels, but noise attenuation devices, such as mufflers, would also be used. To reduce noise nuisance, as well as light pollution, construction activities would be scheduled, to the extent possible, for daylight hours.

Additional noise mitigation steps during the construction phase include:

- All vehicle and construction equipment would be required to be fitted with exhaust silencers; construction contractors would be required to replace damaged silencers promptly. A maintained record of checks of the physical condition of mufflers and necessary replacements would be an indicator of the mitigation.
- All construction equipment shall adhere to the standards set forth in the Trinidad and Tobago Noise Pollution Rules (as administered by the EMA, under the Ministry of Planning, Housing, and the Environment) as indicated through documentation of equipment compliance.
- Construction contractors and CariSal shall ensure that noise levels near residential areas are within the daytime and night-time noise standards.

7.2.2 Operations Phase

7.2.2.1 Public Hazards

Public hazards associated with CariSal facility operations include potential public exposure to toxic gas releases, air emissions, and noise from facility operations, as well as offsite impacts associated with traffic and transportation and operation of offsite pipelines and equipment. Potential public exposure to onsite physical hazards associated with the operations phase would be mitigated by prohibiting public access to the site. Contractors and visitors to the CariSal site would receive appropriate health and safety training and be supplied with personal protective equipment appropriate to the areas of the plant they would access and the activities in which they would be involved. The performance of this mitigation would be measured by both the percentage of those trained within the schedule (with a 100-percent target) and the effectiveness of the training in minimizing occupational incidents.

7.2.2.1.1 Hazardous Materials Exposure

Operation of the CariSal plant would result in air emissions and also could result in toxic gas (e.g., chlorine) releases during upset conditions that trigger the worst case scenarios, both unmitigated and mitigated, examined in the Quantitative Risk Assessment (QRA, see Appendix C). CariSal would ensure that public exposure to air emissions comply with regulatory standards in place for hazardous materials concentrations (e.g., standards summarized in Table 1.5-5 of the QRA, provided as Appendix C). Appendix C addresses the various toxic gas release scenarios associated with the Project. If a release of toxic gas such as chlorine were to potentially affect offsite areas, control room personnel would activate the plant emergency shutdown system. The performance of this mitigation would be measured against the goal of operations shutdowns in 100 percent of all incidents. Local communities downwind of the release (based on the daily wind direction) would be notified and advised to remain indoors until the release is controlled. The performance of this measure would be determined by observing whether, and how quickly, the local communities follow the directions of CariSal. Elements of the CariSal CPHS Plan relevant to response to toxic gas release incidents are described in Section 7.2.2.1.4.

7.2.2.1.2 Noise Exposure

During the operations phase, noise generation is expected from the operation of process equipment and vehicles. Public exposure to noise in offsite locations would be limited by

reducing noise at the source by providing proper mufflers for the equipment, selecting and designing low-noise equipment, and ensuring proper operation and maintenance on relevant equipment to keep noise levels low.

7.2.2.1.3 Operational Traffic and Transportation

Potential traffic and transportation impacts to the public are associated with operations workers travelling to and from the CariSal site and with vehicles moving process raw materials and product. During plant operations, trucks would transport limestone, salt, and other raw material from the port to the plant site, and hypochlorite (bleach) product and hydrochloric acid and hypochlorite (bleach) product from the plant site to the DESALCOTT facility and to the port, respectively.

CariSal would implement traffic and transportation safety practices and procedures for moving raw materials and products. They would also identify specific routes and require that drivers follow them when transporting hazardous materials and would define offsite emergency response procedures for traffic incidents. As with the construction phase, safety on public roads during plant operation would be achieved by:

- Issuing advisories and public announcements to inform residents of construction activities and transportation of pipeline materials;
- Complying with the Highways Act and Motor Vehicle and Road Traffic Act; and
- Consulting with the Point Lisas Port Development Company and the Police Service in the affected areas.

CariSal would implement traffic mitigating measures, which would include erecting traffic warning signs, widening areas near the site approach, defining the most appropriate hours for material transport, and selecting certain transportation routes, as feasible, in coordination with the Ministry of Works and Transport. CariSal would require safety training for all truck drivers transporting hazardous materials to and from the CariSal site.

The performance of this mitigation would be indicated through verification and/or documentation that announcements, citations, and consultations have been issued, as well as through measurements of traffic movements.

7.2.2.1.4 Detailed Community and Public Health and Safety Plan

CariSal would develop a more detailed CPHS Plan through public consultations with local communities before beginning plant operations. The QRA for the CariSal facility operation (see Appendix C) indicates a low likelihood that plant upset conditions or accidental release events would affect areas outside the plant boundary. CariSal nevertheless would develop a detailed response plan, as is standard for the industry per Chlorine Institute and other relevant guidelines. The Plan would be developed with the active collaboration of the local community and government stakeholders, emergency response personnel, and public safety personnel, to ensure the appropriate response to any such events is coordinated and effective.

The detailed CPHS Plan would be developed before commencement of plant operations and would include the following key elements at a minimum:

Section 1 Plan Introduction
Section 2 General Facility Identification and Information
Section 3 Emergency Alarms and Notifications
Section 4 Public Emergency Communication System
Section 5 Hazardous Substance Release Response
Section 6 Fire, Explosion, or Toxic Gas Release Response
Section 7 Shelter-in-Place/Evacuation Preparedness
Section 8 Training and Exercise/Drills
Section 9 Notifications and Call List

CariSal anticipates that the elements of the Plan will be developed during the final detailed engineering design phase of the Project.

7.2.3 Decommissioning Phase

The lifespan of the Project is expected to be 20 or more years, whereupon decommissioning would occur. During decommissioning, tanks and site equipment would be removed. The effects of decommissioning would be similar to those of construction. Decommissioning would result in air, noise, and dust emissions. Vehicle trips for workers and for removing materials for recycling and disposal would occur. Public hazards associated with decommissioning are anticipated to be similar to hazards associated with the construction and operations phases, as described above. Mitigation measures would be implemented during decommissioning to minimize public hazards and effects on the surrounding environment. All relevant mitigation plans implemented by CariSal for construction and operations would be applied to the decommissioning phase. A Decommissioning Plan would be developed by CariSal in collaboration with members of the Project impacted, host communities and approved by EMA and other relevant authorities.

7.3 UPSET CONDITIONS CONTINGENCY PLAN

The Upset Conditions Contingency (UCC) Plan has been developed based on the specific process upset conditions identified in the hazard identification process for the QRA completed for the CariSal facility (see Appendix C). The UCC Plan addresses potential process upsets associated with construction, operation, and decommissioning of the proposed facility. Such upsets might include interruption of electric power, water, or raw material supplies; process equipment failure; fires and explosions; loss of brine flow; loss of cooling water; and similar events. The UCC Plan does not address responses to onsite or offsite liquid spills associated with vessel failure or pipeline or transportation accidents; such incidents are addressed in the Spill and Air Emissions Reporting Plan (see Section 7.9).

The UCC Plan comprises three sections that address three aspects of CariSal plant operation: facility construction and initial start up, facility operations, and facility decommissioning.

CariSal anticipates continuous operation of its facilities. However, as discussed in the QRA (Appendix C), incidents that may result in emergency shutdown of the plant may occur, including power outage, loss of brine flow, loss of cooling water flow, or equipment failure. Plant equipment and facilities have been evaluated for failure modes during process design through the hazard identification analysis. As described below, critical plant equipment has been designed to include emergency shutdown devices, control valves that fail in a safe position to prevent over-pressure or release, and automatic venting of chlorine and hydrogen gasses to the hypochlorite unit and the hydrogen vent through the purge gas system. A backup power generator would be located onsite to supply power to critical systems if a power outage occurs.

Emergency response procedures are established in CariSal's Emergency Response Plan, as well as in detailed written plans applicable to plant operations including the electrolysis modules. Emergency response planning would include preparation and response activities for operational events such as the loss of electrical power or the supply of water, steam, brine, or natural gas. Preparation and response activities also have been established for fire and explosion events, and equipment failure; process upset conditions resulting in toxic gas releases; and geophysical events (e.g., seismic events or hurricanes) that could trigger any of these conditions. Preparation and response activities for such events might include emergency shutdown of the plant and evacuation of plant personnel. The CariSal facility would establish a formal and detailed plan and pre-planned designated safe areas for assembly. Plant personnel would be trained in protection, prevention, and response to incidents.

CariSal also would establish plans to notify local communities and neighbouring industries in the event of a toxic gas release or other accidents or emergencies that might affect offsite areas. Linked to such notification plans would be CariSal's development and implementation of a shelter-in-place program. CariSal would develop programs to educate local community residents and neighbouring industries on the specific circumstances under which shelter-in-place would be implemented, and methods would be established to ensure that the program is effective. The development of detailed evacuation plans would be discussed with local emergency response personnel and law enforcement officials to determine what measures would be suitable. CariSal would design its emergency response program specifically to address emergency health care, employee training measures, and procedures for informing the public and response agencies (e.g., the fire department) should an accident occur.

Emergency response planning would involve non-facility personnel such as local emergency responders and local law enforcement personnel. CariSal would establish contractual arrangements with Bristow (a helicopter service at Piarco Airport) for Medevac of individuals by air, if such services were necessary, and would establish relationships with local ambulance services and medical facilities.

CariSal plant operations personnel would receive thorough training in the proper operation of plant production, emission control, and safety equipment. Such training would specifically cover prevention of and response to potential upset conditions. Advanced process control technology and modern operator interfaces would be used to monitor and control the operation of plant

equipment, including the brine system, electrolysis modules, evaporators, and natural gas and boiler systems. CariSal would implement a predictive and preventative maintenance program to ensure that mechanical systems are inspected and maintained in a timely manner so that equipment failures, process upsets, or other hazard conditions can be prevented. Predictive maintenance (i.e., continuously measuring and trending specific parameters of the equipment or system) enables the integrity or condition of the system or equipment to be determined on an ongoing basis so that appropriate maintenance or repair or other adjustments to the system can be made before any situation deteriorates to catastrophic failure.

7.3.1 Construction and Initial Start-up Phase

7.3.1.1 Construction Phase

Construction of the CariSal plant would require the transport of materials and workers. Construction equipment on site would include trucks, loaders, dozers, excavators and compactors, cranes, pavers, and various other forms of heavy equipment. During site preparation, all construction equipment would remain onsite, without moving off the premises. CariSal anticipates that onsite construction equipment would be fuelled by diesel fuel tank trucks that would periodically access the site. No diesel fuel would be stored onsite during the construction period. During the peak plant construction phase, based on previous construction data provided by CariSal, about 40 vehicles per day, and a maximum of about 5 vehicles per hour, would be expected to visit the site. Visiting vehicles would include CariSal and contractor staff vehicles and supply vehicles for steel, equipment, and building material. Vehicles accessing the site, other than construction equipment, would not be fuelled on site.

Construction-phase incidents associated with potential fuel spills from vehicles and equipment used to fuel onsite construction equipment are discussed in the Spill and Air Emissions Reporting Plan. Fires associated with fuelling of construction equipment or other construction activities could pose a danger to construction workers. Fires associated with fuelling of construction equipment or other construction activities are not anticipated to result in adverse effects to the offsite population.

7.3.1.2 Initial Start-up Phase

To facilitate a smooth and safe start up, the plant would be commissioned and brought online using pure salt (sodium chloride) as a raw material, rather than DESALCOTT brine. For the initial plant start up, pure salt would be imported from a qualified supplier and transported to the CariSal site where it and water would be fed to the salt saturator to produce saturated brine. The brine would be fed to the electrolyser system to produce hydrogen, chlorine, and caustic soda (sodium hydroxide.) CariSal anticipates that the plant would switch from using pure salt raw material to DESALCOTT brine raw material in the future. The frequency and consequences of upset conditions associated with initial start up or restart of the CariSal Plant would not differ from the frequency and consequences of upset conditions under normal plant operation. Therefore no separate analysis of adverse impacts has been conducted for initial plant start up or plant restart.

Construction operations would be conducted in accordance with the Trinidad and Tobago Occupational Safety and Health Act (OSHA). Construction equipment would be fuelled on site

only over paved areas and potential ignition sources would be removed from the fuelling area (e.g., construction equipment and fuel vehicle engines would be off throughout the fuelling process). Onsite workers would be trained in fire protection, prevention, and response; and fire-fighting equipment (e.g., fire extinguishers) would be readily available at the construction site at all times, including during fuelling activities.

The CariSal plant would undergo a pre-start up safety review before initial start up. Impacts associated with initial plant start up and plant restart would not differ from impacts associated with the operations phase.

7.3.2 Operations Phase

Significant adverse impacts attributable to the operations phase would include those associated with the following events:

- Loss of electric power;
- Loss of brine flow;
- Loss of steam flow/boiler control failures;
- Loss of cooling water flow;
- Natural gas leaks and subsequent fires or explosions;
- Process equipment fires or explosions;
- Electrolysis module equipment failures and subsequent chlorine gas releases; and
- Intermixing of hydrochloric acid and hypochlorite and subsequent chlorine gas releases.

Reporting and mitigation of potential releases from onsite vessel failures involving hydrochloric acid, caustic, and bleach tanks and offsite pipeline and vessel failures involving the offsite caustic pipeline and caustic tank at the Earth Investigation Systems Limited facility are discussed in the Spill and Air Emissions Reporting Plan. Reporting and mitigation of potential releases from transportation accidents involving hydrochloric acid or hypochlorite transport trucks are also discussed in the Spill and Air Emissions Reporting Plan.

Plant operations would be conducted in accordance with the Trinidad and Tobago OSHA and in accordance with practices and procedures for management of chlor-alkali facilities published by the Chlorine Institute. These practices and procedures are those associated with the production and handling of chlorine gas, hydrogen gas, sodium hydroxide, hydrochloric acid, and sodium hypochlorite.

The potential consequences of the events listed above are identified in the HAZID and described in the QRA (Appendix C of the EIA.)

7.3.3 Loss of Electric Power

Loss of electric power would result in immediate shutdown of all plant operations. Shutdown of all operations would occur simultaneously without operator action. Following such an emergency shutdown, operators would ensure the DESALCOTT inlet brine valve (or feed valve from the salt saturator) is fully closed. Operators would inspect the entire operation and close the relevant manual valves in all feed systems.

A backup generator would be installed to provide illumination during unforeseen power outages. This generator would also supply power to critical components of the process that are required to run equipment (to operate the fail-safe systems and evacuate any gases or fluids in cells under upset conditions). A nitrogen purge gas system would activate in the event of an emergency shutdown to vent hydrogen from process equipment to the hydrogen stack; this system is also equipped with a dry air purge gas system to vent chlorine from process equipment to the hypochlorite unit. The absorption towers are rated for 20 minutes of absorption according to the process plant design.

The potential for loss of electric power would be substantially reduced after the planned natural gas-fired cogeneration unit becomes operational. The cogeneration unit would provide electric power to the CariSal site only. CariSal anticipates that the backup generator will be maintained on site after the cogeneration unit becomes operational but rarely would be needed.

7.3.4 Loss of Steam Flow

Loss of steam flow to the concentrators would cause an orderly shutdown of each unit operations. The weak brine evaporators would cease taking in new brine, which would cause the feed tank to fill. At a predetermined level, the DESALCOTT inlet valve (or feed valve from the salt saturator) would automatically shut at a predetermined level. Loss of steam flow to the 32-percent caustic soda evaporators would cause orderly shutdown within 1 to 2 minutes as the 32-percent feed tanks fill. The electrolysis process would shut down when the 32-percent feed tank level reaches a predetermined set point. This sequence of events would subsequently cause the HCl production operation to shut down as well. These operations would remain in shutdown mode until steam flow is restored and the evaporators are restarted. The 42-percent calcium chloride liquor preparation process would gradually slow as the slaked lime temperature drops below its set point. When an operator determines a loss-of-steam event, the operator would shut down the process in a controlled manner. The operator would also shut down the 78-percent calcium chloride process when steam loss is verified. In-process liquor would be drained back to the proper feed tanks. Systems would be restarted when steam flow is restored.

7.3.5 Loss of Cooling Tower Water Flow

Loss of cooling water flow would result in a controlled safety shutdown of all CariSal processes. The weak brine evaporators would shut down when cooling is lost resulting in rapid filling of the weak brine feed tank. At a predetermined level, the DESALCOTT inlet valve (or feed valve from the salt saturator) would automatically close to prevent any spill. Chlorine cooling and water flow to the 32-percent caustic soda evaporators would cease. Both events would cause the immediate shutdown of the electrolysis process. Chlorine and hydrogen gasses would be

contained in the process equipment and piping. Start up would require restoration of water flow. The calcium chloride processes are cooling-water dependent and, as such, would be shut down when water flow is lost. The overall sequence of shutdowns would essentially be automatic and occur very quickly (within several minutes).

7.3.6 Loss of Brine Flow/Loss of Salt Supply

Loss of brine flow from DESALCOTT or loss of salt supply from the salt saturator would result in controlled shutdown of all CariSal processes, as described above for the loss of steam flow. Loss of flow to the 32-percent caustic soda evaporators would cause orderly shutdown within 1 to 2 minutes as the 32-percent feed tanks fill. The electrolysis process would shut down when the 32-percent feed tank level reaches a predetermined set point. This shutdown would subsequently cause the HCl production operation to shut down as well. The shutdown operations would remain in that mode until brine flow is restored and the evaporators are restarted. In-process liquor would be drained back to the proper feed tanks. Systems would be restarted when brine flow is restored.

7.3.7 Natural Gas Leak

A natural gas leak could result in a fire or explosion hazard on the plant site. Analysis conducted for the QRA (see Appendix C) indicates that ignition and subsequent vapour cloud explosion resulting from a natural gas leak are unlikely. Plant employees would be trained in fire protection, prevention, and response. Small plant fires may be handled by the plant employee who discovers the fire, if practical, by isolating the flow of gas to the fire and then extinguishing the flames. If the gas flow cannot be isolated or the flames cannot be extinguished readily and safely, plant employees would activate the plant emergency shutdown system, evacuate the area, and inform the plant control room of the situation.

Upon notification by the person discovering the natural gas leak, control room personnel would activate the plant siren to alert plant employees and neighbouring communities, and would shut down natural gas flow to the CariSal plant from the natural gas metering station. Plant personnel would then isolate the natural gas leak, assess the damage, and conduct repairs before restarting plant operations. Under emergency situations, the CariSal Onsite Incident Commander would request that the Trinidad and Tobago Emergency Mutual Aid Scheme be immediately notified by telephone of the situation.

7.3.8 Process Equipment Fire or Explosion

In addition to the conditions described above for natural gas leaks, fires and explosions could result from process upset or failure of process equipment, including failure of the chlor-alkali plant hydrogen gas header, a membrane leak in the electrolysis unit, or a transformer/rectifier fire. Analysis conducted for the QRA (see Appendix C) indicates that ignition and subsequent vapour cloud explosion resulting from a hydrogen gas leak are unlikely. In the event of a fire, the CariSal Plant Emergency Tactical Team would attempt to extinguish the fire, and the Response Management Team (RMT) would assume management and operational control of the situation and initiate plant shutdown. After the fire is extinguished, plant personnel would assess the damage and conduct repairs before restarting plant operations.

7.3.9 Process Equipment Failure and Chlorine Gas Release

An uncontrolled release of chlorine gas could result from several types of events, as described in the QRA (Appendix C), including equipment failure, pipeline rupture, scrubbing system failure, and inadvertent mixing of hydrochloric acid and sodium hypochlorite in the product loading area. If a chlorine gas release were to result from a pipeline rupture, the emergency shutdown system would automatically activate the plant emergency shutdown and the purge gas system, ESD, as a backup, control room personnel would be trained to activate the plant emergency shutdown and the purge gas system. Chlorine gas contained in process equipment would be purged to the hypochlorite unit, and hydrogen gas contained in process equipment would be purged to the hydrogen stack. If a chlorine gas release were to result from scrubber failure or inadvertent mixing of hydrochloric acid and hypochlorite, the scrubber would not control the release. For all types of chlorine gas releases, procedures would be implemented to ensure that all plant personnel other than emergency response personnel remain upwind of the leak location. Plant emergency response personnel, equipped with appropriate personal protective equipment, would isolate the pipeline leak.

Local communities situated downwind of the chlorine gas release (based on the daily wind direction) would be notified and advised to remain indoors until the release is controlled. Plant personnel situated downwind of the chlorine gas release that may be unable to move to upwind locations on the plant site would be advised to remain indoors until the release is controlled.

7.3.10 Geophysical Incidents (Seismic Events/Hurricanes)

Geophysical incidents including seismic events and hurricanes are potential causes of plant upsets/accidental releases. Potential incidents that could be caused by a seismic event include loss of plant electrical power (e.g., a result of downed power lines) loss of cooling water supply, fire or explosion resulting from breached natural gas lines, or toxic gas release resulting from breached process lines. All structures within the CariSal facility would be designed and constructed to American National Standards Institute (ANSI) Standard Zone III. Such structures are expected to be able to withstand a seismic event classified as Zone VIII on the Modified Mercali Scale or Magnitude 6 on the Richter scale.

Plant employees would be provided with safety training to respond to seismic events. Plant personnel situated outdoors would seek open areas away from buildings, power lines, or other structures. Plant personnel situated indoors would seek shelter under tables, desks, or in doorways to avoid potential falling objects. If a seismic event were to affect the CariSal plant, the Response Management Team would be activated to establish operational and management control and orderly plant shutdown would be implemented from the control room. Plant emergency response personnel would then be mobilized to inspect plant equipment and structures to identify fires, natural gas leaks, toxic gas leaks, or other damage caused by the seismic event.

In the event of an approaching hurricane, CariSal would implement the Hurricane Emergency Procedure for the plant. If wind speeds in excess of 100 kilometres per hour in the vicinity of the plant site are anticipated, the plant would be shut down in time for non-essential employees to

return to their homes. Plant personnel performing essential services and who are assigned to the Hurricane Watch Group would remain on site.

7.3.11 Decommissioning Phase

The frequency and consequences of upset conditions associated with planned shut down of the CariSal Plant for decommissioning would not differ from the frequency and consequences of upset conditions under normal plant operation. Therefore no separate analysis of adverse impacts of upset conditions has been conducted for planned shut down and decommissioning of the CariSal Plant.

Impacts associated with plant shutdown and decommissioning do not differ from impacts associated with the operations phase, therefore no separate analysis of decommissioning has been conducted.

7.4 COMMUNITY ENGAGEMENT PLAN

The Project is not expected to produce significant negative or adverse social, cultural, or socioeconomic impacts to its fence line neighbours or the broader Point Lisas study area communities. No adverse impacts to archaeological resources are expected. The Project would provide a moderate socioeconomic benefit to the Project-affected community and to the broader regional communities by providing roughly 200 construction jobs and about 75 permanent positions during operation stages, in addition to the multiplier effects of these jobs and the overall Project operation.[1] Labour encampments or re-settlement of residents or business concerns would be unnecessary. Resource users of the Project site, that is, the plant site and its ex situ facilities would not be adversely impacted during initial start up, construction, the various stages of operation, and decommissioning.

The Project activities that are likely to result in minor impacts during construction primarily, and to a lesser degree during operations, however include increased dust levels; potential health and safety risks to village residents; traffic congestion, increased levels of environmental releases including air emissions, noise and solid wastes; and, in the event of emergency scenarios, the potential for hazardous waste releases, accidental releases of hazardous substances, and fire and explosion risk to workers' and community safety with the resulting increase in demand for limited medical and fire services.

Public involvement is crucial to the success of all stages of project development. Use of extensive, well-crafted (i.e., with community and experts input) and executed participation strategies early in each stage is more likely to result in publicly acceptable plans. Social impacts are even more beneficial in cases where the project proponents actively, over the life cycle of the project, built effective relationships, where the host and other potentially communities accept the

[1] A numeric calculation of the multiplier effects is noted here because the information required for calculating a reasonable, simple output multiplier for the region was not readily available and the quantification task for the multiplier is outside the scope of the EIA as defined by the Project TOR. The analysis assumes that the multiplier is nevertheless greater than 1 because the Project is expected to increase aggregate demand for goods and services in the study area and regionally.

given technology and risks associated with the development and have a stake in the continued operation of the project. Effective public engagement is facilitated by transparency in the decision-making, thereby fostering communities' confidence in the process itself. Timely (as early as possible) provision of sufficient information to community groups and stakeholders also facilitates on-going public engagement by creating opportunities for better understanding of complex issues, minimising mistrust and facilitating productive dialogue, mutual learning (by and creative problem solving. These findings are consistent with best practice in the respective fields (Bond et al. 2004).[2]

Consistent with these practices, CariSal would develop a Community Engagement Plan (CEP) as an overall strategic planning mechanism for

- integrating its stated core values into everyday operations and practice,
- building and maintaining community and stakeholder relationships through active, asset-based engagement, and
- coordinating the various plans for mitigating potential adverse environmental impacts that require meaningful community and stakeholder participation.

The CEP is a blueprint for how CariSal would work with communities to maintain durable relationships that facilitate its and the communities' joint responsibility to ensure safety, protect worker and public health, and monitor or restore the natural environment. The CEP would set the strategic direction for the organization and would be included in its overall business and operating plan. It would be developed in consultation with community stakeholders (commencing soon after the Project's CEC approval) and would describe how CariSal will work with communities to achieve effective design and implementation of the environmental health, safety, and risk monitoring and mitigation plans and programmes.

CariSal has committed to building and fostering durable relationships with the surrounding community and to acting as a responsible community partner and corporate citizen. During the early stages of the Project, CariSal would develop its formal Community Engagement Plan on the basis of using an "Asset-based Community Building" approach. This approach involves a shift in focus from traditional needs-based planning to working with receiver communities to build ongoing relationships and establish communication networks. The approach also focuses on working with community members to identify and evaluate existing community assets that can be developed, connected, or unlocked through community action and effective company-community partnerships.

CariSal's commitment to building community partnerships has as its basis the Company's stated core values (CariSal Limited 2007):[3]

[2] The most prolific social impact and participation literature applied to decommissioning available are those that examine nuclear power plant closures. While such plants likely involve technical issues that are far more complex and controversial than those affecting CariSal, the social impact lessons learned and best practices are nevertheless applicable.

[3] Source: CariSal Presentation, August 4, 2007

Health & Safety	"Every worker has the right to return home **whole.**"
Environment	We are Responsible
	– Actions
	– Technology
	– Community well-being
Ethics	Integrity is our cornerstone
	We keep our promises
	Local Content – Owned, built and operated by the people of Trinidad and Tobago
Community	Partnership/**transparency**/mutual benefit

Effective, ongoing communication with communities and other stakeholders – effected through the development of a Community Engagement Plan (CEP) – is critical to the success of the mitigation and monitoring program and the various emergency responses, upset and contingency, and other plans detailed in this EIA.

For instance, the UCC Plan requires that CariSal establish mechanisms and strategies to notify local communities and neighbouring industries in the event of a toxic gas release or other accidents or emergencies that might affect offsite areas. Given the issues raised in by community members in Focus Groups for instance, it will be important to design the UCC in a manner that would allow residents and workers to distinguish between an alarm testing scenario and a real emergency notification. Linked to such notification plans would be CariSal's development and implementation of a shelter-in-place program. CariSal would develop programs to educate local community residents and neighbouring industries on the specific circumstances under which shelter-in-place would be implemented, and methods would be established to ensure that the program is effectively implemented. Similarly, the development of a detailed CPHS Plan requires public participation by local communities before beginning plant operations. Other environmental mitigation and monitoring issues, such as the Wetland Reserve Area and air, noise, and water quality monitoring programmes and plans would require concerted public engagement. The CEP would also be the primary mechanism to be used by CariSal in its development of a closure/decommissioning or transition plan, the Decommissioning Plan discussed in Section 7.2.3 above. The Decommission Plan will be developed following the basic steps for action plan development and the effectiveness criteria outlined in the text boxes below

Although the CariSal Project represents too narrow a regulatory horizon for addressing the broader social problems identified by workers and residents and requiring input from the appropriate groupings of industrial and agency stakeholders; nevertheless, the Project would play its part in making its contribution to improving local conditions that affect overall health safety and welfare.

During construction the potential exists that ambient air quality background concentrations coupled with onsite construction activities may cause exceedances of the permissible levels for NO_2, PM_{10} and TSP, if mitigation measures are not appropriately implemented, as identified in the air quality analysis.

The CEP also would offer both CariSal and the potentially impacted communities the opportunity to realize innovative problem solving and to create additional jobs. For example, a local green job corps could draw on the long-standing agricultural heritage, knowledge of the local environment, and experience of local residents who may have been part of the Caroni (1975) Limited workforce. It may also present a forum through which CariSal would jointly address the risk concerns raised by community members during the community Focus Groups and other public engagement meetings that were completed prior to and during the EIA process. Among these are the clear need for community education and effective communication about the nature of the risks the Project presents, the need for sharing of community-based knowledge that may affect these risks, and communication about and how residents and workers can protect themselves in the event of an emergency and obtain access to training and jobs.

The CEP[4] identifies the most pressing issues and opportunities associated with the Project and establishes goals, objectives, and actions for resolving them based on CariSal's CEC. The Engagement Plan must be developed in conjunction with affected communities, agencies, and programs to ensure continued stakeholder support and future implementation commitments.

Implementation of demonstration projects during CEP development can showcase innovative management strategies, involve the public, and demonstrate the types of changes that full implementation of the Community Engagement Plan can effect.

The CEP is a "living" document that should be updated on a regular basis – every 3 to 5 years or concurrent with updates to the Project's business and operation and maintenance plans – to ensure that the goals, objectives, and specific actions continue to address the most pressing problems. Regular updating will also ensure that it continues to serve as an effective tool for protecting public, environmental, and worker health and safety, achieving CariSal's mitigation and monitoring goals and realizing its policy commitments.

The CEP would, at a minimum, contain the following five essential components:

1. Statement of priority problems to be addressed in the Plan
2. Mission statement, goals, and objectives for the Project
3. Action plans for achieving goals and objectives
4. Monitoring Strategy
5. Finance Strategy

[4] These CEP Guidelines were adapted from the U.S. EPA (2005).

Basic steps for action plan development	
1	State the problem, identifying the probable causes and sources (source – Project EIA).
2	State the CEP goals related to the problem and its source.
3	Set specific, measurable objectives to attain the goals.
4	Determine the universe of possible management activities, both new and existing, for consideration.
5	Select the activity that will work, that the community and other key stakeholders will support, and that can be implemented within reasonable time and resources.
6	Establish specific action plans needed to abate and control the problem or to protect the resource.
7	Implement and monitor results, collecting data on measurable indicators of progress.
8	Report on progress, costs, and results.
9	Review, re-evaluate, and redirect efforts as needed.

To be effective the CEP would be specific about:

- ✓ ***WHO*:** Identify who will take the lead in carrying out each action; define roles and resource commitments for each participating partner – a guidance document should be developed with community organizations.
- ✓ ***WHAT*:** Describe what will be done. For example, set numeric load reduction targets and use designations for a location; describe which specific activities are necessary to reach them.
- ✓ ***WHERE*:** Describe the location where the action will take place and the area that will be affected
- ✓ ***WHEN*:** Include schedules for action implementation and completion.
- ✓ ***HOW*:** Outline the procedures or steps that will be used to carry out the action.
- ✓ ***HOW MUCH:*** Estimate the cost of implementing the action.
- ✓ ***SOURCE OF FUNDS*:** Identify funding sources that can be used to carry out the action.

In developing the monitoring strategy for the CEP and its EIA mitigation and monitoring plans, CariSal would include a clear and realistic definition/benchmark of success, select appropriate and measurable indicators that track with this definition and reflect best practice in the field, develop a communications plan, and identify the appropriate role that regulatory agency stakeholders might have in the process.

7.5 FLORA AND FAUNA IMPACT MITIGATION AND MONITORING PLAN

7.5.1 Construction Phase

The significant adverse impact attributable to the construction phase of the Project would be conversion or destruction of wetland habitat. About half the plant site is annual wetland, and a small area near the northwest corner of the site is a perennial wetland. These wetland areas, particularly the perennial wetland, provide important ecological services and are ecologically important because they are believed to be among the last remaining remnants of a once larger freshwater wetland system. They provide habitat to a significant range of flora and fauna.

The site wetlands are not subject to any specific regulations regarding protection or use: "The Government of Trinidad and Tobago has signalled its intention to protect wetland areas in Trinidad and Tobago by becoming a Party to the Ramsar Convention on Wetlands and designating Nariva Swamp as a Ramsar Site; also in the appointment of the National Wetlands Committee to formulate a national policy for wetlands. There is no single law providing for the management or regulation of wetlands, and no legal instrument focusing on wetlands...." (National Wetlands Committee 2002). Hence, conversion or destruction of the perennial wetland area within the CariSal site is not proscribed by any national law or regulation, but would be counter to the spirit of Government wetland policies.

In view of the above and in view of the ecological importance of the subject wetlands on the CariSal site, it is recommended that the perennial wetland area near the northwest corner of the site, along with a buffer of annual wetland and upland area approximately 150 feet (45.7 m) in width surrounding the perennial wetland, be protected and left in as close to its current state as possible. It is further recommended that these areas be set aside permanently as a wetland nature reserve, and that CariSal carry out active management and monitoring activities to preserve the ecological values of these areas. Figure 7.5-1 illustrates the proposed boundaries of the Wetland Reserve Area that would be created under this mitigation measure.

Based on the initial site development plan, the following developments were planned to be located in the proposed Wetland Reserve Area:

- A portion of an unpaved access road (on a raised berm)
- A portion of the battery line fence
- A portion of a proposed tree plantation
- A portion of the pipeline from the DESALCOTT desalination plant.

Based on the above recommendations, CariSal now proposes to leave much of the north half of the site (with the exception of the administrative building site) undeveloped. Figure 7.5-2 indicates the portions of the originally-proposed developments that would be foregone or re-aligned under the currently-proposed mitigation measure.

In addition to the site plan changes indicated in Figure 7.5-2, it is also recommended that the pipeline to the DESALCOTT desalination plant also be rerouted to avoid the proposed Wetland Reserve Area.

The mitigation measure of protecting the perennial wetland area and surrounding buffer area would be evaluated through the achievement of the following performance indicators:

- Establishment of clear borders for the Wetland Reserve Area;
- No physical alteration to the topography, vegetation, or water bodies within, or contamination with silt to the area;
- No introduction of contaminated runoff to the area;
- No significant loss of species diversity or abundance within the area as compared to baseline conditions described in the Biological Reconnaissance Report;

- Establishment of staff positions and job descriptions to include Wetland Reserve management and monitoring activities; and
- Development of a monitoring regime and record-keeping system.

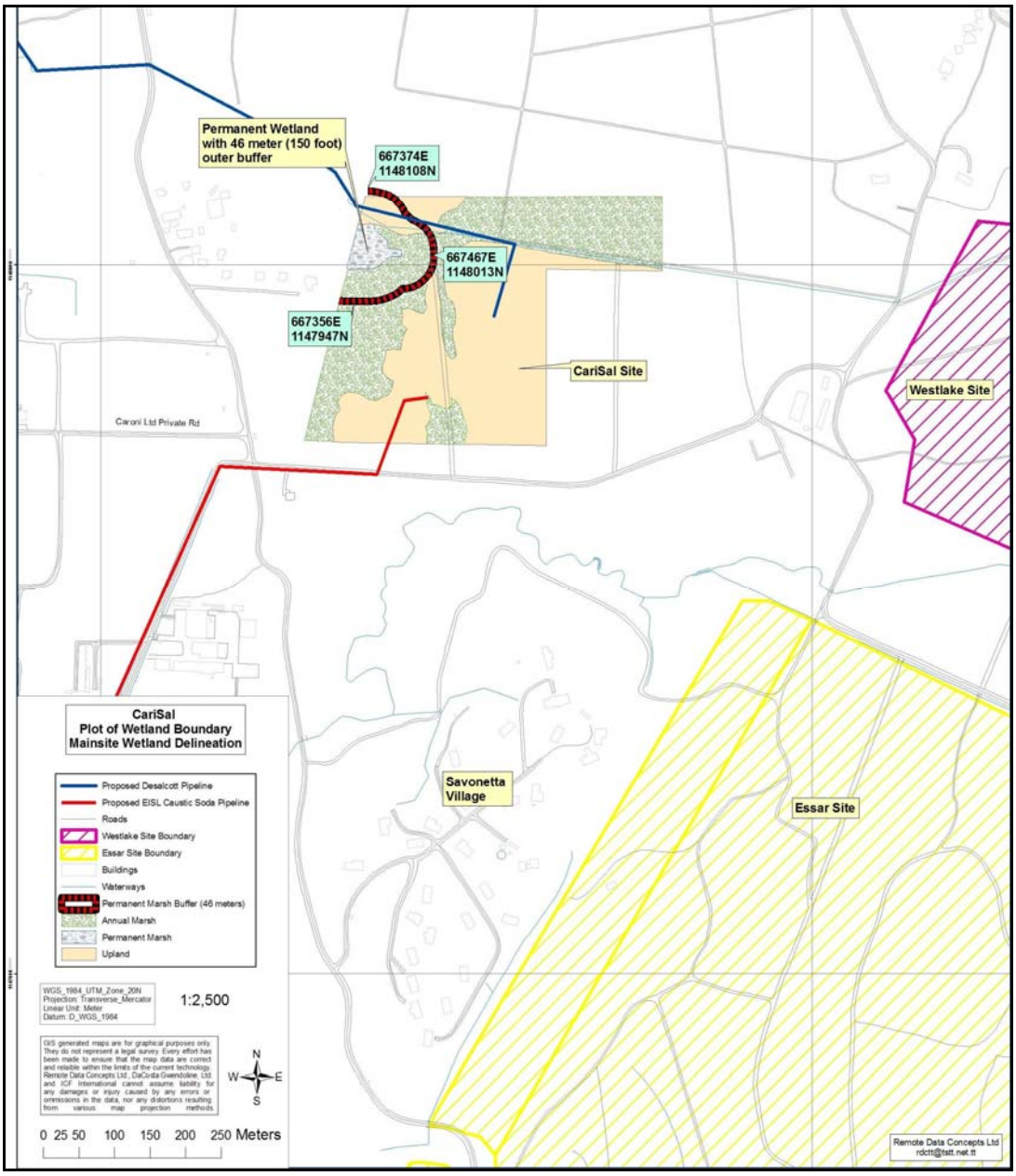

Figure 7.5-1. Proposed wetland reserve area and vegetative community types.

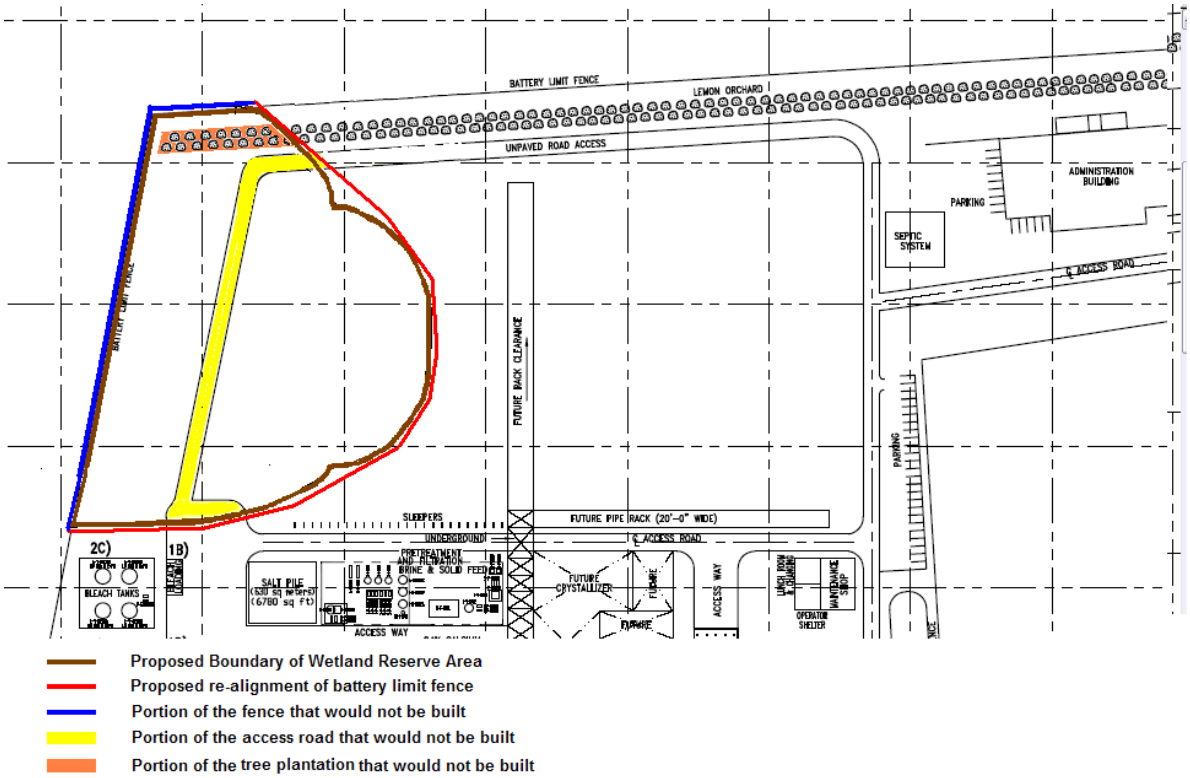

Figure 7.5-2. Boundaries of Proposed Wetland Reserve Area and Associated Site Plan Changes

This mitigation measure would involve several actions during the construction phase in addition to implementation of the changes in plant site layout described above (related operations-phase measures are described in the next section). These include:

- Development of appropriate stormwater control systems to ensure that all contaminated runoff water from the plant site is collected and routed to the lined containment pit, and cannot flow into the Wetland Reserve Area as indicated and verified through documented routine monitoring and a pre-identified corrective action plan;
- Contracting a qualified biologist/wetland expert to provide periodic supervision during the construction phase, and ensure that construction proceeds in a manner that minimizes any impact to the wetland, and preserves to the greatest extent possible the ecological values of the wetland, as indicated by the documentation of a written contract and allocations in the Project budget for the biologist/wetland expert.

- Conducting baseline water quality monitoring in the perennial wetland area. Baseline (pre-construction) values should be obtained of the parameters for three to four sampling points:
  - Biological oxygen demand (BOD)
  - Chemical oxygen demand (COD)
  - Dissolved oxygen
  - Turbidity
  - pH
  - Chloride
  - Calcium
  - Sodium

Mitigation measures to preserve the perennial wetland on the Project site would also have to include working closely with EMA and owners of adjacent and nearby properties. This is because, as described in Chapter 4 and Chapter 5, some hydrologic and topographic features critical to maintaining the integrity of the onsite perennial wetland appear to be located offsite.

Hence, it is recommended that CariSal (and or nearby property owners) contract a qualified watershed hydrologist to carry out a hydrological study of the surrounding area (including areas beyond the Project site) to identify drainage areas and other features critical to the integrity of the perennial wetland area on the Project site. This mitigation would be measured by the following indicator:

- Production of a hydrological report documenting a hydrological study of the surrounding area (including areas beyond the Project site) and identifying all hydrological, topographical and other features critical to the integrity of the perennial wetland area.

It is further recommended that CariSal work closely with EMA and property owners of adjacent and nearby properties to ensure that the offsite features identified in the hydrological report as critical to the integrity of the perennial wetland on the CariSal site will be conserved by adjacent and nearby property owners. Implementation of this mitigation would be monitored through the following indicators:

- a record of communication with EMA and adjacent/nearby property owners regarding conservation of the perennial wetland;

- the development of written agreements with adjacent/nearby property owners to preserve features critical to the integrity of the perennial wetland on the CariSal site;

- establishment of a program by EMA to preserve the perennial wetland and offsite features critical to wetland integrity, and to monitor the area and any changes to

hydrological or landscape features that may affect the integrity of the perennial wetland.

Required measures related to ongoing management of the proposed Wetland Reserve Area during the operations phase are described in the following sections.

In the event that the above proposed mitigation measure (establishment of a Wetland Reserve Area to preserve the perennial wetland area on the Project site) is not practical; it is recommended that CariSal undertake one or more alternative mitigation measures to compensate for the loss of the on-site perennial wetland. Possible alternative mitigation measures include:

- Purchase of other suitable property near the Project site and: (1) development of replacement wetland area to replace the wetland habitat, functions, and values lost at the Project site; and (2) establishment and maintenance of the developed wetland as a permanent wetland reserve.
- Work with EMA or other wetland experts to identify freshwater wetland area near the Project site that has been degraded or is at imminent risk of degradation and loss of its functions and values, and (1) work with wetland experts to restore this offsite wetland area to full functionality as a wetland habitat; and (2) establishment and maintenance of this restored wetland as a permanent wetland reserve.

The objective of these alternative mitigation measures would be to achieve no net loss of wetland habitat, functions, and values as a result of the CariSal development. As part of either of these alternative mitigation measures CariSal should undertake baseline and periodic monitoring of water quality in the developed/restored wetland areas, as described above.

7.5.2 Operations Phase

During the operations phase, calcium chloride ($CaCl_2$) dust would be entrained in the air at the plant site, carried downwind, and deposited. Most deposition is expected to occur within the plant site. However, a portion of the $CaCl_2$ dust would be deposited beyond the plant site boundaries, primarily to the west and west-northwest of the emission points. Deposited dust will dissolve in rainwater and can be introduced to soils and the roots of plants. A moderate amount of chloride in soils is beneficial to plants, but excess chloride causes chloride toxicity. The occurrence and degree of chloride toxicity depends on many soil and plant factors, and the likelihood that $CaCl_2$ releases from CariSal would cause chloride toxicity in plants beyond the boundaries of the plant site, and the likely significance of this impact, cannot be projected with reliability. Chloride toxicity is the sole potential impact to flora and fauna associated with the operations phase of the CariSal plant.

The Wetland Reserve Area described above would require management throughout the plant operations phase.

7.5.2.1 Vegetation Chloride Toxicity

Recommended measures for addressing potential chloride toxicity to vegetation beyond the plant boundary are as follows:

The root zone of soils downwind of the CariSal plant should be monitored for signs of chloride accumulation. Monitoring points should be located on a grid or transects within the land area expected to receive $CaCl_2$ deposition (based on dispersion and deposition modelling conducted for this EIA). A set of samples should be taken before the start of plant operation, to establish a baseline chloride level. Soil chloride levels should then be monitored at least twice per year for the first 3 years, and at least once per year for 2 additional years of plant operation. At any time during this 5-year period, the need for more frequent monitoring (if soil chloride levels appear to be rising) or less frequent monitoring (if soil chloride levels do not appear to be changing significantly from baseline) can be assessed.

If monitoring indicates a significant increase in chloride concentrations in soils, biological monitoring should be added to the monitoring regime. Plant stems, seeds, and leaves should be monitored for chloride accumulation. Vegetation in the deposition zone also should be monitored visually for symptoms of chloride toxicity, which include reduced plant growth, decreased leaf size, chlorosis (yellow leaves due to a lack of chlorophyll), plant necrosis (tissue death), and excessive leaf fall.

Further, CariSal should develop a contingency plan to be adopted if the above monitoring indicates a significant and unacceptable level of chloride toxicity to vegetation outside plant boundaries. Specific indicators of plant chloride toxicity should be established as a basis for determining the need for contingency action. Action levels for these indicators also should be established. If action levels are exceeded, the contingency plan should be automatically put into place. This plan would contain measures for reducing or eliminating calcium chloride dust emissions from the plant.

7.5.2.2 Wetland Reserve Area Management

Biological and water quality monitoring should be carried out within the Wetland Reserve Area described above, throughout the operation phase of the plant. Using the results of the Biological Reconnaissance survey completed onsite for this EIA as a baseline (see Appendix E), the general state of ecological integrity and function of the wetland areas within the preserve should be monitored. The techniques used in the Biological Reconnaissance survey should be replicated for subsequent monitoring, in order to obtain results that are comparable to those generated by the initial reconnaissance survey. The methods used in the Biological Reconnaissance survey are described in detail in Appendix E. The water quality parameters listed for baseline water quality monitoring, above, also should be monitored in the perennial wetland.

As with the vegetation chloride toxicity issue, indicators of wetland ecological integrity should be selected, and action levels should be established. If monitoring results indicate degradation of ecological integrity, CariSal should develop measures specifically addressing the aspects of plant operation that impact the wetlands. CariSal should retain the periodic services of a professional ecologist or wetland specialist to interpret the results of the biological monitoring, identify and develop measures to mitigate any loss in ecological integrity, and generally ensure that the Wetland Reserve Area is remaining healthy and intact.

In the event that CariSal carries out either of the alternative mitigation measures described above (development of a replacement perennial wetland area or restoration of a degraded wetland area

offsite), an offsite Wetland Reserve Area will be established. Such wetland Reserve areas should also be managed as described above for the proposed onsite Wetland Reserve Area. A baseline reconnaissance survey would be required to establish the general state of ecological integrity and function of any offsite area that is the subject of either of these alternative mitigation measures.

7.5.3 Decommissioning Phase

Decommissioning of the CariSal plant is not expected to result in direct impacts to flora and fauna. However, a potential result of decommissioning will be the cessation of monitoring and management activities for the Wetland Reserve Area that is developed either onsite or offsite as a result of the above wetland impact mitigation proposals.

It is recommended that, during the plant operations phase, CariSal investigate options and develop a plan for sustainable management of the Wetland Reserve Area after decommissioning. Possible measures include:

- handing the Wetland Reserve Area over to a nongovernmental organization group or to the Government upon plant decommissioning, so that it can become a protected area open to the public;
- developing a trust fund during plant operations, that would serve to fund basic reserve area management functions on an ongoing basis.

CariSal should be prepared to ensure the sustained protection and management of the Wetland Reserve Area prior to abandoning the proposed plant. This mitigation measure would be verified through the documentation of a clear plan for the sustainable management of the Wetlands Reserve Area, with budgetary resources in place prior to decommissioning.

7.6 WASTEWATER MANAGEMENT PLAN

This section addresses all wastewater streams caused by construction, operation, and decommissioning activities at the CariSal site, including process wastewater, sanitary wastewater, and runoff water from general facility maintenance. It does not include stormwater runoff, which is addressed in Section 7.8 of this EIA.

7.6.1 Construction Phase

No process water would be generated during construction. Portable toilets provided for the construction crews would be pumped regularly and the sanitary waste disposed of at a wastewater treatment plant. Water used for hydrostatic testing of tanks and pipelines would be discharged in accordance with the Hydrostatic Test Water Management Guidelines (CariSal Limited 2006).

In accordance with the Hydrostatic Test Water Management Guidelines, CariSal would obtain all required approvals before any hydrostatic test water is released. The application for approvals would indicate the release location, discharge rate, and expected quality of the test water to be discharged. Any water discharged would be discharged in accordance with the Water Pollution

Rules, 2001 and TTS 547: 1998, Specification for Effluent from Industrial Processes Discharged into the Environment.

No significant, adverse, wastewater impacts during the construction phase are anticipated.

In addition to documenting any discharges and discharge approvals, CariSal would require the contractor to maintain records certifying the periodic pumping of the portable sanitary facilities and documenting proper disposal of the waste.

7.6.2 Operations Phase

During operation, no process water would be discharged from the CariSal plant. Process water would be routed from process sumps and purge points and reused in the process as appropriate. When the supply of process wastewater generated exceeds the need for process system make-up water, the process wastewater would be stored in the Containment Pit until needed.

No sanitary wastewater would be discharged during the operational phase. Disinfected effluent from the sanitary system would be directed to the Containment Pit and reused or recycled as process water. The septic tank would be emptied periodically. CariSal would ensure that the terms of its agreement with the septic system cleanup contractor prohibits uncontrolled, illegal emptying or dumping of sludge into the environment. Operations, responsibilities, and documentation of sludge disposal would be defined through the Environmental Health and Safety Management plans.

No discharge of runoff would occur during the operational phase. Drainage around the proposed loading, processing, and storage facilities would be configured to sufficiently contain the process water generated by operation of the chlor-alkali system. The containment area around the facilities would be periodically drained of excess precipitation as necessary. All rainwater contacting process or storage areas would be directed to the Containment Pit and recycled through the process makeup water system. All rainwater contacting non-process areas would be directed to the Retention Pond for use as cooling tower makeup water.

The retention ponds would be maintained as appropriate. Routine pond maintenance would include mowing of the embankment and buffer areas and inspecting for erosion and nuisance problems (e.g., burrowing animals, weeds, and odours). Trash and debris would be removed routinely to maintain an attractive appearance. The retention ponds would be inspected by CariSal after every storm event. When any problems are observed during inspections, necessary repairs would be made immediately (such as to embankments).

No significant, adverse, wastewater impacts would occur during the operational phase.

During operations, CariSal would verify the implementation of the design elements described above, and would document proper septic waste disposal, inspections of the plant drainage system, and maintenance and inspection of the retention ponds. CariSal would also require the septic system cleanup contractor to maintain records documenting proper disposal of the waste as stipulated in the terms of agreement with the contractor.

7.6.3 Decommissioning Phase

At the end of decommissioning, any residual water in the retention ponds would be discharged to local waterways if testing confirms that the water meets the discharge criteria and such discharge is in accord with regulations in place at the time of plant shutdown. The discharge criteria would be expected to be at least as stringent as the Water Pollution Rules, 2001 and TTS 547: 1998, Specification for Effluent from Industrial Processes Discharged into the Environment.

If discharge is not permitted, the water would be trucked to a suitable treatment and disposal facility.

No significant, adverse, wastewater impacts are anticipated during the decommissioning phase.

CariSal would document the chemical testing of any water intended for discharge, confirm that any water discharged complies with discharge requirements, and maintain a record of the date, time, volume, and water quality results of all discharges.

7.7 WATER MANAGEMENT PLAN

This section addresses all external water requirements for the construction, operation, and decommissioning activities at the CariSal site.

7.7.1 Construction Phase

During the construction phase, CariSal would purchase potable water from WASA for dust control, soil compaction, and line testing at the rate of approximately 19 cubic metres per day (m^3/day) for 180 days (3,420 m^3). The WASA water tank and the process water tank located on the CariSal site, with a combined 4,540-m^3 capacity, would require a one-time fill-up. If the former molasses tanks are used for caustic soda storage, the tank cleaning contractor would need additional water, probably potable, for high-pressure water or steam cleaning of the tanks and the pipeline running to the Yara pier. This potable water requirement would not represent a significant impact.

Approximately 10,000 m^3 of seawater would be used for hydrostatic testing of each tank and for pressure testing the associated pipelines connecting to the CariSal plant and to the Yara pier. This seawater water requirement would not represent a significant impact.

No significant, adverse, water requirement impacts requiring mitigation are anticipated during the construction phase.

7.7.2 Operations Phase

For operations Stages 1, 2, and 3, CariSal would obtain potable water from WASA for process purposes at rates up to approximately 200 m^3/hr. In Stage 4, the process would generate a 153-m^3/hr surplus of demineralised water to be made available to WASA for industrial consumers in the vicinity.

The potable water requirements in Stages 1, 2, and 3 would represent a minor, irreversible impact on the consumption of WASA's potable water production. CariSal has received Outline Approval from WASA for the required water... During Stage 4, the surplus demineralised water the plant produces represents a minor beneficial impact on the region's water supply.

Based on the current start up schedule, the minor water demand impact during Stages 1, 2, and 3 would be temporary. As an additional mitigation measure, CariSal has committed to re-evaluating on an annual basis, the water demand requirements and the start up schedule. In the event that Stage 4 is substantially delayed due to technical, equipment, supply, or economic reasons, CariSal would assess the water demands of the plant and the water supply availability and, if supply augmentation were required, work with WASA, DESALCOTT, and if necessary, the EMA to add an additional reverse osmosis (RO) desalination unit on DESALCOTT's property, addressing the permitting issues for the RO unit at that time. A standard RO unit could be operational within one year of receiving approval.[5]

To minimize the plant's water requirements, cooling tower water, process water, and sanitary system wastewater would be recycled. Run-off from the site would be collected in the Containment Pit and the Retention Pond for use as cooling tower and process water makeup. No groundwater would be used. The administration building would capture and recycle rainwater for landscape irrigation. Water-efficient fixtures would be used in all sanitary facilities. This mitigation would be confirmed through its incorporation into the plant design.

No significant, adverse, water-requirement impacts requiring mitigation are anticipated during the operational phase.

7.7.3 Decommissioning Phase

During the decommissioning phase, CariSal would require water for dust control; rinsing of facility vessels, pipelines, and paved areas; and perhaps irrigation of new ground cover or plantings. To the extent possible, water retained in Retention Pond No. 1 would be used for these purposes.

No significant, adverse, water-requirement impacts requiring mitigation are anticipated during the decommissioning phase.

7.8 WATER QUALITY PROTECTION PLAN

CariSal has incorporated important features within the Project design to avoid adverse water quality impacts. The design requires the preparation of a site-specific Stormwater Pollution Prevention Plan (SWPPP) that would include the sediment and erosion control best management practices (BMPs) the U.S. EPA recommends. This section addresses the expected impacts to surface water and groundwater quality during construction, operation, and decommissioning of the CariSal chlor-alkali facility. This section also addresses the BMPs related to construction

[5] In August 2007, WASA announced plans to construct two new wastewater desalination plants in Point Fortin and Labris with a combined capacity of 3,150 m^3/hr (Ford 2007). Feasibility studies were being conducted in December 2007(Castillo 2007). WASA is also evaluating megawatershed development to increase production capacity (De Verteuil et al. 2001).

site planning and management, runoff control, and good housekeeping/materials management. Issues related to erosion are addressed in Section 7.11.

7.8.1 Construction Phase

The construction activities on the north half of the site would irreversibly reduce the size of the wetlands area. Elimination of the wetland or compromise of its integrity would be a significant negative environmental impact. Section 7.6 discusses wetlands mitigation and residual impacts.

Areas cleared of vegetation and areas of excavation or fill would be more susceptible to erosion than the original ground surface. Stormwater runoff from these surfaces could erode soil particles and transport them to surface water bodies creating unacceptable sedimentation and turbidity. To avoid sediment-laden runoff, CariSal would prepare and implement a comprehensive SWPPP before construction starts. The SWPPP would incorporate the BMPs in the categories described below.

7.8.1.1 Construction Site Planning and Management

The design requires that construction be scheduled to minimize the soil area exposed at one time, especially during the rainy season. No construction across drainages would occur during periods of rain. Construction in drainage channels would be completed as quickly as possible. The design aims to achieve no offsite runoff during the operation phase by specifying construction of permanent dikes around the perimeter of the developed area. The perimeter dikes and retention ponds would be constructed as early as possible during the construction phase to control construction runoff.

A construction site operator would ensure that inspection and maintenance conformed to BMPs. All runoff control measures would be inspected, repaired, and fortified if necessary before any forecast precipitation or pause in construction activities, including weekends. A work crew would be made available to inspect, maintain, and repair runoff control measures during all storm events, including nights and weekends.

Soil surfaces would be contoured to promote sheet flow and to prevent concentrated flow, except when such flow is intentionally concentrated into a stable drainage channel, either natural or engineered.

To preserve natural vegetation, areas not to be cleared would be protected with temporary fencing.

The SWPPP or the contractor's work plan would include the sequencing and schedule for clearing vegetation, performing earthworks, construction across drainage channels, and installing runoff controls. CariSal would include compliance with the SWPPP and the contractor's work plan as a contractual requirement for the contractor, subject to CariSal compliance inspections and, if necessary, area restrictions or stop work orders. The contractor would be required to document inspection and maintenance of the runoff control measures.

7.8.1.2 Runoff Control

Gravel-bag check dams would be used to reduce water velocity and to direct runoff to drainage channels. Temporary drainages would be created during construction to divert stormwater away from cleared areas. Stable drainage channels would carry runoff to collection or discharge points. An earthen perimeter control would consist of a dike constructed along the perimeter of the disturbed part of the site and would divert sediment-laden runoff created on site to onsite sediment-trapping devices or retention ponds, preventing soil loss from the disturbed area. This mitigation would be achieved and verified through documentation of periodic visual inspections.

The effectiveness of the runoff control would be subject to CariSal compliance inspections and, if necessary, area restrictions or stop work orders.

7.8.1.3 Good Housekeeping/Materials Management

Concrete washouts would be used to contain concrete and liquids when the chutes of concrete mixers and hoppers of concrete pumps are rinsed out after delivery. Construction debris would be segregated in waste containers or within contained areas to prevent water quality impacts due to contaminated runoff. CariSal would require contractors to define debris areas in the construction work plan and monitor for compliance. Portable toilets would be provided during construction for construction crews. The plan would include procedures to stop the source of a spill, contain the spill, clean up the spill, dispose of contaminated materials, and train personnel to prevent and control future spills. The SPCP would be part of a more comprehensive emergency response plan. No vehicle staging, cleaning, or fuelling would occur within 100 feet (30.5 m) of drainages on the construction site.

With these design features in place and with implementation of the SWPPP, the expected impacts on surface water quality during construction would be minor.

CariSal would attempt to site pipeline rights-of-way at least 25 feet (7.6 m) from drainages. This would be confirmed in advance, by double-checking engineering drawings and verifying that construction complies with the design. If the pipeline must be constructed closer than 25 feet (7.6 m) to a drainage, then BMPs for erosion, sediment, and runoff control would be implemented to minimize runoff and prevent sedimentation of the drainage. If CariSal constructs a pipeline while the drainage is flowing, a water diversion structure (flume) that can handle 150 percent of the flow would be placed between two manmade, clean sandbag cofferdams (upstream and downstream) to allow flow to continue downstream during construction. After the pipe is laid and the backfilling activities have been completed, the drainage channel banks would be contoured to their original profile and the sandbags removed, allowing the drainage to return to normal flows. The banks would also be re-planted with native species to anchor the soil and prevent erosion. With these design features in place and with implementation of the SWPPP, the expected impacts on surface water quality during pipeline construction would be minor.

Hydrostatic testing of tanks and pressure testing of pipelines would be performed with seawater, brine from DESALCOTT, or fresh water from the retention ponds or WASA, depending on the locations of the individual tanks or pipelines, scheduling needs, and the readiness of connecting

pipelines. If seawater is used, it would be discharged to the sea in the vicinity of the Yara pier, Goodrich Bay. If DESALCOTT brine is used, it would be returned to the DESALCOTT outfall tank for discharge through the combined outfall with Yara Trinidad Limited. If fresh water is used, it would be stored in the Containment Pit or Retention Pond No. 1 for reuse. In all cases, the water used would be tested before discharge to the environment. Because the water would be used to test new tanks and pipelines, with the possible exception of the former molasses tanks and pipeline, the water is expected to meet all discharge criteria. Any water not meeting discharge criteria would either be treated on site or trucked to a water treatment plant. No significant water quality impacts are expected from the use and disposal of test water.

No adverse significant impacts to groundwater are expected during the construction phase.

The BMPs and other procedures in the SWPPP require faithful adherence to CariSal's intent by the contractor. CariSal would include compliance with the SWPPP as a contractual requirement for the contractor, subject to CariSal compliance inspections and, if necessary, stop work orders. CariSal would review pipeline designs for adequate distance from drainages and monitor construction to ensure compliance with the design.

7.8.1.4 Monitoring and Management

The water-quality monitoring program should include continuous monitoring for compliance with the SWPPP, periodic monitoring of discharged water quality, and periodic monitoring of surface water quality. Periodic monitoring of groundwater quality in the naturally clayey soils is not required during the relatively short construction period, but should be done at the end of construction and before plant operations begin to establish a pre-operation baseline condition in permanently located wells.

Monitoring and management of SWPPP compliance entails inspection of runoff control features, and maintenance and repair of any damaged structures. The inspection should determine if the existing features are adequate to control runoff, and should determine where new runoff control BMPs are required. Success of the runoff control measures would be achieved when surface runoff exits the site only at preplanned locations and the discharged runoff meets the discharge requirements of the Water Pollution Rules.

If runoff from construction areas drains into onsite surface water bodies, especially in the area of the wetlands, the surface water bodies should be monitored for possible degradation of water quality. Discharge into onsite surface water bodies must comply with the Water Pollution Rules. The most likely form of noncompliance would be an excess of total suspended solids (TSS) in surface runoff. Mitigation measures would be more intensive use of the erosion, sediment, and runoff control BMPs.

The water quality monitoring program should include monitoring of water used for hydrostatic testing of tanks and pressure testing of pipelines for compliance with the Water Pollution Rules and the TTS 547:1998 Specification for the Effluent from Industrial Processes Discharged into the Environment.

7.8.2 Operations Phase

Runoff from all process areas would be collected in the Containment Pit. Runoff from all other site areas would drain into the clean-water Retention Pond, except for the undeveloped northern half of the site and de minimis, non-process areas around the site perimeter outside of the perimeter roads.

Major sections of the Plant area, including material storage areas, would be paved or concreted to allow for containment before spills could percolate into the groundwater supply. Spills would be minimized by construction of secondary containment around chemical and fuel storage areas/tanks. Use of underground storage tanks would be avoided. All storage tanks except for the septic system would be aboveground for ready monitoring and maintenance, as required.

No expected significant water quality impacts requiring mitigation are expected.

Compliance with the SWPPP would be required during operation. Because most of the site would be self-contained with respect to runoff (i.e., no runoff or run-on), monitoring would be focused on inspecting and maintaining the perimeter dike. Most of the length of the perimeter dike would consist of the elevated perimeter road and the exterior walls of the Containment Pit and Retention Pond No. 1.

The water quality monitoring program should include periodic monitoring of surface water quality. Periodic monitoring of groundwater quality in permanently located wells also is recommended.

7.8.3 Decommissioning Phase

In the final stages of decommissioning, the residual fluids in Retention Pond No. 1 and the Containment Pit would be discharged to local waterways if of suitable quality and if this action were in accord with regulations in place at the time of plant shutdown. If such discharge were not permitted, the waters would be trucked to a suitable disposal facility. It is estimated that the Containment Pit inventory would be no more than 1.6 million gallons (6,020 m^3) of less than 1-percent chloride strength. Retention Pond volume would be a function of rainfall at the time of shutdown, but at a maximum would be 2.0 million gallons (7,680 m^3). The volume of retention pond water requiring disposal could be reduced through natural evaporation, especially in the dry season. No significant water quality impacts are expected from the one-time discharge or disposal of this water.

The water quality monitoring program should include monitoring of the water in the Containment Pit and Retention Pond No. 1, and a final round of surface water and groundwater monitoring.

7.9 WASTE MANAGEMENT PLAN

This section addresses all solid and liquid wastes generated during construction, operation, and decommissioning activities at the CariSal site, including hazardous waste. This section does not include wastewater, which is covered in Section 7.6.

7.9.1 Construction Phase

The construction contractor would be required to submit a comprehensive Waste Management Plan to CariSal for approval prior to initiating construction activities. CariSal would instruct the contractor that the plan should reuse and recycle materials and waste to the extent practicable to minimize the generation of waste requiring disposal or treatment.

The primary solid waste impact during the construction phase of the Project would be the burdening of the available capacity at Forres Park Sanitary Landfill with vegetative waste. An estimated 5,000 MT of vegetative waste would be generated during site clearing, possibly in a span of several weeks. The Forres Park Sanitary Landfill has the storage capacity to accept the waste. CariSal would communicate with Trinidad and Tobago Solid Waste Management Company Limited (SWMCOL) and Forres Park's on-site management to schedule the rate of transport of vegetative waste from the site to meet the landfill's operational requirements. The disposal of vegetative waste during construction is expected to cause a minor, adverse impact. Vegetative waste could be composted on site to avoid this impact.

Additional solid waste generated during the construction phase likely would include construction debris such as wood, metal, concrete, plastics, and paper. The Waste Management Plan would require the segregation of recyclable and non-recyclable wastes. SWMCOL has programs for the recycling of glass, paper, and e-waste. Scrap metal recycling is available in Trinidad, and at least one private vendor on the island offers plastic recovery and recycling. Due to proximity and available capacity, the probable destination of nonrecyclable construction phase waste would be the Forres Park Sanitary Landfill. The generation and management of additional construction solid waste are not expected to cause significant impacts.

Any hazardous wastes generated during construction would remain the property of the construction contractor and would be managed by the contractor in accordance with the approved Waste Management Plan. Potential hazardous wastes generated during construction include oils, cement, cleaning products and other solvents, paints, sealers, asphalt, and pesticides. Excess or used hazardous materials (constituting hazardous waste) would be disposed of by a qualified, experienced contractor according to methods approved by the Environmental Management Authority (EMA) or the Trinidad and Tobago Solid Waste Management Company Limited (SWMCOL). Because no dedicated hazardous waste landfills or disposal facilities are located on the island, the three SWMCOL landfills accept some hazardous wastes as Special Disposal subject to special conditions on a case-by-case basis. The Forres Park Sanitary Landfill has a thick, natural clay liner and a leachate collection system to minimize offsite contamination. Because the hazardous waste generated during construction would be derived from unused construction materials, the contractor has an economic incentive to minimize the amount of hazardous waste. Therefore, the amount of residual hazardous waste generated is expected to be small. The generation and disposal of hazardous waste during construction are expected to cause a minor, adverse impact.

The Waste Management Plan would include a requirement for chain-of-custody documentation to verify disposal in accordance with the plan requirements. SWMCOL provides an Activity Record to the waste hauler so the waste generator can confirm transportation of the waste to the proper destination.

No significant, adverse, waste impacts during the construction phase are anticipated.

The Waste Management Plan would require the contractor's faithful adherence to CariSal's intent. CariSal would include compliance with the Waste Management Plan as a contractual requirement for the contractor, subject to CariSal compliance inspections and, if necessary, stop work orders.

7.9.2 Operations Phase

The operations phase would generate solid wastes in the form of business waste; limestone inerts; lime inerts; magnesium hydroxide; brine muds; cooling tower blowdown solids; settled solids in the containment pit, retention pond and sand traps; and spent membranes.

SWMCOL would require CariSal to test the brine mud solids before accepting them as Special Waste. The tests could include the determination of their mineral and metals composition or their leaching potential. Because the brine muds consist of the mineral impurities found in salt and in seawater, the brine mud solids are expected to be chemically acceptable to SWMCOL. If SWMCOL did not accept the brine mud solids, CariSal would need to either treat the waste to meet the criteria or find an alternate disposal site, possibly outside of Trinidad and Tobago.

Only solids from brine muds would be generated in significant volumes, estimated to be up to 48,356 MT/yr of solid waste in operational Stage 4.. After dewatering, the material is expected to meet SWMCOL's acceptance requirements, and SWMCOL has indicated that it has the capacity to handle the anticipated volume at Forres Park Sanitary Landfill. Acceptance of the quantities of waste generated in Stage 4 would have a permanent, irreversible, moderate or significant impact on the landfill's remaining available space. The potential use of some or all of this material as daily landfill cover would mitigate the adverse impact and produce an offsetting beneficial impact.

The remaining solid wastes would be produced in comparatively low volumes and consist of relatively inert materials, so no significant impacts are expected.

7.9.3 Decommissioning Phase

If a new use for the plant cannot be found, plant equipment would be cleaned, dismantled, and sold. Structures would be sold or demolished. Once the site is clear of all equipment and structures, the foundations would be removed and the site levelled. The disposition of demolition debris and residual materials would have a significant impact on the consumption of available landfill space.

To mitigate this impact, any materials that are not sold would be segregated for disposition. Scrap metal, glass, plastic, and other recyclable materials would be recycled to the extent possible. Concrete structures would be demolished, and the concrete crushed for reuse as aggregate. Steel rebar would be separated and recycled. Asphalt would be crushed and recycled for new asphalt or aggregate. Electronic equipment that cannot be sold would be separated and disposed of as e-waste. The materials remaining would be disposed of in an approved landfill. The residual impacts from waste management are expected to be minor to moderate, depending on the success of the recycling efforts.

CariSal would develop, or require the decommissioning contractor to develop, a Decommissioning Waste Management Plan that specifies the materials to be segregated and the recycling goals. CariSal would perform compliance inspections of the decommissioning process and document the degree of success in achieving the goals.

7.10 EROSION AND SEDIMENT MANAGEMENT PLAN

CariSal has incorporated important features within the Project design to avoid adverse water quality impacts from erosion and sediment transport. The design requires the preparation of a site-specific SWPPP that would include the erosion and sediment control BMPs the U.S. EPA recommends. This section addresses the expected impacts to surface water and groundwater quality during construction, operation, and decommissioning of the CariSal chlor-alkali facility and the BMPs related to construction site planning and management, erosion control, and sediment control. Issues related to runoff are addressed in Section 7.9.

7.10.1 Construction Phase

Areas cleared of vegetation and areas of excavation or fill would be more susceptible to erosion than the original ground surface. To minimize erosion and the transport of sediment, CariSal would prepare and implement a comprehensive SWPPP before construction begins. The SWPPP would incorporate the BMPs in the categories described below.

7.10.1.1 Construction Site Planning and Management

- **Construction Sequencing** – The design requires that construction be scheduled to minimize the soil area simultaneously exposed, especially during the rainy season. Temporary sediment and erosion control measures would be installed before site clearing, and would remain in place until permanent sediment and erosion control measures were installed. Permanent erosion control measures for areas deemed complete would be scheduled as early as possible.
- **Construction Site Operator BMP Inspection and Maintenance** – All erosion and sediment control measures would be inspected, repaired, and fortified if necessary prior to any forecast precipitation or pause in construction activities, including weekends. A work crew would be made available to inspect, maintain, and repair erosion and sediment control measures during all storm events, including nights and weekends.
- **Land Grading** – Soil surfaces would be contoured to promote sheet flow and to prevent concentrated flow, except when such flow is intentionally concentrated into a stable drainage channel, either natural or engineered. The contractor would be required by CariSal to contour surfaces and the grading would be periodically monitored for compliance.
- **Protection of Drainages and Boundaries** – Where construction must occur within 25 feet of a drainage or a site boundary, more intensive use of erosion and sediment control BMPs, such as use of silt fencing, straw bales, staging spoils piles away from the drainage or boundary, geomats, and the like, would be used and more closely monitored to minimize erosion and sediment transport.

- **Preserving Natural Vegetation** – Areas not to be cleared would be protected with temporary fencing.

7.10.1.2 Erosion Control

Erosion control measures, such as those listed below, would be used as necessary to protect erosion -prone areas from damage.

- **Chemical Stabilization** – Soil binders and polyacrylamides could be used if necessary to prevent erosion or to stabilize soil until new vegetation becomes established.
- **Dust Control** – Water tenders would be used as necessary to control dust.
- **Geotextiles and Mats** – Geotextiles and mats would be used as necessary to protect erosion prone areas from damage.
- **Mulching or Compost Blankets** – Straw mulch or compost blankets could be used to reduce runoff velocities, increase infiltration, and reduce erosion potential.
- **Riprap** – Riprap, generally placed over a geotextile, would be used in areas of concentrated flows to protect against soil erosion.
- **Seeding and Sodding** – Seeding and sodding would take place within one month during the dry season, and one week during the rainy season, in areas where construction is otherwise complete.
- **Soil Compaction** – Exposed soil would be compacted to minimize silt and sediment runoff, and to minimize infiltration-induced softening of newly placed fill.

The locations of erosion control measures would be specified in the SWPPP or contractor work plan and monitored for compliance.

7.10.1.3 Sediment Control

Sediment control measures, such as those listed below, would be used to detain and filter sediment-laden runoff. The locations of sediment control measures would be specified in the SWPPP or contractor work plan and monitored for compliance.

- **Compost or Gravel Filter Berms** – Permeable berms would be constructed as necessary to detain and to filter sediment-laden runoff.
- **Stabilized Construction Entrances** – Construction entrances of 3- to 6-inch diameter (7.6- to 15-cm) stones, heavy metal grating, or other device would be used to remove mud and sediment from vehicle tires.
- **Sediment Traps and Basins** – Temporary drainages would incorporate sediment traps along their lengths. Sediment basins would be constructed before clearing and grading work begins. The sediment traps would be cleaned when accumulations reach one-half the designated sediment storage volume. Removed sediment would be disposed of by a qualified industrial waste management

contractor or, if appropriate per environmental standards, reapplied on site. Regular monitoring of traps would occur weekly, or immediately after rainfall events.

- **Silt Fences, Straw or Hay Bales, Fibre Rolls or Compost Filter Socks** – Silt fences or other devices would be installed to intercept surface runoff and trap suspended sediment.
- **Vegetated Buffers** – Vegetated buffers would be maintained around the edges of exposed soil areas where possible to trap sediment and to filter runoff. CariSal would monitor construction for contractor compliance.

With these design features in place and with implementation of the SWPPP, the expected soil impacts from erosion during construction would be minor.

Topsoil would be stockpiled and re-used where possible, although there would still be a moderate local impact in the reduction of topsoil area. Stockpiles of topsoil would be located outside of drainage paths. CariSal would develop a topsoil reuse plan and monitor for contractor compliance.

7.10.1.4 Monitoring and Management

The erosion and sediment control monitoring program would include continuous monitoring for compliance with the SWPPP and regular inspection of the erosion and sediment control measures. All erosion and sediment control measures would be inspected, repaired, and fortified if necessary prior to any forecast precipitation or pause in construction activities, including weekends. A work crew would be made available to inspect, maintain, and repair sediment and erosion control measures during all storm events, including nights and weekends.

The unavoidable reduction in topsoil area caused by construction of the plant and roads could be mitigated by using the stockpiled topsoil offsite in areas that do not currently have an established topsoil layer.

The BMPs and other erosion and sediment control procedures in the SWPPP require faithful adherence to CariSal's intent by the contractor. CariSal would include compliance with the SWPPP as a contractual requirement for the contractor, subject to CariSal compliance inspections and, if necessary, stop work orders.

7.10.2 Operations Phase

During operation, vegetation would be maintained in all areas not containing industrial facilities, buildings, or roads. No large areas of bare soil would be permitted.

Sediment that accumulates in sediment traps or the retention pond would be removed periodically and disposed of by a qualified industrial waste management contractor or, if appropriate per environmental standards, reapplied on site.

No significant adverse impacts related to erosion or sediment control requiring mitigation are expected during operation.

7.10.3 Decommissioning Phase

The erosion and sediment control impacts expected during decommissioning would be similar in type to but lesser in magnitude than those expected during construction. The required sediment and erosion control measures would be similar to those used during the construction phase. Any areas of soil exposed would be covered with topsoil and revegetated.

With the erosion and sediment control features in place and with implementation of the SWPPP, the expected soil impacts from erosion during decommissioning would be minor.

7.11 NOISE MINIMIZATION PLAN

7.11.1 Plant Construction

Pile driving would not likely cause any building damage. However, pile driving is likely to cause perceptible vibration. Therefore, pile driving would be conducted only during the day, and would be minimized in areas closest to residences.

Noise and vibration impacts may occur due to the operation of clearing equipment, earthmoving equipment, and the passage of vehicles (e.g., pipe hauling trucks).

Well-maintained equipment with noise attenuating technologies (such as mufflers) would be used during construction. Construction activity would be limited primarily to day-time hours, to minimize nuisance on residential areas. Workers would use earplugs/muffs for work activities performed near high noise generating equipment.

Construction noise impacts can be minimized through relatively simple and inexpensive measures that can be incorporated into the construction contract. The following construction noise provisions may be considered for this Project:

- All construction equipment powered by an internal combustion engine would be equipped with a properly maintained muffler. Mufflers would be checked regularly and replaced as necessary.
- Noise-insulating enclosures or temporary noise barriers would be used with continuously running equipment, such as air compressors. Furthermore, all barriers would be designed to break the line-of-sight from noise source to listener.
- Noisy construction operations and techniques would be replaced by quieter ones where feasible.
- Where alternative items of equipment can be used, the quietest ones would be selected where feasible.
- Idling of trucks and equipment would be minimized. Signs would be posted in load/unload areas requiring that engines be shut down after 3 minutes of idling.
- Construction equipment and vehicles would be routed in areas that will cause the least disturbance to nearby receptors where possible.
- Any air-powered equipment would be fitted with pneumatic exhaust silencers.

- Operations deemed to be excessively noisy, such as any on-site fabrication and piling work would be limited to day-time hours.

7.11.2 Plant Operations

Because plant operations noise may exceed EMA's ambient increase criterion of 5 dBA, we recommend that noise monitoring be conducted in the vicinity of the nearest residence to the west of the plant both to verify previous ambient noise measurements (which can vary greatly), and to confirm noise modelling results. Noise modelling has a certain amount of tolerance, expressed in dB. In this case, a small amount of variance in the modelling results could mean that the Project would be in compliance with EMA standards. If noise monitoring confirms that plant operations would exceed EMA standards, we recommend that noise barriers to shield front loader and/or cooling tower noise be evaluated and implemented, as appropriate. Another mitigation option, if shown to be reasonable and feasible, would be building sound insulation, applied to receptor locations such as the homes of the nearest residents. Building sound insulation typically consists of upgrading windows and doors with acoustical replacement windows and doors. These mitigation measures should lead to a measured 5 to 10 dBA noise reduction.

7.12 DRAINAGE

This section addresses drainage issues associated with the construction, operation, and decommissioning activities at the CariSal site. The section deals exclusively with quantity of flow and does not include surface water quality, erosion, or sediment control. Surface water quality is covered in Section 7.9. Erosion and sediment management is covered in Section 7.11

7.12.1 Construction Phase

The CariSal site has been designed to be hydraulically isolated from the adjacent lands once site development is complete and operation begins. During construction, the permanent elements of the drainage management system would be constructed in a sequenced fashion to control drainage from construction areas and completed areas, and to direct it to the Containment Pit and Retention Pond (collectively the retention ponds).

The drainage plan would be developed in collaboration with the Ministry of Works Drainage Division. At the February 13, 2007 all-stakeholder meeting CariSal hosted by, it was stated that the Ministry of Works intends to improve the existing water-course at the southern boundary of the site and final drainage plans will be developed in coordination with the Ministry's plans.

The perimeter dikes and retention ponds would be constructed as early as possible during the construction phase to control construction runoff. Most of the length of the perimeter dike would consist of the elevated perimeter road and the exterior walls of the Containment Pit and Retention Pond No. 1. The permanent elements of the drainage management system are also designed to prevent flooding of the CariSal site from adjacent lands and waterways.

CariSal would construct dedicated stormwater drains located all along the premises. The storm drain network would be based on the surface contours of the site and would be designed for 100-

year storm events. The packaging and storage facility would be designed to prevent exposure of the product to potential flooding or water.

The retention ponds would not have the storage capacity to store all of the runoff expected during the construction period, and the plant would not be operational to consume the collected water. To the extent possible, the collected water would be used for dust control, soil compaction, and irrigation of new ground cover and plantings. Excess collected water, which would be expected to be as clean as preconstruction site runoff, would be periodically tested and discharged into the LNG River or the northern drainage channel in a controlled fashion during periods of low flow.

CariSal would require contractors to avoid construction across drainages during periods of rain, to complete construction in drainage channels as quickly as possible, and to inspect, repair, and reinforce runoff control measures before forecasted precipitation events. This mitigation measure would be indicated by documenting a written requirement with the contractor, as well as requiring the contractor to submit weather data and a schedule to obtain a permit from CariSal before performing construction across drainages. The contractor would also be contractually required to make work crews available to repair runoff control measures during all storm events, including nights and weekends.

The volume of water that would drain from the CariSal site during construction would be less than or equal to the volume that would drain under existing conditions. The use of the retention ponds as detention ponds during the construction phase would reduce peak discharges from the site into the LNG River or the northern drainage channel.

No expected adverse drainage impacts during the construction phase requiring mitigation are expected. The detention and controlled discharge of clean water from the detention ponds is a minor beneficial impact because it reduces the flooding potential downstream.

The SWPPP or the contractor's work plan would include the sequencing and schedule for constructing the permanent elements of the drainage management system. CariSal would include compliance with the SWPPP and the contractor's work plan as a contractual requirement for the contractor, subject to CariSal compliance inspections and, if necessary, stop work orders. This would include sequencing of clearing, excavation, backfill, and grading activities. The calculations for the stormwater drainage system would be subject to CariSal's review. CariSal would monitor construction to confirm compliance with the design.

7.12.2 Operations Phase

The CariSal site has been designed to be hydraulically isolated from the adjacent lands once site development is complete. Runoff from all process areas would be collected in the Containment Pit. Runoff from all other site areas would drain into the clean water Retention Pond, except for the undeveloped northern half of the site and de minimis, non-process areas around the site perimeter outside of the perimeter roads. CariSal proposes a closed-loop process water system where no drainage or release into the surrounding environment would occur.

The volume of water that would drain from the CariSal site during operations would be less than the volume that would drain under existing conditions. The collection of water in the retention ponds and its use by CariSal would reduce the peak and total discharges from the site into the LNG River and the northern drainage channel.

Although CariSal's intent is to operate the facility with zero-water discharge to the LNG River, situations may arise during the rainy season when runoff of continued, heavy precipitation exceeds the available storage capacity of the retention ponds and the cooling tower makeup requirements. If the retention ponds reach their maximum safe capacity, CariSal would release water into the LNG River. This contingency release is expected to be extremely rare. The storage capacity of the Containment Pit and Retention Pond No. 1 would be equivalent to the volume of water from more than 8 cm of precipitation over the southern portion of the site. The cooling tower makeup requirements would be equivalent to nearly 8 cm of precipitation over the same area in 24 hours. The combined total of storage and 24-hr consumption (16 cm in 24 hr) exceeds the precipitation that would result from a 50-year, 24-hr storm. During the rainy season, CariSal would endeavour to consume water from the retention ponds to maximize the available storage capacity. Whenever extremely heavy rains are forecast that could overwhelm CariSal's storage capabilities, CariSal would release water from Retention Pond No. 1 in advance of the storm to free up storage capacity.

No adverse drainage impacts during the operation phase requiring mitigation are expected. The retention of clean water in the retention ponds is a minor beneficial impact because it reduces the flooding potential downstream. The controlled contingency discharge of clean water from the retention ponds in advance of a major storm is a minor beneficial impact because it reduces the flooding potential downstream during the storm.

7.12.3 Decommissioning Phase

During decommissioning, the perimeter dikes and retention ponds would remain in place until most of the land had been restored to its final grades and revegetated. Finally, the perimeter dikes and retention ponds would be removed or breached to restore distributed runoff.

No adverse drainage impacts during or after the decommissioning phase, compared to the initial conditions, are expected.

The decommissioning contractor's work plan would include the sequencing and schedule for removing the permanent elements of the drainage management system. CariSal would include compliance with the contractor's work plan as a contractual requirement for the contractor, subject to CariSal compliance inspections and, if necessary, stop work orders.

7.13 Spill and Air Emissions

7.13.1 Construction Phase

Initial construction of the chlor-alkali facility would occur over an 11-month time period with initial site grubbing, filling, and grading occurring during the first 2 months. Initial construction activities would consist of site preparation, which would include the cutting of the cane and

grasses, and grubbing the area to be occupied by the plant facilities, which would cover an area of 5 approximately hectares. This activity would use of several construction vehicles that generate both exhaust and fugitive dust emissions. CariSal intends to employ a number of BMPs during construction that would include frequent water tendering (particularly if construction occurs during the dry season) and maintaining low operating speeds on the property to reduce re-entrained road dust and to minimize soil disturbance. Additional mitigation measures that would be used to further reduce impacts are discussed in the following section.

Mitigation measures to reduce dust include:

- Clearing only the area needed for construction (a performance indicator for this measure would consist of weekly documentation of areas worked and activities conducted in those areas);
- Ensuring that dump trucks and other vehicles carrying construction material are covered to prevent spillage (measured through documentation that materials leaving the site are covered and secured prior to departure and maintaining those records for review);
- Covering and watering all construction material storage piles as appropriate to minimize generation of dust (documentation of the acquisition of covers and instructions and operating procedures for covers would be a performance indicator for this measure); and
- Washing down trucks (especially tyres) before they leave the site (success of this mitigation indicated through the establishment of wash-down areas on site, the documentation of wash-down procedures, and the documentation of the volume of water used and number of vehicles washed).

Mitigation measures to reduce exhaust gases include:

- Using well-maintained vehicle construction equipment (documentation of the condition of equipment using operating records and maintenance logs would serve as measurement of this mitigation);
- Verifying the installation and functionality of vehicle-equipped emission controls (to be measured by checking inspection and visible vapours records at the Ministry of Works and Transportation);
- Requiring that onsite contractors perform vehicle inspections and maintain their internal combustion engines (also verified through records checks); and
- Optimizing the use of equipment and vehicles through management practices such as idle minimization (mitigation measured verified by checking for management practices written into contracts with civil contractors).

During construction, the potential for high ambient air quality background concentrations coupled with onsite construction activities may cause exceedances of the permissible levels for NO_2, PM_{10} and TSP. As identified in the air quality analysis, CariSal intends to implement real-a time monitoring program at a fixed site location for these air pollutants close to the highest

modelled offsite concentration during the construction period. The program would identify when concentrations may be near the air quality permissible levels so that corrective actions can be taken, such as the curtailment or reduction of certain types of construction activities, until more favourable conditions exist. An example of the type of instrumentation that could be used for real-time PM monitoring is the Met-One E-BAM mass monitor, which can measure both TSP and PM_{10} on a 15-minute basis. Similarly, instrumentation is available to monitor NO_2 on a real-time basis. The performance of this monitoring program would be indicated by the procurement of equipment for monitoring, documentation of the methods for reporting readings in real-time, identification of the course of action for exceedance events, and the maintenance of written reports of all incidents.

7.13.2 Operations Phase

Emissions from the proposed chlor-alkali plant have been estimated based on the assumption that the plant will be operated continuously—24 hours a day, 7 days a week, 365 days per year.[6] The proposed facility has several emission sources, including the following:

- Natural gas-fired co-generation or equivalent industrial gas turbine generators
- 94-percent calcium chloride fluidized bed dryer
- 77-percent calcium chloride dryer and cooler
- Hydrogen chloride plant (with chlorine gas scrubber)
- Hydrogen chloride intermediate storage tanks (with hydrogen chloride scrubber)
- Storage and packing of calcium chloride (with scrubber)
- Lime dust silo vent (with bag house)
  - Diesel-fired fire pump
  - Two cooling towers

Modelling of facility operations shows that no exceedances of the air quality permissible levels will occur even when including emissions from existing and future sources (Essar and Westlake) are included in the assessment. Thus, no significant adverse air quality impacts are anticipated.

7.13.2.1 Design Aspects

- Primary plant roads would be paved to minimize dust emissions from vehicular traffic. The success of this mitigation would be measured through the documentation of dates when paving occurs and the amount of pavement materials used in the paving process.

[6] The plant is anticipated to operate 350 days per year, with shutdowns occurring only for emergency repairs. Routine maintenance can be performed without interrupting operation of the plant. Thus the assumption of continuous operation is conservative.

7.13.2.2 Operational Aspects

- Operations personnel would receive thorough training on proper operation of the scrubber and bag house air pollution control equipment. Training would also cover general environmental responsibilities related to air quality control. The performance of this mitigation would be measured using documentation of training records, and the review and evaluation of training materials.
- Advanced process control technology and modern operator interfaces would be used to monitor and control the operation of scrubbers and bag house equipment, including the 94-percent dryer, 77-percent dryer and cooler, lime dust bag house, hydrogen chloride scrubber, and the chlorine scrubber. This mitigation would be indicated using documentation of the procurement and installation of the scrubber, bag house, and metering equipment along with documentation of real-time monitoring of process flow and exhaust rates.
- A formal preventative maintenance program for the scrubbers and bag house would be adopted to ensure that mechanical systems receive maintenance in a timely fashion, to prevent break-downs that could contribute to emissions of air contaminants. Performance of this mitigation would be measured by quarterly review of records, including change out dates for devices/filters and other preventative procedures.
- Vehicle and equipment idling would be discouraged through the use of posted signs at load/unload points on the property that state equipment shutdown after 3 minutes of idling. Performance of this mitigation would be measured by confirmation that signs are posted at all load/unload points.

7.13.3 Decommissioning Phase

No significant or adverse impacts on air quality are anticipated during the decommissioning of the chlor-alkali facility.

7.14 GREENHOUSE GAS MANAGEMENT PLAN

7.14.1 Construction Phase

During the construction phase, CariSal would ensure that equipment is operated in a fuel-efficient manner and would minimize idling periods. Low GHG-emitting diesel fuel would be used rather than gasoline-fuelled vehicles, where practical. Equipment would be maintained and checked periodically to ensure it operates in the most fuel-efficient manner. These mitigation measures would be identified in the construction contract and required by CariSal. Periodic documentation would be used, where applicable, to monitor the performance of this mitigation measure.

7.14.2 Operations Phase

The primary GHG emissions associated with operating the chlor-alkali facility are emissions of carbon dioxide (CO_2) from four activities:

1. Production of the 42-percent liquor from the chemical reaction of HCl and limestone, producing as a by-product 49,600 MT/yr of CO_2 as a by-product.
2. Steam production initially requiring the burning of natural gas from T&TEC, producing some 76,928 MT/yr of CO_2; however, after CariSal installs and begins to operate onsite a cogeneration unit, CO_2 emissions from the electrical power delivered by T&TEC should be reduced as the cogeneration will supply about a third of CariSal's electrical needs. This process is more energy efficient as the combined cycle cogeneration unit produces both the steam needed for the operation as well as the electricity. Also, electric transmission loss is minimized.
3. Operation of the 77-percent dryer by burning natural gas for the production of dry flake calcium chloride, producing 2,106 MT/yr of CO_2.
4. Operation of the 94-percent dryer by burning natural gas for the production of dry calcium chloride pellets, producing 41,828 MT/yr of CO_2.

CariSal has identified the following mitigation measures to reduce CO_2 emissions rates:

- CariSal will seek to negotiate agreements with industrial users of CariSal's excess CO_2 emissions (e.g., furnish CO2 to TEIL for their use as a raw material in urea manufacture, or the oil industry uses CO_2 in oil field gas injection to expand reservoirs to push additional oil to a production well bore.) The KPA Group of Companies is pursuing a project that would compress CO_2 and transport it by pipeline for injection into offshore oil fields for enhanced oil recovery (EOR). The CariSal Project would include a compressor station located adjacent to Yara's east fence. KPA reportedly has already been granted space for the proposed CO_2 compressor station and is in negotiations to use the existing Petrotrin right-of-way for a pipeline to the southern production fields. The site for the proposed compressor station is close to CariSal's proposed caustic soda pipe line corridor to the EISL site. CariSal could easily accommodate a CO_2 line from the proposed CariSal facility to the compressor station in that same corridor as part of the CariSal Project development. No new right-of-way would be required.
- CariSal would plant stands of native, fire-resistant species of trees appropriate for the ecological conditions of the site. The trees would help to stabilise loose soils, aid in the recovery of the disturbed ecosystem resources, and offset carbon emissions by an average of 11 MT/yr per 1,000 trees (averaged over an assumed 100-yr tree lifespan). A total of 948 trees would be planted on the Project site. The purchase of the trees would be documented prior to operations. Tree species that would be considered for this plantation are listed in Table 7.14-1.
- CariSal is working with a Houston-based architect who has Trinidad experience and is Leadership in Energy and Environmental Design (LEED)-certified to design cool and green roofing, which would further reduce emissions of CO_2, absorb other pollutants from ambient air, and absorb excess stormwater during the rainy season.
- Soda ash production (a by-product of the process) would consume 415 MT/yr of CO_2 per 1,000 MT/yr of sodium bicarbonate production.

With these measures implemented, CariSal expects to reduce the process-related CO_2 emissions of the Plant.

- CariSal is currently exploring the possibility of acquiring lime as a primary input to the calcium chloride production process, as opposed to the limestone feedstock presented here. Substitution of lime for limestone will substantially reduce the CO_2 emissions associated with production. CariSal is aggressively pursuing this option and will notify the EMA of any material changes to the process and Application.

To fully support the Government of the Republic of Trinidad and Tobago in its commitment to the Kyoto Protocol, the CariSal facility would compile the data necessary to prepare an annual GHG inventory.

7.14.3 Decommissioning Phase

No significant or adverse impacts are anticipated during the decommissioning of the chlor-alkali facility.

Table 7.14-1. Possible Plantation Tree Species

Family	Genus and Species
Bombacaeae	*Pachira insignis*
Combretaceae	*Buchenavia tetraphylla*
Combretaceae	*Terminalia dichotoma*
Elaeocarpaceae	*Sloanea laurifolia*
Guttiferae	*Calophyllum lucidum*
Guttiferae	*Marila grandiflora*
Guttiferae	*Symphonia globulifera*
Hernandiaceae	*Hernandia sonora*
Humiriaceae	*Sacoglottis amazonica*
Leguminosae	*Clathrotropis brachypetala*
Leguminosae	*Crudia glaberrima*
Leguminosae	*Lonchocarpus domingensis*
Leguminosae	*Mora excelsa*
Leguminosae	*Pentaclethra macroloba*
Leguminosae	*Pterocarpus officinalis*
Leguminosae	*Pterocarpus rohrii*
Meliaceae	*Carapa guianensis*
Meliaceae	*Guarea glabra*
Meliaceae	*Swietenia macrophylla*
Palmae	*Bactris major*
Palmae	*Euterpe oleracea*
Palmae	*Manicaria saccifera*
Palmae	*Mauritia flexuosa*
Podocarpaceae	*Podocarpus coriaceus*

8.0 COMMUNITY ENGAGEMENT, STAKEHOLDER CONSULTATION, AND INVOLVEMENT

8.1 COMPANY COMMITMENTS AND PUBLIC INVOLVEMENT

CariSal Unlimited's shareholders mandate that it operate a highly efficient, technology driven, environmentally superior, and community-focused organization. Consistent with this mandate, the Company has undertaken the design of a state-of-the-art chemical facility using best available and proven technologies. CariSal has designed its manufacturing processes to clean up, reuse and recycle, or eliminate its liquid waste streams and, in Stage 4, to ease demand for industrial water in the Point Lisas industrial estate(s) and environs. CariSal has taken the initiative to fully engage potentially impacted communities and stakeholders early in the project development process to build ongoing partnerships that will endure for the life of its operations. Such initiatives are practiced in a growing number of industrialized and industrializing countries that understand the changing role of business in today's knowledge-based society. CariSal intends to introduce not just a new company to Trinidad and Tobago but to promote a new way of doing business.

Consistent with its commitment to building ongoing relationships in stakeholder communities and its corporate social and environmental policy, CariSal Unlimited developed an initial public engagement programme. This programme was begun in late October 2006 when CariSal initiated a series of meetings between its Project team members and a variety of neighbourhood, agency, and industry stakeholders.

As the Project has developed, the initial public engagement programme and strategy have been modified to integrate the requirements of the EMA's Final Terms of Reference (TOR). Public engagement activities were also designed to incorporate information gathering that informed the evaluation of the potential socioeconomic and social effects of the Project. This initial public engagement programme would be superseded by the Community Engagement Plan described in Section 7.4.

8.2 REQUIREMENTS AS DESCRIBED IN THE FINAL TOR

Requirements for consulting with and engaging the public in projects in Trinidad and Tobago such as CariSal's chlor-alkali project are delineated in the Final TOR issued by the EMA. Appendix A to this EIA contains the Final TOR for the CariSal Project. These requirements are presented below, verbatim, as they appear in the TOR.

> *Consultation and public participation can assist in the identification and mitigation of impacts while preventing environmentally unacceptable development, controversy, confrontation and delay. The stakeholders that can assist in the provision of information relevant to the project should be determined and their input sought into its feasibility as it relates to the impact assessment process. These stakeholders would include, but are not limited to, the following:*

1. *Government Ministries/Departments/Statutory Authorities:*

   - *Ministry of Planning and Development, Town and Country Planning Division*
   - *Ministry of Energy and Energy Industries*
   - *Ministry of Works and Transport, Drainage Division*
   - *Ministry of Public Utilities and the Environment*
   - *Water and Sewerage Authority*
   - *Ministry of Labour and Small and Micro Enterprise Development*
   - *Office of Disaster Management and Preparedness (ODPM)*
   - *Couva/Tabaquite/Talparo Regional Corporation*
   - *Archaeological Committee (if applicable)*
   - *Environmental Management Authority*

2. *People living in the vicinity of the project who can be affected by the project*
3. *Environmental and other non-governmental organizations*
4. *Environmental experts*
5. *Other industries and business interests in the vicinity of the project that can be affected by the project.*

There should be mechanisms to provide meaningful information to these stakeholders and to allow proper consultation and participation. The public consultation should be geared towards the understanding of the general public on the nature of the project, time frame involved and all relevant issues.

A minimum of two public consultations must be held with the determined stakeholders at a time and day of the week appropriate for the community given consideration for religious observances and public holidays. All relevant information, including description of activities, all associated impacts and mitigation measures should be presented at the initial consultation. These consultations should allow the stakeholders time for assessment of the information presented. Their concerns will be largely related to the impacts that

the project is likely to have on their lives. Information should be graphic, concise, clear and designed in a manner to elicit participation.

In particular, the Final TOR emphasizes the following:

> ***All public consultations should be scheduled to include one meeting prior to the completion of the environmental study and one meeting after the environmental study has been completed by the representative of the proponent, and the findings of the study, such as the impacts and mitigation measures, have been made available to the proponent.***

The Final TOR also states:

> ***Public involvement in the process should be accessible, transparent, accountable, flexible and provide for certainty and should be conducted with integrity. A tabular format is a recommended way of summarizing the results of this process. The table is not to replace specific reference to public involvement throughout the impact assessment report. Rather with specific cross-reference to page numbers or section numbers of the report, the table becomes a useful reference tool.***

8.3 APPROACH AND METHODOLOGY

CariSal was designed as an early Trinidad and Tobago case study of how an industrial facility can maximize the triple bottom line of social, environmental, and financial performance – people, planet, and profit (Elkington 1999). A community assets approach to building relationships with potentially impacted communities was adopted to complement the triple bottom line performance requirement.

"Asset-based Community Building involves a change in mindset from traditional needs-based planning. The focus of the effort shifts [emphasis] from examining issues to [an appreciative enquiry framework that entails] examining assets that can be developed, connected, or unlocked through community action. The theory is that every community, no matter how poor, is endowed with extensive strengths, skills, and capabilities. The challenge of community building is to identify those strengths and put in place new" (Mathie and Cunningham 2002) ways of collective knowing, collaboration, and of building the community's capacity to participate in its development.

"*It's a way of relating to people, i.e., seeing all people as problem solvers rather than problems to be solved. It's more of an attitude you bring to what you already do at home and on the job, i.e., believing that people are resources and not problems to be fixed or recipients of services. This attitude or belief can be infused into and developed within any program…. Assets are the*

skills, talents and capacities of individuals, associations, and organizations that are shared with the community."[1]

8.3.1 Objectives

The following public engagement objectives were identified as part of the initial CariSal public engagement programme and are consistent with the community assets approach and the Final Project TOR. The objectives were to:

- Introduce and inform stakeholders about the Company, its products, and plans;
- Provide members of the public with opportunities to participate in the Project development and environmental review processes;
- Engage stakeholders about the Project's benefits and impacts and learn from local experience and community-based knowledge;
- Foster positive ongoing relations between CariSal and its various stakeholder communities, especially its fence-line neighbours and potentially impacted communities;
- Help the community identify and realize its community assets and bring them to bear in their relationship and community building efforts with CariSal;
- Identify and understand on an ongoing basis, the concerns raised by the fence-line or nearby community/ies;
- Identify the community's existing social capital and needs/gaps;
- Identify opportunities for Company partnerships with the community; and
- Provide the public and other stakeholders with information about the Company's organizational structure, decision-making lines of authority, opportunities for employment, and the EMA's administrative process for public involvement on the CEC application and ongoing CEC compliance.

8.3.2 Target Audience

In seeking to secure the full participation of the community that would be affected by the Project, CariSal targeted the following four principal stakeholder groups:

1. Fence-line, nearby, regional, and other potentially project-impacted communities
2. Point Lisas Estate and other regional industries and businesses

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[1] From United Way, Community Compass. "Community Assets Inventory" http://www.uwgnh.org/compass/assets.php. Last accessed May 11, 2008.

3. Government Agencies
4. Non-governmental organizations (NGOs) and community-based organizations (CBOs) and other knowledge experts/professionals

8.3.3 Strategy

The aim of CariSal's initial public engagement strategy was to foster the development of durable relationships with the surrounding communities and to act as a responsible community partner and corporate citizen. To begin, CariSal made several efforts early in the process to officially introduce itself to neighbours, community groups, and individual opinion leaders. CariSal sponsored a series of one-on-one and community meetings and focus groups about the Company, its environmental and community values and commitments, and the assets and needs of the nearby communities. The focus of the public engagement programme activities was geared toward developing partnerships with community members such as schools with an emphasis on job creation and skills building, environmental stewardship, and community safety. CariSal also used informative advertising via its Newsletter, neighbourhood visits, and presentations to stakeholders to raise awareness of its presence and contribution to the goal of environmentally sustainable economic development and the introduction of clean production processes and products in the Trinidad and Tobago market.

8.3.4 Tools & Techniques

CariSal relied on a diversity of outreach tools and approaches to reach the target audience, including the following.

- Study visits – Planned visits designed for CariSal's management and consulting teams to learn about and understand the local environment. They entailed several project site visits and meetings with neighbours, Government agencies, and community members.
- Door-to-door visits – Continuous visits by the plant's General Manager to fence-line neighbours.
- Newsletter – Continuous updates for stakeholders on the Project's plans and progress.
- Public Information Meetings – Public consultations conducted during July 2007 to lay the foundation for Focus Groups and the Public Engagement Meetings.
- Public Engagement Meetings (PEMs) – Presentations of project updates to raise issues and to receive ideas, concerns, and opinions from community members. Two Public Engagement Meetings were planned so that one would be held prior to the completion of the EIA and the other after its completion to present the study results to the public and receive feedback. Information gathered during the PEMs was used to inform the Company's EIA process, mitigations and future community involvement plans. Feedback from the second PEM led to additional refinements in the plant design to further reduce the likelihood of adverse impacts to human and environmental health, especially with respect to air quality.

- Public Notices
  - Advertisements placed in the daily newspapers inviting the public to the information and engagement meetings.
  - Mobile loud speaker announcements made in Study Area communities several days prior to and on the day of each meeting.
- Focus Groups conducted to augment relationship building between CariSal and potentially impacted communities, assist with community asset and gap identification, identification of opportunities for collaboration, and data collection for the SIA. These tools served to enhance community knowledge of the Project's benefits, impacts, and plans, and to provide updates on the status of the EIA and other project-related developments. Focus Groups were conducted with community residents, workers, and industrial neighbours.

CariSal has completed the following public and stakeholder engagement actions:

- Initial meetings with stakeholders (TCPD, NEC, EMA) during late October – early November 2006. These meetings were designed to introduce the Project, learn about the permitting process, and receive early stakeholder input and feedback.
- An all-stakeholder meeting in February 2007 to which a broad range of government agency and industrial stakeholders was invited and participated.
- Press releases about the Project and the team in the local media, which began in early March 2007.
- Dissemination of the Newsletter, beginning in March 2007, to provide stakeholders with Project updates.
- Door-to-door visits by the General Manager of CariSal, Roger Moore, initiated with fence-line neighbours in April 2007.
- Presentation of the Project and Company at an open meeting of the South Trinidad Chamber of Industry and Commerce on April 19, 2007.
- Hosting of two public information meetings on July 21 and July 24, 2007 to provide community members and other stakeholders an opportunity to learn about the Project, development plans, and potential impacts and to provide an opportunity to comment on the draft EMA-issued Project TOR and to share their overall views of the proposed development with CariSal.
- Site visits with the EMA in December 2006 and May 2007.
- Planning and Ministry of Education approval for the launch of CariSal's Lunch and Learn program in Study Area schools.
- First official Public Engagement Meeting held on August 4, 2007.

- Meeting with agency stakeholders on the EIA and permit compliance-related issues in late October and November 2007 (WRA, WASA, Drainage Division, EMA, SWMCOL).
- Meeting with DESALOTT to continue discussions of operational options to inform the EIA and project staging in October and November 2007.
- Meetings with EISL for various site visits and information gathering for the EIA.
- Meeting with EMA to present air dispersion and quantitative risk assessment protocols in November 2007.
- Meetings with community members during two semi-structured Focus Groups to provide Project information, learn about community needs and assets, continue efforts to build relationships with community stakeholders, and receive feedback to inform the EIA on November 3 and 7, 2007.
- Information gathering with industrial neighbours via a semi-structured, confidential questionnaire and Focus Group format to obtain their feedback on the Project and to learn from their concerns and experiences on the estate with regard to issues such as emergency response, incidence of flooding and accidents, expansion plans, availability of utility infrastructure, and the like on December 11, 2007.
- The second official Public Engagement Meeting on January 7, 2008 to present the results of the EIA study and receive public feedback.
- Arrangements for a meeting with a representative from Westlake Trinidad Unlimited in Houston and invitation to Essar's representative to the CariSal Public Information meetings and PEMs.
- Meetings between CariSal's management team and WASA's representatives on four occasions (in April, May, June and July 2007) to address water demand and availability and learn about the approval process for the proposed development. The CariSal environmental review team also met with WASA and the WRA twice (in October and November 2007).
- Meetings between CariSal management and T&TEC representatives on electricity infrastructure and service availability on four occasions (March, May, June, and November 2007).
- Meetings between CariSal management and DESALCOTT on three occasions (in June, September, and October 2007); the environmental review team met and completed site visits in October and November 2007.
- Written invitations sent to a variety of agency, community, industry, and NGO stakeholders to provide comment on the draft TOR, to encourage participation in Focus Groups and to attend the PEMs. Among these, the Council of Presidents of the Environment was invited to comment on the TOR. Stakeholders were also presented with a CD about CariSal as part of the Company's public engagement programme and outreach efforts. Invitations to public meetings were also sent to the Couva/Tabaquite/Talparo Regional office, the Ministry of Public Utilities, and others as indicated in Appendix D to this EIA.

- Meetings between environmental review team members and staff at the Drainage Division, SWMCOL, TCPD, NEC, and other stakeholders in October and November 2007.
- Presentation of EIA results to the EMA in January 2008.
- Meetings with EISL, Yara, and PLIPEDCO in 2007 regarding the use of Savonetta Pier No. 4, acquisition of approvals for pipeline rights of way, access to use the Yara Pier, and the siting of the caustic soda shore tanks.

The Community Engagement Plan (CEP) described in Chapter 7 would continue and build upon these prior stakeholder engagement efforts. The CEP also would establish a baseline for continuous, transparent communication and collaboration with key stakeholders, including and of highest importance, the nearby host communities. The CEP would be designed with inputs from the community and would incorporate the information gathered and the feedback received during the initial public engagement programme.

8.3.5 Summary of Public Comments Received from Community Members to Date

CariSal's General Manager paid visits to neighbours (residents) in Dow Village, Phoenix Park, and Pranz Gardens, three communities that comprise the Project's fence-line neighbours, on the afternoon of July 14, 2007. During the visits, residents were provided with a flier about the Project and were invited to attend CariSal's July 21 and 24, 2007 Public Information Meetings.

During these visits, villagers from Phoenix Park requested that CariSal host one of its introductory public meetings in their village because they felt too removed from Dow village to attend a meeting there. As a result, CariSal shifted the venue for the July 24, 2007 meeting to the Phoenix Park Government School.

Residents expressed general interest in the proposed CariSal development and indicated that they would attend the meetings. CariSal subsequently held the two Public Information Meetings on July 21 and July 24, 2007, respectively. The first meeting was held at the Caldrac Club in Dow Village and the second at the Phoenix Park Government School.

CariSal's General Manager made personal visits to neighbours to invite them to the July meetings. The meetings were also advertised by placing fliers and posters in neighbourhood shops and gathering places, by mobile loud-speaker services in the Study Area villages/communities, and through dissemination of the CariSal Newsletter.

8.3.5.1 July 21, 2007 Public Information Meeting

The July 21 meeting convened at approximately 5:00 p.m. and lasted for approximately one and a half hours. Fifteen individuals from the surrounding community attended. Community members voiced concern about storm water management in the area in general, and focused on the condition of a surface drain that runs east/west along North Sea Drive.

8.3.5.2 July 24, 2007 Public Information Meeting

Twenty-one individuals from fence-line communities attended the July 24 meeting at the Phoenix Park Government School. The meeting lasted for approximately 2 hours. Participation among attendees was productive and, at times, impassioned. Many concerns raised were not about the potential environmental impacts of the Project, but focused on how CariSal and other companies that are locating their facilities in the area would help improve the affected communities. More specifically, attendees asked that residents from nearby communities be given first preference in hiring decisions for the construction phase of these projects, once they have the requisite skills. CariSal and other new companies were asked to direct their subcontractors to give first preference for hiring to local residents.

One attendee expressed the view that the meeting only served the purpose of the EIA requirements and was not a genuine attempt to reach out to the community. Further discussion ensued on the topic, which eventually was resolved to the satisfaction of the particular attendee.

Community participants stated that the meeting was among the better presentations of this nature that they had attended. Many also expressed appreciation for the honesty and sincerity displayed during the discussions.

8.4 FIRST PUBLIC CONSULTATION

The first official public consultation for the EIA process was held on August 4, 2007 at 4:00 p.m. at the Caldrac Club on Railway Road, Dow Village, California. The notices for this meeting and all such meetings were posted in *NewsDay* and the *Trinidad Guardian* and were announced via mobile megaphone announcements throughout Phoenix Park, Pranz Gardens, and Dow Village.

The meeting was attended by 15 participants who offered the following questions and concerns after hearing CariSal's presentation. CariSal management team and environmental review team members participated in informal conversations with attendees and responded to questions about the various posters and maps mounted around the room prior to the formal start of the meeting.

CariSal commenced the formal meeting at approximately 5 p.m. and presented information on the Company, the Project plans and process, and a preliminary assessment of impacts to humans and the environment, and then opened the floor for discussion.

One participant asked whether the CariSal pipelines involved road crossings, where they would likely occur, and whether they would disrupt traffic for an extended period of time. Another noted that a "significant amount of CO_2 will be produced" by the Project and while CariSal has proposed to plant trees and implement a cool and green-roof programme, these efforts are unlikely to sequester or offset the significant amount of CO_2 generated on the site of roughly 12 ha. It was suggested that selling the CO_2 to the proposed urea plant would be a much more appropriate option.

A representative of the CariSal management team stated they are considering substituting lime for limestone to reduce or eliminate the Project's contribution to CO_2 emissions. In response, it

was pointed out that use of lime would simply shift the CO_2 release elsewhere – to the location where it is quarried or manufactured; thus, this approach would not decrease the quantity emitted as a result of the Project.

CariSal acknowledged this feedback and indicated that the facility would undertake a multi-pronged approach to making the Project as environmentally friendly (and responsive to GHG concerns) as locally practicable including the planting of trees, the utilization of a cool and green roof for its administration building, use of CO_2 in the production of soda ash to be used by the process, efforts to sell CO_2 to other nearby industrial users, and allowing the unused parts of the plant site to remain undeveloped and under vegetative cover (see Table 7.0-1).

CariSal received feedback that all units of measure should be provided in metric units.

There were enquiries about whether or not the EMA and the NEC were represented at the meeting.

Participants asked CariSal to elaborate on how liquid waste would be addressed by the Project: Would it be channelled to drains or pipes? What kind of treatment would CariSal use for storm water? CariSal's management team elaborated on their goal of a zero liquid waste policy including plans to recycle process water, to utilize retention ponds, and to design the facility so that process areas, process water, and spills would be segregated from areas of the plant where there would be clean rainwater runoff. During the presentation, CariSal presented information from its Storm Water Pollution Prevention Plan that would be used to minimize the likelihood of flooding. These and other water management procedures were further elaborated in various sections of the EIA including Sections 3.3.1(discussion of the retention ponds), 3.3.5, 3.3.6, 3.4.7, Sections 5.8.1 through 5.8.3, and Table 7.0-1 (drainage and water monitoring and mitigations).

Participants enquired about which air emissions standards would be employed by CariSal in its environmental review studies and about the height of stacks.

The environmental review team indicated that the Trinidad and Tobago Draft Air Pollution Rules (2005) and standards from the State of California – which are stricter than federal U.S. (U.S. EPA) and relevant World Bank standards – were selected for the initial air screening results reported during the presentation. The environmental team acknowledged that it was still too early in the process to determine the cumulative impact assessment results. CariSal's management team indicated that chlorine and dryer stacks were expected to be in the range of roughly 90 feet (27.43 meters) high and there would be trees planted on the northern end of the plant site. Stack parameters are presented in Table 5.9-2.

One participant followed up on informal conversation about the Project prior to the start of the formal meeting by asking about the particulate matter (PM_{10}) that would be emitted by the plant,

indicating that while it was disclosed in conversation, it was not shown on the air quality screening result slide and should be included.

The air quality impact assessment and analysis protocols are presented in Chapter 5 and Appendix E of this EIA. The assessment models the levels of air pollutants expected from the Project (including PM_{10}, $PM_{2.5}$, chlorine, HCl and others) and compares these to appropriate permissible standards. See Section 5.9.

An attendee remarked that, given the expected earnings of $45 million (USD) per year, CariSal should build the plant in this community. The participant stated that knowing CariSal's plans for providing some benefit given that the host communities are largely characterized by unskilled labour was a primary concern. There was recognition on the part of participants that skilled labour would be needed.

CariSal management responded by stating that there will be job opportunities for local villagers, indicating a preference to directly employ and train local workers. CariSal also cited its plans to require its contractors to hire local subcontractors.

Additional questions raised during the meeting and responses are presented below:

Table 8.4-1. Additional Issues Raised at the August 4th, 2007 Public Engagement Meeting

Question/Concern	Response Given at Meeting	Addressed in EIA Section:
Does CariSal have a Health, Safety, and Environment (HSE) person or department? How many people will be employed to do HSE? Who will be responsible?	CariSal would employ a full-time HSE Manager. All employees would receive HSE training as a condition of employment. CariSal invited community input in the development of the Emergency Response Plan and proposed the creation of Community Action Committees, as required by Responsible Care.	See Table 7.0-1 – Emergency Response element and Appendix E (CariSal Emergency Response Plan).
How close are the surrounding communities to the proposed plant? What measures will be put in place to ensure the health and safety of the community? If seepage of waste-water into the ground is likely, how will that affect groundwater?	The closest residential neighbour is about 50 meters from the site boundary. CariSal responded that there would be preventive monitoring. In the process facility, each area would be separated and contained or lined. Process areas of the plant are designed to segregate, treat, and recycle all process water and rainwater that comes in contact with process areas. The only place where there would be a chance of leakage into groundwater is the pipeline system. Pipelines would require monitoring for early identification of leaks and ruptures. All liquid storage facilities would be equipped with secondary containment systems to prevent fires or the release of hazardous materials to the environment. Tanks would have secondary containment comprised of a double-walled structure with an impermeable membrane designed to handle the entire tank capacity.	See Section 4.3 of the Quantitative Risk Assessment (Appendix C) and Table 7.0-1. See also Figure 3.2-2b.
What disaster preparedness measures will be put in place in the event of a high-level emergency at the plant?	CariSal stated that an Emergency Response Plan was being developed and would address disaster preparedness.	See Section 4.3 of the Quantitative Risk Assessment (Appendix C) and Table 7.0-1.

Table 8.4-1. Additional Issues Raised at the August 4th, 2007 Public Engagement Meeting		
Question/Concern	Response Given at Meeting	Addressed in EIA Section:
Will the NEC develop a policy like CARE? Will CariSal and members of the new industrial estate develop a policy similar to CARE or share membership in CARE?	NEC plans regarding CARE implementation were unknown. CariSal responded that their Venture Manager was involved in the development of CARE and CariSal has already applied for CARE membership and is a member of the Chlorine Institute. It would develop its environmental health and safety and disaster preparedness plans with the guidance and resources provided by these bodies for the chlor-alkali industry.	See Appendix E.

A number of participants at the meeting expressed concerns about land tenure issues. They stated that the Cabinet and the NEC are developing the new estate on land that was allocated for sugar workers. They stated that

- No one from the NEC had consulted any of the communities on land tenure and land use matters.
- People in the village must be consulted.
- Villagers do not know exactly what is taking place.
- Greater emphasis should be placed on job opportunities and creation for locals with the transition and development of the Caroni lands.

CariSal noted that the parcel it would lease from the NEC would be a subdivision and the Project would not rely upon the creation of a new estate for its operation. Although it remained an undeveloped greenfield site, the parcel was previously zoned for industrial use according to TCPD records. Following the meeting, CariSal made enquires with the NEC to confirm that the proposed Project development site was available for lease and was not subject to the land tenure issues raised by community members at the PEM.

8.5 SECOND PUBLIC CONSULTATION

The second public engagement meeting was held on January 7, 2008 from 5:00 p.m. to 9:00 p.m. at the Caldrac Club on Railway Road in Dow Village, California. Notices of the meeting were advertised in the *Trinidad Guardian* and *Trinidad Express* from January 3 through January 7, 2008. Announcements were made via mobile megaphone units in Pranz Gardens, Phoenix Park, Dow Village, and Savonetta. CariSal's Newsletter was distributed to people in the streets and to shops and stores in Dow, Phoenix, and Pranz. Mobile announcements were also made over a 3-day period prior to the meeting.

At least 38 participants attended this meeting. A summary of the principal issues and concerns raised at this meeting follows:

- Caroni lands and land tenure (why are new companies receiving land leases before former Caroni workers?)

- Industrial releases and accidents from existing plants and their impacts on public health. Some local area residents and workers already have asthma.

- Support CariSal and the new development, but with conditions. Do not support a large industrial estate with no infrastructure and many different plants. Many companies make environmental promises but do not appear to care about the impacted communities. Welcome development, but not at the cost of human lives and health.

- Need for proper community infrastructure – a fire station, a hospital with an appropriate burn unit, improved roads. The burn unit at Point A Pierre is inadequate for handling burn accidents that occur at Point Lisas/Couva.

- Cracking of homes in the area due to vibration from nearby industry.

- Caroni (1975) Limited provided clear benefits to the surrounding communities. It is unclear that the new developments will provide similar benefits. For example, the Pranz Gardens grounds had not been cut for several months and it was suggested that local area firms could easily arrange for its regular maintenance. Some companies have promised to plant trees and have not done so.

- Need for the community to benefit in meaningful ways from new projects (jobs, community infrastructure).

- Consultations should occur lower down in Claxton Bay or Pranz Gardens

- Concerns about air, water, and noise pollution, and vibration.

- Dow Village has a 140-year-old cemetery and the Ramleela Ground – how can new companies help host communities to acquire facilities to improve the quality of their lives–for example, provide a jogging track?

- The Government should not allow communities to rise and then insert industry. Politics is ruining communities. Crime rates are increasing. What can the new and existing industries do to help the situation?

Questions relevant to the CariSal Project and EIA study results and responses are presented in Table 8.5-1.

Table 8.5-1. Summary of Key Issues Raised at the January 7, 2008 Public Engagement Meeting		
Issue	Response	Relevant EIA Section
Solid Waste		
Re-use of limestone inerts – possibility of using the lignin fibres from sugarcane baggasse to combine with the limestone inerts to make a usable product. If mixed with water, will the inerts harden?	Subject to test results, limestone inerts would be sold as road stabilizer, landfill cover, or structural material. Otherwise, it would be treated (neutralized) as necessary and sent to a landfill.	7.1.1.3 Pollution Prevention 7.9.2 (Waste Management Plan) Operations Phase
Air Quality		
What emissions will the plant have? Will there be acid / hydrochloric acid and so on?	There are small HCl emissions from the facility. We modelled foreseeable plant emissions, and the HCl emissions are well below the permissible level of 100 micrograms per cubic meter for a 30-minute average. Therefore there should be no impact due to HCl emissions from the CariSal facility. Plant emissions include particulate matter, nitrogen oxides, carbon monoxide, sulphur dioxide, hydrogen, and chlorine – all of which are emitted in relatively small quantities and are below the T&T permissible levels.	Chapter 5 – Sections 5.1.1 and 5.9
Where will the emissions go when there are easterly and north-easterly winds blowing?	With easterly (northeast) winds, most emissions will travel downwind in a westerly (southwest) direction with the lateral dispersion of the emissions dependent upon the atmospheric stability. In general, emissions will disperse more rapidly during the daytime when atmospheric mixing is generally highest and more slowly during the night time hours when the atmosphere tends to be more stable.	Chapter 5 – Sections 5.1.1 and 5.9
What effect will emissions have on users of Southern Main Road since it is in close proximity to the plant?	Emissions from CariSal should have no impact on users of Southern Main Road. Ambient air concentrations will be below the T&T permissible levels and deposition of calcium chloride (a salt) from the facility along Southern Main Road nearest the plant is estimated to be no more than 3 grams per square meter per year based on the latest CariSal emission reduction technologies.	Chapter 5, Section 5.9 and Appendix E
Our climate here may be different from California's in the United States (so do your air models apply)?	The meteorological (climate) data used in the air dispersion models was measured in Trinidad at Point Lisas at the EMA's air monitoring shelter – 4 km from the CariSal site. It is a fairly new data collection effort by the EMA and it may be the first time that these data were used in one of these (EIA) studies. The model therefore has climate data relevant to Trinidad and the CariSal Project.	Chapter 5, Section 5.9
What air data and dispersion model was used for the air quality impact analysis and why?	The U.S. EPA regulatory model, AERMOD, was selected for this analysis as the model has all the functional capabilities to simulate all of the physical and meteorological processes that occur in the Point Lisas area. The model has undergone more than a dozen extensive field evaluation studies that compare modelled results with field measurements. More details on the field evaluation studies can be obtained at http://www.epa.gov/scram001/dispersion_prefrec.htm#aermod	Chapter 5, Section 5.9

Table 8.5-1. Summary of Key Issues Raised at the January 7, 2008 Public Engagement Meeting		
Issue	Response	Relevant EIA Section
Why are the air dispersion maps not perfectly round like those examples (from Greece and Romania) shown during the January 7, 2008 public meeting?	Although, the names or references for the studies shown at the public meeting were not provided when requested, it is our understanding that the maps shown at the public meeting could be based on or are similar to a study conducted by Balanescu et al, and presented in 2004 at the 9th International Conference on Harmonization within Atmospheric Dispersion Modelling for Regulatory Proposes. In this modelling study a 3-year period of meteorological data was used in assessing the potential impact from an accidental release from a blast furnace shaft cracking operating under high temperature from the ISPAT SIDEX Galati iron and steel works facility located in Romania. Contours of the maximum 1-hour concentration were then prepared for SO_2, PM_{10} and CO based on modelling using AERMOD or possibly ISC. The shape of the 1-hour maximum concentration contours is determined by a combination of wind direction and atmospheric stability – the latter controls the amount of horizontal and vertical mixing of the pollutants. Although the Balanescu study does not provide a wind rose, it does mention that the prevailing winds are from the northwest to north to northeast 43.4 percent of the time and the southwest component 9 percent of the time, which still leaves winds coming from all other directions 47.6 percent of the time (or, over 3 years, some 12,510 hours). This would suggest that a more circular shape for the maximum concentration field is likely as the probability that favourable atmospheric conditions which lead to high concentrations may occur during these other 12,510 hours. The situation in Point Lisas is different, in that the prevailing wind direction is from the east-northeast to southeast, which occurs for 83 percent of all hours; the emission sources have relatively short stacks and/or minimal plume rise. Also, the plots shown at the public meeting appeared to be for a 24-hour maximum concentration thus, they are dominated by conditions favourable to produce a maximum concentration over a 24-hour period rather than just 1 hour.	Chapter 5, Section 5.9.6.6
What are the health effects of $PM_{2.5}$ and PM?	Offsite concentrations of PM resulting from CariSal-generated emissions under normal operations are estimated to never exceed permissible levels for several size categories and averaging periods, even in combination with the maximum ambient background concentrations. Human health effects associated with inhalation of PM include impaired respiratory function, aggravated asthma, impacts on heart function, and other problems (EPA 2004). The potential for and severity of health effects are related to particle size, with smaller particles posing the greatest problems. See Table 5.9-10 for a detailed assessment of the air quality impacts from CariSal operations and Table 5.9-11 for the cumulative air quality impacts from all sources. During construction, the mitigation measures described in Section 7.2 would greatly reduce the possibility of an off-site exceedance of PM. These measures include: (1) monitoring ambient air quality in real time, (2) reducing the daily construction activity level by extending the construction period, and (3) using newer construction equipment. The net impact after taking these measures into consideration is that it is highly unlikely that nearby communities would have health effects associated with PM from CariSal's construction activities.	Chapter 5, Section 5.9.6.6

Table 8.5-1. Summary of Key Issues Raised at the January 7, 2008 Public Engagement Meeting		
Issue	Response	Relevant EIA Section
What impact would CariSal's air emissions have on Savonetta Village (Estates)?	Air quality modelling was performed using hourly meteorological data and results were presented in Section 5.9.6.6. These results contain the worst-case impacts – additional modelling was conducted presenting the results for a single day when prevailing wind conditions were favourable for high concentrations to occur in the nearby community of Savonetta Village, which is located to the south-southeast of the proposed CariSal Site. A review of 2 years of the Point Lisas meteorological data identified that the highest 24-hour concentrations would occur on a day similar to July 13, 2005. On this date, winds from the northwest (blowing toward the south-southeast) prevailed during most of the day. Results from the modelling show that in no location is the 24-hour PM_{10} permissible level of 75 micrograms per cubic meter exceeded and the maximum increase at any location within Savonetta Village is less than 1 microgram per cubic meter. Similarly, other air pollutants show little to no increase over background concentrations with no period exceeding the air quality permissible levels. Emissions from Essar and Westlake would contribute little to nothing to ambient concentrations over Savonetta Village during the 8 a.m. to midnight time period on this day due to the prevailing northwest wind direction.	Chapter 5, Section 5.9.6.7 and Appendix E
Will the calcium chloride dust cause corrosion to cars or nearby equipment or machinery?	With regard to the potential for calcium chloride to cause corrosion, the estimated annual average deposition amount of 4 grams per square meter was shown to have a very low rate of corrosion to iron. Deposited calcium chloride would be suspended and dissolved by rainwater during rain events and would be transported in runoff. As a conservative upper bound estimate it was shown that without rainfall it would take 16 months to corrode 1 millimetre of bare iron at the Southern Main Road. With consideration of protective coating to metal and rainfall the duration to corrode 1 millimetre becomes considerably longer. Other metals would corrode at even lower rates.	Chapter 5, Section 5.2.3
Public Engagement		
Why were there no public consultations in Pranz Gardens and Claxton Bay?	There was no appropriate venue available in Pranz Gardens at the time scheduled for the Public Engagement Meeting. Loudspeaker announcements were made in Pranz Gardens and Claxton Bay. Fliers and posters were handed out and posted at local shops and other venues. The CariSal Newsletter was also distributed widely. The community Focus Group participants were recruited (by a third party convenor) from around the entire Study Area including Pranz Gardens and Claxton Bay. Attendees were driven to Caldrac Club for the meetings held on November 3 and 7, 2007.	Chapter 8
What kind of contribution will CariSal make to the community/ies?	CariSal asked this question of participants in its August 4, 2007 Public Engagement Meeting and at Focus Groups on November 3 and 7, 2007. The responses received from community members and estate workers who participated included: Locals would be given first preference for training and employment by CariSal and its contractors to the fullest extent practicable; Lunch and Learn programme, through an asset based community building approach; and development of a Community Engagement Plan, Community Public Health Safety Plan and an Upset Conditions Contingency Plan – all with timely community input. CariSal's General Manager also agreed to assist with getting the grass cut at the Pranz Gardens playground.	Chapter 8, Section 8.6.2, Appendix D, Chapter 7, Section 7.4

Table 8.5-1. Summary of Key Issues Raised at the January 7, 2008 Public Engagement Meeting		
Issue	Response	Relevant EIA Section
Why locate here – Point Lisas/Couva?	Trinidad is an ideal location for this capital investment for several key reasons including the opportunity to benefit local communities with employment and an environmentally and socially responsible project that is run by locals. The location is also ideal because of the availability of low-cost electricity and natural gas, access to deep-sea ports, and proximity to export markets. The local market in Trinidad would generate approximately $15 million (USD) in annual revenue from displacement of imports, with the balance of the product slate to be exported. Trinidad is strategic for caustic soda production because of its proximity to the trading routes between the United States and Latin America and Europe and Latin America. Also, a plant in Trinidad would allow CariSal to ship to the other Caribbean community islands duty free and at a lower cost than the competition. Trinidad is a strategic location for the oil service markets because the shipping costs to these international markets would be $75 – $100 per ton lower than the competition.	Chapter 3, Section 3.1

8.6 SUMMARY OF FOCUS GROUP FINDINGS

Two sessions lasting approximately 2 hours each were held at the Caldrac Sports Club, a popular venue often used for staging public meetings and social events in Dow Village, Central Trinidad. Invitations were extended to a diverse sampling of residents drawn from Phoenix Park, Esperanza, Pranz Gardens, Claxton Bay, Savonetta, Dow, and Diamond villages. Community Focus Group participants were recruited from around the entire Study Area (by the canvassing efforts of a third-party convenor). Attendees who wished to participate were driven to the Caldrac Club for the meetings held on November 3 and 7, 2007.

Seventeen residents attended, reflecting a geographically representative mix of participants, comprising housewives, working persons, and young sportsmen whose views and interests were vigorously advanced.

8.6.1 Format and Methodology

Focus Group discussions were based on a semi-structured interview format and were moderated by a third-party facilitator. Focus group and interview topics included positive expectations of the proposed plant, as well as possible negative impacts on the community and the environment. Potential community involvement in efforts to enhance community safety was also discussed.

All focus groups included discussions of the community's challenges and needs and opportunities for collaboration between CariSal and the potentially impacted community and community organizations.

The conversations centred on themes such as community characteristics, the Project location and siting, community health and safety, employment, leisure and recreation, physical and social infrastructure, education, community resource bases, and community assets and needs. Current impacts of the existing Industrial Estate were evaluated against this backdrop. Confidentiality

was emphasized and the deliberations electronically recorded with approval from the gathering. CariSal and its environmental consultants presented information regarding the Company and the status of the environmental review, to which participants responded with questions and comments. Maps and visual aids were on display.

A striking feature of these group discussions was that participants exhibited knowledge of and a keen sensitivity to environmental and social impact issues as a result of long experience living in close proximity to the Point Lisas Industrial Estate. As a consequence, a wide range of views and insights, together with legitimate concerns regarding the establishment of CariSal's proposed plant, were expressed.

Residents presented the following information and concerns for consideration:

- There is no hospital in the area. The nearest health centres are at Couva, California, and Claxton Bay.
- There is an existing sewer plant in the area emitting a strong, offensive smell.
- In Dow Village, testimony was given of a strong and stringent intermittent smell of ammonia in the vicinity that affected the speaker causing her to experience dizziness when pregnant with her first baby.
- The rainy season and westerly winds aggravate the impacts and effects of these hazardous odours. This was especially so in the Savonetta area.
- Frequent venting from a nearby plant impacted adversely on dwellings in Savonetta, causing windows in the houses to shake.
- In both groups, mention was made of the infamous "Bhopal" incident with its highly publicized sequel involving Union Carbide. Fears were expressed regarding the possibility of the CariSal plant creating a similar accident in Trinidad.
- Concerns were also voiced regarding increases in ambient temperature being experienced in the area. Cricketers and others having long exposure to the sun observed that temperatures seemed to be hotter while playing at Dow than at other venues such as Chaguanas. This phenomenon was attributed to operations at the Point Lisas Industrial Estate.
- In the event of an industrial accident, the area was considered to be very vulnerable with its narrow and bad roads, its poor access to public transportation, and evacuation arrangements.

- Concerns were raised with respect to the handling of bleach at the CariSal plant. This was based on the personal knowledge of group members about persons who had lost fingernails and suffered damage to their hands from exposure to bleach manufactured by another local industrial operation.

The following responses were offered by CariSal:

- On the question of gaseous emissions, the operations of CariSal are designed to be safe due to system redundancies. Hydrogen and chlorine gases are used, with the chlorine being absorbed by the end product caustic soda. Moreover, state-of-the-art technology would be provided to execute the production process and ensure safeguards, with several secondary and even tertiary back-ups.

- Lighted landscaping and layout measures with abundant greenery are contemplated by the architectural design of the administration building. This action would help in the absorption of carbon dioxide in the vicinity.

- Regular safety training and drills would be mandatory for the Company's personnel and would be extended to the wider residential community. Workers' protective gear and equipment would be the responsibility of the Company. Contractors and subcontractors would be obliged by legal provision to conform to the Company's safety standards.

- CariSal's General Manager has an impressive safety record in the area, having won a prestigious award from another company (Phoenix Gas) after a 15-year accident-free administrative term.

- Very little noise would result from plant operations but in those plant locations that could be noisy, employees would be provided with and required to use protective gear.

- This present discussion and ongoing exercises are intended to address – with the input of villagers – such issues as evacuation and disaster preparedness.

- CariSal's bleach operations are nearly hazard-free, with precautions taken at every stage.

8.6.2 Employment, Security, and Land Tenure

Community Focus Group participants explained that Caroni's closure has not only triggered land tenure issues, but has led to a broader unravelling of the social fabric of their communities by changing the underlying social structure – both formal and informal – including reduced access to resources for the support of community and cultural activities; changes in the structure of social arrangements and networks; out-migration of youth; loss of employment for an aging population of workers whose primary work experience is based on agriculture (and specifically, sugar cane cultivation); reduced access to resources that support or maintain physical community

infrastructure (such as the maintenance of community playgrounds or points of cultural importance); and a loss of physical, economic, and psychosocial security.

Participating residents observed that although employment in the area was above the national average partly due to the existence of the Estate, quality jobs generally remained outside the reach of villagers due to qualifications criteria. This was more so in Dow Village than in Phoenix Park or Savonetta. Greater access to education and training were identified as the solutions to the problem.

With respect to employment, education, and training, CariSal's General Manager gave the following assurances:

- The economic life of the plant is 20 years but it will likely operate for longer. Priority for employment would be given to local residents. Contractors and subcontractors would be required to follow the same employment preference policy, where possible, while wage rates paid by contractors would be commensurate with the Company's own standards. Clauses to effect these measures would be included in CariSal's contracts. CariSal would initiate operations with a complement of 75 permanent staff. Operations would be 24/7.

- In response to a suggestion by one of the group members who inquired about green spaces within the CariSal plant, it was agreed that landscaping activity should be an avenue for enterprise and employment especially for former Caroni workers.

- Training and re-training opportunities constitute an integral component of the Company's ongoing programme.

Community Focus Group participants identified a series of community assets including Dow Village, which has celebrated the Ramleela for 127 years. The Caldrac Club has been in existence for 61 years and is a centre for social activities of all kinds for residents of the study area. The area has temples, churches, mosques, and masjids. There are Tassa and pan orchestras. Schools are run by the state, Presbyterians, and Muslims. All are testimony to the diversity in this relatively small geographical area.

8.6.3 Leisure, Recreation, and Culture

Football and cricket are but two of the sports in which the locale has excelled. Hilton Phillips Drive was named after one of Trinidad and Tobago's most successful and best known cyclists. Table-tennis, chess, All-Fours, draughts, and martial arts are some of the other recreational pursuits of the communities. Many cultural organizations exist, including groups of tassa-drummers and steel bands. Participants felt that they would want to continue deliberations with the Company on prospects for future collaboration and possible sponsorship. The area's cultural diversity is reflected in its mosques, churches, temples, and mandirs.

Participants noted the more subtle but no less valid social contrasts evidenced in a comparison between the Dow and Savonetta villages. The former is heavily dependent on the recently demised sugar cane estates and lacking the funds or certification necessary to fully exploit available socio-economic opportunity; the latter is affluent heirs to the relative prosperity of the industrial boom.

8.6.4 Physical and Social Infrastructure (Needs)

Focus Group participants took note of the state of local roads and the fact that an entire area of 16 residences at Pierre Street has not received electricity services over the years. Crime, drug use, and alcoholism were described as social problems that are on the rise. It was felt that an incipient organization, the Dow Village Rural Development group, formed to tackle social issues, should be given more support.

8.6.5 Education

Schools in the Study Area were catalogued for the sensitive receptors list with the help of Focus Group participants. They noted that educational opportunities abound but greater advantage must be taken. The University of Trinidad and Tobago facility adds to a compendium of nearby private and public institutions providing training, yet there is a dire need for these institutions to be more accessible to area youth – especially those who are from families attempting to switch from the agrarian legacy of Caroni Limited to the opportunities offered by the new economy.

8.6.6 Community Assets

The Focus Groups revealed a wealth of "home-grown" as well as externally bestowed localized assets. The Caldrac Club, host to the meeting, towers within the community as a longstanding contributor to sporting, recreational, educational, and literary endeavours. The aforementioned Ramleela Cultural Organisation, 127 years in existence, speaks to the cultural stability evidenced by a region steeped in rich tradition. The Dow Village Rural Development group, comprising representatives drawn from different organizations within the community, is also emerging as a developmental agent. Tassa bands and steel bands, orchestras and dance groups, religious organizations, and sports clubs are among the many entities with whom CariSal would dialogue in order to uncover avenues of collaboration and support. There is a labour force eager for re-training and work at fair wages and a wealth of agricultural skill and knowledge that may be harnessed in new ways to benefit locals, the region, and the nation.

8.6.7 Risk Management and Mitigation

Schools, places of worship, sporting events, and recreational congregations are some of the more obvious instances of gatherings to be examined and catered to as high risk locations within the Study Area in the event of an industrial accident or disaster. Other areas of focus include taxi stands, clubhouses, civic centres, and workplaces.

To assess the existing and planned activities in the Study Area, a Focus Group was conducted with local industry experts and key informants. The data from these focus groups informed and augmented field surveys on the frequency and intensity of vehicular traffic in the Study Area

(actual and projected), drainage and flood control, emissions, and construction and operations schedules of each proposed facility.

Nine Industrial Focus Group participants expressed concerns about increased flooding due to land clearing, traffic congestion and dust during construction, possible declining availability of power and industrial power supply to meet new demands, drainage, and impaired emergency response capabilities. Their concerns were not specific to CariSal but were focused on the overall industrial expansion of the area. This group identified the following pre-existing coordinating mechanisms, codes, and bodies that could be useful for addressing the identified concerns for everyone's (including the community's) mutual benefit:

- Trinidad & Tobago Emergency Mutual Aid Scheme (TTEMAS)
- Emergency Response Plan for Savonetta Piers
- ISPS - International Ship and Port Facility Security Code
- CAER - Community Awareness Emergency Response
- PLEA - Point Lisas Energy Association

9.0 REFERENCES

Alkins, M.E. 1979. *The Mammals of Trinidad*. Occasional Paper No. 2, The University of the West Indies, St. Augustine.

Allsopp, R. 1996. **Dictionary of Caribbean English Usage - with a French and Spanish Supplement.** Edited by Allsopp, J. Oxford University Press. 679 pgs.

Atlas, D., Srivastava, R.C., and Sekhon, R.S. 1973. *Doppler Radar Characteristics of Precipitation at Vertical Incidence*, **Reviews of Geophysics** 11:1–35.

Bacon, P.R. 1970. *The Ecology of the Caroni Swamp Trinidad*, Central Statistical Office Printing Unit. pp. 36–37.

Beard, J.S. 1946. **The Natural Vegetation of Trinidad**. Clarendon Press, Oxford. pp. 101–109.

Bolt, B., and Newman. 1971. **Noise from Construction Equipment and Operations Building Equipment, and Home Appliances.** Bolt, Beranek, and Newman, Inc.

Bond, A., Juan P., and Paul, H. 2004. *Public Participation in EIA of Nuclear Power Plant Decommissioning Projects: A Case Study Analysis*. **Environmental Impact Assessment Review** 24:617–641.

Bryce, R. 2005. *Trinidad and Tobago Country Report*, Food and Agricultural Organization of the United Nations Gateway to Land and Water Information. http://www.procicaribe.org/networks/clawrenet/reports/z_tt/tt.htm, accessed December 2007.

Canadian Council of Ministers of the Environment, *Canada-wide Standards for Petroleum Hydrocarbons (PHC) in Soil*, January, 2008.

Canisius, F., and Nancy, C. 2007. *GeoFIS: Flood Insurance System for Trinidad – A Case Study for San Juan Downstream*. http://www.urisa.org/canisius.

Caribbean Environmental Health Institute, 2006. *The Use of Desalination Plants in the Caribbean*, UNESCO (United Nations Educational, Scientific, and Cultural Organization) Scientific/Technical Report, Documentos Técnicos del PHILAC, No. 5.

Carisal Limited. *Application for Certificate of Environmental Clearance (CEC 1743/2006), Appendix F*. 14 December, 2006.

CariSal Limited. 2007. *100,000 Metric Tonnes NaOH per year Chlor-Alkali Plant CariSal Limited – CariSal Project: Point Lisas Industrial Estate, Couva, Trinidad and Tobago, W.I.*, Technical Proposal No. CAR-0607-01 – Rev. 1. Prepared by CAVS, Inc., Miami, Florida. June 26.

CariSal Limited. *CariSal Presentation*, Public Engagement Meeting, Caldrac Club, Point Lisas. 4 August, 2007.

CariSal Limited. *Process Hazard and Environmental Risks Identification Form, Carisal Ltd., Point Lisas, Trinidad and Tobago, West Indies*, Document TTK-3831-P-HAZIP-Rev.C.doc. 23 March, 2007. Prepared by Conve & Avs, Inc.

Castillo, K. 2007. "WASA: Desal plants to improve supply." **Trinidad & Tobago Express**. 20 December.

CDERA (The Caribbean Disaster Emergency Response Agency). 2003. *Status of Hazard Maps, Vulnerability Assessments, and Digital Maps: Trinidad and Tobago Country Report*.

CSO (Central Statistical Office of Trinidad and Tobago), 2000. *Housing and Population Census*.

CSO (Central Statistical Office of Trinidad and Tobago), 2006. *Continuous Sample Survey of Population*. http://www.cso.gov.tt/statistics/survey.aspx, accessed 17 December, 2007.

Chlorine Institute, 1997. **The Chlorine Manual, American National Standard, 6th Edition**. Section 7, Engineering Design and Maintenance.

Colwell, R.K. 2006. *Estimates 8.0 User's Guide*: http://viceroy.eeb.uconn.edu/EstimateSPages/EstSUsersGuide/EstimateSUsersGuide.htm, accessed 13 November, 2007.

Cuffy, G.C. *Seasonal Use of a Neotropical Marsh by Avifauna, Caroni, Trinidad*. M. Phil Thesis, Zoology Department, University of West Indies. St. Augustine, Trinidad,1999.

DaCosta Gwendoline, Ltd. & MHA Inc. *Response to Request for Additional Information Regarding CariSal's CEC Application* (CEC 1743/2006) dated 14 December 2006. Response dated 19April, 2007.

DaCosta Gwendoline, Ltd. & MHA Inc. 2007. *Updated Summary of Environmental Effects and Mitigation.*

De Souza, G. *Culture of the Cascadura*. The Institute of Marine Affairs: The IMA Column. 19 February, 1998.

De Souza, G. "Flash Flood Forecasting on a Tropical Small Island towards Disaster Preparedness – Trinidad." International Workshop on Flash Flood Forecast Workshop, Section 8: Disaster Mitigation, Preparedness, & Emergency Response, Costa Rica, 13–17 March, 2006.

De Verteuil, L., Stawicki, A.W., Hoag, R.B., Bisson, R.A., Ingari, J.C., Maharaj, U.S., and Mulchansingh, K. 2001. "Sedimentary Megawatersheds Delineation: The Role of Genetic Sequence Stratigraphy and Complex Fault Systems Analysis in Groundwater Resource Assessment in Trinidad", Caribbean Water and Wastewater Association 10th Annual Conference & Exhibition, October.

DHV Consultants, Delft Hydraulics, Lee Young and Partners, and Government of Trinidad and Tobago. *Water Resources Management Strategy for Trinidad and Tobago*, Final Report DHV, June, 1999.

Dillon Consulting. "Environment and Natural Resources Management, Draft Document – Part IV of VII." Presented at the Inter-American Development Bank (IADB) meeting "Trinidad and Tobago: Long-term development challenges and opportunities." Port of Spain, Trinidad and Tobago, 13 July, 2004.

Dillon Consulting. Trinidad & Tobago, *Long Term Development Challenges & Opportunities, Environment and Natural Resources Management for Trinidad and Tobago*, Draft Document – Part IV of VII, Inter-American Development Bank, June, 2004.

Dowding, C. 1984. *Blast Vibration Monitoring and Control*. Prentice-Hall, Englewood Cliffs, NJ. p. 177

EcoEngineering Consultants Limited. *Environmental Impact Assessment for Desalination Plant at Point Lisas*, Eco Report No 2/1999, Addendum 2 to the EIA report, TCPD Ref: T5Q 1667199, 21 June, 2000.

EcoEngineering Consultants Limited. 2005. *Environmental Study for a Possible Industrial Estate at Point Lisas (South and East) Extension* (ECO Report No. 32/2005). Reported in Essar Steel Caribbean Limited, *Environmental Impact Assessment Study for the Proposed Steel Complex of Essar Group at Point Lisas, Trinidad and Tobago*.

EcoEngineering Consultants Limited. The National Gas Company of Trinidad and Tobago Limited. *Environmental Impact Assessment for the 36-inch Natural Gas Pipeline Loop to Ring Main Project*, 2 August, 2006.

EIS (Earth Investigation Systems) Limited. *CariSal Calcium Carbide Plant Point Lisas, Geotechnical Investigation Report*, July, 2007.

Elkington, J. 1999. **Cannibals with Forks: The Triple Bottom Line of 21st Century Business.** Capstone Publishing, Oxford.

EMA (Trinidad and Tobago Environmental Management Authority), 2001. Noise Pollution Control Rules, 2001: First Schedule – Prescribed Standards.

FAO, 1998. *World Reference Base for Soil Resources*, Rome: Food and Agriculture Organization of the United Nations.

FAO (Food and Agriculture Organization of the United Nations). *Land Resources Information Systems in the Caribbean*: Proceedings of a Subregional Workshop held in Bridgetown, Barbados 2–4 October, 2000.. ISBN 92-5-104624-7. http://www.fao.org/docrep/004/Y1717E/y1717e00.HTM, accessed December, 2007.

FAO (Food and Agriculture Organization of the United Nations). *Gateway to Land and Water Information*. **Trinidad and Tobago Country Report**, compiled by R. Bryce. http://www.procicaribe.org/networks/clawrenet/reports/z_tt/tttb243.htm, accessed 30 November, 2005.

Ford, M. *WASA Targeting Two Desalination Plants* – Trinidad & Tobago, **Business News Americas**, 31 August, 2007.

Frondel, M., Horbach, J., and Rennings, K. 2004. *End-of-Pipe or Cleaner Production: An Empirical Comparison of Environmental Innovation Decisions across OECD Countries.* Center for European Economic Research, Discussion Paper # 04-82.

FTA (U.S. Federal Transit Administration), 2006. *Transit Noise and Vibration Impact Assessment*. FTA-VA-90-1003-06. http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf

Gemert, L.J. Van and A.H. Nettenbreijer. *Compilation of Odor Threshold Values in Air and Water*. CIVO-TNO, Netherlands (1977).

Gemert, L.J. Van. *Compilation of Odor Threshold Values in Air, Supplement IV*, CIVO-TNO, Zeist, Netherlands (1982).

Hanna, S.R., Chang, J.C., and Strimaitis, D.G. *Hazardous Gas Model Evaluation with Field Observations*. **Atmospheric Environment** 27A(15), 2265–2285, 1993.

Hardy, F. 1974. *Land Capability Survey of Trinidad and Tobago*, No. 6. Trinidad – Land Capability.

Hayes, F.E., White, G., Kenefick, M., and Kilpatrick, H. *Seasonal Variation in Gull Populations along Trinidad's West Coast*, Trinidad and Tobago. **Living World**, **J**. Trinidad & Tobago Field Naturalists' Club 2004:3–5, 2004.

IMA (Institute of Marine Affairs). 1981. *Point Lisas Environmental Protection Project, Flora of the Gulf of Paria Coast of Trinidad from Couva to Claxton Bay – Volume III.*

International Association of Impact Assessment. *Social Impact Assessment: International Principles*. Special Publication Series, Fargo, ND, USA: IAIA, No. 2. May., 2003.

Jacangelo, J.G. "Desalination as an Alternative for a New Water Supply." Presented at the IWA World Water Congress and Exhibition, Beijing, China. 10-14 September, 2006.

JARIC Environment Safety and Health Services Ltd. CariSal Point Lisas Development *Biological Reconnaissance Survey Report*. Submitted to CariSal Limited, 15 November, 2007.

JARIC Environment Safety and Health Services Ltd. CariSal Point Lisas Development *Plot of Wetland Boundary Report*. Submitted to CariSal Limited, 2 June, 2008.

Kaizen Environmental Services Limited. *Baseline Ground Water Quality Monitoring Report*, 28 August, 2007.

Kaizen Environmental Services Limited. *Baseline Ground Water Quality Monitoring Report*, 13 November, 2007.

Kaizen Environmental Services Limited. *Environmental Noise Monitoring At CariSal*, Report, July, 2007.

Kent, J.A. 1993. **Riegel's Handbook of Industrial Chemistry, 9th Edition**. New York: Van Nostrand Reinhold (Ed.).

Lindahl, P. "Plume Abatement Wet Cooling Towers and Drift Eliminator PM10 Performance." Presentation Delivered at san Diego Air and Waste Management Association conference: *Dry Cooling for Power Plants: Is This the Future?,* San Diego, CA, USA. 31 May, 2002.

Macpherson, J. 1982. **Caribbean Lands – A Geography of the West Indies**. Fourth Edition. 200 pp.

Marshall, R.C. 1939. **Silviculture of the Trees of Trinidad and Tobago, British West Indies**. Oxford: Oxford University Press. 247 pp.

Mathie, A. and Gord C. *From Clients to Citizens: Asset-Based Community Development As A Strategy For Community-Driven Development*. Occasional Paper Series No. 4, January 2002. St. Francis Xavier University, Nova Scotia. *See also Kretzmann, J. & McKnight, J. 1993. Building Communities From the Inside Out. ACTA Publications. Chicago, IL.*.

McShine-Mutunhu, H. 1986. *Couva River Diversion: A Problem in Environmental Planning. As referenced in Caribbean Seminar on Environmental Impact Assessment – Case Studies*. The Canadian International Development Agency (Eds., K. Wagner and K. Turner) pp. 58 – 72; and Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007. Westlake Trinidad Unlimited, *EIA for the Proposed Ethylene and Polyethylene Complex, Point Lisas.*

Ministry of Agriculture, 1994. *Land and Marine Resources*. 1994 Aerial Photographs.

Morrison, R.I.G., and Ross, R.K. 1989. *Atlas of Neartic Shorebirds on the Coast of South America*. Canadian Wildlife Services Special Publication. Ottawa, Canada.

Murphy, J.C. 1997. **Amphibians and Reptiles of Trinidad and Tobago**. Malabar, Florida: Krieger Publishing Company.

National Wetlands Committee, 2002. *National Policy and Programmes on Wetland Conservation for Trinidad and Tobago*. http://www.ramsar.org/wurc/wurc_policy_trinidad.htm, accessed 13 November.

Nelson, H.P. 2005. *Tropical Forest Ecosystems of Trinidad: Ecological Patterns and Public Perceptions* [PhD dissertation], University of Wisconsin – Madison.

NOAA (National Oceanic and Atmospheric Administration), 2007. *Costal Services Center Historical Hurricane Tracks*. http://maps.csc.noaa.gov/hurricanes/viewer.html.

OutdoorsTrinidad.com. *Outdoors Trinidad – Popular Fishing Places in Trinidad*. http://www.trinoutdoors.com/pages/popular_fishing.htm, accessed 19 December, 2007.

Phillip, D.A.T., and Ramnarine, I.W., 2001. *An Illustrated Guide to the Freshwater Fishes of Trinidad*. Joint Publication of The Darwin Initiative for the Survival of Species, UK, and The University of the West Indies, Trinidad.

Rapid Environmental Assessments (2003) Limited and SAGE Environmental Consulting, LP. 2007. Westlake Trinidad Unlimited, *EIA for the Proposed Ethylene and Polyethylene Complex, Point Lisas.*

Regulated Industries Commission, *Review of the Status of the Water and Sewerage Authority (WASA)*, ER/002/2005, March, 2005.

Remsen, J.V., Cadena, C.D., Jaramillo, A., Nores, M., Pacheo, J.F., Robbins, M.B., Schulenberg, T.S., Stiles, F.G., Stotz, D.F., and Zimmer, K.J. 2007. *A Classification of the Bird Species of South America*. American Ornithologists' Union, South American Classification Committee. http://www.museum.lsu.edu/~Remsen/SACCBaseline.html.

Republic of Trinidad and Tobago House of Representatives, Parliamentary Debate, House of Representatives Debate, 28 April, 2000.

Republic of Trinidad and Tobago, *The Environmental Management Act 2000, Draft Air Pollution Rules. 2005.*

Republic of Trinidad and Tobago, *The Water Pollution Rules 2001, amended by the Water Pollution (Amendment) Rules 2006.*

Rodriguez, G.E., "Solving Trinidad and Tobago's Water Supply Problems Through the Establishment of Additional Desalination Plants – Practical Solution?" Presentation at the Organisation of Caribbean Utility Regultors (OCCUR) 5th Annual Conference, Georgetown, Guyana, 9 November, 2007.

Scott, A., The Trinidad and Tobago Solid Waste Management Company Limited (SWMCOL). Capacity comment made by Mr. Alban Scott in reference to expected quantity of Stage 4 brine mud waste. Meeting between the CariSal Environmental Review Team and SWMCOL officials on16 November, 2007.

SENES Consultants Limited and EPAS Consultants Limited. *Environmental Impact Assessment Study for Proposed Steel Complex at Pt. Lisas, Trinidad and Tobago,* February, 2006.

TRC Environmental Consultants and American Industrial Hygiene Association. 1989. *Odor Thresholds for Chemicals with Established Occupational Health Standards*. Fairfax, VA: American Industrial Hygiene Association.

Trinidad and Tobago Bureau of Standards, 1998. *Standard for Effluent Discharge from Industrial Processes (TTS 547).*

Trinidad and Tobago Secretariat for the Implementation of Spanish. *Spanish Place Names in Trinidad*. Published in the **Trinidad Guardian,** 31 August, 2005. http://www.tradeind.gov.tt/SIS/newspaper%20articles/Spanish%20place%20names%20in%20Trinidad.pdf, accessed 17 December, 2007.

Trinidad and Tobago Water and Sewer Authority, Water Resources Agency, 1989. *Hydrogeological Map of Trinidad*.

Trinidad and Tobago Water and Sewer Authority, Water Resources Agency, 1998. *Specification for the Effluent from Industrial Processes Discharged into the Environment (TTS 547).*

Turner, D.B., 1994. **Turner Workbook of Atmospheric Dispersion Estimates: An Introduction to Dispersion Modeling**. Boca Raton: Lewis Publishers.

United Way, 2006. Community Compass. "Community Assets Inventory" http://www.uwgnh.org/compass/assets.php, accessed 11 May, 2008.

U.S. Department of State. *Consular Information Sheet, Trinidad and Tobago*, Updated 13 April, 2007. http://travel.state.gov/travel/cis_pa_tw/cis/cis_1043.html, accessed December, 2007.

U.S. DOC (Department of Commerce), NOAA National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Guidelines and Principles for Social Impact Assessment.* Prepared by the Interorganizational Committee on Guidelines and Principles of Social Impact Assessment, May, 1994.

U.S. EPA (U.S. Environmental Protection Agency). *Screening Procedures for Estimating the Air Quality Impacts of Stationary Sources, Revised.* Report (EPA-454/R-92-019) released by EPA Office of Air and Radiation: Office of Air Quality Planning and Standards, October, 1992.

U.S. EPA (U.S. Environmental Protection Agency). *Profile of the Inorganic Chemical Industry*. EPA Office of Compliance, Office of Enforcement and Compliance Assurance, Sector Notebook Project, EPA/310-R-95-004, September, 1995.

U.S. EPA (U.S. Environmental Protection Agency), Region 9, *Preliminary Remediation Goals Table*, October, 2004.

U.S. EPA (U.S. Environmental Protection Agency), "Community-Based Watershed Management: Lessons from the National Estuary Program." Handbook. Ref. # EPA 842-B-05-003, February, 2005. http://www.epa.gov/owow/estuaries/nepprimer.

U.S. Federal Transit Administration. 1995. *Transit Noise and Vibration Impact Assessment*. Report DOT T-95-16. April.

U.S. FHWA (U.S. Federal Highway Administration). Roadway Construction Noise Model, User's Guide. 9.0 Construction Equipment Noise Levels and Ranges. FHWA-HEP-05-054, 2006. http://www.fhwa.dot.gov/environment/noise/handbook/09.htm, accessed 11 October, 2007.

Vanclay, F. 2002. *Conceptualising Social Impacts*, **Environmental Impact Assessment Review**, Vol 22, pp. 183 – 211.

Van den Eynden, V., Oatham M.P., and Johnson W. 2007. *How Free Access Web-Based Electronic Resources Can Benefit Biodiversity and Conservation Research in Resource-poor Countries – Trinidad and Tobago's Endemic Plants and Their Conservation Status*. Oryx.

Water Resources Agency, for the Ministry of Environment, 2001. *National Report on Integrating the Management of Watersheds and Coastal Areas in Trinidad and Tobago*.

White, G. *Noteworthy Bird Records*. **Living World**, Journal of the Trinidad and Tobago Field Naturalists' Club 1987 – 1988:42, 1988.

White, G., and Kenefick, *The Avifauna of the Brickfield Mudflats*. **Living World**, Journal of the Trinidad and Tobago Field Naturalists' Club 2004:6–11, 2004.

White, G.L., Kenefick, M., and Murphy, *The Status and Abundance of Birds in Trinidad and Tobago*. Living World, Journal of the Trinidad and Tobago Field Naturalists' Club 2007:57–68, 2007.

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10.0 ENLARGED FIGURES

This section contains enlarged reprints of maps and figures presented previously in the EIA. These are provided to allow the reader to study the maps and figures in more detail as some of them may be difficult to read at the size used in the previous sections. Each figure is labelled with the same figure number and name as the corresponding figure in the text.

There are two types of maps presented in this EIA – those that were generated using a geographic information system specifically for this project, and those which are graphics presented in other source documents and presented to give the reader context rather than relay data used in our analysis. The availability and reliability of geospatial data is improving as the technologies become more widely available. All maps are for illustration purposes only. They do not represent a legal survey. Every effort has been made to ensure that the map data are correct and reliable within the limits of currently available and accessible technology and relevant official data from local authorities or sources. Remote Data Concepts, DaCosta Gwendoline, Limited and ICF International cannot assume liability for any damages or injury caused by any errors or omissions in the data, nor any distortions resulting from map projection methods.

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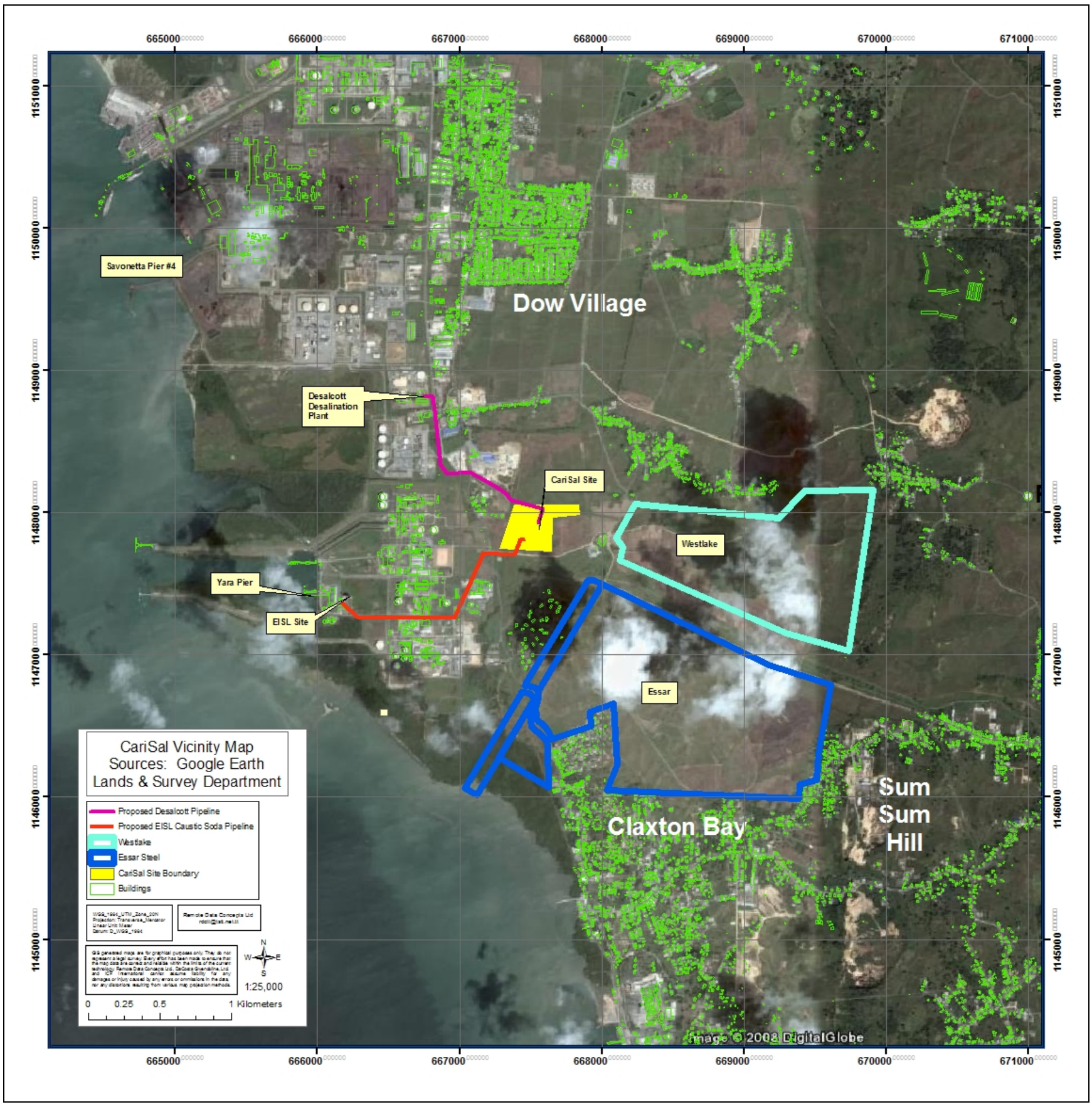


Figure 3.2-1. Vicinity and location of the proposed CariSal site and ex situ pipelines.

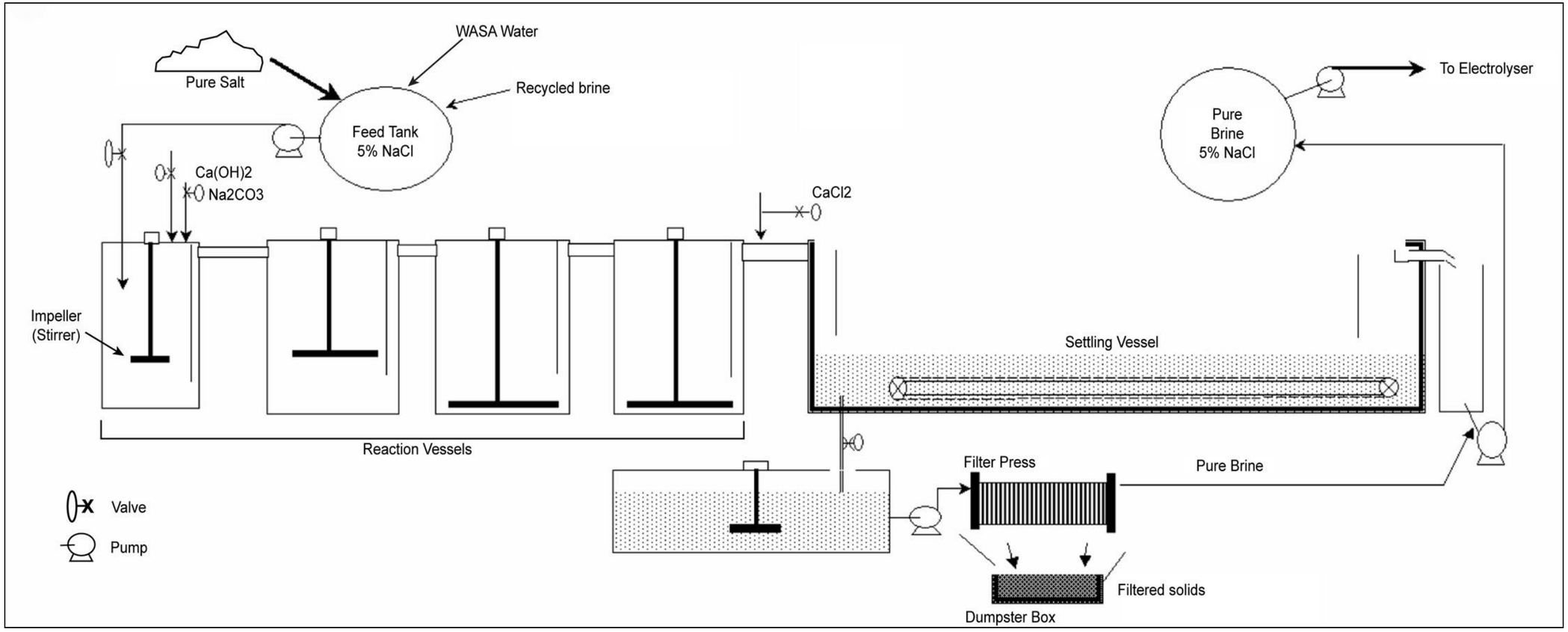


Figure 3.4-1. Brine generation and purification in Stage 1.

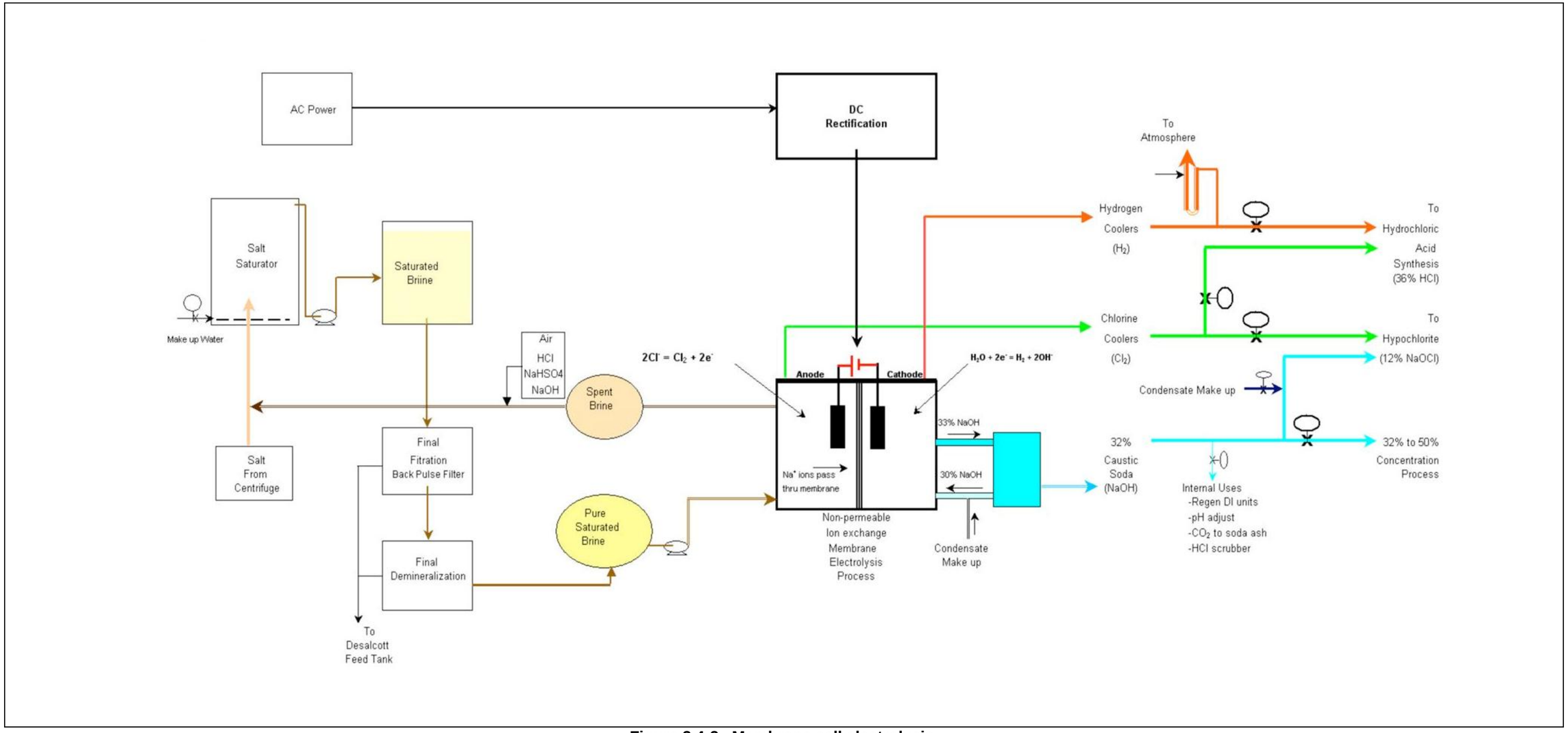


Figure 3.4-2. Membrane cell electrolysis.

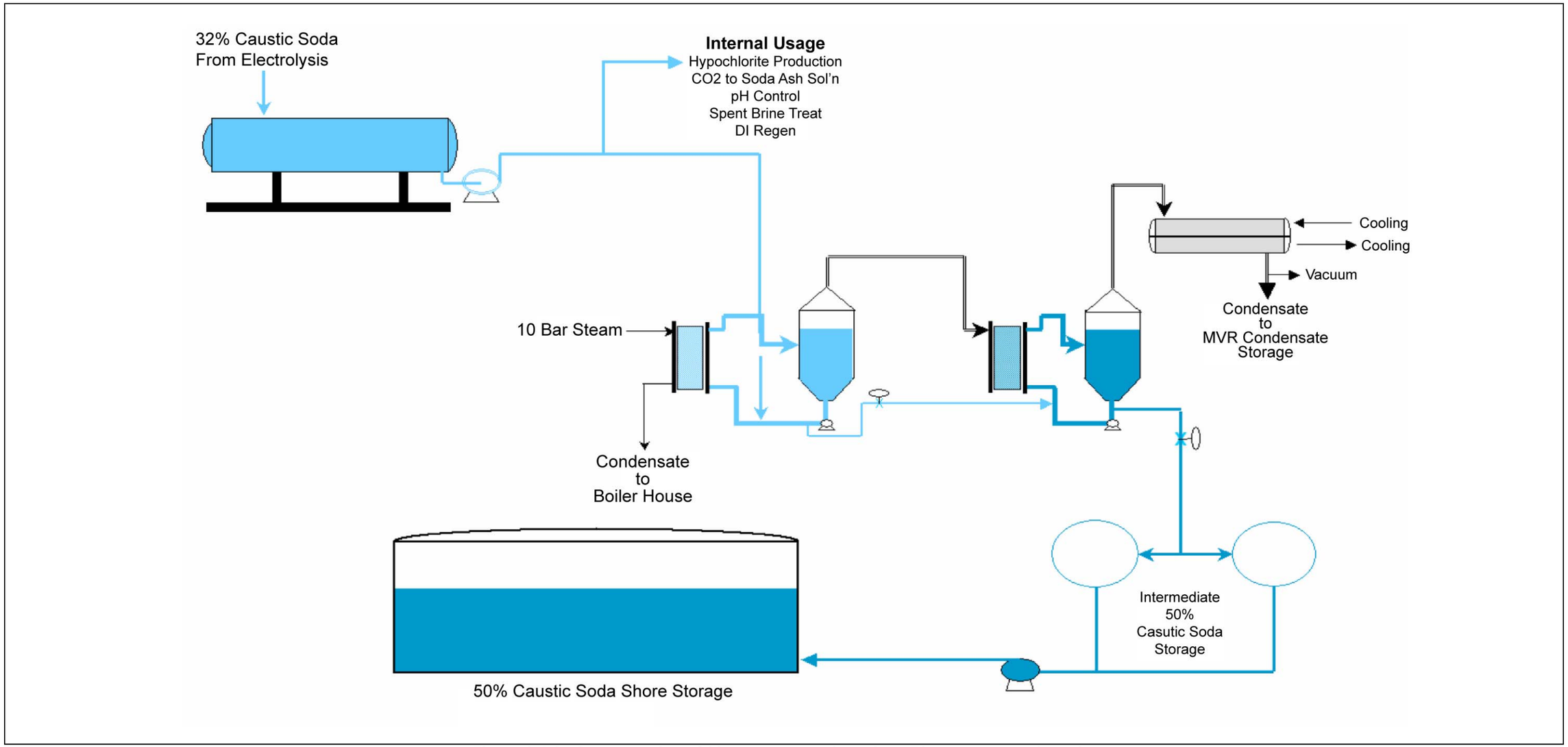


Figure 3.4-3. Concentration of 32-percent caustic soda to 50-percent caustic soda.

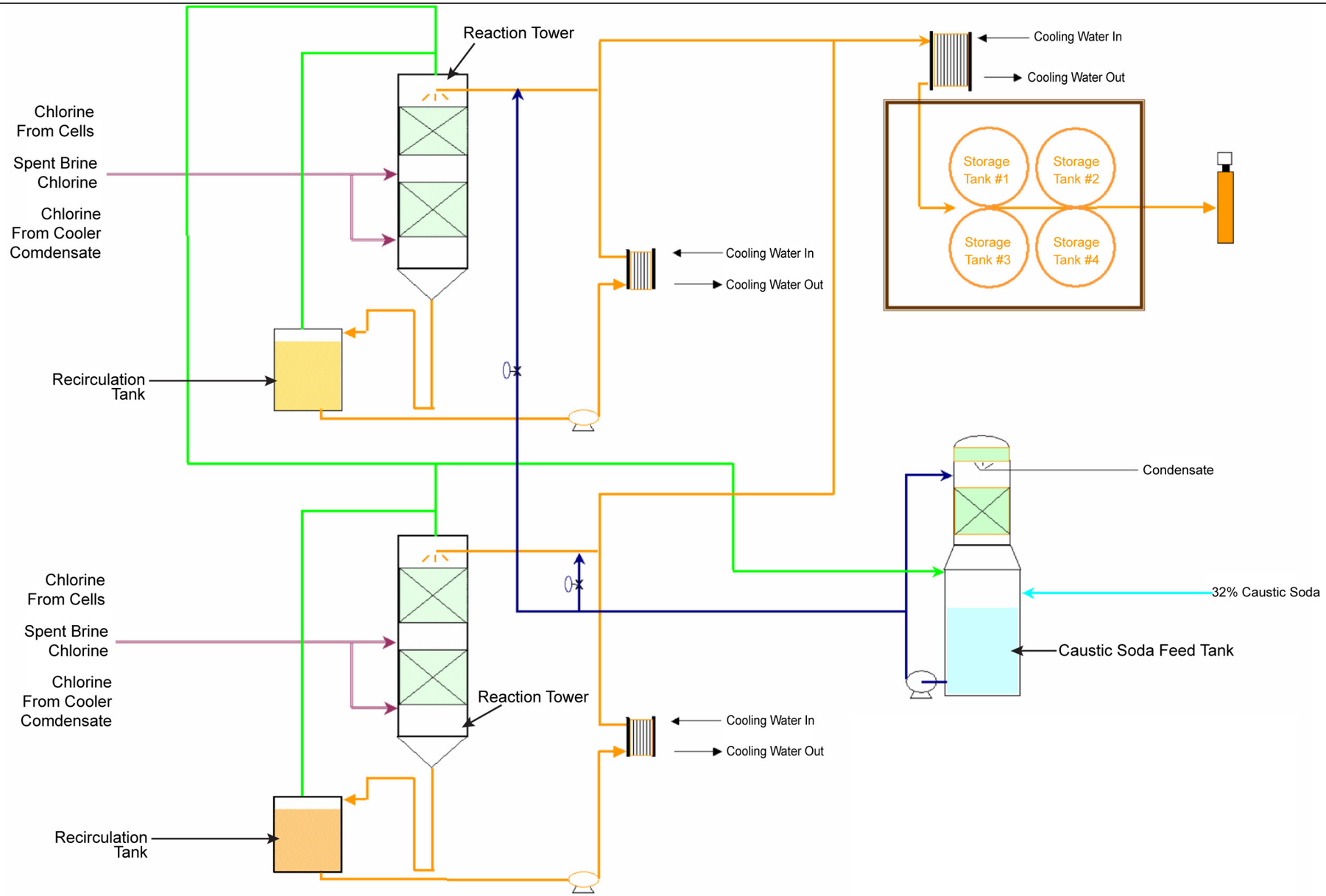


Figure 3.4-4. Generation of 12-percent sodium hypochlorite solution (bleach).

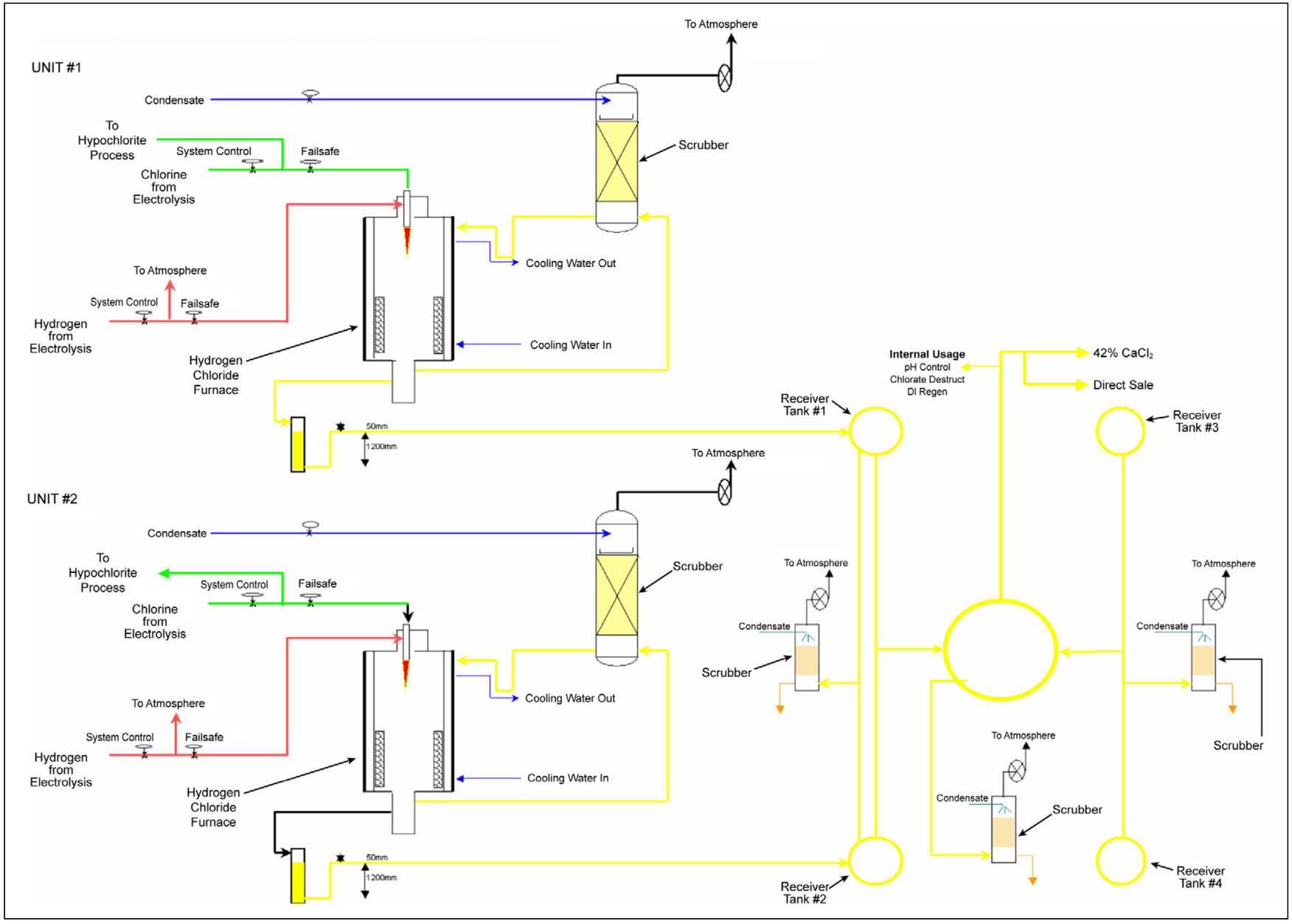


Figure 3.4-5. Generation of 36-percent hydrochloric acid.

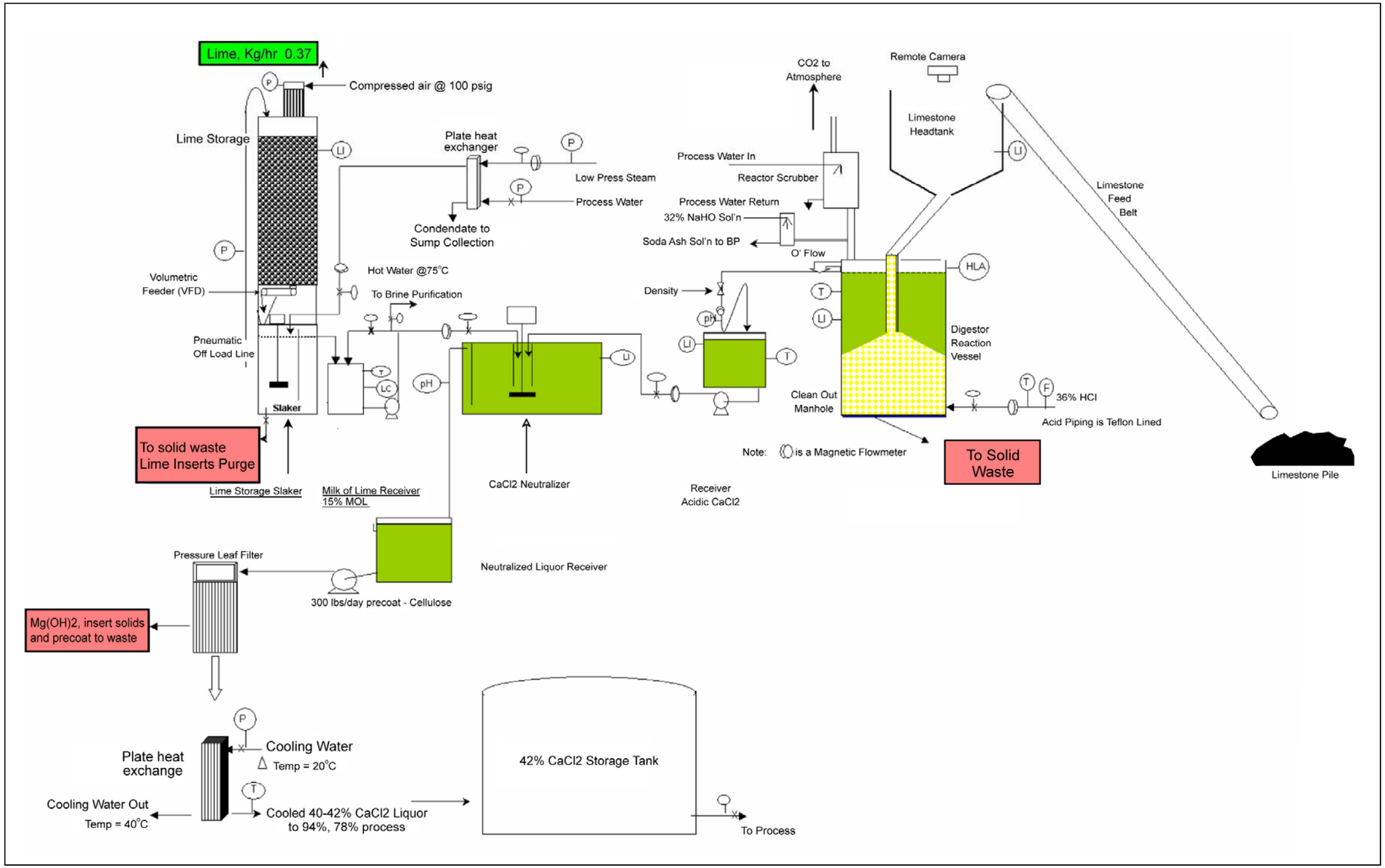


Figure 3.4-6. Generation of 42-percent calcium chloride solution.

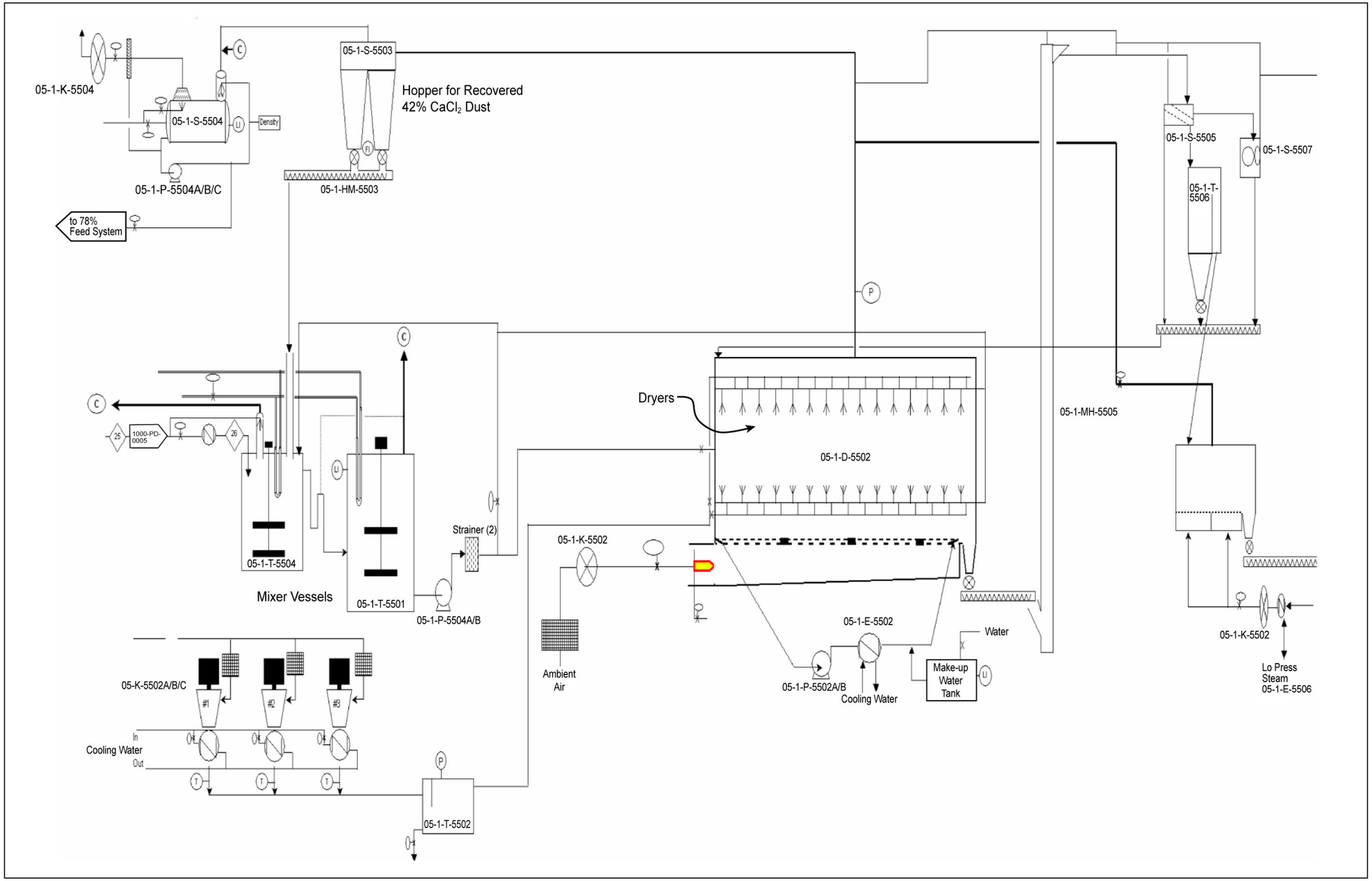


Figure 3.4-7. Production of 94-percent calcium chloride pellets.

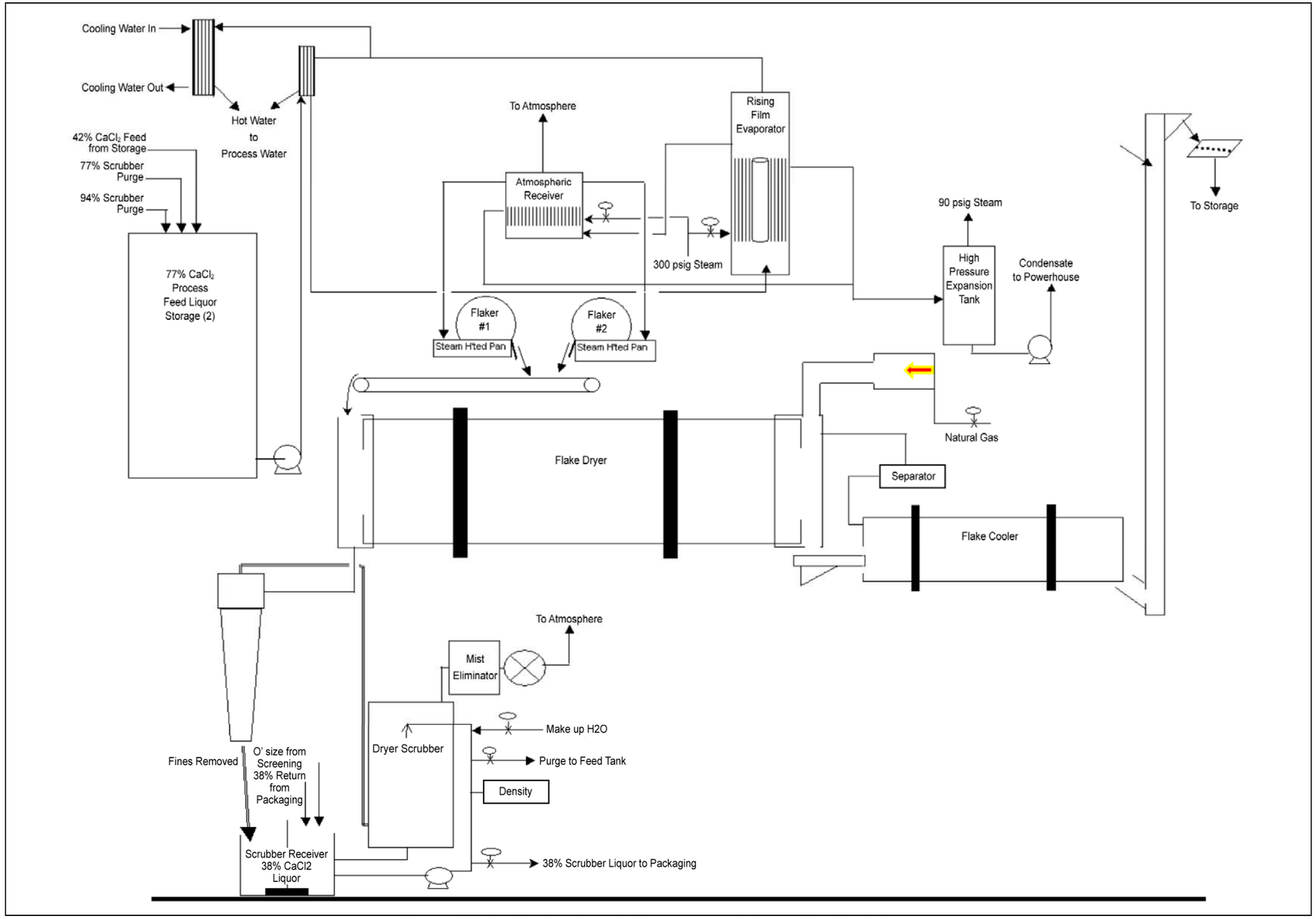


Figure 3.4-8. Production of 77-percent calcium chloride flakes.

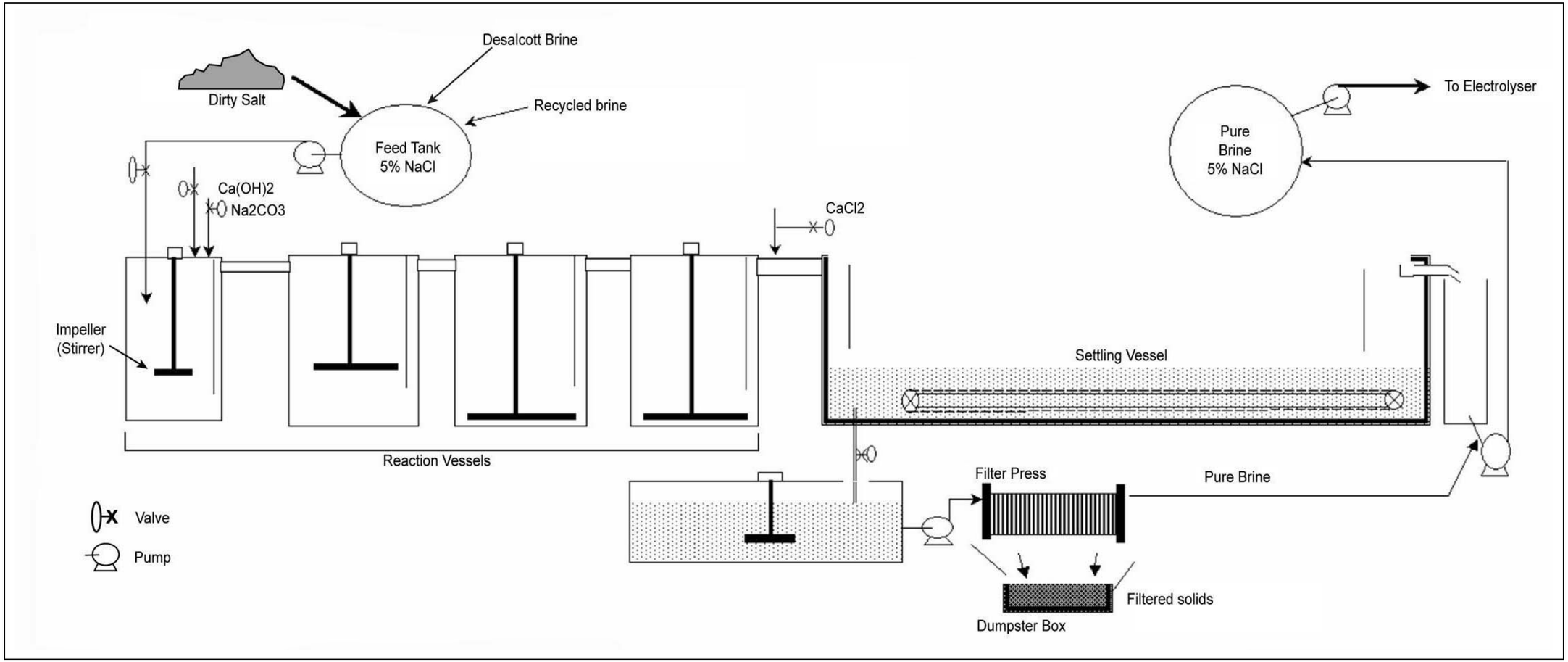


Figure 3.4-9. Brine generation and purification in Stage 2.

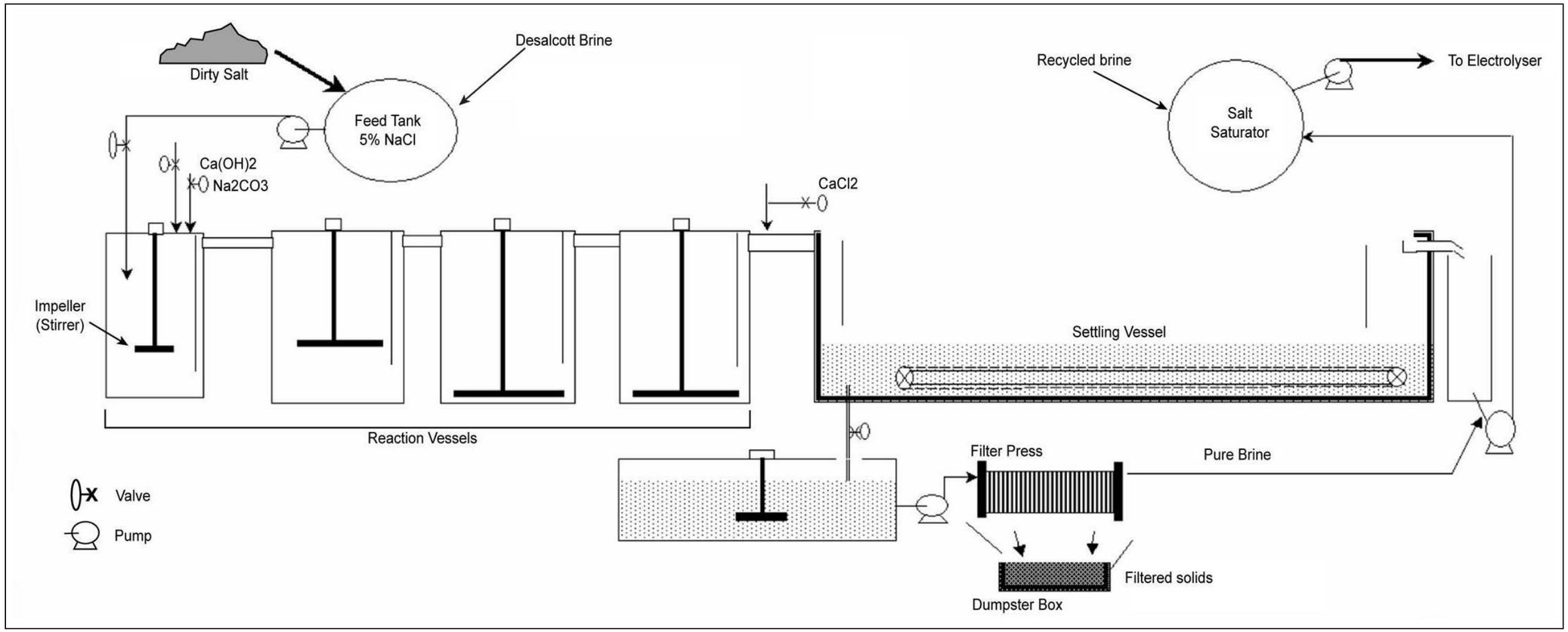


Figure 3.4-10. Brine generation and purification in Stage 3.

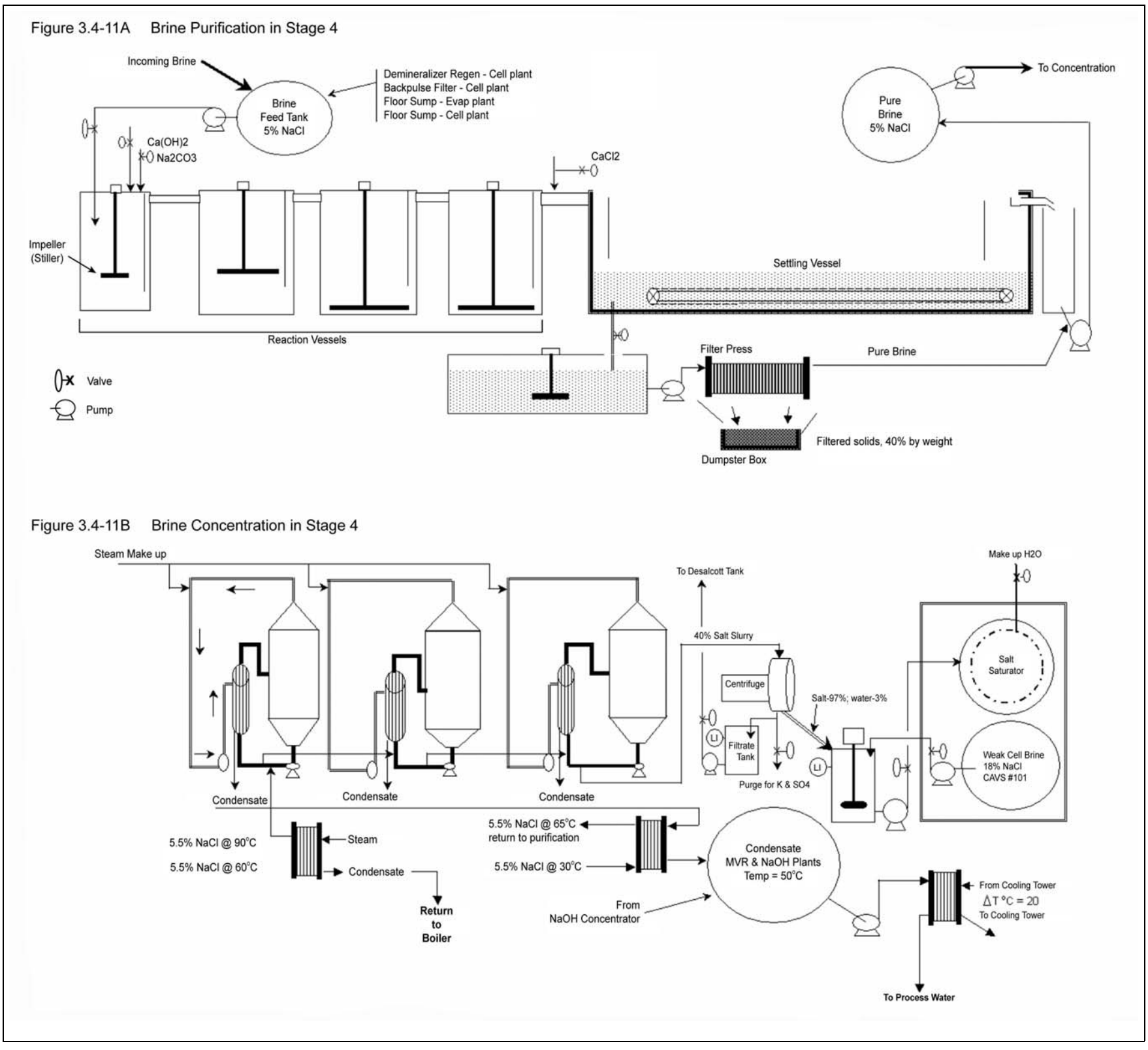


Figure 3.4-11. Brine generation, purification and concentration in Stage 4.

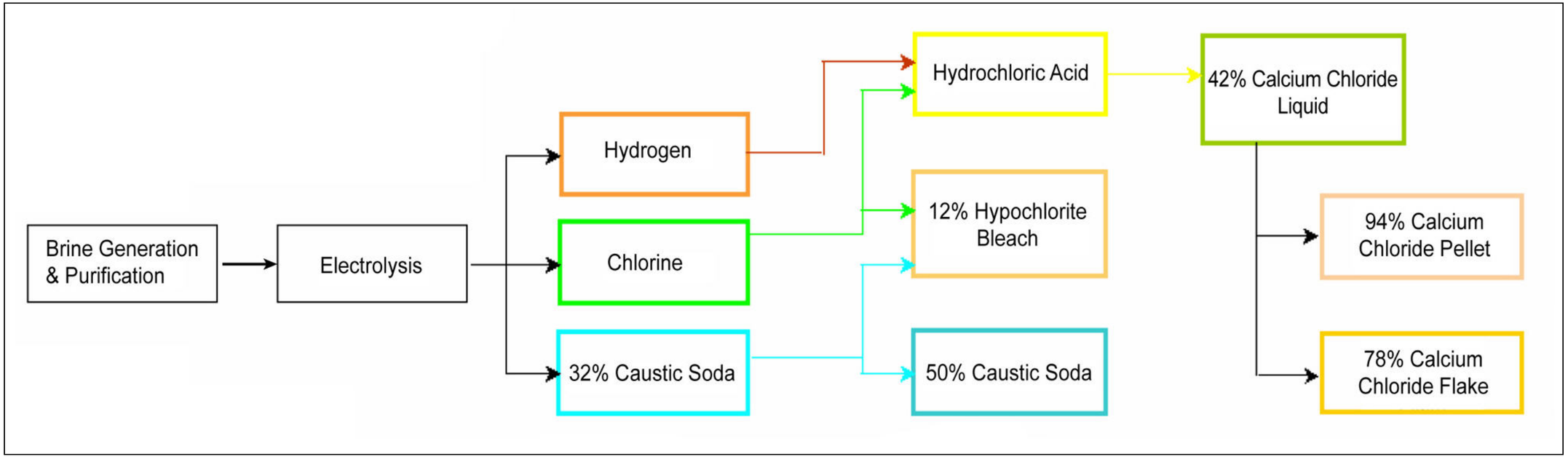


Figure 3.4-12. The CariSal Chlor-alkali process.

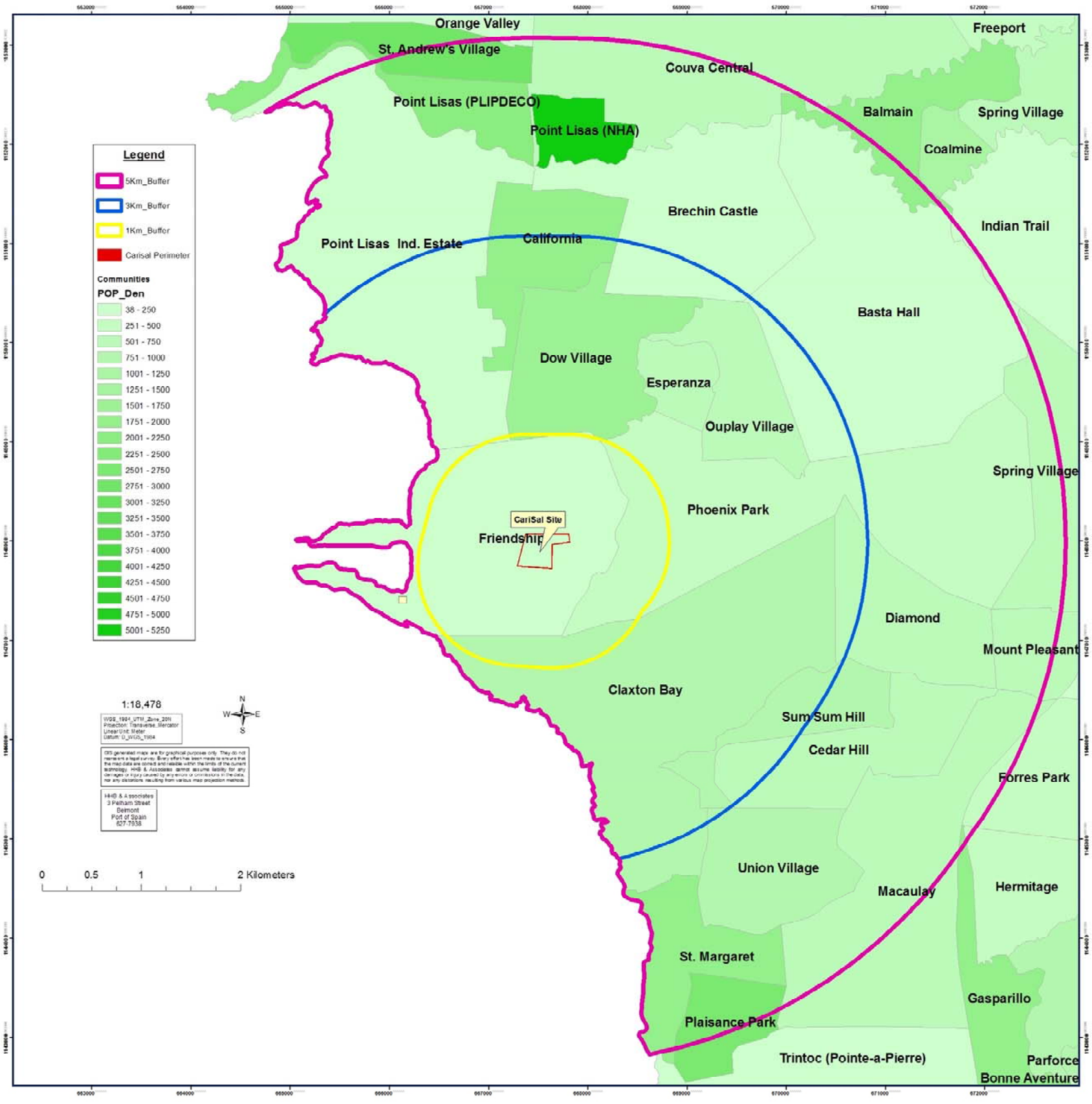
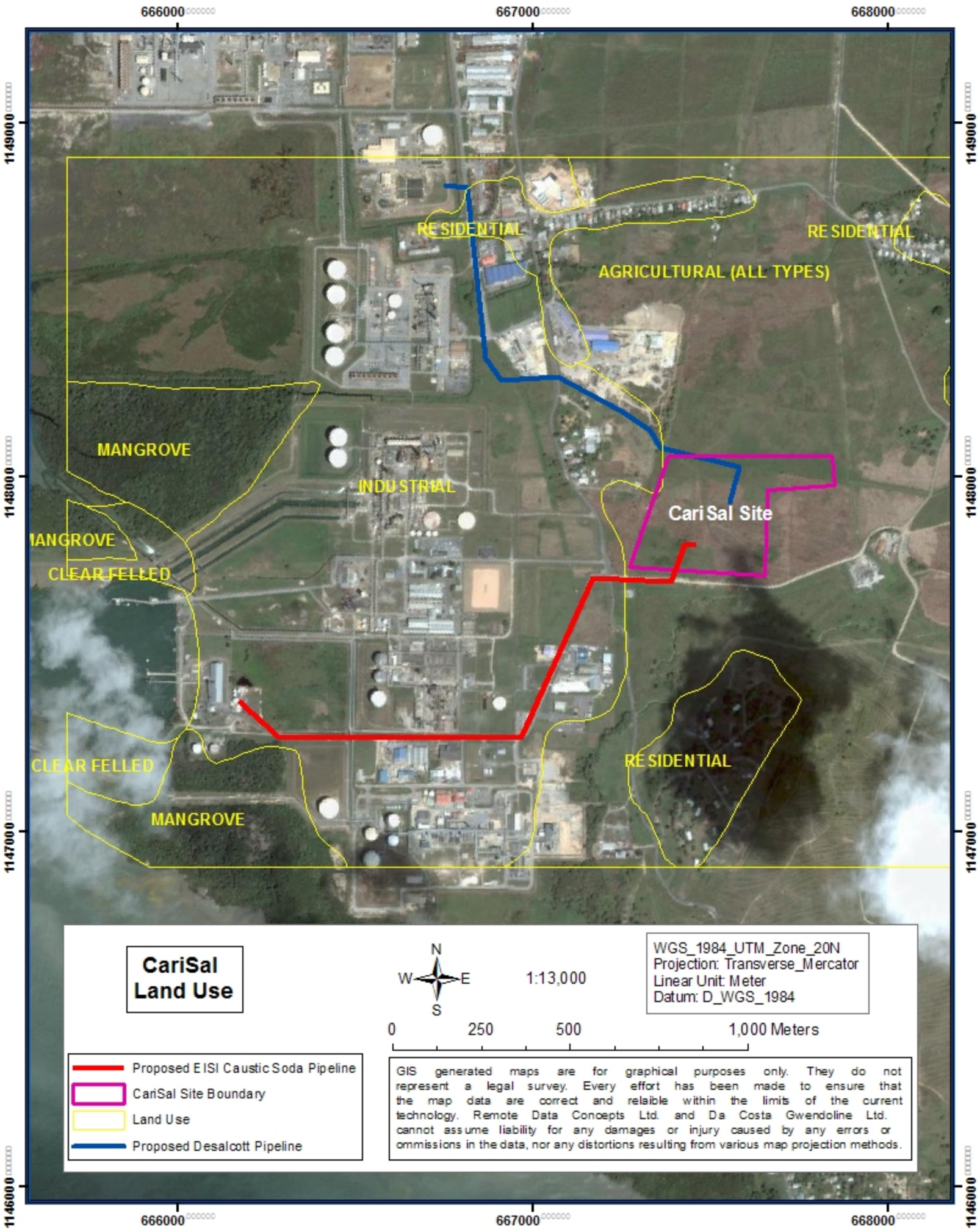
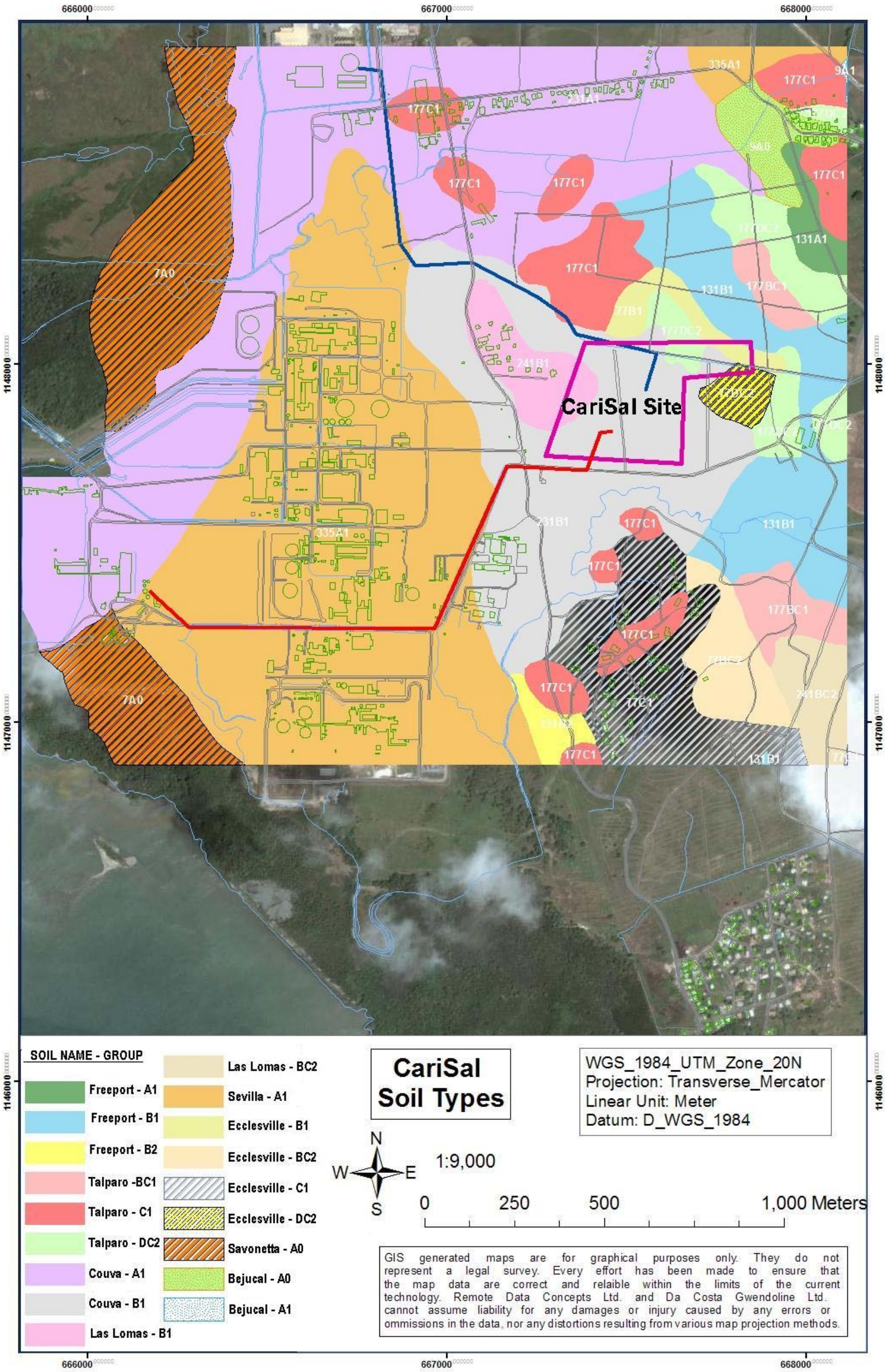


Figure 4.1-1. CariSal Project site and 5-km radius showing population density.



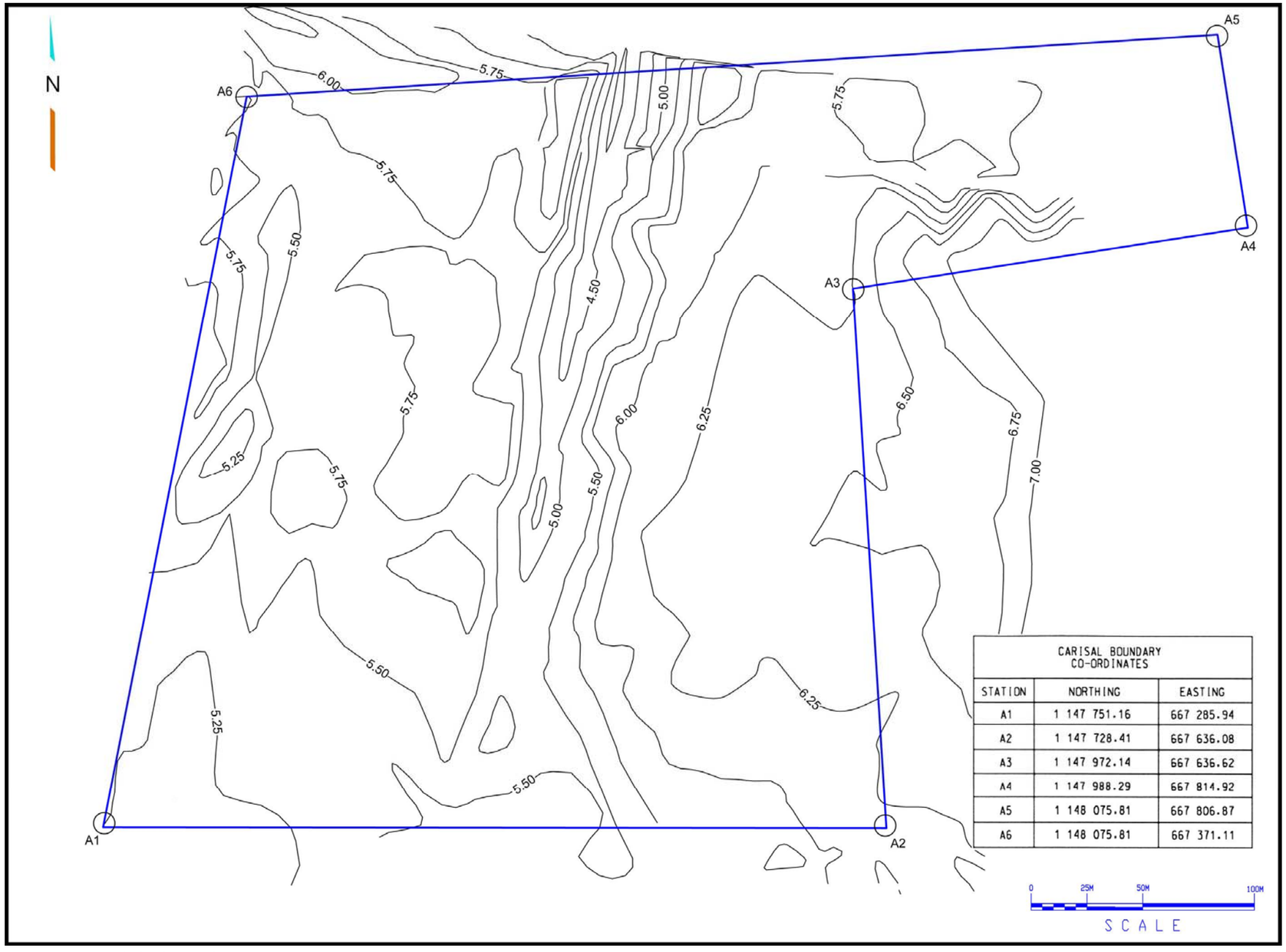
Source: Trinidad and Tobago Ministry of Agriculture

Figure 4.2-2. Land uses in the Project vicinity.



Source: Trinidad and Tobago, Ministry of Agriculture

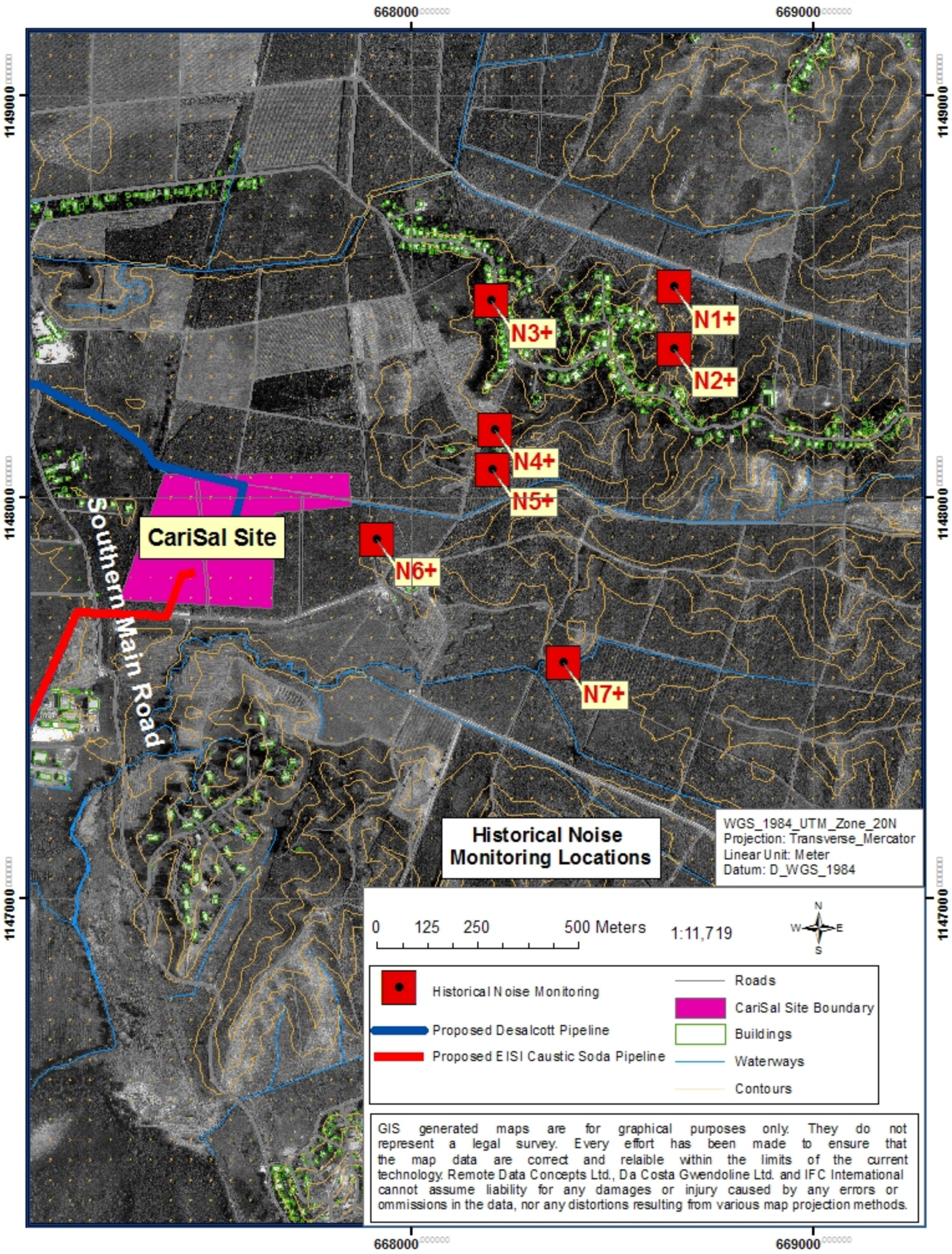
Figure 4.3-6. Soil types and distribution.



CARISAL BOUNDARY CO-ORDINATES		
STATION	NORTHING	EASTING
A1	1 147 751.16	667 285.94
A2	1 147 728.41	667 636.08
A3	1 147 972.14	667 636.62
A4	1 147 988.29	667 814.92
A5	1 148 075.81	667 806.87
A6	1 148 075.81	667 371.11

Source: ABT Engineers & Constructors Limited, Drawing No. CS-000-00100-000

Figure 4.3-8. CariSal site topographic map.



Source: Adapted from EcoEngineering Consultants Ltd. 2005

Figure 4.3-11. Historic noise levels in the study area.

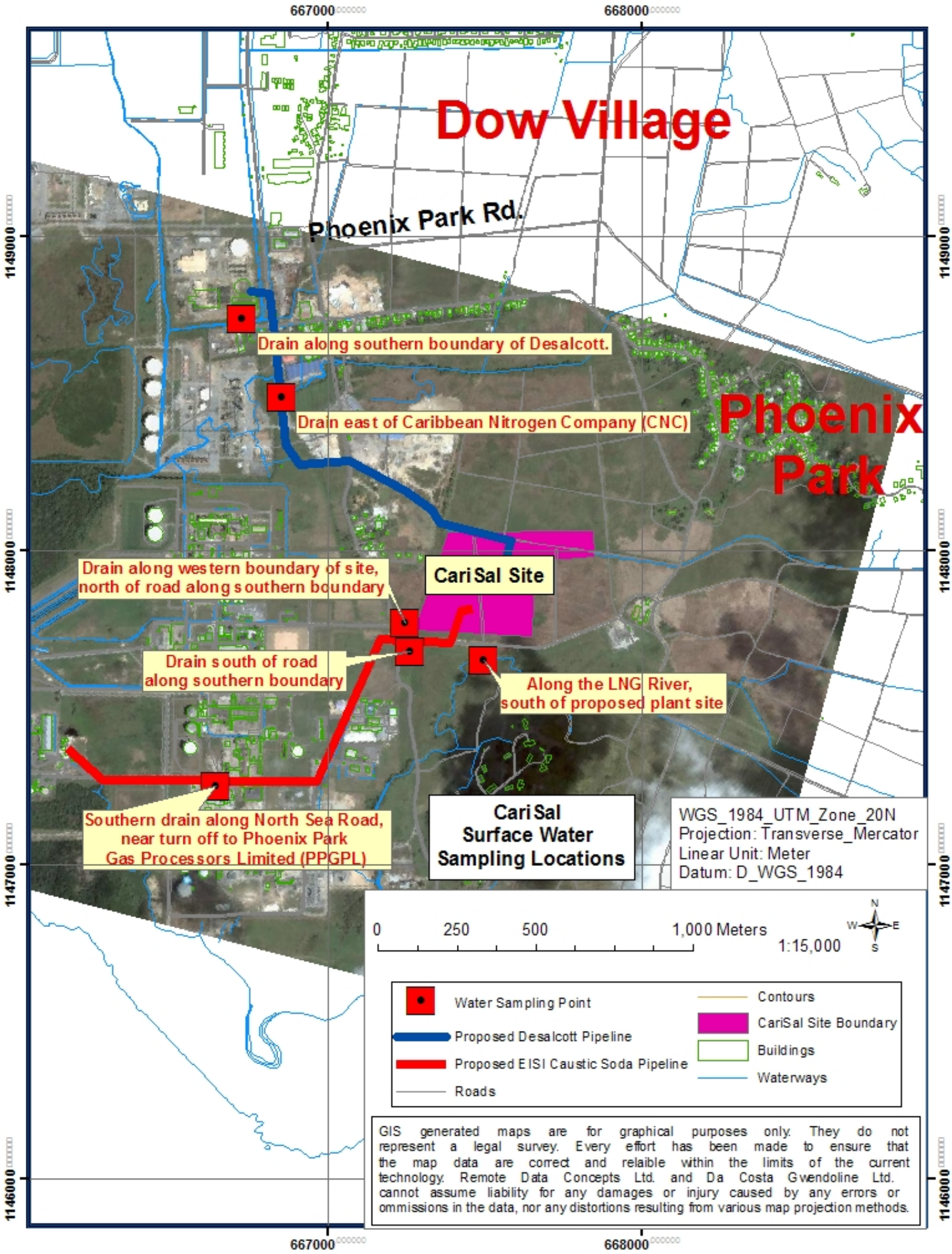
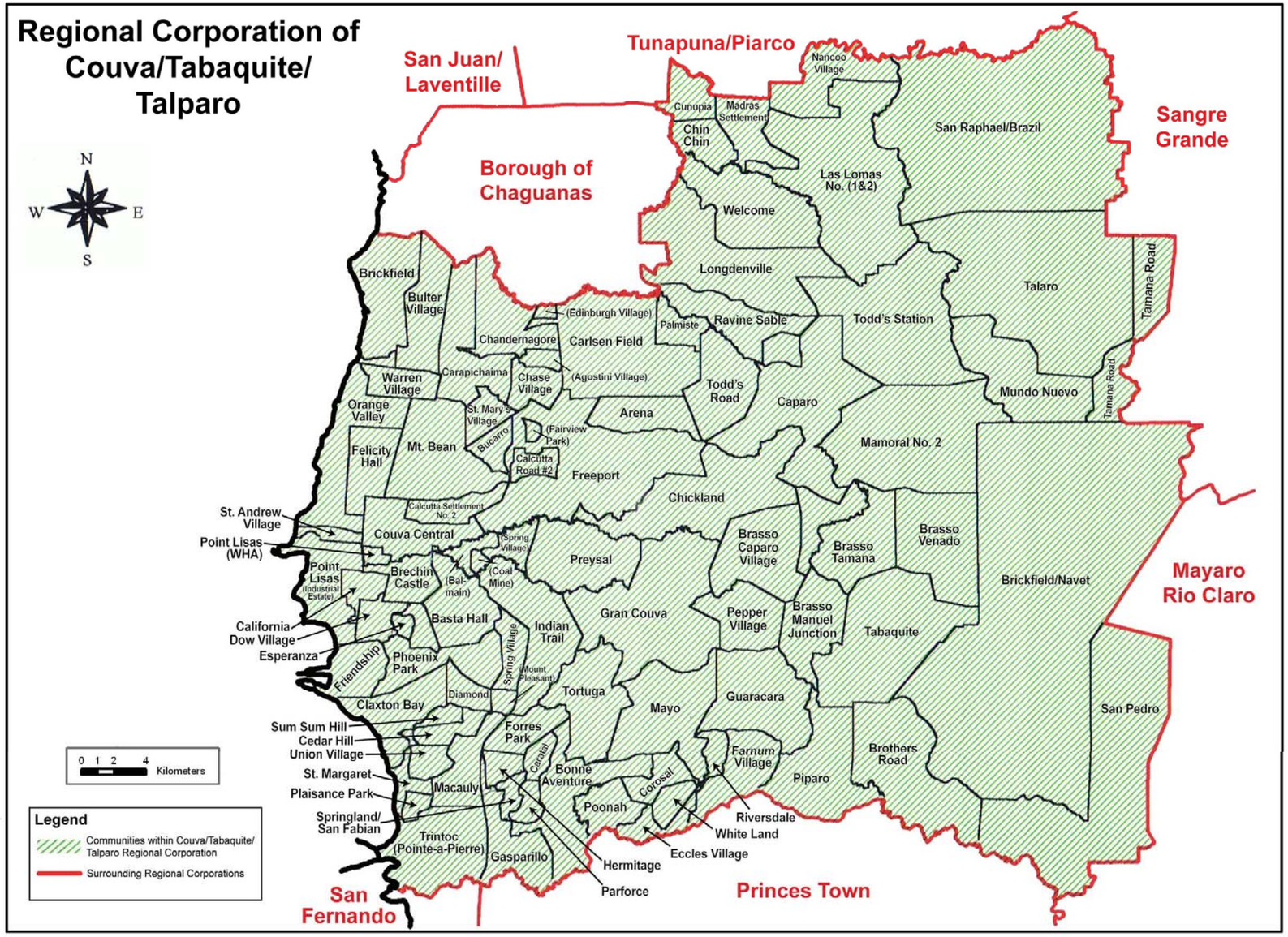


Figure 4.3-15. Surface water monitoring locations.



Source: Central Statistical Office

Figure 4.5-1. Communities surrounding the CariSal facility comprising the Study Area for the socioeconomic assessment

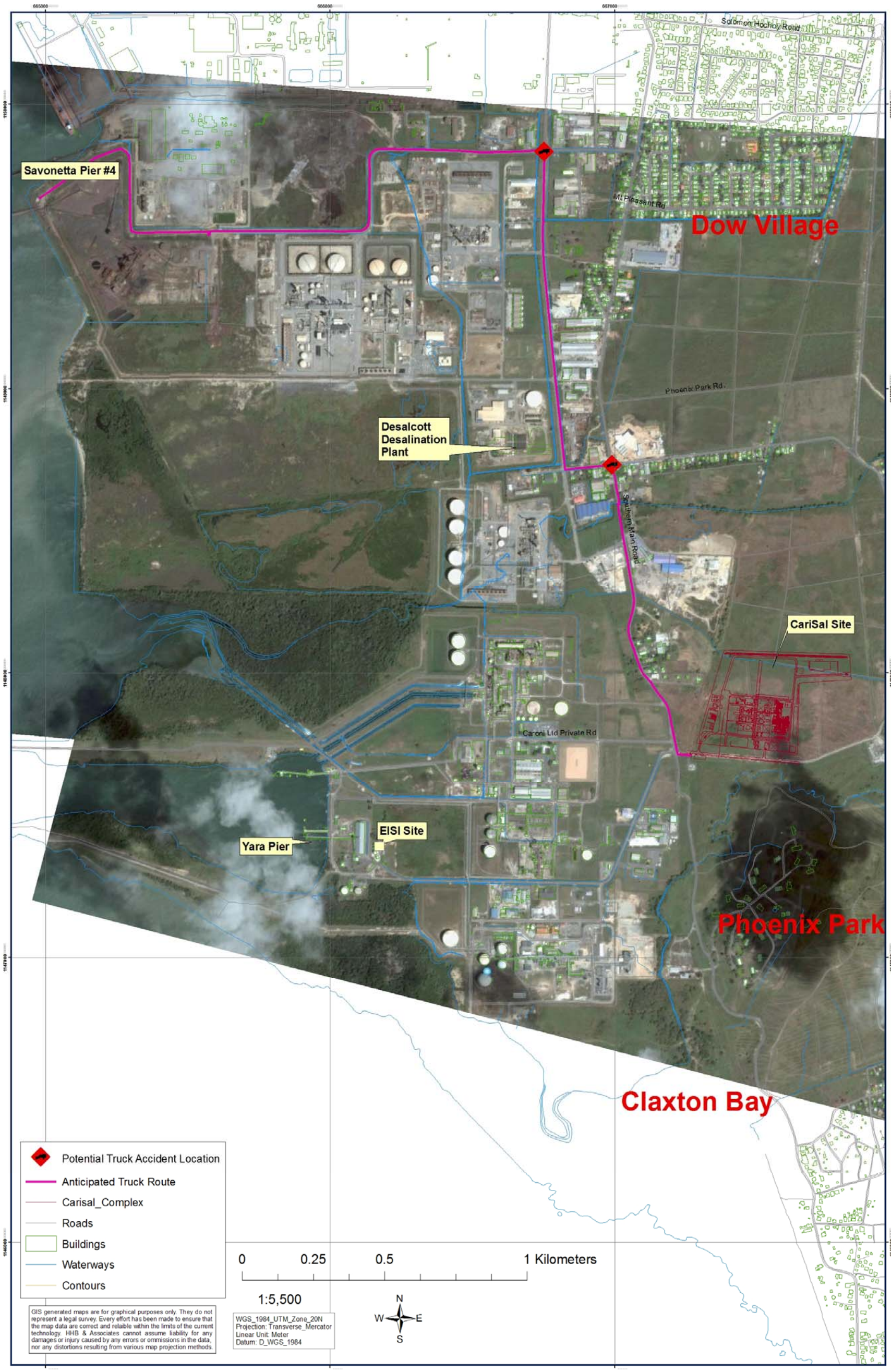


Figure 5.1-1. Transportation Route

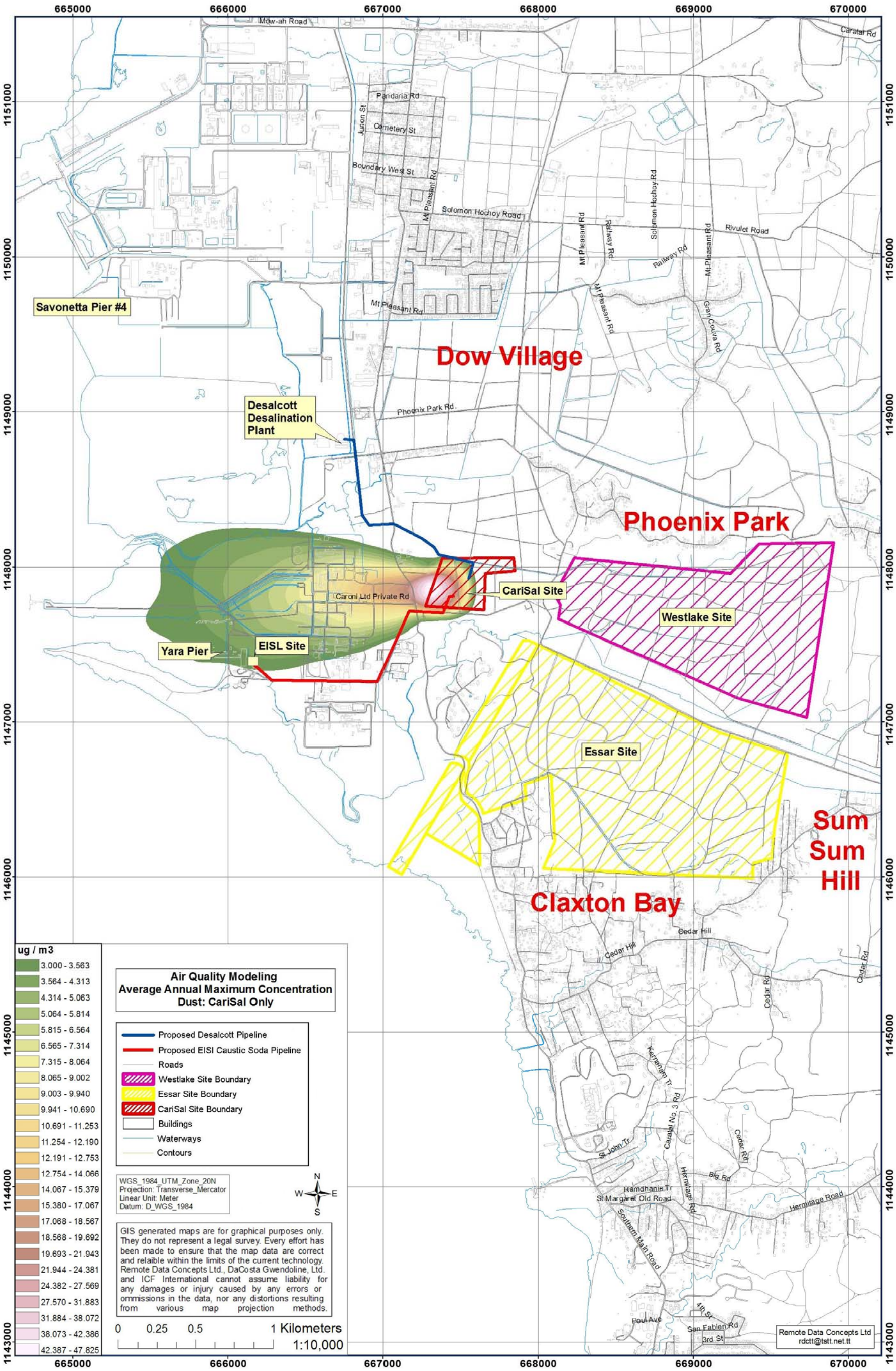


Figure 5.6-1. Average Annual Maximum Concentration of Dust.

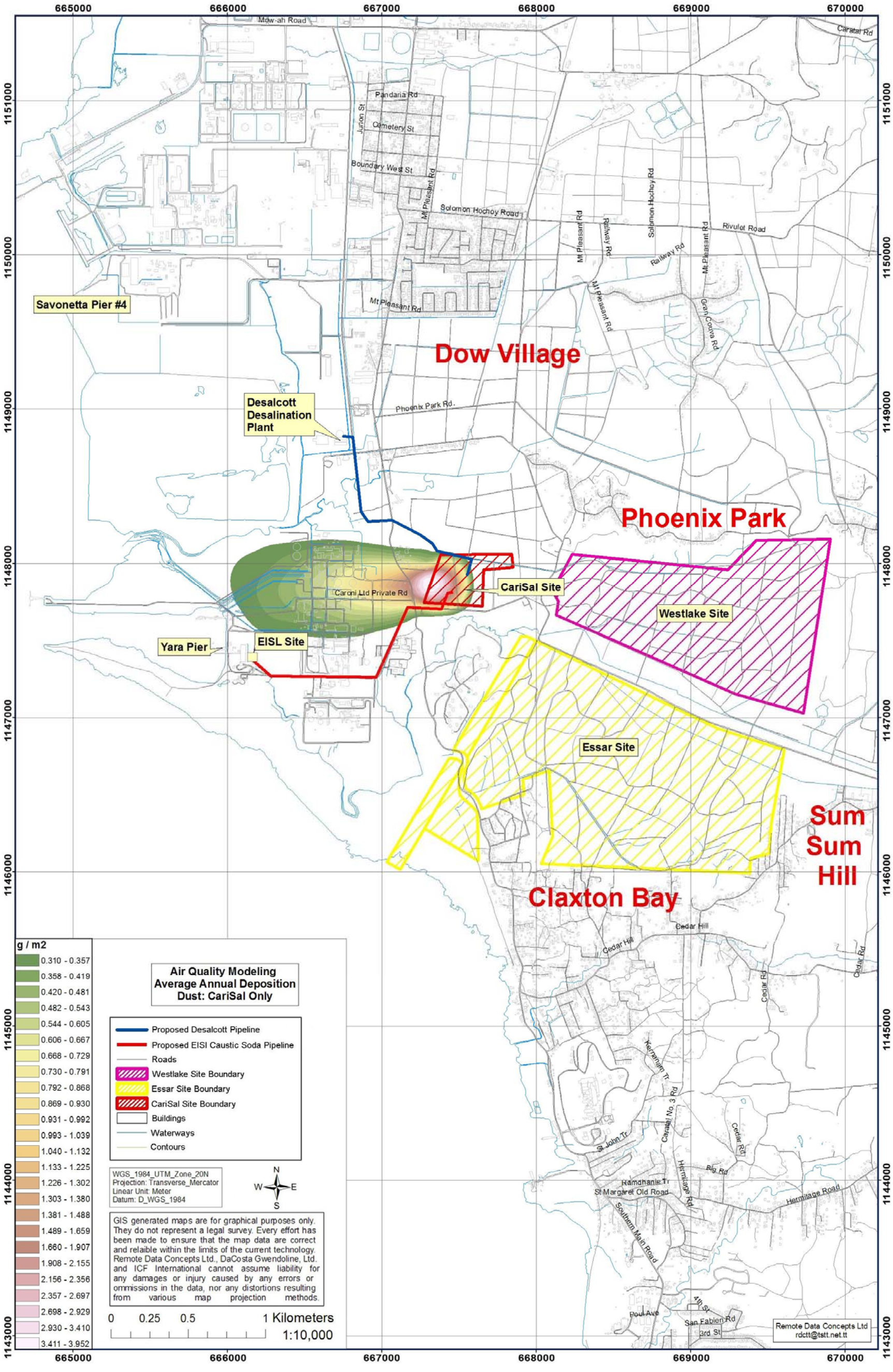


Figure 5.6-2. Average Annual Deposition of Dust.

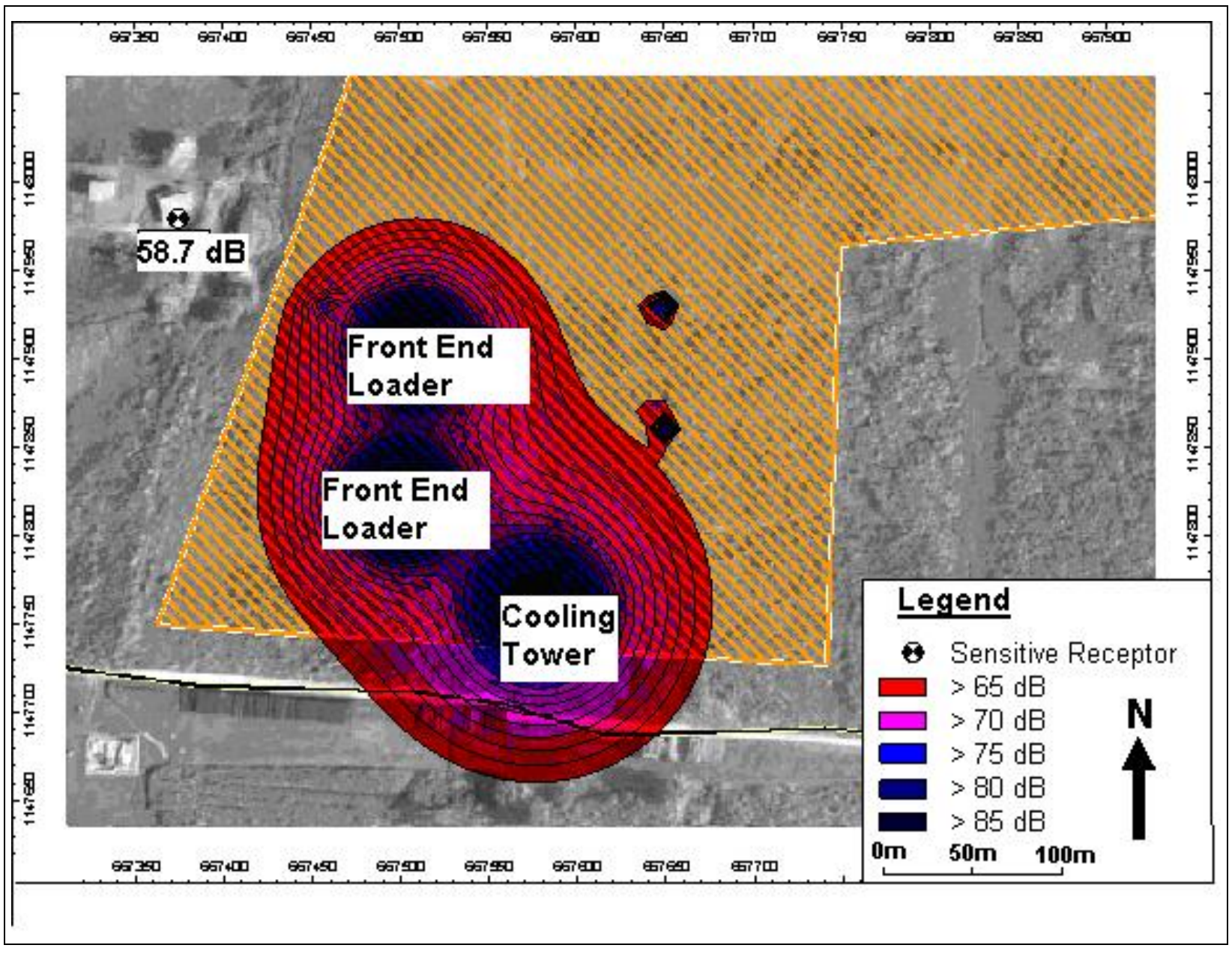


Figure 5.7-1. Plant operation noise contours.

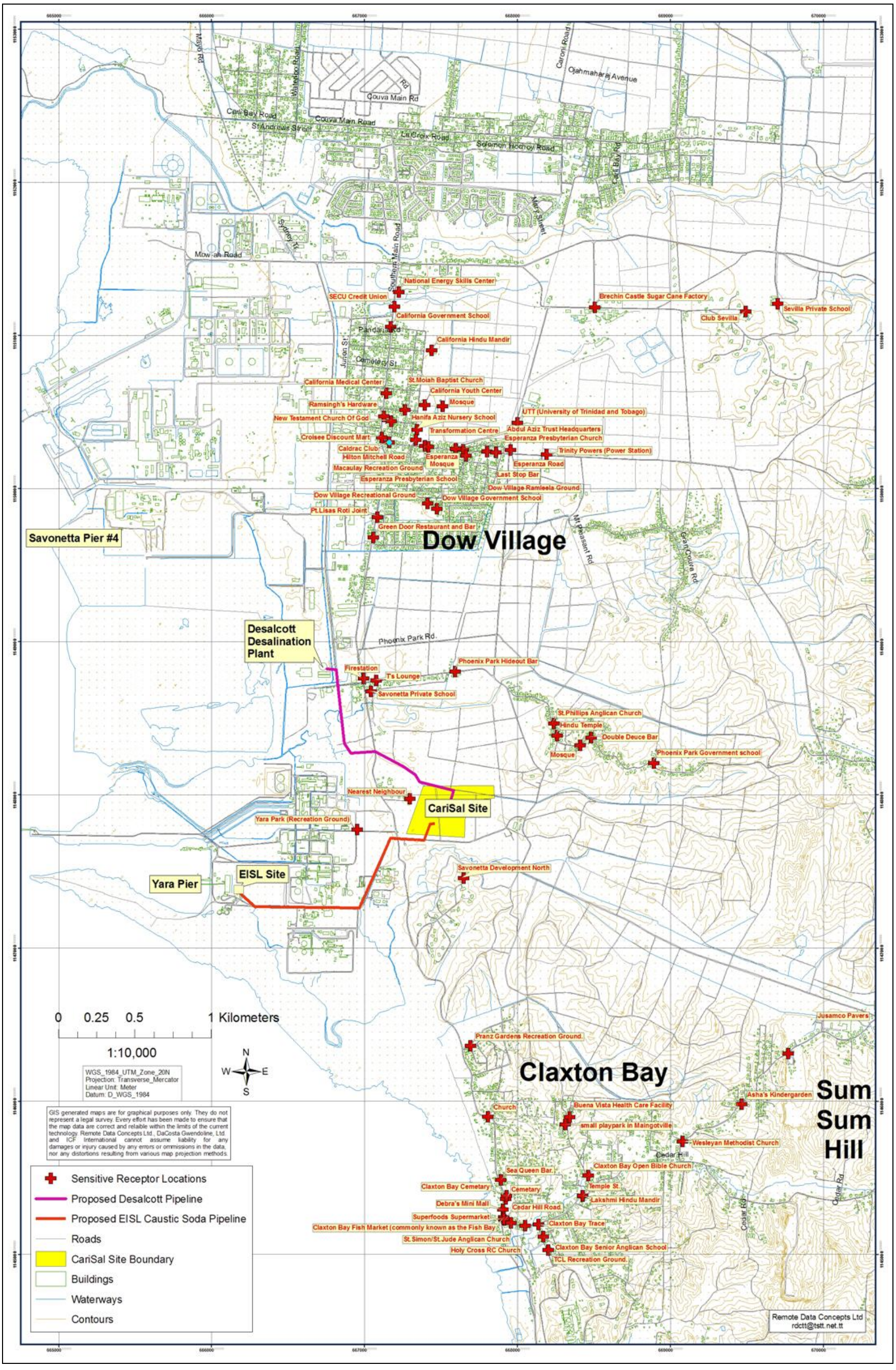


Figure 5.9-2. Sensitive receptor locations in the vicinity of the CariSal Project.

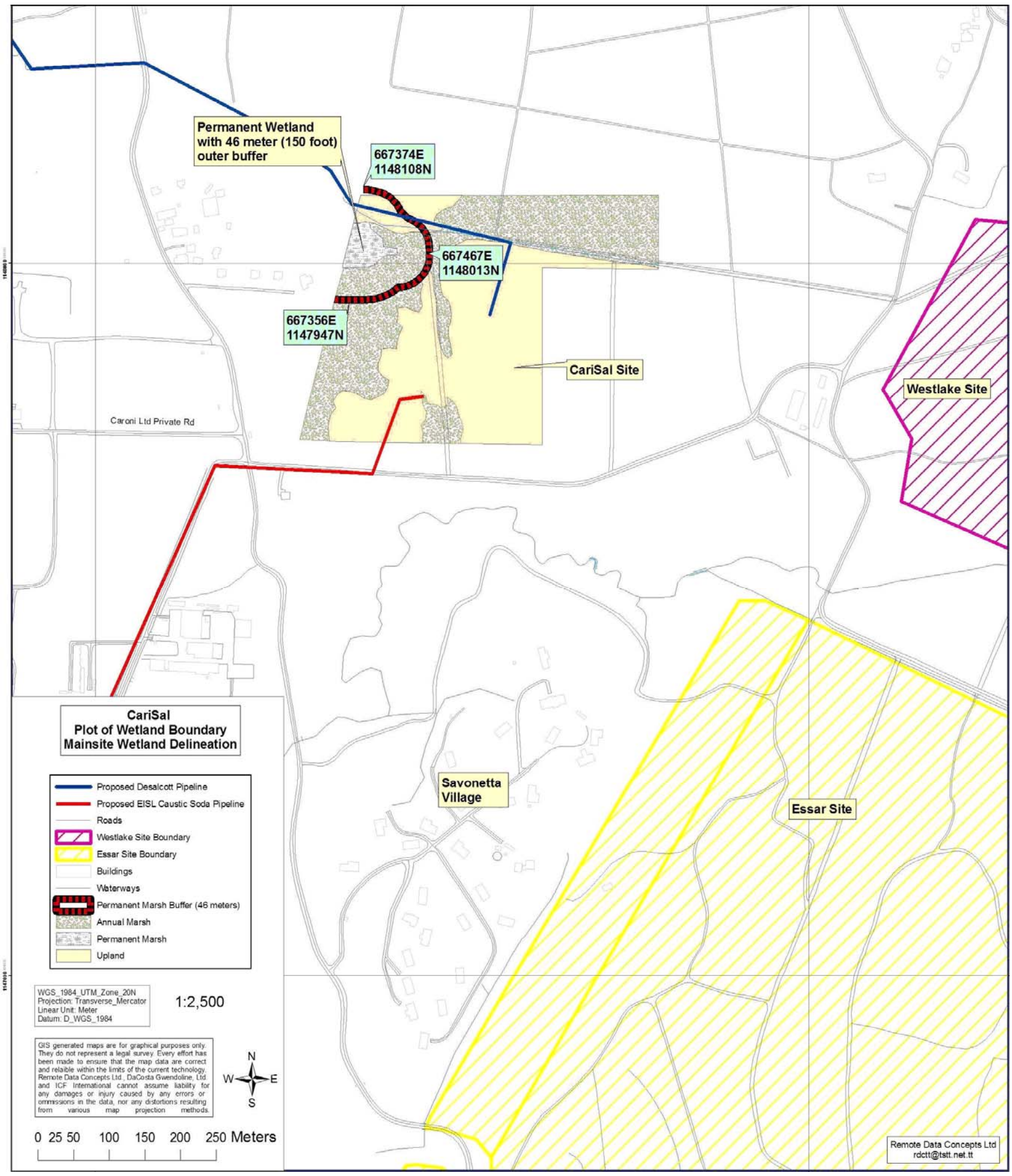


Figure 7.5-1. Proposed wetland reserve area and vegetative community types.

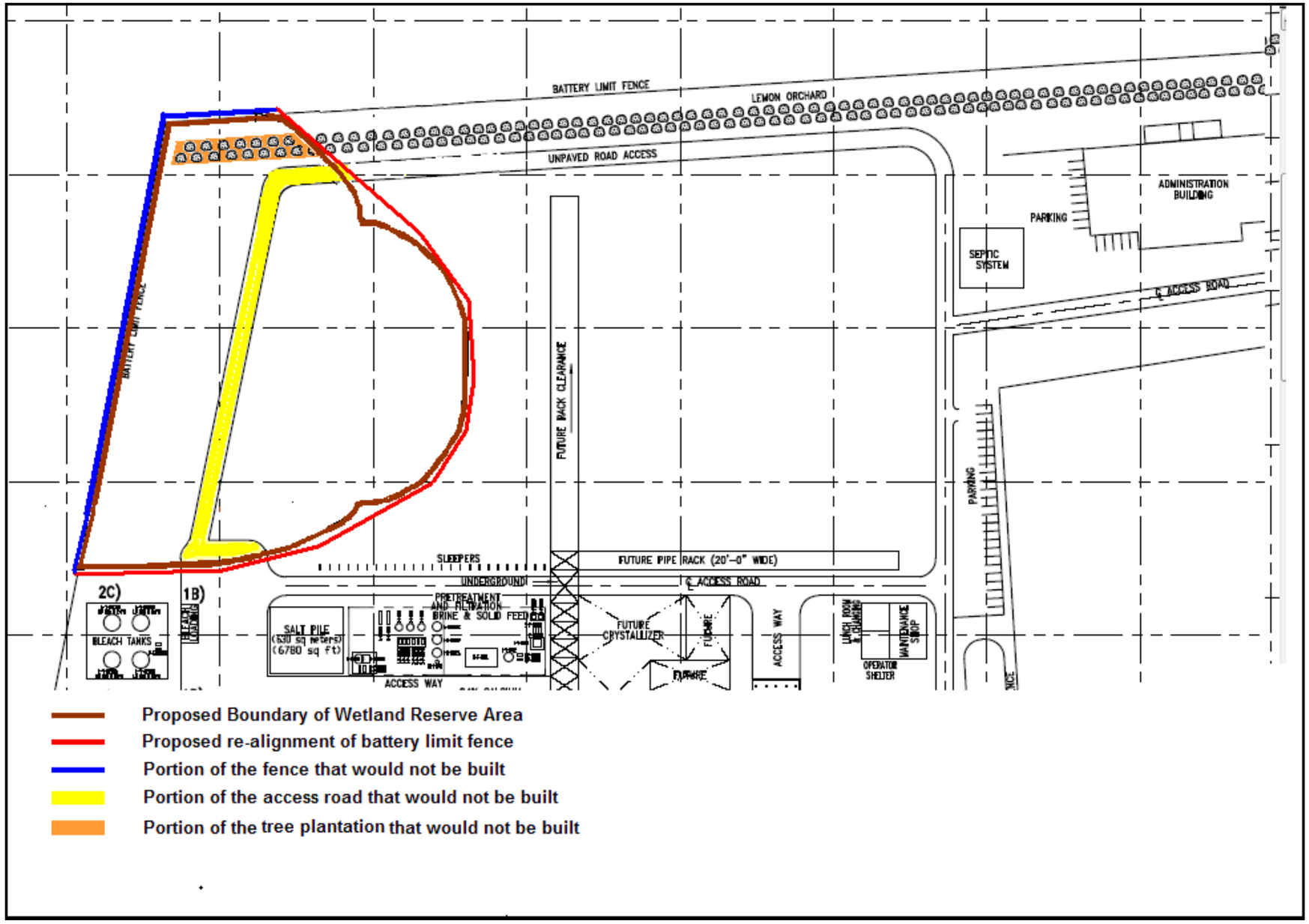


Figure 7.5-2. Boundaries of Proposed Wetland Reserve Area and Associated Site Plan Changes

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