

Esso Highlands Limited



Papua New Guinea LNG Project

**Environmental Management Plan: LNG Plant
and Marine Facilities**

PGGP-EH-OPZZZ-000004-003

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Corporate Separateness Notice

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ACRONYMS

ACRONYM	DESCRIPTION
$\mu\text{g}/\text{m}^3$	micrograms per cubic metre
dBA	A-weighted decibels
DEC	Papua New Guinean Department of Environment and Conservation
E&R	Environmental and Regulatory
EHL	Esso Highlands Limited
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
IESC	Independent Environmental and Social Consultant
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
LNG	Liquefied Natural Gas
mg/m^3	milligrams per standard cubic metre
ng/m^3	nanograms per standard cubic metre
OIMS	Operations Integrity Management System
PNG	Papua New Guinea
PM	Particulate Matter
ppm	parts per million
SHE	Safety, Health and Environment
WHRU	Waste Heat Recovery Unit
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

This Environmental Management Plan: LNG Plant and Marine Facilities is a component of the Environmental and Social Management Plan for production of the Papua New Guinea Liquefied Natural Gas (PNG LNG) Project (the Project).

1.1 Scope

This Environmental Management Plan (EMP) is applicable to the LNG Plant and Marine Facilities.

The location of the LNG Plant and Marine Facilities is shown in Figure 1-1.

This EMP is not applicable to the facilities shown below, which are addressed in the Environmental Management Plan: Upstream Facilities, Infrastructure and Pipelines:

- Hides Gas Field Wellpads (Wellpads B, C, D, E and G)
- Angore Gas Field Wellpads (Wellpads A and B)
- Hides Wellpad Access Road
- Angore Wellpad Access Road
- Produced Water Reinjection Well
- Hides Gas Conditioning Plant
- Hides Waste Management Facility
- Hides Vehicle Wash Facility
- Support camps
- Komo Airfield
- Hides Gathering System including the Hides Spine
- Angore Gathering System
- HGCP-Kutubu Condensate Pipeline
- HGCP-Kutubu Condensate Pipeline Above Ground Installations
- PNG LNG Gas Pipeline (onshore/offshore)
- PNG LNG Gas Pipeline Above Ground Installations
- Pipeline and Above Ground Installation Access Tracks

This EMP is applicable to normal operating conditions, start-up and shut-down activities, and reasonably foreseeable abnormal operating conditions and emergency situations.

This EMP is applicable to the operations and activities of Esso Highlands Limited (EHL) including its contractors and subcontractors. Where deemed necessary by EHL, contractors and subcontractors may be required to develop and implement a site-specific or scope-specific Environmental Management Plan.

This EMP is supported by and makes reference to a number of procedures and other working documents including protocols and method statements, which are internal EHL documents developed on the basis of standard industry methods, where applicable.

1.2 Objectives

This EMP describes the measures in place to manage environmental aspects pertaining to the LNG Plant and Marine Facilities and implement applicable legal and other requirements.

Specific environmental management objectives are outlined in Section 4.0.



Figure 1-1: LNG Plant and Marine Facilities location map

2.0 LEGAL AND OTHER REQUIREMENTS

Details of applicable legal and other requirements are provided below.

2.1 Laws and regulations of Papua New Guinea

Key laws and regulations of Papua New Guinea relevant to this EMP are as follows:

- *Environment Act 2000*
- *Environmental (Prescribed Activities) Regulation 2002*
- *Environmental (Procedures) Regulation 2002*
- *Environmental (Water Quality Criteria) Regulation 2002*
- *Fauna (Protection and Control) Act 1966*
- *International Trade (Fauna and Flora) Act 1979 (Chapter 391)*
- *The Environmental Code of Practice for Sanitary Landfill Sites, Papua New Guinea (The Office of Environment and Conservation, 2001)*
- *Customs (Prohibited Imports) Regulation 1973*
- *Explosives Act 1953*
- *Inflammable Liquid Act 1953 and Regulations*
- *Public Health Act 1973*
- *Public Health (Sanitation and General) Regulation 1973*
- *Public Health (Sewerage) Regulation 1973*
- *Water Supply and Sewerage Act 1996*
- *National Cultural Property (Preservation) Act 1965*

Specific requirements of these laws and regulations are discussed, where relevant, in this EMP.

2.2 Environment Permit

The primary legislation governing environmental matters in Papua New Guinea is the *Environment Act 2000*. The *Environment Act 2000* is supported by the *Environment (Prescribed Activities) Regulation 2002*.

An Environment Permit is required for the Project pursuant to the *Environment (Prescribed Activities) Regulation 2002*. The Environment Permit was issued by the Papua New Guinean Department of Environment and Conservation (DEC) on 9 September 2009. Amendments to the Environment Permit were issued on 29 October 2009 and 22 October 2012.

This EMP, together with the Environmental Management Plan: Upstream Facilities, Infrastructure and Pipeline, constitutes the Project Environmental Management Plan for production, referred to in the Environment Permit. Specific requirements and conditions of the Environment Permit are discussed where relevant in this EMP.

2.3 Operations Integrity Management System

ExxonMobil and its affiliates meet policy commitments and control operations integrity risks through the Operations Integrity Management System (OIMS).

The OIMS Framework establishes common worldwide expectations for addressing inherent risks. It addresses all aspects, including security, which can impact safety, health and environmental performance.

OIMS is certified as equivalent to *ISO 14001:2004 Environmental management systems - Requirements with guidance for use (International Organization for Standardization, 2004)* by Lloyd's Register. Certification is periodically reviewed by Lloyds Register and maintained current.

Several OIMS Systems are relevant to this EMP. Specific OIMS requirements are discussed where relevant, throughout this EMP.

2.4 Lender Group requirements

Debt financing was secured for the Project through various Export Credit Agencies and commercial banks. The Export Credit Agencies and commercial banks, collectively referred to in this document as the Lender Group, apply the International Finance Corporation (IFC) Performance Standards and associated Guidance Notes and Guidelines.

IFC Performance Standards, Guidance Notes and Guidelines applicable to this EMP are:

- *Performance Standard 1: Social and Environmental Assessment and Management Systems (IFC, 2006)*
- *Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)*
- *Performance Standard 4: Community Health, Safety and Security (IFC, 2006)*
- *Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management (IFC, 2006)*
- *Performance Standard 8: Cultural Heritage (IFC, 2006)*
- *Guidance Note 1: Social and Environmental Assessment and Management Systems (IFC, 2007)*
- *Guidance Note 3: Pollution Prevention and Abatement (IFC, 2007)*
- *Guidance Note 4: Community Health, Safety and Security (IFC, 2007)*
- *Guidance Note 6: Biodiversity Conservation and Sustainable Natural Resource Management (IFC, 2007)*
- *Guidance Note 8: Cultural Heritage (IFC, 2007)*
- *Environmental, Health, and Safety General Guidelines (IFC, 2007)*
- *Environmental, Health, and Safety Guidelines for Waste Management Facilities (IFC, 2007)*
- *Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities (IFC, 2007)*
- *Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development (IFC, 2007)*
- *Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (IFC, 2007)*

Specific requirements of the above listed IFC Performance Standards, Guidance Notes and Guidelines are discussed where relevant in this EMP.

3.0 ORGANISATION

OIMS System 1-1 Management Leadership and Accountability requires the allocation of sufficient resources for the implementation and continuous improvement of operations integrity, along with the establishment of OIMS-related roles and responsibilities.

An overview of EHL's organisation as relevant to environmental management during production is provided in this section.

3.1 OIMS Management Committee

Pursuant to OIMS System 1-1 Management Leadership and Accountability, EHL managers and supervisors will demonstrate commitment and accountability to operations integrity, including the implementation of this EMP, through active participation.

As such, EHL will charter an OIMS Management Committee to provide management perspective, set expectations and allocate resources for the implementation and continuous improvement of operations integrity within the organisation.

The OIMS Management Committee will steward OIMS goals and objectives, including goals and objectives pertaining to environmental management as set out in this EMP.

3.2 Environmental and Regulatory organisation

EHL's Environmental and Regulatory (E&R) organisation is allocated primary responsibility for the implementation and ongoing oversight of this EMP. The E&R organisation forms part of the Safety, Health and Environment (SHE) organisation.

An outline of EHL's SHE organisation is shown in Figure 3-1, but it is recognised that the organisation will be adapted as required to meet conditions and operational needs. In addition to the SHE organisation, other EHL production and maintenance personnel have defined roles and responsibilities in respect of this EMP. Roles and responsibilities of key personnel are described in Section 21.0. Competency and training is discussed in Section 22.0.

EHL will retain third party consultants and other specialist organisations and individuals to support implementation of this EMP.

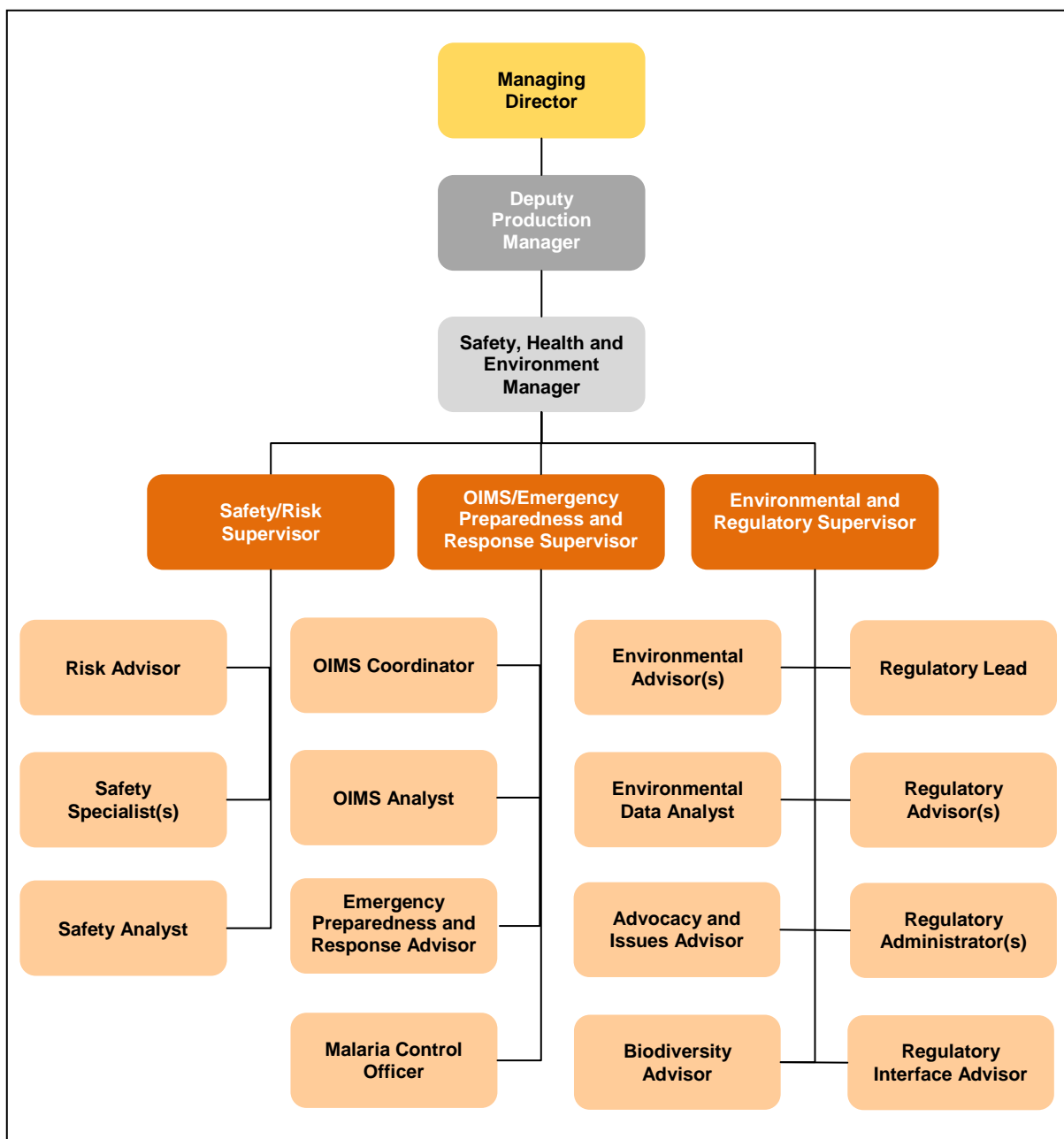


Figure 3-1: Safety, Health and Environment organisation

4.0 ENVIRONMENTAL ASSESSMENT AND MANAGEMENT

OIMS System 6-5 Environmental Management requires the identification of environmental aspects. It also requires that environmental management is fully integrated into the organisation's business planning and that environmental performance is tracked and stewarded to meet performance goals. The process of identification and evaluation of environmental aspects relevant to production is summarised below, as context to the environmental management and mitigation measures set out in this EMP.

4.1 Environmental impact assessment

Environmental aspects and impacts associated with production were initially identified and evaluated as part of the impact assessment conducted for the Environmental Impact Statement (EIS) for the Project. The EIS was finalised and submitted to the DEC in January 2009 as the statutory basis for environmental and social assessment pursuant to Section 50 of the *Environment Act 2000*.

The impact assessment presented in the EIS is based on an impact significance assessment process. For aspects associated with terrestrial biodiversity, surface water and groundwater, soils, air quality and noise, the impact significance is expressed in a matrix of the value (or sensitivity) of a receptor and the magnitude of the impact. In the case of cultural heritage, the impact significance is presented using a matrix of valence (positive or negative), nature of impact (direct, indirect or cumulative), duration, extent, magnitude and likelihood. In both cases, the impact significance assessment process accounted for a range of factors, including the nature (positive, negative, direct or indirect) extent, duration and severity.

The EIS includes environmental management and mitigation measures designed to address potential environmental impacts during production. Each mitigation measure has a unique reference code. Mitigation measures applicable the LNG Plant and Marine Facilities are within the scope of this EMP and are shown in Appendix 1.

Further details are provided in the EIS available at www.pnglng.com.

4.2 Environmental Aspects Assessment

OIMS System 6-5 Environmental Management requires the identification of environmental aspects. An environmental aspect is an activity, product or service that interacts with the environment and may have beneficial, adverse, and/or neutral effects. Environmental aspects are to be evaluated using an Environmental Aspects Assessment process, consistent with requirements of *ISO 14001:2004 Environmental management systems - Requirements with guidance for use (International Organization for Standardization, 2004)*. In accordance with these requirements, EHL undertook an Environmental Aspects Assessment for production. The Environmental Aspects Assessment forms the basis for the management of environmental aspects as set out in this EMP.

A summary of the environmental aspects applicable to the LNG Plant and Marine Facilities, the associated risk scenarios and a reference to the section of this EMP where these aspects and scenarios are addressed is shown in Table 4-1.

4.3 Environmental management and mitigation

This EMP describes management and mitigation measures in place to address the identified environmental aspects and to achieve the environmental management objectives shown in Table 4-2. Mitigation measures include design controls (controls that are inherent to facilities and infrastructure) and operational controls (controls implemented by EHL and other personnel).

Table 4-1: Overview of environmental aspects and risk scenarios

IFC PERFORMANCE STANDARD THEME	ENVIRONMENTAL ASPECT CATEGORY	ENVIRONMENTAL ASPECT OVERVIEW	RISK SCENARIO OVERVIEW	EMP SECTION REFERENCE		
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention, Resource Conservation and Energy Efficiency</p>	Emissions and releases to air	Compressor gas turbine emissions.	Risk of health and ecological impacts associated with release of pollutants to air.	Section 6.0		
		Main power generator emissions.				
		High pressure flare emissions.				
		Regeneration gas furnace emissions.				
		Pressure safety valve emissions.				
		Incinerator emissions.				
		Atmospheric vent emissions.				
		Diesel engine emissions.				
		Fugitive emissions.				
		Dust.				
	Light.					
	Discharges and releases to water	Ambient air quality.	Risk of health and ecological impacts associated with ground-level pollutants.	Section 7.0		
Noise.		Risk of health and ecological impacts associated with exposure to noise.	Section 8.0			
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Waste</p>	Waste	Stormwater discharges.	Risk of health and ecological impacts associated with the release of pollutants to surface water and groundwater.	Section 9.0		
		Retention pond discharges.				
		Waste avoidance and minimisation.			Risk of health and ecological impacts associated with release of pollutants in waste.	Section 12.0
		Waste collection.				
		Waste storage and transfer.				
		Waste reuse, recycling and recovery.				
Waste treatment and disposal.						
Waste tracking and documentation.						

IFC PERFORMANCE STANDARD THEME	ENVIRONMENTAL ASPECT CATEGORY	ENVIRONMENTAL ASPECT OVERVIEW	RISK SCENARIO OVERVIEW	EMP SECTION REFERENCE
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Hazardous Materials</p>	<p>Hazardous materials</p>	Prohibited substances.	<p>Risk of health and ecological impacts associated with the transport, storage, use and disposal of hazardous materials.</p>	<p>Section 11.0</p>
		Avoidance of hazardous materials.		
		Transportation of hazardous materials.		
		Storage and use of hazardous materials.		
		Disposal of hazardous materials.		
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Emergency Preparedness and Response</p>	<p>Releases to soil and water (spills)</p>	Transport of fuel and chemicals.	<p>Risk of health and ecological impacts resulting from a spill or release of pollutants (oil or chemicals) to the environment.</p>	<p>Section 10.0</p>
		Fuel storage and transfer.		
		Chemical storage and transfer.		
		Spill response.		
		Site remediation.		
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Greenhouse Gas Emissions</p>	<p>Emissions and releases to air (greenhouse gases)</p>	<p>Emissions of greenhouse gases.</p>	<p>Contribution to climate related effects associated with the release of greenhouse gases.</p>	<p>Section 6.0</p>
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Pesticide Use and Management</p>	<p>Chemical usage</p>	Use of pesticides.	<p>Risk of health and ecological impacts associated with the use of pesticides and herbicides.</p>	<p>Section 11.0</p>
		Use of herbicides.		

IFC PERFORMANCE STANDARD THEME	ENVIRONMENTAL ASPECT CATEGORY	ENVIRONMENTAL ASPECT OVERVIEW	RISK SCENARIO OVERVIEW	EMP SECTION REFERENCE
<i>Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management (IFC, 2006)</i>	Land and vegetation disturbance	Erosion and sediment.	Risk of impacts to biodiversity values and water quality associated with erosion and sedimentation.	Section 13.0
		Reinstatement and regeneration.	Risk of impacts to biodiversity values associated with failure of reinstatement works and poor vegetation succession.	Section 14.0
		Invasive species and pests.	Risk of impacts to biodiversity values and subsistence and commercial agriculture associated with the introduction and/or spread of priority invasive species and pests.	Section 15.0
		Ecological sensitivities and focal habitats.	Risk of impacts to habitats, specific habitat features and species of ecological importance and other ecological sensitivities.	Section 16.0
<i>Performance Standard 8: Cultural Heritage (IFC, 2006)</i>	Cultural heritage	Management of known and unknown archaeological and oral tradition sites.	Risk of impacts to cultural heritage.	Section 17.0

Table 4-2: Environmental management objectives

ENVIRONMENTAL ASPECT	OBJECTIVE
Emissions to air and ambient air quality	<ul style="list-style-type: none"> • Avoid significant impacts associated with the release of pollutants to the atmosphere • Meet applicable emissions and air quality criteria
Noise	<ul style="list-style-type: none"> • Avoid significant noise and vibration impacts to community and fauna • Meet applicable noise criteria
Discharges to water and water quality	<ul style="list-style-type: none"> • Avoid significant impacts associated with the release of pollutants to surface water and groundwater • Meet applicable discharge criteria
Spill prevention and response	<ul style="list-style-type: none"> • Prevent spills of hydrocarbons and chemicals • Respond quickly and effectively to spills should they occur
Materials management	<ul style="list-style-type: none"> • Avoid significant impacts associated with the procurement and use of raw materials • Use materials which are less hazardous or otherwise preferable from an environmental perspective, where practical
Waste	<ul style="list-style-type: none"> • Apply the waste management hierarchy • Manage and dispose of waste at EHL facilities and licensed third party facilities only
Erosion and sediment control	<ul style="list-style-type: none"> • Control significant erosion and prevent significant sedimentation of surface waters
Regeneration	<ul style="list-style-type: none"> • Promote regeneration of vegetation in areas disturbed during construction and not required for production • Achieve established benchmarks for regeneration areas
Invasive species, pests and pathogens	<ul style="list-style-type: none"> • Prevent priority invasive species and plant pathogens from entering or establishing in the Project area • Contain priority invasive species and plant pathogens already established in the Project area
Ecology	<ul style="list-style-type: none"> • Avoid impacts to specific features of ecological importance
Access	<ul style="list-style-type: none"> • Control vehicle access to Project roads and infrastructure to prevent potentially damaging third party activities
Cultural heritage	<ul style="list-style-type: none"> • Avoid impacts to cultural heritage sites, including archaeological and oral tradition sites • Manage cultural heritage sites in consultation with landowners

5.0 DESCRIPTION OF FACILITIES

An overview and description of the LNG Plant and Marine Facilities is provided in this section.

5.1 LNG Plant and Marine Facilities overview

The LNG Plant is located in the Central Province, approximately 20 kilometres north-west of Port Moresby, between the coastal settlements of Boera and Papa. It occupies four separate lease areas: Portion 2456 and Portion 2459 (formally known as State Portion 152), Portion 2457 (coastal strip) and Portion 2458 (offshore).

The LNG Plant is designed to handle a stream day gas rate (inlet feed gas capacity) of 1,133 thousand standard cubic metres per hour, equivalent to 960,000 standard cubic feet per day, and has a peak capacity of approximately 6.9 million tonnes per annum of LNG.

The Marine Facilities include a trestle jetty, LNG export berth, condensate export berth and tug landing area; and accommodate the loading of LNG carriers in the size range of 125,000 to 220,000 cubic metres and condensate tankers of 7,000 dead weight tonnes. Diagrams of the LNG Plant and Marine Facilities are shown in Figure 5-1 and Figure 5-2 respectively.

The main processing facilities and utility systems are described below.

5.2 Inlet receiving and acid gas removal

High-pressure feed gas from the offshore gas pipeline is delivered to the inlet receiving facilities, which include separation of any entrained liquids and heating to prevent formation of hydrates. Following pressure reduction via inlet pressure control valves, the gas is metered and routed to the Acid Gas Removal Unit for the removal of carbon dioxide to prevent carbon dioxide solidification and plugging of equipment during liquefaction.

5.3 Dehydration and mercury removal

The treated water saturated gas from the Acid Gas Removal Unit is dehydrated using a combination of high level refrigeration, which removes about half the water, and a fixed-bed molecular sieve system, which removes the remaining water. The molecular sieve dries the gas to avoid freezing and formation of hydrates (crystals which may form in the presence of water under certain conditions and may cause line plugging) during liquefaction. Gas leaving the molecular sieves passes through a mercury guard bed to remove any mercury and prevent corrosion of aluminium equipment. The dry gas is then filtered to remove entrained dust.

5.4 Refrigeration, fractionation and liquefaction

The liquefaction process uses proprietary licensed technology to liquefy the gas. Various refrigerants are used to chill and liquefy the gas after removal of heavier hydrocarbons. Heavier hydrocarbons are removed to prevent solids from plugging equipment due to freezing. These heavier hydrocarbons are then fractionated, blended and consumed as fuel gas. Condensate recovered in the fractionation system is vapour-pressure stabilised prior to storage.

5.5 LNG and condensate storage

LNG is stored in two single containment tanks of 160,000 cubic metres per tank. Condensate recovered in the fractionation system is stored in two 10,500-cubic metre capacity floating roof storage tanks.

5.6 Utilities

A number of utilities support the LNG Plant and Marine Facilities including dry and wet flare systems; hot oil system; closed and open drain systems; refrigerant storage; fuel gas system; main power generation; essential power generation; electrical system; diesel

storage and distribution system; instrument and utility air system; nitrogen system; firewater system; utility water storage and distribution; potable water system; and effluent handling system. Further information is provided about these utilities where relevant in this EMP.

5.7 Marine Facilities

Marine Facilities include a combined LNG and condensate vessel berth, with associated mooring systems, cargo transfer system, monitoring, controls and emergency shutdown systems.

The terminal does not supply the vessels with bunkers or water; nor does it provide storage facilities. A small boat wharf is provided close to the head of the trestle to accommodate support vessels. These multi-purpose support vessels provide security escort services, mooring line assistance, man-overboard rescue and jetty evacuation and can also be used to deploy spill containment and response equipment.

No fixed refuelling capability is provided for the boats. Shore power for the boats is available for lighting and other light electrical loads.

The Marine Facilities are staffed by security personnel and equipped to allow security surveillance of the berth and monitoring of the berth operations and equipment.



Figure 5-1: LNG Plant layout



Figure 5-2: Marine Facilities layout

6.0 EMISSIONS TO AIR

6.1 Introduction

EHL's objectives are to avoid significant impacts associated with the release of pollutants to air and meet applicable emissions and air quality criteria.

Information relevant to emissions to air during production including a description of emission sources, applicable emissions criteria/guideline values and relevant design and operational controls, is provided in this section.

Operation of the facilities within the scope of this EMP gives rise to non-polluting and polluting emissions to air. Only polluting emissions are discussed herein. Non-polluting emissions, such as nitrogen, oxygen, and water are not addressed.

Ambient air quality is discussed in Section 7.0.

Provisions for emissions monitoring are set out in Section 18.0.

A summary of emissions to air is provided in Appendix 2.

6.2 Emissions overview

Emission sources at the LNG Plant and Marine Facilities, including continuous and intermittent sources during normal and abnormal operating conditions, are listed in Table 6-1.

The location of each emission source is shown in Figure 6-1, followed by a description of each emission source, applicable emissions criteria and control measures, including design and operational controls.

Table 6-1: LNG Plant emissions sources

SOURCE	EMISSION POINT REFERENCE	TYPE
Propane Refrigerant Compressor Gas Turbine Unit 1	LNGP-A1	Continuous
Propane Refrigerant Compressor Gas Turbine Unit 1A	LNGP-A2	Continuous
Propane Refrigerant Compressor Gas Turbine Unit 2	LNGP-A3	Continuous
Propane Refrigerant Compressor Gas Turbine Unit 2A	LNGP-A4	Continuous
Mixed Refrigerant Compressor Gas Turbine Unit 1	LNGP-A5	Continuous
Mixed Refrigerant Compressor Gas Turbine Unit 1A	LNGP-A6	Continuous
Mixed Refrigerant Compressor Gas Turbine Unit 1B	LNGP-A7	Continuous
Mixed Refrigerant Compressor Gas Turbine Unit 2	LNGP-A8	Continuous
Mixed Refrigerant Compressor Gas Turbine Unit 2A	LNGP-A9	Continuous
Mixed Refrigerant Compressor Gas Turbine Unit 2B	LNGP-A10	Continuous
Main Power Generator 1	LNGP-A11	Continuous
Main Power Generator 2	LNGP-A12	Continuous
Main Power Generator 3	LNGP-A13	Continuous
Main Power Generator 4	LNGP-A14	Continuous
Main Power Generator 5	LNGP-A15	Continuous
Main Power Generator 6	LNGP-A16	Continuous
Main Power Generator 7	LNGP-A17	Intermittent
Regeneration Gas Furnace Unit 1	LNGP-A18	Continuous
Regeneration Gas Furnace Unit 2	LNGP-A19	Continuous

SOURCE	EMISSION POINT REFERENCE	TYPE
Regeneration Furnace (Common)	LNGP-A20	Intermittent
Hot Oil System Furnace	LNGP-A21	Start-up
Wet Flare Stack (Purge and Pilot Gas)	LNGP-A22	Continuous
Wet Flare Stack	LNGP-A23	Pressure relief
Dry Flare Stack (Purge and Pilot Gas)	LNGP-A24	Continuous
Dry Flare Stack	LNGP-A25	Pressure relief
Tankage Flare (Purge and Pilot Gas)	LNGP-A26	Continuous
Tankage Flare	LNGP-A27	Pressure relief
Sludge Incinerator	LNGP-A28	Intermittent
Essential Services Generator 1	LNGP-A29	Intermittent
Essential Services Generator 2	LNGP-A30	Intermittent
Essential Services Generator 3	LNGP-A31	Intermittent
Diesel Firewater Pump Engine	LNGP-A32	Intermittent
Diesel Sea Firewater Pump	LNGP-A33	Intermittent
Acid Gas Vent (Amine Regeneration) Unit 1	LNGP-A34	Continuous
Acid Gas Vent (Amine Regeneration) Unit 2	LNGP-A35	Continuous
Diesel Storage Tank Atmospheric Vent	LNGP-A36	Continuous
Diesel Firewater Tank Atmospheric Vent	LNGP-A37	Continuous
Corrosion Inhibitor Tank Atmospheric Vent	LNGP-A38	Continuous
LNG Storage Tank Pressure Safety Valves	LNGP-A39	Pressure relief
Condensate Storage Tank Pressure Safety Valves	LNGP-A40	Pressure relief
Amine Regeneration Column Pressure Safety Valves	LNGP-A41	Pressure relief
Note: LNGP = LNG Plant		

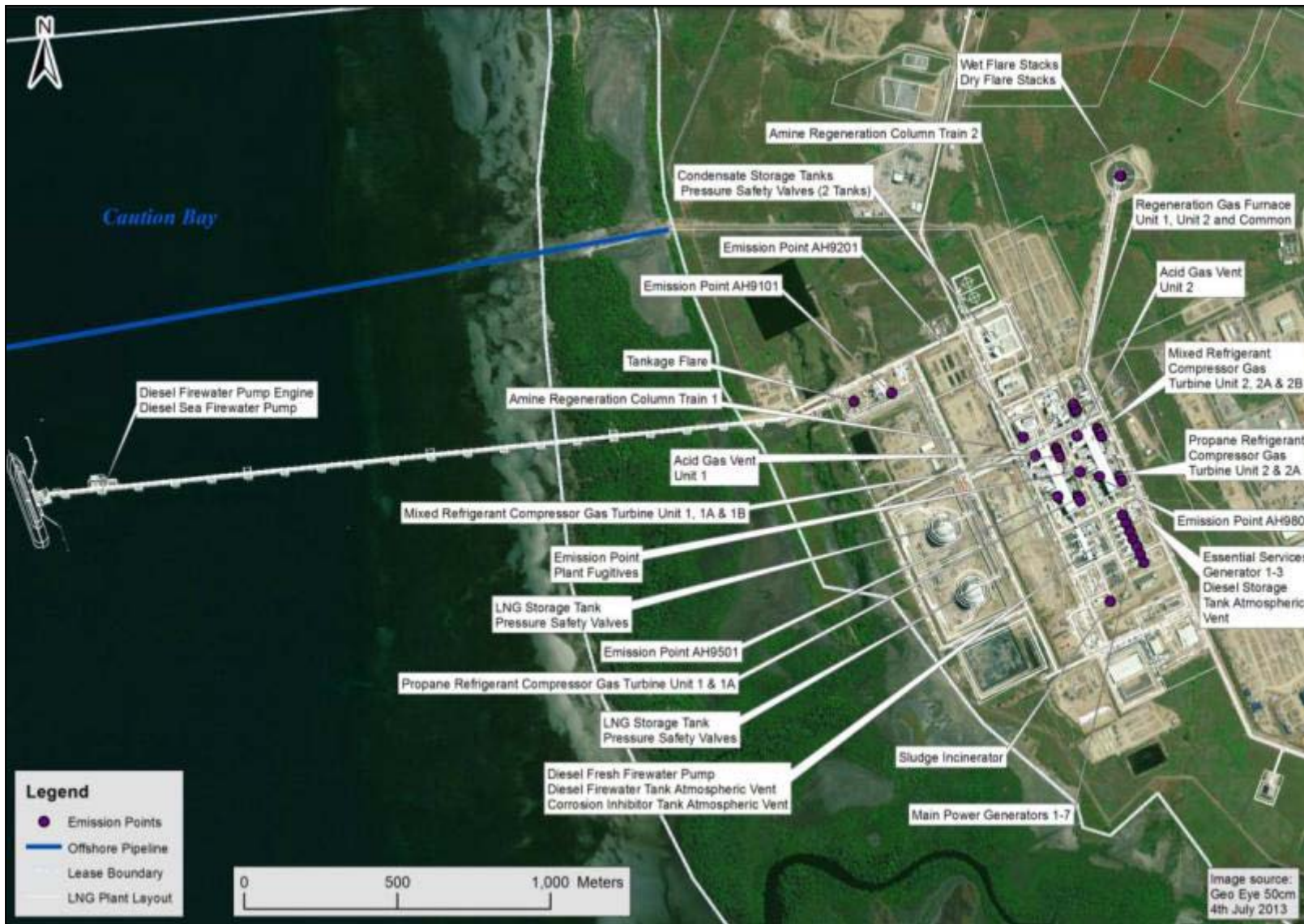


Figure 6-1: LNG Plant emission and discharge sources

6.3 Compressor gas turbine exhausts

As part of the refrigeration and liquefaction process, three mixed refrigerant compressor strings operate in two parallel trains (total of six) and two propane refrigerant compressor strings operate in two parallel trains (total of four). All compressors are gas turbine driven and are fitted with dry low emission combustion systems.

Fuel gas is collected from various sources in the process trains and storage facility, including boil-off gases from the LNG storage tanks.

Hot exhaust gases from the mixed refrigerant compressor gas turbines are directed to Waste Heat Recovery Units (WHRUs), which provide heating for the LNG Plant hot oil system.

During steady state operations, emissions from the WHRU stacks and propane refrigerant compressor stacks are continuous and the relevant pollutant is oxides of nitrogen.

Table 6-2 shows the design emissions specification for the WHRUs and propane refrigerant compressor gas turbines; and the applicable emission guideline values.

Table 6-2: Compressor gas turbine/Waste Heat Recovery Unit emissions

PARAMETER	DESIGN EMISSION SPECIFICATION	EMISSION GUIDELINE VALUE
Oxides of nitrogen	25 ppm	25 ppm
<p>Source: <i>General Environmental, Health and Safety (EHS) Guidelines (IFC, 2007)</i>, Table 1.1.2 - Small Combustion Facilities Emissions Guidelines.</p> <p>Emission guideline values stated in parts per million (ppm).</p> <p>Emission guideline values apply at reference conditions of 15 percent oxygen, dry gas. Emission guideline values apply during normal steady state operations, and not to start-up, shut-down and abnormal operations.</p>		

The stack height of each WHRU is 44 metres above grade. The stack height of each propane refrigerant compressor is 42 metres above grade. In addition to the low emission combustion system, the stack heights serve to control ground level concentrations of nitrogen dioxide and achieve applicable ambient air quality criteria.

6.4 Main power generator exhausts

The main power generators supply electrical power to the LNG Plant through a low and high voltage electrical distribution network. The network consists of seven dry low emission single shaft combustion turbine generators. Six turbine generators operate in parallel, with one spare. Fuel gas is supplied to each turbine from the fuel system (compressed air and high pressure fuel gas). Essential generators, required for a black start/restart of the LNG Plant, are diesel-engine driven.

During steady state operations, emissions from the turbine generators are continuous and the relevant pollutant is oxides of nitrogen.

Table 6-3 shows the design emissions specification for the turbine generators and the applicable emission guideline values.

Table 6-3: Main power generator emissions

PARAMETER	DESIGN EMISSION SPECIFICATION	EMISSION GUIDELINE VALUE
Oxides of nitrogen	25 ppm	42 ppm
<p>Source: <i>General Environmental, Health and Safety (EHS) Guidelines (IFC, 2007)</i>, Table 1.1.2 - Small Combustion Facilities Emissions Guidelines.</p> <p>Emission guideline values for fuel gas at reference conditions of 15 percent oxygen, dry gas. Emission guideline values apply during normal steady state operations, and not to start-up, shut-down and abnormal operations.</p>		

The turbine generator stack heights are 44 metres above grade which, in addition to the low emission combustion system, serves to control ground level concentrations of nitrogen dioxide and achieve applicable ambient air quality criteria.

6.5 Regeneration gas furnace exhausts

As part of the dehydration and mercury removal process, the molecular sieve beds are dried using regeneration gas. The regeneration gas is heated to approximately 290 degrees Celsius by regeneration gas furnaces, two of which operate in parallel trains with a common spare. Spent regeneration gas downstream of the molecular sieves is cooled through an air cooler and used as a source of fuel gas for the LNG Plant. Combustion efficiency of the regeneration gas furnaces is approximately 80 percent.

6.6 Hot oil system furnace exhausts

During start-up, when the WRHUs are not available. A hot oil furnace operates to provide heating duty for the LNG Plant hot oil system. The hot oil furnace is also available to supplement the WHRUs when necessary. Emissions from the hot oil furnace are intermittent and *de minimis*¹ and are not considered further in this EMP.

6.7 Flare system

A multi-flare system operates at the LNG Plant to segregate and accommodate wet hydrocarbon vapours, cryogenic dry vapours, and a low pressure vapour relief system. A combination of wet and dry gas flares are used for pressure relief and a tankage flare operates intermittently during ship cool-down.

There is no routine flaring during steady state operations; however there are certain continuous, intermittent and relief-case emissions from the flare stacks, described below.

The wet flare collects vapour and liquids that are susceptible to freezing during a depressurisation event. It is sized to handle relief and blow down streams from the inlet area, inlet gas treating systems, fractionation unit, hot oil system and fuel gas systems. Vapours and liquids are collected in the same header and a knock out drum equipped with a hot oil heating coil vaporises the volatile components to the flare stack. Liquids remaining after vaporisation are transferred via a knock out drum pump to the slop oil tank or the neutralisation tank (for the case where amine relieves from the amine absorber).

The dry flare collects moisture-free vapours and liquid hydrocarbons from relief valves, vents, and drains throughout the process areas. The dry flare is sized to handle relief and blow down streams from the liquefaction, refrigeration, and fractionation systems. Gas flows through the knock out drum where hydrocarbon liquids are collected. Liquid is stored in the dry flare knock out drum until vaporised by heat intake or by sparging with defrost gas or fuel gas. Any remaining liquids are transferred to the wet flare knock out drum.

A tankage gas flare operates to dispose of inert gas from LNG vessels. Due to a very low operating pressure and temperature, a separate tankage gas collection system is provided. The tankage flare is designed for pressure relief from the LNG storage and loading systems, and from the boil-off gas system. Boil-off gases flow to the flare stack directly without a knock out drum.

Continuous pilots are used to ignite all flares and the stacks are continuously purged with nitrogen to prevent ingress of oxygen. Pilot and purge gases consist of nitrogen, oxides of nitrogen, carbon monoxide, and light/volatile hydrocarbons and represent continuous, although *de minimis*, emissions.

¹ A term used by the United States Environmental Protection Agency to describe emissions levels which are negligible and for which no conformity levels are established.

Polluting emissions from the flare stacks during design relief cases are oxides of nitrogen, carbon monoxide, and light/volatile hydrocarbons. There are no applicable emission guideline values.

The flares are designed to achieve up to 99 percent thermal destruction efficiency and are designed for smokeless flaring over their operating range. The wet and dry flares use high pressure fuel gas as assist gas for achieving smokeless operation.

The wet flare tip and dry flare tip are located at 93 metres above grade. The tankage flare tip is located at 65 metres above grade.

The design criteria serve to control ground level concentrations of pollutants in ambient air.

6.8 Waste incinerator

A diesel fired incinerator with a capacity of >300 kilograms per hour operates at the LNG Plant to dispose of combustible waste streams. The incinerator is a rotary kiln of dual combustion chamber design. Combustion temperature in both chambers is maintained via automatic control. A minimum retention time in the secondary combustion chamber of two seconds is achieved via automatic control.

Flue gas from the incinerator is treated through a pollution control system consisting of a wet spray quench and gas cleaning system. The temperature of the flue gases exiting the secondary combustion chamber is quenched by the water spray quench. Drainage from the incinerator area is directed to the effluent treatment system for further collection, treatment and discharge to the permanent retention pond. The cooled flue gas is directed to a gas cleaning system consisting of a baghouse filter for the removal of particulates.

The relevant emission guideline values are shown in Table 6-4. The incinerator stack is 20 metres above grade, which serves to control ground level concentrations of residual pollutants in ambient air.

Table 6-4: Incinerator emissions

PARAMETER	EMISSION GUIDELINE VALUE
Particulate Matter (PM)	70 mg/m ³
Carbon monoxide	157 ppm
Oxides of nitrogen	388 ppm
Oxides of sulphur	20 ppm
Hydrogen chloride	62 ppm
Cadmium	0.004 mg/m ³
Lead	0.04 mg/m ³
Mercury	0.47 mg/m ³
Dioxin/furan	0.41 ng/m ³
Opacity	10 percent

Source: Based on *Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 60]* (United States Environmental Protection Agency, 2008,) Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units), including threshold for applicability relating to throughput, as referenced in *Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007)*.

Emission guideline values stated in ppm by dry volume, milligrams per standard cubic metre (mg/m³) and nanograms per standard cubic metre (ng/m³), as indicated above.

Emission guideline values apply during normal steady state operations, and not start-up, shut-down and abnormal operations.

Emission guideline values for dioxin/furan at toxic equivalency basis. Emission guideline values except opacity are stated at reference conditions of 7 percent oxygen, dry basis at standard conditions.

6.9 Pressure control valves and pressure vacuum safety valves

A number of pressure safety valves operate at the LNG Plant to provide pressure relief. Of note, the LNG storage tanks pressure safety valves are sized for extreme high vapour relief conditions (such as a tank fire, rollover of liquid contents or a sudden drop in barometric pressure) and at low pressure it is not practical to vent to the flare. Emissions from the pressure safety valves are intermittent and *de minimis* and are not considered further in this EMP.

6.10 Atmospheric vents

A number of atmospheric vents operate at the LNG Plant. Carbon dioxide recovered from the feed gas in the Acid Gas Removal Unit is vented to atmosphere through a dedicated high point vent at 60 metres above grade. The vent elevation has been selected to ensure that any entrained benzene is adequately dispersed. Emissions from the atmospheric vents are *de minimis* and are not considered further in this EMP.

6.11 Diesel engines

Essential services generators (high speed diesel) are available for start-up, shut-down or when main power generators are unavailable, catering for essential loads at the LNG Plant and Marine Facilities. Diesel engine driven firewater pumps and sea firewater pumps also serve the firewater system. For maintenance purposes, generators and firewater pump engines are operated for several hours per week.

Low sulphur diesel will be used in the LNG Plant diesel system where commercially available and not cost prohibitive. Emissions from the diesel engines are intermittent and *de minimis* and are not considered further in this EMP.

6.12 Fugitive emissions

Fugitive source air emissions refer to emissions that are distributed spatially over a wide area and not confined to a specific discharge point. There are no significant sources of fugitive emissions anticipated at the LNG Plant. Boil-off gas from the LNG storage tanks is normally directed to a vapour recovery system and where this system is out of service, vapour is routed to the tankage flare. Condensate storage tanks use floating roofs with double seals.

6.13 Dust

Dust may be generated in dry conditions. To reduce the occurrence of dust, appropriate vehicle speed limits apply within EHL facilities and on public roads. In the event that dust causes a nuisance, appropriate control measures (for example road dampening) will be implemented.

6.14 Light

Light has the potential to disturb nocturnal fauna, including turtles on Idihi Island. Potential impacts of perimeter and other lights will be reduced by directing light to where it is required for operations and security, as well as avoiding directing light to the marine environment, where practical.

7.0 AMBIENT AIR QUALITY

EHL's objectives are to avoid significant impacts associated with the release of pollutants to air and meet applicable emissions and air quality criteria.

The ambient air quality guidelines applicable to EHL's operations are described in this section. Ambient air quality monitoring is discussed in Section 18.0.

Emissions to atmosphere from the LNG Plant have the potential to result in localised effects on ambient air quality. Applicable ambient air quality guideline values, designed for protection of human health and the environment, are shown in Table 7-1.

Table 7-1: Ambient air quality guidelines

	AVERAGING PERIOD			
	1 HOUR ($\mu\text{G}/\text{M}^3$)	24 HOUR ($\mu\text{G}/\text{M}^3$)	ANNUAL ($\mu\text{G}/\text{M}^3$)	OTHER
Sulphur dioxide	-	20	-	10 minute average: 500
Nitrogen dioxide	200	-	40	-
Carbon monoxide	30,000	-	-	15 minute average: 100,000 30 minute average: 60,000 8 hour average: 10,000
Hydrogen sulphide	-	-	-	No offensive odour at boundary: $<5 \text{ mg}/\text{m}^3$
PM ₁₀	-	150	70	-
PM _{2.5}	-	75	35	-
Total suspended particulates	-	150-230	60-90	-
Ozone	-	-	-	8 hours, daily max: 100 (not to be exceeded more than 24 times per year)

Source: Based on *Ambient Air Quality Guidelines (World Health Organization, 2006)*, as cited in the *General Environmental, Health and Safety (EHS) Guidelines (IFC, 2007)*, Table 1.1.1 - WHO Ambient Air Quality Guidelines.

Ambient air quality values are expressed in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) unless otherwise stated.

PM 24-hour value is the 99th percentile.

Several air quality assessments, including the air quality assessments undertaken as part of the EIS and subsequent air quality and dispersion modelling undertaken during detailed design, show that the air quality guideline values shown in Table 7-1 are achievable.

8.0 NOISE

EHL's objectives are to avoid significant noise impacts to community and fauna and meet applicable noise criteria.

The noise guidelines applicable to production are described in this section.

Noise from the LNG Plant and Marine Facilities has the potential to cause localised noise impacts to nearby receptors. Noise guidelines applicable to steady state operation of the LNG Plant and Marine Facilities are shown in Table 8-1.

Table 8-1: Noise guidelines

RECEPTOR	ONE HOUR EQUIVALENT CONTINUOUS SOUND PRESSURE LEVEL IN A-WEIGHTED DECIBELS (dBA)	
	DAY	NIGHT
Residential, Institutional Educational	55	45
Industrial, Commercial	70	70

Source: Based on *General Environmental, Health and Safety (EHS) Guidelines (IFC, 2007)*, Table 1.7.1 Noise Level Guidelines.

IFC noise level guidelines state that noise should not exceed the guideline levels above or result in a maximum increase in background levels of 3dBA at the nearest off-site receptor.

Day is 07.00-22.00 hours.
Night is 22.00-07.00 hours.

The noise guidelines shown in Table 8-1 are deemed to apply at the perimeter fence line. The perimeter fence and the layout of noise generating equipment have been designed to achieve these criteria.

The criteria shown in Table 8-1 will be achieved without consideration of background noise (that is, only point source noise from the facility will be accounted for). Conformance will be demonstrated through noise modelling, supplemented by noise monitoring, as discussed further in Section 18.0.

In addition to the above steady state criteria, planned short-term high intensity noise events will be limited and potentially affected communities will be notified in advance of the intended work and its duration.

9.0 DISCHARGES TO WATER

EHL's objectives are to avoid significant impacts associated with the release of pollutants to surface water and groundwater and meet applicable discharge criteria.

Information about the discharge of wastewater during production is provided in this section, including a description of the discharges and the applicable discharge criteria/water quality criteria.

Also described below are relevant control measures, including design and operational controls. Monitoring of discharges and water quality is discussed in Section 18.0.

A summary of discharges to water is provided in Appendix 2.

9.1 Discharge locations

All effluent and wastewater generated at the LNG Plant is directed, following partial treatment as necessary, to the retention pond. The retention pond is lined with high density polyethylene to prevent release of its contents to the environment. Clean water from the retention pond is discharged to sea via the marine outfall. Management of each effluent and wastewater source prior to the retention pond is outlined below.

9.2 Stormwater

A system of open and closed drains, connecting to treatment facilities and the retention pond is used to separate clean from potentially contaminated surface water.

Stormwater from uncontaminated areas at the LNG Plant collects in an open ditch system and routes to the retention pond.

Stormwater from potentially contaminated areas, including the process area, utility area, effluent treatment system area, wet and dry flare drums area and condensate storage area is directed by gravity to sealed collection pits that provide retention time for initial solids separation and oil water separators to remove oil and grease in the water. The partially treated water is directed to the oily water treatment facility for further treatment. The treated water is then routed to the retention pond.

Potentially contaminated stormwater from the liquefaction portion of the process area is collected in insulated concrete lined ditches, routed to a process spill containment sump before being pumped to the corrugated plate interceptor separator using a floating oil skimmer. Similarly, potentially contaminated stormwater from the power generation area, maintenance area and waste storage area is collected in concrete-lined ditches, routed to area sumps and then pumped to the corrugated plate interceptor separator. Effluent from the corrugated plate interceptor separator is routed to the oily water treatment facility and then to the retention pond.

9.3 Oily water system and chemical drains

Oily wastewater from the collection pits and dehydration unit are routed to an equalisation tank, which has a baffle and a fixed weir for oil skimming.

Skimmed oil from the equalisation tank is collected to an above ground skimmed oil tank and transferred to a slop-oil tank. Oily water from the equalisation tank is fed to a dissolved air flotation unit, which reduces oil content and the treated water is subsequently routed to a sand filter by gravity flow to remove suspended sediment. The treated water is discharged to the retention pond. Oily sludge from the dissolved air flotation unit is collected in a sludge tank and transferred to the sludge incinerator.

Grading, sloping and curbs are used to avoid the entrance of other waters, such as clean stormwater, into the oily water drains.

The oily water treatment facility consists of an equalisation tank, a dissolved air flotation unit and sand filters that remove oil and suspends solids in the water. A sand filter treats effluent

from the dissolved air flotation unit to remove suspended solids. Inlet wastewater is combined with an air-saturated water recycle stream prior to entering the dissolved air flotation storage tank. Once the combined stream reaches the dissolved air flotation tank, dissolved air is released as bubbles. The mass of rising bubbles carries the contaminants (oil and suspended solids) to the surface forming a floating layer which is then removed using a skimmer. The treated water is then routed to sand filters. These filters are continuous self-washing operating filters. Inlet water is introduced to the filtering bed through an inlet nozzle and a distributor is located at the bottom of the filters. The water then rises through the downward moving sand, until filtered water exits the filter via the filtrate outlet pipe. As part of the filtration process, fouled sand is pumped to the sand washer, where it is rinsed. Cleaned sand falls back to the surface of the filtering bed. Wash water, containing suspended solids, is discharged via the wash water outlet and flows by gravity to the dissolved air flotation storage tank. In the lower part of the filter, a sand distribution cone ensures that the sand moves with even velocity over the entire filter area.

Effluent from the oily water treatment facility is routed to the retention pond. Skimmed oily sludge will be stored in drums and directed to the LNG Plant waste storage area.

Hot oil is drained, using nitrogen if necessary, to the hot oil sump drum. The hot oil collection drum can be drained by pumping the contents to the slop oil tank and from there to temporary containers. Hot oil that cannot be reused in the system will be incinerated.

Amine-contaminated wastewater is collected from the amine regenerator reflux pump and wet flare knock out drum pump. These streams are routed to a neutralized water tank and stored for offsite treatment and disposal (see Section 12.0). Overflow diversion devices are provided upstream of collection pits to divert excess rain water and firewater to the clean water sewer. The first flush of potentially amine-contaminated water is normally routed to the equalisation tank in the oily wastewater system. Where water in the collection pits is contaminated with amine, it is routed to the neutralized water tank via a pit pump.

Non-amine-contaminated chemical wastewater is collected from the hydrocarbon/water sump pump and the reverse osmosis cleaning effluent pit and routed to the neutralisation pit. The water is then neutralised and routed to the equalisation tank in the oily water treatment facility. Drains from the laboratory and chemical storage buildings are collected in dedicated sumps and will be conveyed to the equalisation tank by vacuum truck.

9.4 Sewage

A packaged Wastewater Treatment Plant (WWTP) operates at the LNG Plant to treat domestic wastewater. Domestic wastewater is collected and routed to an equalisation pit with a rotating filtering drum. Materials from the rotating drum are directed to the waste incinerator. From the equalisation pit wastewater is directed to a bio-treatment unit. Treated sanitary effluent from the bio-treatment unit is directed to the retention pond. Sludge from the bio-treatment unit will be taken to the sludge dewatering unit and then the dewatered sludge will be incinerated.

9.5 Desalination system

Seawater from the seawater intake is transferred to the desalination unit for the production of desalinated water via reverse osmosis. Concentrated brine produced from the desalination unit is routed to the retention pond along with brine generated in the demineralisation system.

9.6 Leachate

Leachate from the LNG Plant landfill will be taken to the WWTP for treatment.

9.7 Water quality and discharge criteria

9.7.1 Water quality criteria

Annex 2 of EHL's Environment Permit sets out applicable freshwater quality criteria, as shown in Table 9-1 and Table 9-2.

Discharges to receiving waters should not cause a lowering of receiving water quality below the criteria shown in Table 9-1. Table 9-2 shows maximum permitted criteria of ammonia-nitrogen for protection of freshwater aquatic life.

The *Environment (Water Quality Criteria) Regulation 2002* prescribes that a permit that provides for a mixing zone within its terms and conditions shall specify the location and size of the mixing zone and the corresponding water quality criteria that apply at the boundary of the mixing zone.

The Environment Permit for the Project does not specify a mixing zone.

Table 9-1: Water quality criteria

PARAMETER	WATER QUALITY CRITERIA (FRESHWATER)	WATER QUALITY CRITERIA (SEAWATER)
pH	6.5 – 9 (pH units)	No alteration to natural pH
Temperature	No alteration greater than 2 degrees Celsius	No alteration greater than 2 degrees Celsius
Turbidity	No alteration greater than 25 NTU or no change >10 percent from background levels at any particular time (whichever is greater)	No alteration greater than 25 NTU or no change >10 percent from background levels at any particular time (whichever is greater)
Total Suspended Solids	50 mg/L or no change >10 percent from background levels at any particular time (whichever is greater)	50 mg/L or no change >10 percent from background levels at any particular time (whichever is greater)
Insoluble residues	No insoluble residues or sludge formation to occur	No insoluble residues or sludge formation to occur
Dissolved oxygen	Not less than 6 mg/L or no change >10 percent from background levels at any particular time (whichever is greater)	Not less than 5 mg/l or no change >10 percent from background levels at any particular time (whichever is greater)
Chemical oxygen demand	125 mg/l	125 mg/l
Biological oxygen demand	25 mg/l	25 mg/l
Sulphate as SO ₄ ²⁻	400 mg/l	---
Sulphide as HS-	0.002 mg/l	0.002 mg/l
Ammonia-nitrogen	Dependent on pH and temperature (see Table 9-2)	---
Nitrate	45 mg/l	45 mg/l
Potassium	5 mg/l	600 mg/l
Barium	1 mg/l	1 mg/l
Boron	1 mg/l	10 mg/l
Cadmium	0.01 mg/l	0.001 mg/l
Chromium (as hexavalent)	0.05 mg/l	0.01 mg/l
Cobalt	Limit of detection	Limit of detection
Copper	1 mg/l	0.03 mg/l
Iron	1 mg/l	1 mg/l

PARAMETER	WATER QUALITY CRITERIA (FRESHWATER)	WATER QUALITY CRITERIA (SEAWATER)
Lead	0.005 mg/l	0.004 mg/l
Manganese	0.5 mg/l	2 mg/l
Mercury	0.0002 mg/l	0.0002 mg/l
Nickel	1 mg/l	1 mg/l
Selenium	0.01 mg/l	0.01 mg/l
Silver	0.05 mg/l	0.05 mg/l
Tin	0.5 mg/l	0.5 mg/l
Zinc	5 mg/l	5 mg/l
Oil and grease	No visible film (for construction discharges) 10 mg/l (for production discharges)	No visible film (for construction discharges) 10 mg/l (for production discharges)
Phenols	0.002 mg/l	0.002 mg/l
Faecal coliform	Not to exceed 200 colonies per 100 ml or no change >10 percent from background levels at any particular time (whichever is greater)	Not to exceed 200 colonies per 100 ml or no change >10 percent from background levels at any particular time (whichever is greater)

Source: Annex 2 of EHL's Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection.

Metal concentrations are for dissolved substances (passing through a nominal 0.45 µm medium).

NTU = nephelometric turbidity unit.

Cobalt (as 'limit of detectability') uses graphite furnace atomic absorption spectrometry.

The criteria for faecal coliform bacteria is based on not fewer than five water samples collected over not more than a 30-day period.

Values for boron and potassium agreed with DEC due to high background levels in Caution Bay.

Table 9-2: Water quality criteria: ammonia-nitrogen

TEMPERATURE (DEGREES CELSIUS)	pH UNITS		
	7	8	9
5	16.1	1.6	0.2
10	11	1.1	0.1
15	7.5	0.8	0.09
20	5.2	0.5	0.07
25	3.6	0.4	0.06
30	2.6	0.3	0.05
35	1.6	0.2	0.04

Source: Annex 2 of EHL's Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection.

10.0 SPILL PREVENTION AND RESPONSE

EHL's objectives are to prevent spills of hydrocarbons and chemicals and to respond effectively to spills should they occur.

Management measures to prevent the spillage or release of fuels and chemicals, including hazardous chemicals, to the environment, and the actions to be taken in the event of a spill or release, are described in this section.

Control measures including design and operational controls, have been developed in accordance with requirements and through the methods prescribed under OIMS. Relevant OIMS processes include OIMS System 2-1 Risk Assessment and Management, OIMS System 6-5 Environmental Management, OIMS System 9-1 Incident Management and OIMS System 10-2 Emergency Preparedness and Response.

10.1 Transport of fuel and chemicals

Fuel and chemicals will generally be delivered to the LNG Plant and Marine Facilities by third party suppliers, primarily from Port Moresby. EHL will take responsibility for purchased fuel and chemicals upon receipt.

As part of the procurement process, the agreements in place between EHL and third party suppliers will include minimum requirements relating to spill prevention, preparedness and response. Third party suppliers of fuel and chemicals are subject to prior assessment and approval. Follow-up assessments of third parties will be undertaken periodically.

10.2 Fuel storage and transfer

Diesel fuel is stored at the LNG Plant diesel system in a 100 cubic metre tank. The tank is purpose-built above ground and includes secondary containment sufficient to enable containment of 110 percent of the storage capacity of the largest vessel present.

Integrity of diesel transfer facilities, including transfer lines, vehicles and associated pumps and couplings, will be routinely inspected as part of preventive maintenance.

Diesel is not required for the main process during normal operations but is provided for the essential services generators and the diesel firewater and sea firewater pumps. Diesel is also used to fuel mobile operations equipment at the LNG Plant and Marine Facilities. Purpose-built fuel bowsers provide for refuelling mobile equipment.

10.3 Chemical storage and transfer

Chemicals are stored at various locations at the LNG Plant. Chemical storage facilities are purpose-built and include secondary containment sufficient to enable containment of 110 percent of the storage capacity of the largest vessel present. Integrity of chemical transfer facilities including transfer lines, vehicles and associated pumps and couplings, will be routinely inspected as part of preventive maintenance.

10.4 Condensate storage and transfer

Condensate product from the fractionation system is transferred to the condensate storage tanks. There are two condensate storage tanks of 10,500 cubic metres. The tanks have bunding providing 110 percent of the largest tank capacity.

Condensate is loaded from the combined LNG/condensate loading berth to condensate vessels. An emergency shutdown system is installed to reduce the risk of spills. Condensate spill containment is provided for the jetty and a spill basin is provided to prevent release of condensate to sea.

10.5 LNG storage and transfer

LNG produced in the liquefaction section of the process area is directly rundown to the LNG storage tanks via a common rundown header. Back-pressure control valves are provided on

top of each tank to ensure the rundown system remains liquid-full. There are two LNG storage tanks of 160,000 cubic metres. The tanks are of single containment design with bunds providing 110 percent of the largest tank capacity.

Loading pumps are installed in each LNG storage tank for transfer of LNG to vessel via a common loading line. During holding mode, the loading line is maintained cold by circulating LNG. At the loading berth, loading arms and a vapour return arm are provided for loading.

An emergency shutdown system is installed to reduce the risk of product spills and mechanical damage to the loading arms. The first stage is shutdown of cargo transfer and the second stage is release of loading arms.

The grade of the LNG Plant process area is sloped to an insulated concrete trench running parallel to the process area to collect potential LNG spills and then routed away from sources of ignition and collected in a sump. Potential cryogenic spill exposed areas have been identified and structural support elements located within these areas are provided with adequate protection such as concrete coating and insulation. Fixed high-expansion foam systems are provided for cryogenic spill vapourisation reduction at relevant locations.

The jetty loading platform is designed to route LNG spills to sea via a dedicated spill collection system consisting of a cold-spill resistant drip pan and downcomers located under equipment where leaks of LNG could occur. Cryogenic spill protection is installed for the loading platform area and supporting piles.

10.6 Spill response

Third party suppliers of fuels and chemicals are responsible for responding to a spill or release at their own facilities or while in transit. EHL will assess third party suppliers prior to approval and will review spill response arrangements. The agreements in place between EHL and third party suppliers will include minimum requirements relating to spill preparedness and response. Follow-up assessments of third parties will be undertaken periodically.

EHL will respond to a spill or release of fuel or chemical at EHL facilities, or while in transit by EHL between EHL facilities. The level of spill response is dependent upon the potential impact of the spill. In general, spills are categorised as Tier 1 (within the capability of EHL to respond on-site), Tier 2 (exceeds the capability of EHL's on-site resources) and Tier 3 (exceeds available resources in Papua New Guinea and requires resources to be mobilised internationally). EHL will respond to Tier 1 spills directly using on-site resources. In the case of a Tier 2 spill, EHL will respond using on-site resources and resources mobilised from other EHL facilities.

Further details about EHL's response to spills of hydrocarbons are provided in EHL's Oil Spill Response Plan.

Subsequent to a spill where significant site contamination has occurred, action will be taken to remediate the site and prevent any further impacts to the environment, or human health risks. A site-specific risk assessment will be undertaken to identify human health and environmental risks associated with the contaminated site. Corrective actions and monitoring needs will be evaluated as part of the assessment. Appropriate management and monitoring plans will be developed using information gathered during the inspection.

11.0 MATERIALS MANAGEMENT

EHL's objectives are to avoid significant impacts associated with the procurement and use of raw materials and to use materials that are less hazardous or otherwise preferable from an environmental perspective, where practical.

Controls necessary to achieve the above objectives relating to the use and management of materials, including prohibited substances, hazardous materials, water, aggregate and quarry materials and timber, are described in this section.

11.1 Materials review

Materials used during production will be reviewed periodically to determine whether alternative materials are available which are less hazardous or otherwise preferable from an environmental perspective, and to evaluate opportunities for waste reduction.

11.2 Prohibited substances

EHL will avoid the use of chemicals and hazardous materials subject to international bans or phase-outs due to their high toxicity to living organisms, environmental persistence, potential for bio-accumulation, or potential for depletion of the ozone layer, consistent with the objectives of the *Stockholm Convention on Persistent Organic Pollutants (The Secretariat of the Stockholm Convention, 2009)*, *Montreal Protocol on Substances that Deplete the Ozone Layer (Ozone Secretariat United Nations Environment Programme, 2000)* and *Rotterdam Convention (Secretariat of the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, 2011)*.

EHL will also avoid the use of lead-based coatings, primers, paints and lubricants; leaded thread compound; fluorescent lights containing mercury; asbestos; chlorinated solvents (e.g. carbon tetrachloride); chromate corrosion inhibitors and heavy metals (such as in reverse emulsion breakers and grit blast).

11.3 Hazardous materials

EHL will seek to reduce the use of hazardous materials by evaluating opportunities to use alternative materials that are less hazardous or otherwise preferable from an environmental perspective.

Where the use of a hazardous material is unavoidable, product-specific controls will be implemented. Controls may include engineering (e.g. alarms, shut-off systems) or operational controls commensurate with the nature of the hazard.

In general, hazardous materials will be stored separately pursuant to compatibility requirements, within a covered area. Hazardous materials containers and vessels will be clearly labelled with the name and description of the hazardous material. Material Safety Data Sheets will be readily available and prominently displayed in relevant storage areas. Personnel will be trained in the handling of hazardous materials in accordance with specific job responsibilities.

11.4 Surface water and groundwater abstraction

Seawater is used for the desalination system and there is no planned abstraction of other surface or groundwater during normal operation of the LNG Plant and Marine Facilities.

Should surface water abstraction be required, and where there is potential for the abstraction to have adverse effects on downstream users and/or environmental flows, generally when the proposed abstraction is in excess of 10 percent of indicative stream flow, EHL will conduct an environmental assessment, and the abstraction will be managed so as to mitigate identified impacts.

Water abstraction permits will be obtained where necessary, pursuant to the Environment Permit.

In case of demonstrable disruption to community water supply as a result of water abstraction or other activity, EHL will provide alternate water supply, pursuant to the Environment Permit.

11.5 Aggregate and quarry material

New quarries developed by EHL or directly on behalf of EHL are permitted under the Environment Permit and additional permits are not necessary.

Prior to the development of new quarries a pre-disturbance survey will be undertaken of the area to be affected and environmental and social sensitivities will be identified.

On the basis of the pre-disturbance survey results, site-specific mitigation and management measures will be adopted to avoid and/or otherwise mitigate identified sensitivities prior to and/or during exploitation of the quarry and render the quarry area safe upon abandonment.

Aggregate and quarry material purchased from third party suppliers will be sourced from legal quarries/borrow pits that are in possession of permits where necessary. To ensure that the facilities and operations of third party suppliers of aggregate and quarry material are fit-for-purpose, they are subject to prior assessment and approval.

Aggregate will not be sourced from any water body, including ephemeral streams and flood plains (including aggregate purchased from third parties).

11.6 Timber

Timber and wood products purchased from third party suppliers will be sourced from legal operations that are in possession of permits where necessary and operate in an environmentally acceptable manner.

To ensure that the operations of third party suppliers are fit-for-purpose, they are subject to prior assessment and approval.

12.0 WASTE

EHL's objectives are to apply the waste management hierarchy and to manage and dispose of waste at EHL facilities and licensed third party facilities only.

Measures to prevent, mitigate and otherwise control potential significant environmental impacts associated with waste are described below. Information about waste to be generated during production and a description of how waste will be managed, including design and operational controls, is also provided.

The control measures set out in this section, including design and operational controls, have been developed in accordance with the waste management requirements prescribed in OIMS System 6-5 Environmental Management.

12.1 General provisions

EHL will apply the waste minimisation and management hierarchy where practical, by prioritising the avoidance and reduction of waste in the first instance, followed by reuse, recycling and recovery, with treatment and disposal being the least preferable options.

With the exception of reuse, recycling and recovery, EHL waste facilities will be used for the treatment and disposal of wastes. Where wastes are transferred to a third party, duty of care applies and such transfer of wastes is subject to formal audit and approval by EHL.

Wastes are categorised as either non-restricted or restricted depending on their toxicity and treated accordingly at EHL or EHL approved third party facilities.

Non-restricted wastes are those that do not pose an immediate threat to health, safety and/or the environment (examples are canteen waste, paper, cardboard, packing materials, scrap metal, rubble, timber and plastic).

Restricted wastes are those that are easily ignited, corrosive or reactive, toxic, pathogenic or otherwise hazardous (examples are oils and greases, oil-contaminated rags, containers, filters, degreasing agents, fluorescent tubes, batteries, and health care waste).

An indicative inventory of wastes is shown in Table 12-1. An inventory of wastes will be maintained in a register.

The register describes and categorises each type of waste and sets out provisions for its management. It also includes a waste record section that describes the quantities and ultimate fate of each waste generated.

Table 12-1: Typical waste types, treatments and disposal methods

CLASSIFICATION	TYPE	SOURCE	ESTIMATED QUANTITY (KILOGRAMS /YEAR)	TREATMENT	DISPOSAL
Restricted	Waste lube oils	Plant area	11,900	Recycle	Third party
	Spent oils	Hot oil system	100	Incinerate	Landfill
	Oily sludge	Corrugated plate interceptor separator	49,400	Recycle	Third party
	Spent solvents	Plant area	100	Incinerate	Landfill
	Activated carbon	Acid Gas Removal Unit	3,090		Landfill
	Medical waste	Clinic	3,000	Incinerate	Landfill
Non-restricted	Inorganic sludge	Dissolved air floatation unit	300	Incinerate	Landfill

CLASSIFICATION	TYPE	SOURCE	ESTIMATED QUANTITY (KILOGRAMS /YEAR)	TREATMENT	DISPOSAL
	Plastics	Plant area/office	1,500	Recycle	Off-site
	Ceramic balls	Dehydration unit	4,200	Aeration	Landfill
	Molecular sieve	Dehydration unit	41,500	Aeration	Landfill
	Biological sludge	Sewage treatment plant	36,500	Incinerate	Landfill
	Trash	Plant area/office	64,100	Incinerate	Landfill

Note: Actual waste types and treatment/disposal methods may vary. An inventory of actual wastes and treatment/disposal methods is maintained in the register of wastes.

12.2 Waste avoidance and minimisation

The potential for waste generation is considered at the early stage of materials selection. As discussed in Section 11.0 materials used during production will be reviewed periodically to evaluate opportunities for waste reduction.

12.3 Waste collection

Non-restricted wastes will be separated at source into labelled receptacles. The contents of the receptacles will be collected periodically and transferred to the LNG Plant waste storage area for further sorting as necessary.

Restricted wastes will be separated at source at designated collection points that enable appropriate segregation and storage of waste pursuant to compatibility requirements. The restricted waste collection points are secure and fitted with a roof and appropriate containment to prevent release to the environment. The contents of the restricted waste collection points will be transferred periodically to the LNG Plant waste storage area.

Non-routine wastes will be categorised as part of the register of wastes and provisions for their management will be determined prior to transfer to the LNG Plant waste storage area.

12.4 Waste storage

The LNG Plant waste storage area provides for the separate storage of non-restricted and restricted wastes in a manner which facilitates subsequent management (reuse, recycling, recovery, treatment and disposal).

Wastes transferred to the LNG Plant waste storage area will be verified and documented upon receipt. Wastes will be screened to ensure only acceptable waste types are received and the weight and volume of wastes will be recorded.

Restricted wastes will be stored, separately pursuant to waste compatibility requirements, within a covered area with appropriate containment to prevent release to the environment.

12.5 Waste reuse, recycling and recovery

In accordance with the waste minimisation and management hierarchy, wastes will be preferentially reused, recycled or recovered.

Third parties and third party facilities receiving EHL waste for purposes of reuse, recycling and recovery are subject to prior assessment and approval by EHL.

12.6 Waste treatment and disposal

Wastes that cannot be reused, recycled and/or recovered will be treated and disposed of at the LNG Plant. Treatment and disposal generally consists of the following key activities:

- Treatment (pre-treatment as necessary in preparation for incineration/disposal)

- Incineration (of combustible wastes)
- Ash stabilisation (handling and stabilisation of bottom and fly ash from incineration)
- Landfill (disposal of inert waste that is not suitable for incineration and ash residues from the incineration process)
- Leachate treatment (treatment of landfill leachate)

Each process is outlined below.

12.6.1 Treatment

Treatment of solid wastes in preparation for incineration or disposal to landfill may include crushing of metal and plastic drums. The sewage sludge dewatering system treats sludge prior to incineration.

12.6.2 Incineration

Combustible wastes (material that will burn effectively such as organics, paper/card and plastics) will be incinerated. A high-temperature industrial incinerator featuring a dual combustion chamber design is located at the LNG Plant to reduce the volume of appropriate waste streams prior to burial of residual ash in the on-site engineered landfill.

12.6.3 Ash stabilisation

Bottom and fly ash from the incineration process is subject to the toxicity characteristic leaching procedure to determine its hazard category. Ash categorised as non-restricted will be directed to landfill without further treatment. Ash categorised as restricted will be stabilised in cement and then directed to landfill.

12.6.4 Landfill

The LNG Plant has an on-site engineered solid waste landfill within the property limits for the disposal of non-combustible unrestricted solid waste including the incinerator residue ash.

The landfill is intended to receive non-restricted wastes. It is constructed with a barrier liner of high density polyethylene geo-membrane liner and geo-synthetic clay layers.

The design of the landfill provides for up to two separate cells, which will be developed sequentially over time as required, with each cell being filled and covered prior to the next cell being commissioned. The cells are to be separated by internal bunds, which will provide for stormwater and leachate management and each will be provided with a leachate sump.

In order to avoid damage to the geo-membrane liner, waste will be placed with care (for example, avoidance of rigid wastes) over the entire base of the cell until a sufficiently compacted base has been established. Waste will then be added to the active face and compacted from the base up in layers. A cover of earthen material (with low clay and organic content) will be placed periodically over the waste that has been added in order to prevent wind-blown litter and suppress odour. When a cell reaches capacity, an interim cover of earthen material will be put in place to secure the surface.

Final covering of landfill cells will be undertaken in stages, but in general will occur as soon as practicable in order to reduce ingress of rain and hence generation of leachate and to collect and vent landfill gases. The final cover will consist of three layers. The first layer will be a landfill gas distribution layer consisting of porous material and containing a network of high density polyethylene pipes connected to landfill gas trenches that enable the venting of landfill gases. The second layer will consist of compacted soil and a geo-synthetic clay liner. The final layer will contain topsoil. The surface of the covered landfill will then be vegetated to prevent erosion. Further design requirements included *The Environmental Code of Practice for Sanitary Landfill Sites, Papua New Guinea (The Office of Environment and Conservation, 2001)*, *Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007)* and *Title 40 – Protection of Environment, Part 258 – Criteria for*

Municipal Solid Waste Landfills [40 CFR 258] (United States Environmental Protection Agency, 2011), Subpart D. A diagram of the LNG Plant landfill is shown in Figure 12-1.

12.6.5 Leachate treatment

Leachate from the landfill will be directed to the WWTP for treatment.

12.7 **Waste tracking and documentation**

Wastes will be tracked and documented through all stages of the management process, from the point of generation and collection, through to storage, treatment and final disposal at the LNG Plant or transfer to third party facilities for reuse, recycling and/or recovery.

A waste manifest will be completed upon collection of wastes. The manifest identifies the point of generation and the type, volume/quantity and categorisation of the waste.

Waste received at the landfill will be inspected and the waste manifest will be verified as part of the waste acceptance process. Similarly, waste received at the incinerator will be inspected and the waste manifest verified as part of the waste acceptance process. The waste manifest will be updated with details of the fate of the wastes.

A waste incineration record will be maintained for all incinerator burn cycles to track the type and quantity of incinerated wastes. A landfill acceptance record will be maintained to track the type and quantity if all wastes disposed of to landfill.

Wastes transferred from the LNG Plant to third party facilities for reuse, recycling and/or recovery will be accompanied by a waste transfer record identifying the type and quantity of wastes being transferred including details and signatures of the shipper and receiver.

Information from the waste manifest, waste incineration record, landfill acceptance record and waste transfer record documents will be compiled in the register of wastes.

12.8 **Waste monitoring**

EHL undertakes periodic inspections of the waste management process from the point of generation and collection, through to storage, treatment and final disposal. Inspections are discussed further in Section 19.0.

12.9 **Export of restricted waste**

EHL may at its discretion export certain restricted wastes for treatment and disposal. In such cases, applicable provisions of the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Secretariat of the Basel Convention, 1992)* and the *Waigani Convention: Convention to Ban the Importation of Hazardous and Radioactive Wastes into Forum Island Countries and to Control the Transboundary Movement and Management of Hazardous Waste within the South Pacific Region (Secretariat Pacific Regional Programme, 2001)* will be applied.

Third parties and third party facilities receiving exported restricted waste are subject to prior assessment and approval by EHL.



Figure 12-1: LNG Plant landfill layout

13.0 EROSION AND SEDIMENT CONTROL

EHL's objectives are to control significant erosion and prevent sedimentation of surface waters.

Land disturbed for temporary facilities and infrastructure, along with land in the immediate vicinity of permanent facilities and infrastructure, were reinstated following construction. Reinstatement works included temporary and permanent measures to control erosion.

Provisions for ongoing monitoring and maintenance of permanent erosion control works and measures to control potential environmental impacts associated with erosion and sedimentation, are described below.

13.1 Inspection

EHL will conduct inspections within and in the immediate vicinity of the LNG Plant and Marine Facilities. The integrity of permanent erosion control structures and other measures in place to control erosion will be checked as part of the inspections. Particular attention will be paid to areas in the vicinity of surface waters, where sedimentation could occur.

13.2 Maintenance and remedial action

Where deemed necessary, for example to protect asset integrity and/or prevent sedimentation of surface waters, EHL will respond to erosion, slope stability and/or sedimentation issues.

Response may include remedial work to permanent erosion control structures, and/or the installation of temporary control measures, where appropriate, in particular where there is potential for sedimentation of surface waters.

Controls implemented by EHL may be supplemented by controls undertaken by the service provider, under direction from EHL.

14.0 REINSTATEMENT AND REGENERATION

EHL's objectives are to promote regeneration of temporary work areas disturbed during construction and achieve vegetation succession according to established benchmarks.

Land disturbed for temporary facilities and infrastructure, along with land in the immediate vicinity of the LNG Plant and Marine Facilities, was reinstated following construction. The overall objective of the construction phase reinstatement program was to establish stable landform conditions and create ground conditions conducive to natural regeneration. Reinstatement works included measures to control erosion and sedimentation and facilitate regeneration.

Measures to inspect and maintain permanent reinstatement works and reinstatement measures associated with new disturbance of land are described below.

14.1 Access control

Access to regenerating areas will be restricted where practical to prevent disturbance of regenerating areas and enable natural regeneration of vegetation.

14.2 Inspection

EHL will conduct inspections of regenerating areas to observe status of reinstatement and regeneration.

14.3 Maintenance and remedial action

EHL will use a risk-based approach to determine whether remedial action is required to address poor reinstatement and regeneration performance. Risk screening will be undertaken to identify relevant risks and identify appropriate remedial measures.

15.0 INVASIVE SPECIES, PESTS AND PLANT PATHOGENS

EHL's objectives are to prevent priority invasive species, pests and plant pathogens from entering or becoming established in or in the vicinity of EHL's facilities and infrastructure; and contain existing priority invasive species, pests and plant pathogens already present.

Measures to prevent, mitigate or otherwise control potential environmental impacts associated with weeds, pests and plant pathogens are described in this section.

15.1 Invasive species: identification

Invasive species are categorised according to their potential for environmental harm and hence priority for management, as shown in Table 15-1.

Table 15-1: Categorisation of invasive species

PRIORITY	DESCRIPTION
Priority 1	Invasive of a natural ecosystem; ability to rapidly colonise bare ground.
Priority 2	Persistent in the natural ecosystem; ability to become locally dominant.
Priority 3	Persistent in the natural ecosystem only where there is ongoing disturbance.

Details of all invasive species identified in EHL's area of operations; including categorisation, location and degree of occurrence; are included in a register.

To facilitate identification and management, details of Priority 1 and Priority 2 invasive species, including photographs and appropriate control measures, are included in an invasive species identification manual.

15.2 Invasive species: management and monitoring

Based on the occurrence, distribution and trends of invasive species in the area of EHL's operations, invasive species management zones have been established. For each management zone, specific management and monitoring priorities are established.

Invasive species management zones relevant to this EMP are summarised in Table 15-2.

EHL will conduct inspections within and in the immediate vicinity of the LNG Plant and Marine Facilities. The presence of invasive species will be checked as part of the inspections in accordance with the priorities established in the invasive species management zones. Inspections focus on the potential occurrence of previously unrecorded species and the potential expansion or increase in abundance of Priority 1 and Priority 2 species.

15.3 Invasive species: remedial action

Where intervention is required in accordance with the priorities established in the invasive species management zones, EHL will implement invasive species controls, which may include physical removal, slashing (cut stump), mulching and/or application of herbicides as appropriate.

The occurrence, distribution and trends of invasive species in the area of EHL's operations are subject to a periodic assessment by an independent expert advisor. As part of these assessments, the advisor will provide recommendations for the remedy of any identified problems and update the invasive species management zones as appropriate.

Table 15-2: LNG Plant and Marine Facilities invasive species

ZONE	EXISTING PRIORITY 1 SPECIES	OBJECTIVES
Riparian	Mile a Minute <i>Mikania micrantha</i>	Control Priority 1 species. Conduct surveys to monitor occurrence and distribution.
	Milkweed <i>Euphorbia heterophylla</i>	
	Purple Bush-bean <i>Macroptilium atropurpureum</i>	
	Miracle Tree <i>Leucaena leucocephala</i>	
	Baja Passion Vine <i>Passiflora foetida</i>	
	Gamba Grass <i>Andropogon gayanus</i>	
	Giant Cane <i>Arundo donax</i>	
	Forest Bluegrass <i>Bothriochloa ewartiana</i>	
	Para Grass <i>Brachiaria mutica</i>	
	Cloncurry Buffel <i>Cenchrus pennisetiformis</i>	
	Kunai <i>Imperata cylindrical</i>	
Grassland	Purple Bush-bean <i>Macroptilium atropurpureum</i>	
	Baja Passion Vine <i>Passiflora foetida</i>	
	Forest Bluegrass <i>Bothriochloa ewartiana</i>	
	Cloncurry Buffel <i>Cenchrus pennisetiformis</i>	
Coastal	Crab's Eye <i>Arbus precatorius</i>	
	Baja Passion Vine <i>Passiflora foetida</i>	
	Thatch Grass <i>Hyparrhenia rufa</i>	

15.4 Quarantine

EHL has adopted quarantine requirements that aim to prevent the importation and spread of foreign invasive species, pests, pathogens or disease.

While responsibility for quarantine control rests with the Papua New Guinean National Agriculture Quarantine and Inspection Authority, EHL's quarantine requirements are designed to ensure that National Agriculture Quarantine and Inspection Authority requirements and international good practice for the import of goods are followed.

Requirements include avoidance of prohibited packaging materials, International Standards For Phytosanitary Measures No. 15 treatment and stamping for all timber packaging, cleaning of shipping containers at point of origin and maintenance of all necessary documentation to verify quarantine hygiene.

Suppliers and importers of goods directly and solely for EHL are required to inspect cargo, containers and break-bulk cargo at the point of origin and ensure quarantine hygiene measures, such as cleaning and fumigation, are applied as necessary to containers, container contents and break-bulk cargo (which must be as clean as new) at point of origin.

EHL will follow International Maritime Organization requirements and industry good practice with respect to ballast water discharge and hull cleaning to prevent the introduction of invasive species.

EHL may, at its discretion, audit suppliers and importers of goods.

Quarantine requirements are further described in the Quarantine Procedure.

16.0 ECOLOGY

EHL's objective is to avoid impacts to specific features of ecological importance.

Disturbance and/or harassment of wildlife, hunting of fauna, gathering of plants or bush foods, collection of firewood or possession of wildlife products is prohibited.

Focal habitats and other ecological sensitivities within and in the immediate vicinity of the LNG Plant and Marine Facilities were identified as part of the environmental pre-construction survey program undertaken during construction. Site-specific mitigation and management measures were adopted to avoid and otherwise mitigate potential impacts where feasible.

Measures to monitor the condition of focal habitats and sensitive ecological features within and in the vicinity of the LNG Plant and Marine Facilities and prevent impacts to these features are described in this section.

It should be noted that direct impacts to focal habitats and sensitive ecological features during normal operations are expected to be negligible.

16.1 Inspection

Details of focal habitats and other ecological sensitivities within and in the vicinity of the LNG Plant and Marine Facilities are included in a register.

EHL will conduct inspections to check the condition of focal habitats and other sensitive ecological features and determine the significance of any change to the condition of the ecological sensitivity.

16.2 Remedial action

Where problems are noted, EHL will determine appropriate mitigation measures, in consultation with an independent expert advisor where needed.

Certain circumstances may hinder EHL's ability to control outcomes, for example where landowners insist on access to a focal habitat or ecological feature. In these situations, EHL will engage with the relevant party/parties and endeavour to achieve desired outcomes.

17.0 CULTURAL HERITAGE

EHL's objectives are to avoid impacts to cultural heritage sites, including archaeological and oral tradition sites and to manage cultural heritage sites in consultation with landowners.

Cultural heritage sensitivities within and in the immediate vicinity of the LNG Plant and Marine Facilities were identified as part of the EIS and the environmental pre-construction survey program undertaken during construction. Site-specific mitigation and management measures were adopted to avoid and otherwise mitigate potential impacts where feasible.

Measures to monitor the condition of cultural heritage sensitivities in the vicinity of the LNG Plant and Marine Facilities and prevent impacts to these features are described in this section.

Direct impacts to cultural heritage sensitivities during normal operations are expected to be negligible.

17.1 Inspection

Details of cultural heritage sensitivities in the vicinity of the LNG Plant and Marine Facilities are included in a register. EHL will conduct inspections to check the condition of cultural heritage sensitivities.

17.2 Remedial action

Based on the results of inspections, and where problems are noted, EHL will determine appropriate mitigation measures in consultation with landowners and where appropriate with the Papua New Guinea National Museum and Art Gallery and qualified archaeologists or other practitioners.

Where intervention is required and is within EHL's control, intervention will be undertaken by qualified archaeologists supported by EHL as needed.

Certain circumstances may hinder EHL's ability to control outcomes, for example where landowners insist on access to a cultural heritage site. In these situations, EHL will engage with the relevant party/parties and endeavour to achieve desired outcomes.

17.3 Management of salvaged archaeological material

Archaeological salvage undertaken during construction was completed in accordance with the terms of the Permit for Investigation and Salvage Protocol (LNG Plant) issued by National Museum and Art Gallery on 26 August 2009.

The salvage process and the cultural material obtained from the salvage is documented and described in the *Final Report on the Archaeological Salvage Excavations at the PNG LNG Facilities Site and Bypass Road Corridor (Monash University, 2011)* and all cultural material has been transferred to the National Museum and Art Gallery pursuant to the requirements of the *National Cultural Property (Preservation) Act 1965*.

Cultural heritage material recovered as part of any salvage work undertaken during production will be managed in consultation with National Museum and Art Gallery and in accordance with the terms of the Permit for Investigation and Salvage Protocol (LNG Plant) and the *National Cultural Property (Preservation) Act 1965*.

18.0 ENVIRONMENTAL MONITORING

The environmental monitoring program for production is described in this section. For the purposes of this EMP, environmental monitoring does not include the processes of verification, inspection, assessment and audit, which are discussed in Section 19.0.

The monitoring measures outlined have been developed in accordance with the requirements of, and using the methods prescribed in OIMS System 6-5 Environmental Management.

18.1 Monitoring of emissions to air

Monitoring of emissions to air from relevant emissions sources at the LNG Plant and Marine Facilities is outlined in Table 18-1.

Table 18-1: Monitoring of emissions to air

FACILITY	PARAMETER	EMISSION GUIDELINE VALUE	SUMMARY	FREQUENCY**
Compressor gas turbines/WHRU	Oxides of nitrogen	25 ppm	Stack test	Annual
Main power generators	Oxides of nitrogen	42 ppm	Stack test	Annual
Waste incinerator	PM	70 mg/m ³	Stack test	Annual
	Carbon monoxide	157 ppm		
	Oxides of nitrogen	388 ppm	Stack test	Annual
	Oxides of sulphur	20 ppm	Stack test	Annual
	Hydrogen chloride	62 ppm	Stack test	Annual
	Cadmium	0.004 mg/m ³	Stack test	Annual
	Lead	0.04 mg/m ³	Stack test	Annual
	Mercury	0.47 mg/m ³	Stack test	Annual
	Dioxin/furan	0.41 ng/m ³	Stack test	Annual
	Opacity	10 percent	Visual observation	Daily

Source (compressor gas turbines/WHRU and main power generators): *General Environmental, Health and Safety (EHS) Guidelines (IFC, 2007)*, Table 1.1.2 - Small Combustion Facilities Emissions Guidelines.

Source (waste incinerator): Based on *Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 60] (United States Environmental Protection Agency, 2008)*, Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units), including threshold for applicability relating to throughput, as referenced in *Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007)*.

Emission guideline values apply during normal steady state operations, and not start-up, shut-down and abnormal operations.

Emission guideline values for dioxin/furan at toxic equivalency basis.

Compressor gas turbines/WHRU and main power generator parameters are stated at reference conditions of 15 percent oxygen, dry gas.

Incinerator parameters are stated at reference conditions of 7 percent oxygen, dry basis at standard conditions.

**Monitoring will be undertaken twice yearly for the first two years of operations and annually thereafter.

Emissions monitoring consists of periodic stack sampling undertaken on behalf of EHL by a competent specialist in accordance with standard industry methods and subject to the provisions set out in the Stack Emissions Monitoring Procedure.

18.2 Monitoring of ambient air quality

Monitoring of ambient air quality will be undertaken periodically in the vicinity of the LNG Plant and Marine Facilities to validate the predictions of the ambient air quality assessments (see Section 7.0) and evaluate conformance with the guideline values outlined in Table 7-1.

An initial monitoring campaign will be undertaken once the facility has achieved steady state operations, but in any case within the first two years of production. A second monitoring campaign will be undertaken during start-up following the first planned maintenance shut-down. Ambient air quality monitoring will then be undertaken at regular intervals. The frequency of ambient air quality monitoring will be determined on the basis of need and environmental risk but in any event will be undertaken no less than every five years. Ambient air quality monitoring will be conducted on behalf of EHL by a competent specialist in accordance with standard industry methods. The focus of ambient air quality monitoring will be sensitive community receptors identified as part of baseline air quality assessments and dispersion modelling exercises.

18.3 Monitoring of noise

Monitoring of noise will be undertaken periodically at perimeter fence line of the LNG Plant to validate data obtained through noise modelling and evaluate conformance with the guideline values in Table 8-1. Monitoring will be undertaken in accordance with the method set out in the Noise Monitoring Procedure.

18.4 Monitoring of discharges to water

Monitoring of discharges from the retention pond consists of periodic in-situ sampling of the parameters shown in Table 9-1. Monitoring will be undertaken in accordance with the method set out in the LNG Plant and Marine Facilities Effluent Monitoring Procedure.

The criteria referenced in Table 9-1 are the full suite of water quality criteria prescribed in the *Environment (Water Quality Criteria) Regulation 2002*. Not all of these parameters are relevant to the discharge from the retention pond. In order to determine those parameters relevant to the discharge, EHL will undertake initial monitoring campaigns during the first two years of production, which cover the full range of parameters prescribed in the *Environment (Water Quality Criteria) Regulation 2002*. Thereafter, only relevant parameters will be monitored. For the purposes of monitoring, the criteria shown in Table 9-1 are deemed by EHL to apply end of pipe (at the discharge location) and not in the receiving water body. Should monitoring indicate that any of the criteria have not been met end of pipe, monitoring shall be undertaken in the receiving water body, where feasible, in order to evaluate compliance with the *Environment (Water Quality Criteria) Regulation 2002*.

18.5 Monitoring of water quality

Monitoring of marine water quality will be undertaken periodically at several locations in the vicinity of the marine outfall. Parameters to be monitored are shown in Table 9-1. Monitoring will be undertaken in accordance with the method set out in the Marine Water Quality Monitoring Procedure.

Monitoring of freshwater quality will be undertaken periodically at several locations in the Vaihua River. Parameters to be monitored are shown in Table 9-1. Monitoring will be undertaken in accordance with the method set out in the Surface Water Quality Monitoring Procedure.

18.6 Monitoring of groundwater quality

Monitoring of groundwater quality in the vicinity of the LNG Plant landfill consists of periodic grab samples of the parameters shown in Table 18-2.

Samples will be taken at one up-gradient well, two cross-gradient wells and two down-gradient wells in accordance with the method set out in the Groundwater Monitoring Procedure.

Table 18-2: Monitoring of groundwater

PARAMETER	GUIDELINE VALUE	SUMMARY	METHOD
pH	No alteration above background	Grab sample at one up-gradient well, two cross-gradient wells and two down-gradient wells. Conducted every six months.	See Groundwater Monitoring Procedure.
Dissolved oxygen			
Sulphate			
Ammonia-nitrogen			
Nitrates			
Major ions (calcium, magnesium, sodium, potassium)			
Electrical conductivity			
Arsenic	No alteration above background	Grab sample at one up-gradient well, two cross-gradient wells and two down-gradient wells. Conducted every six months.	See Groundwater Monitoring Procedure.
Barium			
Boron			
Cadmium dissolved			
Chromium (as hexavalent)			
Cobalt			
Copper			
Iron (dissolved)			
Lead			
Manganese (dissolved)			
Mercury			
Nickel			
Selenium			
Silver			
Tin			
Zinc			
Total petroleum hydrocarbons			
Faecal coliforms			
Phenols			
Source: Annex 2 of EHL's Environment Permit, based on <i>Environment (Water Quality Criteria) Regulation 2002</i> , Water Quality Criteria for Aquatic Life Protection.			

18.7 Monitoring of freshwater ecology

Monitoring of ecological conditions of the Vaihua River will be undertaken at the discretion of EHL.

18.8 Monitoring of marine ecology

Monitoring of ecological conditions in Caution Bay will be undertaken at the discretion of EHL.

18.9 Non-conformance and corrective action

Non-conformances identified through the environmental monitoring program will be tracked using an action tracking system. The action tracking system includes details of all environmental non-conformances, the remedial/corrective action(s) required, responsible parties assigned to actions/timings and the status of the remedial/corrective action(s).

19.0 ASSESSMENT AND AUDIT

Processes for environmental verification, inspection, assessment and audit are described in this section. The processes have been developed in accordance with the requirements prescribed in OIMS System 1-1 Management Leadership and Commitment, OIMS System 6-5 Environmental Management and OIMS System 11-1 OIMS Assessments.

19.1 Verification and inspection

EHL will undertake a field-based verification and inspection program to evaluate environmental aspects, verify and document the implementation, and in some cases the effectiveness, of environmental controls set out in this EMP.

The verification and inspection program will be undertaken by EHL in accordance with a predetermined protocol that sets out the methods, frequency and scope of inspections. Frequency of inspections will be determined on the basis of need and environmental risk, but in general inspections will be carried out on a daily, weekly, monthly or quarterly basis as appropriate.

The protocol for the field-based verification and inspection program will be periodically reviewed and adapted in response to inspection results, changing circumstances and lessons learned (for example practicality, interpretability and usefulness).

The field-based verification and inspection program will be documented in a register that includes details of the inspections undertaken and a summary of the findings and results.

The verification and inspection program is outlined in Table 19-1.

19.2 Assessment

EHL will undertake assessments to evaluate environmental aspects, verify and document the implementation, and in some cases the effectiveness, of environmental controls set out in this EMP. OIMS assessments will be undertaken in accordance with OIMS System 11-1 OIMS Assessments, to evaluate the degree to which OIMS requirements are met as part of the implementation of this EMP.

In addition to periodic assessments, EHL will conduct targeted assessments in response to particular circumstances.

EHL may undertake assessments of third party facilities and providers, as relevant to this EMP.

Assessments undertaken by EHL will be documented in a register including details of the assessments and a summary of the findings and results.

Table 19-1: Verification and inspection

ASPECT/CONTROL	GENERAL SCOPE OF VERIFICATION/INSPECTION
Emissions to air	<ul style="list-style-type: none"> • Visual inspection of stack and flare emissions • Stack emissions monitoring results • Continuous emissions monitoring system results • Incinerator operating conditions and combustion temperatures • Visual inspection of diesel engines • Diesel engine maintenance records • Fugitive emissions • Direction of perimeter and other lighting
Ambient air quality	<ul style="list-style-type: none"> • Ambient air quality monitoring results
Noise	<ul style="list-style-type: none"> • Noise monitoring results • Notification to affected communities of high intensity noise events

ASPECT/CONTROL	GENERAL SCOPE OF VERIFICATION/INSPECTION
Discharges to water	<ul style="list-style-type: none"> • Visual inspection of water systems and discharge location • Visual inspection of WWTP • WWTP operating conditions • Discharge monitoring results
Spill prevention and response	<ul style="list-style-type: none"> • Third party transport of fuel and chemicals • Fuel and chemical storage facilities • Fuel and chemical transfer facilities and operations • Spill response equipment
Materials management	<ul style="list-style-type: none"> • Registers • Prohibited substances • Hazardous materials controls and Material Safety Data Sheets
Waste	<ul style="list-style-type: none"> • Registers • Waste avoidance and minimisation • Waste collection areas and process • Waste storage areas and process • Waste reuse, recycling and recovery • Waste transfer to third parties • Waste treatment areas and process • Waste incineration area and process • Landfill area and process • Waste tracking documentation
Erosion and sediment	<ul style="list-style-type: none"> • Condition of erosion control works • Condition of surface waters • Mitigations for new disturbance
Reinstatement and regeneration	<ul style="list-style-type: none"> • Condition of reinstatement works/devices • Status of reinstatement and regeneration • Encroachment of regenerating areas • Mitigation for new disturbance
Invasive species, pests and plant pathogens	<ul style="list-style-type: none"> • Registers • Invasive species identification manual • Presence of new invasive species and pests • Spread of existing invasive species and pests
Ecology	<ul style="list-style-type: none"> • Register of focal habitats and ecological sensitivities • Condition of focal habitats and ecological sensitivities • Mitigation for new disturbance
Cultural heritage	<ul style="list-style-type: none"> • Registers • Condition of cultural heritage sensitivities • Mitigation for new disturbance

19.3 Audit and review

The Independent Environmental and Social Consultant (IESC), on behalf of the Lender Group, will undertake an annual review of the environmental aspects set out in this EMP.

Co-venture parties may undertake environmental audit of the environmental aspects controls set out in this EMP.

The DEC may undertake environmental audit of the environmental aspects controls set out in this EMP.

Audits undertaken by external parties will be documented using a register that includes details of the audits and a summary of the findings and results.

19.4 Non-conformance and corrective action

Non-conformances identified through the field-based verification and inspection program, assessments and audits will be tracked using an action tracking system. The action tracking system includes details of all environmental non-conformances, the remedial/corrective action required, actions/timings assigned to responsible parties and status of the remedial/corrective action.

19.5 Performance indicators

In accordance with OIMS System 6-5 Environmental Management, EHL will steward environmental performance data through the use of performance indicators.

Performance indicators relevant to this EMP are shown in Table 19-2, including relevant indicators from the Environmental Performance Indicators Manual.

The performance indicators will be periodically compiled using data collected from the registers and monitoring, verification, assessment and audit processes described in this EMP.

Table 19-2: Performance indicators

ASPECT	OBJECTIVE	INDICATOR	MEASUREMENT <small>NOTE 1</small>
Emissions to atmosphere and ambient air quality	Avoid significant impacts associated with the release of pollutants to the atmosphere.	Exceedance of emissions criteria.	Number
	Meet applicable emissions and air quality criteria.	Exceedance of air quality criteria.	Number
Noise	Avoid significant noise and vibration impacts to community and fauna.	Noise-related grievances.	Number
	Meet applicable noise criteria.	Exceedance of noise criteria.	Number
Discharges to water	Avoid significant impacts associated with the release of pollutants to surface water and groundwater.	Exceedance of discharge criteria.	Number
	Meet applicable discharge criteria.		
Spill prevention and response	Prevent spills of hydrocarbons and chemicals.	Release of hydrocarbons and/or chemicals to the environment.	Type and number
	Respond quickly and effectively to spills should they occur.		
Materials management	Avoid significant impacts associated with the procurement and use of raw materials.	Use of chemicals and/or hazardous materials subject to international bans or phase-outs.	Number
	Use materials that are less hazardous or otherwise preferable from an environmental perspective, where practical.		
Waste	Apply the waste management hierarchy.	Waste managed and disposed of at EHL facilities and approved/licensed third party facilities only.	Percent
	Manage and dispose of waste at EHL facilities and licensed third party facilities only.		
Erosion and sediment	Control significant erosion and prevent sedimentation of surface waters.	Occurrence of significant erosion.	Number
		Sedimentation of surface waters.	Number
Invasive species, pests and plant pathogens	Prevent priority invasive species from entering or establishing in the Project area.	Ingress of new priority invasive species in and between invasive species management zones.	Type, abundance and distribution

ASPECT	OBJECTIVE	INDICATOR	MEASUREMENT ^{NOTE 1}
	Contain priority invasive species and plant pathogens already established in the Project area.	Increases in abundance and/or distribution of existing priority invasive species and/or plant pathogens in and between invasive species management zones.	Type, abundance and distribution
Ecology	Avoid impacts to specific features of ecological importance.	<p>Condition of specific features of ecological importance assessed:</p> <ul style="list-style-type: none"> • Level 1 – Minor change to condition of a sensitive/protected habitat or population of an International Union for Conservation of Nature (IUCN) listed (or Papua New Guinea protected) species • Level 2 – Moderate change to condition of a sensitive/protected habitat or population of an IUCN listed (or Papua New Guinea protected) species • Level 3 – Major change of condition of a sensitive/protected habitat or population of an IUCN listed (or Papua New Guinea protected) species 	Significance of change to the condition of specific ecological features
Cultural heritage	Avoid impacts to cultural heritage sites, including archaeological and oral tradition sites.	Cultural heritage sites disturbed.	Number
	Manage cultural heritage sites in consultation with landowners.	Cultural heritage sites managed in accordance with landowner direction.	Number
Note 1: 'Number' in this column refers to number of occurrences.			

20.0 INCIDENT MANAGEMENT, NOTIFICATION AND REPORTING

Environmental incidents are managed, reported and notified as outlined in this section. These processes have been developed in accordance with the requirements prescribed in OIMS System 9-1 Incident Management.

20.1 Incident management

OIMS System 9-1 Incident Management defines the incident management process to be followed by EHL during production, including requirements for managing environmental incidents.

For the purposes of this EMP, an incident is defined as a specific event, sequence of events, or extended condition that has an unwanted or unintended impact on the environment. EHL's Incident Management Guide defines types of incidents and their Severity Level.

In general, environmental incidents during production will be managed as follows:

- Reduce further harm where applicable to personnel, the environment and assets
- Classify the incident and notify and/or report to internal and external stakeholders as appropriate
- Investigate incidents, regardless of the Severity Level, to identify causes and implement corrective actions to prevent incident recurrence
- Stimulate learning opportunities by sharing lessons learned internally and externally as appropriate

Contractors and subcontractors will adhere to EHL's incident management requirements.

20.2 Incident notification and reporting

All environmental incidents will be documented, notified and reported in accordance with EHL's Incident Management Guide, which defines requirements for managing incidents, including environmental incidents, and the method and timing required for the notification and reporting of incidents dependent upon classification of Severity Level (<0, 0, 1, 2, 3).

20.2.1 Internal notification and reporting

Environmental incidents are notified and reported in accordance with the EHL's Incident Management Guide.

20.2.2 Statutory notification and reporting

Environmental incidents are notified to government agencies pursuant to statutory notification requirements.

Condition 95 of the Environment Permit requires EHL to promptly report to the DEC any significant environmental incidents that occur.

The Department of Petroleum and Energy is notified of significant environmental incidents pursuant to the requirements of the *Oil and Gas Act 1998* and the associated *Oil and Gas Regulation 2002*. Section 8 of the *Oil and Gas Act 1998* requires immediate notification of all incidents involving spillage of hydrocarbons in excess of 10 barrels (1,600 litres).

20.2.3 Notification and reporting to IESC/Lender Group

The IESC/Lender Group is notified of environmental incidents pursuant to the requirements of the Common Terms Agreement.

Contractors and subcontractors will adhere to EHL's incident notification and reporting requirements.

21.0 ROLES AND RESPONSIBILITIES

Organisational roles and responsibilities relating to the implementation of this EMP are outlined in this section. These roles and responsibilities are defined in accordance with the requirements prescribed in OIMS System 1-1 Management Leadership and Commitment, which contains requirements pertaining to the allocation of resources.

In general, and as mandated by OIMS, EHL will ensure sufficient resources are allocated on an ongoing basis to achieve effective implementation of this EMP. Organisational charts and individual job descriptions are periodically reviewed.

EHL's E&R organisation is allocated primary responsibility for the implementation of this EMP. In addition to the SHE and E&R organisations, other EHL production and maintenance personnel have defined roles and responsibilities regarding this EMP. Roles and responsibilities of key personnel are outlined in Table 21-1.

Table 21-1: Roles and responsibilities

ROLE	RESPONSIBILITY
LNG Plant Manager	<ul style="list-style-type: none"> • Overall accountability for conformance with the requirements of this EMP pertaining to the LNG Plant and Marine Facilities • Ensure operational resources are allocated to the effective implementation of this EMP, in respect of the LNG Plant and Marine Facilities
SHE Manager	<ul style="list-style-type: none"> • Overall responsibility for conformance with the requirements of this EMP
LNG Plant Waste Contractor	<ul style="list-style-type: none"> • Operate the LNG Plant waste management facility in conformance with the provisions of this EMP and other applicable requirements
E&R Supervisor	<ul style="list-style-type: none"> • Ensure environmental resources are allocated to the effective implementation of this EMP

22.0 COMPETENCY, TRAINING AND AWARENESS

Information relating to competency, training and awareness regarding the implementation of this EMP is provided in this section. EHL aims to ensure that personnel involved in the implementation of this EMP have the experience, knowledge and other skills necessary to meet the requirements of their specific job functions.

The processes set out in this section have been developed in accordance with the requirements prescribed in OIMS System 5-1 Personnel Selection, Placement and Competency Verification and OIMS System 5-2 Personnel Training.

22.1 Competency

In accordance with OIMS System 5-1 Personnel Selection, Placement and Competency Verification, EHL will define competency requirements for specific job functions and verify competency during personnel selection and placement.

Competency requirements for the job functions and roles involved in the implementation of this EMP will be specified and documented. Competency will be verified during personnel selection and placement to ensure that individual qualifications, knowledge and skills (namely competencies) are appropriate for the specific job requirements. Competency will also be verified on an ongoing basis through observation and performance assessments.

Where an individual does not meet all competency requirements required for his or her specific job function, appropriate training requirements are identified.

22.2 Training and awareness

In accordance with OIMS System 5-2 Personnel Training, EHL will ensure that personnel responsible for the execution of the tasks and requirements contained within this EMP are trained, on an ongoing basis, and have the knowledge and skills necessary to meet the requirements of their specific positions.

Training and awareness associated with this EMP will be planned and documented by means of a training needs assessment, training program and training records. Training needs assessments and training programs will be reviewed periodically.

The training program will include several levels of competency and training, delivered as a function of job descriptions and individual duties, as summarised in Table 22-1.

Table 22-1: Training and awareness

TYPE OF TRAINING	DESCRIPTION
Induction	Induction is provided to visitors. Inductions include a summary of key environmental aspects, controls and other relevant instructions. This training is specific to each location and facility.
General awareness	Awareness and overview training is provided to personnel who do not have direct duties in relation to this EMP. The training includes a summary of key environmental aspects, controls and other relevant instructions.
Management awareness	Awareness is provided to management and supervisors. The training includes key aspects of this EMP.
Job-specific training	Job-specific training is provided to personnel who have direct duties in this EMP. The training includes a detailed review of specific components of this EMP and a detailed description of individual duties.

Training will consist of on-the-job training, mentoring, self-study, classroom instruction, seminars, workshops, computer-based training and practical drills, as appropriate.

22.3 Training of third parties

EHL will ensure that third parties and service providers have the necessary competencies through the procurement and selection process, as outlined in OIMS System 8-1 Third Party Services.

23.0 DATA MANAGEMENT

Registers and data obtained from the monitoring, verification, assessment, audit and performance indicator processes described in this EMP will be managed using an electronic information management system.

The information management system acts as a repository for all data relating to this EMP and is designed to handle and manipulate data as required (for example tracking and trend analysis) to facilitate reporting.

24.0 REPORTING

24.1 Internal reporting

Summary reports concerning the implementation of this EMP will be compiled periodically as necessary for the E&R Supervisor, SHE Manager or other EHL management.

The summary reports will include qualitative and quantitative data, reporting against performance indicators, non-conformance and incident data, and other information as relevant.

24.2 External reporting

24.2.1 Reporting to the Department of Environment and Conservation

Pursuant to the Environment Permit, EHL will submit periodic environmental reports to the DEC. The reports will include qualitative and quantitative data, environmental monitoring data (sampling and analysis), non-conformance and incident data (including remedial and corrective actions), reporting against performance indicators, water extraction volumes, pre-construction surveys undertaken in the reporting period, and other information as relevant to this EMP.

24.2.2 Reporting to the Lender Group

Pursuant to the Common Terms Agreement, EHL will submit a biannual/annual production Environmental and Social Report to the Lender Group and the IESC.

The Environmental and Social Report will include qualitative and quantitative data, environmental monitoring summaries (sampling and analysis), verification, assessments and audits undertaken during the reporting period, non-conformance and incident data (including remedial and corrective actions), reporting against performance indicators, notifications made to the Lender Group, pre-construction surveys undertaken and other information as relevant to this EMP.

25.0 REFERENCES

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26.0 APPENDICES

Appendix 1: Environmental Impact Statement mitigation measures

Appendix 2: Summary of emissions and discharges

APPENDIX 1: ENVIRONMENTAL IMPACT STATEMENT MITIGATION MEASURES

IFC PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i></p> <p>Pollution Prevention, Resource Conservation and Energy Efficiency</p>	M43, M49	Use low mono-nitrogen oxides turbines at in the LNG Plant. Turbine generators will use dry, low-emissions technology to maintain mono-nitrogen oxides and carbon monoxide concentrations at less than 25 ppm.	Section 6.0
	M46	Collect and dispose of benzene, toluene, ethylbenzene, and xylene emissions through thermal destruction or industry best practice from all significant sources.	Section 6.0
	M47	Regularly inspect and maintain valves, pipes and tanks, etc. to reduce fugitive volatile organic compound emissions.	Section 18.0
	M48	WHRUs will utilise heat from the exhaust from the aero-derivative turbines driving the two propane refrigeration compressors to provide the main source of heat to the hot oil system.	Section 6.0
	M96	Manage sewage in an appropriate manner to limit contamination and protect human health.	Section 9.0
	M129	Treat effluents to appropriate standards and allow time for sediment to settle prior to discharge.	Section 9.0
	M133	Operate sewage treatment plants in accordance with the manufacturer's specifications and comply with the conditions of discharge quality specified in the Environment Permit.	Section 9.0
	M134, M135, M149	Treat all water and wastewater discharges as necessary to comply with the prescribed conditions for discharge quality established in the Environment Permit.	Section 9.0
	M136	Non-equipment areas at plant facilities will be graded and sloped to allow uncontaminated stormwater to drain naturally via the stormwater drains prior to routing off-site.	Section 9.0
	M159	Site-specific surface water and stormwater management procedures will be implemented.	Section 9.0
	M171	Adhere to specific criteria for construction and production that are aligned to the intent of the IFC and World Health Organization guidelines. A boundary noise limit of 55 dBA Leq (day) and 45 dBA Leq (night) from noise sourced from the operation of the facilities will apply to protect the amenity of landowners.	Section 8.0
	M174	Notify potentially affected persons of intended high intensity work and its duration.	Section 8.0
	M206	Consider discharging wastewater and brine in the same vicinity to assist with salinity dilutions.	Section 9.0
M219	Treated effluent will be sent to retention pond for polishing prior to discharge into Caution Bay in accordance with the required Environment Permit (waste discharge) conditions.	Section 9.0	

IFC PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Waste</p>	M92	Dispose of waste to EHL-approved waste facilities.	Section 12.0
	M97, M128, M181	Incinerate combustible waste at EHL approved facilities, dispose of ash to EHL-approved landfills.	Section 12.0
	M98	Track all wastes to be disposed or recycled.	Section 12.0
	M103	Establish procedures for waste that comply with applicable parts of the <i>General Environmental, Health and Safety (EHS) Guidelines (IFC, 2007)</i> and <i>Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007)</i> and meet the intent of limits in <i>Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 258] (United States Environmental Protection Agency, 2008)</i> Subpart D, as applicable.	Section 12.0
	M132	Treat and dispose of biological, pharmaceutical and medical wastes using appropriate technologies, including use of special containers, segregation and handling procedures.	Section 12.0
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Hazardous Materials</p>	M26	Fuel, lubricating oils and chemicals will be stored in appropriately designed and sized designated areas that have impervious liners and/or bunds as appropriate.	Section 10.0
	M30	Suitable containment provided for all parts of the plant area where hazardous or dangerous goods are stored or used.	Section 10.0
	M100	Establish appropriate procedures for fuel handling transport and storage.	Section 10.0
	M101	Establish appropriate procedures for materials handling, storage and disposal.	Section 10.0
	M102	Establish appropriate procedures for the storage and handling of radioactive materials.	Section 11.0
	M146	Fuel and chemical storage systems shall be purpose-built, located in designated above ground areas away from watercourses, and provided with secondary containment. As appropriate secondary containment will be designed to enable containment of 110 percent of the storage capacity of the largest container present.	Section 10.0
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Emergency Preparedness and Response</p>	M25	Vehicles and machinery are to be maintained to a high level of safety with respect to leaks. Drivers will be appropriately trained and have the required driving licence.	Section 10.0
	M27	Establish an onshore Oil Spill Contingency Plan appropriate to the Project phase and include staff training at induction to inform workers of their responsibilities under the Plan.	Section 10.0
	M209	Establish an offshore Oil Spill Contingency Plan appropriate to the Project phase and include staff training at induction to inform workers of their responsibilities under the Plan.	Section 10.0
	M151	An appropriate number of staff will be trained in the handling of emergency response and spill scenarios.	Section 10.0

IFC PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
<p><i>Performance Standard 3: Pollution Prevention and Abatement (IFC, 2006)</i> Pollution Prevention and Abatement: Pesticide Use and Management</p>	M80	Use herbicides only for the eradication of a serious invasive weed if considered to be most effective control.	Section 11.0
<p><i>Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management (IFC, 2006)</i></p>	M1	Establish and enforce Project-wide quarantine management procedures as part of the Ecology, Natural Habitat and Biodiversity Plan.	Section 15.0
	M2	Establish and enforce pest and weed management procedures for the LNG Plant as part of the Ecology, Natural Habitat and Biodiversity Plan.	Section 15.0
	M8	Prohibit staff from disturbing migratory species and associated habitats, especially along perimeter fence adjacent to mudflat habitat.	Section 16.0
	M9	Prohibit disturbance/harassment of wildlife, hunting of fauna, gathering of plants or bush foods, collection of firewood or possession of wildlife products by Project workers or contractors while working, travelling in Project vehicles, and residing in Project field accommodation. Implement appropriate inductions and education to encourage staff to comply with regulations.	Section 16.0
	M18	Where practicable, disturbed areas will be returned to former landforms and vegetation of exposed areas will occur as soon as practicable once construction activities are completed in any particular location. Areas prone to erosion will receive particular attention.	Section 14.0
	M41	Where practicable, utilise treatments for the reduction of light spill into the marine environment to reduce visibility of the site from Ihidi Island where turtles may be nesting. Reduce lighting on jetty when not loading while meeting navigation and security guidelines.	Section 6.0
	M222	A Project-wide quarantine management plan will follow International Maritime Organization requirements and industry good practice with respect to ballast water discharge and hull cleaning to prevent the introduction of invasive species.	Section 15.0
	M53	Prohibit establishment of gardens with introduced plants and introduction of exotic plants or animals.	Section 15.0
	M58	Implement appropriate inductions to encourage staff to comply with hunting and collecting regulations.	Section 16.0

IFC PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
<i>Performance Standard 8: Cultural Heritage (IFC, 2006)</i>	M230	Develop and implement a cultural heritage management plan in consultation with the Museum and Art Gallery, archaeologists and cultural heritage specialists.	Section 18.0
	M239	Periodically monitor cultural sites within the vicinity of pipelines and facilities to ensure Project personnel are not disturbing these sites.	Section 18.0
<p>Note: The language of some measures has been revised since the EIS to better reflect actual circumstances and provide greater clarity.</p>			

APPENDIX 2: SUMMARY OF EMISSIONS AND DISCHARGES

SUMMARY OF EMISSIONS TO AIR					
SOURCE ^{NOTE 1}	NATURE	POLLUTANTS ^{NOTE 2}	GUIDELINE		MONITORING
Compressor gas turbines	Continuous	Oxides of nitrogen	25 ppm ^{NOTE 3}		Annual stack test ^{NOTE 4}
Main power generators			42 ppm ^{NOTE 3}		
Regeneration gas furnaces			N/A		N/A
Wet flare stack (purge and pilot gas)			N/A		N/A
Dry flare stack (purge and pilot gas)			N/A		N/A
Tankage flare (purge and pilot gas)			N/A		N/A
Essential services generators	Intermittent	Oxides of nitrogen, carbon monoxide, sulphur dioxide	N/A		N/A
Diesel firewater pump					
Diesel sea firewater pump					
Waste incinerator	Intermittent	Waste dependent ^{NOTE 5}	PM	70 mg/m ³ ^{NOTE 6}	Annual stack test ^{NOTE 4}
			Carbon monoxide	157 ppm	
			Oxides of nitrogen	388 ppm	
			Oxides of sulphur	20 ppm	
			Hydrogen chloride	62 ppm	
			Cadmium	0.004 mg/m ³	
			Lead	0.04 mg/m ³	
			Mercury	0.47 mg/m ³	
			Dioxin/furan	0.41 ng/m ³	
			Opacity	10 percent	

SUMMARY OF DISCHARGES TO WATER						
DISCHARGE TYPE	SOURCE	NATURE	POLLUTANTS AND GUIDELINE VALUES <small>NOTE 7</small>			MONITORING
				WATER QUALITY CRITERIA (FRESHWATER)	WATER QUALITY CRITERIA (SEAWATER)	
Stormwater Wastewater Treatment Plant Process Leachate	Retention pond	Intermittent	pH	6.5 – 9 (pH units)	No alteration to natural pH	Periodic in-situ sampling
			Temperature	No alteration greater than 2 degrees Celsius	No alteration greater than 2 degrees Celsius	
			Turbidity	No alteration greater than 25 NTU or no change >10 percent from background levels at any particular time (whichever is greater)	No alteration greater than 25 NTU or no change >10 percent from background levels at any particular time (whichever is greater)	
			Total Suspended Solids	50 mg/L or no change >10 percent from background levels at any particular time (whichever is greater)	50 mg/L or no change >10 percent from background levels at any particular time (whichever is greater)	
			Insoluble residues	No insoluble residues or sludge formation to occur	No insoluble residues or sludge formation to occur	
			Dissolved oxygen	Not less than 6 mg/L or no change >10 percent from background levels at any particular time (whichever is greater)	Not less than 5 mg/l or no change >10 percent from background levels at any particular time (whichever is greater)	
			Chemical oxygen demand	125 mg/l	125 mg/l	
			Biological oxygen demand	25 mg/l	25 mg/l	
			Sulphate as SO ₄ ²⁻	400 mg/l	---	

SUMMARY OF DISCHARGES TO WATER						
DISCHARGE TYPE	SOURCE	NATURE	POLLUTANTS AND GUIDELINE VALUES ^{NOTE 7}			MONITORING
				WATER QUALITY CRITERIA (FRESHWATER)	WATER QUALITY CRITERIA (SEAWATER)	
Stormwater Wastewater Treatment Plant Process Leachate (cont.)	Retention pond (cont.)	Intermittent	Sulphide as HS-	0.002 mg/l	0.002 mg/l	Periodic in-situ sampling
			Ammonia-nitrogen	Dependent on pH and temperature (see Table 9-2)	---	
			Nitrate	45 mg/l	45 mg/l	
			Potassium	5 mg/l	600 mg/l	
			Barium	1 mg/l	1 mg/l	
			Boron ^{NOTE 8}	1 mg/l	10 mg/l	
			Cadmium	0.01 mg/l	0.001 mg/l	
			Chromium (as hexavalent)	0.05 mg/l	0.01 mg/l	
			Cobalt	Limit of detection	Limit of detection	
			Copper	1 mg/l	0.03 mg/l	
			Iron	1 mg/l	1 mg/l	
			Lead	0.005 mg/l	0.004 mg/l	
			Manganese	0.5 mg/l	2 mg/l	
			Mercury	0.0002 mg/l	0.0002 mg/l	
			Nickel	1 mg/l	1 mg/l	
Selenium	0.01 mg/l	0.01 mg/l				
Silver	0.05 mg/l	0.05 mg/l				
Tin	0.5 mg/l	0.5 mg/l				

SUMMARY OF DISCHARGES TO WATER						
DISCHARGE TYPE	SOURCE	NATURE	POLLUTANTS AND GUIDELINE VALUES ^{NOTE 7}			MONITORING
				WATER QUALITY CRITERIA (FRESHWATER)	WATER QUALITY CRITERIA (SEAWATER)	
Stormwater Wastewater Treatment Plant Process Leachate (cont.)	Retention pond (cont.)	Intermittent	Zinc	5 mg/l	5 mg/l	Periodic in-situ sampling
			Oil and grease	No visible film (for construction discharges) 10 mg/l (for production discharges)	No visible film (for construction discharges) 10 mg/l (for production discharges)	
			Phenols	0.002 mg/l	0.002 mg/l	
			Faecal coliform	Not to exceed 200 colonies per 100 ml or no change >10 percent from background levels at any particular time (whichever is greater)	Not to exceed 200 colonies per 100 ml or no change >10 percent from background levels at any particular time (whichever is greater)	

Note 1: This table does not include emissions sources associated with vents or pressure relief devices such as pressure control valves or pressure vacuum safety valves at HGCP, for details refer to Section 6.0.

Note 2: Includes only the key pollutants of relevance.

Note 3: Based on *General Environmental, Health and Safety (EHS) Guidelines (IFC, 2007)*, Table 1.1.2 - Small Combustion Facilities Emissions Guidelines.

Note 4: Stack tests will be undertaken twice yearly for the first two years of operations, thereafter annually.

Note 5: Incinerator emissions will depend upon the composition of the waste incinerated during each burn cycle.

Note 6: All incinerator parameters based on *Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 60] (United States Environmental Protection Agency, 2008)*, Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units), including threshold for applicability relating to throughput, as referenced in *Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007)*.

Note 7: Annex 2 of EHL's Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection.

Note 8: Value for boron agreed with DEC due to high background levels in Caution Bay.