Bulk Liquids Berth No. 2 - Port Botany

ENVIRONMENTAL ASSESSMENT

- Final
- 9 November 2007

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Environmental Assessment

The Environmental Assessment was prepared by:

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Qualifications: BSc

In respect of : Bulk Liquids Berth Number No. 2 – Port Botany

Certification

I certify that I have prepared the contents of this Environmental Assessment and to the best of my knowledge the information contained in the Assessment is neither false nor misleading.

Signature:

Name: Jonas Ball

Date: 9 November 2007

Executive Summary

Introduction

This Environmental Assessment has been prepared to obtain approval for the construction and operation of a second Bulk Liquids Berth (BLB2) facility at Port Botany. BLB2 is proposed primarily to cater for future growth of imported and exported chemical, petroleum and gas products and reduce potential demurrage costs. The BLB2 project comprises:

- Construction of a steel piled pier berth adjacent to the existing BLB1;
- Installation of associated infrastructure such as marine loading arms (MLA) and fire fighting equipment;
- Installation of additional pipelines from existing user sites to the new berth; and
- Unloading/ loading and maintenance activities associated with the operation of the facility 24 hours a day 7 days a week.

BLB2 would be located adjacent to the existing Bulk Liquids Berth (BLB1) at the south-western end of Brotherson Dock approximately 11 km south of the Sydney CBD.

Strategic Objective

The primary strategic objective of the project is to ensure New South Wales has adequate berth capacity to satisfy existing and future forecast demands for the import and export of bulk liquids for the benefit of the NSW economy.

Purpose of the Environmental Assessment

The Environmental Assessment has been prepared under Part 3A of the *Environmental Planning and Assessment Act 1979* to obtain project approval for the BLB2. It assesses the environmental issues associated with the construction and operation of the BLB2 and provides mitigation measures to address any potential impacts. It also includes a draft 'Statement of Commitments' that outlines commitments for the management of environmental effects that could occur from the construction, operation and maintenance of the project.

Description of the Project

The project would consist of the following main elements:

- Central working platform providing a work area, with berthing face (including bollards and fenders) and pipe manifold/ marine loading arm (MLA) arrangements;
- Adjacent berthing dolphins on each side of working platform designed to accommodate up to the maximum length vessel;

- Two mooring dolphins on each side of the working platform (four in total). Mooring dolphins would be required on the northern side of the working platform, instead of the existing land based mooring point arrangement used for the BLB1 due to the geometry of the existing shoreline.
- Walkways (catwalks) connecting the dolphins and working platform;
- An access bridge structure connecting the working platform with the shore and providing for vehicle access and pipeline support structures;
- Support infrastructure including fire control facilities (pumps, foam/water monitors and associated tanks, gatehouse and amenities (the need for a gatehouse is dependant on site security arrangement); and
- Berth fitout, including fire fighting monitors, services such as water, sewer, electrical and communications, amenities and blastproof Operator Shelter.

Alternatives

Options were considered for the relocation or creation of additional bulk liquids facilities including:

- Construction of additional petroleum and chemical storage facilities at Port Kembla;
- Construction of additional petroleum and chemical storage at the port of Newcastle;
- Augmentation of Shell facility at Gore Bay for importation of petroleum products; and
- Augmentation of Caltex facility at Kurnell for importation of petroleum products.

Port Botany was selected as the preferred BLB2 location as it would:

- Allow existing and planned storage and transfer infrastructure at Port Botany to be fully utilised;
- Provide a common user facility; and
- Be located near the existing BLB1 and augment existing BLB1 infrastructure. The design and operation of BLB2 and the frequency, size and types of vessels envisaged to use BLB2 would be consistent with the current operations of BLB1. In addition, BLB2 would be constructed within the identified context and setting of Port Botany and would compliment existing port functions in that it would:
- Form part of an established port and industrial area as being suitable for such uses;
- Contribute to the economic significance of the area; and
- Be physically suitable with existing land for a bulk liquids berth.

Environmental Impact and Mitigation

Hazard and Risk

The project involves the handling and transfer of hazardous liquids and gases and a Preliminary Hazard Analysis (PHA) was prepared in accordance with the Department of Planning's *Hazardous Industry Planning Advisory Paper No. 6, Guidelines for Hazard Analysis* and *Multi-Level Risk Assessment*.

The methodology used the Multi-Risk Assessment approach, published by the NSW Department of Planning and included the following steps:

- Hazard Analysis;
- Consequence analysis;
- Frequency analysis; and
- Risk Analysis and Review.

The following hazards associated with BLB2 development and operations were identified during the hazard identification workshop held on 26 June 2007:

- Ship strikes the wharf at excessive speed;
- Moored ship is struck by passing ship;
- Chemical hose failure leading release of chemicals;
- Chemical pipeline failure leading to release of chemicals;
- Marine loading arm failure leading to flammable gas release;
- Liquefied Flammable Gas (LPG) pipeline failure leading to flammable gas release
- Marine loading arm failure leading to flammable liquid release;
- Flammable liquid pipeline failure leading to flammable liquid release; and
- Mooring systems fail leading to ship moving away from the wharf and breaking transfer connections.

The risk analysis identified two main areas where risk impacts may occur:

- BLB2 Marine Loading Arm area on the wharf deck; and
- Pipeline isolating valve station located on the shoreline adjacent to the road.

The cumulative risks for incidents at the MLA and pipeline isolating valve station were assessed. The risk impacts occur at the existing 50pmpy contour that currently surrounds the proposed BLB2 facility in the Port Botany Land Use Study. There would be no or negligible impact on the existing 50pmpy contour or 1pmpy contour. The individual fatality risk at the closest industrial facility (Elgas) was assessed. It was identified that the fatality risk at this facility, as a result of the proposed BLB2 operation would be less than 19.3pmpy and is below the acceptable risk criteria of 50pmpy for industrial sites.

Appropriate equipment and systems safeguards would be applied to minimise risks and hazards during the operation and construction of BLB2.

Water Quality

There are three main habitat types in the Botany Bay marine environment and include:

- Seagrass beds including *Posidonia australis*, *Zostera capricorni* and *Halophila oralis* (closest located 1.5km east and north of BLB2 in Phillip Bay and Penrhyn Estuary, respectively);
- Mangrove communities (located in Penrhyn Estuary and approximately 4.5km from BLB2 at Towra Point wetlands); and
- Unvegetated soft sediments.

The area has been previously dredged to allow ships to access the port which has resulted in a highly modified seabed that does not support sensitive marine vegetation. Potential water quality impacts could occur during construction of piles which would involve boring, and chemicals, fuels and concrete used in the construction of BLB2. During operation, any spills or contaminated stormwater on the working platform would be captured in a bunded area and transferred to a wastewater storage tank for appropriate off-site disposal. Existing spill response procedures and resources would be reviewed and potentially upgraded to cater for BLB2. The design features of marine loading arms and associated infrastructure would also minimise risks of spills. Standard construction environmental management strategies and appropriate operational safeguards would also be implemented to minimise risks to water quality to be included in the Operational and Construction Environmental Management Plan.

Hydrodynamics

Botany Bay is a complex hydrodynamic environment affected by natural processes and modifications from dredging and reclamation. There are four main processes which influence the hydrodynamics of Botany Bay:

- Tidal movements – the main mechanism for flushing and mixing in the Bay;
- Wind generated waves – common occurrence due to shallow depth of most the Bay;
- Ocean generated waves – swells from ocean may impact wave generation due to relatively wide opening of Bay to the ocean;
- Inflows – from Cooks River and Georges River which may affect water movement primarily following periods of extended wet weather.

BLB2 is unlikely to have any impacts on the hydrodynamics of Botany Bay as it would be constructed in a highly modified environment (away from any foreshore areas), built on piles rather than a solid structure in the water and would not involve any dredging.

Air quality

An assessment of noise impacts was made accordance with the *Approved Methods for Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005). BLB2 construction air quality impacts would be minor and localised given the minor nature of works and that no sensitive receivers are located within 1.5 km of the site. Appropriate mitigation measures for dust minimisation and management during excavation works would be included in the Construction Environmental Management Plan.

The main impact to operational air quality would be an increase of emissions due to increased ship activities. The main pollutants of concern comprise NO_2, SO_2 and PM_{10} (particulate matter). Modelling undertaken to assess increase shipping activity indicates that no significant air quality impacts would result during the operation of the BLB2. Vapours would be controlled using DECC approved vapour emission controls.

Noise and Vibration

An assessment of noise impacts was made according to the requirements of the Department of Environment and Climate Change's *Industrial Noise Policy*. A noise model (SoundPLAN) was used to predict the noise impacts at residential locations resulting from the operations of BLB2. Noise impacts were predicted using neutral and adverse weather conditions. The modelling results indicate that noise levels from BLB2 only are lower than the most stringent night time noise criteria for both neutral and adverse weather conditions.

Construction noise levels are predicted to be below the background noise environment at all nearby residential locations. Operations of the BLB2 are predicted to be below the noise criteria for an industrial noise source. Although noise impacts are not expected to result from construction activities, noise minimisation strategies would be implemented.

Security

Access to BLB2 would be via the existing Charlotte Road Sydney Ports Corporation Security Gate /Administration Building which currently controls access to BLB1. Access would only be gained with authorised security cards to open the personnel access gate, or through the controlled gates for Operating Company vehicles. Conditions of entry to Bulk Liquids Berth are detailed in the Operations Manual and these measures would ensure security at BLB2 would be maintained as detailed in the CEMP.

Other environmental issues

Aspect	Existing Environment	Impacts & Mitigation Measures
Groundwater and Hydrology	■ BLB2 located within the boundaries of Botany Sands Aquifer. ■ Groundwater is classified as "high risk resource" due to contamination.	■ Construction impacts unlikely given the distance to groundwater users and most pipes are laid above ground. ■ Potential operation impacts from contaminated water from berth operations infiltrating into groundwater and pipe leakages. ■ Operational activities would not impact on Elgas Groundwater Management Zones. ■ Provided design initiatives are maintained and appropriate mitigation measures implemented, there would be a low potential for BLB2 to adversely affect groundwater quality and levels.
Geology, Topography and Soils	■ Sandstone and shale underlie BLB2 site. ■ BLB2 located on disturbed land and previous SPC study identified ASS could be encountered >1m below ground surface.	■ Excavation and piling works may result in sediment disturbance and runoff into Botany Bay, however impacts would be minor. ■ CEMP would be prepared to minimise impacts on groundwater, soils and water quality.
Visual Amenity	■ BLB2 site located within industrial area including existing port facilities and Sydney Airport runway, therefore has a low amenity value. ■ Nearest residential land use approximately 1.5km southeast at Phillip Bay.	■ Given substantial distance to sensitive receivers and low amenity of nearby industries, construction and operational impacts would not be significant. ■ Operation of BLB2 would comply with the lighting requirements of the Civil Aviation Safety Authority.
Terrestrial Ecology	■ No vegetation present on BLB2 site. ■ Penrhyn Estuary and Molineux Point are potential habitat for migratory birds and threatened species, however BLB2 would not impact on any flora or fauna species.	■ No mitigation measures required as BLB2 unlikely to affect terrestrial environment.
Socio-economic	■ BLB2 would cost approximately $69.7 million ■ Operation of BLB2 would generate an additional $43.8 million per annum to Gross State Product (67% increase in economic output).	■ BLB2 would provide local employment opportunities, rate levy generation for local authorities and contributions to social infrastructure. ■ General community will be able to view EA and write submissions to Department of Planning. Vopak Terminals would arrange site visit, presentation and question period for interested local community organisations.
Waste	■ Construction waste includes surplus materials (including pipes	■ Construction and Operational EMP would be developed using the

Aspect	Existing Environment	Impacts & Mitigation Measures
	and conduits), concrete and aggregate, and sewage and general garbage. ▪ Operational waste includes maintenance activities waste, stormwater treatment waste, and sewage and general garbage. ▪	principles in the WARR Act to minimise waste generation.
Utilities and Services	▪ BLB2 would require connection of electricity, sewerage and water, stormwater, communications and port infrastructure.	▪ Liaison with utility and service providers would mitigate potential impacts on utilities and services.
Heritage	▪ No recorded items of non-Indigenous and Indigenous heritage within or in the area of BLB2 site.	▪ Minimal potential for heritage items to be discovered, however appropriate mitigation measures implemented in the unlikely event a previously unrecorded item is discovered.
Traffic	▪ A number of major vehicle routes provide access to BLB2 site. ▪ Traffic generated around Port Botany is from Sydney Airport, large industrial facilities and residential development.	▪ Construction and operational impacts would be negligible, therefore no mitigation measures are required.

Justification for the Project

Sydney's population growth has placed increasing demand for bulk liquids storage and distribution. In addition, changing regulatory controls have created further pressures for the importation of petrol, liquid petroleum gas (LPG) hydrocarbons and chemical products. These pressures threaten the ability of bulk liquids storage facilities to operate efficiently, competitively and responsibly. It has therefore been recognised that without the installation of an additional berth, the bulk liquids market would deteriorate, erode in efficiency and degrade current standards expected from customers of bulk liquids. Without the new bulk liquids berth there may be impacts on the NSW economy due to increased costs associated with handling bulk liquids.

Overall, the construction and operation of BLB2 would have minor or negligible impacts on the surrounding community and environment, while ensuring that increasing regional demands for products handled at BLB2 are able to be accommodated.

1. Introduction

This Environmental Assessment has been prepared to obtain approval for the construction and operation of a second Bulk Liquids Berth (BLB2) facility at Port Botany. BLB2 will ensure the continued supply of and support the growth in bulk liquids for the State of NSW. The proposed BLB2 will be a shared common user facility managed by Sydney Ports Corporation (SPC). BLB2 will be used for importing and exporting refined fuels including petroleum products, chemicals and hydrocarbons (LPG). The project will consist of the following:

- Construction of a steel piled pier berth adjacent to the existing BLB1 parallel to privately owned Fishburn Road;
- Installation of associated infrastructure such as Marine Loading Arms (MLA) and fire fighting equipment;
- Installation of additional pipelines from existing user sites to the new berth;
- Unloading/loading and maintenance activities associated with the operation of facility 24 hours a day 7 days a week; and
- Servicing ships.

BLB2 is proposed to handle the predicted increase in imported and exported chemical, petroleum and gas products transferred into Port Botany and to reduce potential risk of demurrage costs. The proposed new berth would also allow the capacity to remain ahead of demand and ensure New South Wales has an efficient facility to service the State.

1.1 Background

The existing Bulk Liquids Berth (BLB1) at Port Botany is 30 years old and is heavily utilised by the bulk liquids industry. A second bulk liquids berth (BLB2) is required to meet increasing demand for bulk liquids in the State of NSW.

The existing BLB1 is located in Botany Bay at the south-western end of Brotherson Dock, Port Botany, approximately 11 km south of the Sydney CBD (**Figure 1-1**). BLB1 was commissioned in 1979 as a common-user facility and currently handles hazardous and non-hazardous bulk liquids and gases which are transferred by pipeline to nearby storage and distribution facilities.

The following companies have established bulk liquids/gas storage terminals at the Port and are current tenants of SPC:

- Terminals Pty Ltd;
- Qenos Australia Pty Ltd (Hydrocarbon Storage Facility);

- Origin Energy
- Elgas Pty Ltd; and
- Vopak Terminals Australia.

Beneficiaries of BLB1 (and of BLB2) include the chemical manufacturing industry, LPG users, oil majors and fuel supply to Sydney Airport.

- **Figure 1-1 Location of Existing BLB1**

The three main product groups which are handled at BLB1 are:

- Hydrocarbons (LPG);
- Chemical products (organic chemicals, solvents, caustic soda); and
- Petroleum products (petroleum, diesel, naphtha, jet fuel).

In the near future, a fourth product group is intended for import and export, being:

- Biodiesel feedstock and finished products.

BLB1 was initially designed for a maximum vessel with a ‘length overall’ (LOA) and a dead-weight tonnage (DWT) of 40,000 tonnes. However, since its commissioning there have been a number of additions and alterations to the berth and the facility can now berth ships with a LOA of 230m and a DWT of 90,000 tonnes (SPC Handbook, 2005-2007).

The demand for bulk liquids through the existing bulk loading berth (BLB1) has grown significantly in recent years. Berth utilisation at BLB1 varies and although currently it is less than the accepted economic maximum of 65%, (or between 200-250 occupancy days per year), the potential for demurrage charges are increasing to the users of the berth due to scheduling conflicts and operational limitations.

A second berth bulk liquids berth (BLB2) is proposed primarily to cater for future growth. It would operate concurrently with BLB1 and would be located adjacent to BLB1 (on the privately accessed Fishburn Road) and would be of a similar construction to BLB1. BLB2 would be a common-user facility which would handle hazardous and non-hazardous bulk liquids and gases similar to BLB1.

1.1.1 The Applicant

Vopak Terminals Sydney Pty Ltd (‘the Applicant’) is submitting this Major Project Application and Environmental Assessment Report for the construction and operation of a second Bulk Liquids Berth (BLB2) facility at Port Botany NSW, on behalf of SPC.

The Applicant is a company that provides bulk liquid storage and distribution facilities (transport, bulk handling and road tanker filling distribution) to independent operators and large corporations. These bulk liquids include fuel-based products used for energy and transport functions throughout NSW and chemicals that have a wide range of industrial applications.

Vopak operates two bulk liquid storage terminals in Port Botany. The first is known as the Site A Terminal and is located at 49 Friendship Road. The second facility, known as the Site B Terminal, is located at 20 Friendship Road (**Figure 1-2**). Site A stores chemicals and Site B stores petroleum products. The BLB2 development would take place upon SPC land at the privately owned Fishburn Road side (western) of the Site B Terminal, adjacent to the boundary with the Elgas Caverns, and on NSW Maritime land below the mean high water mark.

The existing Bulk Liquids Berth (BLB1) is owned and managed by SPC. As currently established with BLB1, BLB2 would be an open access/common user facility for the use of all potential bulk liquids customers. In order to minimise the duplication of facilities between BLB1 and BLB2, BLB2 would augment existing BLB1 infrastructure for access control, administration, and fire protection system, together with a new berth structure and ancillaries (user pipelines, hose handling gantries, berthing and mooring equipment).

- **Figure 1-2 Location of Vopak Site A and Site B Terminal**

1.1.2 Overview of the Proposal

BLB2 would comprise of the following main elements:

- A central working platform providing a work area, with berthing face (including integral berthing dolphins) and pipe manifold/marine loading arm (MLA) arrangements;
- Adjacent berthing dolphins on each side of working platform designed to accommodate up to the maximum length vessel;
- Two mooring dolphins on each side of the working platform (four in total). Mooring dolphins would be required on the northern side of the working platform, instead of the existing land based mooring point arrangement used for the BLB1 due to the geometry of the existing shoreline.

- Walkways (catwalks) connecting the dolphins and working platform;
- An access bridge structure connecting the working platform with the shore and providing for vehicle access and product pipeline support structures;
- Support infrastructure including fire control facilities (pumps, foam/water monitors and associated tanks, gatehouse and amenities (the need for a gatehouse is dependant on site security arrangement);
- Berth fitout, including fire fighting monitors, services such as water, sewer, electrical and communications and amenities.

1.2 Environmental Impact Assessment Process

1.2.1 Objectives of the Environmental Assessment

The Environmental Assessment (EA) prepared for BLB2 would be assessed under the requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation* (EP&A Regulation).

The objectives of the EA are:

- To comply with the requirements of the EP&A Act, as formalised in specific requirements issued by the Director General of the Department of Planning (DoP);
- To provide the Minister for Planning with sufficient information to make an informed decision on the environmental impacts and benefits of the proposal; and
- To inform the community about the proposal.

1.2.2 Exhibition of the Environmental Assessment

The EP&A Regulation requires that the EA be placed in public exhibition for comment for a minimum of 30 days.

1.2.3 Assessment and Decision

Following exhibition of the EA, copies of all submissions, or a report of all issues raised will be provided to Vopak and relevant Government authorities. Vopak, with assistance from SPC will review the submissions and consider and respond to issues raised, including the need or otherwise to modify the proposal.

DoP will prepare an assessment report on the proposed BLB2 at Botany Bay which will consider comments from the relevant Government authorities and relevant stakeholders. The assessment report will be provided to the Minister for Planning, who will make a decision on approval and set conditions in accordance with the EP&A Act.

1.3 Environmental Assessment Report Structure

To achieve the objectives of the EA specified above, the EA was prepared as follows:

- Section 2 – Statutory Planning – details the statutory and legislative framework of the proposed development
- Section 3 – Project Need and Alternatives – provides the justification for the expansion of BLB at Port Botany and considers alternative options.
- Section 4 – Project Description – describes the infrastructure associated with the proposed development including construction methodology and operation characteristics.
- Section 5 – Key Issues – environmental impact assessment of key aspects of the environment potentially impacted by proposed development.
- Section 6 – General Environmental Risk Analysis – discusses the key potential environmental impacts and mitigation measures to minimise those impacts.
- Section 7 – Stakeholder Engagement and Consultation – describes stakeholder engagement and community consultation during the environmental assessment preparation.
- Section 8 – Conclusion and Justification – summarises the overall impact of the proposed development.

2. Statutory Planning

2.1 Major Project

Development in NSW is subject to the requirements of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation, 2000* (EP&A Regulation). Environmental planning instruments prepared pursuant to the Act set the framework for approvals under the Act.

The proposed BLB2 would be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) as it is described in Schedule 1 and 2 of the *State Environmental Planning Policy (Major Projects) 2005*, which was gazetted along with the introduction of Part 3A of the EP&A Act. *State Environmental Planning Policy (Major Projects)* defines shipping berths in Group 8 of Schedule 1, with a capital investment of over $30 million as a Major Project in Clause 22:

> *"Development for the purpose of shipping berths or terminals or wharf-side facilities (and related infrastructure) that has a capital investment value of more than $30 million."*

The construction of BLB2 is estimated to cost approximately $69.7 million and thus would be classified as a Major Project as it falls under the definition of a shipping berth with a capital investment of over $30 million.

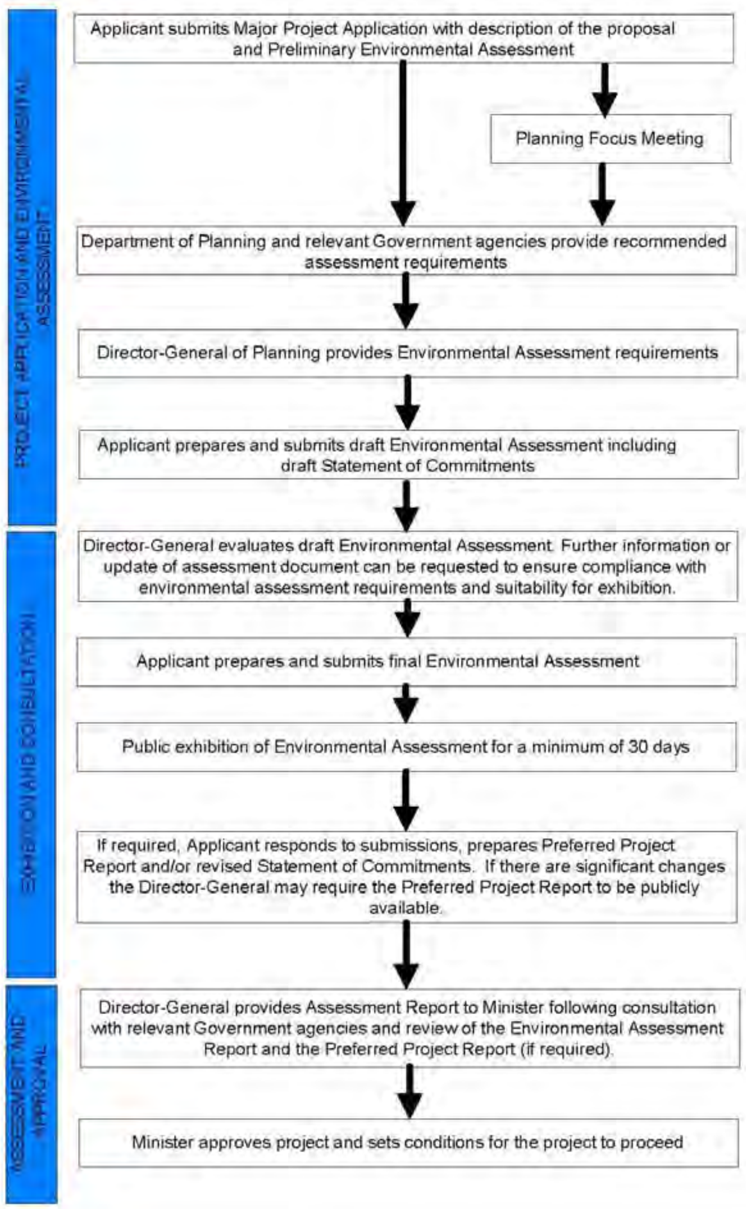
Part 3A of the EP&A Act provides an assessment and approvals regime specifically tailored for major infrastructure where the Minister for Planning is the approval authority. Under Part 3A the general process is as follows and is illustrated in **Figure 2-1:**

- Project application and environmental assessment, where the proponent submits a project application to the DoP with an outline of the proposal and a preliminary environmental assessment of the project;
- The DoP consults relevant Government agencies and the local Council and prepares requirements for an Environmental Assessment (EA). These requirements were provided to the proponent by the Director-General of Planning on 4th July 2007 and a copy is attached in **Appendix A**;
- The proponent prepares and presents an Environmental Assessment (this document), along with a draft Statement of Commitments. The Environmental Assessment is evaluated and, if adequate, is exhibited for public comment. The DoP receives submissions and provides copies to the proponent who considers and addresses these submissions in a Submissions Report provided to the Department. The proponent may modify the proposal to address concerns

raised and to minimise impacts and, if so, provides a Preferred Project Report to the Department;

- The proposal is assessed by DoP and a Director-General's Report is prepared for the project and submitted to the Minister for Planning for his decision.

- **Figure 2-1 Part 3A Assessment Process**



2.2 State Environmental Planning Policies

2.2.1 State Environmental Planning Policy (Major Projects) 2005

State Environmental Planning Policy (Major Projects) 2005 identifies development to which the development assessment and approval process under Part 3A of the EP&A Act applies. The *State Environmental Planning Policy (Major Projects) 2005* defines a development for the purpose of shipping berths or terminals or wharf-side facilities (and related infrastructure) that has a capital investment value of more than $30 million as a Major Project under Group 8 of Schedule 1. The proposed BLB2 would be classified as a Major Project as it would cost approximately $69.7 million.

2.2.2 State Environmental Planning Policy No 33 – Hazardous and Offensive Development

State Environmental Planning Policy No 33 – Hazardous and Offensive Development (SEPP 33) applies to any proposal that has the potential to create an off-site risk or offence to human health or life, property or the environment.

Under SEPP 33, "potentially hazardous industry" is defined as:

> *"A development for the purposes of any industry which, if the development were to operate without employing any measures to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:*
>
> *(a) to human health, life or property; or*
>
> *(b) to the biophysical environment*
>
> *and includes a hazardous industry and a hazardous storage establishment."*

The handling and transfer of a range of liquid hazardous goods during the operational stage at the proposed new berth would be considered as "potentially hazardous".

Part 3 of SEPP 33 contains provisions that apply to potentially hazardous development. In particular, clause 12 requires preparation of a Preliminary Hazard Analysis (PHA), and submission with the development application. The PHA must be conducted in accordance with DoP's *Hazardous Industry Planning Advisory Paper No 6, Guidelines for Hazard Analysis.*

The proposal is a "potentially hazardous industry" and therefore a PHA has been undertaken and is presented in **Appendix D** and summarised in **Section 5**.

2.2.3 State Environmental Planning Policy No 11 – Traffic Generating Developments

State Environmental Planning Policy No 11 – Traffic Generating Developments (SEPP 11) requires that the Roads and Traffic Authority (RTA), the Police Department (Traffic branch) be consulted and their requirements to be considered for any developments in Schedule 1 or Schedule 2 of the Policy. The proposed works are not included in Schedule 1. It should be noted that the proposed work are not defined as a liquid fuel depot under the *Environmental Planning and Assessment Model Provisions 1980* as they do not involve the storage of liquid fuels.

2.3 Regional Environmental Plans

Regional Environmental Plans (REPs) are intended to provide a framework in which the local and state governments can manage planning and action for different regions around the state.

There are no current REPs which apply to the project site.

2.4 Local planning requirements

The proposed BLB2 is located within the Randwick City Council local government area, and is subject to the provisions of the *Randwick Local Environmental Plan 1998* (LEP 1998).

2.4.1 Randwick Local Environmental Plan 1998 (LEP 1998)

The zoning of the area proposed for the BLB2 is Zone 4B (Port Botany). Part 2, clause 16(3) of LEP 1998 specifies activities permitted within the zone with development consent. The proposed development falls into two categories in clause 16(3), port facilities and potentially hazardous development. Hence the proposed development is permissible with development consent.

The objectives of Zone 4B are:

a) To facilitate the development and operation of Port Botany as a major cargo handling and distribution centre, and
b) To allow a range of activities which complement the continued and effective operation of the port, and
c) To encourage development of, and accommodate innovation in, the sources of economic growth, and
d) To enhance and improve the physical environment by minimising disturbances caused by air pollutants, water pollutants, noise pollutants and other pollutants.

The proposed development is consistent with the objectives of the zoning as the proposed BLB2 would:

- Increase the efficiency of the port;

- Assist the effective operation of the port;
- Encourage economic growth at the port; and
- Minimise impacts.

Clause 37 of LEP 1998 reinforces the role and function of the land within zone 4B (Port Botany Zone) as a major shipping and cargo handling facility. The clause states:

> *"The Council may grant consent to the development of land within Zone No 4B only if it is satisfied that the proposed development is, by virtue of the nature of the activity or activities involved, suited to being in close proximity to Port Botany and will not adversely affect the continued operation of the port."*

As the proposal is for port use and would increase the efficiency of existing port operations and is consistent with the aims of zone 4B (Port Botany Zone) is it considered permissible with consent and is clearly consistent with clause 37.

2.4.2 Development Control Plans

Development activity within the Randwick City Council is also controlled through Development Control Plans (DCPs).

There is only one DCP which has been adopted by Council which is relevant to the proposed Bulk Liquid Berth No. 2. This is the *Parking DCP 1998* (DCP 1998) which aims to provide adequate off-street parking to meet parking demand within the City of Randwick and to specify Standards, guidelines and design parameters for parking, car parks and vehicle manoeuvring and access.

Parking for the low number of additional operational personnel (<5) required to service and maintain BLB2 would be accommodated in the existing parking arrangements.

2.5 Commonwealth Legislation

2.5.1 Environment Protection and Biodiversity Conservation Act 1999

Approval of the Commonwealth Minister for the Environment is required for any actions that may have a significant impact on matters of Environmental Significance, except in circumstances which are set out in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Approval from the Commonwealth is in addition to any approvals under NSW legislation.

Matters of national environmental significance include:

- World heritage properties;
- Commonwealth Heritage properties;
- Ramsar wetlands;

- Nationally threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions, including uranium mining.

The proposal would not directly impact on any known threatened species, populations, endangered ecological communities or critical habitats. Whilst there are significant wetlands and migratory species in the area of Botany Bay, based on assessment of potential impacts contained in this EA, it is considered that the proposal would not affect any areas of national environmental significance.

2.6 Other NSW Legislation

2.6.1 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is the primary piece of legislation regulating air, water and noise pollution control and waste disposal in NSW and is administered by the Department of Environment and Climate Change (DECC) (formerly DEC). Under Section 48 of the PEO Act, premise-based scheduled activities (as defined in Schedule 1 of the Act) require an Environment Protection Licence (EPL). The proposed Bulk Liquids Berth is covered by the following in Schedule 1:

> *"Shipping facilities (bulk) for loading or unloading, in bulk, agricultural crop products, rock, ores, minerals or chemicals into or from vessels (but not where any material is wholly contained within a shipping container), being wharves or associated facilities with an intended capacity exceeding 500 tonnes per day or 50,000 tonnes per year"*

Clause 47 of the Act specifies that an EPL is required for development of a premise for the purpose of scheduled activities.

An EPL would therefore be required for construction and operation of the Project. Liaison with the DECC would determine appropriate licence requirements.

2.6.2 Occupational Health and Safety Act 2000

The *Occupational Health and Safety Act 2000*, administered by NSW WorkCover, includes notification and storage requirements where substances classified as dangerous goods are kept. Where quantities exceed the manifest amounts, WorkCover must be advised through a notification system. There will be large quantities of dangerous goods handled at BLB2, however the storage will be outside the proposed berth and therefore notification will not be required.

2.6.3 Ports and Maritime Administration Act 1995

This Act established State Owned Corporations to operate New South Wales's ports facilities in the major ports including Botany Bay. SPC was established under this Act and manages Port Botany. Under this Act, NSW Maritime's functions and responsibilities for the management of specific waterways are detailed. This includes the ownership of land below the mean high water mark in Port Botany. Land owners consent would be required for the construction of BLB2.

2.6.4 Rivers and Foreshores Improvement Act 1948

The *Rivers and Foreshores Improvement Act 1948* provides for the protection of riverside land in NSW and is administered by the NSW Maritime Authority in Port Botany. Under Part 3A of the EP&A Act, a permit would no longer be required. Notice of the project would be given to the NSW Maritime Authority.

2.6.5 Management of Waters and Waterside Lands Regulation – NSW

The *Management of Waters and Waterside Lands Regulation – NSW* was made under the *Maritime Services Act 1935*. Clause 67 requires written permission of the Harbour Master if the bed of Port Botany is to be disturbed in any-way. The Applicant is required to contact and seek approval of the Harbour Master prior to construction to ensure that during the construction phase, the impact of commercial shipping operations is minimised.

2.6.6 Soil Conservation Act 1938

The *Soil Conservation Act 1938* is administered by DECC for the purposes of conserving soil and water resources and mitigating soil erosion. Section 15A of the Act provides for Notices that would allow DECC to prescribe measures for soil erosion and sediment control that must be adopted. Notices can be issued before construction begins or can be issued to halt an offending activity until proper erosion and sediment controls are instituted. DECC can also undertake the specific works if it finds that the Section 15A Notice is not complied with.

DECC would be consulted to determine if DECC would issue a pre-construction notice to prescribe measures for soil erosion and sediment control. The proposed development site is not in an area of high sedimentation and erosion risk and therefore it is unlikely the DECC would issue a pre-construction Notice for the proposed works. A Soil and Water Management Plan (as part of the Construction Environmental Management Plan) would be prepared to minimise sediment and erosion impacts associated with construction.

2.6.7 Contaminated Lands Management Act 1997

The *Contaminated Lands Management Act 1997* enables the DECC to respond to contamination that risks causing significant harm to human health or the environment. The Act sets out criteria for determining whether such a risk exists and gives the DECC the power to:

- Declare an investigation site and order an investigation;
- Declare a remediation site and order remediation to take place; and
- Agree to a voluntary proposal to investigate or remediate a site.

The DECC may also direct an organisation to investigate or remediate contaminated land. Those directed to investigate or remediate land may appeal against the direction. They can also recover costs from the polluter/s in some circumstances. The Act allows the DECC to accredit people as site auditors. Site auditors must issue a Site Audit Statement indicating the land uses that any site is suitable for. The DECC is required to keep a record of current and former sites regulated by it. Information about current sites is referred to councils, which must record and make such information available. The proposed BLB2 would be subject to the *Contaminated Lands Management Act 1997* and would be investigated or remediated if DECC deems that land is actually or possibly contaminated that risks causing significant harm.

2.6.8 Fisheries Management Act 1994

Sections 204 and 205 of the Fisheries Management Act 1994 provide for the conservation and protection of aquatic resources. The Act requires that potential impacts on threatened species and aquatic habitat be addressed during the environmental planning and assessment process.

Reviews of available data on fish and other aquatic species have been conducted to determine the presence of threatened species in the vicinity. There would be no impacts to fish or threatened species from the proposed development.

A permit under Section 205 of the Act is no longer required from the Minister for Primary Industries for the cutting, damage, removal or destruction of marine vegetation as the Project will be assessed under Part 3A of the EP&A Act.

2.6.9 Heritage Act 1977

The Act provides for the identification and conservation of the State’s natural heritage and built heritage.

The proposed development would not disturb any indigenous or non-indigenous heritage. The proposal would not impact on any heritage items on the state heritage register and therefore notice to the heritage Council would not be required.

A summary of the heritage context of the area and the site is presented in **Section 6.10**.

2.6.10 National Parks and Wildlife Act 1974

The National Parks and Wildlife Act 1974 (NPW Act) provides for the protection, preservation and management of flora and fauna in NSW. Section 120 of the NPW Act requires a license to harm protected and threatened species in the course of carrying out development.

The NPW Act also provides for the protection, preservation and management of all Aboriginal relics throughout NSW. A license is also required to disturb, destroy or damage aboriginal objects or places in course of carrying out of development (under Section 87 and Section 90 of the Act) where development consent has been granted under the EP&A Act.

The implementation of the NPW Act is the responsibility of the Department of Environment and Climate Change (National Parks and Wildlife Service Division).

Reviews of available data on terrestrial and aquatic ecology have also been conducted to determine the presence of threatened species in the vicinity. A summary of the results and assessment of potential impacts is presented in **Section C**.

2.6.11 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) identifies threatened species, populations, endangered ecological communities, critical habitats and key threatening processes. In relation to development assessment, the provisions of the TSC Act have been integrated into the EP&A Act. Section 5A of the EP&A Act requires that the assessment of all development applications under Part 4 of the EP&A Act include consideration of whether the proposal is likely to impact on threatened species, populations or ecological communities. The equivalent process is not applicable under Part 3A of the EP&A Act.

Reviews of available data on terrestrial and aquatic ecology have been conducted to determine the presence of threatened species in the vicinity. A summary of the results and assessment of potential impacts is presented in **Section C**. The proposal would not directly impact on any known threatened species, populations, endangered ecological communities or critical habitats.

2.6.12 Waste Avoidance and Resource Recovery Act 2001

The Act aims to encourage the most efficient use of resources, to reduce environmental harm, and to provide for the continual reduction in waste generation in line with the principles of environmentally sustainable development (ESD).

The proposed development would generate waste and as such, is required to consider the hierarchy of resource management referred to in this Act. This is considered in detail in **Section 5** – Waste Management.

2.6.13 Roads Act 1993

The *Roads Act 1993* (Roads Act) sets out rights of members of the public to pass along public roads, establishes procedures for opening and closing a public road, and provides for the classification of roads. It also provides for declaration of the Roads and Traffic Authority (RTA) and other public authorities as roads authorities for both classified and unclassified roads, and confers certain functions (in particular, the function of carrying out roadwork) on the RTA and other roads authorities.

Under Section 138 of the *Roads Act*, approval is required for work on a public road including erecting a structure or carrying out a work in, on or over a public road, and to dig or disturb the surface of a public road. The proposed development does not require work on, over or disturbance of a public road and therefore this act does not apply to the development.

2.7 Policy Context

2.7.1 Port Botany Land Use Study 1996

The Department for Urban Affairs and Planning (now DoP) prepared the updated Land Use Safety Study Overview Report 1996. It is a cumulative risk assessment of the study of the existing Port Botany area and provides a strategic land use safety framework for future developments in Port Botany and surrounding areas. The study was undertaken in liaison with SPC and in consultation with representatives of local councils, the community and industry.

The key findings of the study included:

- Cumulative risk from operations on SPC land is within acceptable limits, measured against national and international criteria, and no residential areas are affected; this excludes the transportation of dangerous goods to and from the port area;
- Further expansions of bulk liquid facilities in the port area may be accommodated with appropriate safety control, without significantly increasing the cumulative risk, but the intensification of storage and handling of toxic compressed or liquefied gases is inappropriate; and
- Assessment of new proposals will need to have particular regard to risk interactions between sites and should involve consultation with the community.

The proposal is considered consistent with the recommendations made by the planning risk assessment as it would be located in an area suitable for bulk liquids handling and distribution.

In fact, the 1996 study included an assessment and a resulting risk contour for future developments which were listed as including, amongst other Dangerous Goods storage facilities, two (2) extra Bulk Liquids Berths

2.7.2 City of Cities – Sydney Metropolitan Strategy (2005)

The Sydney Metropolitan Strategy (DoP 2005) provides for centres with different functions within all parts of the metropolitan area. The strategy identifies centres of different types across the city as it aims to provide a fair distribution of economic activity across the city. The strategy establishes a typology of centres which are supported by state and local planning and infrastructure development.

Port Botany and the surrounding area is classified as a 'Specialised Centre'. Port Botany is a major port which is defined as a vital economic and employment node. The strategy identifies the importance of industry clustering and specialisation of centres. The strategy provides an employment capacity target within each specialised centre to meet the 500 000 extra jobs required by 2031 to cater for Sydney's population growth and competitiveness. The (direct) employment capacity for Port Botany is 12 000 jobs which is an increase of 6.5% from 11 264 (2001 figures). The strategy also aims to support and encourage Specialised Centres in their designated functions.

The proposed bulk liquids shipping berth supports the aims and intent of the Metropolitan Strategy for Port Botany. Clustering and specialisation of Port Botany is enhanced by the proposal, a contribution to the employment target is also made. The proposal reinforces the significance of Port Botany is a vital economic and employment centre for metropolitan Sydney.

2.7.3 Sydney Ports Corporation Green Port Guidelines

SPC commissioned Arup Sustainability to develop the Green Port Guidelines checklist.

The aim of the guidelines is to improve the environmental sustainability of new developments and to encourage continuous environmental improvement of existing activities on the land SPC manages. Developers are asked to consider the guidelines during planning and application stages of a project or activity and demonstrate compliance by completing the associated Green Port Guidelines Checklist in **Appendix B.**

The proposal incorporates these principles where appropriate.

2.8 Licences and Approvals

The licences and approvals which will be required for the project are summarised in **Table 2-1** below.

- **Table 2-1 Licences and Approvals Required**

Reference	Requirements	Licence/approval to be obtained	Timing
Protection of the Environment Operations Act 1997			
Section 43(a)	The owner or operator of a premise that is engaged in scheduled activities is required to hold an environment protection licence	Construction licence Operation licence	Construction licence – prior to construction Operation licence – Prior to operation
Ports and Maritime Administration Act 1995			
	NSW Maritime owns the sea bed under BLB2	Land owner consent	Already obtained
Management of Waters and Waterside Lands Regulation - NSW			
	Any disturbance of Port Botany bed requires Harbour Master approval.	Harbour Master written permission	Prior to construction

3. Project Need and Alternatives

3.1 Strategic Objective

The primary strategic objective of the project is to ensure New South Wales has adequate berth capacity to satisfy existing and future forecast demands for the import and export of bulk liquids.

3.2 Regional Context

3.2.1 Existing Sydney Market Demand & Capacity for Petroleum Products

The Sydney region existing demand for finished petroleum products is approximately 11,600,000 Kilolitres (kL) per annum. Sydney refineries at Caltex Kurnell and Shell Clyde produce the majority of petroleum products (including petrol, diesel, and aviation products) for the local market.

In addition to these refined products produced by Caltex and Shell, there is approximately 2,800,000 kL of products imported into the Sydney region (via BLB1, Shell Gore Bay and Caltex Kurnell) to supplement the refinery output.

BLB1 is utilised by SPC Tenants and Exxon Mobil. The volume of petroleum fuels imported via BLB1 is approximately 1,100,000 kL split mainly over various grades of petrol, diesel and aviation products.

Chemicals and LPG gases are also imported and exported through BLB1. Gas imports and exports total approximately 870,000 kL and Chemicals 150,000kL per year.

3.2.2 Projected Demand

The Australian Government Greenhouse Report released in 2000 and 2006 industry advice indicates the future increase in market demand for petroleum products of 2% per annum. Part of this increase in market demand is the supply of jet fuel to Sydney Airport. This supply is currently from Shell Clyde, Caltex Kurnell, Exxon Mobil Botany and Vopak Site B at Port Botany. Exxon Mobil Botany is limited in capacity and the pipeline from Shell Clyde and Caltex Kurnell is close to capacity. Therefore, the bulk liquids berths and facilities will play a major role to satisfy the growing airport fuel requirements.

Due to legislated changes to the product specifications, increased refinery production will be limited. Therefore, there is an increasing requirement to import refined petroleum products including petrol, diesel and aviation fuels to satisfy the shortfall between current production capacities and growing demand.

Due to infrastructure limitations, the only alternative facilities available to handle this projected increase in imported petroleum products are Caltex Kurnell and the existing BLB1. It is anticipated that a majority of the increase in imports for petroleum products will be via the BLB1 (and BLB2). Gas imports and exports are estimated to grow long term at 0.5% p.a. and 3% p.a. respectively. Chemicals imports are not expected to increase significantly over the long term.

Berth occupancy is increasing and will be further driven by industry growth through increasing utilisation of existing storage facilities to their maximum capacity and additional facilities either being installed or planned to be installed in the Port Botany area.

Some of the facilities that receive imported products have been operating under capacity over the recent years. By way of example, during 2005 and the first half of 2006, Vopak Terminals Australia Site B1 was only operating at 25% capacity. By late 2007, this site is expected to be at full capacity. This will increase the BLB1 berth occupancy by approximately 3% due to further use of the facilities.

With respect to the facilities planned to be installed in the Port Botany area, there are two main contributors to forecast berth occupancy increases:

- Firstly, the development of petroleum import facilities by Vopak. Vopak has recently extended its Site B2 and has received planning approval for the construction of additional storage facilities and pipelines at its Site B3 (approximately $100m in capital investment).

  Vopak Site B2 was commissioned in February 2007 and will result in an additional 8% berth occupancy. When the first stage of Vopak's Site B3 is commissioned in November 2008, an additional berth occupancy of 10% will result and then another 9% in January 2011 when the second stage of Site B3 is commissioned.

  In total, the developments at Vopak's sites B2 and B3 will result in an additional 30% berth occupancy. This is equivalent to half of the real usable capacity of a single berth.
- Secondly, Vopak, and more tentatively Terminals Pty Ltd, have announced plans for biodiesel plants to be installed in the Port Botany area. Each of the biodiesel plants will potentially have capacity for 225,000 kL per annum, giving a total additional BLB1 throughput of 450,000kL. Biodiesel will account for approximately 30% berth occupancy increase.

This corresponds to the following berth utilisation for BLB1 only (**Table 3-1**):-

- **Table 3-1 Berth Utilisation (BLB1 only)**

Year	Percentage (%) of Berth Utilisation
2007	53
2008	58
2009	63

It is generally accepted that a Berth Utilisation Factor of 65% is a practical and economical working limit for a Bulk Liquids Berth. Higher utilisation creates the potential for increasing demurrage costs whereby transport economics are severely impacted. Hence, BLB2 will be necessary by 2010. With BLB2 operating, berth utilisation would remain at economical working limits (see **Table 3-2** and **Table 3-3**).

- **Table 3-2 Expected Total Import and Export Volumes (kL) for Port Botany**

	2007	2008	2009	2010	2011	2012
Chemicals	140 918	140 918	140 918	140 918	140 918	140 918
Gas	1 000 538	1 034 830	1 054 820	1 063 536	1 072 895	1 082 422
Biodiesel	65 625	112 500	288 719	288 719	449 998	449 998
Refined Petroleum	1 116 603	1 234 053	1445 652	1 575 264	1 619 193	1 843 744
Total	**2 323 684**	**2 522 301**	**2 930 109**	**3 068 437**	**3 283 004**	**3 517 082**

- **Table 3-3 Projected berth utilisation for BLB1 and BLB2**

	2010	2011	2012
BLB1	53.2 %	54 %	55 %
BLB2	26.1 %	35 %	36.4 %

3.2.3 Capacity of Existing BLB1

The existing BLB1 is a common user facility handling petroleum, chemicals, gas products and future biodiesel products with maximum discharge rates as set out in **Table 3-4**:

- **Table 3-4 BLB1 Maximum discharge rates**

Product	Maximum Pumping Rate
Petroleum products to Vopak	1,000 kL per hour per marine loading arm with a maximum of two MLA's simultaneously
Petroleum products to Exxon Mobil at Stephens Rd	340 kL per hour
Chemicals	170 kL per hour average across multiple simultaneous hose discharges
Gas	80 to 500 tonnes per hour depending on the ship
Biodiesel products	150 to 400 kL per hour depending on the product

Each Operating Company at BLB1 has its own infrastructure, marine loading arms (MLA) and/or manifold. BLB1 capacity has been optimised by Vopak's installation of a second MLA to reduce the pumping time associated with petroleum products.

Other products (chemicals and LPG) are at their maximum pumping capacities as the pumping rates are ship dependent and additional berth equipment would provide limited scope to improve the berth occupancy further. However, even with the optimisation of BLB1, it is recognised that existing customers incur a higher risk of demurrage costs despite the berth utilisation being under 65% or between 200-250 days occupancy per year. This impact is caused by a number of factors, including:

- Scheduling conflicts – i.e. availability of berthing slots, partly due to the complexity and hence the lack of international co-ordination in the delivery of petroleum, gas and chemical products into Port Botany
- Operational limitations – i.e. number of loading arms, ship size and discharge performance.

3.3 Consideration of Alternatives

In October 2003, the NSW State Government's Ports Growth Plan was announced. The plan identified strategic directions which included relocating certain port operations from Port Jackson to Port Kembla and Newcastle Port. The plan does not address the bulk liquids trade. Additional capacity at Port Botany would be required in the future to service the industry and it is envisaged that a third bulk liquids berth B3 would be developed.

The alternatives for relocating or creating additional bulk liquids facilities to direct trade through Sydney Harbour, Port Kembla or Port Newcastle have been considered during the development of the proposal and are discussed below:

1. Construction of additional petroleum and chemical storage facilities at Port Kembla (80 km south of Sydney) and transport the petroleum/chemical products to the customers in Sydney. As there is no similar BLB or storage facilities in Port Kembla, there would be significant infrastructure costs required. Also additional transport cost would be incurred from Port Kembla to Sydney requiring either the installation of a pipeline (high capital cost) or an increase in the number of large road tankers to make the deliveries resulting in a potential safety issues.

2. Construction of additional petroleum and chemical storage at the port of Newcastle (approximately 180 km north of Sydney) and transport the petroleum/chemicals products to customers in Sydney. As there is no similar BLB flammable liquids berth (one is currently under investigation to serve a small portion of the Newcastle market) and only limited dangerous goods terminal storage facilities in Newcastle, again there would be significant infrastructure and significant investment required. Also additional transport costs would be incurred from Newcastle to Sydney requiring either an increase in the number of large road tankers to make the deliveries (and so introduce safety issues) or reversing the flow in the existing Sydney/Newcastle pipeline used to distribute products from Sydney to the Newcastle area. This second option of using the pipeline would be dependant on the capacity of the line and would require significant investment in pumping systems to provide the volume required and in extending the pipeline a further 20km to connect Port Botany.

3. Augmentation of Shell facility at Gore Bay for the importation of petroleum products through Gore Bay in Sydney Harbour. This does not appear an option due to capacity constraints on tanks and pipelines, limited area to expand due to surrounding residential land use constraints and current high berth occupancy. Residential areas are located in close proximity to Gore Bay and additional bulk liquid facilities would increase result in acceptable risks to these areas. Also this facility is privately-owned and not a common-user facility.

4. Augmentation of Caltex facility at Kurnell to cater for the increase in the importation of petroleum products. The Caltex facility is currently private and not a common-user facility. Also the current submarine pipelines may not have sufficient capacity, would not handle the range of products BLB does and has other operational constraints.

5. The “Do Nothing” approach is not considered appropriate as the utilisation of BLB1 will soon reach uneconomic limits. Already there is an increased risk of incurring demurrage costs as efficiency of bulk liquids unloading is restricted.

4. Description of the Project

4.1 Location and Setting

The site of BLB2 is to be located on the west side of privately owned Fishburn Road, adjacent to the boundary of Vopak Site B and the Elgas Caverns, in the suburb of Port Botany. Port Botany has been substantially developed for industrial purposes relating to shipping and port activities. The resulting built form of the suburb has resulted in complex infrastructure and services reliant on and providing niche services to the larger economic activities associated with the Port.

Most of the facilities near the site are involved in bulk liquids storage and transfer, including petrochemicals, ethylene, naphtha and propane.

BLB2 is to extend in a southerly direction from the land to the south of Brotherson Dock. The following companies have established bulk liquids/gas storage terminals at the Port and are current tenants of the Sydney Port Corporation:

- Terminals Pty Ltd;
- Qenos Australia Pty Ltd (Hydrocarbon Storage Facility);
- Origin Energy Pty Ltd;
- Elgas Pty Ltd; and
- Vopak Terminals Australia Pty Ltd.

The following land uses can be found in the immediate surroundings of the study site:

- 7.11 hectares of land (Lot No. 2) adjacent to the study site occupied by Elgas Pty Ltd (The Sydney LPG Cavern Project which has capacity for 65,000 tonnes of gas 150m below ground);
- 7.5 hectares block of land, east of the study site, in use as a hydrocarbon gas storage facility operated by Qenos Australia Pty Ltd;
- 9.1 hectares of land to the south east of the study site occupied by Austate Logistics; and
- 6 hectares of land leased to Vopak.

4.2 Shipping and Navigation

The shipping channel approach to the Brotherson Dock is some 210m wide and is generally dredged to a minimum depth of 18 m. The ship turning basin has been dredged to 14.4m. Commercial shipping visits to Port Botany are controlled by the SPC.

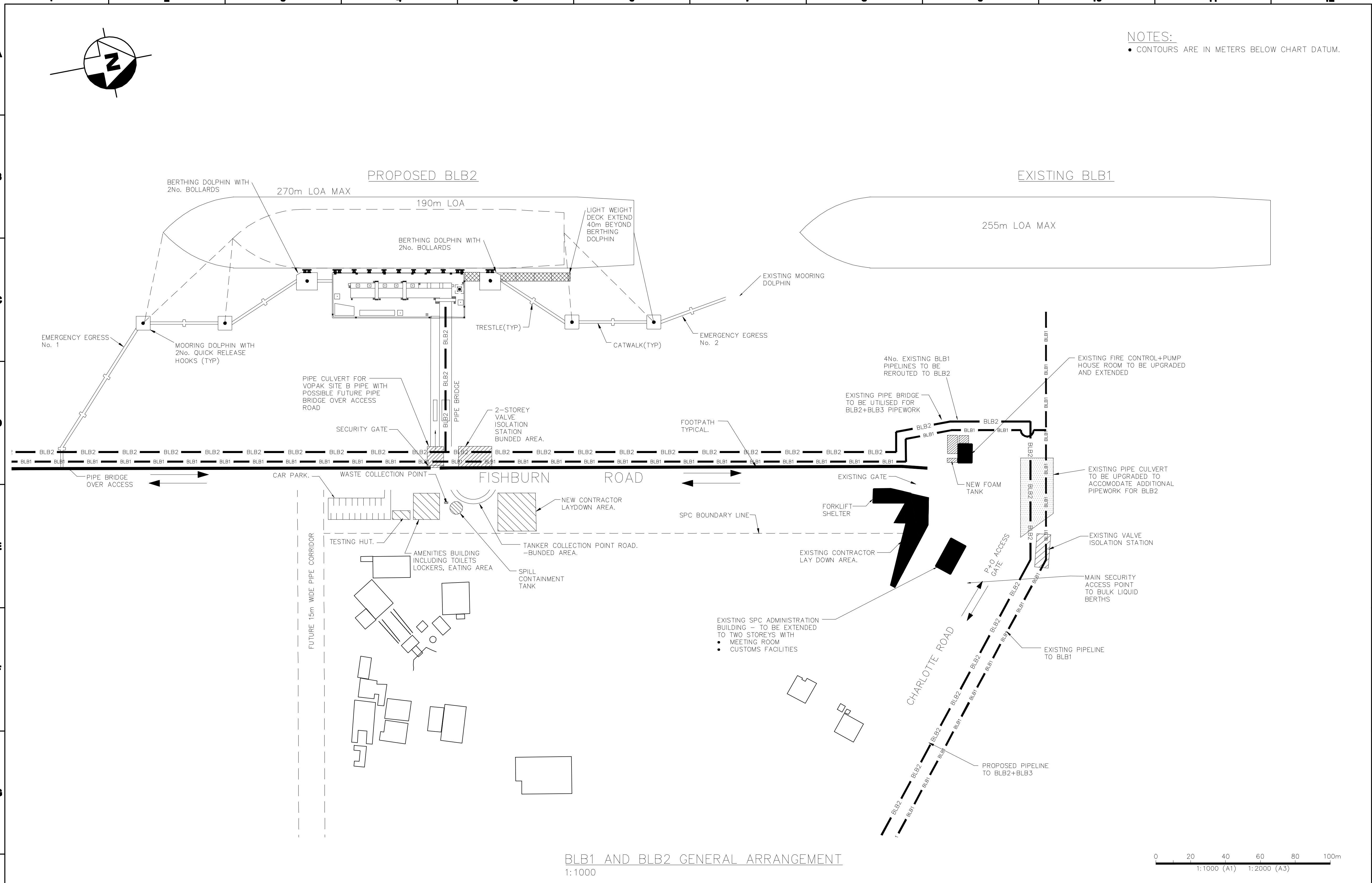
The number of ships visiting Port Botany is increasing and in 2005 approximately 1,200 ships visited the Port of which approximately 165 visited the BLB (SPC: 2005). As ships must also exit the Port by the same route, the total number of ship movements in and out of the Bay in 2005 was approximately 2,400.

A study by Access Economics and Maunsell (2003), as part of the Port Botany Expansion EIS, forecast the number of ship visits to Port Botany under a moderate productivity scenario until 2025. Under this scenario, shipping visits to Port Botany Brotherson Dock is expected to increase by 932 visits per year. In addition, accounting for growth in BLB and shipping visits and to Caltex wharf at Kurnell, it is estimated that shipping visits could reach approximately 3,000 visits by 2025 (Access Economics and Maunsell, 2003). Hence theoretically ship movements (in and out) could reach approximately 6,000 per year from 2025 (or approximately 17 movements a day). However, further technological and port operational improvements may actually lead to a decrease in ship movements due to infrastructure being able to handle larger ship sizes.

4.3 Overview of BLB2

BLB2 would be an open access/common user berth which would handle the same type of products and would be designed and operated consistent with the current ship capacity and operations of BLB1 (see **Figure 4-1** and **Figure 4-2**). However, the working platform of BLB2 would be 80% larger than BLB1 to enable more effective operation of the berth. The frequency, size and types of vessels envisaged to use BLB2 is consistent with the current use of BLB1.

It should be noted that the following description of BLB2 is based upon preliminary designs and the final size and exact location of specific elements may change once the detailed design is completed. However, the general scale, capacity and function of the specific elements described in the following sections would be maintained.



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CLIENT: VOPAK/SYDNEY PORTS CORPORATION
PROJECT: BULK LIQUIDS BERTH No. 2 UPDATE CONCEPT DESIGN

FIGURE 4-1
BLB1 AND BLB2 GENERAL ARRANGEMENT

SCALE	PROJECT No	DRAWING No	AMDT
1:1000	EN02254	6808-02	A

- **Figure 4-2 Location of proposed BLB2**

BLB2 would comprise of the following main elements:

- A central working platform and working area, with berthing face (including bollards and fenders) and pipe manifold/marine loading arm (MLA) arrangements;
- Adjacent berthing dolphins on each side of working platform designed to accommodate up to the maximum length vessel;

- Two mooring dolphins on each side of the working platform (four in total). Mooring dolphins would be required on the northern side of the working platform, instead of the existing land based mooring point arrangement as used for the BLB1 due to the geometry of the existing shoreline;
- Walkways (catwalks) connecting the dolphins and working platform;
- An access bridge structure connecting the working platform with the shore, providing vehicle access and pipeline support structures;
- Support infrastructure including fire control facilities (pumps, foam/water monitors and associated tanks, gatehouse and amenities (the need for a gatehouse is dependant on site security arrangement); and
- Berth fitout, including fire fighting monitors, services such as water, sewer, electrical and communications, amenities and blast proof Operator Shelter.

There have been some major differences in design between BLB2 and BLB1 are:

- Working platform would be 80% larger than existing BLB1 working platform;
- Pipes would remain above deck on the access bridge and working platform to reduce corrosion of pipes and improve access for maintenance; and
- The ‘T-head’ berth would be an ‘L-head’, so that the pipework does not need to cross the road access and working space behind the MLA/manifold area.

4.4 Working Platform

The working platform would be a suspended deck structure (76m x 32m) which is approximately 80% larger than the existing BLB1.

The working platform would be designed to resist lateral berthing loads from medium sized ships. Larger vessels would also impact the independent berthing dolphins.

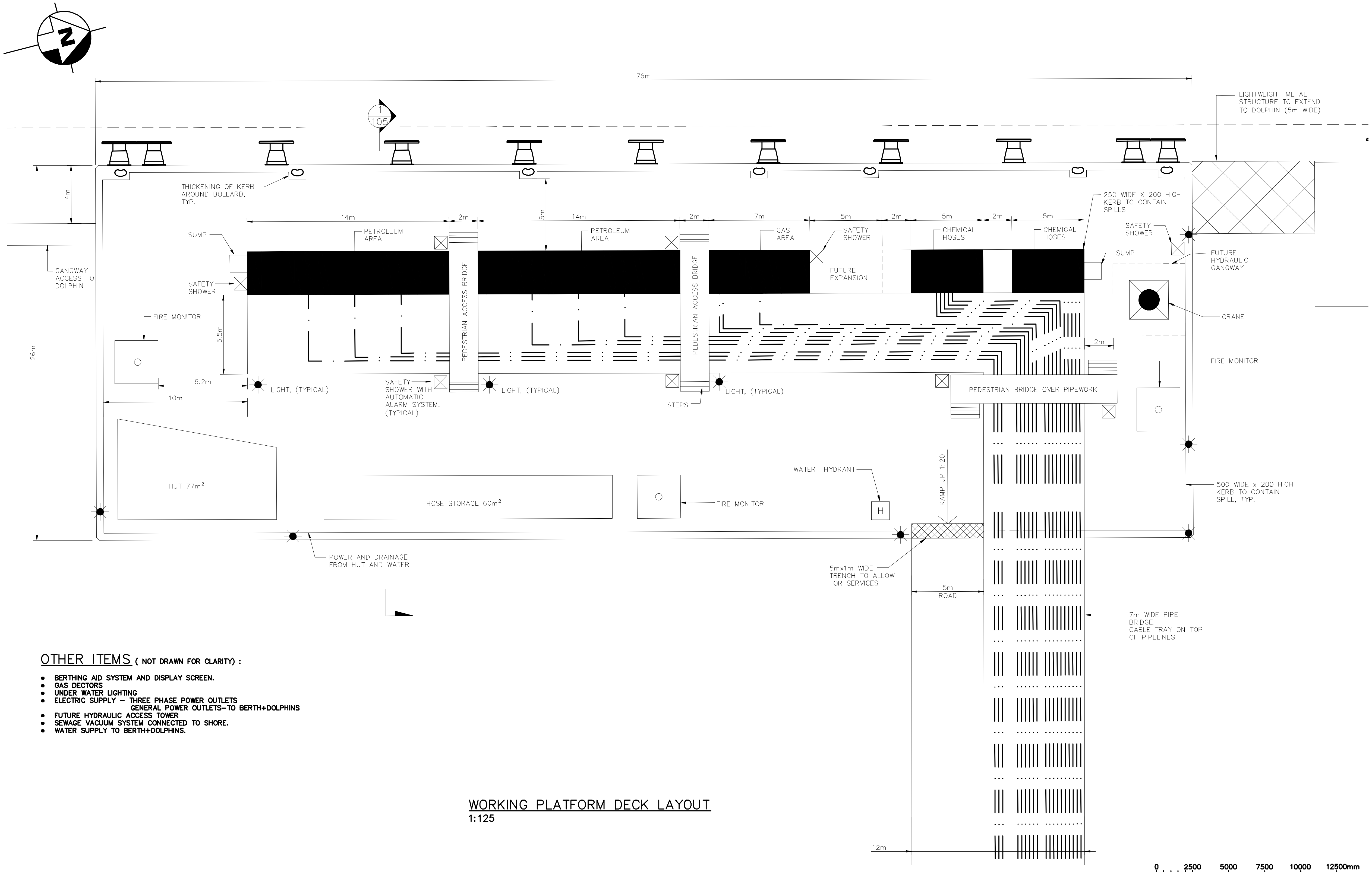
The working platform structure would consist of the following main elements:

- Tubular steel vertical piles (protected against corrosion with high build epoxy paint and/or wrapping system);
- Raked tubular steel piles to resist lateral loads (similarly protected against corrosion), including rock anchors to resist uplift loads where necessary;
- Precast reinforced concrete caps, beams and slabs;
- In-situ reinforced concrete topping over precast units;
- Cone fenders on the berthing face; and
- Bollards.

SKM

The working platform would support the following (See **Figure 4-3**):

- MLAs/hose manifolds
- Pipework;
- Pedestrian access bridges;
- Hose storage;
- Personnel hut;
- Fire Foam Water monitors;
- Lighting;
- Services;
- Hose crane/ship access tower (future); and
- Spill containment.



OTHER ITEMS (NOT DRAWN FOR CLARITY) :

- BERTHING AID SYSTEM AND DISPLAY SCREEN.
- GAS DECTORS
- UNDER WATER LIGHTING
- ELECTRIC SUPPLY – THREE PHASE POWER OUTLETS
  GENERAL POWER OUTLETS–TO BERTH+DOLPHINS
- FUTURE HYDRAULIC ACCESS TOWER
- SEWAGE VACUUM SYSTEM CONNECTED TO SHORE.
- WATER SUPPLY TO BERTH+DOLPHINS.

WORKING PLATFORM DECK LAYOUT
1:125

SKM
Sinclair Knight Merz

VOPAK/SYDNEY PORTS CORPORATION
BULK LIQUIDS BERTH No. 2
UPDATE CONCEPT DESIGN

FIGURE 4-3
WORKING PLATFORM
DECK LAYOUT

SCALE 1:1000 | PROJECT No EN02254 | DRAWING No 6808-104 | AMDT A

4.4.1 Marine Loading Arms and Manifolds

There would be 23 product connection points in total. Five of these connection points would be Marine Loading Arms (MLAs) of which four would be petroleum MLAs and one gas MLA. The remainder of the product connection points would be for chemicals and other products.

- **Figure 4-4 Existing BLB1 bulk liquids berth**

- **Figure 4-5 Existing MLAs at BLB1**

4.4.2 Spill containment

Two spill containment areas (bunds) would be located on the deck situated at the:

- Manifold area (an inner bund); and
- The entire working platform (an outer bund).

The manifold area inner bund would include raised kerbing around the product hose manifold area and the MLA/manifold area. This inner bund would contain any accidental minor spills or leaks of petroleum or other chemicals. This bunded area is connected to a collection sump which can be pumped to a wastewater storage tank. During ship unloading, any liquid (i.e. product) that enters this bunded area is deemed to be potentially contaminated and would be pumped to the storage tank for treatment and/or disposal to a DECC approved waste handling facility. The working platform would be provided with a 200mm high continuous vehicle kerbing around the entire deck (this is the outer bund). The access road is to have a trafficable ramp, 200mm high, as part of the bund system.

All stormwater from the working platform that is collected during the loading/unloading operations would be initially visually assessed to determine whether it is free from pollution. Clean stormwater would be suitable for release to Botany Bay, however, if any contamination is detected, the stormwater would be diverted to the wastewater storage tank. Water from the wastewater storage tank would be tested (if required), classified according to the DECC waste management guidelines and then disposed of at an appropriately licensed liquid waste management facility appropriate facility. When no loading/unloading operations are occurring, the bund valves would be left open and stormwater would drain to Botany Bay.

4.4.3 Ship Gangway/bow access

Gangway access would be light-weight decking between the end of the working platform, the northernmost berthing dolphin and beyond the dolphin for 40m. This is to ensure that adequate space is available for the ships gangway or ships brow (platform carried by the ship for access between ships or to the pier) to be adequately supported and safely accessible from the wharf deck.

4.4.4 Future Hydraulic gangway and hose crane

A future hydraulic gangway and hose crane has been allowed for at the working platform (shown in dashed lines).

The hydraulic gangway usually consists of a steel framed structure with platforms at various levels to which a ship’s gangway can slew and ship access can be obtained. The gangway and hose crane would be located near the stern of the ship where access is required. It has also been positioned in order to service as many ships as possible, however the gangway may not be able to service the larger ships at BLB2. Larger ships would be serviced by gangways directly to the deck of smaller ships or serviced by a provided brow to the pier.

4.5 Services

4.5.1 Water Supply

A water service standpipe and stopcock would be provided on the working platform. It is assumed that, in addition to the hose stopcock, a water supply service to the dolphins and Operator hut would be provided (sink and WC).

4.5.2 Sewage

A vacuum sewer system connected to the existing sewer system would be constructed.

4.5.3 Power and lighting

Three-phase power (32 amp) would be provided to the working platform for the MLAs, welding and other industrial electrical needs. In addition, the motorised capstans on the quick release mooring hooks on the mooring dolphins would require three-phase power.

General power outlets (240v x 15amp), in weatherproof outlets and suitable for hazardous areas, would be provided around the working platform, including on all dolphins, and in the control building.

Lighting, in the form of non-glare mast lighting on the working platform and on each dolphin would be provided. Lighting would comply with the Civil Aviation Safety Authority (CASA) requirements (*MOS 129 9:21 Lighting in the vicinity of Aerodromes)*.

4.5.4 Cathodic Protection

A Cathodic protection system would be installed to prevent corrosion to the BLB2 steel support piles.

4.6 Berthing and Access

4.6.1 Berthing Dolphins

The two berthing dolphins either side of the working platform would be suspended deck structure approximately 12m x 11m. All tubular steel piles would be raked to resist large axial compression and tension loads due to lateral berthing and mooring of the large vessels. It is likely that all raked piles would be anchored into rock. The position of the berthing dolphins may move slightly (up to 50m) as their location is based on preliminary designs, which may be subject to further changes.

The front of each berthing dolphin would accommodate two SCN core fenders, face panel, support structure and chains. The top of each berthing dolphin would have a 150 tonne bollard.

4.6.2 Mooring Dolphins

The construction of the mooring dolphins would be similar to the berthing dolphins; that is; suspended deck structures approximately $8m^2$ but only 3m deep with similar raked tubular steel piles.

4.6.3 Bollards and Quick Release Mooring Hooks

Quick release hooks would be provided on the mooring dolphins, while bollards would be installed on the shipside mooring structures which includes the working platform and berthing dolphins. All quick release hooks would have motorised capstans.

Bollards would be located along the working platform for spring lines.

4.6.4 Access Bridge

The access bridge would support vehicular and pedestrian access and the pipework to the working platform.

The access bridge would consist of a suspended deck structure similar to the working platform.

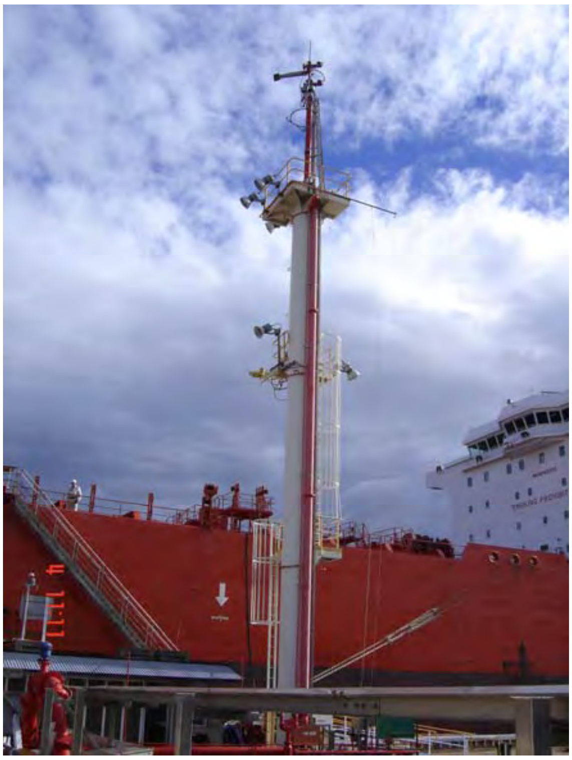
The overall width of the access bridge would be approximately 17m. This would consist of the following:

- 5m wide vehicular and delineated pedestrian road access;
- 7m wide pipe corridor (single level of pipes) over a solid deck;
- 4m wide cable tray corridor over a solid deck.

4.6.5 Emergency Egress

Two emergency egresses would be provided via the mooring dolphins allowing egress from the berth in two directions.

Three fire monitor towers would be provided on BLB2 with a height of approximately 24m. A fully developed fire would require the full foam flow from two monitors with a backup third monitor for redundancy.



▪ **Figure 4-6 Existing Fire Monitor at BLB1**

4.7 Pipelines

The majority of the pipelines from the existing BLB1 run through a SPC Pipeline Corridor which runs along Charlotte Road to Terminals Pty Ltd, Qenos Australia Pty Ltd, Origin Energy and Vopak Terminals Australia Site A. Pipelines from Elgas Pty Ltd and Vopak Terminals Australia Site B run along the western side of privately owned Fishburn Road adjacent to Botany Bay through another SPC Pipeline Corridor. The majority of the existing pipelines from BLB1 have been in place for about 30 years.

The majority of new pipelines for the proposed BLB2 would run along the Charlotte Road SPC Pipeline Corridor, through the existing culverts, along the inner pipe bridge and then along privately owned Fishburn Road SPC Pipeline Corridor.

There are currently some pipelines running along privately owned Fishburn Road SPC Pipeline Corridor and which service the Vopak Terminals Australia Site B and Elgas Pty Ltd which would need to be included in the new pipe rack.

The current pipelines which run to the BLB1 would remain largely unchanged however, some would be modified and rerouted to the BLB2.

Approximately 25 pipes, including the fire system's pipes will occupy the pipe corridor or the access bridge.

A Pipeline Valve Isolation station would be provided for the BLB2. The isolation station would be located within the pipeline corridor on privately owned Fishburn Road. This Valve Isolation station would house isolating gate valves for each line going to the adjacent BLB2. Access to the valves would be provided by platforms which would be positioned at both upper and lower pipeline rack levels.

- **Figure 4-7 Existing Pipelines at BLB1**

4.7.1 Pipeline Culverts

Existing culverts that cross privately owned Fishburn Road to both Elgas Pty Ltd and Vopak Terminals Australia site B would be checked for adequacy and location and, where possible, used for both the new pipelines and the existing re-routed pipelines from BLB1.

The major culvert at BLB1 (Charlotte Road) would need to accommodate approximately 21 new pipelines. While the culvert was designed and sized to take these lines, some earthworks and construction would be needed to complete the culvert during the early part of the construction phase.

A new culvert would be required to take up to 10 pipes to Vopak Terminals Australia site B at the access road to BLB2, adjacent to the privately accessed Fishburn Road. The new culvert would be located on the northern side of Fishburn Road and would be approximately 10 m long by 5 m wide.

4.7.2 Pipe Rack

A low level pipe rack arrangement is proposed with pipework at ground and intermediate levels and support for cable trays at the top level. The pipe rack would be 4 m high and 7 m wide and house all existing, new and future pipelines that would be located along privately owned Fishburn Road Pipeline Corridor.

The low level pipe rack is intended to be used in conjunction with culverts to traverse access roads and would also be used on the BLB2 access bridge. Any pipelines that traverse privately owned Fishburn Road would be buried or placed within culverts.

4.7.3 Pedestrian Access

Pedestrian access would be provided on both sides of the new pipeline corridor along privately owned Fishburn Road and extending onto the BLB2 working platform. Low level access platforms would cross over the pipelines to provide local access on the working platform to valves, equipment and the marine loading arms. All normal health and safety requirements to segregate pedestrian and vehicle movements and to provide walkways and hand railing that complies with AS 1657 requirements will be satisfied in the detailed design.

4.8 Construction Methodology

Construction of maritime structures is typically difficult as work is required over-water. Consideration of tides, waves, currents and wind need to be undertaken for the construction of the working platform, berthing dolphins, mooring dolphins, access bridge and catwalks. Due to the difficulties with access and over-water construction, specialist waterfront contractors would generally undertake this type of work. The tubular piles required for the support of the concrete deck and access way would be bored piles and would comply with all requirements of Groundwater Management Zone Deed (Nov 2003) agreed between SPC and Elgas for protection of the underground LPG caverns. Elgas Pty Ltd's preliminary communications with their overseas consultants confirmed that the integrity of the cavern and ancillary water curtain will need to be maintained at all times. Elgas Pty Ltd's consultants were unable to provide specifics for design and construction techniques at this time, therefore the method of piling for BLB2 should be conservative to reduce the likelihood of damage to underground infrastructure. Based on this conservative approach, bore piles have been chosen.

4.8.1 Water Based Plant

The type of plant required for the construction of the BLB2 would likely include the following:

- jack-up platform / barge;
- barge-mounted cranes;
- work barges;
- work boats;
- dive boats;
- mobile cranes;
- fork lifts;
- compressors.

A 'jack-up' barge consists of a barge which is held in place by 'spuds' *(piles)* located temporarily into the seabed so there is no movement of the barge due to wind, waves and currents. The jack up barge would primarily be involved with the installation of piles. All water based plant would have minimal impact on the operation of BLB1.

4.8.2 Piling

The maritime structures making up the BLB2 would be suspended deck structures supported on tubular steel piles. The piles would be handled, pitched and secured into the seabed by a crane/rig mounted on either a jack-up barge or floating barge restrained by mooring lines.

Where drilling of rock anchors is required *(e.g. raked piles)*, this would require a steady platform such as a jack-up barge. It is possible that a jack-up barge would be used for installation of all piles.

4.8.3 Concrete Deck

For over-water concrete work it is typical to use precast elements including beams and slabs so that limited formwork / falsework is required. The precast elements are then typically 'stitched' together using an in-situ concrete topping. The in-situ concrete topping would be provided by concrete trucks pumping the concrete from the shore.

4.8.4 Fenders

The fenders would be installed from floating plant, or possibly from a mobile crane located on the working platform.

4.8.5 Pipelines and MLAs

The pipelines and MLAs would be installed after the structures are completed. This work would be no different to the landside works.

4.8.6 Wharf Furniture

Miscellaneous wharf furniture including bollards, quick release mooring hooks, handrails, catwalks, etc. would be installed when the working platform and dolphins are substantially completed.

4.8.7 Metal Catwalks

Aluminium truss catwalks would be fabricated off-site and transported in sections for assembly onsite. The catwalks would be lifted into position by cranes and barge mounted cranes.

4.9 Timing

4.9.1 Maritime Structures

The construction period for BLB2 would be:

- Maritime structures – 18 months
- Users Infrastructure – 10 months

Both the offshore maritime work and land-based pipeline work would be undertaken concurrently as they are generally independent.

4.10 Operation - Expected Throughput of Chemicals, Petroleum Fuels and Gases

Currently BLB1 provides facilities to import products into:

- Exxon Mobil terminal at Stephens Road Port Botany for petroleum products;
- Terminals Pty Ltd at 43-45 Friendship Road and 11-13 Simblist Road at Port Botany for petroleum and chemical products;
- Qenos Australia Pty Ltd at 39 Friendship Road, Port Botany for LPG;
- Origin Energy at 47 Friendship Road, Port Botany for LPG.
- Elgas Pty Ltd at 30 Friendship Road, Port Botany for LPG;
- Vopak Terminals Australia Site A and Site B for chemical and petroleum products.

It also provides facilities to export products from the following locations:

- Exxon Mobil for petroleum products;
- Terminals Pty Ltd for chemical products;
- Qenos Australia Pty Ltd for LPG (small amounts).
- Origin Energy for Py-Gas and Ethylene;
- Elgas Pty Ltd for LPG;
- Vopak Terminals Australia Sites A and B for chemical and petroleum products;

Exports (with the exception of gas exports) currently form only a small portion of the BLB throughput. Based on time at the berth, the major products influencing the berth time are petroleum products and LPG.

Presented in the following tables is information on the predicted throughput of chemicals, gases, fuels and biodiesel for BLB1 and BLB2. For a full description of the predicted throughput, number of ships and expected loading/ unloading rates in **Appendix B** should be consulted. It should be noted that unloading/loading activities would be undertaken 24 hours a day 7 days a week.

Total expected throughput of chemicals is not expected to change over the next 15 years and the handling of these products would be shared between the two BLB as shown in **Table 4-1.**

- **Table 4-1 Expected Delivery of Chemicals Volumes (kL) for Port Botany**

Chemicals Type	2010 to 2022 BLB1 & BLB2	2010 to 2022 BLB2 only
Dangerous Goods Class 3	28 184	14 092
Dangerous Goods Class 6	7 045	3 523
Dangerous Goods Class 8	7 046	3 523
Combustibles	98 643	49 321
Total	**140 918**	**70 459**

Gas imports and exports would increase gradually over the next 15 years (**Table 4-2** and **Table 4-3**). It should be noted that GBLB2 would not be operational for gas imports/exports until 2016; i.e. BLB1 would continue to service 100% of the Gas Market until 2016.

Table 4-2 Expected Gas Volumes (kL) for Port Botany (BLB1 + BLB2)

	2016	2017	2018	2020	2021	2022
Import	1 005 173	1 020 251	1 035 555	1 066 854	1 082 857	1 099 100
Export	311 950	316 630	321 379	331 093	336 059	341 100
Total	**1 317 123**	**1 336 880**	**1 356 933**	**1 397 947**	**1 418 916**	**1 440 199**

Table 4-3 Expected Gas Volumes (kL) for BLB2 only

	2016	2017	2018	2020	2021	2022
Import	502 587	501 125	517 777	533 427	541 429	544 850
Export	155 975	158 315	160 690	165 546	168 029	170 550
Total	**658 562**	**668 440**	**678 467**	**698 973**	**709 458**	**715 400**

With the construction of at least one bio-diesel refining facility at Port Botany in the next three years, there would be a new requirement to handle raw and finished products at the BLBs. Expected biodiesel volumes for Port Botany are in **Table 4-4**.

Table 4-4 Expected Biodiesel Volumes (kL) for Port Botany (BLB1 + BLB2) and BLB2 only

Chemicals Type	2010 BLB1 & BLB2	2011-2022 BLB1 & BLB2	2010 BLB2 only	2011-2022 BLB2 only
Import	288 719	352 438	144 710	176 219
Export	0	97 560	0	48 780
Total	**288 719**	**449 998**	**144 710**	**224 999**

By far the most significant increase in throughput at the BLB will be in petroleum products (**Table 4-5** and **Table 4-6**). An approximate threefold increase in the volume of petroleum products import via the BLBs is predicted between 2010 and 2022.

Table 4-5 Expected Petroleum Volumes (kL) for Port Botany (BLB1 + BLB2)

Type	2010	2011	2012	2020	2021	2022
DG Class 3	1 102 685	1 113 435	1 290 621	2 666 722	2 854 573	3 046 182
Combustibles	472 579	485 758	553 123	1 142 881	1 223 389	1 305 506
Total	**1 575 264**	**1 619 193**	**1 843 744**	**3 809 603**	**4 077 962**	**4 351 688**

SKM

- **Table 4-6 Expected Petroleum Volumes (kL) for BLB2 only**

Type	2010	2011	2012	2020	2021	2022
DG Class 3	661 611	680 061	903 435	1 333 361	1 427 287	1 523 091
Combustibles	283 547	291 455	387 186	571 441	611 694	652 753
Total	**945 158**	**971 516**	**1 290 621**	**1 904 802**	**2 038 981**	**2 175 844**

5. Key Issues

Presented in this section is a detailed environmental impact assessment of key issues identified in the Director-General requirements and a risk assessment for the project. These key issues are generally environmental aspects that may be potentially significantly impacted by the proposed development. Other environmental aspects that are not assessed in this section can be found in Section 6.

5.1 Hazard and Risk

The BLB2 will be used for the transfer of dangerous and non-dangerous goods, including flammable liquids and liquefied gases. A Preliminary Hazard Analysis (PHA) for the proposed BLB2 development was conducted and prepared by Sinclair Knight Merz in accordance with the requirements of the Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 Guidelines for Hazard Analysis. The objective of the PHA study is to determine whether assessed risks impact existing risk contours developed for the Port Botany area in the Port Botany Land Use Safety Study. The scope of work includes the assessment of hazards and risks associated with the operation of BLB2, and does not include an assessment of any existing facilities at the bulk liquids berth site. The PHA is summarised below and the full report can be found in **Appendix D**.

5.1.1 Methodology

The NSW Department of Planning (DoP) Multi-Level Risk Assessment approach was used for this study. The approach considered the development in context of its location and its technical and safety management control. There are three levels of assessment and are:

Level 1 – Qualitative Analysis, primarily based on the hazard identification techniques and qualitative risk assessment of consequences, frequency and risk;

Level 2 – Partially Quantitative Analysis, using hazard identification and the focused quantification of key potential offsite risks; and

Level 3 – Quantitative Risk Analysis (QRA), based on the full detailed quantification of risks, consistent with HIPAP No.6 Guidelines for Hazard Analysis.

The assessment of the BLB2 project was undertaken as part of the Port Botany Land Use Safety Study using a quantitative approach. A key component of the Director General's Requirements (DGRs) is a review of the impact of the proposed facility on the existing contours developed for the Port Botany Land Use Safety Study. Hence, the selected approach for this study was to assess the risks associated with the operation of the proposed BLB2 facility and to compare these to existing risk contours developed in the Port Botany Land Use Safety Study. In the event assessed risks exceeded the existing contours, risk reduction measures were developed and recommended as part of this study.

The following detailed risk assessment approach was used, based on the HIPAP No.6 guidelines.

Hazard Identification

A hazard identification workshop was held on 26 June 2007 with SPC and Vopak Terminals to consider the BLB2 development and operation. The results of the study were used to develop a Hazard Identification table and list hazards for the consequence, frequency and risk assessment.

Consequence Assessment

The identified hazards listed in the Hazard Identification Table were subjected to a consequence assessment. Where hazards could be quantified for impact to people, the impact severity was assessed and carried forward for frequency analysis. Where impacts to the environment were identified, release quantities were estimated and carried forward for frequency analysis.

Frequency Assessment

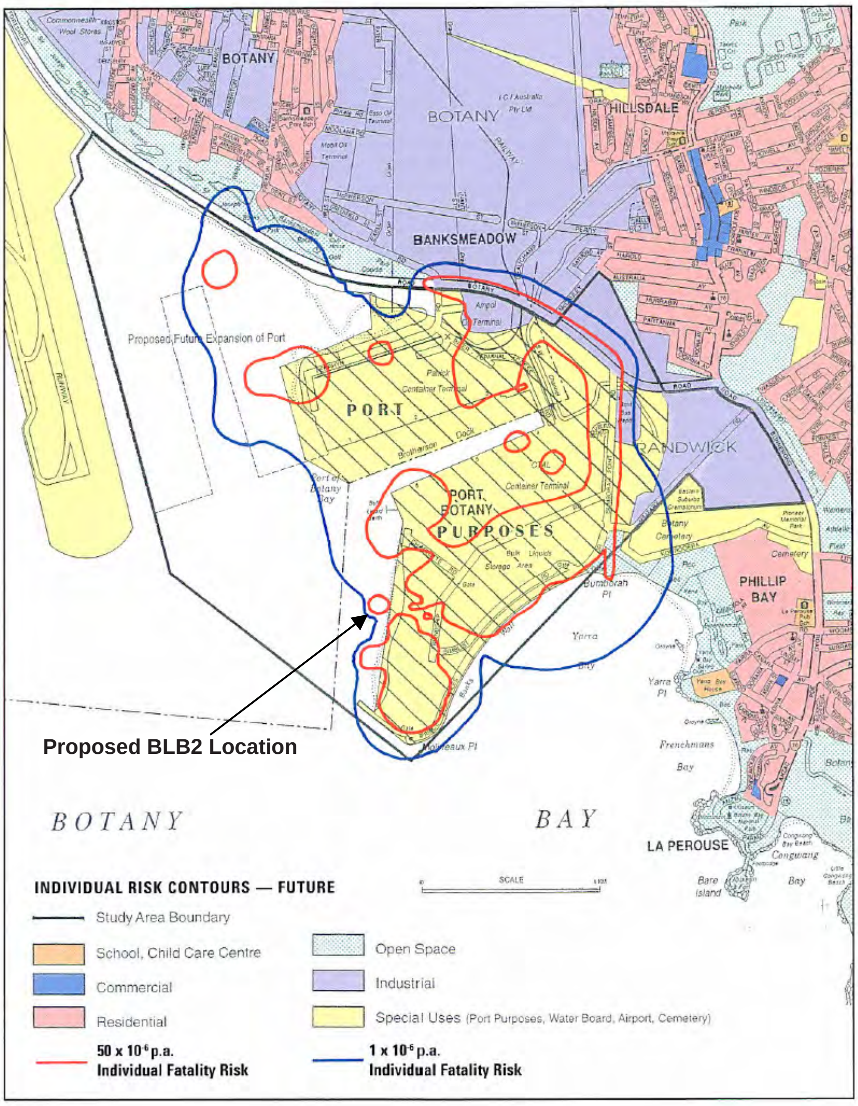
Incidents carried forward from the consequence analysis were subject to a frequency analysis. This involved the assessment of the initiating event (i.e. leak) and then the application of the probability of failure of the protection systems. Fault and event trees were used to assess the final event frequency.

Risk Assessment and Review

Existing risk contours (**Figure 5-1**) were used to determine selected points for which risk was assessed. For example, the location of the closest point on the fatality risk contour to the south of the site was selected and the distance to this point used to determine the cumulative impacts and risks at this location from the operations at the BLB2 facility. The assessment results were then compared to the risk contour value to determine whether the existing value was exceeded.

Where the results of the assessment did not exceed the risk contour value, no further assessment was conducted. Where risk contour values were exceeded, major risk contributors were identified and risk reduction was applied to these. The risks were then reviewed to ensure the applied risk reduction was successful in reducing the risks by the required amount.

Figure 5-1 Cumulative Individual Risk Contours Including Postulated Future Development



5.1.2 Hazard Analysis

The BLB2 would be constructed with two main liquid transfer mechanisms comprising MLA and manifolds for the connection of flexible lines. Fuels (flammable liquids and liquefied gases) would be transferred using MLA and chemicals would be transferred using flexible hoses. When transferring LPG only one MLA will be used, however, for transferring flammable and combustible liquids, up to 4 MLAs may be used simultaneously. Up to 8 flexible hoses can be used simultaneously to transfer chemicals ashore. The operation is conducted under the requirements of the International Safety Guide for Oil Tankers and Terminals (ISGOTT) which includes a full transfer checklist administered by SPC. Transfer operations would be monitored throughout the full transfer period by a number of personnel.

Once the MLA or hoses are connected, they would be pressure tested to 800kPa for chemicals and flammable liquids, and 900kPa for LPG to ensure hose connection integrity. The transfer operation pressure of the system is 700kPa for chemicals and flammable liquids and 850kPa for LPG. Once hose integrity is proven, transfer would commence at low pressure under monitoring from wharf and ship operators, and would gradually rise to the maximum operation pressure.

Once transfer is complete, lines would be purged with nitrogen to remove any liquid, vapour or gas from the pipes and hoses. All isolation valves would be closed, appropriate checks made, and hoses or MLA would be disconnected. It is noted that MLA will incorporate dry-break couplings to eliminate potential for any spills when disconnected.

The flammable liquids, liquefied flammable gases and chemicals (including combustibles) proposed for transfer and handling at BLB2 are listed in **Table 5-1**.

- **Table 5-1 Proposed Dangerous Goods for Transfer and Handling at BLB2**

Material Name	Class	Hazardous Properties
Liquefied Petroleum Gas – LPG	2.1 Flammable Gas	▪ Gas is flammable and if released could ignite. ▪ Ignited leak at the release source would result in a jet fire. ▪ Un-ignited releases could vaporise and causes a gas cloud, which may ignite after a delay and explode. ▪ Minimal environmental damage as gas evaporates rapidly with little or no impact to surroundings.
Refined Petroleum and Chemicals	3 (PG I & II) Flammable Liquid	▪ Liquid is flammable or combustible (C1 & C2) and will burn if ignited, resulting in pool fire in the area under the release point. ▪ Potential impact to the bio-physical environment depending on spill quantity and containment.
Bio-Diesel	C1 Combustible Liquid	▪ Liquid is combustible and will burn if ignited, resulting in pool fire in the area under the release point. ▪ Potential impact to the bio-physical environment depending on spill quantity and containment.
Corrosive Substance	8 (PG II & III) Corrosive Liquids	▪ Liquid is corrosive and may damage materials which it contacts causing weakening of structures and equipment. ▪ Impact to people could result in chemical burns. Inhalation of vapours could impact mucous membranes. The severity depends upon concentration and duration of impact. ▪ Potential impact to the bio-physical environment depending on spill quantity and containment.
Toxic Substances	6 (PG II & III) Toxic Liquids	▪ Liquids are toxic and may impact the bio-physical environment depending on the spill quantity and containment. ▪ Impact to people could result in acute or chronic illness and/or dermatological impacts. Vapours may affect mucous membranes and cause breathing impairment. The severity depends upon concentration and duration of impact.

All products and materials are classified as Dangerous Goods in the Australian Dangerous Goods Code and the International Maritime Dangerous Goods (IMDG) Code.

The hazard analysis workshop resulted in the identification of potential hazards at BLB2 and a summary is provided in **Table 5-2.**

- **Table 5-2 Hazard identification at BLB2**

Area/Section	Hazard Cause	Hazard Consequence
Chemical Deliveries and Transfers		
Ship mooring	Ship strikes wharf at excessive speed	Potential to damage ships hull resulting in release (fuel/gas/chemical) directly to the environment
Moored Ship	Passing ship strikes the moored ship	Potential to damage ships hull resulting in release (fuel/gas/chemical) directly to the environment
Chemical hoses (150mm ID)	Coupling failure	Release of chemical from joint
Chemical hoses	Hose split/failure	Release of chemical from hose
Pipeline	Pipeline corrosion	Release of chemical from pipeline
Chemical Hoses	Ship securing lines fails	Ship moves away from wharf and hoses coupling parts – release of chemical
Gas Delivery and Transfer		
Marine Loading Arm	Ship moves away from wharf – securing line failure	Limited gas release: immediate ignition & jet fire delayed ignition and flash fire
Pipelines	Pipeline corrosion	Leak, gas release: immediate ignition & jet fire delayed ignition and flash fire
Flammable & Combustible		
Marine Loading Arm	Ship moves away from wharf – securing line failure	Limited liquid release – potential pollution to the bay, ignition and pool fire
Pipelines	Pipeline corrosion	Liquid release – potential pollution to the bay
Emergency Response		
Wharf/Pipelines	Fire at the wharf/ pipelines	Requirement to apply fire water, which could carry contaminants into the bay

The risks of a ship striking the wharf when mooring, a moored ship being struck by a passing ship, chemical pipeline failure, failure of mooring systems and application of fire water were considered low and within the ‘as low as reasonably possible’ (ALARP) range. Hence, these incidents would not require further analysis based on the assumption that the safeguards in **Section 5.1.6** are implemented.

However, hazards that have a higher risk must be further analysed. The following incidents were identified to have the potential to increase the existing risk profile for the Port Botany area:

- LPG Transfer MLA Failure – leak/release, ignition and explosion/fire;
- Flammable/Combustible Liquid transfer hose failure –leak/release, ignition and fire;
- LPG Pipeline Failure – leak/release, ignition and explosion/fire;
- Flammable/Combustible Liquid MLA Failure – leak/release, ignition and fire;
- Flammable/Combustible Liquid Pipeline Failure - leak/release, ignition and fire;

Minor leaks from valves, flanges, joints and gaskets at MLA or pipelines that are not detected may lead to larger quantities of gas release. A gas cloud could form, and if ignited, could cause a flash fire or gas cloud explosion. Also minor leaks or failure of the MLA or pipelines may cause a pool of flammable or combustible liquid to form, and if ignited, a pool fire would occur, radiating heat to the surrounding areas. These events could have consequent impacts beyond the confines of the BLB area and may impact the risk at existing Port Botany Land Use Safety Study risk contours. Hence, these incidents would be further analysed (Consequence, Frequency and Risk).

5.1.3 Consequence Analysis

To determine whether the proposed BLB2 will impact the existing Port Botany Land Use Study risk contours, the consequence impacts were determined from the potential incidents at the BLB2 facility, at the risk contour distances detailed in the Port Botany Study.

A review of the Port Botany Land Use Study risk criteria indicates that there are two contours plotted for risk; $1x10^{-6}$ chances in a million per year (pmpy) and $50x10^{-6}$ pmpy. The lower criterion applies to residential areas, the higher criterion to industrial sites. Hence, as the fatality risk has been used in the development of contours, incidents at the BLB2 must result in fatality for these to impact the existing risk contours. Where an incident does not result in fatality, at the impact distance from the incident to the contour, then there is no risk of the incident impacting the contour, and no further analysis is required.

The Port Botany Study was reviewed to determine the impact distance from BLB2 for each fatality risk criteria. The existing BLB wharf was used as a basis for the scaling to determine the contour impact distances. The distance from the wharf to the 50 pmpy contour is 50m (radius) and the distance from the wharf to the 1 pmpy contour is 80m (west).

The following consequence criteria will be used in the assessment:

- Heat Radiation Impact – levels below 4.7 kW/m^2 not considered to result in fatality;
- Explosion Overpressure – levels below 7 kPa not considered to result in fatality;
- Flash Fire – fatality occurs to people inside the flash fire, no fatalities where people are beyond the LEL;

Each incident assessed in this section has been reviewed against these criteria and is summarised in **Table 5-3** and further discussed in **Appendix D.** The table also includes the results of the probit analysis.

- **Table 5-3 Impact Distances of Incidents at BLB2**

Incident	Jet Fire – Heat Radiation Impact	Within 50 pmpy contour?	Flash Fire	Within 50 pmpy contour?	Explosion	Within 50 pmpy contour?
LPG Transfer – MLA Failure						
LPG Incident at Ships Manifold and MLA	4.7 kW/m^2 = 10m 12.5 kW/m^2 = 6m 23 kW/m^2 = 4m	**Yes**	20m	**Yes**	62m	**No**
Catastrophic LPG Incident at MLA	4.7 kW/m^2 = 160m 12.5 kW/m^2 = 120m 23 kW/m^2 = 80m	**No**	195m	**No**	160m	**No**
LPG Incident from Flange Leak	4.7 kW/m^2 = 10m 12.5 kW/m^2 = 6m 23 kW/m^2 = 4m	**Yes**	44m	**Yes**	62m	**No**
LPG Incident from Valve Leak	4.7 kW/m^2 = 18m 12.5 kW/m^2 = 10m 23 kW/m^2 = 7m	**Yes**	44m	**Yes**	62m	**No**
Pool Fire - Ship's Connection Flange Leak	4.7 kW/m^2 = 40m 12.5 kW/m^2 = 29m 23 kW/m^2 = 22m	**Yes**	-	-	-	-
Pool Fire – Flexible Hose Failure	4.7 kW/m^2 = 70m 12.5 kW/m^2 = 50m 23 kW/m^2 = 33m	**No**	-	-	-	-
Pool Fire – MLA Catastrophic Failure	4.7 kW/m^2 = 68m 12.5 kW/m^2 = 39m 23 kW/m^2 = 24m	**No**	-	-	-	-
Pipeline Flange Leak – Pipeline Isolation Valve Station	4.7 kW/m^2 = 33m 12.5 kW/m^2 = 24m 23 kW/m^2 = 18m	**Yes**	-	-	-	-
Pipeline Valve Leak – Pipeline Isolation Valve Station	4.7 kW/m^2 = 33m 12.5 kW/m^2 = 24m 23 kW/m^2 = 18m	**Yes**	-	-	-	-

Incidents that are not within the existing 50 pmpy contour were carried forward for frequency and risk assessment. The Pipeline Isolation Valve station is located outside the 50 pmpy contour and whilst there would be no impacts as a result of flange/valve leaks, there is a potential that the 50 pmpy contours could be extended onto the shoreline as a result of flange/valve related incidents. Hence, these incidents have been carried forward for frequency and risk assessment.

Based on initial criteria, all flash fire incidents are all assumed to result in fatality, however, explosion overpressure and heat radiation impacts may not necessarily result in fatality. The probability of fatality from these incidents is a function of heat radiation intensity and exposure time and for explosion overpressure, the magnitude of pressure wave.

A probit analysis has also been conducted to assess the fatality probability to determine whether the incident has the propensity to impact existing risk contours of adjacent sites. Probit analysis is a relationship between an incident exposure time and impact severity and is summarised in **Table 5-4.** The probit was applied to each of the events determine whether further analysis is required. Flash fire incidents have not been included in this assessment as the probability of fatality in a flash fire is 1, and therefore these incidents have been carried directly for risk assessment.

- **Table 5-4 Summary of Probit Analysis Applied to Incidents at BLB2**

Incident	Fatality Probability	Further analysis required?
Explosion – Ship's manifold connection (LPG)	0	No
Jet fire – MLA catastrophic failure (LPG)	1	Yes
Explosion – MLA catastrophic failure (LPG)	0	No
Flexible hose rupture (flammable/ combustible liquids –pool fire (wharf)	0	No
Jet Fire – Flange leak isolating valve station (LPG)	0.35	Yes
Jet Fire – Valve leak Isolating valve station (LPG)	0.35	Yes
Explosion – Flange/valve leak isolating valve station (LPG)	0	No
Pool Fire – MLA catastrophic failure (Flam/Comb Liquid)	0	No
Pool Fire – Flange/ valve leak isolation Valve station (Flam/Comb Liquid)	0.48	Yes

Impacts at BLB1

Incidents occurring at BLB2 may impact the closest facility, the BLB1 wharf, at levels exceeding the acceptable impact or risk criteria. A review of the incidents indicates only two incidents have the potential to impact the BLB1 comprising jet fire and explosion as a result of a catastrophic MLA failure. The distance to the maximum impact criteria from BLB2 is 160m for heat radiation and explosion overpressure, and as the impact criteria distance does not exceed 160m, there will be no impact at BLB1 from incidents at BLB2.

5.1.4 Frequency Analysis

The incidents that have been carried forward from the consequence analysis for frequency analysis are in **Table 5-5**. To ensure the results of the BLB2 risk analysis is consistent with the outcomes of the existing study, the Port Botany study frequency data will be used in the analysis.

- **Table 5-5 Frequency Analysis of Incidents**

Incident	Frequency
Environmental Impact – Flexible Hose Failure (Chemical Transfer)	Environmental impact risk 6.5×10^{-6} p.a.
Jet Fire – MLA Catastrophic Failure (LPG)	Immediate ignition 2.6×10^{-7} p.a.
Flash Fire – MLA Catastrophic Failure (LPG)	Delayed ignition 2.6×10^{-7} p.a.
Jet Fire – Flange Leak Isolating Valve Station (LPG)	Immediate ignition including exposure 1.3×10^{-7} p.a.
Jet Fire – Valve Leak Isolating Valve Station (LPG)	Immediate ignition including exposure 2.16×10^{-6} p.a.
Flash Fire – Flange Leak Isolating Valve Station (LPG)	Immediate ignition including exposure 1.3×10^{-7} p.a.
Flash Fire – Valve Leak Isolating Valve Station (LPG)	Immediate ignition including exposure 2.16×10^{-6} p.a.
Pool Fire – Flange Leak Isolating Valve Station (flammable/combustible liquid)	Class 3/C1 flange leak including exposure 1.7×10^{-5} p.a. Chem. Class 3/C1 flange leak including exposure = 3.6×10^{-6}p.a
Pool Fire – Valve Leak Isolating Valve Station (flammable/combustible liquid)	Class 3/C1 flange leak including exposure = 6.8×10^{-6} p.a. Chem. Class 3/C1 flange leak including exposure = 6.1×10^{-6} p.a.

5.1.5 Risk Analysis and Assessment

The combination of incident consequences and frequencies provides an assessment of the incident risk. **Table 5-6** summaries the results of the fatality probability and incident frequency for those incidents carried forward for risk analysis.

Table 5-6 Summary of Fatality Probability, Incident Frequency and Risk Results

Incident	Fatality Probability	Incident Frequency	Risk (pmpy)
Jet Fire-MLA Rupture (LPG)	1	$2.6x10^{-7}$p.a.	**0.26**
Flash Fire – MLA Rupture (LPG)	1	$2.6x10^{-7}$ p.a.	**0.26**
Jet Fire – flange leak isolating valve station (LPG)	0.35	$1.3x10^{-7}$ p.a.	**0.045**
Jet Fire – valve leak isolating valve station (LPG)	0.35	$2.16x10^{-6}$ p.a.	**0.76**
Flash Fire – flange leak isolating valve station (LPG)	1	$1.3x10^{-7}$ p.a.	**0.13**
Flash Fire – valve leak isolating valve station (LPG)	1	$2.16x10^{-6}$ p.a.	**2.16**
Pool Fire – flange leak isolation valve station (Flammable/Combustible Liquid)	0.48	$2.06x10^{-5}$ p.a.	**10**
Pool Fire – valve isolation valve station (Flammable/Combustible Liquid)	0.48	$1.3x10^{-5}$ p.a.	**6.24**

The risk analysis has identified two main areas where the risk impacts may occur:

- The BLB2 MLA area on the wharf deck; and
- The pipeline isolating valve station located on the shoreline adjacent to the road.

Cumulative Risks

The cumulative risks at each location are the summation of the individual risk events for each incident at that location.

The two incidents relating to MLA risks described in **Table 5-6**, each have a risk of 0.26pmpy and hence the total risk (cumulative) is 0.26 x 2 = 0.52pmpy. This occurs at the existing 50pmpy contour that currently surrounds the proposed BLB2 facility in the Port Botany study. Therefore, there would be negligible impact on the existing 50pmpy contour or the 1pmpy contour a further 30m beyond the 50pmpy contour.

For cumulative risks at the pipeline isolating valve station, there were six incidents identified. The cumulative risk is the summation of the risk values in **Table 5-6**, which is 19.3pmpy. This risk impact occurs at the existing 50pmpy contour that currently surrounds the BLB2 facility in the Port Botany study (Ref.1). Therefore, there would be no increase to the existing 50pmpy contour or the 1pmpy contour a further 130m into Botany Bay.

In addition to existing risk contour impacts, there is potential for the risk at the adjacent facilities to the BLB2 to exceed the risk criteria. The closest adjacent facility to the BLB2 wharf is the Elgas

gas storage facility to the east, which is located approximately 120m from the BLB2 wharf facilities and 20m from the pipeline valve station. The individual risk at the adjacent Elgas gas storage facility, as a result of incidents at the BLB2 wharf is below the 1pmpy and less than 19.3pmpy for incidents at the pipeline isolation valve station. As the Elgas gas storage facility is an industrial site, the acceptable risk criterion is 50pmpy. Hence, as these criteria are not exceeded, the BLB2 and pipeline valve station facility meets the acceptable (published) risk criteria.

5.1.6 Mitigation measures

A number of hazards were identified which may result in equipment failure and liquid release. BLB2 would be constructed and operated using the following hardware (equipment) and software (systems) safeguards.

To prevent ships from striking the wharf as it berths:

- Ships would be moored using tugs to minimise the potential for loss of movement control;
- SPC Pilot would bring the ship alongside eliminating the chance of unfamiliar berthing;
- Fixed fenders would be used on the wharf to provide cushioning should excessive impact with the wharf occur; and
- Most ships have a double hull (liquid not in contact with outer hull) eliminating the potential for a leak should the hull be breached.

To minimise the potential for a passing ship to strike a moored ship at the BLB:

- Most ships have a double hull (liquid not in contact with outer hull) eliminating the potential for a leak should the hull be breached;
- A marine exclusion zone is in force around the BLB (no unauthorised vessels in BLB area);
- Ships sail at low speed past the BLB, hence, low impact potential should control be lost; and
- Ships passing the BLB would be under tug and pilot control.

To minimise potential leaks from flexible hoses during chemical transfer:

- Connections would be made using bolted flanges only;
- All hoses would be pressure tested annually, minimising potential for hose rupture;
- Hoses would be pressure tested with nitrogen prior to each use (800kPa), minimising potential for hose leak during operation;
- New gaskets would be used for each transfer, minimising potential for gasket failure;

- Hoses would be operated at <700kPa, minimising potential for leak, considering the test is conducted at 800kPa;
- Start-up procedure to monitor pressuring of hoses including leak detection;
- Operators would be in attendance during full transfer cycle;
- Operators would have full radio communication with the wharf and shore operations;
- Manual shut down valves located at each end of the flexible hose;
- Operator dedicated to monitoring of all equipment during transfer (leak detection);
- Ship decks have a spill catchment to prevent any release overboard in the event of a spill; and
- Wharf would be bunded with a 200mm bund wall all round.

To minimise potential leaks from pipelines:

- Pipeline would be along transfer route, minimising flanges and potential leak points;
- Wharf would be fully bunded with a bund height of 200mm;
- Containment pit would be constructed around the pipe isolation valves (onshore);
- Hydrostatic testing of pipes and commissioning would be conducted every two years (or when maintenance is performed on pipelines);
- Pipes would be empty and liquid free between transfers; and
- Operator would monitor operations during transfer (leak monitoring of pipelines).

To minimise risks of MLA or flexible line ruptures in the event the ship mooring lines are broken and the ship moves away from the wharf:

- Transfers may cease at high wind speeds (hoses isolated) and when lightning occurs;
- Operators (marine) would continually monitor the mooring security;
- Wind warning system from Bureau of Meteorology would be continually monitored;
- Securing lines would be designed to secure against normal passing ships (i.e. waves generated in the bay); and
- A tug would be on 24 hour call in the nearby dock area (Brotherson Dock).

To minimise risks of a marine loading arm potentially leaking at the rotating arm joints:

- MLA would be hard piped (no flexible connections);

- Arm movement outside predefined operating “envelope” would cause an alarm, would activate an emergency shutdown and disconnect the arm;
- Connection of the MLA to the ship would be bolted or other SPC approved method;
- Connections would be pressure tested with nitrogen to 800kPa for liquids and 900kPa for LPG prior to use;
- Joints and connections would be continually monitored for leaks by the ship and shore crews;
- The MLA start up procedure would include a staged pressurisation and monitoring to detect any leaks;
- An operator would be stationed on board the ship to respond to any incidents and initiate isolation of the transfer in the event of an incident;
- MLA would be monitored and controlled from a central control room on shore, with Supervisory Control and Data Acquisition systems (SCADA);
- An emergency shutdown would be installed at the base of the MLA on the wharf;
- A dry break & weak coupling would be part of the MLA connection to the ship;
- All equipment would be classified to AS60079 (Hazardous Area Classification) to eliminate ignition sources in the wharf area;
- Three remote-control operated fire monitors would be located on the wharf; and
- A fire water pump station would be located on the shore (diesel duty/stand-by).

5.2 Water quality

5.2.1 Existing Environment

Port Botany is located on the northern foreshore of Botany Bay. The Bay is not a typical estuary in that a sand bar is not present near its entrance (MacIntyre, 1975). Therefore, Botany Bay could be considered as an extension of the open ocean. However, outside the main shipping channel the bay is relatively shallow (mean depth approximately 5m) and shoals westward. The width of the entrance of the bay is approximately 1.1 km and is exposed to wind from all directions. Tidal processes are the predominate influence of circulation and flushing of the Bay.

Over the years Botany Bay has been modified substantially due to the construction of a revetment wall, dredging and industrial activities on the northern side of the Bay (Airport runway, Port Botany, Molineux Point and relocation of the Cooks River). Such activities have considerably modified wave action in the Bay. Two rivers discharge into the Bay – the Cooks and Georges Rivers. The Cooks River was relocated further west to accommodate the Sydney Airport runway.

Dry weather water quality in Botany Bay is generally good and complies with relevant guidelines (SWC, 2005). However, during and wet weather events, stormwater from the surrounding industrial and high density built environment and sewage overflows results in a deterioration in water quality, and water quality in enclosed embayments, depressions around the Cooks River and within dredged channels often does not comply with relevant guidelines. The absence of fine grained sediments within other areas of Botany Bay indicates that the Bay is well flushed and sediments do not accumulate but are transported out of the Bay with the ebb tide. There are three main habitat types in the Botany Bay marine environment, these include:

- Seagrass Beds (including *Zostera capricorni, Posidonia australis* and *Halophlia oralis*). The closest seagrass beds are located in Phillip Bay, approximately 1.5km east of the proposed BLB2 and Penrhyn Estuary located approximately 1.5km north of the proposed BLB2;
- Mangrove communities. The closest mangroves are located at Penrhyn Estuary, and also at Towra Point wetlands approximately 4.5 km from the proposed BLB2; and
- Unvegetated soft sediments, which consist of sand and shell debris and silt within dredged channels.

These seagrass habitats have come under threat due to the proliferation of the aquatic weed *Caulerpa Taxifolia* (aquarium weed), which was probably discarded from homebased aquariums into the stormwater network and thence into Botany Bay. Dredging, reclamation and other activities which directly disturb the sea bed have also resulted in a significant decrease in the area of seagrass beds. There are wide range of benthic invertebrates and fishes within Botany Bay (e.g. flathead and flounder). In addition there are potentially threatened species that may use the marine environment of the Bay including birds, fishes, marine mammals and marine reptiles.

BLB2 will be located in the Brotherson Dock area, which has been dredged to allow ships with relatively deep drafts to access the port. The dredging of this area has resulted in a highly modified seabed that does not support sensitive marine vegetation such as seagrasses.

5.2.2 Environmental impact assessment

There are a number of potential impacts on water quality in relation to the construction and operation of the proposed BLB2 namely:

- Construction impacts related to piling for the berth and moorings and the storage and use of chemicals and fuels for construction;
- Spills of materials during loading/unloading operations and from the pipelines transferring liquids between the BLB2 and storages; and
- Discharge of ballast water and impacts of anti-fouling paints from visiting ships.

Construction of BLB2 and pipelines

The construction of the berth and moorings associated with BLB2 would involve piling to provide support for the surface structures. It is estimated that approximately 137 piles would be required.

During boring for the piles turbid water near the seabed would be generated, however, the impact of the turbid water on the marine environment would be minor as:

- The seabed has already been highly modified in this area due to dredging and is over 14m deep; and
- Any turbid water generated from piling would have dissipated (or suspended sediment concentrations would have returned to background levels) before affecting the seagrass beds which are at least 1.5 km away.

Due to the minor impacts associated with piling and the depth of the water, it is not intended to use silt curtains during piling activities. Also the depth of water limits the practicality and effectiveness of silt curtains. However, visual monitoring of water turbidity would be undertaken during piling.

Chemicals, fuels and concrete used during the construction of BLB2 have the potential to impact upon water quality in Botany Bay. However, provided standard mitigation measures such as the storage of chemicals and fuels in appropriately bunded areas, development of procedures for the handling and uses of chemicals and fuels near or over water and the provision of concrete washout areas, the risk of impacts upon water in quality in Botany Bay are minor. These mitigation measures and procedures would be incorporated into the CEMP (Construction Environmental Management Plan). SPC's emergency oil spill response team is located nearby in Brotherson Dock, if required.

For the construction of the land-based pipeline support structures, some disturbance of the ground would be required. This has the potential to increase the risk of sedimentation and erosion from exposed soils and stockpiles. However, the area to be disturbed is relatively small and appropriate sediment and erosion controls would be installed to minimise this risk to the water quality of Botany Bay. A soil and water management plan would be prepared as part of the CEMP.

Spills during operation

During loading/unloading, potential spillage scenarios associated with the operation of the proposed BLB2 include:

- Spills into the ocean during loading/unloading operations – which have the potential to impact upon water quality in Botany Bay;
- Spills on to the working platform during loading/unloading operations - which have the potential to impact upon water quality in Botany Bay and stormwater runoff from the berth; and

- Leakage of pipelines between the berth and storages – which have the potential to impact upon stormwater runoff from the pipeline corridors and soil and groundwater beneath the pipeline corridors;

The risk of multiple spills would be very rare and has not occurred in Botany Bay.

The MLAs and associated infrastructure would have a number of design features that minimise the risk of spills during unloading/loading operations including:

- Valves that would not operate unless the MLAs are correctly connected to the ship;
- Emergency Release Couplings (dry-break type) if MLAs suddenly disconnect from the ship (if the vessel suddenly moves outside the preset operating range of the MLA);
- Emergency Shutdown systems that shut valves at the base of each MLA and at a number of other locations that can be activated locally or remotely from the operating Company's Control Room;
- Regular inspection and testing regime for flexible hoses used for chemical discharges;
- Nitrogen pressure testing of all MLA and hose connections to the ship prior to discharge (to ensure that flanges do not leak); and
- A Fire Safety System which would meet the appropriate standards for this type of facility – this would ensure that any fires (which have the potential to cause spills) are controlled.

An oil boom facility from Brotherson Dock would be available for rapid deployment in the event of a spill. Other resources are available to respond to spills into the ocean. SPC have the following responsibilities in both Sydney Harbour and Botany Bay:

- Administer dangerous goods transported in marine waters;
- Provide a 24 hour emergency response crew for spills into marine waters;
- Clean up and investigation of spills;
- Prosecution of spill offenders; and
- Provide 24 hour port communication.

The SPC has a large inventory of oil spill equipment and invests approximately $11 million a year on preparedness, prevention and protection of the marine environment (SPC: 2005). With such measures in place by the SPC, it is considered that the proposal's potential for hazardous spills to adversely affect the marine environment is manageable to best practice standards. SPC has also developed a comprehensive spill response manual and procedures for Port Botany operations.

SPC personnel are trained in spill boom deployment and recovery of spilt materials with emergency exercises conducted at least annually. As well as SPC being the primary agency to respond to water based spills in Port Botany, SPC is supported by the State Oil and Chemical Spill Plan as well as the Port Botany and Port Hacking Marine Plan and the Port Botany Emergency Response Plan. All these plans provide for escalating response support all the way to National (ie interstate support) level.

Spills also have the potential to occur on the working platform during loading/unloading operations. However as discussed in Section 4, a spill containment bund would be constructed around the manifold areas and a 200mm bund would be constructed around the perimeter of the working platform. The bunds would be closed when loading/unloading operations are occurring. This two barrier spill containment system would prevent spills on the working platform impacting upon Botany Bay water quality. If a significant spill on the work platform did occur, the liquid material would be pumped out from the bund to the wastewater storage tank and/or an approved waste road tanker and taken off-site for appropriate disposal. If minor spills did occur, the spilled liquid would be cleaned up by operational personnel.

Once loading/unloading operations have ceased, the bunded areas would be visually assessed to determine whether the area is free from product spills. Stormwater runoff assessed to be pollution free would be discharged to Botany Bay. Contaminated stormwater would be captured in the bunded area and disposed off-site to a DECC approved waste handling facility. If there are no unloading/loading operations occurring, the bunds would be open and any stormwater would be discharged to Botany Bay. Stormwater handling is based on preliminary design and further appropriate management methods will be determined during the detailed design stage.

Pipelines between BLB2 and the tenant's terminals potentially may leak causing pollution of stormwater runoff, soil and groundwater. It should be noted that most pipelines would be installed at or above ground level, rather than below the ground surface. This would ensure that any leaks from or failures of the pipelines could be easily detected visually. Regular inspections and maintenance of the pipelines would occur and any leaks would be repaired rapidly. Also, the LPG and Petroleum pipelines have pressure and flow monitoring systems (SCADA) that alarm (if preset limits are exceeded) in the respective Control Rooms so that the Control Room Operator can investigate and take appropriate action The combination of inspections/maintenance and pressure monitoring would ensure that any leaks are quickly detected and repaired.

The ground beneath the pipeline racks would be concrete or compacted sand/gravel to provide sufficient geotechnical support for the pipeline racks. In the unlikely event of a leakage from the pipeline, the leaked material would be cleaned up as soon as possible. As the volume of leaked material would be small (after cleanup activities) and there are no groundwater users in the immediate vicinity, the risk of groundwater impacts is negligible. Stormwater runoff from the pipeline area is not considered to be a significant risk to water quality in the Bay because of the relative infrequency of leaks and the rapid clean up of any leaks that might occur.

Marine Pests and Antifouling

In addition potential hazardous spills, the introduction of marine pests from ship hulls and ballast water exchange represents a potential environmental impact. The Australian Quarantine Inspection Service (AQIS) is the regulatory body responsible for the management of international vessels and ballast water exchange inside Australian territorial waters.

In July 2001, the AQIS initiated new rules for ballast water discharges. These include the prohibition of ballast water discharges within Australia's 12 nautical mile territorial sea without approval from AQIS. Should international ballast waters be discharged in Australian waters, the use of the AQIS risk assessment tool (the Ballast Decision Support System) is highly precautionary in favour of potential environmental risks and subsequently ballast waters discharges from international ships inside Australian waters are a rare event (Barry and Bugg, 2002). Since Port Botany regularly receives more imports than exports, there is a requirement for most ships to take on ballast water rather than undertake a discharge. NSW Department of Primary Industries (DPI) currently has responsibility for management of marine pest species including domestic ballast discharges.

In addition, management of marine pests are also controlled by antifouling paints to prevent marine pests attaching to ship hulls and anchors. Antifouling paints are no longer allowed to contain the organotin Tributyltin (TBT) and TBT paint removal is not permitted. Ships docking at Port Botany do not require use of anchors as cables perform docking functions. It is also illegal for ships to clean hulls while docking in ports and to discharge accumulated sediments in hulls while in Australian waters.

With such measures in place to meet AQIS requirements, it is considered that the proposal's potential for ships to introduce marine pests is low and can be managed through recognised practices.

5.2.3 Mitigation measures

The following mitigation measures would be implemented to minimise the risk to water quality of construction and operation of BLB2:

- An appropriate Environmental Management Plan and procedures would be developed and implemented for construction. The CEMP and procedures would contain mitigation measures to minimise the impact of construction on water quality including piling activities and the handling of chemicals, fuels and concrete;

- The manifold areas would be bunded and would drain to the wastewater storage tank. All water collected would be treated for appropriate disposal;
- The working platform would be bunded and closed off when bulk liquid pumping is being undertaken. When BLB2 is vacant, the working platform would be checked beforehand to ensure no residual spills and stormwater run-off on the platform would be discharged to Botany Bay. When pumping operations are underway, the bund drain valve would be closed and any liquid within the bunded area sump would be inspected to determine whether to discharge to sea or to drain to the wastewater storage tank;
- Features such as Fire Safety System and Emergency Shutdown Systems linked to pipeline valves would be installed to ensure that loading/unloading operations would only be undertaken when the infrastructure is working correctly;
- An oil boom capable of being deployed rapidly would be easily available from Brotherson Dock;
- As for BLB1, procedures for spills and leaks including notifications and clean ups would be developed;
- SPC would continue to supply appropriate spill response resources that would be available in case of a major spill;
- All unloading/loading infrastructure and pipelines would be regularly inspected and maintained to minimise the potential of leaks or spills; and
- Ballast water and hull fouling from visiting ships would continue to be managed as per AQIS requirements. No TBT paint removal is permitted.

5.3 Hydrodynamics

5.3.1 Existing Environment

Botany Bay is generally shallow (average about 5m in depth) and current and swell conditions in the Bay can be influenced by ocean through its relatively large opening to the sea (about 1.1 km across). In some areas, predominately around the airport and Port Botany, significant dredging has occurred either for reclamation (e.g. Third Runway) or to allow access for large ships. The area adjacent to BLB2 has been dredged to allow ship access to BLB1 and the container terminal. Water depth in this area is approximately 14m.

BLB2 would be located near the Brotherson Dock area, which is heavily modified by dredging, foreshore protection structures, wharves and berths and other facilities associated with an operating port. There are no natural, undisturbed foreshore features (e.g. beaches, reefs etc) within the immediate vicinity of BLB2.

There are four main processes which control the hydrodynamics of Botany Bay, namely:

- Tidal movements – this is considered to be the main mechanism for flushing and mixing in the Bay. Tidal movements are almost identical to ocean tidal movements because of the proximity of the Bay to the ocean and its relatively wide opening to the ocean;
- Wind generated waves – because of the shallowness of most of the Bay wind generated waves are a common occurrence;
- Ocean generated waves – swells from the ocean may impact on wave generation within the bay due to its relatively wide mouth to the ocean; and
- Inflows – the two major inflows are the Cooks River and Georges River. These rivers may affect water movement primarily after periods of extended wet weather.

Overall Botany Bay is a complex hydrodynamic environment affected both by natural processes and modifications from dredging and reclamation.

5.3.2 Environmental Assessment

The construction of BLB2 would involve the installation of 137 piles to enable the required marine structure to be built. Overall the construction and operation of the proposed BLB2 would not have any impact on hydrodynamics of Botany Bay as:

- The berth and moorings would be built upon piles rather than a solid structure. The piles would have minimal influence on currents and the hydrodynamics;
- The size of berth relative to the Bay and other structures is small and would be unlikely to have an influence on hydrodynamics;
- BLB2 would be constructed in a highly modified environment of Brotherson Dock. There are no natural features in the immediate vicinity of the proposed BLB2 that could be affected by any changes in hydrodynamics associated with BLB2; and
- The construction of BLB2 would **not** involve any dredging as the seabed adjacent to the proposed BLB2 is of sufficient depth to accommodate ships that would utilise the berth.

5.3.3 Mitigation Measures

The following mitigation measures would be implemented to minimise the risk of construction and operation of BLB2 on hydrodynamics of Botany Bay:

- BLB2 would be constructed on piles, rather than a solid fill reclaimed structure.

5.4 Air Quality

An air quality impact study for the construction and operation of the proposed BLB2 development was undertaken by Sinclair Knight Merz. The objectives of the study are to review existing air quality in the Port Botany area and to provide an assessment of the likely impacts on air quality during construction and operation of the proposed BLB2. The following tasks were undertaken to achieve these objectives:

- A review of air quality issues relevant to the construction and operation of the proposed BLB2;
- An outline of the ambient air quality objectives relevant to the project;
- Description of prevailing meteorology and existing air quality in the Port Botany area;
- Quantification of emissions and assessment of air quality impacts once the BLB2 becomes operational; and
- Provision of general recommendations for the mitigation of any adverse air quality impacts.

The results of the assessment are provided in **Appendix E** and are summarised below.

5.4.1 Existing Environment

Air quality within the area surrounding Port Botany is influenced by both local and regional pollutant sources, including road traffic, domestic sources, aircraft and a variety of industrial emissions. The proximity to local pollutant sources and the influence of sea breezes play significant roles in the dispersion of pollutants around Botany Bay.

The main air pollutants emitted due to ship activities are oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and particulates. The production of NO_x occurs in most combustion processes due to the oxidation of nitrogen in fuel and air and a number of nitrogen oxides are formed including nitric acid (NO) and nitrogen dioxide (NO_2). Generally at the point of emission NO to NO_2 ratio is 90:10 by volume of NO_x. Ultimately, all NO emitted into the atmosphere is oxidised to NO_2 and to other oxides of nitrogen. SO_2 is generated during the combustion process of fuels containing sulphur, e.g. coal, oil or diesel. Emissions of SO_x (sulphur oxides) from shipping due to combustion of marine fuels with high sulphur content contribute to air pollution in the form of sulphur dioxide and particulate matter. Volatile organic compounds are also generated during loading operations, however these are considered minimal due to vapour recovery systems in place.

As part of the NSW DECC's air quality monitoring network, PM_{10} (1-hour, TEOM), SO_2 (1-hour), ozone (1-hour) and NO_2 (1-hour) are monitored at Randwick station, located approximately 5.3 km north-east of Port Botany at the Randwick Barracks, and also at Sydney Airport, located approximately 4.9km to the north-west of the site.

SKM

Higher concentrations of particulate matter are generally experienced during the summer months, often due to the hot dry conditions which lead to airborne dust. The mean monthly NO_2 and ozone concentrations vary on a seasonal basis, with higher concentrations being recorded during the warmer months of the year. It was considered that local Sydney Airport air monitoring data for this study would be representative of the background air quality in the Port Botany area, and is comparable to the NSW DECC monitoring data.

5.4.2 Air Quality Criteria

Ambient Air Quality Objectives

Key emissions that have the potential to impact on the local environment are from ship exhausts including fine particulate matter, NO_x and SO_2. The criteria for assessment of ambient air quality is sourced from DECC's *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales* (2005) and the objectives are provided in **Table 5-7**.

- **Table 5-7 Ground Level Impact Assessment Criteria (DECC, 2005)**

Pollutant	Averaging Period	Concentration (pphm)	Concentration ($\mu g/m^3$)
Sulphur Dioxide	10 minutes	25	712
	1 hour	20	570
	24 hours	8	228
	Annual	2	60
Nitrogen Dioxide	1 hour	12	246
	Annual	3	62
PM_{10}	24 hours	50	50
	Annual	30	30
TSP	Annual	90	90

It should be noted that these criteria refers to the total impact from all sources in the area i.e. emissions from the port as well as emission from motor vehicles, airport activities and other industry.

Ship Emissions Standards

Ship emissions are covered in Marine Air Pollution 1973/1978 (Marpol 73/78), the International Convention for the Prevention of Pollution From Ships. Marpol 73/78 covers ship emissions for NO_x and has been developed to minimise pollution of the seas, including dumping, oil and exhaust pollution.

Annex VI, the Prevention of Air Pollution from Ships, 2005, sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances. The annex includes a global cap of 4.5% m/m on the sulphur content of fuel oil and calls on the International Maritime Organisation (IMO) to monitor the worldwide average sulphur content of fuel.

Regulation 13 of Annex VI represents the NO_x Technical Code: *Technical Code on Control of Emissions of Nitrogen Oxides from Marine Diesel Engines*. The Code applies to all engines installed on ships constructed after 1 January 2000 or engines which undergo a major conversion after 1 January 2000. Ship engines are required to operate such that NO_x emissions are within the following limits:

- 17.0 g/kWh for engines less than 130 rpm (slow speed engines);
- $45.0*n^{-0.2}$ g/kWh, when 130 < n (engine rating) < 2,000 rpm; and
- 9.8 g/kWh for engines greater than 2,000 rpm (high speed engines).

5.4.3 Construction Impacts

Construction of the BLB2 is expected to take approximately 18 months for maritime structures and 10 months for users infrastructure. It is possible that both the offshore maritime work and land-based pipeline work could be undertaken concurrently as they are generally independent.

The pipelines and MLAs on the BLB2 structures would be installed after the berth construction was completed. The construction and installation phases for the pipe infrastructure have been estimated to require around 10 months in total, however may change during design development when a more detailed cost estimate is prepared. Given the nature of the works i.e. pipe laying and no sensitive receivers exist within 1.5 km of the site, air quality impacts during the construction phase are expected to be minimal and localised. There is a potential for dust generation during excavation works which would be minimised with the implementation of appropriate mitigation measures detailed in the CEMP.

5.4.4 Operational Air Quality Impacts

The main air quality impact from the operation of BLB2 would be from an increase in the number of ships visiting the port and impacting local air quality through emissions from their engines. Increases in truck movements at BLB2 and dockside equipment are expected to be negligible, and as such are not assessed. The main air pollutants of concern include NO_2, SO_2 and PM_{10}.

Air dispersion modelling (AUSPLUME v6.0) has been conducted in accordance with DECC guidelines. The year 2000 meteorological file based on data collected by BoM at Sydney was used as it is representative of historical data and is consistent with previous modelling undertaken for the expansion of Sydney Ports. Ship emissions and sulphur fuel content correction values for existing and future scenarios have been determined using the *National Pollutant Inventory Emission Estimation Manual for Maritime Operations*. A variable background file for pollutants PM_{10}, NO_2

and SO_2 has also been used. NO_2 was modelled using the Janssen et al (1988) NO to NO_2 conversion methodology which is approved by DECC methods.

Two operational scenarios have been modelled in this assessment. Scenario 1 models the incremental impacts from BLB2 only. Scenario 2 models total impacts from all port activities, BLB1 and BLB2. It assumes the proposed Port Botany Expansion has been finalised and is operating at an expected throughput capacity of 3.2 million twenty foot equivalent containers (TEU) and includes the impacts of BLB1 and BLB2 future operations. Scenario 2 includes contemporary hourly meteorological and background pollution data as recorded at Sydney Airport in 2000, therefore a full cumulative assessment of impacts is provided.

Impacts were assessed by assuming a worst case scenario in any given hour, and a worst case positioning of ships while at berth at Port Botany (in terms of ship TEU size). Peak emissions for the proposed development have been determined assuming that there would be ten ships docked at three terminals with auxiliary engines operating continuously at 100% Maximum Continuous Rating (MCR), and two of the ships operating their main engines at 30% MCR (as modelled in the Port Botany Expansion EIS). This represents the scenario of a ship just arriving and a ship simultaneously just ready to depart.

For simplicity, annual impacts have been assessed for the worst case scenario, and therefore are considered highly conservative as all berths would not be occupied 100% of the time. In reality 65% utilisation of the BLB is considered more appropriate.

5.4.4.1 Scenario 1 – Incremental Impacts from BLB2

For this assessment, the emissions from the Berge Trader ship have been used as it represents one of the largest ships to visit the BLB in 2006, and therefore provides a conservative assumption of emissions. A summary of the Berge Trader ship emission rates is provided below as **Table 5-8**.

- **Table 5-8 BLB Emission Estimations**

Ship	Peak Emission Scenario (g/s)			Hours at Berth (60% of year)	Annual Emission (tonnes/year)		
	SO_2	NO_x	PM_{10}		SO_2	NO_x	PM_{10}
BLB (Main)	15.1	23.3	1.2	5,256	22.0	34.0	1.8
BLB (Auxiliary)	1.6	7.4	0.07	5,256	2.3	10.8	0.1

5.4.4.2 Scenario 2 – Total Impacts from all Port Activities, BLB1 and BLB2

This emission scenario assumes that the Port Botany upgrade has been completed and is operating at the expected throughput of 3.2 million TEU, and includes the impacts from BLB1 and BLB2. This modelling is based on work previously conducted by SKM for Sydney Ports Corporation (SKM, 2004). Background concentrations of the pollutants were also included in the modelling, with data sourced from Sydney Airport.

It has been assumed that there would be a ship at both BLB1 and BLB2 for this model scenario. Emissions from BLB2 are the same as those used in Scenario 1, with emissions from BLB1 from the auxiliary engine only. Net impact of traffic movement associated with Vopak operations within Port boundaries is expected to be minimal. As such no additional port side traffic has been included in the modelling. A summary of emissions for all source groups are given in **Table 5-9.**

- **Table 5-9 Summary of Emissions for All Source Groups**

Source Group	Peak Model (g/s)			Annual Emission (tonnes/year)		
	NO_x	PM_{10}	SO_2	NO_x	PM_{10}	SO_2
Ships	381	3.9	162	927.10	9.49	394.20
Trains	2.5	0.08	0.01	6.08	0.19	0.02
Trucks	4.5	0.15	0.03	10.95	0.37	0.07
Dockside	21.1	4.8	21.2	51.34	11.68	51.59
TOTAL	409.1	8.93	183.24	995.48	21.73	445.88

5.4.4.3 Results of Air Dispersion Modelling

The results of modelling for Scenario 1 and 2 are presented for a model domain of 6 km × 5 km, at a grid resolution of 150 metres. Four discrete receptors are identified and air pollution impacts at these locations are compared to DECC criteria. The discrete receptor locations include the proposed Port Botany expansion site, Sydney Airport, Patrick Terminal and P&O Terminal.

NO_2

All modelled NO_2 concentrations are displayed in **Table 5-10.** Modelled impacts of NO_2 for Scenario 1 and 2 are below the DECC criteria both 1-hour and annual averaging time periods.

The maximum modelled 1-hour impact in Scenario 2 is 232 µg/m^3 at receptor 3. Annual average modelling for Scenario 2 also show compliance with the DECC criteria beyond the port boundary, with the highest concentration of 41 µg/m^3 at receptor 1.

Table 5-10 Modelled NO_2 Concentrations at Discrete Receptors (µg/m^3)

Discrete Receptor	Scenario 1	Scenario 2	DECC Guideline
1-hour			
1	12.3	162	**246**
2	12.6	215	**246**
3	11.8	232	**246**
4	11.0	218	**246**
5	10.5	204	**246**
Annual			
1	0.3	41	**62**
2	0.2	38	**62**
3	0.2	37	**62**
4	0.2	37	**62**
5	0.3	39	**62**

SO_2

Results of SO_2 modelling are displayed in **Table 5-11**. Incremental impacts of SO_2 concentrations for Scenario 1 are well below the DECC criteria for all averaging periods.

Modelled maximum 10-minute, 1-hour, 24-hour and annual SO_2 concentrations for Scenario 2 are below the DECC criteria of 712 µg/m^3, 570 µg/m^3, 228 µg/m^3 and 60 µg/m^3 respectively at all resident locations. The maximum SO_2 concentration at a discrete receptor is 381 µg/m^3 for 10-minute (receptor 4), 336 µg/m^3 for 1-hour (receptor 4), 116 µg/m^3 for 24-hour (receptor 2) and 27 µg/m^3 (receptor 1).

- **Table 5-11 Modelled SO_2 Concentrations at Discrete Receptors (μg/m^3)**

Discrete Receptor	Scenario 1	Scenario 2	DECC Guideline
10-minute			
1	56	247	**712**
2	78	352	**712**
3	89	319	**712**
4	53	355	**712**
5	75	267	**712**
1-hour			
1	43	203	**570**
2	43	275	**570**
3	40	302	**570**
4	37	336	**570**
5	36	308	**570**
24-hour			
1	8	87	**228**
2	7	115	**228**
3	7	99	**228**
4	7	79	**228**
5	9	84	**228**
Annual			
1	1	27	**60**
2	1	24	**60**
3	1	21	**60**
4	1	22	**60**
5	1	26	**60**

Modelled PM_{10}

Modelled incremental impacts in Scenario 1, are well below the DECC criteria for both 24-hour and annual time periods i.e. <1 μg/m^3 at all receptor locations outside of Port Botany (refer to **Table 5-12**).

Modelled cumulative PM_{10} impacts (including background air quality, all port operations, BLB1 and BLB2) result in exceedances of the DECC 24-hour criteria at residential locations. However, the incremental impacts due to BLB2 are very low i.e. <1 μg/m^3 and are unlikely to result in additional exceedances at the residences near the port. Modelled impacts are large due to existing days where PM_{10} 24-hour criteria is already exceeded. Annual average PM_{10} concentrations comply with the DECC criteria, although this compliance is marginal. This impact is again due to existing activities in the area, with an incremental impact of less than 1 μg/m^3.

- **Table 5-12 Modelled PM_{10} Concentrations at Discrete Receptors (µg/m^3)**

Discrete Receptor	Scenario 1	Scenario 2	DECC Guideline
24-hour			
1	0.6	72	**50**
2	0.5	70	**50**
3	0.5	70	**50**
4	0.5	70	**50**
5	0.7	71	**50**
Annual			
1	0.1	28	**30**
2	0.1	27	**30**
3	0.1	27	**30**
4	0.1	27	**30**
5	0.1	27	**30**

5.4.4.4 Volatile Organic Compound Emissions

Small amounts of vapour will be generated during the discharging of liquids from the ships to shore-based storage tanks. GHD (2006) have previously assessed the air quality impacts from the proposed Site B3 Bulk Liquids Storage Terminal. The assessment considered sources of fugitive emissions including storage tank losses, pipeline losses, emissions during truck loading and transport vehicle emission. The GHD assessment was used to further quantify potential VOC impacts, and potential impacts were scaled up to represent throughput in 2022 and emissions associated with BLB pipework. Impacts are predicted to be approximately 34% of the relevant DECC criteria.

VOC emissions have been estimated for the valves and flanges associated with BLB2 operations using the *Emission Estimation Technique Manual for Petroleum Refining (*DEH, 1999). **Table 5-13** provides emission estimates for VOCs from valve and flanges.

- **Table 5-13 Fugitive VOC Emission Factors and Calculations**

Product	Equipment Type	Number of Sources	Emission Factor (kg/hr/source)	Emission Rate (kg/hr)	Annual Emission Rate (kg)	
					BLB2	**BLB1 + BLB2**
Light Liquids	Valve	92	0.0109	1.0028	2896	5793
	Flange	208	0.00025	0.052	150	300
Gas	Valve	7	0.0268	0.1876	161	323
	Flange	16	0.00025	0.004	3	7
Total					3211	6423

For BLB2, VOCs will be emitted when pumping chemicals and petroleum to the respective chemical and petroleum terminal. When the ships is pumping the chemicals or petroleum to the terminal, the volume of product in the ship tank decreases and the ship tank masthead vents will open to allow air to ingress to prevent a vacuum occurring in the ship tank. Ship tanks are not designed to withstand any significant level of vacuum, and a vacuum could cause the ship tank to collapse. Therefore, no significant air emissions would result from the ship discharge operation.

Pigging operations are carried out from the wharf to the terminal using compressed nitrogen supplied to the wharf. Any associated air emissions are controlled at the terminal end via DECC approved vapour emission controls (usually a carbon bed adsorption system, a vapour return to ship system or a Scrubber designed for the specific chemical for chemicals; and a de-pressuring vessel to the atmosphere for petroleum).

Bulk Liquids Transfer Emission Control

LPG ships generally have good emissions controls through their vapour return systems. Petroleum and chemical ships have no vapour emission control systems on board. Vapour return systems are not used on petroleum ships, and for some chemical products (propylene oxide and hexene). Any vapour remaining in the petroleum and chemical ship tank after discharge will be released to the atmosphere. After chemicals are discharged at the BLB2, nitrogen is pushed through the hose to remove residual product from the hoses, therefore minimal vapours are emitted when hoses are disconnected. Blank flanges are attached to both ends of the hoses and the ship and shore manifold flanges upon disconnection of the hose which also minimises vapour emissions at the BLB2.

After pipelines are pigged to the respective terminals, the nitrogen/vapour mix remaining in the pipeline can be directed to the Terminal Vapour Emission Control Systems, thereby further reducing emissions.

5.4.4.5 Summary for Operational Impacts

Modelling results for both NO_2 and SO_2 comply with the relevant DECC criteria for all averaging periods for all residential locations. Modelled total PM_{10} impacts (all port operations, BLB1 and BLB2) result in exceedances of the DECC 24-hour criteria at residential locations. However, the incremental impacts due to BLB2 are very low i.e. $<1\ \mu g/m^3$ and are unlikely to result in additional exceedances at the residences near the port. Modelled impacts are large due to impacts from the background file. Modelling of Sydney Port operations and the BLB result in two additional exceedances at Receptor 1 and no additional exceedances are experienced at Receptors 2-5 due to port activities.

Overall, operational impacts from the proposed BLB2 would be minimal for all pollutants modelled as well as potential vapour releases. As such the potential air quality impacts of the additional berth in Port Botany and surrounding suburbs are considered to be acceptable.

5.4.5 Mitigation Measures

No specific mitigation measures are required to minimise the impact of air emissions from ships berthed at BLB1 and BLB2. There is potential for dust generation during excavation works, however, the risk is minor as the area of ground disturbed during construction would be very small. Appropriate mitigation measures for dust minimisation and management would be included in the CEMP.

5.5 Noise and Vibration

An assessment of noise impacts from the construction and operation of the proposed BLB2 was undertaken by Sinclair Knight Merz. The results of the assessment are provided in **Appendix F.** The assessment considered noise impacts from additional shipping and unloading activities and the potential to affect the amenity of residential and other sensitive receivers near the Port. Operational scenarios and construction activities related to the new berth were assessed for noise impacts.

5.5.1 Study Objectives

The objectives of the noise study are as follows:

- Establish background noise levels at nearby residential locations;
- Identify operational noise limits at receiver locations;
- Predict noise levels resulting from the operation of the BLB;
- Compare predicted operational noise levels to the noise limits at receiver locations;
- Predict noise levels from construction noise impacts; and
- Identify any mitigation requirements for the proposed facility to meet the required noise limits.

5.5.2 Existing Environment

The area around Port Botany is subject to high traffic numbers due to the port and nearby industrial activities, and as a result nearby residential locations experience elevated ambient noise levels. In addition to these existing noise sources, recent approval for an expansion of port operations by the Department of Planning will produce additional freight movements and therefore a corresponding increase in existing noise levels.

Statistical descriptors used in this noise assessment describe how variations in the noise environment occur over any given period and are given below:

- L_{A90} – the noise level exceeded for 90 percent of the fifteen minute interval. This is commonly referred to as the background noise level and represents the quietest 90 seconds in a fifteen minute period;
- L_{Aeq} – the noise level having the same energy as the time varying noise level over the fifteen minute interval; and
- L_{Amax} – maximum noise level measured at a given location over the fifteen minute interval.

The Rating Background Level (RBL) in is the overall, single-figure, background level representing each of the day, evening or night assessment periods over the whole monitoring period. This level is the tenth percentile of the background noise environment evaluated in the absence of noise from the development in question, and is the level used for assessment purposes when referring to background noise.

The most detailed information available for noise monitoring studies was identified from a noise monitoring assessment undertaken by Wilkinson Murray (WM) in June 2003, for the Port Botany Expansion. Not all locations identified in the report are relevant to the BLB2 site due to the distance and the proximity of other noise sources such as aircraft and road traffic. Additional information was sourced from SPC for a residential location in La Perouse.

The locations of the unattended surveys are shown in **Table 5-14,** the results of attended measurements are summarised in **Table 5-15** and unattended background noise monitoring results are presented in **Table 5-16**.

- **Table 5-14 Noise Monitoring Locations**

ID	Location Description	Position on the site
Location 4	Botany Golf Course, Botany	northern boundary
Location 5	74 Australia Avenue, Port Botany	centre of front lawn
Location 6	Eastern Suburbs Crematorium Military Road, Port Botany	north western boundary
Location A	21 Elaroo Avenue, La Perouse	front yard

- **Table 5-15 Summary of Attended Noise Monitoring**

Location	Noise Level dB(A)		Survey Period	Comment
	L_{Aeq}	L_{A90}		
Location 4	51	42	Night	Industrial noise from port operations audible approx. 48
Location 5	49	47	Night	Industrial noise from port operations audible approx. 48
Location 6	-	-	Night	-
Location A	49	36	Night	No audible industrial noise sources

- **Table 5-16 Summary of Background Noise Monitoring**

ID	Location Description	RBL dB(A)		
		Daytime (7am – 6pm)	Evening (6pm – 10pm)	Night Time (10pm – 7am)
Location 4	North of Golf Course	57	50	43
Location 5	Australia Avenue	42	40	42
Location 6	Military Road	46	46	45
Location A	Elaroo Avenue	38	37	36

Figure 5-2 shows the unattended noise monitoring locations that have been adopted for the BLB2 noise assessment.

- **Figure 5-2 Proposed BLB2 and Sensitive Receiver Locations**

5.5.3 Noise Assessment Criteria

The DECC's *NSW Industrial Noise Policy* (INP) provides guidance for the noise impact assessment of both scheduled and unscheduled premises. The DECC guidelines provide a method of determining if noise emissions from industrial sources are likely to cause an intrusive noise impact or longer term planning issues concerning noise. These guidelines cover impacts from any industrial noise source to any other potentially affected noise sensitive receiver.

The guidelines are based on an assessment of the pre-existing background noise levels in the absence of industrial noise or a zone based noise goal where industrial noise is already part of the existing environment. The Intrusive Criteria considers the existing environmental or “background” noise when determining the appropriate noise levels for a project, the zone based noise assessment is known as the Amenity Criteria. The more stringent of the Intrusive or Amenity Criteria is used to set project noise limits. The existing noise environment is important in determining the noise criteria for any new developments, which is quantified by undertaking measurements of background noise levels.

A noise source is considered to be non-intrusive if the $L_{Aeq,\ 15\ minute}$ level does not exceed the RBL by more than 5 dB(A) for each of the day, evening and night-time periods, and does not contain tonal, impulsive, or other modifying factors as detailed in the INP. This is usually assessed prior to the commencement of operations.

The amenity criteria apply to the L_{Aeq} noise level determined for the period of assessment of day, evening or night being 11, 4 and 9 hours respectively. The definition of the noise amenity classification for the area surrounding the port is ‘urban’ based on the description given by the INP. An acceptable amenity criteria for an urban area is given in the INP as $L_{Aeq\ (Period)}$ of 60, 50 and 45 dB(A) for day, evening and night periods respectively. Residential areas located in a suburban area across the bay would have lower amenity criteria and the INP recommends that an acceptable amenity criteria would be an $L_{Aeq\ (Period)}$ of 55, 45 and 40 dB(A) for day, evening and night periods respectively.

To account for cumulative noise impacts resulting from the combined effects of existing and new projects, the INP recommends modifying the above amenity criteria where there is an existing industrial noise influence. The amenity criteria are decreased in accordance with Table 2.2 of the INP. Based on attended measurements and the estimate of existing industrial noise at these locations, the Amenity Criteria noise levels for Locations 4, 5 and 6 will be reduced by 10dB(A). For the residential areas represented by Location A, there was no industrial noise influence identified and therefore there will be no penalty applied to the Amenity Criteria.

For the construction phase of the project, noise objectives documented in the DECC *Environmental Noise Control Manual* (ENCM, 1994), Chapter 171 Construction Site Noise, are used for assessing the potential impacts. The noise criteria are dependent on the existing background noise levels and the expected duration of the works. The conditions of operation (for construction activity) are expressed in terms of L_{A10} noise levels above the nominated background level and are detailed in **Table 5-17**.

- **Table 5-17: DECC Construction Criteria Guidelines**

No.	Duration Of Works	DECC Noise Guidelines
1	Construction period of 4 weeks and under	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).
2	Construction period greater than 4 weeks and not exceeding 26 weeks	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).
3	Construction period greater than 26 weeks	The EPA does not provide noise control guidelines for construction periods greater than 26 weeks duration, however, it is generally accepted that provided L_{A10} noise levels from the construction area do not exceed a level of 5 dB(A) above background, then adverse (intrusive) noise impacts are not likely to be experienced at nearest sensitive receptor locations.

The following time restrictions would apply to noisy construction activities:

- Monday to Friday, 7 am to 6 pm;
- Saturday, 7am to 5pm; and
- Sunday and Public Holidays (only as the construction schedule requires).
- No audible work outside these hours unless approval is obtained from the DECC prior to works being undertaken.

Project Specific Noise Criteria

Table 5-18 summarises the noise criteria that would be applicable to the locations to the north and the east of the BLB2 site. Construction noise objectives at residential locations for day time construction activities are given in **Table 5-19**.

- **Table 5-18 Derivation of Project Specific Noise Criterion Yarra Road**

Intrusiveness Criteria	$L_{Aeq15\ min}$	$L_{Aeq15\ min}$	$L_{Aeq15\ min}$
Project Intrusiveness Criteria	RBL + 5 dB(A)	RBL + 5 dB(A)	RBL + 5 dB(A)
Project Specific Intrusiveness Criteria			
Location 4	62 dB(A)	55 dB(A)	48 dB(A)
Location 5	47 dB(A)	45 dB(A)	47 dB(A)
Location 6	51 dB(A)	51 dB(A)	50 dB(A)
Location A	43 dB(A)	42 dB(A)	40 dB(A)
Amenity Criteria	$L_{Aeq\ 11hr}$	$L_{Aeq\ 4hr}$	$L_{Aeq\ 9hr}$
Acceptable Amenity Criteria Urban	60 dB(A)	50 dB(A)	45 dB(A)
Acceptable Amenity Criteria Suburban	55 dB(A)	45 dB(A)	40 dB(A)
Project Amenity Criteria			
Location 4 (Modified)	55 dB(A)	45 dB(A)	40 dB(A)
Location 5 (Modified)	55 dB(A)	45 dB(A)	40 dB(A)
Location 6 (Modified)	55 dB(A)	45 dB(A)	40 dB(A)
Location A (Non-Modified)	55 dB(A)	45 dB(A)	40 dB(A)
Project Specific Noise Criteria			
Location 4 Modified Amenity Criteria	50 dB(A) $_{11hr}$	45 dB(A) $_{4hr}$	40 dB(A) $_{9hr}$
Location 5	47 dB(A) $_{11hr}$	45 dB(A) $_{4hr}$	40 dB(A) $_{9hr}$
Location 6	51 dB(A) $_{15\ min}$	45 dB(A) $_{4hr}$	40 dB(A) $_{9hr}$
Location A	43 dB(A) $_{15\ min}$	42 dB(A) $_{15\ min}$	40 dB(A) $_{9hr}$

- **Table 5-19 Construction Noise Objectives**

ID	Location Description	L_{A10} Construction Noise Objectives dB(A)
		Daytime (7.00am – 6.00pm)
Location 4	North of Golf Course	62
Location 5	Australia Avenue	47
Location 6	Military Road	51
Location A	Elaroo Avenue	43

5.5.4 Noise Impact Assessment

Operational Impacts

A noise model (SoundPLAN) was used to predict the noise levels at residential locations resulting from the operations of BLB2. Noise impacts have been predicted using two meteorological scenarios as follows:

1. Neutral weather conditions D class stability conditions winds < 0.5m s^{-1}; and

2. Adverse weather conditions, i.e. F class stability conditions and winds at $2ms^{-1}$ in the direction of a receiver.

A complete assessment of local weather conditions has not been undertaken for the project as the assessment includes neutral conditions which have no impact on the predicted noise levels and default adverse conditions that are essentially a worst case scenario as identified by the INP.

The noise levels predicted at receiver locations have been assessed using noise data obtained from the existing operations at BLB1. The noise level used in the assessment is presented in **Table 5-20**.

- **Table 5-20 Ship Unloading Sound Power Level**

Description	SWL	Comments
MV Jasmine	108 dB(A)	Auxiliary engines audible during the survey. Dominant noise source was from product pumps (gear pumps) operating in the ships hold.

The noise level represents a L_{Aeq} measurement over a 15 minute period however, the operational noise from the Jasmine was observed to be generally constant for the monitoring period. The constant nature of the noise source means that the predicted levels may be taken as either the L_{Aeq} 15 minute intrusiveness or the L_{Aeq} period amenity noise level.

Table 5-21 presents the results of noise modelling for the operation of the BLB2 at the selected sensitive receiver locations. **Table 5-22** presents the predicted noise levels resulting from the simultaneous operation of BLB1 and BLB2.

- **Table 5-21 Predicted Noise Levels**

Residential Location	BLB 2 Neutral Weather	BLB2 Adverse Weather	Night Time Criteria
	$L_{Aeq\ Period}$	$L_{Aeq\ Period}$	$L_{Aeq\ Period}$
Botany Road (north of Golf Club)	23 dB(A)	27 dB(A)	35 dB(A) $_{9hr}$
Australia Avenue	23 dB(A)	28 dB(A)	35 dB(A) $_{9hr}$
Military Road	26 dB(A)	30 dB(A)	35 dB(A) $_{9hr}$
Elaroo Avenue	23 dB(A)	28 dB(A)	40 dB(A) $_{9hr}$

- **Table 5-22 Predicted Noise Levels BLB1 and BLB2 Combined**

Residential Location	BLB1 and BLB2 Neutral Weather	BLB1 and BLB2 Adverse Weather	Night Time Criteria
Botany Road (north of Golf Club)	28 dB(A)	32 dB(A)	35 dB(A) $_{9hr}$
Australia Avenue	28 dB(A)	32 dB(A)	35 dB(A) $_{9hr}$
Military Road	30 dB(A)	34 dB(A)	35 dB(A) $_{9hr}$
Elaroo Avenue	26 dB(A)	31 dB(A)	40 dB(A) $_{9hr}$

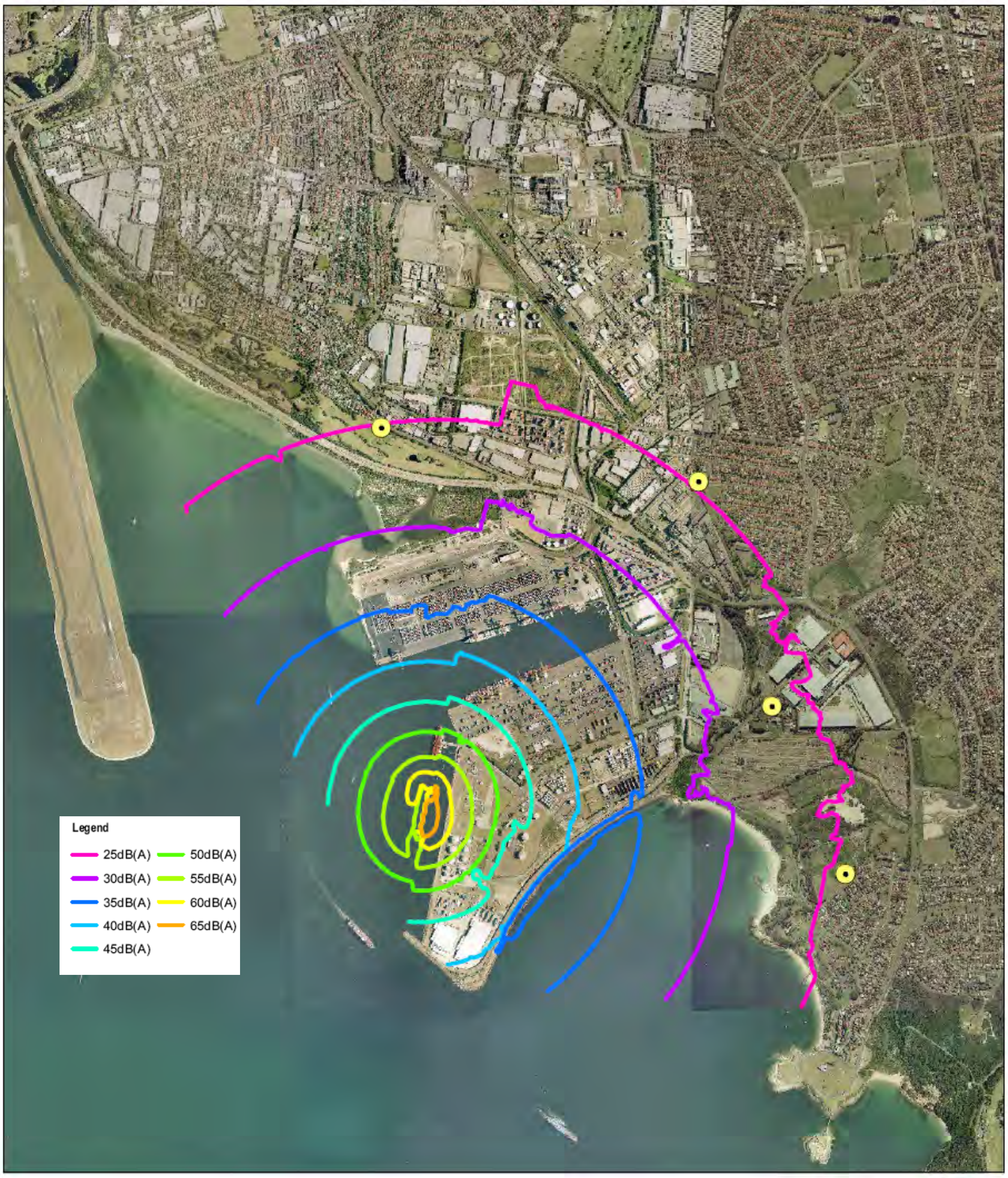
The modelling results indicate that noise levels from BLB2 only are lower than the night time noise criteria for both neutral and adverse weather conditions. The assessment of the combined operations of the existing berth and proposed berth at the nearest sensitive receivers indicated that noise levels are expected to be significantly below the night time noise criterion of 40 dB(A) at all locations.

Noise levels from road traffic and other nearby industrial noise sources would provide a greater contribution to the overall noise environment in the vicinity of the ports and therefore the predicted levels from the operation of BLB2 alone is expected to be insignificant.

Figure 5-3 shows the noise contours from the modelling for BLB2 under neutral conditions and **Figure 5-4** presents the noise contours for BLB2 under adverse meteorological conditions. **Figure 5-5** and **Figure 5-6** shows the predicted noise contours for the combined operation of BLB1 and BLB2 for neutral and adverse conditions.

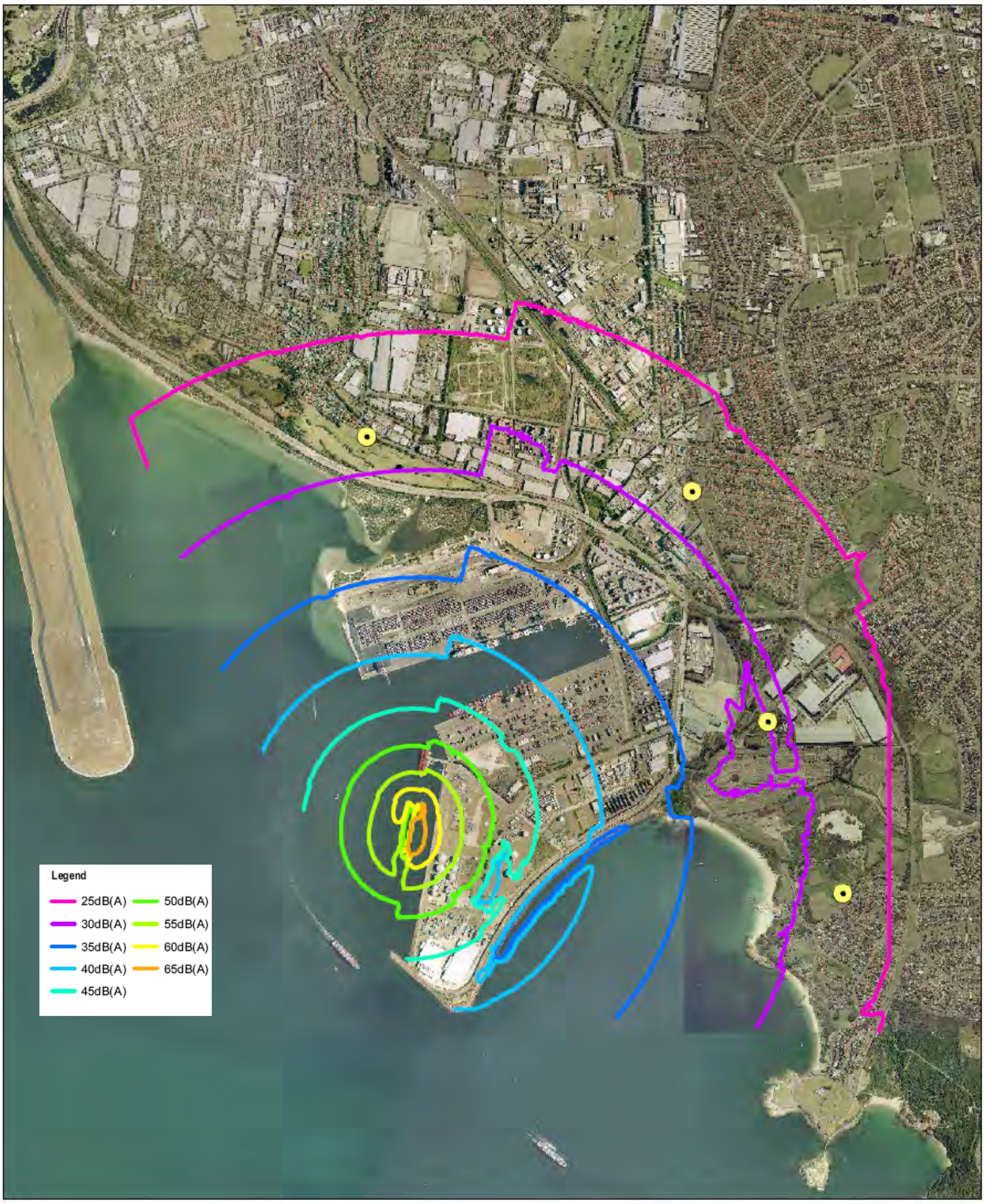
SKM

■ **Figure 5-3 Predicted Noise Levels from BLB2 – Neutral Weather Conditions**



SKM

- **Figure 5-4 Predicted Noise Levels from BLB2 – Adverse Weather Conditions**



SKM

- **Figure 5-5 Predicted Noise Levels from BLB1 and BLB2 – Neutral Weather Conditions**

- **Figure 5-6 Predicted Noise Levels from BLB1 and BLB2 – Adverse Weather Conditions**

Construction Impacts

The sound power levels assumed for the noisiest construction equipment are shown in **Table 5-23**. These levels have been extracted from the in-house SKM database and reflect typical L_{A10} noise emissions from similar equipment.

- **Table 5-23 Sound Power Levels for Construction Activities**

Description	Quantity	Sound Power Level L_{A10} dB(A)
Drilling Barge (Compressor, Crane)	1	115
Excavator	1	112
Concrete Pump	1	108

The $L_{A10\ 15\ min}$ noise levels at residential locations from construction activities are in **Table 5-24** and show the worst case scenario when all equipment is operational. The predicted noise levels for construction activities is largely due to the use of the drilling barge for piling activities, however noise levels, are expected to be below measured background noise levels at nearby residential locations.

- **Table 5-24 Predicted Construction Noise Levels**

ID	Location Description	Predicted L_{A10} Construction Noise Levels dB(A)	L_{A10} Construction Noise Objectives dB(A)
		Daytime (7.00am – 6.00pm)	Daytime (7.00am – 6.00pm)
Location 4	North of Golf Course	35	62
Location 5	Australia Avenue	34	47
Location 6	Military Road	36	51
Location A[1]	Elaroo Avenue	35	43

5.5.5 Mitigation Measures

Operations of the BLB2 are predicted to be below the project specific noise levels which have been determined with respect to existing industrial noise influences. Construction noise levels are predicted to be below the background noise environment at all nearby residential locations. Although noise impacts are not expected to result from construction activities, noise minimisation strategies during the construction period should be included in the CEMP such as those listed in **Table 5-25**.

- **Table 5-25 Management Practices for Construction Activities**

Item	Action
1	Ensure compliance with the construction hours
2	Equipment having directional noise characteristics (emits noise strongly in a particular direction) are to be oriented such that noise is directed away from sensitive areas
3	Avoid the coincidence of noisy plant working at the same time where possible
4	Plant with the lowest noise rating which meets the requirement of the task would be selected
5	Ensure that internal combustion engines (all mobile and stationary equipment) are fitted with a suitable muffler in good repair
6	Ensure that tailgates on trucks are securely fitted to avoid unnecessary “clanging” noise, particularly during movement of empty trucks
7	Where using pneumatic equipment, select silenced compressors or use quieter hydraulic equipment
8	Conduct regular inspections and effective maintenance of both stationary and mobile plant and equipment (including mufflers, enclosures etc)
9	Equipment not being utilised as part of the work would not be left standing with engines running for extended periods

5.6 Security

Port Botany and the BLB are categorised as a security regulated port and port facility under the Maritime Trade and Offshore Facilities Security Act 2003 (MTOFSA). In accordance with the MTOFSA, a security assessment and subsequent common government approved Maritime Security Plan (MSP) is in effect to mitigate terrorist and security risks within the Port. This MSP details the relevant security measures for the port and the BLB1. Any new development for BLB2 will require a review of both the existing security assessment and the approved MSP to ensure appropriate security measures are maintained.

Security at BLB2 would be controlled by a variety of measures. Access to BLB2 would be via the existing Charlotte Road SPC Security Gate / Administration Building which currently controls access to BLB1.

Government issued personal identity (ID) cards (including Maritime Security Identification [MSIC] cards which require the applicant to have undergone a number of background security checks) would be a pre-requisite for any personnel to gain access to BLB2. These access cards are magnetic proximity type cards which are registered by the SPC Security Computer control system. Only authorised cards would open the personnel access gate. Unauthorised persons during construction and/or operation would always be accompanied by an authorised MSIC cardholder.

Similarly, operating company vehicles (forklifts, vehicles carrying product discharge equipment including hoses, pumps & ancillaries) can only gain access to BLB2 through the controlled gates adjacent to the personnel access gate at BLB1.

An indicative level of the security measures for BLB2 includes those employed at BLB1. The conditions of entry to Bulk Liquids Berth as detailed in the Operations Manual for the berth are detailed below.

A condition of entry of Persons to the wharf or berth area is that no weapons or prohibited items of any type are permitted on the berth or ship unless authorised under the Maritime Transport and Offshore Facilities Security Act.

The only authorised persons permitted to enter the berth or wharf area are:

- *Persons having appropriate identification i.e. MSIC, BLB Access card & photo ID*
- *Having a lawful duty within the berth or wharf areas.*
- *Having a lawful duty vessel*
- *Or persons having written or verbal authorisation from the Master or Shipping Agent (email or fax or phone call).*
- *All other persons seeking admission to the berth area shall be authorised to enter by the Bulk Liquids Berth Manager, Marine Supervisor or the BLB Port Officer.*
- *All persons would be required to enter the berth using the electronic access card system or record their name in the visitors logbook before entering the berth area and be in possession or relevant photo identification or otherwise under appropriate escort.*
- *All visitors to the ship would be required to be escorted to the ship by an MISIC holder, or be constantly monitored by CCTV. The BLB Port Officer (Fire and Safety) would contact the ships office and advise the name and reason for the visit and request the ship to approve the person being permitted onboard.*
- *All persons would be required to be appropriately dressed for entry onto a hazardous facility which includes shirts with long sleeves, trousers, covered shoes, helmet and goggles or eye protection. Persons who do not comply may be refused entry. In this case the BLB Manger or the Duty Marine Supervisor should be notified.*
- *All persons proceeding to or from the wharf area must be notified in advance by the ships office or BLB Port Officer (Fire and Safety) to the wharf operators so that they are prepared*

for personnel on the wharf and can give clearance for personnel on the wharf. This notification is to be made by authorised radios.

Further to the above requirements all person seeking entry to the berth must undergo an appropriate OH&S Induction or be continuously escorted by an SPC staff member.

Currently approved upgrades to the security measures at BLB1 include:

- Installation of an additional automated gate on Charlotte Road.
- Upgrade to the electronic access control system
- Installation of High security fencing on the perimeter.

Currently maintained waterside security measures include:

- The maintenance of legislated on water security zones (significant penalties for unauthorised access).
- The use of CCTV surveillance to monitor channels, berthing boxes and security zones.
- Waterside security patrols by SPC staff and NSW police including response by NSW Port.
- The use of shipside signage and land based signs to warn Port visitors or relevant security zones.

6. General Environmental Risk Analysis

6.1 Overview

The preceding chapter addressed the key potential environmental impacts associated with the proposal. In addition to the key impacts, there are a range of other issues to be considered to address the appropriate environmental assessment framework for the construction and operation of the proposal. These issues include:

- Context and setting;
- Groundwater and hydrology;
- Geology, topography and soils;
- Visual Amenity;
- Terrestrial Ecology;
- Socio-economic environment;
- Waste;
- Utilities and Services;
- Heritage;
- Traffic.

6.2 Context and Setting

The proposed BLB2 would be located at Port Botany, which has long been identified as an area for importing and exporting operations since the 1980s for container docks and, since the 1970s, for bulk liquids when BLB1 was constructed.

The storage facilities within the Port Botany area include tank farms for the purpose of bulk liquids, mostly imported through the BLB1. These tank farms dominate the south and east of the Port Botany peninsula. The proposed BLB2 would be similar in form and appearance to BLB1 and would be in keeping with the character of the port area. The existing streetscape in the south and east of the Port Botany peninsula is therefore somewhat a homogenous one consisting of shipping berths of similar appearance in a similar setting.

The proposal consists of building an additional bulk liquids berth (BLB2) near the existing BLB1 and is entirely within the identified context and setting of Port Botany. In addition the proposal compliments existing port functions in that:

- BLB2 would form part of an established port and industrial area as being suitable for such uses;
- BLB2 would contribute to the economic significance of the area; and

- The existing land is physically suitable for a bulk liquids berth.

Therefore it is considered that the proposal would not have a significant impact in the terms of context or setting as the proposed use of the site remains dedicated to service SPC operations and the material finishes respond to the existing homogenous context of shipping berths.

6.3 Groundwater and hydrology

6.3.1 Existing Environment

The site is located within the boundaries of Botany Sands Aquifer. Groundwater levels within the Botany Sands Aquifer are influenced by rainfall and extraction rates from private bores. The general pattern of groundwater flow is south-westerly towards Botany Bay (URS, 2003: pp172).

The Botany Sands Aquifer has been impacted by industrial development and subsequently the groundwater is classified as a "high risk resource" due to contamination (including Botany Industrial Park). BLB2 is located in Zone 4 of the Groundwater Management Zone, restricting the domestic use of groundwater.

However, known contamination plumes, plume paths and the ground water protection zone is located north of the Port Botany Container Terminal, some 1.5 km from BLB1. It is therefore unlikely that contaminated groundwater would migrate towards BLB1 and the proposed BLB2 and SPC pipeline corridors.

Groundwater occurs and moves in both the shallow sand sediments and deeper sandstone under the site due to both the primary and secondary permeability of these rocks. The shallow sand sediments of the Botany Bay deposits (the Botany Sands) are an important local aquifer in numerous areas around Botany Bay.

The Elgas Pty Ltd LPG storage facility (cavern) is 130 metres underground and located to the north east of the subject site. To enable this facility to function effectively an acceptable hydrostatic pressure is required to be maintained within the aquifers at all times during the operational phase. In particular, the underground storage environment requires protection against:

- Water table drawdowns of limited extension but of large amplitude, which may be generated by water production wells in the immediate vicinity of the caverns;
- A general decrease of the water table level which may be generated by new water extraction, even from remote areas, but adversely located or too large; and
- Any new subsurface construction or development that may adversely affect the facility's hydrogeological environment. This includes quarrying, tunnelling, mining, etc.

There are two zones associated with the Elgas LPG Caverns.

- "Groundwater Management Zone (A) (GMZ A)" extending to the boundaries of privately owned Fishburn Road, Charlotte Road and Friendship Road and to the southern boundary of the Skymill (Elgas) site; and
- "Groundwater Management Zone (B) (GMZ B)" extending from the boundaries of Zone (A) to a distance of not less than 500 metres from any cavern.

The BLB2 development is located within GMZ B. The Groundwater Management Zone Deed, May 1994, which includes SPC and Elgas Pty Ltd as parties to the Deed, stipulates the requirement of SPC to seek approval from Elgas Pty Ltd in relation to undertaking any development within the GMZ B Zone. Consistent with this requirement, the following actions would be undertaken by SPC for the BLB2 works:

- A copy of the proposed development would be served to Elgas Pty Ltd at least 35 days prior to any works in relation to the BLB2 development being carried out;
- Elgas Pty Ltd would be allowed 30 days to review and comment on the proposal;
- Comments received from Elgas Pty Ltd within the 30 days would be considered in good faith in the context of the BLB2 development; and
- DWE would be notified and provided with a copy of the response from Elgas Pty Ltd immediately after the response is received by SPC.

If any excavations intercept the groundwater during construction or new bores or wells are required for dewatering purposes, a licence under Part 5 of the *Water Act 1912* would be sought. The area impacted upon by the proposed BLB2 is reclaimed land of varying types of fill. There are no groundwater users (i.e. extractors) within 250m of the area impacted by the works.

6.3.2 Construction Impacts

Given the distance to groundwater users and that most of the pipes are laid above ground, it is unlikely that proposal would impact on groundwater levels, quality or users.

6.3.3 Operation Impacts

There are two potential impacts on groundwater quality from operations, namely:

- Contaminated water from the berth operations infiltrating into groundwater; and
- Leakages from pipes.

An impermeable layer would be used in Valve Isolation pit areas and diversion to the wastewater storage tank would prevent groundwater pollution from contaminated water runoff during operation of the proposal. Provided these design initiatives are maintained, there is a low potential for the proposal to adversely affect groundwater quality.

Leaks or spills from pipelines would be rapidly detected (See Section 6.2) and cleaned up before they could contaminate groundwater.

Operational activities associated with the proposal would not impact upon the Elgas Pty Ltd Groundwater Management Zones as defined in SPC Groundwater Deed.

6.3.4 Mitigation Measures

The following mitigation measures would be implemented to minimise the potential for adverse impacts on groundwater and hydrology:

- Leakages from pipes would be minimised by pressure pipe monitoring and regular general inspections;
- In the event that contaminated groundwater is discovered, a groundwater management plan and remediated plan would be developed; and
- Appropriate disposal of any contaminated soil or water in accordance with DECC waste management guidelines.

6.4 Geology, topography and soils

6.4.1 Existing Environment

The site forms part of an area of reclaimed land, which was formed during the early 1970s. Reclamation was completed in the 1970s and Fishburn Road and the adjacent seawall were built in 1993.

The proposal is situated within the central coastal portion of the Sydney Basin, and comprises a sequence of PermoTriassic sandstone and shales, overlain in part by Cainozoic sediments. Diatremes, dolerite dykes and dolerite sills varying in age from Jurassic to Tertiary intrude the gently deformed sedimentary sequence.

Investigations within the vicinity of the site were undertaken by Geolight in two stages in 1991 and 1992 as part of the Sydney LPG Cavern project. These investigations found that the material immediately below the surface, ranging to a depth of 10m to 14m contained minor amounts of masonry fragments, demolition rubble and steel reinforcement. The bulk of the material consists of light grey, very loose, fine to medium grained, sub-angular to sub-rounded, moderately sorted quartzose sand containing minor amounts of clay, organic matter and shell fragments.

DLWC Acid Sulphate Soil Risk Maps indicate that the proposed BLB2 is located on disturbed land. A previous study of ASS undertaken for SPC identified that there was a risk that ASS could be encountered greater than 1m below the surface.

6.4.2 Construction Impacts

Excavation works may be required for pipework. However, it is expected that the existing pipeline culverts (in Friendship Road and Charlotte Road) will be utilised wherever practicable. It is expected that if excavation is required, it will be of a minor nature and is not likely to exceed two metres in depth. In addition, earthworks may potentially result in sediment disturbance and runoff into nearby waterways (Botany Bay). Provided appropriate mitigation measures are implemented, these impacts can be adequately managed.

It is not anticipated that there would be any contamination that would prevent the site from being suitable for the proposed industrial use. In addition, the current lease for the site involves a contractual obligation to ensure that any potential contamination of the site resulting from operations is appropriately remediated. Piling for the berth, moorings and working platform may result in the temporary disturbance of Botany Bay sediments. However, the number of piles is relative low and therefore disturbance of the Botany Bay sediments would be minor. Given the temporary and minor disturbance of sediments and the significant distance to any environmentally important marine species, no additional mitigation measures such as silt curtains would be required. Any excavation would be monitored to detect any potentially contaminated material or ASS. Based on the preliminary BLB2 designs, acid sulphate soils are unlikely to be encountered. In the event that BLB2 designs are altered and acid sulphate soils may be encountered during construction works, an Acid Sulphate Soil Management Plan would be developed.

6.4.3 Operation Impacts

As the proposed bulk liquids berth would be situated over the water, soil and geology impacts would be restricted to pipework which would cause low environmental impact restricted to the construction phase.

6.4.4 Mitigation Measures

The following mitigation measures would be implemented to minimise the potential for adverse impacts on topography, geology and soils:

- A Construction Environmental Management Plan (CEMP) would be prepared and implemented. The CEMP which would contain measures (including an Erosion and Sedimentation Control Plan) which would minimise any impacts on water quality, groundwater and soils.
- In the event that contaminated soil or groundwater or ASS are discovered, an appropriate management plan would be developed; and
- Any soil contaminated as a result of operation would be disposed of in accordance with DECC waste management guidelines.

6.5 Visual Amenity

6.5.1 Existing Environment

The proposal is within a regional industrial area, dominated by shoreline port facilities and Sydney Airport runway. These facilities have significantly altered the visual environment through the impacts of large cranes, docking facilities, support industries and shipping and air traffic. These developments can be seen from as far south as Kurnell and along the western foreshores of Botany Bay stretching from Kyeemagh to Dolls Point.

The nearest residential land use can be found approximately 1.5 km to the southeast at Phillip Bay. The suburbs of La Perouse, Phillip Bay and Henry Head, located to the southeast along the shoreline from Port Botany, provide recreational users along the shoreline with a viewing vista towards Molineux Point (**Figure 6-1** and **Figure 6-2**). Molineux Point also provides a viewing vista towards the south to the Kurnell Peninsula, with its the natural wetland area of Towra Point, natural terrestrial landscape of Botany Bay National Park (south) and the heavily industrialised section of the peninsula related to the Caltex Oil Refineries.

- **Figure 6-1 View from residential area at La Perouse looking north west**

- **Figure 6-2 View from Endeavour Avenue, La Perouse looking north west**

On a local scale, the site of the proposal is generally flat and cleared of vegetation and has low amenity value due to existing local infrastructure (BLB1 and storage facilities) and the scenic dominance of the container terminals and Sydney Airport. The nearby surrounding storage tanks to the east of the site include Qenos Australia Pty Ltd hydrocarbon storage facility and Terminal's Bulk Liquids Storage Facility. These facilities have approximate tank heights of 26.9m and 18m respectively.

Container cranes in the locality exceed 55m in height. These developments provide a context upon which the proposal can be assessed. The former State Pollution Control Commission (now DECC) conducted a visual assessment of the Botany Bay foreshores in 1979. It characterised the proposed site within the Port Botany visual area as administrative buildings, bulk liquid storage tanks, container cranes, gas flares, container stacks, container ships, oil tankers and chemical tankers.

A revetment wall (seawall), known as Banks Wall upon which runs a four lane roadway, Prince of Wales Drive, dominates the visual environment of eastern side of the Port Botany peninsula. The revetment wall is a sloping concrete block wall, rising 14.5m above the high tide water level. The wall's edge gives the area a built up character and builtform when viewing from the suburbs of Phillip Bay and La Perouse (**Figure 6-1** and **Figure 6-2**). The revetment wall height is approximately 10 metres above the reclaimed land on Molineux Point and is a highly visible feature within the locality.

Figure 6-3 depicts the appearance of the existing BLB1 at Brotherson Dock, BLB2 would be similar in appearance. The tallest element of the proposal would be the fire monitors and the future hose crane/ accessway. BLB2 would be located behind the BLB1 in **Figure 6-3.**

BLB1 is visually prominent when a sizable ship is berthed. When no ship is berthed it is difficult to locate BLB1 in the industrial landscape.

Given the small scale of the infrastructure associated with BLB2, the complex existing visual environment of Port Botany and the substantial distance to nearest sensitive receivers, a qualitative assessment of visual impacts is present in the following sections.

- **Figure 6-3 Existing BLB1, BLB2 would be similar in appearance looking south**

6.5.2 Construction Impacts

Potential impacts from construction of the proposal would be:

- Water based construction activities including barges, small boats and cranes; and
- Land based construction activities including pipeline installation, cranes, stockpiling and excavation.

The relative distance of sensitive receivers, such as residents, from the site indicate that construction of the proposal is unlikely to be noticed and therefore would not significantly affect such receivers.

Nearby industries are unlikely to be affected due to the relative distance from the proposal and existing operational amenity of nearby industries would diminish potential visually intrusive impacts.

6.5.3 Operation Impacts

The maximum height of any infrastructure on the site would be 24 m for the fire monitors and the hose crane /access way tower. The proposed hose crane/access way tower is a metal framed multi storey open structure that will be visible but will tend to blend into the surrounding background because of its open construction. The fire monitors themselves are narrow and would not be visually intrusive.

The State Pollution Control Commission (1979) report analysed viewing points and the impact of allowing maximum allowed height of facilities at Port Botany. The report identified the following issues relevant to the site:

- For close observers the key viewing point will be from Prince of Wales Drive and the road along the top of the revetment wall (**Figure 6-4**);
- Medium distance views from the east and southeast, i.e., Phillip Bay and La Perouse from the land and water would be obscured by the revetment wall, except for the berthed ship which would be just visible;
- For long distance views, a structure over 30 m high, when viewed from areas such as Kyeemagh and Brighton Le Sands, would break the skyline. From Captain Cooks Landing Place at Kurnell, a ship at berth would be visible; and
- Other potential prominent long distance views are outside a 6km radius from Port Botany and would not be discernible to the naked eye as the proposal would become part of the industrial urban fabric.

- **Figure 6-4 View from top of revetment wall looking north west**

According to the State Pollution Control Commission report a number of objectives were developed to protect and improve the visual resources of the Botany Bay environment. Objectives of relevance to the proposed expansion are examined below.

Reduce the visual impact of the Port: The location of the proposal at water level, the 14.5m revetment wall, the backdrop provided by the storage tanks and surrounding developments (including the Port's gantry cranes) and nearest residences being located 1.5 km away, all assist in the partial screening / amelioration of the impact of the proposed BLB2.

Protect views of Port Botany: The site forms part of the Port Botany visual area. The proposed BLB2 is compatible with the visual features typical of the area and within the context of existing development.

Preserve and protect natural features: Identified natural features include La Perouse ridge, Forest Road ridge and Cape Solander. The visual impact of the proposed BLB2 on natural features is described below.

The proposed BLB2 when viewed from areas such as Kyeemagh, Brighton Le Sands and Kurnell would not be visible, however the additional ship at the berth would be clearly visible (**Figure 6-5**).

- **Figure 6-5 View from Brighton Le Sands looking east**

The Forest Road ridge represents the background component of the views from the east of the site (La Perouse, Phillip Bay). The proposed bulk liquids berth (with a ship in the dock) would not break the ridgeline and the dominant elements of the view would remain greatly unchanged.

Cape Solander forms the background of the proposed bulk liquids berth when viewed from sections of Foreshore Road, Lady Robinsons Beach and Sir Joseph Banks Park in Kurnell. Views by motorists along Foreshore Drive would be limited to an additional ship at the dock when it is berthed. These views would be screened by vegetation. Views from Lady Robinsons Beach and

Sir Joseph Banks Park would be dominated by mid-ground views of facilities at Port Botany. Overall, the visual impact of BLB2 is minor in context of its surrounding visual environment and nearby sensitive receivers.

Lighting Impacts

The lighting requirements for proposal would be designed to Australian Standard 1680.1 2002 minimum requirements. Light spillover is to comply with Civil Aviation Safety Authority (CASA) requirements (i.e. *MOS 139 9:21 Lighting in the vicinity of Aerodromes*) to ensure the operations of Sydney Airport are not affected and that external lighting is minimised from spill off site. The visual mitigation measures include a commitment by the proponent that detailed designs would comply with the requirements, and this would include minimisation of light spillover.

It is therefore considered that light spillover would be minor, minimal and mitigated to the appropriate Australian Standards so as not to affect the operations of Sydney Airport, nearby properties or public land.

Mitigation Measures

The construction areas would be managed to minimise any potential visual impacts including measures such as maintaining the site in an orderly manner and storing work equipment and materials within the work site. Lighting would comply with CASA requirements (i.e. *MOS 139 9:21 Lighting in the vicinity of Aerodromes*) to minimise light spillover from the site.

6.6 Terrestrial Ecology

6.6.1 Existing Environment

There are a few remaining patches of the natural vegetation in the suburb of Port Botany however, these are degraded and of low ecological and conservation significance. The most significant vegetation in the area is the heathlands of the Botany Bay National Park some 2 km southeast – across the other side of the Bay. Botany Bay National Park is well known for its ecological and historical significance and includes sensitive communities of dense low growth shrubs, which have limited growth due to the skeletal soils and saltladen winds.

The vegetation on the BLB2 site and SPC's dedicated pipeline corridor has been kept free of vegetation. There are no trees on the BLB2 site or the SPC pipeline corridor.

No significant flora or fauna communities have been identified on the site (Molineux Point Master Plan: 2002: pp22). The URS study (2003) into the expansion of Port Botany found no significant floral communities that would be expected to occur within the study area.

Penrhyn Estuary is located between Foreshore Beach and Brotherson Dock North, approximately 1.5km north of the proposed BLB2 site. The estuary developed as a result of land reclamation and comprises saltmarsh, intertidal sand and mudflats and mangroves. Penrhyn Estuary is an important habitat for various migratory bird species and local shorebirds. Shorebird species at Penrhyn Estuary include the Red-necked Stint, Curlew Sandpiper, Red Knot, Pacific Golden Plover, Double-banded Plover and Sharp-tailed Sandpiper (URS, 2003). The enhancement of habitat for shorebirds would be implemented as part of the Port Botany Expansion project. The aim of the habitat enhancement is to create new and maintain existing roosting and feeding habitats for the shorebirds at Penrhyn Estuary.

The URS study (2003) identified 86 listed *Threatened Species Conservation Act* (TSC Act) and *Environment Protection Biodiversity Conservation Act* (EPBC Act) faunal species that were previously recorded in the vicinity of the SPC Port Botany container terminal area. Of the 86 specifies identified, 23 shorebirds and one seabird were identified as having a moderate to high likelihood of occurrence (URS, 2003: pp2018).

The study identified Molineux Point as a potential habitat for the following species:

- *Charadrius bicinctus* (Doublebanded Plover) – listed as migratory under EPBC Act;
- *Limicola falcinellus* (broadbilled Sandpiper) – listed as vulnerable under TSC Act, migratory under EPBC Act, Japan – Australia Migratory Birds Agreement (JAMBA) and China – Australia Migratory Birds Agreement (CAMBA); and
- *Sterna albifrons* (Little Tern) – listed as Endangered under TSC Act, migratory under EPBC Act, JAMBA and CAMBA agreements.

The 1995 EIS for the B1 development identified the area as a possible habitat for the Pied and the Sooty Oystercatcher (Haematopus) and these two birds are listed as vulnerable under the TSC Act.

6.6.2 Environmental Assessment

The site consists of land reclaimed as part of the SPC expansion of the Port area in the 1970s. Regrowth of vegetation since this period has been mostly noxious weeds which have avoided control mechanisms (BBC Consulting Planners: 2002: pp22). This is likely to arise due to exposure to saltladen winds, lack of nearby native floral plants and communities to establish a seed base and poor quality soil. Consequently, significant or potential floral plants and communities are unlikely to be present within the site or in the immediate vicinity and are thus discounted from this assessment.

The Molineux Point habitat is such that faunal species including small lizards and birds may utilise the site (BBC Consulting Planners: 2002: pp22). The proposal would result in a negligible loss of habitat. Such a loss is considered insignificant, as the site is not a recognised ecological feature of importance or significance to the regional ecological environment or the community.

Whilst the B1 EIS study in 1995 identified Molineux Point as a potential habitat for the Pied and the Sooty Oystercatcher, it is doubtful whether the study site and surrounding area is a major habitat for these bird species due to their preferred habitats (Straw, 1993).

The URS study identified Molineux Point as a roosting habitat for the Double Banded Plover (*Charadrius bicinctus*) (URS, 2003: pp2012), which are known to feed and roost on rocky shores. However they are mainly found on intertidal sand and mudflats in estuaries often preferring sites near saltmarshes or other low, moist vegetation, where birds roost and feed at high tide (URS, 2003: pp2012). It is therefore doubtful whether the proposal site or the immediate vicinity is a major habitat for this bird species and as such are likely to utilise areas of the Penrhyn Estuary and Boat Harbour or places further afield. In addition, the proposal would not utilise the rocky foreshore area and a buffer between the proposal and foreshore would be observed.

The broadbilled Sandpiper (*Limicola falcinellus*) has been recorded on the northern shores of Botany Bay in 1953 (Straw: 1996). A single sighting has been recorded since the mid 1970s along the northern shoreline (URS, 2003: pp2013). The preferred habitat for this bird is intertidal sand and mudflats. The site, consisting of reclaimed land, suggests that this particular bird species is unlikely to utilise Molineux Point.

Although found throughout the world, the Little Tern (*Sterna albifrons*) is known to mostly nest on sand spits or sand islands where rivers, creeks or lakes enter the sea. The Little Tern has been recorded to nest at Towra Spit Island in recent years, however during 2001/02 aborted this site due to presence of foxes and nested at Molineux Point. The NSW National Parks and Wildlife Service (now DECC) undertook a baiting program in late 2001 within Towra Point Nature Reserve to control foxes (DECC: Internet reference: April 2006). The species returned to Towra Spit in 2002/03 and had a successful breeding season (URS, 2003: pp2015).

The likelihood of the Little Tern occupying the site of the proposal is considered low as it is predominantly impervious. However in the immediate vicinity of the proposal site, the species may migrate for a breeding season should foxes return to prey on the species in Towra Point Nature Reserve.

The partial loss of potential secondary habitat for the Little Tern at Molineux Point is unlikely to affect this species due to availability of other areas of Molineux Point and potential habitats that include sand splits and islands at the nearby Penrhyn Estuary.

6.6.3 Assessment under the TSC and EPBC Act

The assessment of potential impacts on migratory species indicates that the proposal is unlikely to have an impact on these species and that an "Assessment of Significance "under the TSC Act is not required.

The species identified above are also listed under the EPBC Act. However the proposal is unlikely to affect these species, therefore, a Referral to the Department of Environment and Heritage is not required, as the proposal is unlikely to constitute a controlled action. There are number of factors that support this conclusion the proposal is unlikely to affect the terrestrial environment, including:

- The proposal is located on cleared and disturbed land;
- The proposal site is currently utilised and as such provides low potential for suitable flora and faunal habitat to be established;
- Although it is acknowledged that Molineux Point may provide a secondary habitat for migratory birds, the site of the proposal is unlikely to provide ideal habitat for such species;
- Other more potentially suitable habitats exist nearby, including the Penrhyn Estuary; and
- The proposal does not impact on the rocky foreshore areas of Molineux Point.

6.6.4 Mitigation Measures

The proposal is unlikely to affect the terrestrial environment. Therefore no specific mitigation measures are identified.

6.7 Socio-economic environment

The Port Botany area provides a dedicated area for bulk liquids storage and handling and is of important strategic significance to the Sydney and NSW economy. The industrial and commercial enterprises in the Port Botany area provide significant employment opportunities for the local population, rate levy generation for local authorities and subsequent contributions to local social infrastructure.

In 2003, the SPC commissioned a report on the economic value of Sydney's Ports. The value of bulk liquids and gas generated from SPC Ports (e.g. operations in Port Botany and Sydney Harbour) for the financial year 2001/02, are summarised in **Table 6-1.**

- **Table 6-1 Economic value of bulk liquids and gas at SPC Ports**

Indicator	Direct effect	Flow on effect	Total effect
Output[1] ($AU million)	265	302	567
Value Added[2] ($AU million)	139	166	305
Employment (full time equivalent jobs)	1,602	2,267	3,869
Household Income[3] ($AU million)	-	-	458.3

Table Source: SPC, 2003: pp7

Table 6-1 provides an econometric indication of the value of bulk liquids and gas trade within SPC ports. Although this sector has a relatively low labour loading and unloading operation, the high processing and land transport activity means that the sector provides a total economic impact of $567 million pa, generates over 3,800 fulltime equivalent jobs, $458 million in household income and a value added estimate of $305 million.

The Vopak Terminals Australia operation alone currently services approximately three ships per month, with an added value contribution to the Gross State Product in order of $730,000 per ship (SPC, 2003: pp8). Therefore approximately $26.3 million per annum is contributed to the NSW Gross State Product from Vopak Terminals Australia operations from ship visits alone. Direct and indirect household income generated by Vopak Terminals Australia operations is approximately $16 million per annum. Direct and indirect jobs generated from Vopak Terminals Australia operations are approximately 14 fulltime equivalent jobs per $1 million of output (EconSearch: 2003: pp15), therefore Vopak currently contributes approximately 368 direct and indirect jobs to the economy.

Other social indicators are more difficult to measure, and include philosophical values, feelings of happiness and wellbeing, externality values and perceptions on existing social fabric and governance. Whilst the econometric value of SPC is econometrically measurable, other indicators suggest that some members of the community feel threatened by port related activities.

One issue raised by the community was the potential increased risk of terrorist attack associated with BLB2. The following comments are provided on this issue:

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[1] Output is defined as gross business revenue from port related firms

[2] Value added is defined as the net contribution of port related firms to Gross State Product

[3] Resulting from combined direct and flow-on employment

- BLB2 would be a duplication of an existing facility – and would not involve a new potential threat to surrounding land uses. If BLB2 was not to proceed, BLB1 would still be a potential terrorist target;
- The risk of terrorist attack is impossible to quantify especially in relation to NSW hazard assessment guidelines and procedures. Also this issue was not raised in the Director-General requirements for the EA;
- Mitigation measures to reduce the risk of terrorist attacks are primarily a responsibility of NSW and Commonwealth law enforcement agencies;
- The overall issue of locating bulk liquid handling facilities (and other potential terrorist targets) is beyond the scope of the EA;
- The only additional impact of BLB2 poses in relation to a terrorist attack would be in the extremely unlikely event that a terrorist attack impacted ships berthed at BLB1 and BLB2.

The local community may also identify an attachment to the Port Botany area and surrounds – for example dog walking, bird watching or recreational sports. Molineux Point, however, is not a significant community focal point for passive and recreational activities. It is noted that Molineux Point does offer a viewing area and park for potential users.

6.7.1 Construction Impacts

The proposal is expected to cost approximately $69.7 million and would directly generate an average construction workforce between 10 and 80 personnel during the 22 month construction period which is considered to be a positive aspect of the proposal.

Payroll and contractors fees are then filtered through the economy by multiplier effects, which include effects attributable to expenditure arising from income received during construction. Construction would also result in indirect effects such as the production of necessary piping, plant and instrumentation and other construction materials necessary during the construction phase. These would not be made on the site of the proposal.

There would be no significant construction impacts on sensitive receivers as the proposal is located approximately 1.5 km from the nearest residents at Phillip Bay. Therefore potential direct construction impacts such as traffic impacts, visual views, noise and general air quality (addressed in Section 5 and 6), are unlikely to significantly affect local communities. In addition construction impacts would not prevent users to access Molineux Point for viewing or other potential community and recreational activities.

6.7.2 Operational Impacts

SPC (2003: pp 8) estimate that for each bulk liquid and gas vessel visiting the port creates an added value contribution to the Gross State Product in order of $730,000. The operational of BLB2 would generate an additional five ships per month. Therefore the operational stage of the proposal would contribute an additional $43.8 million to the Gross State Product, an increase in economic output of 67% at the Vopak Terminals Australia facility. This is of considerable economic benefit to the NSW's economy.

The operation of the proposed BLB2 would be operated by the existing BLB1 staff which includes the BLB Manager, Port Officer (shift arrangement 24/7) and Environmental Port Officer (during shipping operations). SPC may involve two extra staff when two vessels are berthed simultaneously.

Whilst the direct Vopak Terminals Australia staff numbers are low, the extra operational productivity would produce significant indirect job growth due to the transport and logistical requirements of distributing bulk liquids.

There would be no significant operational impacts on sensitive receivers as the proposal is located approximately 1.5 km from the nearest residents at Phillip Bay. Therefore, potential operational impacts such as traffic impacts, visual views, noise and general air quality (addressed in **Section 5** and **Section 6**), would not significantly affect local communities.

In addition operational impacts would not prevent users to access Molineux Point for viewing or other potential community and recreational activities.

6.7.3 Mitigation Measures

The following mitigation measures would be implemented to minimise adverse socio-economic impacts:

- When the EA is complete and available to the public, Vopak Terminals Australia would arrange a site visit together with a presentation and question period for any interested local community organisations;
- The general community will have the opportunity to register interest, view the EA and write a submission through the Department of Planning 30 day submission period; and
- Nearby industries and the SPC will be provided with targeted information in relation to the construction timetable and identification of potential impacts.

6.8 Waste

As with any infrastructure and development project, the proposal has the potential to generate a number of different types of waste, which would require appropriate management and disposal in accordance with relevant state legislation and government policies.

Waste management in NSW is prioritised according to the principles of a resource management hierarchy, giving consideration to the principles of Environmental Sustainable Development. The principles embodied in the *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) are as follows:

- Avoidance as top priority
- Resource Recovery – reuse or recycle
- Disposal as last resort

Waste generated during construction of the proposal would include:

- Surplus materials such as pipe, conduits and prefabricated metal;
- Concrete and aggregate; and
- Sewage and other waste, such as food scraps, as a result of the presence of the construction work force.

As the construction works are relatively minor, only small quantities of waste are expected to be generated. It is unlikely that much of the waste could be reused, however some may be able to be recycled.

Waste generated during the operation of the proposal would include:

- Waste generated from maintenance activities;
- Waste stream generated from stormwater treatment; and
- Waste generated, such as sewage and food scraps as a result of the presence of the operational work force.

6.8.1 Environmental impact assessment

A Construction Environment Management Plan would be prepared which would address waste generated during the construction phase of the proposal. This would focus on minimising the volumes of waste generated through careful planning of works. Waste minimisation would also occur according to the hierarchy of avoidance, reuse, recycle, and finally disposal. Wherever possible, recyclable waste would be segregated and sent to appropriate facilities for recycling. All waste disposal would occur in accordance with the DECC *Environmental Guideline: Assessment, Classification and Management of Liquid and Non-Liquid Waste (1995)*.

During operations wastewater from the bunds around the manifold area and working platform would be collected in a wastewater storage tank. The management of the wastewater is discussed in Section 5. If contaminated, the wastewater would be treated and disposed of in accordance with the DECC *Environmental Guideline: Assessment, Classification and Management of Liquid and Non-Liquid Waste (1995)*.

6.8.2 Mitigation measures

The following mitigation measures would be implemented to minimise adverse waste generation.

- A Construction and Operational EMP for BLB2 would be prepared that would detail waste management measures;
- All waste to be managed, classified and disposed of in accordance with EPA *Environmental Guideline: Assessment, Classification and Management of Liquid and Non-Liquid Waste (1995)*.

6.9 Utilities and services

The services and utilities in the area include:

- Communications connections;
- Electricity connections;
- Sewerage and potable water connections;
- Port infrastructure;
- Stormwater infrastructure; and
- An integrated bulk liquids pipe distribution network to distribute petroleum products to the market.

6.9.1 Environmental impact assessment

The proposal would require connection to the following services:

- Electricity;
- Sewerage and water;
- Stormwater;
- Communications; and
- The integrated bulk liquids pipe distribution network.

These connections would be done in consultation with utility departments, SPC and other petroleum companies. Potential impacts are likely to include temporary disruptions to services during connections. Other potential impacts would be associated with the small increase in demand for electricity, water, stormwater and sewerage capacity and services. These increases can be readily accommodated and would not impact on local residents or businesses.

6.9.2 Mitigation measures

Potential impacts on services and utilities would be mitigated by liaison with:

- The SPC and relevant utility and service providers regarding timing of connections to the services, location of services and utilities on the site;
- Relevant petroleum distributors that could potentially be impacted in regards to timing of connections with the integrated bulk liquids pipe distribution network;
- Utility and service providers to confirm the location of services and utilities prior to construction commencing; and
- Installation of pipeline level detection systems.

6.10 Heritage

Reclamation works at Port Botany have resulted in high disturbance to the land and sea bed in the vicinity of the proposed development. A search of the Heritage schedule of the Randwick LEP, State Heritage Register and Inventory and Australian heritage database was undertaken as part of this assessment. The results of these searches indicated that there are no recorded items of non-Indigenous heritage significance within the site or in the area of Port Botany.

The closest recorded Indigenous site is located approximately 1.3km to the east of the site (GHD, 2006). A previous study of the area was undertaken for the Port Botany Expansion project (URS, 2003), and the potential impacts on Aboriginal sites was considered to be negligible given that no sites were recorded and any material would have been destroyed by waves and currents.

Due to the proposed BLB2 location on reclaimed land, it is unlikely that new archaeological items will be discovered during the proposed works.

6.10.1 Environmental Impact Assessment

Given that there are no items of Aboriginal and non-Indigenous heritage within or in the vicinity, the potential for impacts on heritage is considered unlikely. However, management measures would be incorporated to handle unexpected discovery of heritage items during the works.

6.10.2 Mitigation measures

There is minimal potential for items of heritage significance within and in the vicinity of the site. In the unlikely event that a previously unrecorded item (or suspected item) of heritage significance is discovered during construction, all works in the vicinity of the find would cease and the appropriate authorities contacted.

6.11 Traffic

6.11.1 Existing Environment

The surrounding road network is characterised by a number of major heavy vehicle routes providing access to areas surrounding the site. The BLB2 site is located in close proximity to

Sydney Airport, large industrial facilities and residential development which are major traffic generators.

The main traffic access to the BLB2 site is via a signal controlled intersection on Botany Road at Bumborah Point Road through to Friendship Road. This provides the site with direct access to the regional road network. Bumborah Point Road is a wide road and has been built to accommodate heavy vehicles. Botany Road is a major arterial road serving the Port Botany area and industrial operations. It connects to Foreshore Road and thence to General Holmes Drive and Southern Cross Drive and the M5 Motorway. There are truck restrictions along Botany Road between Mill Pond Road and Hale Street with no trucks allowed for vehicles over 12.5m long, hence Foreshore Road would be used.

Simblist Road also serves the Port Botany area, and is joined to Military Road which is joined to Bunnerong Road. Bunnerong Road would provide main road access from the eastern suburbs. Bunnerong Road is adjoined to Anzac Parade which carries a significant proportion of heavy vehicle traffic.

Simblist Road and Friendship Road operate in a one-way clockwise manner. Traffic would enter through Simblist Road and exit at Friendship Road. The right hand turn from Bumborah Point Road to Friendship Road is prohibited.

A summary of traffic volumes along the surrounding road network is provided in **Table 6-2**.

- **Table 6-2: Existing Daily Traffic Volumes**

Road	Location	AADT	Source (Year)
Botany Road	West of Beauchamp Road	35,826	RTA (2002)
	East of Beauchamp Road	20,331	RTA (2002)
	South of Mill Pond Road	27,237	RTA (2002)
Bunnerong Road	North of Beauchamp Road	19,582	RTA (2002)
Foreshore Road	East of General Holmes Dr	29,851	RTA (2002)
Southern Cross Drive	West of Wentworth Ave	85,163	RTA (2002)
General Holmes Drive	At runway tunnel	133,393	RTA (2002)
Anzac Parade	North of Fitzgerald Ave	23,522	RTA (2002)

6.11.2 Environmental Impact Assessment

Some additional traffic would be generated during the construction of BLB2. This includes:

- Construction personnel – a maximum of 80 vehicles a day; and

- Deliveries of material for construction (e.g. pipes, concrete, precast structures, pumps) – on average 5 deliveries per day. During peak periods of construction (e.g. concrete pours) up to 10 deliveries a day may be required.

Most of the construction vehicles and deliveries would be directed to privately owned Fishburn Road , adjacent to the Elgas Caverns where a dedicated parking, site offices and laydown area would be established. Road is currently closed to traffic and therefore there would no conflict with existing traffic and accesses. As noted above, the site would be accessed via highly trafficked regional roads with AADTs in excess of 20000 movements per day. Any increases in traffic on these regional roads due to construction activities would be negligible.

There would also be a negligible increase in traffic associated with the operation of BLB2. This increase would be from increased operational and maintenance staff required to operate the new facility (<5 staff). It should be noted that increases in truck movements associated with the greater throughput of chemicals, gases and petroleum products would be considered in development approvals for storages connected to the BLB1 and BLB2, rather than this development.

6.11.3 Mitigation Measures

No mitigation measures are required to manage traffic impacts from the construction and operation of BLB2.

SKM

7. Stakeholder Engagement and Consultation

7.1 Consultation during Environmental Assessment Preparation

Consultation was undertaken with the following parties during the preparation of the EA as specified in the Director-General's Requirements:

- NSW Department of Environment and Climate Change;
- Randwick City Council;
- Council of the City of Botany Bay;
- NSW Maritime Authority;
- NSW Fire Brigades;
- Sydney Ports Corporation;
- Sydney Airport Corporation; and
- The local community.

Table 7-1 shows the issues to be addressed in the EA as identified by the stakeholders.

Table 7-1 Issues by stakeholders to be considered in the Environmental Assessment

Stakeholder	Issues	Section addressed in the EA
NSW Department of Environment and Climate Change	▪ Air emissions (plant and equipment) in accordance the Protection of the Environment Operations (Clean Air) Regulations 2002 and Approved Methods for the Modelling and Assessment of Air Pollutants in NSW at boundary of premises and at sensitive receivers including different operating scenarios and vapour recovery during fuels handling;	Section 5.4. Shipping operations have been assessed. Vapour recovery systems not part of BLB2.
	▪ Noise Impact Assessment in accordance with the NSW Industrial Noise Policy;	Section 5.5
	▪ Acid Sulphate Soil Assessment including environmental measures taken during disturbance of soil;	Section 6.4
	▪ Detailed stormwater management plan;	Section 5.2
	▪ Detailed spill management procedures including loading/unloading fuel;	Section 5.2
	▪ Bunding details of all loading, unloading and fuel storage areas;	Section 5.2
	▪ Waste generation and classification in accordance with the Environmental Guidelines: Assessment, Classification and Management of Liquid and Non Liquid Wastes;	Section 6.8
	▪ Aboriginal cultural heritage assessment, if applicable;	Not applicable
	▪ Flora and fauna survey, if applicable;	Not applicable

Stakeholder	Issues	Section addressed in the EA
	▪ Comprehensive assessment and report on predicted greenhouse gas emissions (tCO2e) and reduction of waste energy.	Not applicable
Randwick City Council	▪ SEPP (Major Projects) Clause 16 – Zone 4B Port Botany. Appropriate assessment of proposed development, permissibility and consistency with zone objectives;	Section 2.2
	▪ SEPP (Major Projects) Clause 37 – address that development is port-related activity and not adversly affect the continued operation of the Port;	Section 2.2
	▪ SEPP (Major Projects) Clause 42B – Site Audit Statement (SAS) and Summary Site Audit Report (SSAR) prepared and submitted to DECC and Council. SAS and SSAR shall confirm that land has been remediated and site and groundwater is suitable for intended development and satisfies National Environment Protection (Assessment of Site Contamination) Measure 1999 criteria;	Not required
	▪ Hazard Analysis – assessed against SEPP No. 33 provisions. Causes and consequences of potential hazardous events should be identified and analysed. Identification of appropriate standards and criteria which proposed infrastructure and facilities of BLB2 will be designed and built;	Section 5.1
	▪ Ecological issues including loss of biodiversity in Botany Bay, disturbance of ASS, impacts on water quality, groundwater levels and quality including Botany Aquifer and wetland areas. Also, focus on ecological sustainability and Sydney Ports Corporation Green Port policy;	Section 2.7, 5.2, 6.3 and 6.6
	▪ Potential Noise, Odour and Pollution Impacts – proposal must obtain DECC approval as part of Integrated Development provisions for State Significant Development (Section 92) of EP&A Act;	Section 5.4 and 5.5
	▪ Appropriate acoustical assessment and report as regular residential noise complaints during night and evening;	Section 5.5
	▪ Operation of plant and equipment shall not give rise to “offensive noise” under PEO Act 1997 and Regulations. Operations should not exceed background (LA90), 15 min noise level by more than 5dB(A);	Section 5.5
	▪ Address potential for odour and other pollution form future uses. No emissions or discharges from premises which would give rise to public nuisance or an offence under PEO Act 1997 and Regulations;	Section 5.4
	▪ ASS – recognition and plan for any constraints that ASS soils are likely to pose. Regard for assessment advice in Randwick City Council’s Advice on ASS, and NSW ASS Manual;	Section 6.4
	▪ Visual Impacts – increase in visual bulk from additional tanks. Treatment of key edges (street frontages, entries and exists) to improve visual amenity;	Section 6.5
	▪ Traffic – indicate clearly amount of operational (road tanker, visitor and staff) and construction traffic movements that development will generate. Address controls, measures and management practices to prevent traffic from facility away from residential streets;	Section 6.11

Stakeholder	Issues	Section addressed in the EA
	▪ Drainage – Site stormwater should be taken through pollutant traps prior to discharge. Fuel dispensing/loading gantry area runoff should not be directed to site stormwater system;	Section 5.2
	▪ Infrastructure – details of how supply pipelines will be installed and infrastructure reinstatement details;	Section 4
	▪ Landscape – details of any vegetation affected by proposal. Approval under Council's Tree Preservation Order required to remove any tree/s covered by order. Landscaping works to address visual impact;	No vegetation affected
	▪ Construction issues – impacts of construction (noise, traffic and dust) on local and regional land-uses and local residents. Traffic and safety measures at construction stage should be detailed;	Section 5.4, 5.5 and 6.11
	▪ Matters should be included in Statement of Commitments or included as a condition in any Instrument of Approval for the project.	Section 9
Council of the City of Botany Bay	▪ Hazard and risks – cumulative effects of the new berth;	Section 5.1
	▪ Traffic and transportation including impacts outside port precinct;	Section 6.11
	▪ Coastal processes and water quality;	Section 5.2
	▪ Hydrodynamics;	Section 5.3
	▪ Air quality;	Section 5.4
	▪ Noise;	Section 5.5
	▪ Security;	Section 5.6
	▪ Validity of Port Botany Landuse Safety Study and its relevance to BLB2.	Section 2.7
NSW Maritime Authority	▪ Assessment of bank/bed stability or seawalls adjacent to port bed;	Section 4
	▪ Identification of potential disturbance of contaminants and/or acid sulphate material including management measures to limit potential adverse impacts;	Section 6.4
	▪ Measures to minimise effects of potential adverse water quality impacts, if any.	Section 5.2
NSW Fire Brigades	▪ Require Detailed Design information	Section 4
Sydney Ports Corporation	▪ SPC has reviewed this Environmental Assessment and is satisfied all issues are addressed.	
Sydney Airport Corporation	▪ Issues of size and height of ships that will be accessing BLB2 in relation to the airport operations and requirements;	Section 4
	▪ Height of any temporary and permanent infrastructure in relation to airport operations and requirements;	Section 4
	▪ Lighting design must be assessed and comply with MOS 139 9:21 Lighting in the vicinity of Aerodromes;	Section 6.5
	▪ Potential impacts of construction and operation on roosting birds – including disturbance during construction and ensuring the design does not encourage additional roosting;	Section 6.6
	▪ Security at BLB2 including increased threat of terrorist attacks;	Section 6.7
	▪ Comment on OLS matters may be warranted.	

Consultation with the local community as specified in the Director-General's Requirements included identifying key community groups and issuing the Preliminary Environmental Assessment to the following identified key community groups:

- La Perouse Local Aboriginal Land Council;
- La Perouse Precinct Committee; and
- Botany Bay and Catchment Alliance.
- Botany and Eastern Regional Environmental Protection Association (BEREPA)

A summary of key issues raised by the key community groups is provided in **Table 7-2**.

Table 7-2 Issues by community groups to be considered in the Environmental Assessment

Community Group	Issues	Section addressed in the EA
La Perouse Local Aboriginal Land Council	▪ As of 3 September 2007, no significant issues to report from La Perouse Local Aboriginal Land Council.	
La Perouse Precinct Committee	▪ Community safety in relation to burns physical injury and poisoning stemming from fires and explosions at the Port and also property damage. Ships carrying liquefied gases are of particular concern;	Section 5.1
	▪ DUAP Safety Study completed in 1996 must be updated to consider accidents and attacks around the world and at Port Botany especially in relation to tankers conveying petroleum liquids and liquefied gases;	Section 5.1
	▪ Danger and consequences of acts of terrorism and mitigation measures;	Section 6.7
	▪ Consideration for possible modes of transmission of materials and fire to the community clusters and not be calculated solely on the basis of a plume going up into the air;	Section 5.1
	▪ Commonwealth Government assesses Port Botany as subject to medium level of threat. If disagreement with level of threat, detailed reasons should be given;	Not relevant
	▪ Address possibility and consequences of full range in size of aerial explosions up to several thousand tonnes;	Section 5.1
	▪ Address inadequate road system surround Port Botany and how adverse effects of increased number of trucks will be mitigated.	No trucks Section 6.11
Botany Bay and Catchment Alliance	▪ Overscaling of port precinct activities;	Not relevant
	▪ Need for the BLB2 project;	Section 8
	▪ National policy on alternative fuels such as biodiesel. Significant environmental concerns about biodiesel.	Not relevant
Botany and Eastern Regional Environmental Protection Association (BEREPA)	▪ Security of berth from water side and how to secure the exclusion zone.	Section 5.1 and 6.7

8. Conclusion and Justification

8.1 Background

Sydney's population growth has placed increasing demand for bulk liquids storage and distribution. In addition, changing regulatory controls have created further pressures for the importation of petrol, LPG hydrocarbons and chemical products. These pressures threaten the ability of bulk liquids storage facilities to operate efficiently, competitively and responsibly. It has therefore been recognised that without the installation of an additional berth, the bulk liquids market would deteriorate, erode in efficiency and degrade current standards expected from customers of bulk liquids.

The proposal represents a large capital investment of some $69.7 million. The contribution of the proposal to the NSW Gross State Product is approximately $43.8 million p.a.

Should planning approval for the proposal not be granted, the significant economic benefits the proposal provides would be lost as an opportunity cost. The proposal is therefore an important development that would contribute to Sydney's liveability, economic prosperity and competitiveness.

The do nothing option would restrict Sydney's response to development pressures as outlined in the Metropolitan Strategy – *City of Cities* plan, and also restrict the Port Botany bulk liquids industries, their customers and potential direct and indirect benefactors, to the current status quo.

However there is clear evidence that Sydney and the bulk liquids market are subject to pressure due to population growth, international market competition and changes to local environmental regulations. The do nothing option is therefore considered an unviable option in the current circumstances.

8.2 Impacts of the Project

The construction of BLB2 may result in both minor and temporary impact on the environment and community, although the proposed development was designed to minimise these impacts. Environmental and community aspects during the operation of BLB2 may be potentially significantly impacted by the proposed BLB2 development as it involves the transfer of hazardous and non-hazardous goods, including flammable liquids and liquefied gases.

A number of hazards and risks during the construction and operation of BLB2 including chemical transfers, spills and leaks and accidents involving ships were identified.

Risks to water quality during construction works are considered to be minor, given the area to be disturbed is relatively small. The potential for increased risk of sedimentation and erosion during construction works would be minimised with the implementation of appropriate sediment and erosion controls. Oil spill equipment and other safeguards would be applied during operation of BLB2.

The project may also cause temporary effects on the local amenity including air, noise and traffic impacts. These impacts would be minimised using appropriate mitigation measures and procedures. BLB2 would be visible from some surrounding areas but will be compatible with the existing environment and the views would be further screened by vegetation.

Groundwater quality and geology may potentially be impacted, however given the BLB2 design, minor nature of works and appropriate mitigation measures it is unlikely that the project would impact on groundwater.

Overall, the impacts of the construction and operation of BLB2 on the environment and community would be minor or negligible and would be managed using appropriate mitigation measures.

8.3 Benefits of the Project

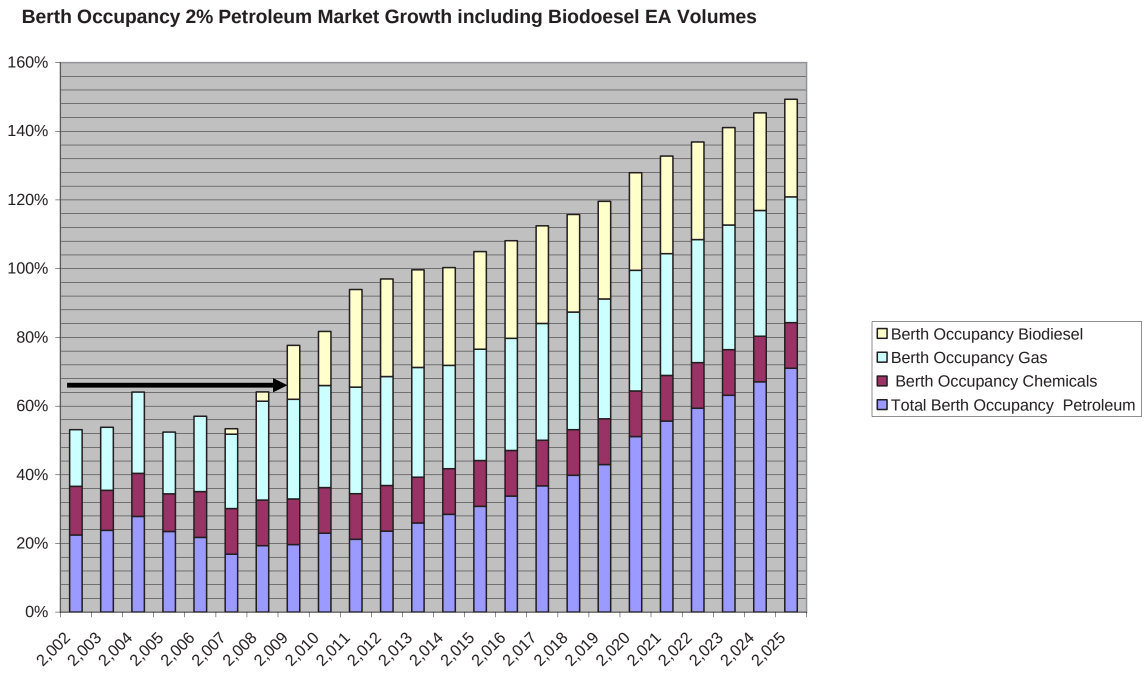
The proposal’s strategic objectives and benefits would be fulfilled should planning consent be granted as the following outcomes would be achieved:

- To ensure New South Wales has adequate berth capacity to satisfy existing and future estimated demands for the import and export of bulk liquids for the benefit of the state;
- To ensure the provision of sufficient berth availability for bulk liquids importers and exporters through Port Botany, through commercially viable facilities, such that users are not subject to excessive demurrage;
- To ensure adequate throughput capacity is available to service the bulk liquids distribution market demand through Sydney;
- Provide sufficient berth capacity to allow bulk liquid import/export industrial developments to be undertaken;
- To utilise the ideal location for an additional import/export facility; and
- To optimise the utilisation of existing SPC and user assets.

8.4 Justification for the Project

Based on SPC data and government and industry forecasts, combined with facilities development projects scheduled for the Port Botany area, the current and future berth occupancy rates are as per the graph below.

▪ **Figure 8-1 Berth Occupancy 2% Petroleum Market Growth including Biodiesel EA Volumes**



From the graph shown at **Figure 8-1**, and based on the assumption that berth occupancy is greater than 65% there would be significant demurrage costs. It is projected that there would be significant issues with berth occupancy from 2009/2010.

Based on this projection, it is contended that SPC's ability to meet its strategic and business objectives in the provision of port facilities for sustainable economic benefit to both the organisation and the NSW economy as whole, would be impeded without the provision of a second bulk liquids berth in or around 2009/10.

Additional research is required by SPC and the Port Botany Bulk Liquids industry to determine when construction of BLB2 would occur. The trigger point for the actual construction of BLB2 is reliant upon the timing of actual commitments by the companies that are investing in the bulk liquid storage facilities cognisant of the estimated lead time to construct the berth.

Based on the trigger point, the timetable for the construction of BLB2 can be agreed and the construction timetable, contracting strategy and funding can be approved in the appropriate timeframes.

8.5 Conclusions

The Environmental Assessment has been prepared in accordance with Part 3A of the EP&A Act to assess the potential environmental impacts associated with the proposal. The provisions of the Major Projects SEPP apply to the proposal. A range of detailed environmental investigations were undertaken during the preparation of the Environmental Assessment to assess the potential environmental impacts in accordance with the NSW DoP Director-General's Requirements for the proposal. These included assessment in key issues involving potential environmental impacts in risks and hazards, traffic and transport, air quality, noise and water quality. In addition, a general environmental assessment was undertaken and an assessment of the proposal with the principles of ecologically sustainable development was completed.

The proposal has been sited on reclaimed land which is zoned for port use. The proposal is consistent with the context and character of the site and the adjacent industries and is considered the best available site for the development.

No significant adverse impacts have been identified within the Environmental Assessment, or the studies that accompany it. It is considered that potential environmental impacts can be adequately mitigated provided that mitigation measures outlines in the Statement of Commitments are strictly implemented. These measures include the preparation and implementation of a Construction Environment Management Plan and Operational Management Plan to ensure that all recommendations are implemented and monitored to ensure compliance with relevant legislation and conditions impose. It is therefore recommended that the proposal receive approval, subject to the measures identified in the Environmental Assessment and Statement of Commitments.

9. Draft Statement of Commitments

9.1 Introduction

The environmental impacts of the project have been assessed in this Environmental Assessment (EA) and measures to manage those impacts have been outlined. These mitigation measures, along with any conditions of approval issued by the Minister for Planning, would be incorporated into the detailed design, as well as where appropriate, the preparation of construction and operational Environmental Management Plans (EMPs) for the project.

GENERAL

1) Development will be carried out generally as described in *Bulk Liquids Berth Terminal No. 2, Port Botany, Environmental Assessment*, prepared by Sinclair Knight Merz and dated September 2007.

SERVICES

2) Liaison will be undertaken with SPC and the relevant utility and service providers regarding timing of connections to the services, location of services and utilities on the site.
3) Liaison will be undertaken with utility and service providers to confirm the location of services and utilities prior to construction commencing.
4) Liaison will be undertaken with relevant petroleum distributors that could potentially be impacted in regards to timing of connections with the integrated bulk liquids pipe distribution network.

NOISE MANAGEMENT

5) Audible construction activities at residential land uses will occur:
   a) Monday to Friday, 7 am to 6 pm;
   b) Saturdays, 7 am to 5 pm; and
   c) Sundays and Public Holidays (only as the construction schedule requires),
   d) No audible work outside these hours unless approval is obtained from the DECC prior to works being undertaken.
6) Mitigation measures to minimise noise during construction would be included in the Construction Environmental Management Plan.

CONTAMINATION

7) Leakages from pipes would be minimised by pressure pipe monitoring, with any required urgent corrective actions, and regular general inspections.

8) In the event that contaminated groundwater/soil is discovered during construction, a groundwater/soil management plan would be developed;

9) Appropriate disposal of any contaminated water or soil in accordance with DECC waste management guidelines.

HERITAGE

10) In the event of an item of Aboriginal or European heritage significance being discovered during construction, works in the area would cease and the appropriate authority contacted.

WATER QUALITY

11) The working platform and manifold areas would be bunded and would drain to wastewater storage tank. All water collected in the manifold area would be assessed, treated and/or disposed of at an appropriately licensed liquid waste management facility. Water from the working platform would initially be assessed to determine whether it is unpolluted and suitable for release to Botany Bay – or requires disposal at an appropriately licensed liquid waste management facility

12) Features such as Fire Safety System testing and Critical Equipment checks prior to a ship discharge would be implemented to ensure that loading/unloading operations would only be undertaken when the infrastructure is working correctly.

13) An oil boom facility would be readily available to be deployed rapidly from the nearby Brotherson Dock and brought to BLB2 in the event of a spill.

14) Procedures for spills and leaks including notifications and clean ups would be developed.

15) All unloading/loading infrastructure and pipelines would be regularly inspected and maintained to minimise the potential of leaks or spills.

16) Soil and Water Management Plan implemented during construction.

AIR QUALITY

17) Mitigation measures to minimise dust during construction would be included in the Construction Environmental Management Plan.

VISUAL AMENITY

18) Mitigation measures to minimise visual impacts during construction would be included in the Construction Environmental Management Plan.

SECURITY

19) A review of both the existing security assessment and the approved MSP would be undertaken to ensure appropriate security measures are maintained.

20) Government issued personal identity (ID) cards including Maritime Security Identification [MSIC] cards which require the applicant to have undergone a number of background security checks) would be a pre-requisite for any personnel to gain access to BLB2.

21) Operating Company vehicles (forklifts, vehicles carrying product discharge equipment (hoses, pumps & ancillaries) would only gain access to BLB2 through the controlled gates adjacent to the personnel access gate at BLB1.

WASTE MANAGEMENT

22) Mitigation measures to minimise waste impacts during construction would be included in the Construction Environmental Management Plan.

23) All waste generated would be removed from the work area as soon as practicable and disposed in accordance with DECC waste management guidelines (*Assessment, Classification and Management of Liquid and Non-Liquid Waste 1995*).

CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

24) The Applicant will prepare a Construction Environmental Management Plan at least a month before construction work commences. The CEMP would address issues, impacts and mitigation measures associated with construction

Navigation and Shipping

25) As required by the *Management of Waters and Waterside Lands Regulations NSW (C167)* the written permission of the harbour master will be obtained prior to construction to ensure the impact on commercial shipping is minimised.

Soil and Water

26) Mitigation measures to minimise soil and water impacts during construction would be included in the Construction Environmental Management Plan.

OPERATIONS MANUAL

27) Operation of the BLB2 will be carried out in accordance with the Operations Manual which includes operational environmental management procedures.

SKM

10. References

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Appendix A Director General Requirements

<table>
<tr><th>Director-General Requirements</th><th>Section addressed in the EA</th></tr>
<tr><td>General Requirements</td><td></td></tr>
<tr><td>Executive Summary</td><td></td></tr>
<tr><td>Description of the project, including:
▪ Existing site characteristics and environmental features;
▪ Design elements;
▪ Construction and operation; and
▪ Staging</td><td>Section 4</td></tr>
<tr><td>Strategic justification for the project, with specific reference to State policies, the scale of the project, any staging of works, predicted industry growth and demand, and identify how the project is consistent with this strategic assessment;</td><td>Section 3</td></tr>
<tr><td>Identification of relevant planning, land use and development matters (including strategic and statutory matters) that have been considered in the environmental impact assessment and/or in developing management/mitigation measures;</td><td>Section 2</td></tr>
<tr><td>An assessment of the environmental impacts of the project (construction and operation) in accordance with relevant policies and guidelines, with particular focus on the key assessment requirements specified below;</td><td>Section 5 & 6</td></tr>
<tr><td>A project justification with consideration of project objectives, project alternatives, benefits and impacts of the project, the suitability of the site, cumulative and synergistic impacts, Ecologically Sustainable Development principles, and whether the project is in the public interest;</td><td>Section 3</td></tr>
<tr><td>A draft Statement of Commitments detailing measures for environmental mitigation, management and monitoring for the project (including references to recognised standards); and</td><td>Section 9</td></tr>
<tr><td>Certification by the author of the EA that the information contained in the statement is neither false or misleading.</td><td></td></tr>
<tr><td>Key Assessment Requirements</td><td></td></tr>
<tr><td>Hazards and Risk Management
▪ A Preliminary Hazard Analysis (PHA), prepared in accordance with the Department’s publications Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis (DUAP, 1997) and Multi-Level Risk Assessment (DUAP, 1997). The PHA must also demonstrate that the project will not conflict with the recommendations contained in the Port Botany Land Use Safety Study (1996).
▪ Include details of spill management procedures and bunding provisions.
▪ Outline contingency plans for any potential incidents and equipment failures during the operation of the project, as well as details of a proposed monitoring and maintenance regime to be implemented for the project to ensure performance within acceptable risk limits.</td><td>Section 5</td></tr>
<tr><td>Air Quality
▪ A comprehensive air quality impact assessment prepared in accordance with Approved Methods for Modelling and Assessment of Air Pollutants in NSW (DEC, 2005). Consideration shall be given to all potential operating scenarios from normal operation conditions to worst case. The assessment must also include details relating to vapour recovery during the handling of fuels.</td><td>Section 5</td></tr>
<tr><td>Noise Impacts
▪ A noise impact assessment for the project, conducted in accordance with NSW Industrial Noise Policy (EPA, 2000). The assessment must include</td><td>Section 5</td></tr>
</table>

consideration of noise impacts of the development, with a particular focus on scenarios under which meteorological conditions characteristic of the locality may exacerbate impacts at sensitive receivers. The probability of such occurrences must be quantified. ■ An assessment of the construction noise impacts of the project, against the criteria provided in Chapter 171 of the *Environmental Noise Control Manual* (EPA, 2004).	
Water and Hydrodynamic Impacts ■ An assessment of the water quality impacts with particular reference to potential for spillage and impacts on surface, groundwater and stormwater management. ■ The EA must reflect a design goal of no discharge of water to Botany Bay, other than natural surface run-off, during operation of the project. ■ An assessment of the implications of the project on the hydrodynamics of the Bay. ■ Description of the water quality and hydrodynamic mitigation, monitoring and management measures the Proponent intends to apply to the project.	Section 5
Environmental Risk Analysis – notwithstanding the above key assessment requirements, the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of the proposed mitigation measures. Where additional key environmental impacts are identified through this environmental analysis, and appropriately detailed impact assessment of this additional key environmental impact must be included in the EA.	Section 6
Consultation Requirements	
An appropriate and justified level of consultation must be undertaken with the following parties during the preparation of the EA: ■ NSW Department of Environment and Climate Change; ■ Randwick City Council; ■ Council of the City of Botany Bay; ■ NSW Maritime Authority; ■ NSW Fire Brigades; ■ Sydney Ports Corporation; ■ Sydney Airport Corporation; and ■ the local community. The EA must clearly indicate the issues raised by stakeholders during consultation, and how those matters have been addressed in the EA.	Section 7
Deemed Refusal Period	
Under clause 9E(2) of the *Environmental Planning and Assessment Regulation 2000,* the applicable deemed refusal period is 60 days from the end of the proponent's environmental assessment period for the project.	

Appendix B   Green Port Guidelines Checklist

Sydney Ports Corporation

Checklist

The completed Checklist is to accompany all applications for new developments/activities submitted to Sydney Ports, or when requested by Sydney Ports.

The Checklist has the following features:

- The Headings (shaded in blue), Item numbers and Purpose/Criteria descriptions directly correspond to those in the Green Port Guidelines. This allows easy reference between this Checklist and the Guidelines.
- Applicants are to state whether each item has been addressed, not addressed or whether it is not applicable to the specific development. The Stages of Development indicators in the Green Port Guidelines may assist in this assessment.
- Applicants are then to explain how each item has been addressed, why it hasn't been addressed or why it is not applicable. Applicants are directed to the Suggested Measures provided in the Green Port Guidelines for guidance on how to address each item although alternative and innovative measures that may be more specific or relevant to the individual facility or operation are also encouraged.
- Supporting documentation (such as a Waste Management Plan, Environmental Management Plan or Design Specifications) may be referenced or attached to the Checklist.
- The Checklist can be filled out either electronically or by hand and sent back to Sydney Ports for review.

Applicant details

Name	Neil Trillo		**Company**	Vopak	
Address	Friendship Rd				
City/Town	Port Botany	**State**	NSW	**Postcode**	
Telephone		**Mobile**		**Email**	Neil.trillo@vopak.com.au

Project details

Location of proposed development

Fishburn Road, Port Botany adjacent to Vopak Terminals Australia Site B and Elgas Pty Ltd.

Description of proposed development

The second Bulk Liquids Berth (BLB2) at Port Botany is proposed to cater for the future growth of imported and exported chemical, petroleum and gas products. The BLB2 would comprise the construction of a steel piled pier berth, installation of associated infrastructure (such as marine loading arms), additional pipelines and unloading/loading and maintenance activities associated with operation of BLB2.

The details on this form are the provisions and intentions for maximising the environmental sustainability of this development.

Name ______________________

Signature ______________________ **Date** ______________________

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Materials selection	R1	Reduce the quantity of new materials being used by reusing materials or by utilising recycled materials.	Yes	Materials would be reused where possible during construction and operation of BLB2.	
	R2	Encourage environmentally friendly production of materials.	N/A	Only certain materials can be used for construction of BLB2	
	R3	Specify materials that have minimal embodied energy and environmental impact.	N/A	Only certain materials can be used for construction of BLB2.	
	R4	Consider the end of life of materials and the whole building, design for deconstruction.	N/A	BLB2 not expected to be deconstructed in near future and only certain materials can be used for construction of BLB2.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Waste management	W1	Minimise the generation of wastes.	Yes	CEMP would be prepared which would focus on minimising volumes of waste generated through works.	
	W2	Facilitate recycling to reduce the amount of waste going to landfill.	Yes	Wherever possible, recyclable waste would be segregated and sent to appropriate facilities for recycling.	
	W3	Ensure the safe storage and handling of hazardous wastes.	Yes	Ensure correct handling and storage of hazardous wastes and disposal by licensed contractor to approved facility. All waste including hazardous waste would be managed, classified and disposed of in accordance with EPA *Environmental Guideline: Assessment, Classification and Management of Liquid and Non-Liquid Waste (1995)*.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Water consumption	H1	Reduce consumption of potable water internally.	N/A	Water consumption during construction/operation of BLB2 would be minimal.	
	H2	Manage and monitor water usage and any leaks.	Yes	Pipelines installed above-ground to easily detect leaks visually. Regular inspections and maintenance of pipelines.	
	H3	Reduce the quantity of potable water used for landscape irrigation.	N/A	No natural vegetation on proposed site, therefore no landscape irrigation required.	
	H4	Treat water on-site and reuse the treated water to reduce demand on the local potable water supply and the demand on the local infrastructure.	N/A	Water use for BLB2 is minimal. BLB2 would be unlikely to increase demand on local potable water supply.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Energy use	E1	Reduce energy consumption and hence greenhouse gas emissions.	N/A	BLB2 energy consumption would be minimal.	
	E2	Manage the use of energy to minimise consumption.	N/A	BLB2 energy consumption would be minimal.	
	E3	Source energy from renewable sources.	N/A	Renewable energy can not be generated on-site and energy consumption would be minimal.	
	E4	Source energy from alternate energy sources and use less greenhouse intensive fuels (in particular limit diesel use).	No	Alternate energy sources unavailable at BLB2 site and energy consumption would be minimal at BLB2.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Transportation	T1	Encourage the use of alternative modes of transport by employees, in order to reduce the amount of inefficient/individual car travel and therefore greenhouse gas emissions.	No	Limited public transport servicing Port Botany area. Car travel only reasonable method of transport to BLB2.	
	T2	Reduce greenhouse gas emissions from operational vehicles and equipment.	Yes	DECC approved vapour emission controls would be implemented.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Indoor environment	IE1	Improve the quality of indoor air to protect the health of employees and enhance productivity.	N/A	BLB2 would be predominantly open-air.	
	IE2	Optimise daylighting and make best use of artificial lighting to assist eye health and productivity.	N/A	BLB2 would be predominantly open-air.	
	IE3	Provide optimum acoustical environment for productivity and to prevent ear damage.	N/A	Noise operation of BLB2 would be minimal and insignificant. Noise levels from road traffic and surrounding industrial sources have a greater contribution to the noise environment in Port Botany.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Emissions	EM1	Protect the ozone layer and reduce the potential for global warming.	Yes	DECC approved vapour emission controls would be implemented.	
	EM2	Limit the generation of air pollutants and ensure that they are emitted away from sensitive receptors.	Yes	Dust minimisation methods included in CEMP. DECC approved vapour emission controls would be implemented.	
	EM3	Minimise odours.	N/A	No odours anticipated during construction or operation of BLB2. Nearest sensitive receiver located approximately 1.5km away.	
	EM4	Minimise noise nuisance.	No	Construction of BLB2 would be below background noise environment (road traffic and industrial noise) at all nearby residential locations. Operations of BLB2 would be below project specific noise levels. Noise levels would be minimal and insignificant.	
	EM5	Avoid light spill into night sky or neighbouring properties/areas.	Yes	Detailed designs would minimise light spillover. Light spillover to comply with Civil Aviation Safety Authority (CASA) requirements.	
	EM6	Avoid accidental contact with hazardous or	Yes	Hose connections would be pressure tested prior to each use.	

		poisonous goods.		Monitoring of all equipment during transfer of hazardous goods. Joints and connections continually monitored for leaks. New gaskets would be used for each transfer.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Water quality	HQ1	Manage stormwater to reduce peak stormwater flows and protect water quality.	Yes	Stormwater would be pumped to wastewater storage tank for treatment and/or disposal to a DECC approved waste handling facility.	
	HQ2	Manage water quality to protect the harbour and other water bodies.	Yes	Storage of chemicals in appropriately bunded areas Procedures developed for handling/use of chemicals and fuels near or over water. Emergency oil spill response team located in Brotherson Dock.	
	HQ3	Prevent damage from potential flood events and water table changes.	N/A	Proposed development located on reclaimed land.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Land use	L1	Encourage the redevelopment of sites that have previously been developed and remediate contaminated land.	Yes	Current lease on site involves contractual obligation to ensure any potential contamination is appropriately remediated. Appropriate control measures for acid sulphate soils would be implemented if acid sulphate soils are observed.	
	L2	Use landscaping to enhance biodiversity and conserve and create habitat for flora and fauna.	N/A	No vegetation on BLB2 site.	
	L3	Enhance visual amenity.	Yes	Proposed development compatible with existing features and context of surrounding industrial area. Some views would be screened by vegetation. Design of BLB2 would blend into surrounding background area.	
	L4	Avoid impact on identified heritage items.	N/A	No identified items of Aboriginal and non-Indigenous heritage within or in vicinity of proposed development.	

	Item No	Purpose/criteria	Has this been addressed? (Yes, No, N/A)	How has it been addressed? Or, why has it not been addressed?	Provide details of supporting documentation/ reference material
Environmental management	M1	Maintain good relationships with stakeholders and respond to any complaints.	Yes	Identify and consult with stakeholders about environmental issues.	
	M2	Provide a framework for identifying, managing and minimising environmental impacts, and maximising environmental benefits.	Yes	Development of Construction and Operational Environmental Management Plans. Comply with relevant planning and environmental legislation.	
	M3	Educate developers, tenants and employees about ESD and how to improve sustainability.	Yes	Would be included in Operations Manual. Operations Manual would be updated and appropriate ESD and sustainability training/workshop would be provided.	

Appendix C Operation – Expected Throughput of Chemicals, Petroleum Fuels and Gases

- **Table B1 Expected Delivery of Chemical Volumes (kL) for Port Botany**

Chemicals Type	2010 to 2022 BLB1 & BLB2	2010 to 2022 BLB2 only
Dangerous Goods Class 3	28 184	14 092
Dangerous Goods Class 6	7 045	3 523
Dangerous Goods Class 8	7 046	3 523
Combustibles	98 643	49 321
Total	**140 918**	**70 459**

- **Table B2 Expected Chemicals Ship Arrivals for Port Botany (BLB2 only)**

Number of Ships	Cargo Size (kL)	Pumping Rate (kL/hr)
31	1000- 2300	171

- **Table B3 Expected Gas Volumes (kL) for Port Botany (BLB1 + BLB2)**

	2016	2017	2018	2020	2021	2022
Import	1 005 173	1 020 251	1 035 555	1 066 854	1 082 857	1 099 100
Export	311 950	316 630	321 379	331 093	336 059	341 100
Total	**1 317 123**	**1 336 880**	**1 356 933**	**1 397 947**	**1 418 916**	**1 440 199**

NOTE : BLB2 would not be Operational for Gas Imports/Exports until 2016; i.e. BLB1 would continue to service 100% of the Gas Market until 2016.

- **Table B4 Expected Gas Volumes (kL) for BLB2 only**

	2016	2017	2018	2020	2021	2022
Import	502 587	501 125	517 777	533 427	541 429	544 850
Export	155 975	158 315	160 690	165 546	168 029	170 550
Total	**658 562**	**668 440**	**678 467**	**698 973**	**709 458**	**715 400**

- **Table B5 Expected Number of Gas Ship Arrivals for Port Botany (BLB2 only)**

	2016	2017	2018	2020	2021	2022
Import – small ship	13	14	14	14	14	15
Import- large –ship	5	6	6	6	6	6
Export	39	40	40	42	42	43
Total	**57**	**60**	**60**	**62**	**62**	**64**

Table B6 Average Parcel Size - Gas Volumes (kL) for Port Botany (BLB2 only)

Type	2016	Pumping Rates (kL/hr)
Import –small ship	4 530	395
Import –large ship	80 000	986
Export	4 530	395

Table B7 Expected Biodiesel Volumes (kL) for Port Botany (BLB1 + BLB2) and BLB2 only

Chemicals Type	2010 BLB1 & BLB2	2011-2022 BLB1 & BLB2	2010 BLB2 only	2011-2022 BLB2 only
Import	288 719	352 438	144 710	176 219
Export	0	97 560	0	48 780
Total	**288 719**	**449 998**	**144 710**	**224 999**

Table B8 Expected Biodiesel Ship Arrivals for BLB2 only

	Number of Ships		Parcel Size (kL)	Pumping Rate (kL/hr)
	2010	2011-2022		
Biodiesel	25	38	5 882	171

Table B9 Expected Petroleum Volumes (kL) for Port Botany (BLB1 + BLB2)

Type	2010	2011	2012	2020	2021	2022
DG Class 3	1 102 685	1 113 435	1 290 621	2 666 722	2 854 573	3 046 182
Combustibles	472 579	485 758	553 123	1 142 881	1 223 389	1 305 506
Total	**1 575 264**	**1 619 193**	**1 843 744**	**3 809 603**	**4 077 962**	**4 351 688**

Table B10 Expected Petroleum Volumes (kL) for BLB2 only

Type	2010	2011	2012	2020	2021	2022
DG Class 3	661 611	680 061	903 435	1 333 361	1 427 287	1 523 091
Combustibles	283 547	291 455	387 186	571 441	611 694	652 753
Total	**945 158**	**971 516**	**1 290 621**	**1 904 802**	**2 038 981**	**2 175 844**

- **Table B11 Expected Petroleum Ship Arrivals for BLB2 only**

2010	2011-2012	2020	2021	2022
32	35	61	75	79

- **Table B12 Average Parcel Size - Petroleum Volumes (kL) for BLB2 only**

Parcel Size (kL)		Ship Discharge Rate (kL/hr)	
2010-2012	2020-2022	2010-2012	2020-2022
37 500	50 000	1 500	1 875

Appendix D Preliminary Hazard Analysis

Bulk Liquids Berth No. 2 – Port Botany

PRELIMINARY HAZARD ASSESSMENT

- Final
- 12 November 2007

Bulk Liquids Berth No. 2 – Port Botany

PRELIMINARY HAZARD ASSESSMENT

- Final
- 12 November 2007

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EXECUTIVE SUMMARY

Introduction, Objectives and Scope

Vopak Terminals Sydney Pty Ltd (Vopak) is proposing, on behalf of the Sydney Ports Corporation (SPC) to obtain approval for the construction and operation of a second Bulk Liquids Berth (BLB2) facility at Port Botany NSW. The proposed Bulk Liquids Berth No. 2 (BLB2) will be a shared facility and will be administered by SPC. The project will consist of the following:

- Construction of a steel piled pier berth adjacent to the existing BLB1 parallel to the privately accessed Fishburn Road (approximately at the boundary between Vopak Site B and Elgas Caverns);
- Installation of associated infrastructure such as Marine Loading Arms (MLA) and fire fighting equipment; and
- Installation of additional pipelines from existing user sites to the new berth.

BLB2 is proposed to handle the predicted increase in chemical, petroleum and gas products to be transferred at Port Botany and to reduce the demurrage costs which some customers are currently incurring due to operational limitations and scheduling conflicts. The proposed new berth would also allow the capacity to remain ahead of demand and ensure New South Wales has an efficient and competitive facility in comparison with other Australian ports.

To ensure the appropriate safety provisions are made for the facility, a preliminary hazard analysis (PHA) is required as part of the Director General's requirements. Vopak has commissioned Sinclair Knight Merz to conduct the PHA study of the site.

The objectives are to conduct a PHA study of the proposed BLB2 project, using the Hazardous Industry Planning Advisory Paper (HIPAP) No.6 guidelines (Ref.12) and to determine whether assessed risks impact the existing risk contours developed for the Port Botany area in the Port Botany Land Use Safety Study (Ref.1). The scope of work is for the assessment of the BLB2 impacts on the existing risk contours only. The study does not include the assessment of other facilities in the Port Botany Area.

Methodology

The methodology used for the study was that described in the Multi-Level Risk Assessment approach, published by the NSW Department of Planning (Ref.2). The approach used the following steps:

- **Hazard Analysis** – identify those hazards that have the potential to impact the existing risk contours for the Port Botany Area;
- **Consequence Analysis** – assess the consequence impacts of the identified hazards and eliminate those incidents that have no consequence impacts on the existing contours, carry forward for further analysis those incidents with impacts to existing contours;

- **Frequency Analysis** – assess the frequency of those incidents identified to have a potential impact on the existing contours, carry these results forward for risk analysis;
- **Risk Analysis & Review** – combine the consequence and frequency results to determine the risks, compare the risks to the existing contours and determine whether there are any incidents that could result in contour extension. Apply risk reduction to those incidents identified to impact contours and review risks. Continue this process until there is no impact on contours.

Brief Description of the BLB2 Facility

The proposed BLB2 facility will be constructed on the western side of the Port Botany peninsular, south of the existing BLB1 facility. The wharf will have a single deck 76m long by 32m wide. Five marine loading arms (MLAs) will be installed on the wharf, four for petroleum products and one for LPG. Two chemical transfer manifolds will also be installed on the northern section of the deck to facilitate chemical transfers as required.

The deck will also be constructed with a hose storage shed and a small operator's shed. Three fire monitors will also be installed on the wharf deck. These monitors will be remote control operated from the shore to facilitate operation without approaching a hazard.

Ships will come alongside the wharf with the assistance of tugs. Once moored, the relevant safety checks will be performed and the flexible hose (chemicals) or MLA will be connected to the ships manifold (bolted connection). Only 1 MLA will be used for the transfer of LPG and up to 4 MLAs, simultaneously, for the transfer of flammable/ combustible liquids. Up to 8 flexible hoses can be connected simultaneously for the transfer of chemicals (toxic, corrosive, flammable and combustible), however, it is unlikely that hoses and MLAs will be used simultaneously. A pressure test will then be conducted with nitrogen at 800kPa for liquids and 900kPa for gases. The product will then be transferred via the specific pipeline to the user's facility/storage. On completion of the transfer, all pipelines will be purged and will rest empty until the next required use.

Hazard Identification

A hazard identification workshop was conducted to identify those hazards that could result in impacts to the existing risk contours for the BLB2 area. The following hazards were identified:

- Ship strikes the wharf at excessive speed;
- Moored ship is struck by passing ship;
- Chemical hose failure leading to release of chemicals;
- Chemical pipeline failure leading to release of chemicals;
- Marine loading arm failure leading to flammable gas release;
- Liquefied Flammable Gas (LPG) pipeline failure leading to flammable gas release;
- Marine loading arm failure leading to flammable liquid release;
- Flammable liquid pipeline failure leading to flammable liquid release; and

- Mooring systems fail leading to ship moving away from the wharf and breaking transfer connections.

Each hazard was assessed for potential to impact the existing contours. Those incidents identified to have no potential to impact the existing risk contours were not assessed further in the study. A list of hazards was then developed and carried forward for consequence analysis.

Consequence Analysis

After detailed hazard assessment, the following hazards were identified to have a potential to impact the existing risk contours for the Port Botany area:

- LPG Transfer MLA Failure – leak/release, ignition and explosion/fire;
- LPG Pipeline Failure – leak/release, ignition and explosion/fire;
- Flammable/Combustible Liquid MLA Failure – leak/release, ignition and fire;
- Flexible hose failure (rupture) – flammable/combustible liquid release, ignition and fire;
- Flammable/Combustible Liquid Pipeline Failure - leak/release, ignition and fire;

Each incident was subjected to a detailed consequence analysis. It was identified that each incident has a number of sub-incidents, for example, a release of LPG at a flange could result in an immediate jet fire, a flash fire or explosion. The consequence analysis identified that the severity of some incidents was not sufficient to impact the existing risk contours, hence, these incidents were eliminated from further analysis. A list of incidents was then developed and carried forward for frequency analysis.

Frequency Analysis

The following incidents were carried forward for frequency analysis:

- Environmental Impact – flexible hose failure (chemical transfer);
- Jet fire – MLA catastrophic failure (LPG);
- Flash Fire – MLA catastrophic failure (LPG);
- Jet Fire – flange leak isolating valve station (LPG);
- Jet Fire – valve leak isolating valve station (LPG);
- Flash Fire – flange leak isolating valve station (LPG);
- Flash Fire – valve leak isolating valve station (LPG);
- Pool Fire – flange leak isolating valve station (flammable/combustible liquid); and
- Pool Fire – valve leak isolating valve station (flammable/combustible liquid).

Each incident was subjected to a frequency analysis to determine whether the frequency of the event was high enough to cause impact to the existing risk contours for the site. The frequency of incidents was then carried forward for risk assessment.

Risk Assessment and Review

Table 1-1 shows a summary of the fatality probability as a result on incidents, the incident frequency and the risk.

Table 1-1 Summary of Fatality Probability, Incident Frequency and Risk Results

Incident	Fatality Probability[1]	Incident Frequency[2]	Risk[3] (pmpy)
Jet Fire-MLA Rupture (LPG)	1	2.6×10^{-7} p.a.	0.26
Flash Fire – MLA Rupture (LPG)	1	2.6×10^{-7} p.a.	0.26
Jet Fire – flange leak isolating valve station (LPG)	0.35	1.3×10^{-7} p.a.	0.045
Jet Fire – valve leak isolating valve station (LPG)	0.35	2.16×10^{-6} p.a.	0.76
Flash Fire – flange leak isolating valve station (LPG)	1	1.3×10^{-7} p.a.	0.13
Flash Fire – valve leak isolating valve station (LPG)	1	2.16×10^{-6} p.a.	2.16
Pool Fire – flange leak isolation valve station (Flammable/Combustible Liquid)	0.48	2.06×10^{-5} p.a.	10
Pool Fire – valve isolation valve station (Flammable/Combustible Liquid)	0.48	1.3×10^{-5} p.a.	6.24

Notes: 1. see **Table 5-1**
2. Summarised from Section 6
3. Multiple of Fatality probability and incident frequency (per million per year – pmpy)

Conclusions

Cumulative Risks for Incidents at the MLA

The two incidents described in **Table 1-1**, relating to the MLA risks, each have a risk of 0.26pmpy. Hence, the total risk (cumulative) is 0.26 x 2 = 0.52pmpy. This occurs at the existing 50pmpy contour that currently surrounds the proposed BLB2 facility in the Port Botany study (Ref.1). Hence, it is concluded that there would be negligible impact on the existing 50pmpy contour or the 1pmpy contour a further 30m beyond the 50pmpy contour.

Cumulative Risks for Incidents at the Pipeline Isolating Valve Station

There were six incidents identified at the pipeline isolating valve station. The cumulative risk is the summation of the risk values in **Table 5-1**, which is 19.3pmpy. This risk impact occurs at the existing 50pmpy contour that currently surrounds the BLB2 facility in the Port Botany study (Ref.1). Hence, it is concluded that there would be no increase to the existing 50pmpy contour or the 1pmpy contour a further 130m into Botany Bay.

Risk Impacts to Adjacent Industrial Facilities

In addition to the assessment of impacts of the proposed BLB on the existing risk contours, the individual fatality risk at the closest industrial facility (Elgas) was assessed. It was identified that the fatality risk at this facility, as a result of the proposed BLB2 operation would be less than 19.3 pmpy. This is below the acceptable risk criteria of 50 pmpy for industrial sites. Hence, it is concluded that the proposed BLB would only be classified as potentially hazardous and not actually hazardous under the definition detailed in State Environmental Planning Policy No.33.

Recommendations

Notwithstanding the assessment conducted in the study a number of recommendations have been made to ensure the risks are maintained within the as low as reasonably practicable (ALARP) range. The following recommendations are made:

1) It was identified that leaks of flammable liquid or chemicals into the pipeline isolation valve pit (at the shore line) could result in the pit filling and overflowing to the bay close by. It is therefore recommended that consideration be given to installing a level alarm switch at the isolation valve pit to detect any leaks and alarm at the transfer control room.
2) It was identified that leaks of LPG near the valve pit could result in the pit filling with LP gas. In the event an ignition of the gas occurs, an explosion could result leading to pipeline and valve damage and further release of products (domino incident). It is therefore recommended that the gas isolation valves at the shoreline be separated from the other isolation valves and located away from the pit (i.e. flammable liquids and chemicals) to eliminate the potential for any leaks to accumulate in the pit.

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ABBREVIATIONS AND TERMS

Abbreviation/Term	Description
ALARP	As Low As Reasonably Practicable
AS	Australian Standard
BLB	Bulk Liquids Berth
CFG	Compressed Fibre Gasket
DG	Dangerous Goods
DoP	Department of Planning
Double Bottom	A void section of the ship between the hull and tank
EA	Environmental Assessment
ESD	Emergency Shut Down
HIPAP	Hazardous Industry Planning Advisory Paper
IMDG	International Maritime Dangerous Goods
ISGOTT	International Safety Guide for Oil Tankers & Terminals
kPa	kilo Pascals
kW/m^2	kilo Watts per square metre
LPG	Liquefied Petroleum Gases
M	Metres
MLA	Marine Loading Arm
OREDA	Offshore Reliability Data
p.a.	per annum
PG	Packaging Group
PHA	Preliminary Hazard Analysis
Pmpy	per million per year
QRA	Quantitative Risk Assessment
SCADA	Supervisory Control & Data Acquisition
Scupper	A drain on the deck of the ship that discharges overboard
SEPP	State Environmental Planning Policy
SPC	Sydney Ports Corporation
SWG	Spiral Wound Gasket
Taxonomy	A reference number for reliability data sheets

1. INTRODUCTION

1.1 Background

Vopak Terminals Sydney Pty Ltd (Vopak) is proposing, on behalf of the SPC to obtain approval for the construction and operation of a second Bulk Liquids Berth (BLB2) facility at Port Botany NSW. The proposed Bulk Liquids Berth No. 2 (BLB2) will be a shared facility and will be administered by Sydney Ports Corporation (SPC). The project will consist of the following:

- Construction of a steel piled pier berth adjacent to the existing BLB1;
- Installation of associated infrastructure such as marine loading arms (MLA) and fire fighting equipment;
- Installation of additional pipelines from existing user sites to the new berth; and
- Unloading/ loading and maintenance activities associated with the operation of the facility.

BLB2 is proposed to handle the predicted increase in imported chemical, petroleum and gas products into Port Botany and to reduce the demurrage costs which customers are currently incurring due to operational limitations and scheduling conflicts. The proposed new berth would also allow the capacity to remain ahead of demand and ensure New South Wales has an efficient and competitive facility in comparison with other Australian ports.

To ensure the appropriate safety provisions are made for the facility, a preliminary hazard analysis (PHA) is required as part of the Director General's requirements. Vopak has commissioned Sinclair Knight Merz to conduct the PHA study of the site.

This document details the objectives, scope of works, methodology, results, conclusions and recommendations for the Botany BLB2 project.

1.2 Objectives

The objectives of the study are to:

- Conduct a PHA study of the proposed BLB2 project in accordance with the requirements of Hazardous Industry Planning Advisory Paper No.6, Guidelines for Hazard Analysis;
- Identify whether the proposed BLB2 facility will impact on the existing risk contours for the Port Botany Area (Ref.1); and
- Report on the findings of the study for inclusion in the Environmental Assessment (EA).

1.3 Scope of Works

The scope of works is for a PHA study of the BLB2 facility at Port Botany, NSW. The study includes the assessment of hazards and risks associated with the operation of the proposed berth. The scope does not include assessment of any existing facilities at the bulk liquids berth site.

2. METHODOLOGY

2.1 General Approach

The NSW Department of Planning (DoP) Multi Level Risk Assessment (Ref.2) approach was used for this study. The approach considered the development in context of its location and its technical and safety management control. The Multi Level Risk Assessment Guidelines are intended to assist industry, consultants and the consent authorities to carry out and evaluate risk assessments at an appropriate level for the facility being studied.

The Multi Level Risk Assessment approach is summarised in **Figure 2-1**. There are three levels of assessment, depending on the outcome of preliminary screening. These are:

- **Level 1** – **Qualitative Analysis**, primarily based on the hazard identification techniques and qualitative risk assessment of consequences, frequency and risk;
- **Level 2** – **Partially Quantitative Analysis**, using hazard identification and the focused quantification of key potential offsite risks; and
- **Level 3** – **Quantitative Risk Analysis (QRA)**, based on the full detailed quantification of risks, consistent with Hazardous Industry Planning Advisory paper No.6 – Guidelines for Hazard Analysis.

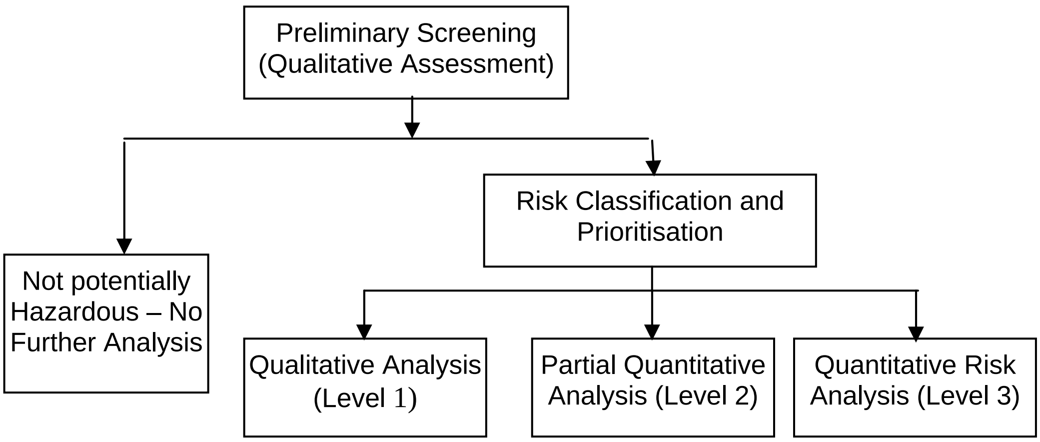


Figure 2-1 The Multi Level Risk Assessment Approach

The document "Applying SEPP 33" (Ref.3) guideline may also be used to assist in the selection of the appropriate level of assessment. This guideline states the following:

"It is considered that a qualitative PHA may be sufficient in the following circumstances:

- *where materials are relatively non-hazardous (for example corrosive substances and some classes of flammables);*
- *where the quantity of materials used are relatively small;*

- *where the technical and management safeguards are self-evident and readily implemented; and*
- *where the surrounding land uses are relatively non-sensitive.*

In these cases, it may be appropriate for a PHA to be relatively simple. Such a PHA should:

- *identify the types and quantities of all dangerous goods to be stored and used;*
- *describe the storage/processing activities that will involve these materials;*
- *identify accident scenarios and hazardous incidents that could occur (in some cases, it would also be appropriate to include consequence distances for hazardous events);*
- *consider surrounding land uses (identify any nearby uses of particular sensitivity); and*
- *identify safeguards that can be adopted (including technical, operational and organisational), and assess their adequacy (having regards to the above matters).*

A sound qualitative PHA which addresses the above matters could, for some proposals, provide the consent authority with sufficient information to form a judgement about the level of risk involved in a particular proposal".

The proposed BLB2 facility will be located on the end of the Port Botany peninsular and within an industrialised port area. Sensitive land users are well clear of the site, the closest residential buildings being over 1.7kms to the east (Matraville/Phillip Bay area). Detailed technical and management safeguards are currently used at the existing BLB and these will be implemented at the proposed BLB2. An assessment of the BLB2 project was undertaken as part of the Port Botany Land Use Safety Study (Ref.1) using a quantitative approach and therefore a qualitative study is not considered appropriate for the proposed BLB2 assessment.

As the Port Botany Land Use Safety Study used a quantitative approach, the analysis for the BLB2 study in this document will also be quantitative in nature. A key component of the Director General's Requirements (DGRs) is a review of the impact of the proposed facility on the existing contours developed for the Port Botany Land Use Safety Study. Hence, the selected approach for this study will be to assess the risks associated with the operation of the proposed BLB2 facility and to compare these to the existing risk contours developed in the Port Botany Land Use Safety study. In the event assessed risks exceed the existing contours, risk reduction measures will be developed and recommended as part of this study.

The following detailed risk assessment approach will be used, which is based on the HIPAP No.6 guidelines.

2.1.1 Hazard Identification

.A hazard identification workshop was held with the stakeholders in the BLB2 development and operation. The results of the study were used to develop a Hazard Identification table for use in the consequence, frequency and risk assessment.

2.1.2 Consequence Assessment

The identified hazards, listed in the Hazard Identification Table were subjected to a consequence assessment. Where hazards could be quantified for impact to people, the impact severity was assessed and carried forward for frequency analysis. Where impacts to the environment were identified, release quantities were estimated and carried forward for frequency analysis.

2.1.3 Frequency Assessment

Those incidents carried forward from the consequence analysis were subjected to a frequency analysis. This involved the assessment of the initiating event (i.e. leak) and then the application of the probability of failure of the protection systems. Fault and event trees were used to assess the final event frequency.

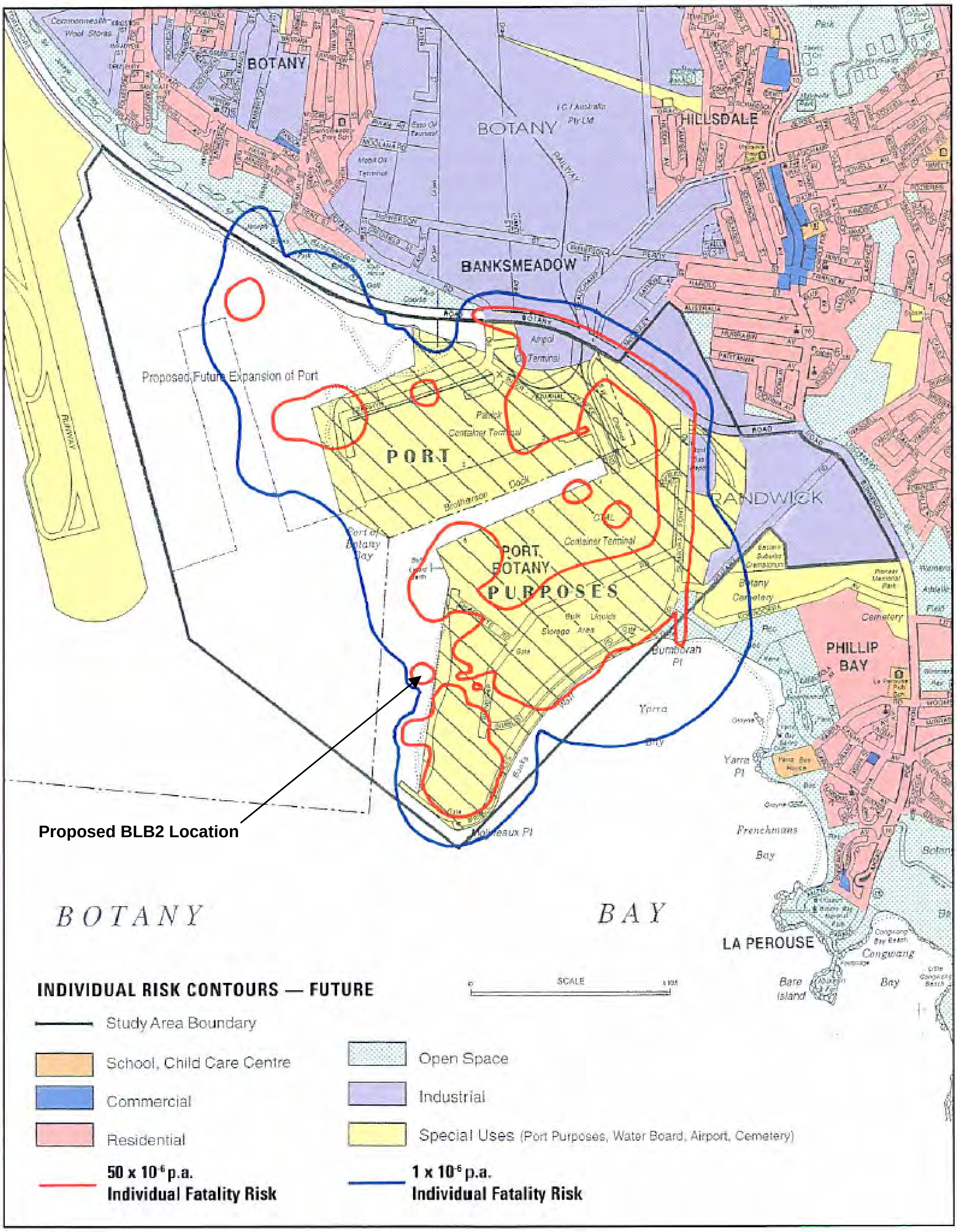
2.1.4 Risk Assessment and Review

The existing risk contours (see **Figure 2-2**) were used to determine selected points for which risk was assessed. For example, the location of the closest point on the fatality risk contour to the south of the site was selected and the distance to this point used to determine the cumulative impacts and risks at this location from the operations at the BLB2 facility. The assessment results were then compared to the risk contour value to determine whether the existing value was exceeded.

Where the results of the assessment did not exceed the risk contour value, no further assessment was conducted. Where risk contour values were exceeded, the major risk contributors were identified and risk reduction was applied to these. The risks were then reviewed to ensure the applied risk reduction was successful in reducing the risks by the required amount.

2.1.5 Reporting

On completion of the study, a draft report was developed for review by the stakeholders. Comments on the draft were then incorporated and a final report issued for inclusion in the EA.



(Ref.1)

Figure 2-2 Cumulative Individual Risk Contours including Postulated Future Development (i.e. BLB2)

3. BRIEF DESCRIPTION OF THE BLB2 FACILITY AND OPERATION

3.1 Surrounding Land Uses

The proposed BLB2 will be constructed south of the existing BLB1 facility, at the south-western end of Brotherson Dock, Port Botany, NSW. **Figure 3-1** shows the Port Botany regional location. The site will be accessed from the main Botany area via Simblist Road, privately accessed Fishburn Road and Charlotte Road. The BLB site is located in an industrialised area zoned 4b (Port Botany) and is surrounded by a number of bulk liquid storage facilities, wharves and docks. The closest residential area is located about 1.7kms to the east (Matraville/Phillip Bay Area). **Figure 3-2** shows an aerial photograph of the Port Botany area, showing the location of the BLB facilities in relation to the surrounding land uses.

The following land uses surround the BLB site:

- North – Patricks Container Terminal (across Brotherson Dock);
- East – Elgas surface facilities for underground bulk LPG storage, Vopak bulk liquids storage, Fishburn Road and Qenos bulk liquids storage;
- South – Molineux Point (end of Port Botany peninsular) and Botany Bay; and
- West – Botany Bay

There are no sensitive land users close to the proposed BLB site. The closest school to the facility (La Perouse Primary School) is located about 2.5kms from the proposed berth.

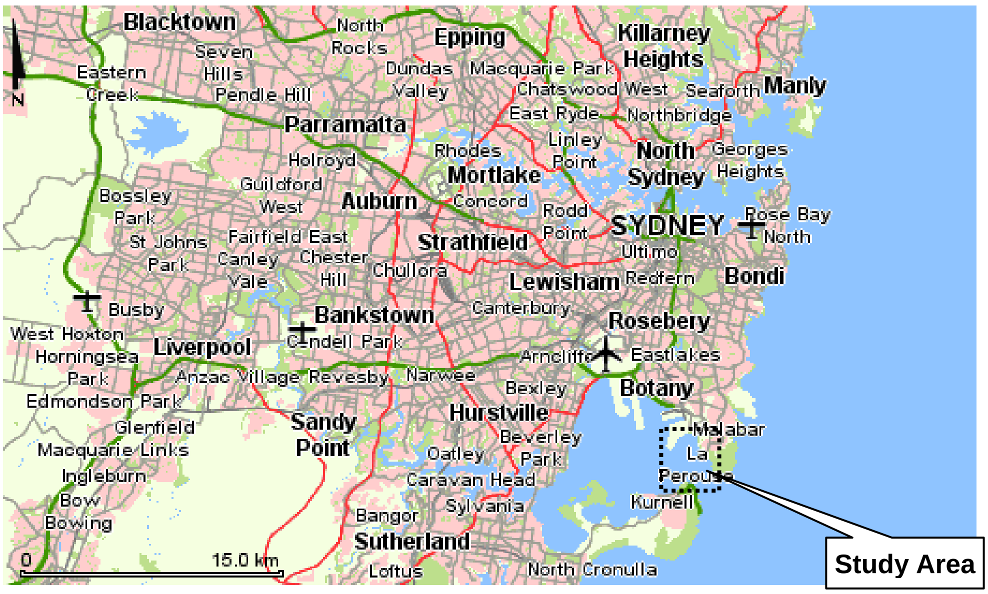


Figure 3-1 Port Botany Regional Location

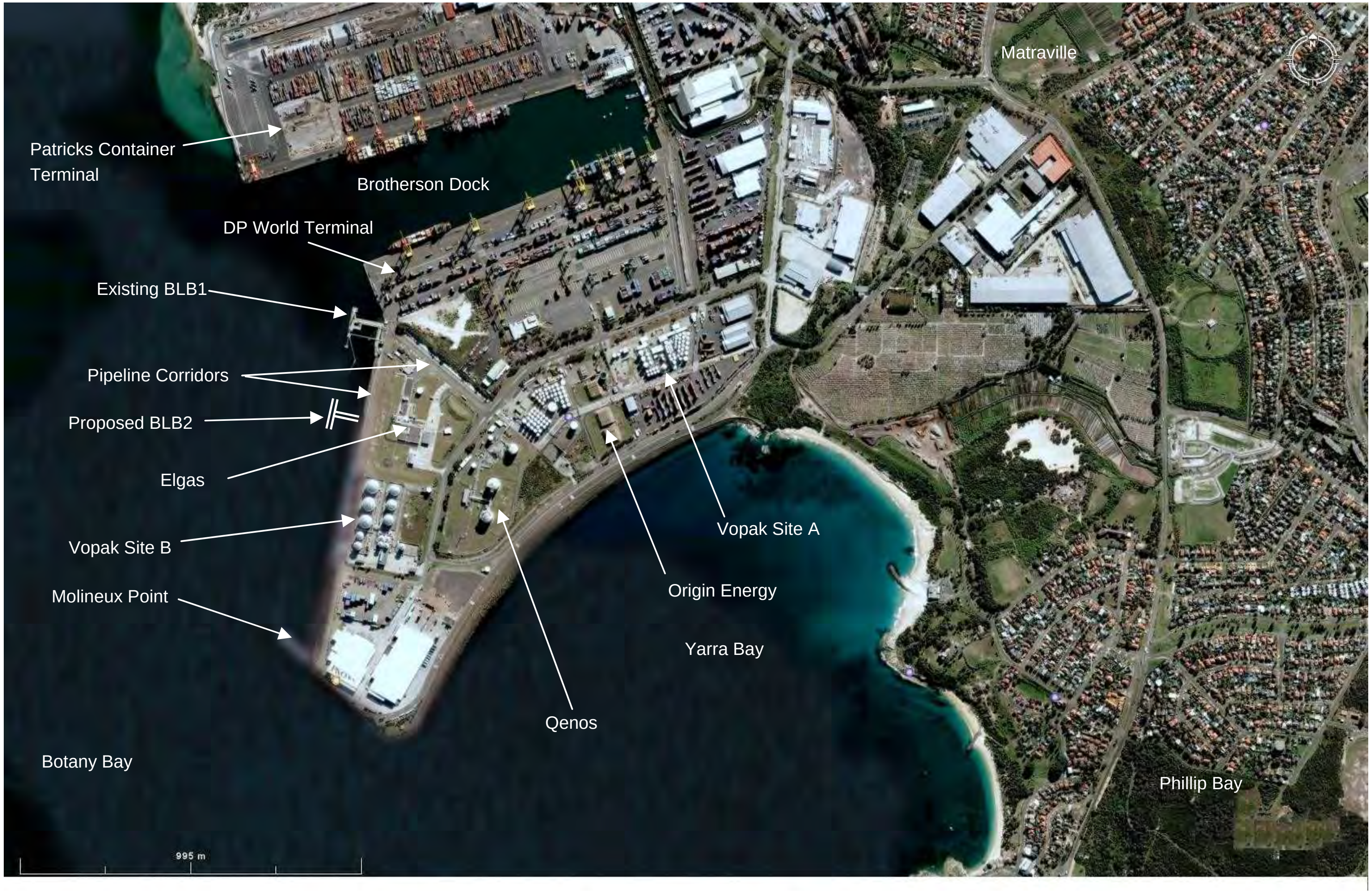
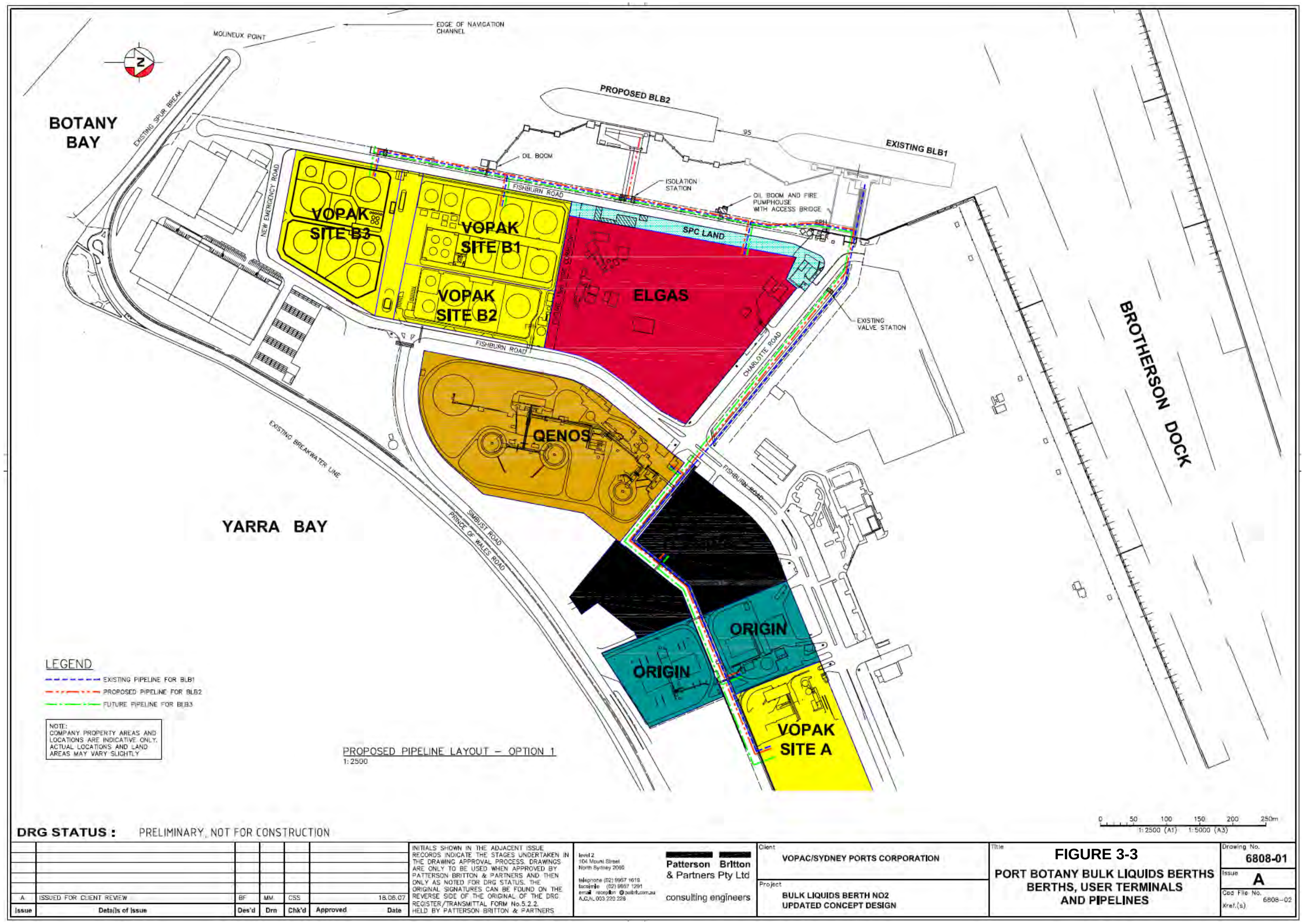


Figure 3-2 Aerial photograph of Port Botany showing BLB2 and surrounding land uses


EDGE OF NAVIGATION CHANNEL
MOLINEUX POINT
PROPOSED BLB2
EXISTING BLB1
BOTANY BAY
EXISTING SPUR BREAK
OIL BOOM
ISOLATION STATION
OIL BOOM AND FIRE PUMPHOUSE WITH ACCESS BRIDGE
FISHBURN ROAD
NEW EMERGENCY ROAD
VOPAK SITE B3
VOPAK SITE B1
VOPAK SITE B2
SPC LAND
ELGAS
EXISTING VALVE STATION
CHARLOTTE ROAD
BROTHERSON DOCK
QENOS
EXISTING BREAKWATER LINE
YARRA BAY
SIMBLIST ROAD
PRINCE OF WALES ROAD
ORIGIN
ORIGIN
VOPAK SITE A
LEGEND
EXISTING PIPELINE FOR BLB1
PROPOSED PIPELINE FOR BLB2
FUTURE PIPELINE FOR BLB3
NOTE: COMPANY PROPERTY AREAS AND LOCATIONS ARE INDICATIVE ONLY. ACTUAL LOCATIONS AND LAND AREAS MAY VARY SLIGHTLY
PROPOSED PIPELINE LAYOUT – OPTION 1
1:2500
DRG STATUS : PRELIMINARY, NOT FOR CONSTRUCTION
A ISSUED FOR CLIENT REVIEW BF MM CSS 18.08.07
Issue Details of Issue Des'd Drn Chk'd Approved Date
Patterson Britton & Partners Pty Ltd
consulting engineers
VOPAC/SYDNEY PORTS CORPORATION
BULK LIQUIDS BERTH NO2
UPDATED CONCEPT DESIGN
FIGURE 3-3
PORT BOTANY BULK LIQUIDS BERTHS BERTHS, USER TERMINALS AND PIPELINES
6808-01
A

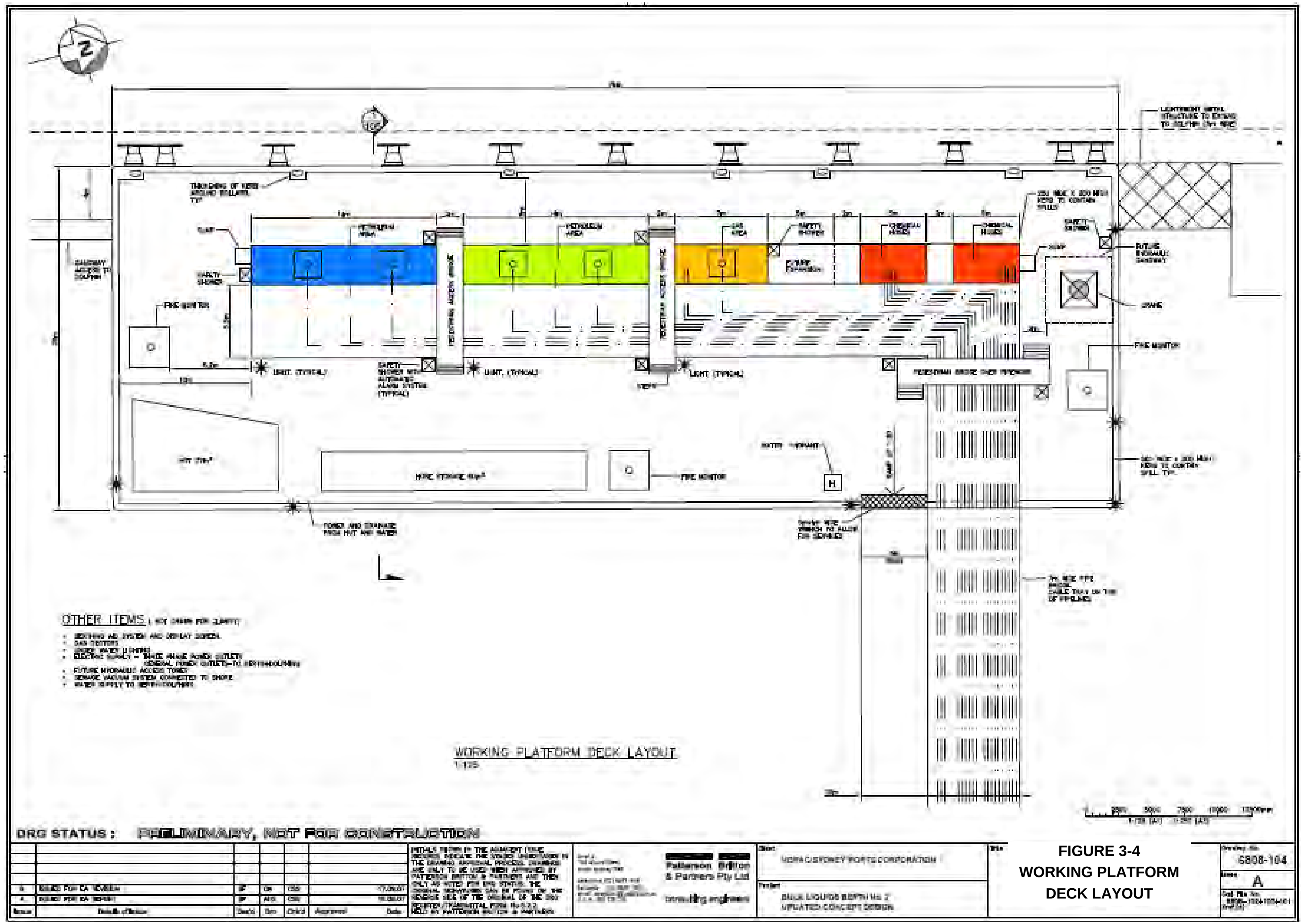


FIGURE 3-4
WORKING PLATFORM
DECK LAYOUT

3.2 Background & General Site Description

The existing Bulk Liquids Berth (BLB1) at Port Botany is nearly 30 years old and is heavily utilised by the bulk liquids industry. A second bulk liquids berth (BLB2) is required to meet increasing demand.

The existing BLB1 is located in Botany Bay at the south-western end of Brotherson Dock, Molineux Point, Port Botany, approximately 11 km south of the Sydney CBD (**Figure 3-1)**. BLB1 was commissioned in 1979 as a common-user facility and currently handles hazardous and non-hazardous bulk liquids and gases which are transferred by pipeline to nearby industries.

The demand for bulk liquids imported and exported through the existing bulk loading berth (BLB1) has grown significantly in recent years. Berth utilisation at BLB1 varies and although currently it is less than the accepted maximum of 65%, (or between 200-250 occupancy days per year), demurrage charges are currently being incurred by the existing users of the berth due to scheduling conflicts and operational limitations.

A second berth bulk liquids berth (BLB2) is proposed to cater for the growth. **Figures 3-2, 3-3** & **3-4** show the detailed location and layout of the proposed BLB2 facility. The proposed BLB2 will operate concurrently with BLB1 and will be located adjacent to BLB1 (see **Figure 3-2**) parallel to privately accessed Fishburn Road and will be of a similar construction to BLB1. BLB2 will be a common-user facility which will handle hazardous and non hazardous bulk liquids and gases similar to BLB1. The BLB2 berth comprises the following main elements:

- a central working platform with a berthing face (including bollards and fenders) and pipe manifold/marine loading arm (MLA) arrangements;
- adjacent berthing dolphins on each side of working platform designed to accommodate up to the maximum design vessel;
- two mooring dolphins on each side of the working platform (four in total). Mooring dolphins will be required on the northern side of the working platform, instead of the existing land based mooring point arrangement used for the BLB1, due to the geometry of the existing shoreline;
- walkways (catwalks) connecting the dolphins and working platform;
- an access bridge structure connecting the working platform with the shore providing for pipeline support and vehicle access;
- support infrastructure including fire control facility/pumphouse and associated tanks, gatehouse and amenities (note that ultimately the need for a gatehouse is dependant on site security arrangement);
- berth fitout, including fire fighting monitors, services such as water, sewer, electrical and communications, amenities and blast proof Operator Shelter.

The BLB2 structure will be owned and maintained by SPC. The pipes, pipe manifolds and MLAs will be owned and maintained by the users.

3.3 Detailed Description of the BLB2 Facility

3.3.1 The BLB2 Working Platform

The working platform is proposed to be a suspended deck structure 76m x 32m in plan (approximately 80% larger than the existing BLB1). It will primarily support the MLAs/manifolds and associated pipework. The working platform will include two 'integral' berthing dolphins to resist lateral berthing loads from medium sized ships (large vessels will impact the independent berthing dolphins).

The working platform structure will be made up of the following main elements:

- tubular steel vertical piles (protected against corrosion with high build epoxy paint and/or wrapping system);
- raked tubular steel piles to resist lateral loads (similarly protected against corrosion), including rock anchors to resist uplift loads where necessary;
- precast reinforced concrete caps, beams and slabs;
- in-situ reinforced concrete topping over precast units;
- cone fenders, fence panels and associated chains on berthing face; and
- bollards.

The working platform will support the following:

- MLAs/pipe manifold;
- pipework;
- pedestrian access bridges;
- hose storage;
- personnel hut;
- fire foam water monitors;
- lighting;
- services;
- hose crane/ship access tower (future) and
- spill containment.

3.3.2 Pipelines

The proposed pipelines to be installed as part of the BLB2 project range in sizes depending on the specific pipeline use. Pipelines will range in size, for example, from 80mm (nitrogen lines), 200mm (chemical lines), 250mm (petroleum/bio-diesel lines) and 300mm (LPG lines). Where personnel and vehicles are required to cross pipelines, bridges or culverts will be used.

The pipeline routes, from the wharf to the various users, are shown on **Figures 3-3** & **3-4**. The pipelines will generally be located on the northern side of the BLB2 wharf and access bridge, and along the western side of access road along the shoreline. Pipes will then run parallel to Charlotte Street and into the various user sites in the Port Botany area. All product pipelines will be constructed from welded steel pipe.

3.3.3 Marine Loading Arms & Manifolds

Marine Loading Arms (MLA) are used to transfer the majority flammable and combustible gases and liquids from ships to the transfer pipework and tanks. The arm is a series of pipes connected by sealed swivel joints that permit the end of the arm (i.e. the part that connects to the ship) to move in a three dimensional envelope. The MLAs at the BLB2 will be constructed from 300mm pipework and will be secured to the wharf deck by bolts. The MLA will be fitted with counterweights to facilitate movement of the connection point to the ships manifold, obviating the need for cranes and other handling equipment.

To facilitate liquid transfer, ships will moor adjacent to the MLA such that the operating envelope of the arm connection is within reach of the ship delivery manifold. Once the ship is secured to the wharf, the arm connection will be manoeuvred into place and the connection flange bolted to the ships manifold. New gaskets (spiral wound) will be used for each transfer connection. The MLAs will be installed with a number of safety features as part of the design and operation. These are summarised below.

- Arm is fitted with proximity sensors such that arm movement outside a predefined “envelope” causes alarm, activates an emergency shut down (ESD) and disconnects the arm;
- Connections from MLA to ship are bolted minimising potential for connection failure and release of transfer products;
- Connections are pressure tested to 800kPa (nitrogen) prior to each transfer;
- Transfers are continually monitored for leaks;
- Procedure includes slow pressure and monitoring during start-up;
- An operator is located at the ship’s transfer manifold at all times, the operator is in radio communication with the ship’s control room and wharf operations;
- MLA is monitored and controlled from a central control room (on the shore) with Supervisory Control and Data Acquisition Systems (SCADA);
- An ESD is installed on the wharf (at base of MLA);
- Dry break & weak coupling at MLA connection to the ship; and
- All equipment is classified to AS60079 (Hazardous Area Classification).

When transferring LPG only one MLA will be used, however, for transferring flammable and combustible liquids, up to 4 MLAs may be used simultaneously.

3.3.4 Pedestrian Bridge Over Pipes

Pedestrian access bridges over the pipework will be provided and would include galvanised grill walkway with handrails and a platform over the pipe. The platform would comply with AS1657 (Ref.6).

3.3.5 Spill Containment

Two spill containment areas (bunds) would be located on the deck situated at the:

- Manifold area (an inner bund); and
- The entire working platform (an outer bund).

The manifold area inner bund would include raised kerbing around the product hose manifold area and the MLA/manifold area. This inner bund would contain any accidental minor spills or leaks of petroleum or other chemicals. This bunded area is connected to a collection sump which can then be pumped to a wastewater storage tank. Any liquid (i.e. product or stormwater) that enters this bunded area is deemed to be potentially contaminated and pumped to the storage tank.

The working platform would be provided with a 200mm high continuous vehicle kerbing around the entire deck (this is the outer bund). The access road is to have a trafficable hump, 200mm high, as part of the bund system. As a consequence, all rainwater from the working platform would be collected in a sump which would include a valve outlet to allow drainage to Botany Bay. The valve is normally left open, but closed during ship discharge operations. SPC permission would be required prior to opening the valve after ship discharge operations are completed. If any contamination by product is detected, the stormwater would be diverted to the wastewater storage tank.

Water from the wastewater storage tank would be tested (if required), classified according to the DEC waste management guideline and then disposed of at an appropriate facility.

The closure of the sump discharge valve will be included as part of the pre-transfer checklist.

3.4 Current BLB Users Infrastructure

The current users of BLB1, and who will use the proposed BLB2 and future BLB3, are:

- **Vopak Site A** (chemical terminal) – Vopak A imports a full range of petrochemicals and solvents, lube oils and additives, vegetable oils and tallow. The site currently stores the products in tanks and transfers these from the ship via multiple stainless steel and mild steel product and vapour dock lines running to the BLB1.
- **Vopak Site B** (petroleum terminal) – Vopak B imports gasoline, distillate and jet fuel. The site currently stores the products in tanks and transfers these via 2 x 300mm mild steel dock lines running to the BLB1 and each fitted with a 250mm marine loading arm at the BLB1 wharf.
- **Origin Energy** (LPG terminal) – Origin operates a 6-inch marine loading arm at BLB1.

- **QENOS** (formerly Orica) (propane and butane terminal) **-** Qenos import propane and butane. Facilities exist for the import of ethylene and LPG as well as ethylene exports. Purging facilities are also available. Qenos stores products in tanks and transfers them via pipeline to the BLB1 and a 6 inch marine loading arm at the BLB1 wharf.
- **Elgas Ltd** (LPG facility) – Elgas stores LPG in underground caverns and transfers the product via pipelines to the BLB and a 300mm marine loading arm at BLB1 wharf.
- **Terminals Pty Ltd** (bulk liquid storage) – Terminals provides a bulk liquid storage, handling and repackaging services, and import and export shipping of hazardous and non-hazardous liquid chemicals. In the future Terminals plan to import petroleum products. They currently operate multiple stainless and mild steel dock lines.

The landside terminal and transfer pipeline locations for the above users are shown on **Figure 3-2**.

3.5 Materials Proposed for Transfer at the BLB2 Facility

A range of flammable liquids, liquefied flammable gases and chemicals (including combustibles) are transferred at the BLB. The following range of materials will be transferred:

- Liquefied Petroleum Gas Products – Class 2.1 Flammable Gas;
- Refined Petroleum Products – Class 3 (PG I, II & III) Flammable Liquid;
- BioDiesel – Class C1 (Combustible Liquid);
- Chemical – Class 3 (PGII) Flammable Liquid;
- Chemical – Class 8 (PGII & III) Corrosive Liquids; and
- Chemical – Class 6 (PGII & III) Toxic Liquids.

All products and materials are classified as Dangerous Goods in the Australian Dangerous Goods Code (Ref.4) and the International Maritime Dangerous Goods (IMDG) Code (Ref.5).

3.6 BLB2 Operations

The BLB2 will be constructed with two main liquid transfer mechanisms: marine loading arms and pipelines or pipelines designed for connection of flexible lines. Fuels (flammable liquids and liquefied gases) will be transferred using the marine loading arms whilst chemicals will be transferred using flexible hoses.

3.6.1 Chemical Transfer

Ships will approach the wharf from Botany Bay accompanied by tugs. The ships will be guided into the berth and moored by Ship & BLB crews. Once secured, a detailed and exhaustive procedure is used to establish the transfer operation. The operation is conducted under the requirements of the International Safety Guide for Oil Tankers and Terminals (ISGOTT – Ref.13), which includes a full transfer checklist administered by SPC.

The establishment of the transfer operation includes the connection of the flexible transfer hoses to the ship and wharf. The hoses will be removed from their dedicated storage on the wharf and one end lifted to the ship where it will be bolted to the ship's manifold. The other end of the hose will be bolted to the shore manifold. Up to 8 flexible hoses can be used simultaneously to transfer chemicals ashore. Once connected the hoses will be pressure tested with nitrogen to 800kPa to ensure hose connection integrity (i.e. no leaks).

Once the pre-operations checklist is complete, which includes the configuration of valves in the transfer line to ensure the chemical is transferred to the correct storage, the pumping operation commences. During this operation there are a number of personnel monitoring the transfer including:

- **Ship Operator -** who remains in the ship manifold area during the full transfer operation. The ship operator is in constant radio contact with the ship's operations centre and control room, where pumping operations are controlled.
- **Shore Operator** – who remains in the shore manifold area during the full transfer operation. The shore operator is in constant radio contact with the shore operations centre and control room where tank filling is controlled.
- **Ship Control Room Operator** – who monitors the ships pumping operations (e.g. flow rates, pressures, tank levels, etc.). The ship control room remains staffed at all times during the transfer operation.
- **Shore Control Room Operator** – who monitors the tank filling and pipeline operations (e.g. pipeline pressures, flow rates, tank levels, etc.). The shore control room remains staffed at all times during the transfer operation.

Each Operating company uses intrinsically safe UHF radios that transmit/receive frequencies unique to that Operating Company. One of these portable radios is temporarily given to the Ship Operator so that communications can be maintained effectively between Ship and Shore.

In addition to the operations control and monitoring personnel detailed above, additional operations staff will monitor the pipeline corridor during the transfer operation.

Once the transfer is complete, the hoses will be purged with nitrogen and the pipeline pigged with nitrogen to remove any remaining liquid from the pipes and hoses. All isolation valves will then be closed. The appropriate ISGOTT checks will then be made and the hoses disconnected and stowed in the dedicated wharf area. The process of purging the hoses whilst still connected to the ship manifold ensures that there is no spillage when the hoses are disconnected and lowered to the wharf deck area.

3.6.2 Flammable Liquids & Liquefied Flammable Gas Transfers

The ship mooring operations will be the same as the chemical transfer operations as detailed in **Section 3.6.1**. Once the ship is moored, and the appropriate checklists (ISGOTT, etc.) have been completed, the MLA can be connected to the ship's manifold. Like the flexible hoses previously described, this is also a bolted connection.

Once the MLA is connected, the system is pressure tested to 800kPa for flammable liquids and 900kPa for LPG to ensure connection integrity. Delivery valves are then configured to transfer the LPG to the required storage and the transfer operations commenced. The transfer operations are monitored throughout the full transfer period by a number of personnel. The monitoring operations will be the same as those described in **Section 3.6.1.**

Once the transfer operations are complete, the MLA and associated vapour return lines to the storage will be purged with nitrogen to remove any liquid/vapour/gas from the lines. All isolation valves will then be closed. The applicable ISGOTT checks will then be made and the MLA disconnected. It is noted that the MLA is fitted with a dry-break coupling at the ship's manifold connection. This will eliminate the potential for spills when disconnecting the MLA from the manifold. Once disconnected, the ship can cast-off from the wharf with the assistance of tugs, and sail as required.

3.7 BLB2 Safeguards

It has been identified that a number of hazards could result in equipment failure and liquid release. Hence, to mitigate this BLB2 will be constructed and operated with a number of hardware (equipment) and software (systems) safeguards, these are summarised below.

To prevent the ship from striking the wharf as it berths, the following safeguards will be used:

- The ship is moored using tugs to minimise the potential for loss of movement control;
- An SPC Pilot is used to bring ship alongside eliminating the chance of unfamiliar berthing;
- Fixed fenders used on the wharf to provide cushioning should excessive impact with wharf occur; and
- Ships have a double hull (liquid not in contact with outer hull) eliminating the potential for leak should the hull be breached.

To minimise the potential for passing ship to strike the moored ship at the BLB or minimise the potential for leak should this occur:

- Ships have a double hull (liquid not in contact with outer hull) eliminating the potential for leak should the hull be breached;
- A marine exclusion zone is in force around the BLB (no unauthorised vessels in the area around the BLB);
- Ships sail at low speed past the BLB, hence, low impact potential should control be lost; and
- Ships passing the BLB would be under tug and pilot control.

The flexible hoses used for chemical transfer are potential leak sources, to mitigate the potential for leak, following safeguards are applied:

- Connections are made using bolted flanges only;

- All hoses are pressure tested annually, minimising potential for hose rupture;
- Hoses are pressure tested with nitrogen prior to each use (800kPa), minimising potential for hose leak during operation;
- New gaskets are used for each transfer, minimising potential for gasket failure;
- Operation of hoses <700kPa, minimising potential for leak considering the test is conducted at 800kPa;
- Start-up procedure to monitor pressuring of hoses including leak detection;
- Operators are in attendance during full transfer cycle;
- Operators in full radio communication with the wharf and shore operations;
- Manual shut down valves located at each end of the flexible hose;
- Operator dedicated to monitoring of all equipment during transfer (leak detection);
- Ships deck has a spill catchment to prevent any release overboard in the event of a spill (i.e. ships scuppers are plugged); and
- Wharf is bunded with a 200mm bund wall all round.

Pipelines are a potential leak source and, hence, to mitigate leaks, the following safeguards are applied:

- Fully welded pipeline along transfer route, minimising flanges and potential leak points;
- The wharf is fully bunded with a bund height of 200mm;
- A containment pit is constructed around the pipe isolation valves (onshore);
- Hydrostatic testing of pipes at commissioning and every 2 years (or when maintenance is performed on pipelines);
- Pipes are maintained empty & liquid free between transfers; and
- Operator monitors operations during transfer (leak monitoring of pipelines).

In the event the ship mooring lines are broken, the ship may move away from the wharf, resulting in rupture of MLA or flexible lines. To minimise this risk the following safeguards are applied:

- Transfer ceases at wind speeds >35kph (hoses isolated);
- Operators (marine) continually monitor the mooring security;
- Wind warning system from Bureau of Meteorology are continually monitored;
- Transfers cease when lightning occurs;
- Predominant winds are “on to the wharf” (ship is blown on to and not off the wharf);
- Securing lines are designed to secure against normal passing ships (i.e. waves generated in the bay); and
- Tug is on 24 hour call in adjacent dock area (Brotherson Dock)

The marine loading arm is a jointed structure with potential leak sources at the rotating arm joints. To mitigate the potential for leaks the following safeguards are applied:

- MLA is hard piped (no flexible connections);
- Arm movement outside established operating “envelope” causes alarms, shuts down (ESD) and disconnects;
- The connection of the MLA to the ship is bolted;
- Connections are pressure tested with nitrogen to 800kPa for liquids and 900kPa for LPG prior to use;
- Joints and connections are continually monitored for leaks by the ship and shore crews;
- The MLA start up procedure includes a staged pressurisation and monitoring to detect any leaks;
- An operator is stationed on board the ship to respond to any incidents and initiate isolation of the transfer in the event of an incident;
- MLA is monitored and controlled from a central control room on shore, with Supervisory Control and Data Acquisition systems (SCADA);
- An ESD is installed at the base of the MLA on wharf;
- A dry break & weak coupling (Emergency Release Coupling) is part of the MLA connection to the ship;
- All equipment is classified to AS60079 to eliminate ignition sources in the wharf area (i.e. Hazardous Area Classification);
- Three fire monitors located on the wharf and can be operated by remote control; and
- A fire water pump fire water pump station is located on the shore (diesel duty/stand-by).

4. HAZARD ANALYSIS

4.1 General Hazard Identification

A hazard identification table has been developed and is presented in **Appendix A**. Those hazards identified to have a potential impact offsite are assessed in detail in the following section of this document.

Section 3.5 lists the type of Dangerous Goods (DGs) proposed for transfer and handling at the BLB2 facility. It is noted that all goods listed in this section will be transferred and handled in accordance with ISGOTT and the requirements of the applicable Australian Standard specific to the particular DG listed. **Table 4-1** lists the characteristics of the DGs proposed for transfer and handling at the BLB2 facility.

Table 4-1 Properties of the Dangerous Goods proposed for transfer and handling at the BLB2 facility

Material Name	Class	Hazardous Properties
Liquefied Petroleum Gas – LPG	2.1	Gas is flammable and if released could ignite. Ignited leak at the release source would result in a jet fire. Un-ignited releases could vaporise and causes a gas cloud, which may ignite after a delay and explode. Minimal environmental damage as gas evaporates rapidly with little or no impact to surroundings.
Bio-Diesel (Liquid)	C1	Liquid is combustible and will burn if ignited, resulting in pool fire in the area under the release point. Potential impact to the bio-physical environment depending on spill quantity and containment.
Refined Petroleum Products (Liquids)	3	Liquid is flammable or combustible (C1 & C2) and will burn if ignited, resulting in pool fire in the area under the release point. Potential impact to the bio-physical environment depending on spill quantity and containment.
Corrosive Substance (Liquids)	8	Liquid is corrosive and may damage materials which it contacts causing weakening of structures and equipment. Impact to people could result in chemical burns. Inhalation of vapours could impact mucous membranes. The severity depends upon concentration and duration of impact. Potential impact to the bio-physical environment depending on spill quantity and containment. Note: Chemicals may also have a sub-risk of Class 3 (flammable liquid)
Toxic Substances (Liquids)	6	Liquids are toxic and may impact the bio-physical environment depending on the spill quantity and containment. Impact to people could result in acute or chronic illness and/or dermatological impacts. Vapours may affect mucous membranes and cause breathing impairment. The severity depends upon concentration and duration of impact. Note: Chemicals may also have a sub-risk of Class 3 (flammable liquid)

4.2 Detailed Hazard Identification

4.2.1 Hazard Analysis Workshop

A hazard analysis workshop was conducted to determine the potential hazards, their impact and proposed safeguards at the BLB2 facility. The study was conducted on 26 June 2007 over a three hour period. The following participants attended the study:

Name	Company	Position
Neil Trillo	Vopak Terminals	Safety Manager
Jim Pullin	Sydney Ports Corporation	Manager BLB
Roy Garth	Sydney Ports Corporation	Safety Engineer
Steve Sylvester	Sinclair Knight Merz	Facilitator/Risk Engineer

The hazard identification workshop resulted in the development of a hazard identification table, which is included in the document at **Appendix A**. The study identified a number of potential incidents that could lead to impact to people, plant and the environment. A summary list of hazards is presented below:

- Ship strikes the wharf at excessive speed;
- Moored ship is struck by passing ship;
- Chemical hose failure leading release of chemicals (including flammables/combustibles);
- Chemical pipeline failure leading to release of chemicals;
- Marine loading arm failure leading to flammable gas release;
- Liquefied Flammable Gas (LPG) pipeline failure leading to flammable gas release;
- Marine loading arm failure leading to flammable liquid release;
- Flammable liquid pipeline failure leading to flammable liquid release; and
- Mooring systems failure leading to ship moving away from the wharf and breaking transfer connections.

Each identified hazardous incident has been assessed in detail below.

4.2.2 Ship Strikes the Wharf When Mooring

It was identified that when ships are moored at the BLB, there is a potential for the ship to strike the wharf resulting in hull breach and possible loss of cargo (fuel/gas/chemical) directly to the bay. A review of the mooring procedures identified that ships are brought alongside the BLB under the direction of a SPC Pilot and with the aid of tugs. The ships do not moor at the BLB under their own power or control from the ships Captain. The control of the mooring operation by SPC Personnel and Pilots reduces the potential for errors of unfamiliarity with the mooring operation at the BLB.

By using experienced SPC Pilots and tugs, the ship's speed is minimised and the speed of approach to the wharf carefully controlled. Further, the wharf is fitted with permanent fenders that provide cushioning as the ship touches the wharf. Hence, the potential for impact at speed is negligible.

A review of the designs of ships visiting the BLB indicates that all ships are constructed with double-bottoms, meaning that the tanks storing liquids/gases in the ships do not contact the ships hull (i.e. tank exterior is not in contact with the water). The double-bottom design ensures that there is a space between the storage tank shell and the ship's hull, preventing release of liquid in the event a hull breach occurs.

Based on the procedures for bringing ships alongside at the BLB and the ship design (double bottom), it is concluded that the risk of release as a result of errors in bringing the ship alongside is considered to be negligible, and the risks are assessed to be in the as low as reasonably practicable (ALARP) range. Hence, this incident has not been carried forward for further analysis.

4.2.3 Moored Ship is Struck by Passing Ship

It was identified that ships passing the BLB could move off course, by error, and strikes the moored ship at the BLB. This could result in a hull breach and release of gas/liquid/ chemical. A review of the BLB layout indicates that an exclusion zone has been developed around the BLB whereby vessels are not permitted within the zone. The exclusion zone area is clearly marked on charts and maps of Botany Bay and, hence, any ship approaching the BLB will identify the exclusion zone and remain clear. Large ships moving to and from the Brotherson Dock area (see **Figure 3-1**) will operate under the control of an SPC Pilot, who is well aware of the exclusion zone requirements.

It could be argued that some ships may not be operating using SPC Pilots, charts or maps. This would be valid for smaller vessels that by error could enter the zone and in the worst case strike the moored vessel. However, smaller ships, operating without Pilots, charts or maps, would not be of sufficient size to impact a large tanker (ship) causing hull breach. Further, as noted in **Section 4.2.2**, the ships that unload at the BLB are all constructed with double-bottoms, eliminating the potential for gas/liquid/chemical release in the event of a hull breach.

It is therefore concluded that the risk of a ship striking a moored vessel at the BLB is low and the current safeguards are considered adequate to maintain the risks in the ALARP range.

4.2.4 Chemical Transfer Hose Failure

Chemical Transfers

Once chemical ships are moored, and the appropriate pre-transfer checks are complete, the chemical transfer hose will be connected to the wharf manifold and ship's manifold. Connection will be bolted and a new gasket will be used for each transfer. Once connected, the transfer hose will be tested with nitrogen to 800kPa and the joints and hose examined for leaks. Once the hose integrity is proven, transfer will commence, under monitoring from wharf and ship operators, at low pressure, gradually rising to a maximum transfer pressure of 700kPa.

Although the operating pressure is below the test pressure, there is a potential for hose rupture or leak during the transfer, releasing hose contents to the environment. In the event a hose rupture occurs in the ship's deck area, spills will be retained on the deck of the ship, preventing release to the bay, as the ship's scuppers will be plugged during the transfer. In the event the rupture leak occurs in the wharf area, the wharf bund will contain leaks and prevent release to the bay. However, if the rupture or leak occurs in the section between the ship and wharf, then the chemical could be released directly to the bay, resulting in potential environmental impact to the area where the chemical spill occurs. Due to the height of the ships side, a rupture could result in the hose "whipping" and spraying chemicals beyond the ships deck or wharf deck bund, however, the flexible hoses are constructed with an internal steel spiral and are bound externally with rope. Hence, hose rupture may result in a split, but a complete severing of the hose in not considered feasible due to the hose design.

It is noted that some chemicals transferred by flexible hose are toxic. However, a review of the toxic materials transferred via hose (during the PHA) identified that all materials transferred, containing a toxic content, are liquids only and transferred at ambient temperature. The liquids do not vaporise readily as they are transferred at temperatures well below flash point. There are no toxic liquefied gases transferred by hose. Any minor vaporisation around the surface of the spill would not generate a toxic vapour cloud as the materials are all transferred well below flash point temperatures. The release rates from pools of toxic materials spill would be too low to enter into models (i.e. there would be no impact downwind from such releases).

As there is a potential for failure of the flexible transfer hose (i.e. rupture or leak) resulting in chemical release directly to the bay, this incident has been carried forward for frequency analysis, noting that there is an immediate consequence as a result of the release (e.g. environmental damage from chemical impact to Botany Bay).

Flammable-Combustible Liquid Transfer

The liquid transfer by flexible hose will also include transfer of flammable and combustible (C1/C2) liquids. Release incidents could occur in a similar manner to those described above for chemicals. However, unlike chemicals, a spill could be ignited resulting in a fire.

Flammable & combustible liquids will be transferred using a 150mm flexible hose with a maximum transfer rate of 200m3/hour or 50 Litres/second (L/s). Hence, in the event of a catastrophic hose failure, the maximum flow rate from the hose is 50L/s.

In the event a release of flammable/combustible liquid occurs, the release will pool on the wharf deck. Ignition of the pool would result in a pool fire that could radiate heat beyond the wharf area, impacting the risk at the existing contour. This incident has therefore been carried forward for consequence analysis.

4.2.5 Chemical Pipeline Failure

The chemicals will be transferred from the ship to the selected shore tank via pipelines. Pipelines will be fully welded along their length, eliminating the potential for release at joints, flanges, etc. Flanges and valves at the wharf manifold are contained within the manifold bund and wharf deck bunded areas. Hence, in the unlikely event of a release in this area, the spill will be contained within the bunds and there will be no spill to the environment.

A pipe line isolation valve station will be located at the shoreline and will be constructed with a containment pit to prevent release to the environment in the unlikely event of leaks from flanges and valves. It is understood that the valve containment pit will be fitted with a drain valve that will normally be open, permitting rainwater to be released during non-transfer operations. During this period, there will be no potential for release of chemicals from the pipeline as all pipelines will be purged after transfer ensuring pipelines rest empty between transfers. Prior to transfers commencing, the isolation valve pit drain valve will be closed to ensure any spill are contained. However, should a larger spill occur between manual inspection periods, there is a potential for the pit to fill and release chemicals to the environment. Hence, **it is recommended that consideration be give to installing a level alarm switch at the isolation valve pit to detect any leaks and alarm at the transfer control room.**

Based on the above analysis and the assumption that a level switch will be installed on the isolation valve pit, it is considered that the risk of chemical release to the environment from pipelines and vales is low and within the ALARP range. Hence, this incident has not been carried forward based on the assumption that the recommendation is implemented.

4.2.6 Marine Loading Arm Failure (Flammable Gas)

Un-odorised liquefied flammable gases will be transferred from the ship to the Elgas, Qenos and Origin Energy storage facilities using a marine loading arm (MLA). Once the pre-transfer checks have been completed, the MLA will be connected to the ship’s manifold via a bolted connection, using a new spiral wound gasket for each transfer connection. Once connected to the ship, the MLA system is pressure tested to 900kPa and the connection, MLA swivel joints, valves, etc., examined for leaks. A Vapour Return hose is connected to the Ship’s Vapour Return line and to the wharf pipeline Vapour Return. Once the MLA integrity is proven, transfer will commence, under monitoring from wharf and ship operators. The operation will commence at low pressure, gradually rising to a maximum transfer pressure of 850kPa.

Although the operating pressure of the system (850kPa) is below the transfer test pressure (900kPa), there is a potential for minor leaks to develop at gaskets, MLA swivel joints and valves. A release of gas would be detected by operators who continually monitor the transfer operation (both ship and wharf sides). Once detected, the transfer would be isolated at the ship by stopping the ship’s discharge pump and at the wharf by an isolation valve at the base of the MLA.

In addition to the manual leak detection, provided by continual operator monitoring, a gas detection system will be installed at the wharf. This system will be linked to the Elgas control room, which is staffed 24 hours per day, 7 days per week. For BLB2 the gas detectors will be established to initiate an alarm at 20% LEL. Operators will immediately shut down transfer operations in this event and conduct the appropriate investigation.

However, if not detected minor leaks may grow into larger leaks, which could lead to the release of larger quantities of gas forming a gas cloud that could ignite resulting in a flash fire or gas cloud explosion. This could have consequence impacts beyond the confines of the BLB area and could result in the increase of the existing Port Botany Land Use Safety Study risk contours. Hence, this incident has been carried forward for further analysis (Consequence, frequency and risk).

4.2.7 LPG Pipeline Failure

The LPG will be transferred from the ship to the selected storage vessels via pipelines. Pipelines will be fully welded along their length, eliminating the potential for release at joints, flanges, etc. Flanges and valves at the wharf manifold have been minimised to maintain a low potential release profile and joints will be made using spiral wound gaskets, eliminating the potential for gasket blowout. Hence, major releases from flanges are eliminated.

A pipe line isolation valve station will be located at the shoreline and liquid isolation valves will be will be constructed with a containment pit to prevent release to the environment in the unlikely event of leaks from flanges and valves. However, gas systems should not be located near to or over pits, as releases could fill the pit with gas and, if ignited, result in explosion. Hence, **it is recommended that the gas isolation valves at the shoreline be separated from the other isolation valves (i.e. flammable liquids and chemicals) to eliminate the potential for any leaks to accumulate in the pit.**

Notwithstanding the above discussion, failure to detect minor leaks at valves and flanges could result in the leaks growing, leading to larger gas releases. This could lead to the potential for the formation of a gas cloud that if ignited, could cause a flash fire or gas cloud explosion. This could have consequence impacts beyond the confines of the BLB area and could result in the increase of the existing Port Botany Land Use Safety Study risk contours (Ref.1). Hence, this incident has been carried forward for further analysis (Consequence, frequency and risk).

4.2.8 Marine Loading Arm Failure (Flammable/Combustible Liquid)

Once the flammable/combustible liquid ships are moored, and the appropriate pre-transfer checks are complete the flammable/combustible liquid MLA will be connected to the ship's manifold via a bolted connection, using a new gasket for each transfer connection. Once connected to the ship, the MLA system is pressure tested to 800kPa and the connection, MLA swivel joints, valves, etc., examined for leaks. Once the MLA integrity is proven, transfer will commence, under monitoring from wharf and ship operators. The operation will commence at low pressure, gradually rising to a maximum transfer pressure of 700kPa.

Although the operating pressure of the system (700kPa) is below the transfer test pressure (800kPa), there is a potential for minor leaks to develop at gaskets, MLA swivel joints and valves. A release of flammable/combustible liquid would be detected by operators who continually monitor the transfer operation (both ship and wharf sides). Once detected, the transfer would be isolated at the ship, by a manifold isolation valve, and at the wharf by an isolation valve at the base of the MLA. Leaks and spills from the equipment could reach the environment, however, spills will be retained on the deck of the ship, preventing release to the bay, as the ship's scuppers will be plugged during the transfer. In the event the rupture leak occurs in the wharf area, the wharf bund will contain leaks and prevent release to the bay. It is noted that the section of MLA that stretched over the water (i.e. the space between the ship and wharf, is a solid pipeline and failures in this section are considered to be negligible. Hence, based on the proposed protection systems, the risk of flammable/combustible liquid release to the environment is low and within the ALARP range.

Notwithstanding the low assessed risk of impact to the environment, in the event a release occurs, a pool of flammable liquid will form under the spill area. In the unlikely event of spill ignition, a pool fire would occur, radiating heat to the surrounding areas. In this unlikely event, the impacts may occur beyond the BLB2 area resulting in a potential increase of the existing Port Botany Land Use Safety Study risk contours. Hence, this incident has been carried forward for further analysis (Consequence, frequency and risk).

4.2.9 Flammable/Combustible Liquid Pipeline Failure

The flammable/combustible liquids will be transferred from the ship to the selected shore tank via pipelines. Pipelines will be fully welded along their length, eliminating the potential for release at joints, flanges, etc. Flanges and valves at the wharf manifold are contained within the manifold bund and wharf deck bunded areas. Hence, in the unlikely event of a release in this area, the spill will be contained within the bunds and there will be no spill to the environment.

A pipe line isolation valve station will be located at the shoreline and will be constructed with a containment pit to prevent release to the environment in the unlikely event of leaks from flanges and valves. It is understood that the valve containment pit will be fitted with a drain valve that will normally be open, permitting rainwater to be released during non-transfer operations. During this period, there will be no potential for release of flammable/combustible liquids from the pipeline as all pipelines will be purged after transfer ensuring pipelines rest empty between transfers. Prior to transfers commencing, the isolation valve pit drain valve will be closed to ensure any spill are contained. However, should a larger spill occur between manual inspection periods, there is a potential for the pit to fill and release flammable/combustible liquids to the environment. Hence, **it is recommended that consideration be give to installing a level alarm switch at the isolation valve pit to detect any leaks and alarm at the transfer control room.**

Notwithstanding the environmental protection systems discussed above, in the event a release occurs, a pool of flammable liquid will form under the spill area (pit). In the unlikely event of spill ignition, a pool fire would occur, radiating heat to the surrounding areas. In this unlikely event, the impacts may occur beyond the BLB2 area resulting in a potential increase of the existing Port Botany Land Use Safety Study risk contours (Ref.1). Hence, this incident has been carried forward for further analysis (Consequence, frequency and risk).

4.2.10 Mooring Systems Fail

It was identified that in the event the mooring lines failed, there is a potential for the ship to move away from the wharf. If a flexible hose or MLA was connected, the transfer system could be broken, resulting in a line rupture and gas/flammable-combustible liquid/chemical release.

A review of the MLA design identified that this system is fitted with an Emergency Release Coupling (ERC) that is a Weak-Link at the ship to arm connection point. This ERC link is fitted with a dry break coupling that will automatically isolate in the event the link is broken. Hence, should the ship move away from the wharf, and the MLA be breached, the dry break coupling will activate and prevent release of material to the environment. In addition, the MLA is fitted with proximity sensors at the swivel joints. These sensors monitor the MLA position and in the event arm moves outside a predetermined operating envelope (i.e. the ship moves too far forward/aft or away from the wharf), the emergency shut down valves at the wharf and ship will be isolated. In addition to the automatic protection systems, ship and shore operators will be present during the full transfer operation. Hence, at the first sign of potential mooring security integrity failure, all transfers will be isolated, eliminating the potential for release of material to the environment. Hence, for the MLA transfer, movement of the ship and potential extension of the MLA will not result in a release to the environment. This incident has, therefore, not been carried forward for further analysis.

A review of the flexible transfer hose operations, for chemical transfers, identified that the chemical hoses are connected to the ship via bolted connections. In the event the ship's moorings fail, and the ship moves forward/aft or away from the wharf, there is a potential that the hoses could be stretched eventually rupturing. A review of the hose design identified that there was no weak link coupling planned for this installation. However, a number of operational safety features are planned for the BLB2 operation, these include:

- Review of operations at wind speeds >35knots. Wind warning systems have been established with the Bureau of Meteorology for BLB1 and will be incorporated into the BLB2 operations. BLB Management will review wind/weather conditions to determine whether operations should cease, based on the wind direction and potential for mooring failure. In these cases, additional mooring lines can be deployed, hoses isolated to prevent any release should the moorings fail under high wind loads or hoses purged of product and disconnected;
- Operators (marine) continually monitor the mooring security. In the event mooring security integrity becomes compromised, transfer operations will cease until the mooring security has been re-instated. This will prevent any potential release to the environment;
- In the event of lightning, there is a potential for a lighting strike that could impact the moorings or transfer equipment resulting in chemical release. However, where lighting is imminent, all transfer operations will cease until the electrical storm has passed;

- Securing lines have been designed to withstand normal loadings for waves generated by passing ships and refracted waves entering Botany Bay from the Pacific Ocean. Hence, potential for un-warned failure of these lines is low; and
- Tug is on 24 hour call in adjacent dock area (Brotherson Dock).

A review of the wind rose for the Botany Bay area identified that the predominant wind is from the south east, blowing onto the wharf and minimising the risk of the ships moorings being under wind load from the ship being blown off the wharf. In addition to all of the above safeguards (hardware, software and inherent), a tug, located in the adjacent Brotherson Dock, is on call 24 hours per day. Hence, in the event of an imminent failure of the moorings, a tug could be called to stabilise the ship and prevent it from moving away from the wharf.

Based on the above safeguards, the risk of failure of the moorings and subsequent chemical transfer line failure is considered to be low and within the ALARP range. Hence, this incident has not been carried forward for further analysis.

4.2.11 Application of Fire Water – Containment of Contaminated Fire Water

In the event of an incident at the BLB2 facility, it will be necessary to initiate a response. A spill of chemicals may occur as a result of chemical hose or transfer system incidents. However, these would be retained by the proposed containment systems at the BLB2 (e.g. wharf bunding). However, in the event of a gas release or flammable/combustible liquid release, it will be necessary to apply fire water to mitigate the incident.

In the event of an ignited gas leak, a gas jet fire would occur. This could radiate heat to the surrounding areas and there will be a need to cool these areas with fire water. Fire water monitors have been installed on the wharf and these will be used to cool the jet fire impacted areas. As the fire burns flammable gas, the fuel source is fully consumed in the fire and the cooling fire water does not absorb any contaminants. Hence, a release of fire water from a gas jet fire will not result in contamination of the fire water or the environment.

However, in the event of a flammable/combustible liquid fire, there is a potential for the contaminants to pool. Applied fire water could become contaminated with these products and, if the fire water escapes from the bunded wharf deck, these contaminants could be carried to the bay. In this event, the contaminants (flammable/combustible liquids) generally have a lower specific gravity than water and, hence, they would float on top of the bay. SPC has emergency procedures for the deployment of marine booms, which can be quickly deployed to contain marine pollutants. The booms will contain any flammable/combustible liquid contaminants that are carried into the bay by fire water. Contained liquids will then be “swept” to a collection point and transferred to tankers for disposal at a registered waste disposal facility.

The deployment of booms is contained within a marine spill response emergency plan and procedure. This plan and procedure is regularly tested by desk top and actual drills/exercises conducted with SPC and combat agency personnel.

Based on the above safeguards, the risk of impact to the bay and surrounds is considered low and within the ALARP range. Hence, this incident has not been carried forward for further analysis.

5. CONSEQUENCE ANALYSIS

5.1 Consequence Impact Criteria

To determine whether the proposed BLB2 will impact the existing Port Botany Land Use Study risk criteria (Ref.1), it will be necessary to determine the consequence impacts, from the postulated incidents at the BLB2 facility, at the risk contour distances detailed in the Port Botany Study (Ref.1).

A review of the Port Botany Land Use Study risk criteria indicates that there are two contours plotted for risk; 1x10-6 chances per year (or 1 chance per million per year (pmpy)) and 50pmpy. The former risk applies to residential areas, the latter to industrial sites. Hence, as the fatality risk has been used in the development of contours, incidents at the BLB2 must result in fatality for these to impact the existing risk contours. Where an incident does not result in fatality, at the impact distance from the incident to the contour, then there is no risk of the incident impacting the contour, and no further analysis is required.

The following consequence criteria will be used in the assessment:

- **Heat Radiation Impact** – levels below 4.7kW/m^2 not considered to result in fatality (Ref.9);
- **Explosion Overpressure** – levels below 7kPa not considered to result in fatality (Ref.9);
- **Flash Fire** – fatality occurs to people inside the flash fire, no fatalities where people are beyond the LEL;

Each incident assessed in this section has been reviewed against these criteria.

5.2 Distances from the BLB2 Facility to the Port Botany Study Criteria

A review of the Port Botany Land Use Safety Study was conducted to determine the impact distance from the BLB2 for each of the fatality risk criteria. The existing BLB wharf was used as a basis for the scaling to determine the contour impact distances. The distance from the wharf to the 50 pmpy contour is 50m (circular). The distance from the wharf to the 1pmpy contour is 80m (west).

5.3 Incidents Carried Forward for Consequence Analysis

The following incidents were identified in the hazard analysis (**Section 4**) to have a potential to increase the existing risk profile for the Port Botany area, as detailed in the Port Botany Land Use Safety Study (Ref.1):

- LPG Transfer MLA Failure – leak/release, ignition and explosion/fire;
- Flammable/Combustible Liquid transfer hose failure –leak/release, ignition and fire;
- LPG Pipeline Failure – leak/release, ignition and explosion/fire;
- Flammable/Combustible Liquid MLA Failure – leak/release, ignition and fire; and
- Flammable/Combustible Liquid Pipeline Failure - leak/release, ignition and fire.

A detailed consequence analysis has been conducted in **Appendix B**. Incident consequence summaries are presented in the following sections.

5.4 LPG Transfer - MLA Failure

Incidents at the MLA transfer point can occur as a result of a number of scenarios. The scenarios selected for this study were the following:

- Leak of LPG at the ships manifold connection due to a failed flange connection;
- Leak of LPG due to a catastrophic failure of the MLA at a swivel joint;
- Leak of LPG at a pipeline flange; and
- Leak of LPG at a valve stem.

The consequences of each incident are summarised in the sections below. The detailed analysis of the ship's manifold incidents is developed in **Section B3** of **Appendix B**.

5.4.1 LPG Incident at the Ships Manifold and MLA

In the event of a gasket failure at the ship's manifold (i.e. where the MLA connects to the ship) or at the MLA (i.e. flanges in the MLA system) a gas release could be immediately ignited or ignited after a delay. In the event of an immediate ignition, a jet fire would result. If a delayed ignition occurred a flash fire or gas cloud explosion could occur.

The analysis in **Appendix B** identified the impact distances for each of these incidents. The results are summarised below.

Jet Fire - Heat Radiation Impact

As a results of a flange leak and immediate ignition, the distances to the selected heat radiation impacts from a ship's manifold or MLA flange jet fire are:

- 4.7kW/m^2 = 10m.
- 12.5kW/m2 = 6m
- 23kW/m^2 = 4m

Based on the above values, there is no potential for fatality beyond 10m. This is within the existing 50pmpy contour, hence, this incident will not impact the existing risk contours. This incident has not been assessed further in the study.

Flash Fire

As a result of a flange leak, gas cloud formation, ignition and flash fire, the maximum distance of an LPG gas cloud from the ships manifold flange or MLA flange release is 20m, based on F1.5 wind weather conditions (worst case incident dispersion). This is within the existing 50pmpy contour, hence, this incident will not impact the existing risk contours. This incident has **not** been assessed further in the study.

Explosion

As a result of a flange leak, gas cloud formation, ignition and explosion, the distance from the ship's manifold or MLA flange to an explosion overpressure of 7kPa is 62m. This exceeds the 50pmpy contour distance of 50m (scaled from the Botany Land Use Safety Study, Ref.1) and therefore this incident has been carried forward for frequency and risk assessment.

5.4.2 Catastrophic LPG Incident at the MLA

In the event of a catastrophic failure of the LPG MLA (i.e. rupture of a swivel joint), then the following impacts would occur.

Jet Fire - Heat Radiation Impact

As a result of a catastrophic failure of the LPG MLA, immediate ignition and jet fire, the distances to selected heat radiation impacts from a fire are:

- $4.7kW/m^2$ = 160m.
- 12.5kW/m2 = 120m
- $23kW/m^2$ = 80m

Based on the above values, there is a potential for fatality up to 160m from the MLA. This exceeds the distance to the existing 50pmpy contour, hence, this incident has been carried forward for further assessment in the study.

Flash Fire

As a result of a catastrophic failure of the LGP MLA, gas cloud development, ignition and flash fire, the maximum distance of an LPG gas cloud from the LPG MLA is 195m, based on a continued release for 60 seconds (i.e. before the emergency valves close) and an E2 wind weather conditions (worst case dispersion incident). Hence, the flash fire will impact up to 195m. This exceeds the distance to the existing 50pmpy contour of 50m; hence, this incident has been carried forward for further assessment in the study.

Explosion

As a result of a catastrophic failure of the LPG MLA, gas cloud development, ignition and explosion, the distance from the MLA to an explosion overpressure of 7kPa is 160m. This exceeds the 50pmpy contour distance of 50m and, therefore, this incident has been carried forward for further assessment in the study.

5.4.3 LPG Incident at the Transfer Pipework

Incidents at the LPG transfer pipework include flange and valve leaks. These may occur at the isolating valve station only, as the remaining pipework is fully welded. In the event of a leak from a flange or valve, the following consequences would result.

Jet Fire - Heat Radiation Impact from Flange Leak

As a result of a leak at a valve flange in the pipeline isolating valve station (i.e. any gas flange in the valve station), immediate ignition and jet fire, the distances to selected heat radiation impacts are:

- 4.7kW/m^2 = 10m.
- 12.5kW/m2 = 6m
- 23kW/m^2 = 4m

The pipework isolation valve station is located outside the existing 50pmpy contour, and is within 20m of the adjacent property. Whilst there will be no impact at the adjacent property as a result of this postulated incident (i.e. fatalities may occur only up to 10m from the valve station), there is a potential that the 50pmpy contour could be extended onto the shore line as a result of this incident. Hence, this incident has been carried forward for frequency and risk assessment.

Jet Fire - Heat Radiation Impact from Valve Leak

As a result of a valve stem leak at the pipeline isolating valve station (i.e. any LPG valve in the valve station), immediate ignition and jet fire, the distances to the selected heat radiation impacts from a jet fire are:

- 4.7kW/m^2 = 18m.
- 12.5kW/m2 = 10m
- 23kW/m^2 = 7m

The pipework isolation valve station is located outside the existing 50pmpy contour, and is within 20m of the adjacent property. Whilst there will be no impact at the adjacent property as a result of this postulated incident (i.e. fatalities may occur only up to 10m from the valve station), there is a potential that the 50pmpy contour could be extended onto the shore line as a result of this incident. Hence, this incident has been carried forward for frequency and risk assessment.

Flash Fire

As a result of a valve/flange leak at the pipeline isolating valve station (i.e. any flange/valve in the valve station), delayed ignition and flash fire, the maximum distance of an LPG gas cloud to LEL from the pipeline valve/flange leak incident is 44m, based on F1.5 wind weather conditions. There is a potential that a fatality could occur at the adjacent property to the east (Elgas gas storage facility) and that the 50pmpy contour could be extended, onto the shore line (i.e. location of the pipeline isolation valve station). Hence, this incident has been carried forward for frequency and risk assessment.

Explosion

As a result of a valve/flange leak at the pipeline isolating valve station (i.e. any flange/valve in the valve station), delayed ignition and explosion, the distance from the pipeline isolating valve station to an explosion overpressure of 7kPa is 62m, based on a valve/flange leak incident. There is a potential that a fatality could occur at the adjacent property to the east (Elgas gas storage facility) and that the 50pmpy contour could be extended, slightly, onto the shore line. Hence, this incident has been carried forward for frequency and risk assessment.

SKM

5.5 Flammable/Combustible Liquids – Ship Connection Failure

Pool Fire - Heat Radiation Impact from Ship's Connection Flange Leak

As a result of a flammable/combustible liquid leak at the ships connection flange, immediate ignition and pool fire, the distances to the selected heat radiation impacts are:

- 4.7kW/m^2 = 40m
- 12.5kW/m2 = 29m
- 23kW/m^2 = 22m

Based on the above values, there is no potential for fatality beyond 40m. This is within the existing 50pmpy contour, hence, this incident will **not** impact the existing risk contours. This incident has **not** been assessed further in the study.

5.6 Flammable/Combustible Liquids – Flexible Hose Failure

As a result of a flammable/combustible liquids transfer hose failure (rupture), immediate ignition and pool fire, the distances to the selected heat radiation impacts are:

- 4.7kW/m^2 = 70m.
- 12.5kW/m^2 = 50m
- 23kW/m^2 = 33m

Based on the above values, there is a potential for fatality up to 65m from the fire. This is beyond the existing 50pmpy contour, which is only 50m from the fire (heat radiation = 10kW/m2 at this contour), hence, this incident may impact the existing risk contours and, therefore, has been carried forward for further analysis in the study.

5.7 Flammable/Combustible Liquids – MLA Failure

Pool Fire - Heat Radiation Impact from MLA Catastrophic Failure

As a result of an MLA catastrophic failure, flammable liquid release, immediate ignition and pool fire on the wharf, the distances to selected heat radiation impacts are:

- 4.7kW/m^2 = 68m.
- 12.5kW/m^2 = 39m
- 23kW/m^2 = 24m

Based on the above values, there is a potential for fatality up to 68m from the MLA. As the distance from the BLB2 wharf to the existing 50pmpy contour is 50m, there is a potential for fatality to occur at the contour location, hence, this incident has been carried forward for further assessment in the study.

5.8 Flammable/Combustible Liquids – Pipeline Failure

As discussed in the hazard analysis section, the pipelines will be fully welded along their lengths, with flanges and valves being located at the point where the pipelines meet the wharf. At this location, a valve station will be installed to provide isolation of the pipelines from the wharf. The analysis conducted in **Appendix B** identified that leaks from valves and/or flanges would be retained in the bunded valve pit. Hence, the magnitude of fires in this area is governed by the size of the valve pit and not by the magnitude of releases from the valves/flanges. The heat radiation analysis below, for the flange/valve releases, results in the same magnitude of impact.

5.8.1 Pipeline Flange Leak – Pipeline Isolation Valve Station

As a result of a valve station flange leak, immediate ignition and pool fire, the distances to selected heat radiation impacts are:

- 4.7kW/m^2 = 33m.
- 12.5kW/m^2 = 24m
- 23kW/m^2 = 18m

The pipework isolation valve station is located on the shore line and outside the existing 50pmpy contour, hence, as fatalities may occur up to 33m from the valve station (valve leak), there is a potential that the 50pmpy contour could be extended, onto the shore line itself. Further, there is also a potential that the fatality risk impacts could exceed the published risk criteria (Ref.9) at the closest adjacent facility to the east (Elgas gas storage facility). Hence, this incident has been carried forward for frequency and risk assessment.

5.8.2 Pipeline Valve Leak – Pipeline Isolation Valve Station

As a result of a valve leak (at the valve pipeline station) immediate ignition and pool fire, the distances to selected heat radiation impacts are:

- 4.7kW/m^2 = 33m.
- 12.5kW/m^2 = 24m
- 23kW/m^2 = 18m

The pipework isolation valve station is located outside the existing 50pmpy contour, hence, as fatalities may occur up to 33m from the valve station (valve leak), there is a potential that the 50pmpy contour could be extended onto the shore line. In addition, there is also a potential that the fatality risk impacts could exceed the published risk criteria (Ref.9) at the closest adjacent facility to the east (Elgas gas storage facility). Hence, this incident has been carried forward for frequency and risk assessment.

5.9 Summary of Incidents Carried Forward for Further Analysis

From the analysis conducted above, for each of the postulated hazardous incidents, the following list of incidents has been carried forward for further analysis:

- Flange Leak at the Ship’s manifold connection (LPG) resulting in explosion;
- MLA catastrophic failure (LPG) resulting in jet fire;
- MLA catastrophic failure (LPG) resulting in flash fire;

- MLA catastrophic failure (LPG) resulting in explosion;
- Flexible hose rupture (flammable/combustible liquids) resulting in fire;
- Flange leak at the isolating valve station (LPG) resulting in jet fire;
- Valve leak at the isolating valve station (LPG) resulting in jet fire;
- Flange/Valve at the isolating valve station (LPG) resulting in flash fire;
- Flange/valve leak isolating valve station (LPG) resulting in explosion;
- MLA catastrophic failure (Flam/Comb Liquid) resulting in pool fire on the wharf; and
- Flange/ valve leak isolation Valve station (Flam/Comb Liquid) resulting in pool fire.

Based on the initial criteria against which these incidents were selected (**Section 5.1**), the flash fire incidents are all assumed to result in fatality. Hence, the probability of fatality as a result of these incidents is 1. However, explosion overpressure and heat radiation impacts may not necessarily result in fatality. The probability of fatality from these incident impacts is a function of the heat radiation intensity and exposure time, and for explosion overpressure the magnitude of the pressure wave. Therefore, it is necessary to assess the probability of fatality to determine whether the incident has the propensity to impact the existing risk contours of adjacent sites.

5.10 Fatality Probability

In order to determine whether there is a fatality probability at the distance to the selected heat radiation contours from each of the incidents, a probit analysis has been conducted. Probit analysis is a relationship between an incident consequence and the probability of fatality based on incident exposure time and impact severity.

The probit equation takes the form:

$$Y = k_1 + k_2 \ln (C^n t) \qquad \text{- (Ref.10)}$$

Where: k_1 = constant;
k_2 = constant;
n = constant
C = exposure concentration; and
t = exposure time (s)

The constants k1, k2 and n are values related to the specific event, the exposure concentration, C, may be toxic gas, heat radiation or explosion overpressure exposure. The time (t), may be based on a number of factors such as time to evacuate, time for the emergency response personnel to fight the fire, time for operators to isolate systems within the impact zone, etc.

Once the probit value has been estimated, it is compared to the probit curve (shown at **Figure 5-1**). The probability of fatality may then be read from the curve.

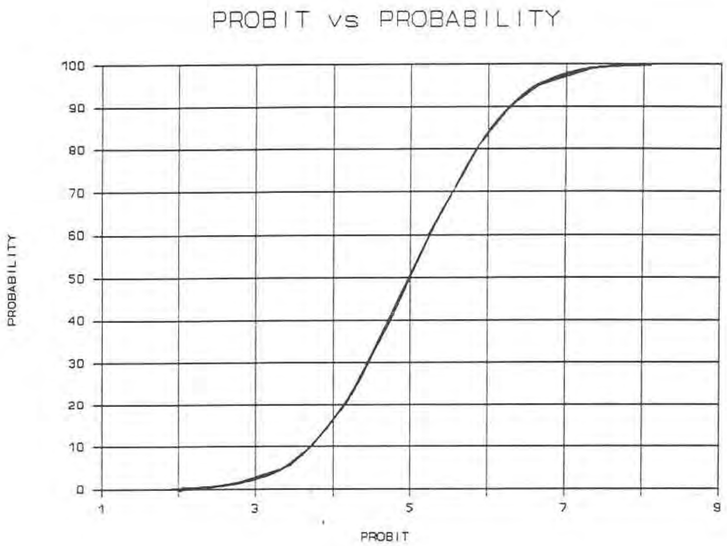


Figure 5-1 Probit vs Probability Curve (Ref.10)

The probit has therefore been applied to each of the events detailed in this section to determine the probability of fatality at the points of interest.

An example of the probit application has been applied to an explosion as a result of an LPG leak from the ship's manifold connection. The Cirrus model (Ref.7) was reviewed and the overpressure impact at 50m from the explosion centre (i.e. the location of the 50pmpy contour) is 9.3kPa.

The probit equation for explosion is:

$Y = k_1 + k_2 \ln (P_s)$ ------- (Ref.10)

Where: $k_1 = -77.1$;
$k_2 = 6.91$;
Ps = Static Overpressure (Pa)

$Y = -77.1 + 6.91 \ln (9300) = -13.95$.

Applying -13.95 to **Figure 5-1** results in a 0 (zero) fatality probability. Hence, this incident will not impact the contours and no further analysis is required for this scenario.

An example of the probit application has been applied to fire as a result of a flammable liquid leak from a ruptured flexible hose. The Cirrus model (Ref.7) was reviewed and the heat radiation impact at 50m from the fire (i.e. the location of the 50pmpy contour) is 10kW/m2.

The probit equation for fire is:

$$Y = k_1 + k_2 \ln (I^{4/3}\ t) \quad \text{------- (Ref.10)}$$

Where: k_1 = -36.4.1;
k_2 = 2.56;
I = Heat Radiation Intensity (kW/m^2)
t = 60 seconds

Y = -36.4 + 2.56 ln (104/3 x 60) = -18.1

Applying -18.1 to **Figure 5-1** results in a 0 (zero) fatality probability. Hence, this incident will not impact the contours and no further analysis is required for this scenario.

Table 5-1 has been developed to summarise the application of probit to each of the events to determine whether further analysis is required. It is noted that the flash fire incidents have not been included in this assessment as the probability of fatality in a flash fire (where people are caught within the gas cloud envelope) is 1. These incidents (flash fires) have been carried forward directly to **Section 7** for risk assessment.

Table 5-1 Summary of Probit Analysis applied to incidents at the BLB2 facility

Incident	k_1	k_2	n	I/P_s	t	Y	P_f	Remarks
Explosion – Ship's manifold connection (LPG)	-77.1	6.91	-	9,300kPa	-	-13.95	0	Not carried forward for further analysis
Jet fire – MLA catastrophic failure (LPG)	-36.4	2.56	4/3	23kW/m^2	180s	11.9	1	Incident carried forward for further analysis
Explosion – MLA catastrophic failure (LPG)	-77.1	6.91	-	27,900kPa	-	-6.4	0	Not carried forward for further analysis
Flexible hose rupture (flammable/ combustible liquids –pool fire (wharf)	-36.4	2.56	4/3	12.5kW/m^2	60	-17.3	0	Not carried forward for further analysis
Jet Fire – Flange leak isolating valve station (LPG)	-36.4	2.56	4/3	23kW/m^2	30s	4.6	0.35	Incident carried forward for further analysis
Jet Fire – Valve leak Isolating valve station (LPG)	-36.4	2.56	4/3	23kW/m^2	30s	4.6	0.35	Incident carried forward for further analysis
Explosion – Flange/valve leak isolating valve station (LPG)	-77.1	6.91	-	53,500kPa (at the road)	-	-1.86	0	Not carried forward for further analysis
Pool Fire – MLA catastrophic failure (Flam/Comb Liquid)	-36.4	2.56	4/3	8kW/m^2	30	-20.6	0	Not carried forward for further analysis
Pool Fire – Flange/ valve leak isolation Valve station (Flam/Comb Liquid)	-36.4	2.56	4/3	25kW/m^2 (at the road)	30	4.88	0.48	Incident carried forward for further analysis

5.11 Impacts at BLB1

The closest facility to the BLB2 wharf is the BLB1 wharf. Hence, incidents occurring at the BLB2 wharf may impact the BLB1 wharf at levels exceeding the acceptable impact or risk criteria. A review of the incidents assessed above indicates that only two incidents have the potential to impact the BLB1, these are listed below along with the impact distances.

Jet fire as a result of a catastrophic MLA failure - Heat Radiation Impact Distances:

- $4.7kW/m^2$ = 160m }
- 12.5kW/m2 = 120m } see **Appendix B**, **Section B4.2**
- $23kW/m^2$ = 80m }

Explosion as a result of a catastrophic MLA failure - Heat Radiation Impact Distances:

- 0.15 barg = 90m }
- 0.07 barg = 160m } see **Appendix B**, **Section B4.4**

A review of the selected impact criteria (**Section 5.1**) indicates that the distance to the maximum impact criteria, from BLB2 is 160m for heat radiation and 160m for explosion overpressure.

Figure 5-2 shows the separation distance between the BLB1 & BLB2 wharf/ships. It can be seen that the distance from the area where incidents may occur at BLB2 (i.e. the wharf deck/ship's manifold) is over 200m from the adjacent ship's bow. As the impact criteria distance does not exceed 160m, there will be no impact at BLB1 from incidents at BLB2. Hence, impacts at BLB1 from incidents at BLB2 have not been carried forward for further analysis.

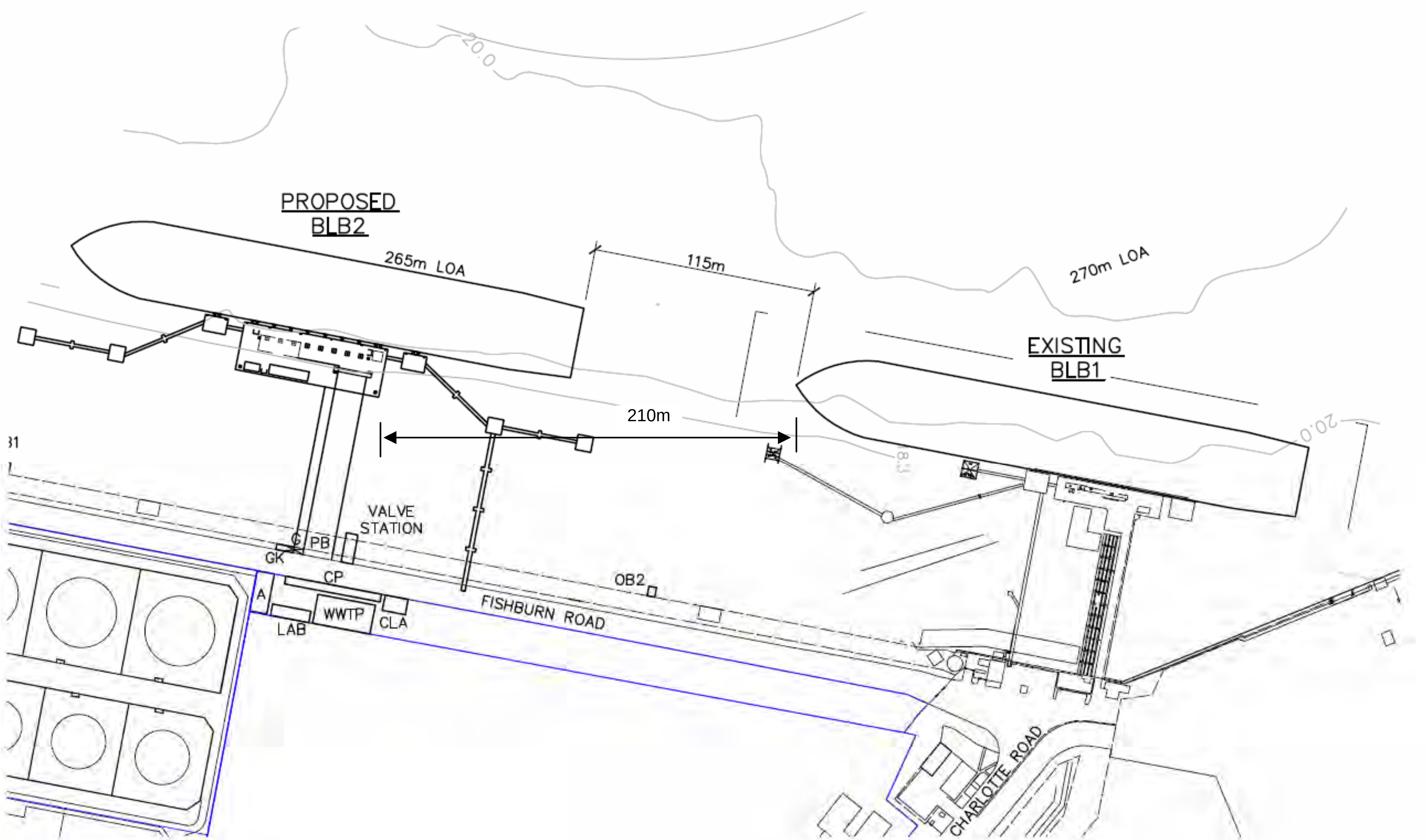


Figure 5-2 Separation Distance BLB1 to BLB2

6. FREQUENCY ANALYSIS

6.1 Incidents Carried Forward for Frequency Analysis

The consequence analysis was conducted to identify those incidents that had the potential to impact the existing fatality contours detailed in the Port Botany Land Use Planning Safety Study (Ref.1). The analysis identified a number of incidents that could result in increases to the contours, should the risks exceed those published in the Port Botany study (Ref.1).

Those incidents carried forward for frequency analysis are:

- Environmental Impact – flexible hose failure (chemical transfer);
- Jet fire – MLA catastrophic failure (LPG);
- Flash Fire – MLA catastrophic failure (LPG);
- Jet Fire – flange leak isolating valve station (LPG);
- Jet Fire – valve leak isolating valve station (LPG);
- Flash Fire – flange leak isolating valve station (LPG);
- Flash Fire – valve leak isolating valve station (LPG);
- Pool Fire – flange leak isolating valve station (flammable/combustible liquid); and
- Pool Fire – valve leak isolating valve station (flammable/combustible liquid).

The Port Botany Land Use Safety Study (Ref.1) lists a number of failure frequencies that have been used as the basis for the study. To ensure the results of the BLB2 risk analysis is consistent with the outcomes of the existing study (Ref.1), the Port Botany study frequency data will be used in the analysis below.

6.2 Environmental Impact – Flexible Hose Failure

Chemicals will be transferred using a flexible hose system. A number of hoses will be connected together, by flanged joints, to establish the required hose length from the ship to the wharf connection. Releases of chemical from those sections of hose on the ship and wharf will not result in impact to the environment as these areas are bunded. However, releases where the hose passes over the water would result in environmental impact.

A review of the equipment failure data bases reveals that CCPS (Ref.14) publishes a flexible hose failure rate as 0.005 p.a. This failure frequency is based on general hose transfer operations whereby hoses are tested annually in accordance with the ADG (Ref.4) or IMDG (Ref.15). It is noted that for chemical transfer operations at the BLB, the hoses will be pressure tested prior to every transfer, including full test of the hose connection integrity. Hence, hoses at the BLB would be less likely to fail as they are tested more frequently. An estimate of the reduction in failure rate as a result of the increased testing frequency has been made based on the number of additional tests conducted per annum. The total number of deliveries of chemicals is planned for 31 per annum, hence, hoses are tested 31 times more frequently than for standard hoses tested under the requirements of the ADG (Ref.4) & IMDG (Ref.15). The reduction in failure rate as a result of the additional testing is assumed to be proportional to the number of tests. Therefore, the failure frequency of hoses at the BLB2 facility is:

F_f hoses = 0.005 x 1/31 = 1.6x10^{-4} p.a.

In the event of hose failure, the failed section of hose may not be in the area between the ship and wharf. Hence, for those releases on the ship and wharf areas, the spillage would be contained and there would be no impact to the environment. The hose is 30m long and the section between the wharf and ship is only small (about 5m). Hence, the probability of failure in the hose section over the water is 5/30 = 0.17.

In addition, the transfer operation is continually staffed by a ship and wharf operator. These operators keep continual watch over the transfer operation. In the event of signs of hose distress (i.e. wet patches, minor weeps at joints, etc.) the transfer is stopped and the hose replaced. Hence, in the event the operators fail to detect an impending failure, a leak/release may occur causing environmental impact. A review of the human error failure probability (i.e. failure of the operators to detect the impending leak) has been estimated using the HEART Human Error Data Base (Ref.17). The selected human error probability is 0.03, a miscellaneous human error probability.

Hence, the risk of release to the environment, based on a maximum of 8 hoses in use at one time is:

Environmental Impact Risk = 8 x 1.6x10-4 x 0.17 x 0.03 = 6.5x10^{-6}p.a.

A review of the HIPAP No.4, “Risk Criteria for Land Use Safety Planning” (Ref.9), reveals that there are no published criteria for environmental risk. However, a review of HIPAP No.3 (Ref.16), Guidelines for Environmental Risk Assessment”, indicates that assessment of risk impacts to the environment should use the guidelines listed in the other HIPAP documents, based on consequence and frequency. A review of the fatality risk for industrial areas (HIPAP No.4 – Ref. 9) indicates that the acceptable risk criterion is 50 chances in a million per year. By comparison the risk of chemical release and damage to the environment is 6.5 chances in a million per year. Taking into consideration the fact that the BLB2 is within an industrial zone, and the assessment form environmental impact is conservative, the risk is considered to be low and no further analysis is conducted for this incident.

6.3 Jet Fire – MLA Catastrophic Failure (LPG)

The BLB2 will be constructed with a single gas MLA. The BLB2 MLA is basically a 300mm diameter pipeline with a number of swivel joints. The MLA length (including associated pipework) is about 30m (conservative). The failure frequency for a 300mm pipeline rupture is given as 5.8x10-8/m.yr. Hence, the failure frequency of the MLA is estimated to be:

MLA Rupture = 30 x 5.8x10^{-8} = 1.74x10^{-6} p.a.

This is considered a reasonable failure frequency for the MLA, as there are a number of safety features installed on the MLAs such as weak connections and dry-break couplings and the ship-shore connection point, pre-use pressure test (i.e. prior to every transfer) at a higher pressure than the operating pressure, proximity detectors to identify when the arm moves out of the predetermined operating envelope (i.e. alarm and automatic shut down of isolation valves), continual monitoring by operators both on the wharf and ship and non-return valves in the delivery line. All these safety features reduce the likelihood and magnitude of any incident. Hence, the likelihood of a release for 60 seconds (see **Section 5.4.2** – Flash Fire) is very low, as indicated by the estimated release frequency.

In the event of a release, ignition may not occur at every release. Hence, the probability of jet fire is estimated by multiplying the release frequency by the ignition probability (immediate ignition). The ignition probabilities used in the Port Botany Study (Ref.1) are not published in the study document. Hence, alternative ignition probabilities have been sourced for this study. An ignition probability, for a large gas release, of 0.3 has been used in this study (Ref.8). This ignition probability covers both immediate and delayed ignitions. Hence, the probability of delayed ignition vs. immediate ignition has been equally divided for this study. The immediate ignition probability is therefore 0.15.

Hence, the jet fire frequency has been estimated to be:

Jet Fire Frequency (immediate ignition) = 1.74×10^{-6} x 0.15 = **2.6×10^{-7} p.a.**

This result is conservative, as no account of the intermittent use of the MLA is taken into consideration.

6.4 Flash Fire – MLA Catastrophic Failure (LPG)

In the event of a major release at the MLA, the gas will evaporate and if not immediate ignited, may form a gas cloud that could drift finding an ignition source at a distance and after a time. Ignition in this case would result in a flash fire. Section 6.2 estimated the delayed ignition probability to be 0.15. Hence, the flash fire frequency is estimated to be:

Flash Fire Frequency (delayed ignition) = release frequency x ignition probability
= 1.74×10^{-6} x 0.15 = **2.6×10^{-7} p.a.**

This result is conservative, as no account of the intermittent use of the MLA is taken into consideration.

6.5 Jet Fire – Flange Leak Isolating Valve Station (LPG)

In the event of a release at LPG flanges, in the isolating valve station, a jet fire could result. The fire frequency is the multiple of the flange leak frequency x the ignition probability. There are three main gas pipelines delivering LPG products to the various terminals (Elgas, Qenos and Origin). Based on three lines and three valves, there would be six flanges that could leak at the pipework isolating valve station.

The flange failure frequency, published in the Port Botany study, is 3.6x10-4 p.a. The study does not indicate whether the flange is installed with a spiral wound gasket (SWG) or plain compressed fibre gasket (CFG). The probability of leak from a SWG is less than that of a CFG, due to the gasket construction and installation methods. Hence, for this study, releases from SWGs have been selected to be one order of magnitude less than the standard CFG. The selected value is therefore 3.6x10-5p.a.

The ignition probability for an LPG leak from a flange has been selected as 0.01 (Ref.8). This is the total ignition probability and therefore the potential for immediate ignition vs. delayed ignition has been equally apportioned.

The jet fire frequency is a function of the release frequency per flange x the number of flanges x ignition probability. Hence, the jet fire frequency has been estimated to be:

Jet Fire Frequency (immediate ignition) = $3.6\text{x}10^{-5}$ x 6 x 0.005 = $1.1\text{x}10^{-6}$p.a.

The above release frequency is based on the continued use of the system 24 hours per day, 7 days per week. However, the BLB2 will only transfer LPG products for a portion of the time. The remainder of the time the liquid lines will be purged and rest empty.

BLB Management estimate the total number of LPG product ships using the BLB2 facility will be as shown in **Table 6-1**.

Table 6-1 Expected LPG Ship Arrivals for BLB2

Product	2010	2011	2012
LPG	40	41	42

The average number of LPG ships to attend the BPB2 will be around 41, however, for conservatism, 42 has been used in the analysis. Assuming a ship stays alongside for a 1 day (on average) to transfer the flammable liquids, the exposure period for which fire can occur is 42/356 = 0.12.

Hence, the jet fire frequency for a flange leak incident, including exposure is:

Jet Fire Frequency (immediate ignition including exposure) = $1.1\text{x}10^{-6}$ x 0.12
= **$1.3\text{x}10^{-7}$p.a.**

6.6 Jet Fire – Valve Leak Isolating Valve Station (LPG)

In the event of a release at LPG valves, in the isolating valve station, a jet fire could result. The fire frequency is the multiple of the valve leak frequency x the ignition probability. There are three main gas pipelines delivering LPG products to the various terminals (Elgas, Qenos and Origin), hence, there are three valves that could leak at the pipework isolating valve station.

The valve failure frequency has not been published in the Port Botany study. Hence, an alternate valve failure frequency has been sourced. The offshore reliability data base (OREDA – Ref.11) provides information relating to valve leaks. A value of 0.14 external leaks per 10^6 hours (Taxonomy No. 4.3.5) has been selected for this study. This release frequency equates to $1.2x10^{-3}$ leaks p.a.

The ignition probability for an LPG leak from a valve has been selected as 0.01 (Ref.8). This is the total ignition probability and therefore the potential for immediate ignition vs. delayed ignition has been equally apportioned.

The jet fire frequency is a function of the release frequency per valve x the number of valve x ignition probability. Hence, the jet fire frequency has been estimated to be:

Jet Fire Frequency (immediate ignition) = $1.2x10^{-3}$ x 3 x 0.005 = $1.8x10^{-5}$p.a.

Using the same exposure probability as that developed in **Section 6.4**, the jet fire frequency for a valve leak is:

Jet Fire Frequency (immediate ignition including exposure) = $1.8x10^{-5}$ x 0.12
= **$2.16x10^{-6}$p.a.**

6.7 Flash Fire – Flange Leak Isolating Valve Station (LPG)

In the event of a release at LPG flanges, in the isolating valve station, a flash fire could result if the release does not ignite immediately. The fire frequency is the multiple of the flange leak frequency x number of flanges x the ignition probability. There are six LPG flanges in total at the pipeline isolating valve station (see **Section 6.5**) and the selected flange leak frequency is 3.6x10-5p.a. (see **Section 6.5**).

The ignition probability for an LPG leak from a flange has been selected as 0.01(Ref.8). This is the total ignition probability and therefore the potential for immediate ignition vs. delayed ignition has been equally apportioned.

The flash fire frequency is therefore estimated to be:

Flash Fire Frequency (delayed ignition) = $3.6x10^{-5}$ x 6 x 0.005 = $1.1x10^{-6}$p.a.

Using the same exposure probability as that developed in **Section 6.4**, the flash fire frequency for a flange leak is:

Flash Fire Frequency (immediate ignition including exposure) = $1.1x10^{-6}$ x 0.12

= **$1.3x10^{-7}$p.a.**

6.8 Flash Fire – Valve Leak Isolating Valve Station (LPG)

In the event of a release at LPG valves, in the isolating valve station, a flash fire could result if the release does not ignite immediately. The fire frequency is the multiple of the flange leak frequency x number of valves x the ignition probability. There are three LPG valves in total at the pipeline isolating valve station (see **Section 6.6**) and the selected valve leak frequency is 1.2x10-3p.a. (see **Section 6.6**).

The ignition probability for an LPG leak from a valve has been selected as 0.01(Ref.8). This is the total ignition probability and therefore the potential for immediate ignition vs. delayed ignition has been equally apportioned.

The flash fire frequency is therefore estimated to be:

Flash Fire Frequency (delayed ignition) = $1.2x10^{-3}$ x 3 x 0.005 = $1.8x10^{-5}$p.a.

Using the same exposure probability as that developed in **Section 6.5**, the flash fire frequency for a valve leak is:

Flash Fire Frequency (immediate ignition including exposure) = $1.8x10^{-5}$ x 0.12
= **$2.16x10^{-6}$p.a.**

6.9 Pool Fire – Flange Leak Isolating Valve Station (flammable/combustible liquid)

In the event of a release of flammable/combustible liquid from a flange, at the pipeline valve isolation station, the leak will accumulate in the valve pit and, if ignited would result in a pool fire. The frequency of fire is a function of the release frequency x the number of flanges x ignition probability.

There are six petroleum product pipelines and six chemical pipelines from the wharf to the various storage areas. Hence, each line has a valve and two flanges, however it is noted that chemical transfers will not involve chemicals with flammable/combustible characteristics on every occasion. The flange leak frequency has been selected as 3.6x10-4 p.a. (Ref.1). The probability of ignition in the event of a leak has been selected as 0.01. Based on a conservative estimate that 50% of the chemical products transferred have a sub-risk of Class 3/C1, the pool fire frequency for each product pipeline is estimated to be:

Ff_{pool} (flammable/combustible liquid flange leak) = $3.6x10^{-4}$ x 12 x 0.01 = $4.32x10^{-5}$p.a.

Ff_{pool} (chemical Class 3/C1 liquid flange leak) = $3.6x10^{-4}$ x 12 x 0.01 x0.5 = $2.16x10^{-5}$p.a.

The above release frequencies are based on the continued use of the system 24 hours per day, 7 days per week. However, the BLB2 will only transfer flammable/combustible & chemical liquids for a portion of the time. The remainder of the time the liquid lines will be purged and rest empty.

BLB Management estimate the total number of flammable/combustible & chemical liquid ships using the BLB2 facility will be as shown in **Table 6-2**.

Table 6-2 Expected Petroleum & Biodiesel Ship Arrivals for BLB2

Product	2010	2011	2012
Petroleum	32	35	35
Biodiesel	25	38	38
Total	57	73	73
Chemical	30	31	31

The average number of flammable and combustible liquids ships to attend the BLB2 will be around 68, however, for conservatism, 73 has been used in the analysis. Assuming a ship stays alongside for two days to transfer the flammable liquids, the exposure period for which fire can occur is 2x73/356 = 0.4. For conservatism, the number of chemical ships berthing and the BLB2 has been selected as 31. The exposure period, based on a 2 day attendance is 2 x 31/365 = 0.17.

Hence, the fire frequencies including exposure for the flammable/combustible and chemical liquid releases at the valve pit are:

Ff_{pool} (Class 3/C1 flange leak including exposure) = $4.32\times10^{-5} \times 0.4 =$ **1.7×10^{-5}p.a.**

Ff_{pool} (Chem. Class 3/C1 flange leak including exposure) = $2.16\times10^{-5} \times 0.17 =$ **3.6×10^{-6}p.a.**

The total frequency of fire in the valve pit, due to flange releases is the summation of the two frequencies, therefore combined frequency is:

Ff_{pool} (Class 3/C1 & Chemicals) = $1.7\times10^{-5} + 3.6\times10^{-6} = 2.06\times10^{-5}$

6.10 Pool Fire – Valve Leak Isolating Valve Station (flam./ comb. liquid)

In the event of a release of flammable/combustible liquid from a valve, at the pipeline valve isolation station, the leak will accumulate in the valve pit and, if ignited would result in a pool fire. The frequency of fire is a function of the release frequency x the number of valves x ignition probability.

There are six petroleum product pipelines and six chemical pipelines from the wharf to the various storage areas. Hence, there are six petroleum and six chemical valves from which leaks could occur. The valve leak frequency has been selected as 1.2x10-3 p.a. (see **Section 6.8**). The probability of ignition in the event of a leak has been selected as 0.01. As for the chemical flange frequency estimates, the chemicals with a flammable/combustible nature will not be transferred on every delivery occasion. It has been conservatively estimated that 50% of the products transferred will be Class 3/C1. Hence, the pool fire frequency for the two valve sets is estimated to be:

Ff_{pool} (Class 3/C1 valve) = $1.2x10^{-3}$ x 6 x 0.01 = $7.2x10^{-5}$p.a.

Ff_{pool} (flammable/combustible chemical valve) = $1.2x10^{-3}$ x 6 x 0.01 x 0.5 = $3.6x10^{-5}$p.a.

Similar to the flange assessment, conducted in **Section 6.9**, the flammable liquid and chemical pipelines are only used part of the time. Using the same values estimated in **Section 6.9**, the pool fire frequency is modified to cater for the proportional use of the pipelines. The fire frequencies for valve leaks, including exposure for the flammable/combustible and chemical liquid releases at the valve pit are:

Ffpool (Class 3/C1 flange leak including exposure) = 7.2x10-5 x 0.4 = **$6.8x10^{-6}$p.a.**

Ffpool (Chem. Class 3/C1 flange leak including exposure) = 3.6x10-5 x 0.17 = **$6.1x10^{-6}$p.a.**

The total frequency of fire in the valve pit, due to valve releases is the summation of the two frequencies, therefore combined frequency is:

Ffpool (Class 3/C1 & Chemicals) = 6.8x10-5 + 6.1x10-6 = $1.3x10^{-5}$

7. RISK ANALYSIS & ASSESSMENT

7.1 Summary of Incident Frequencies and Fatality Probabilities

Sections 5 and **6** assessed incident consequences and frequencies. The combination of these provides an assessment of the incident risk. **Table 7-1** summaries the results of the fatality probability and incident frequency for those incidents carried forward for risk analysis.

Table 7-1 Summary of Fatality Probability, Incident Frequency and Risk Results

Incident	Fatality Probability[1]	Incident Frequency[2]	Risk[3] (pmpy)
Jet Fire-MLA Rupture (LPG)	1	2.6×10^{-7}p.a.	0.26
Flash Fire – MLA Rupture (LPG)	1	2.6×10^{-7} p.a.	0.26
Jet Fire – flange leak isolating valve station (LPG)	0.35	1.3×10^{-7} p.a.	0.045
Jet Fire – valve leak isolating valve station (LPG)	0.35	2.16×10^{-6} p.a.	0.76
Flash Fire – flange leak isolating valve station (LPG)	1	1.3×10^{-7} p.a.	0.13
Flash Fire – valve leak isolating valve station (LPG)	1	2.16×10^{-6} p.a.	2.16
Pool Fire – flange leak isolation valve station (Flammable/Combustible Liquid)	0.48	2.06×10^{-5} p.a.	10
Pool Fire – valve isolation valve station (Flammable/Combustible Liquid)	0.48	1.3×10^{-5} p.a.	6.24

Notes: 1. see **Table 5-1**
2. Summarised from Section 6
3. Multiple of Fatality probability and incident frequency (per million per year – pmpy)

7.2 Assessment of Risks and Impact on Existing Risk Contours

The risk analysis has identified two main areas where the risk impacts may occur:

- The BLB2 MLA area on the wharf deck; and
- The pipeline isolating valve station located on the shoreline adjacent to the road.

The cumulative risks at each location are the summation of the individual risk events for each incident at that location. The assessment of cumulative risks and the impact on the existing contours (Ref.1) is conducted in the following sections.

7.2.1 Cumulative Risks for Incidents at the MLA

The two incidents described in **Table 7-1**, relating to the MLA risks, each have a risk of 0.26pmpy. Hence, the total risk (cumulative) is 0.26 x 2 = 0.52pmpy. This occurs at the existing 50pmpy contour that currently surrounds the proposed BLB2 facility in the Port Botany study (Ref.1). Hence, there would be negligible impact on the existing 50pmpy contour or the 1pmpy contour a further 30m beyond the 50pmpy contour.

In addition to the impact on the existing risk contours, there is a potential for the risk at the adjacent facilities to the BLB2 to exceed the risk criteria. The closest adjacent facility to the BLB2 wharf is the Elgas gas storage facility to the east, which is located about 120m from the BLB2 wharf facilities. The individual risk at the adjacent Elgas gas storage facility, as a result of incidents at the BLB2 wharf, is therefore below the 1pmpy and as the Elgas gas storage facility is an industrial site, the acceptable risk criteria is 50pmpy. Hence, as this criterion is not exceeded, the BLB2 facility meets the acceptable (published) risk criteria.

7.2.2 Cumulative Risks for Incidents at the Pipeline Isolating Valve Station

There were six incidents identified at the pipeline isolating valve station. The cumulative risk is the summation of the risk values in **Table 7-1,** which is 19.3pmpy. This risk impact occurs at the existing 50pmpy contour that currently surrounds the BLB2 facility in the Port Botany study (Ref.1). Hence, there would be no increase to the existing 50pmpy contour or the 1pmpy contour a further 130m into Botany Bay.

In addition to the impact on the existing risk contours, there is a potential for the risk at the adjacent facilities to the BLB2 to exceed the risk criteria. The closest adjacent facility to the pipeline valve station is the Elgas gas storage facility to the east, the boundary of which is located about 20m from the pipeline valve station. The individual risk at the adjacent Elgas gas storage facility is less than 19.3pmpy. As the Elgas gas storage facility is an industrial site, the acceptable risk criterion is 50pmpy. Hence, as this criterion is not exceeded, the pipeline valve station facility meets the acceptable (published) risk criteria.

8. REFERENCES

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Appendix A Hazard Identification Table

BLB Hazard Analysis

Area/Section	Hazard Cause	Hazard Consequence	Safeguards
Chemical Deliveries and Transfers			
Ship mooring	Ship strikes wharf at excessive speed	Potential to damage ships hull resulting in release	- Ship is moored using tugs - Pilot used to bring ship alongside - Fixed fenders used on the wharf - Double hull (liquid not in contact with outer hull)
Moored Ship	Passing ship strikes the moored ship	Potential to damage ships hull resulting in release	- Double hull (liquid not in contact with outer hull) - Marine exclusion zone (no unauthorised vessels - Low impact (low speed of operations) - Ships under tug and pilot control
Chemical hoses (150mm ID)	Coupling failure (i.e. flexible hose joints/ flanges)	Release of chemical from joint	- Bolted flanges - Annual testing of hoses/joints (new gaskets used at each transfer) - Pressure test with nitrogen prior to each use (800kPa) - Operation of hoses <700kPa - Start-up procedure to monitor pressuring of hoses including leak detection - Operator in attendance during full transfer (PPE available but not worn) - Operators in full radio communication with the wharf and shore operations - Manual shut down valves at each end - Loss is limited by hose length and reaction time - Operator dedicated to monitoring of all equipment during transfer

Area/Section	Hazard Cause	Hazard Consequence	Safeguards
			(leak detection) - Ships deck catchment (scuppers plugged) - Wharf is bunded with a 200mm bund wall all round.
Chemical hoses	Hose split/failure	Release of chemical from hose	- Annual testing of hoses/joints - Pressure test with nitrogen prior to each use (800kPa) - Operation of hoses <700kPa - Start-up procedure to monitor pressuring of hoses including leak detection - Operator in attendance during full transfer (PPE available but not worn) - Operators in full radio communication with the wharf and shore operations - Manual shut down valves at each end - Loss is limited by hose length and reaction time - Operator dedicated to monitoring of all equipment during transfer (leak detection) - Ships deck catchment (scuppers plugged) - Wharf is bunded with a 200mm bund wall all round.
Pipeline	Pipeline corrosion Leaks at flange locations (MLA, isolation valve pit)	Release of chemical from pipeline or flanges	- Fully welded pipeline along transfer route (pipeline joints are minimised) - Bunded deck on wharf - Containment pit around the pipe isolation valves (onshore) - Hydrostatic testing of pipes at commissioning and every 2 years (or when maintenance is performed on pipelines)

Area/Section	Hazard Cause	Hazard Consequence	Safeguards
			- Pipes are maintained empty & liquid free between transfers - Operator monitors operations during transfer (leak monitoring of pipelines) - Spiral wound gaskets (SWG) used throughout the pipeline connection points
Chemical Hoses	Ship securing lines fails	Ship moves away from wharf and hoses coupling parts – release of chemical	- Transfer ceases at wind speeds >35kph (hoses isolated) - Operators (marine) - Wind warning system from Bureau of Meteorology - Transfers cease when lightning occurs - Predominant winds are "on to the wharf" (ship is blown on to and not off the wharf - Securing lines are designed to secure against normal passing ships (i.e. waves generated in the bay) - Tug is on 24 hour call in adjacent dock area (Brotherson Dock)
Gas Delivery and Transfer			
Marine Loading Arm	Ship moves away from wharf – securing line failure	Limited gas release: - immediate ignition & jet fire - delayed ignition and flash fire	- MLA is hard piped - Arm movement outside "envelope" causes alarms and shuts down (ESD) and disconnects - Bolted connections from MLA to ship - Connections are pressure tested to 800kPa (nitrogen), leaks monitored - Start up procedure including slow pressure and monitoring - Operator on board ship

Area/Section	Hazard Cause	Hazard Consequence	Safeguards
			- MLA is monitored and controlled from a central control room with SCADA - ESD on wharf (at base of MLA) - Dry break & weak coupling at MLA connection to the ship - All equipment is classified to AS60079 (Hazardous Area Classification) - Fire Monitors located on the wharf (remote control) - Fire water pumps (diesel duty/stand-by)
Pipelines	Pipeline corrosion Leaks at flanges and valves	Leak, gas release: - immediate ignition & jet fire - delayed ignition and flash fire	- Fully welded pipeline along transfer route (only one isolation valve along the route, pipeline joints are minimised) - Bunded deck on wharf - Containment pit around the pipe isolation valves (onshore) - Hydrostatic testing of pipes at commissioning and every 2 years (or when maintenance is performed on pipelines) - Pipes are maintained empty & liquid free between transfers - Operator monitors operations during transfer (leak monitoring of pipelines) - SWGs used throughout the LPG system (i.e. at all joints)
Flammable & Combustible			
Marine Loading Arm	Ship moves away from wharf – securing line failure	Limited liquid release – potential pollution to the bay	- MLA is hard piped - Arm movement outside “envelope” causes alarms and shuts down (ESD) and disconnects - Bolted connections from MLA to ship

Area/Section	Hazard Cause	Hazard Consequence	Safeguards
			- Connections are pressure tested to 900kPa (nitrogen), leaks monitored - Start up procedure including slow pressure and monitoring - Operator (ships crew) on board ship during full transfer - MLA is monitored and controlled from a central control room with SCADA - ESD on wharf (at base of MLA) - Dry break & weak coupling at MLA connection to the ship - All equipment is classified to AS60079 (Hazardous Area Classification) - Bunded wharf - Ship deck is bunded (scuppers sealed) - Fuel spill emergency response plan & procedure
Marine Loading Arm	Ship moves away from wharf – securing line failure	Limited liquid release – ignition and pool fire	- MLA is hard piped - Arm movement outside “envelope” causes alarms and shuts down (ESD) and disconnects - Bolted connections from MLA to ship - Connections are pressure tested to 900kPa (nitrogen), leaks monitored - Start up procedure including slow pressure and monitoring - Operator (ships crew) on board ship during full transfer - MLA is monitored and controlled from a central control room with SCADA

Area/Section	Hazard Cause	Hazard Consequence	Safeguards
			- ESD on wharf (at base of MLA) - Dry break & weak coupling at MLA connection to the ship - All equipment is classified to AS60079 (Hazardous Area Classification) - Fire Monitors located on the wharf (remote control) - Fire water pumps – single pump provides 100% duty (diesel duty/stand-by)
Pipelines	Pipeline corrosion Leaks from flanges and valves	Liquid release – potential pollution to the bay	- Fully welded pipeline along transfer route (minimise joints and flanges) - Bunded deck on wharf - Containment pit around the pipe isolation valves (onshore) - Hydrostatic testing of pipes at commissioning and every 2 years (or when maintenance is performed on pipelines) - Pipes are maintained empty & liquid free between transfers - Operator monitors operations during transfer (leak monitoring of pipelines)
Emergency Response			
Wharf/Pipelines	Fire at the wharf/ pipelines	Requirement to apply fire water, which could carry contaminants into the bay	- Bunded area on the wharf deck (200mm high) - Containment pit for isolation valve station at the shoreline - Contaminant containment booms located at the shore line (i.e. deployed around ship and wharf) - Marine spill retention plan and procedures

Appendix B Consequence Analysis

B.1 INCIDENTS ASSESSED FOR CONSEQUENCE SEVERITY

Section 4 of the main report identified a number of incidents that could result in consequence impacts to the areas adjacent to the BLB2 facility. Those incidents for which a detailed consequence analysis is conducted are:

- LPG Transfer MLA Failure – leak/release, ignition and explosion/fire;
- LPG Pipeline Failure – leak/release, ignition and explosion/fire;
- Flammable/Combustible Liquid MLA Failure – leak/release, ignition and fire; and
- Flammable/Combustible Liquid Pipeline Failure - leak/release, ignition and fire.

Each incident has been assessed for consequence below.

B.2 MODELS USED IN THE ASSESSMENT

The modelling of incident consequences can involve complicated calculation requiring lengthy assessment. Hence, to assist in this analysis computer models have been developed to determine the impact of postulated incident scenarios. For this study the BP Cirrus model (Ref.7) has been used. CIRRUS is a compendium of physical models which can be used to predict the effects of a release of material, normally a hydrocarbon or chemical liquid or vapour. This model has been developed for use in the petroleum industry and is particularly applicable to the transfer and handling of flammable gases and liquids.

B.3 LPG Ship Connection Incidents

B.3.1 Release at the Ships Manifold Connection or MLA Flange

The MLA is connected to the ship's manifold by a bolted connection. A new spiral wound gasket (SWG) is used for this connection every time a transfer of LPG is performed. Flanges associated with the MLA are permanently connected using SWG, these flanges are not "disturbed" (i.e. disconnected) after each ship unloading operation. The system is tested using nitrogen, prior to each transfer operation. Hence, the potential for undetected leaks is low.

Notwithstanding this, a leak could occur at the flange face, resulting in initial slow release, with little impact and growing to a wire cut across the flange face. As the leak grows, the operator would detect the leak and commence shut down, Hence, the leak would be isolated and further release prevented. However, should an operator fail to isolate the leak (i.e. isolation valve fails, pump stop fails and manual valve isolation at the ships tank fails), the leak could continue. In the event of an immediate ignition, a jet fire would result. In the event of a delayed ignition the gas released could develop a cloud, which if ignited could result in a flash fire or explosion. Explosions will only occur where a cloud is confined. A review of the ships design and area surrounding the BLB indicates that there are no structures in the area beyond the immediate confines of the wharf and the only areas where an explosion could occur is the ship's deck or wharf itself. The cloud could be carried by the wind and drift beyond the unloading area where if ignited a flash fire could occur, which would flash back to the leak source where a jet fire would result. Each incident has been assessed below.

B.3.2 Release from Flange – Ships Manifold Connection or MLA Flange

The description above details the potential for a wire cut across the face of the flange, resulting in gas release. A conservative estimate has been made that the wire cut diameter would be 5mm. This would take considerable time to develop, hence, results would be conservative. The Cirrus model was run with the release diameter set a 5mm. **Figure B1** shows the results.

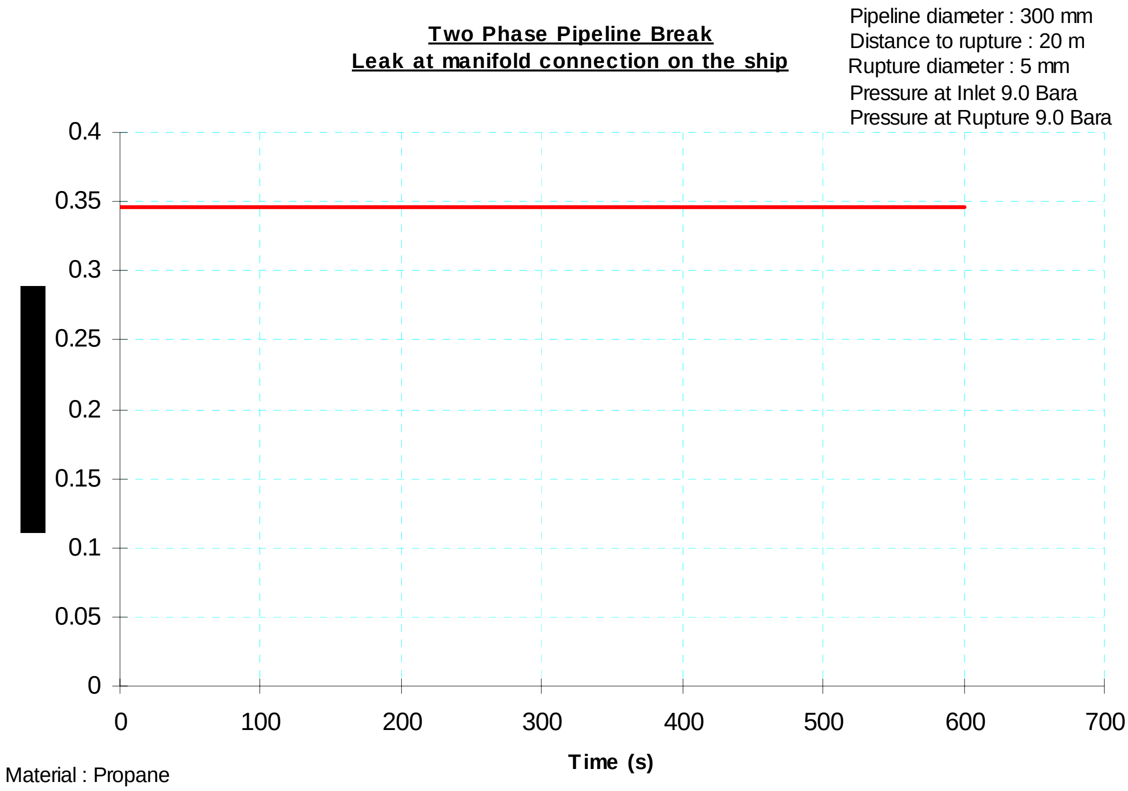

Figure B1 LPG Release from Flange – 5mm Dia. Hole

The release rate from the flange is estimated to be 0.35kg/s. This has been used in the following assessments.

B3.3 Jet Fire – Ships Manifold Incident

The Cirrus model was run using a gas release rate of 0.35kg/s. **Figure B2** shows the heat radiation impacts from the jet fire.

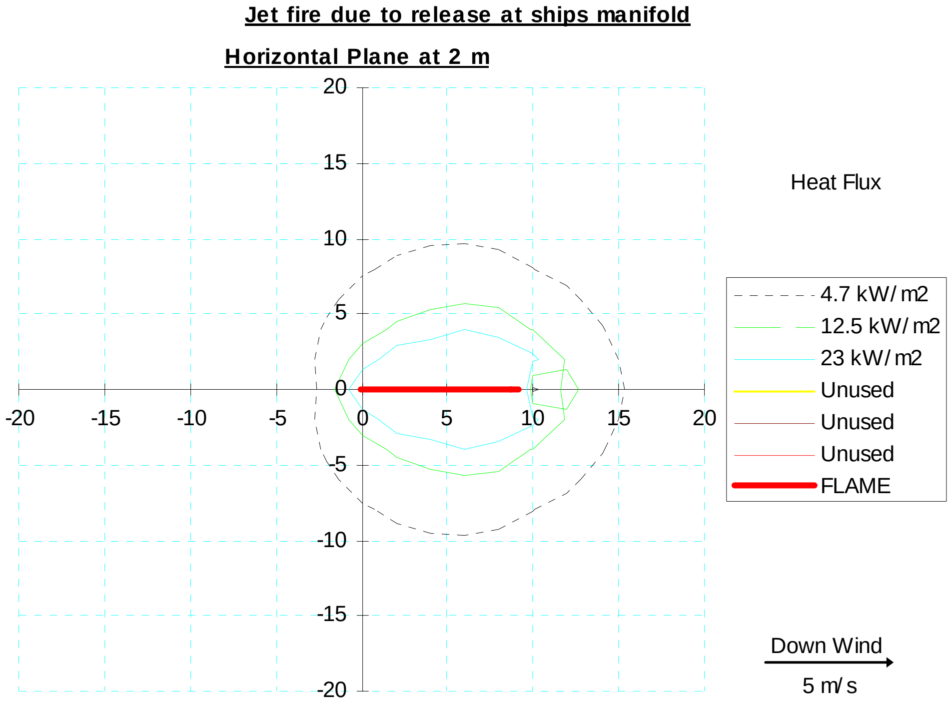

Figure B2 Heat Radiation Impacts Jet Fire at Ships Manifold Flange

It can be seen from **Figure B2** that the maximum impact distance to the heat radiation levels of interest is

- 4.7kW/m^2 = 10m.
- 12.5kW/m2 = 6m
- 23kW/m^2 = 4m

B3.4 Flash Fire – Ships Manifold Incident or MLA Flange Release

In the event a release does not immediately ignite, there is a potential for a gas cloud to build up. In the event the cloud drifts and finds an ignition source, a flash fire could result. In order to determine the cloud dimensions and distance to the furthest cloud limit, a dispersion analysis was performed for a range of wind weather conditions.

It is noted that dispersion of release gas is heavily influenced by the wind speed and weather conditions. Where the wind speed is high (5m/s) and there is bright sunshine, the gas will tend to disperse easily, hence, downwind concentrations of interest (i.e. Lower Flammable Limit, toxic concentrations) would be relatively close to the release source. However, where wind is light (1m/s) and conditions are cloudy, downwind concentrations of interest (i.e. LEL, toxic concentrations) would be relatively far from the source. A range of wind/weather conditions were selected for the LPG dispersion to identify the distance to the most conservative dispersion characteristics.

The Cirrus model was run with a variety of wind weather conditions to determine the distance to the LEL for the LPG. A conservative value of 2.1% of LPG in air was selected as the LEL for LPG. **Table B1** shows the results of the analysis.

Table B1 Distance to LEL for LPG Release at the Ships Manifold Dispersion for Selected Wind Weather Conditions

Wind Condition	Weather Condition	Distance to LEL 2.1% (m)
B	3	10
B	5	6
C	5	7
C	7	4
D	3	12
D	5	8
D	9	3
E	2	17
F	1.5	20

It can be seen from the analysis that the maximum impact distance for an LPG cloud in the LEL range, as a result of a joint failure at the ship manifold, is 20m at F1.5 wind/weather conditions.

B3.5 Explosion – Ships Manifold Incident or MLA Flange Release

In the event of a delayed ignition in F1.5 wind conditions, the explosion could generate a blast wave that could extend beyond the confines of the BLB. The explosion impact could affect the Port Botany Land use safety study contours (Ref.1). A review of a typical ships deck and layout (i.e. the location of the cloud on the ships deck, indicates that there is some confinement from pipework and equipment up to a height of 2m. The cloud dimensions are 50 x 10 x 0.4 high. Based on these dimensions the cloud confinement is estimated to be 100%.

Running the Cirrus explosion model with 100% cloud confinement results in explosion contours, as shown in **Figure B3**.

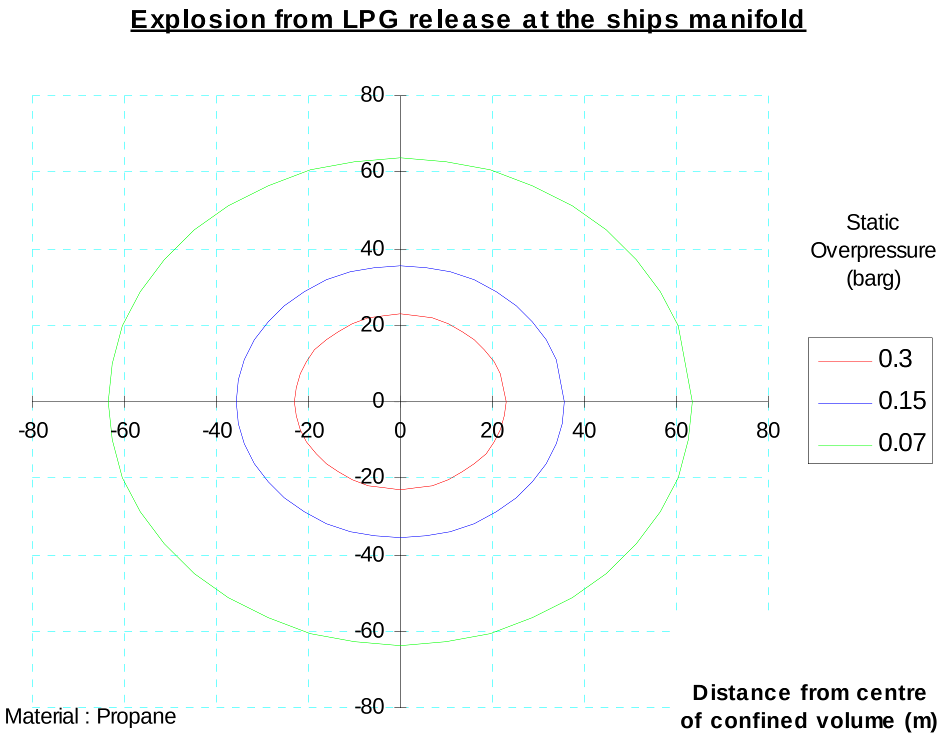

Figure B3 Explosion Overpressure Contours Gas Cloud as a Result of an LPG Leak at Ships Manifold

The distance to an explosion overpressure of 7kPa can be seen on **Figure B3** and is 62m.

B.4 MLA Catastrophic Incidents - LPG

The hazard analysis identified that in the event of small leaks at the MLA joints, there is a potential for the leaks to continue to grow, resulting in the release of gas at the swivel joints on the arm. Small leaks would not be initially detected, however as the leak grows, the release would become noticeable and operators would shut the transfer process down. Analysis of small leaks has been assessed in **Section B3**. Failure of instrument fittings could also cause releases. Instrument fittings have been estimated to have a pipe diameter of 5mm NB. Hence, leaks described in **Section B3** (5mm holes) would result in a release of about 0.35kg/s. This leak quantity is a considerable release and would be easily detected by operators, hence, the release conditions and consequences detailed in **Section B3**, would be applicable in the worst case leak incident at the MLA.

Notwithstanding this, an MLA failure (swivel joint) has been reviewed below to determine the worst case scenario should a swivel joint fail catastrophically. In this case the release diameter would be 300mm and the release would project into the BLB area.

B.4.1 Release at the MLA- Catastrophic Failure

The Cirrus program was run using an LPG release with a diameter of 300mm and a pipe length of 30m (i.e. estimated distance from the ship to the MLA failure point). The initial burst of LPG release settles quickly and a steady state release occurs almost immediately to a value of 82kg/s. It is estimated that the operator would respond immediately and close the delivery valves. The delivery valves are actuated and are 300mm nominal bore (NB). A valve of this size would take about 30 seconds to close, gradually shutting off the gas flow as the valve shuts. A conservative response time for the operator to access the emergency shut down button, and depress this button, has been estimated as 30 seconds. Total valve closure time is therefore estimated to be 60 second. Hence, a total of 60s x 82 kg/s would be released = 4,920kg (this is conservative as the flow rate would reduce as the gas isolation valve closes over the 30 second shut down period). There would be some initial flashing and the formation of a pool under the MLA from the material that did not flash. The evaporation rate from the pool was estimated using the Cirrus program based on a pool diameter of 32m (i.e. spread of LPG into the bunded wharf area). Based on this data, the average evaporation rate is 15kg/s for 328 seconds or 5.5 minutes.

B.4.2 Jet Fire at the MLA – Catastrophic Failure

The Cirrus model was run using a gas release rate of 82kg/s. **Figure B4** shows the heat radiation impacts from the jet fire.

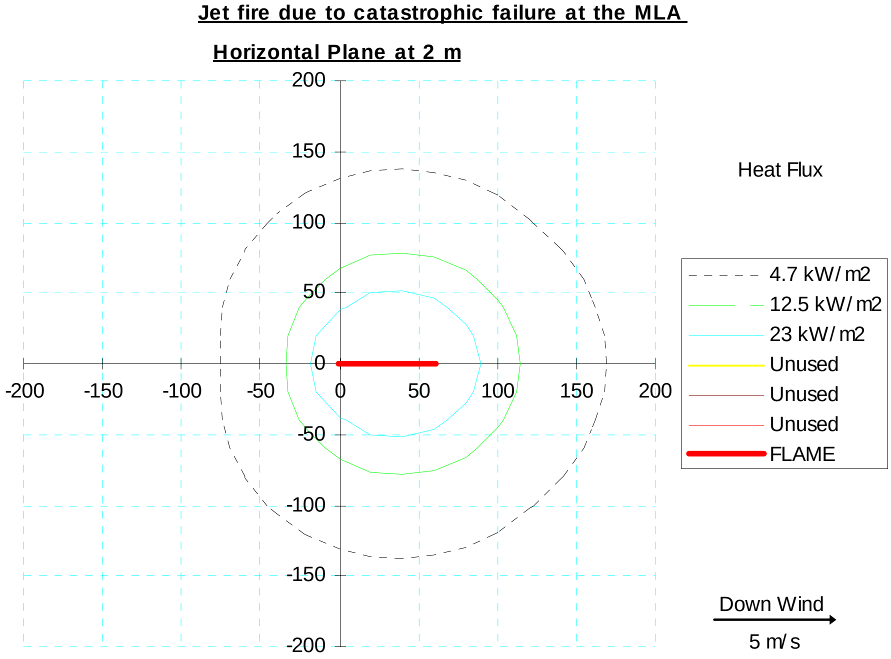

Figure B4 Heat Radiation Impacts Jet Fire at Ships Manifold Flange

It can be seen from **Figure B4** that the maximum impact distance to the heat radiation levels of interest is

- 4.7kW/m^2 = 160m.
- 12.5kW/m2 = 120m
- 23kW/m^2 = 80m

B.4.3 Flash Fire at the MLA – Catastrophic Failure

A gas dispersion was performed, using Cirrus, to determine the distance to the LEL. Release rate was 15kg/s. The distance to the LEL at selected wind weather conditions is shown in **Table B2**.

Table B2 Distance to LEL for LPG Release at the MLA Dispersion for Selected Wind Weather Conditions

Wind Condition	Weather Condition	Distance to LEL 2.1% (m)
B	3	90
B	5	60
C	5	80
C	7	75
D	3	150
D	5	100
D	9	120
E	2	195
F	1.5	160

It can be seen from the analysis that the maximum impact distance for an LPG cloud in the LEL range, as a result of a MLA catastrophic failure, is 195m at E2 wind/weather conditions.

B.4.4 Explosion at the MLA – Catastrophic Failure

In the event of a delayed ignition in E2 wind conditions, the explosion could generate a blast wave that could extend beyond the confines of the BLB. The explosion impact could affect the Port Botany Land use safety study contours (Ref.1). A review of the wharf deck layout (i.e. the location of the cloud on the wharf deck), indicates that there is some confinement from pipework and equipment up to a height of 2m. The cloud dimensions are 190 long x 150 wide x 1.2 high. Based on these dimensions and the wharf deck dimensions of 75mx25m, the cloud confinement is estimated to be 7%.

Running the Cirrus explosion model with 7% cloud confinement results in explosion contours as shown in **Figure B5**.

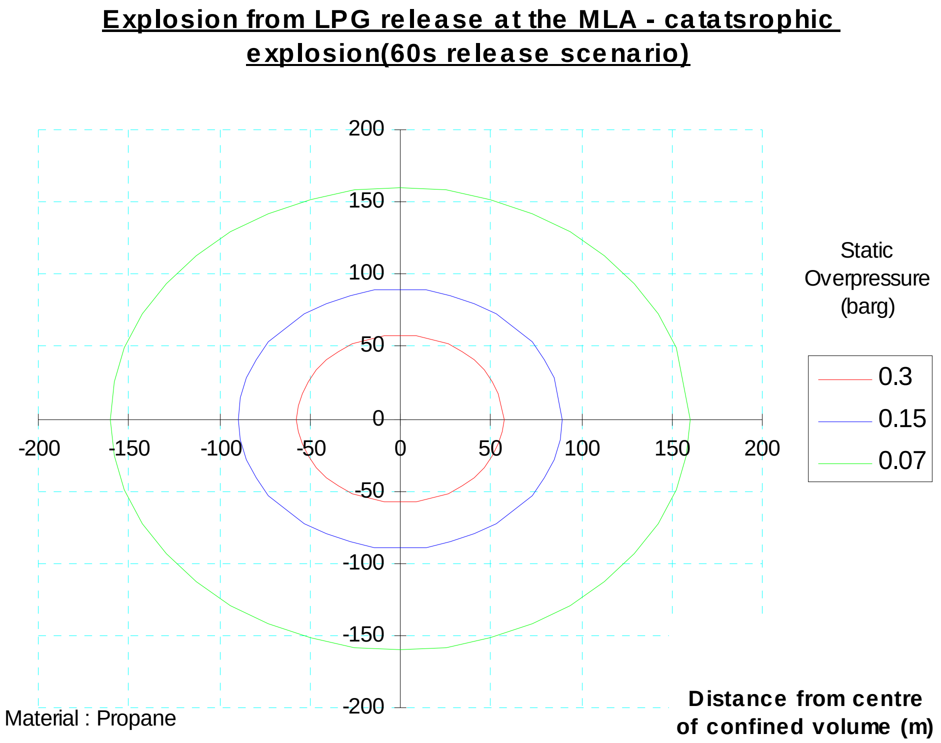

Figure B5 Explosion Overpressure Contours Gas Cloud as a Result of an LPG Catastrophic Release at the MLA

The distance to an explosion overpressure of 7kPa can be seen on **Figure B5** and is 160m.

B.5 Pipeline Incidents - LPG

The hazard identification section of the report identified that pipeline failures were a low risk due to the fully welded pipeline design, the commissioning testing and the regular hydrostatic testing (every two years). Hence, the main areas of release are identified to be valves and flanges.

B.5.1 Release at the Pipeline Valve

Flange releases will occur in the same manner as that described in **Section B3**. Hence, the data from this section may be used in the analysis of LPG flange releases in the pipeline. However, valves along the pipeline route may also leak at the valve stem. The valve stem is fitted with a gland, that prevents the release of LPG during normal operations. In the event of a gland failure, there is a potential for LPG to leak between the valve stem and body. This space is about 1mm wide and based on a valve stem of 25mm diameter (i.e. 300mm valve), the area of the annulus of 1mm around the stem is estimated by:

$$\text{Annulus Area} = \pi/4 \text{ x } (D_o^2 - D_i^2) = \pi/4 \text{ x } (0.026^2 - 0.025^2) = 8.2\text{x}10^{-5}\text{m}^2$$

The equivalent release diameter = $(4/\pi \text{ x } 8.2\text{x}10^{-5}) = 0.010$m

Based on similar operating conditions to those described for the flange release (Section B3.1.1) the release rate from a 10mm hole is estimated using the Cirrus model. The results of the analysis are shown in **Figure B6**.

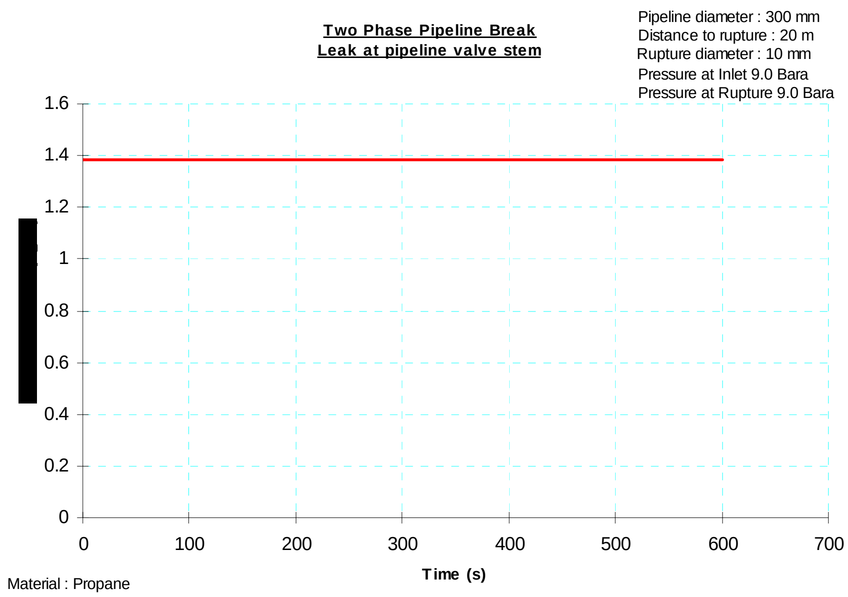

Figure B6 LPG Release from Valve Stem – 10mm Dia. Hole

The release rate from the valve stem is estimated to be 1.4kg/s. This has been used in the following assessments.

B.5.2 Jet Fire – Valve Leak Incident

The Cirrus model was run using a gas release rate of 1.4kg/s. **Figure B7** shows the heat radiation impacts from the jet fire.

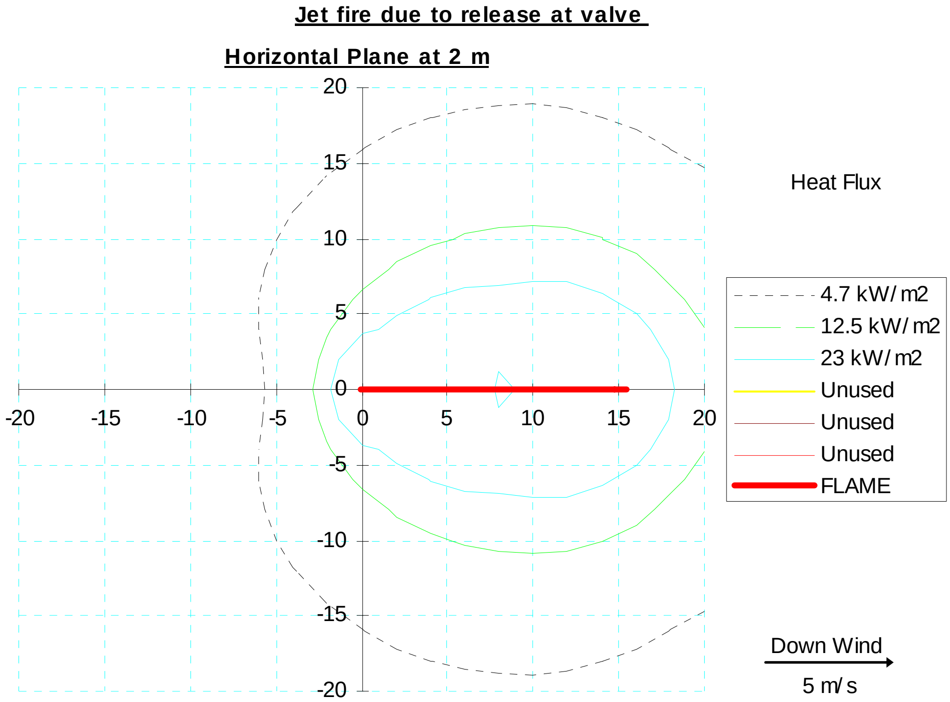

FIGURE B7
HEAT RADIATION IMPACTS JET FIRE DUE TO VALVE RELEASE

It can be seen from **Figure B7** that the maximum impact distance to the heat radiation levels of interest is

- 4.7kW/m^2 = 18m.
- 12.5kW/m2 = 10m
- 23kW/m^2 = 7m

B.5.3 Flash Fire – LPG Valve Leak Incident

As detailed in **Section B.3.4**, in the event a release does not immediately ignite, there is a potential for a gas cloud to build up. In the event the cloud drifts and finds an ignition source, a flash fire could result. In order to determine the cloud dimensions and distance to the furthest cloud limit, a dispersion analysis was performed for a range of wind weather conditions.

The Cirrus model was run with a variety of wind weather conditions to determine the distance to the LEL for the LPG. A conservative value of 2.1% of LPG in air was selected as the LEL for LPG. **Table B3** shows the results of the analysis.

Table B3 Distance to LEL for LPG Release at a Pipeline Valve Dispersion for Selected Wind Weather Conditions

Wind Condition	Weather Condition	Distance to LEL 2.1% (m)
B	3	25
B	5	17
C	5	20
C	7	16
D	3	32
D	5	21
D	9	15
E	2	38
F	1.5	44

It can be seen from the analysis that the maximum impact distance for an LPG cloud in the LEL range, as a result of a valve leak at the pipework valve station, is 44m at F1.5 wind/weather conditions.

B.5.4 Explosion – LPG Valve Leak Incident

In the event of a delayed ignition in F1.5 wind conditions, an explosion as a result of a leak at a valve could generate a blast wave that could extend beyond the confines of the BLB. The explosion impact could affect the Port Botany Land use safety study contours (Ref.1). A review of the pipeline layouts indicates that the pipelines are located at ground level up to a height of about 0.5m. The cloud dimensions are 20 x 120 x 0.4 high. Based on these dimensions, and the fact that the pipe corridor is about 20m wide, the cloud confinement is estimated to be 25%.

Running the Cirrus explosion model with 25% cloud confinement results in explosion contours, as shown in **Figure B8**.

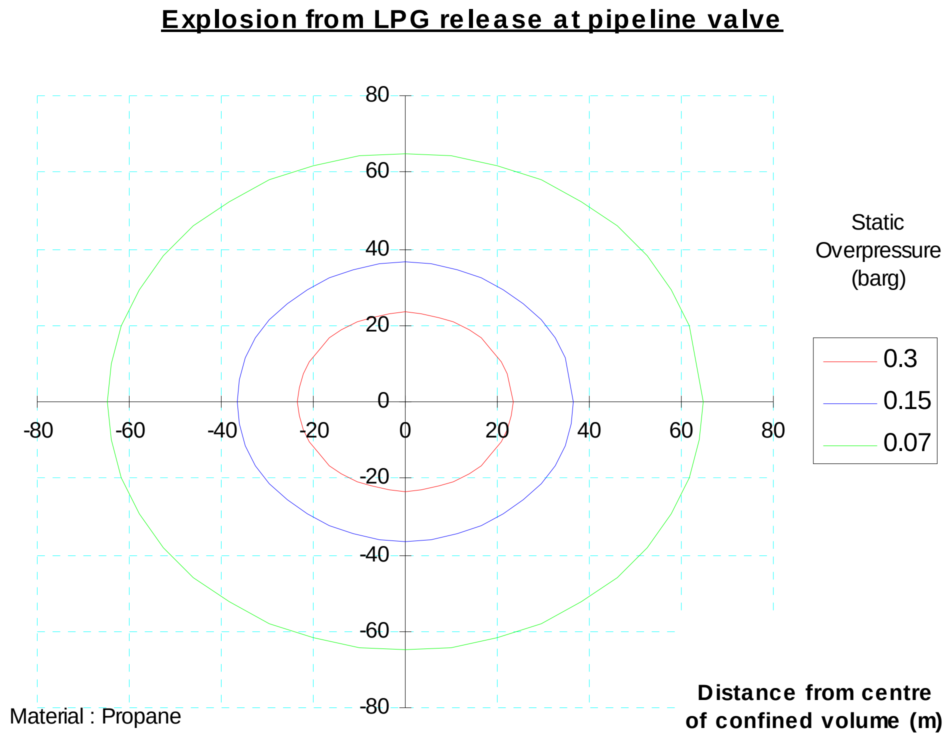

Figure B8 Explosion Overpressure Contours Gas Cloud as a Result of an LPG Leak at a Pipeline Valve

The distance to an explosion overpressure of 7kPa can be seen on **Figure B8** and is 62m.

B.6 Flammable/Combustible Liquid – Ship Connection Incident

B.6.1 Flammable Combustible Liquid Release Rate

Like the LPG loading arms, the flammable and combustible liquid loading arms will be connected to the ships manifold by a bolted connection. Flammable and combustible liquid connections will use compressed fibre gaskets to form a seal between the manifold and MLA flanges. Once connected the MLA and manifold connection will be tested to 800 kPa to identify any leaks prior to use.

Notwithstanding the pre-start leak tests, there is a potential for a gasket to fail, blowing out the compressed fibre section of the gasket between two flange bolts, however, this is unlikely. Nonetheless, an estimation of the quantity of leak that occurs from this event has been made.

Based on 300mm pipework and flanges, the space between the flange bolts are estimated to be 100mm (using 12 bolts a 400mm pitch circle diameter for the bolts). The gasket thickness between the flanges is 3mm. Hence, the release area is 0.100 x 0.003m2 = 0.0004m2. The equivalent release diameter for use in the Cirrus model is therefore D= (4/π x 0.0004)0.5 = 0.0195m or 19.5mm

The Cirrus model was used to estimate the liquid release rate. **Figure B9** shows the steady state release rate for the flammable/combustible liquid.

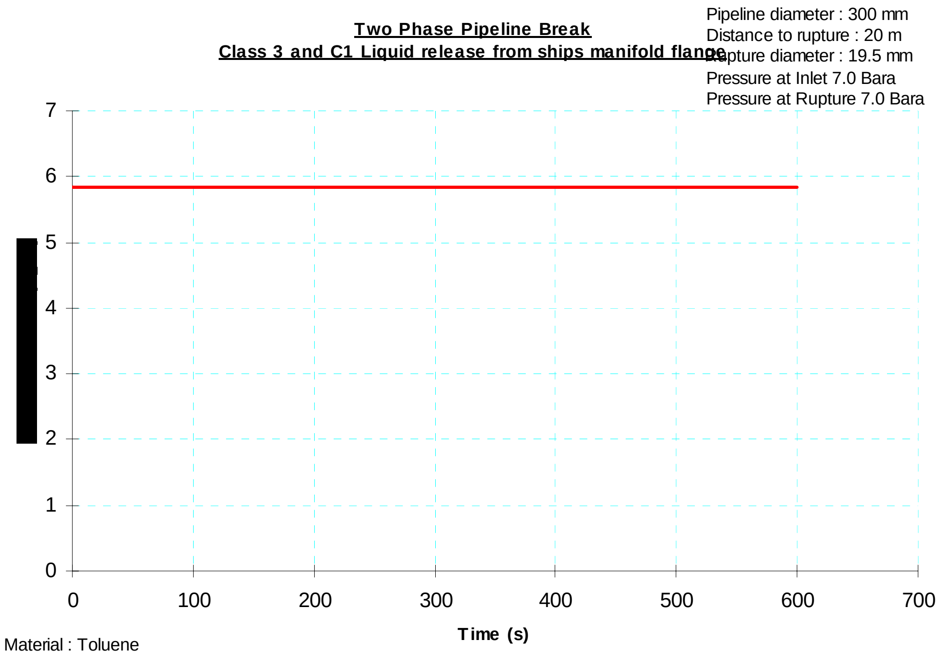

Figure B9 Flammable/Combustible Liquid Release Rate from a Flange Leak Ships Manifold Connection

The release rate for flammable/combustible liquids, from a 19.5mm hole, has been estimated to be 5.8kg/s.

B.6.2 Flammable Combustible Liquid Pool Diameter

In the unlikely event of a release of flammable/combustible liquid to the deck of the ship, the release would be identified immediately by the operator and the delivery valves closed. This would stop the release and prevent further flammable/combustible liquid from spilling to the deck. It has been conservatively assumed that it would take an operator about 60 seconds to isolate the valve, resulting in a total of 60s x 5.8kg/s = 348kg released to the deck. The average density of flammable and combustible liquid transferred at the BLB has been estimated to be 800kg/m3. Hence, the volume of flammable and combustible liquids released is 348/800 = 0.435 or 435 Litres.

The flammable/combustible liquid, released to the deck, would pool on the deck and be contained by the ships scuppers (which are plugged for the transfer operation). The spread of the pool would be unconfined and therefore based on a pool thickness of 5mm (Ref.8), the diameter of the pool, based on a volume of 218 Litres and a pool thickness of 0.005m, is:

Pool Diam. = $(4/\pi \text{ x } 0.435/0.005)^{0.5}$ = 10.5m

B.6.3 Flammable/Combustible Liquid Pool Fire Impacts – MLA Failure

To estimate the impacts of a fire on the ships deck, the Cirrus model was run using an unconfined pool of 10.5m diameter. The results of the analysis are shown in **Figure B10**.

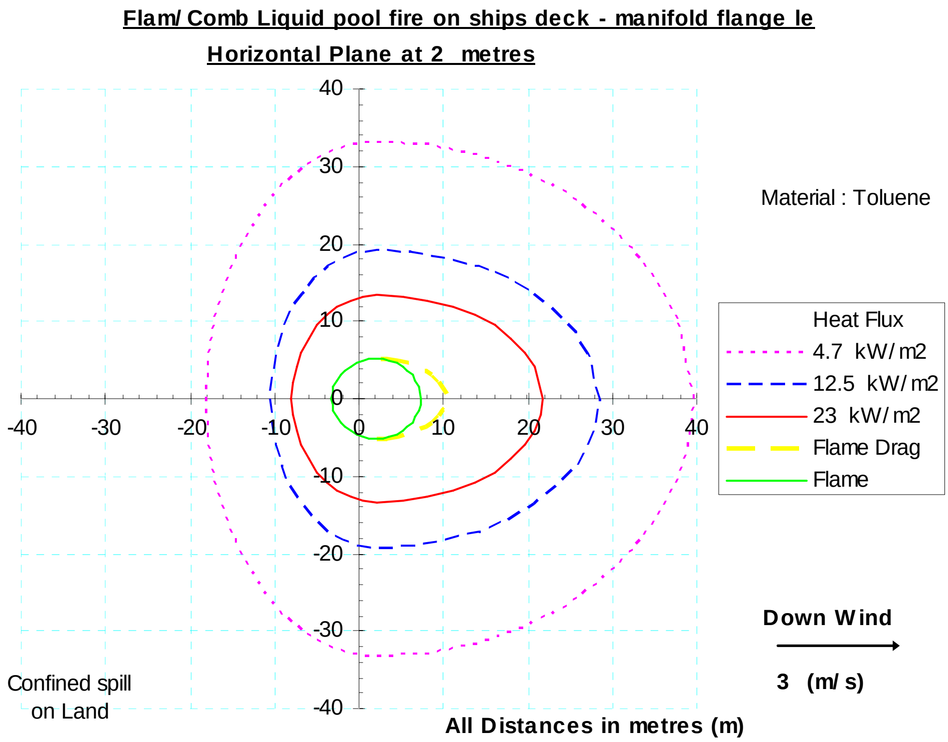

Figure B10 Flammable/Combustible Liquid Leak – Ships Manifold Connection Heat Radiation Contours

It can be seen from **Figure B10** that the maximum impact distance to the heat radiation levels of interest is:

- $4.7 kW/m^2$ = 40m.
- 12.5kW/m2 = 29m
- $23 kW/m^2$ = 22m

B.7 Flammable/Combustible Liquid – MLA Catastrophic Failure

B.7.1 Flammable Combustible Liquid Release Rate

The flammable and combustible liquid loading arms contain a number of swivel joints that permit the end of the arm to be located at the ships manifold, without placing stress on the arm components. In the event of a minor leak, the release quantities will be small and the operations will be shut down to repair the leak before continuing transfer. However, in the event of a swivel joint catastrophic failure, there is a potential for the flammable/ combustible liquid to escape via the full 300mm diameter hole.

Notwithstanding the pre-start leak tests, and the unlikely potential for this incident to occur, an assessment of release and pool fire consequences has been conducted.

Based on 300mm MLA pipework, a failure of the swivel joint would result in a full diameter release at 700kPa. These values have been used to determine the release rate of the flammable/combustible liquid for this incident.

The Cirrus model was used to estimate the liquid release rate. The steady state release rate for the flammable/combustible liquid release from a catastrophic failure of the MLA was estimated to be 80kg/s.

B.7.2 Flammable Combustible Liquid Pool Diameter

In the unlikely event of a release of flammable/combustible liquid from the MLA, the spill would fall to the deck of the wharf, where it would be contained by the wharf bunding. It has been conservatively assumed that it would take an operator about 60 seconds to isolate the valve, resulting in a total of 60s x 80kg/s = 4,800kg released to the deck. The average density of flammable and combustible liquid transferred at the BLB has been estimated to be 800kg/m3. Hence, the volume of flammable and combustible liquids released is 4,800/800 = 6m3.

The flammable/combustible liquid, released to the deck, would pool on the deck and be contained by the bunded sides of the wharf. The spread of the pool would be generally unconfined and therefore based on a pool thickness of 5mm (Ref.8), the diameter of the pool, based on a volume of 6m3 and a pool thickness of 0.005m, is:

$$\text{Pool Diam.} = (4/\pi \times 6/0.005)^{0.5} = 39\text{m}.$$

However, the wharf deck is only 31m wide (bund inside dimensions) and hence, the spread of liquid to 5mm deep would be:

$V = 6m^3 = L \times 31 \times 0.005$; $L = 38.7$, and an equivalent fire diameter is estimated by:

$$D = ((38.7 \times 32) \times 4/\pi)^{0.5} = 39.7\text{m}$$

B.7.3 Flammable/Combustible Liquid Pool Fire Impacts – MLA Catastrophic Failure

To estimate the impacts of a fire on the wharf deck, the Cirrus model was run using an unconfined pool of 39.7m diameter. The results of the analysis are shown in **Figure B11**.

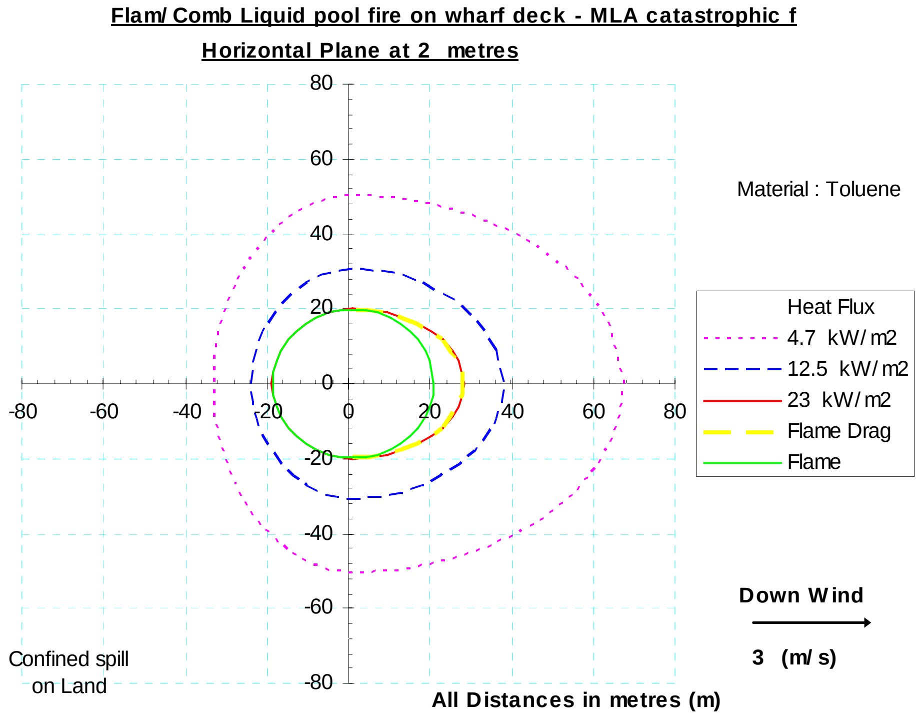

Figure B11 Flammable/Combustible Liquid Leak – MLA Catastrophic Failure Heat Radiation Contours

It can be seen from Figure B11 that the maximum impact distance to the heat radiation levels of interest is:

- $4.7kW/m^2$ = 68m.
- $12.5kW/m^2$ = 39m
- $23kW/m^2$ = 24m

B.8 Pipeline Incidents – Flammable/Combustible Liquids

The hazard identification section of the report identified that pipeline failures were a low risk due to the fully welded pipeline design, the commissioning testing and the regular hydrostatic testing (every two years). Hence, the main areas of release are identified to be valves and flanges.

B.8.1 Release at the Pipeline Valve

Flange releases would occur in the same manner as that described in **Section B.6**. Hence, the data from this section may be used in the analysis of flammable combustible liquid flange releases in the pipeline. Flange release rates were estimated to be 5.8kg/s (see **Section B.6**).

However, valves along the pipeline route may also leak at the valve stem. The analysis of valve stem releases was conducted in **Section B.5.1** and the resultant equivalent release diameter for a valve stem leaks was estimated to be 10mm.

Based on similar operating conditions to those described for the flange release (**Section B.6.1**) the release rate from a 10mm hole is estimated using the Cirrus model. The results of the analysis are shown in **Figure B12**.

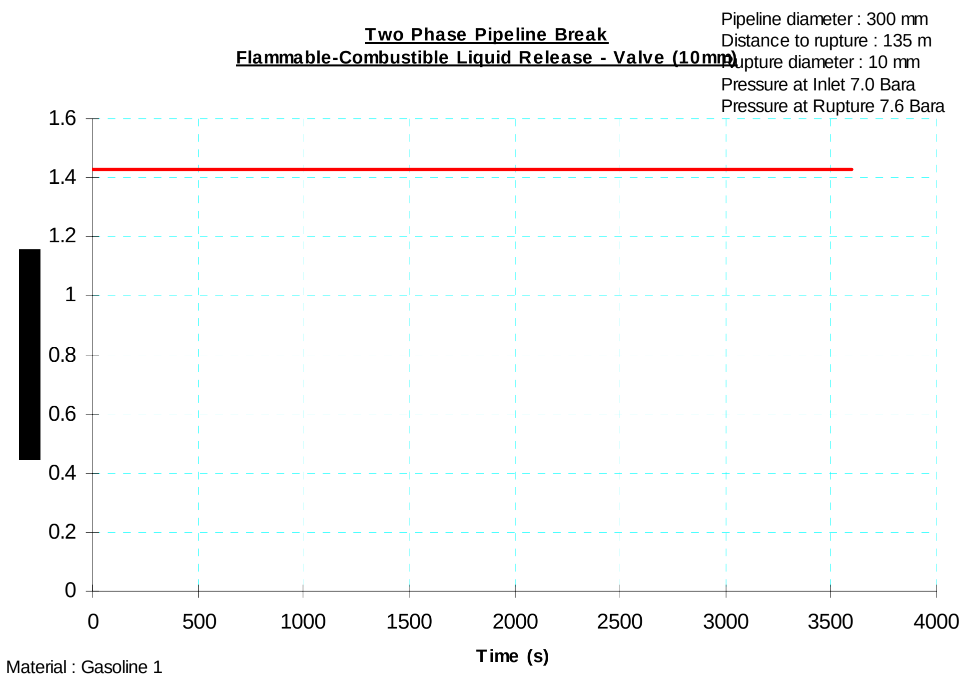

Figure B12 Flammable & Combustible Liquid Release Valve Stem – 10mm Dia. Hole

The release rate from the valve stem is estimated to be 1.45kg/s. This release rate along with the release rate for flanges (5.8kg/s) has been used in this assessment.

B.8.2 Flammable Combustible Liquid Pool Diameter – Valve Leak

In the unlikely event of a release of flammable/combustible liquid from a valve or flange on the wharf, the release would be identified by the operator and the transfer isolated immediately. The estimated release rate from the flange is 5.8kg/s and from a valve, 1.45kg/s. These release rates are significantly less than the impact from an MLA release of 80kg/s. Hence, for this analysis, the worst case incident has been estimated to be the MLA catastrophic failure and should this incident be identified to impact the Port Botany Risk contours (Ref.1), a review will be conducted to include the valve leak incident on the wharf.

A flange or valve leak in the main shoreline isolating pit could release flammable and combustible liquid to the ground or bay, however, the pipeline isolation valve area is constructed with a collection pit that contains any spillage. In the event the spill occurs in the pit, and is ignited, a pool fire will result radiating heat to the surrounding areas. As the pit contains any spills, the magnitude of the release is not the contributing factor to the size of the fire. This is governed by the pit dimensions.

The valve pit dimensions are 12m long by 5m wide (60m2). Hence, the equivalent pool diameter as a result of a fire in the pit is:

$$\text{Pool Diam.} = (4/\pi \times 60)^{0.5} = 8.75\text{m}$$

B.8.3 Flammable/Combustible Liquid Pool Fire Impacts – Pipeline Isolation Valve Pit

To estimate the impacts of a fire on the areas adjacent to the valve pit (shore) from a valve leak and pool fire in the pit, the Cirrus model was run using a confined pool of 8.75m diameter. The results of the analysis are shown in **Figure B13**.

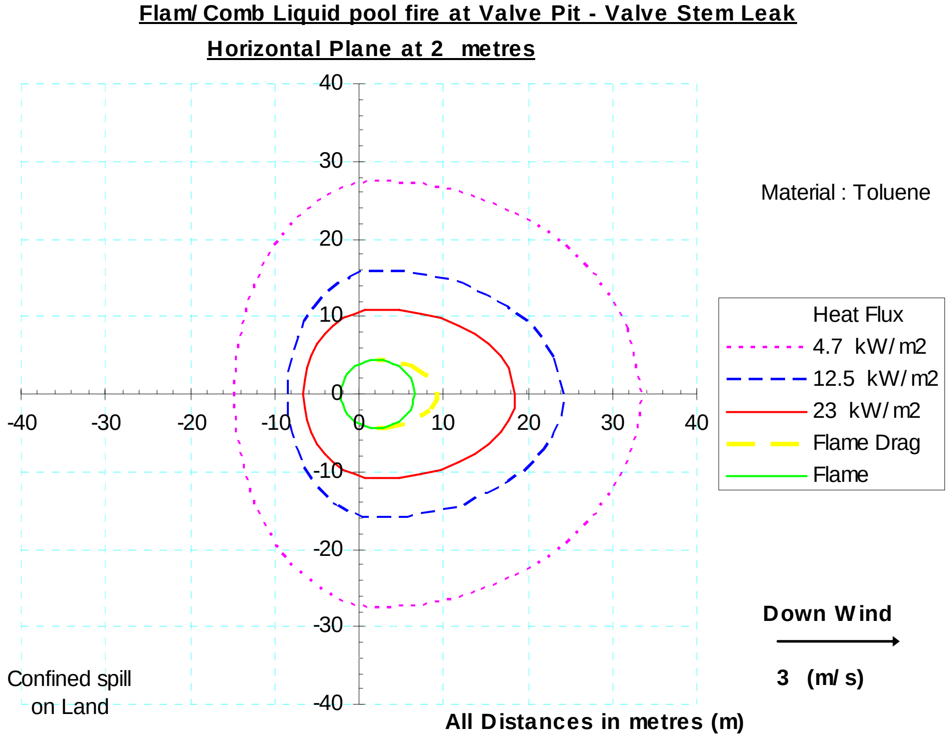

Figure B13 Flammable/Combustible Liquid Leak – Valve Leak at Shore Isolation Heat Radiation Contours

It can be seen from **Figure B13** that the maximum impact distance to the heat radiation levels of interest is:

- 4.7kW/m^2 = 33m.
- 12.5kW/m^2 = 24m
- 23kW/m^2 = 18m

B.9 Flammable/Combustible Liquid Pool Fire Impacts – Flexible Hose Failure

The hazard analysis (**Section 4.2.4**) identified that in the event of a flexible hose rupture, the maximum flow rate from the hose would be 50 L/s. Hence, the worst case incident for hose failure would result in a maximum of 50L/s discharge to the wharf. In the event of a flexible hose rupture, the operator on the ship would immediately notify the pump room crew to stop the transfer pump and the operator would then isolate the transfer valve at the ships manifold. The pump stop sequence and isolation has been assumed to take up to 60 seconds, hence, the total discharge quantity would be 60 seconds x 50 L/s plus the quantity in the hose.

The quantity of liquid in a 150mm hose from ship to shore = the hose cross sectional area x the hose length. Assuming a hose length of 30m and a diameter of 150mm, the volume of liquid in the hose is:

Volume Liquid in the Hose = $\pi/4 \times 0.15^2 \times 30 = 0.53m^3$ or 530 Litres

Quantity release before isolation = 60 seconds x 50 L/s = $3m^3$ or 3,000 Litres

Total release = $2.3m^3$ or 3,530 Litres

The liquid released onto the wharf will spread in a pool to a thickness of 5mm (Ref.8, main report). Hence, the pool diameter is estimated by:

$$D = [(4x\pi) \times (3.53/0.005)]^{0.5} = 30m$$

It is noted that the wharf dimensions are 76m long x 32m wide, hence, the pool will spread to a full diameter of 30m without constriction by the wharf bunding.

To estimate the impacts of a fire on the areas surrounding the wharf, from a flexible hose failure and pool fire on the wharf, the Cirrus model was run using a confined pool of 30m diameter. The results of the analysis are shown in **Figure B14**.

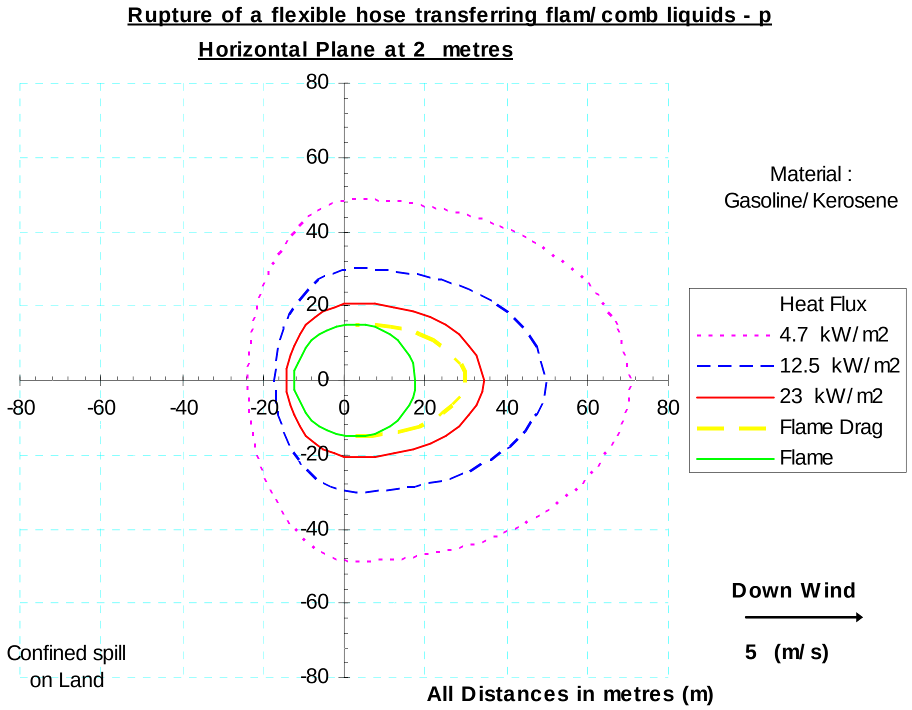

Figure B14 Flammable/Combustible Liquid Leak – Valve Leak at Shore Isolation Heat Radiation Contours

It can be seen from **Figure B14** that the maximum impact distance to the heat radiation levels of interest is:

- $4.7kW/m^2$ = 70m.
- $12.5kW/m^2$ = 50m
- $23kW/m^2$ = 33m

The heat radiation impact at 50m (50pmpy contour) is $12.5kW/m^2$.

Appendix E Air Quality Assessment

Bulk Liquids Berth No. 2 - Port Botany

AIR QUALITY IMPACT ASSESSMENT

- Final
- 7 November 2007

Bulk Liquids Berth No. 2 - Port Botany

AIR QUALITY IMPACT ASSESSMENT

- Final
- 7 November 2007

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Contents

1. Introduction

1.1 General Introduction

Vopak Terminals Sydney Pty Ltd ('the Applicant') is a company that provides bulk liquid services (storage, transport, bulk handling, packaging and distribution) and access to distribution facilities to independent operators and large corporations. These bulk liquids include fuel-based products used for energy and transport functions throughout NSW. Vopak operates two bulk liquid storage terminals in Port Botany, approximately 13 km south of the Sydney CBD. The first is known as the Site A Terminal and is located at 49 Friendship Road. The second facility, known as the Site B Terminal, is located at 20 Friendship Road. Site A stores chemicals and Site B stores petroleum products. Vopak is proposing to obtain approval for the construction and operation of a second Bulk Liquids Berth (BLB2) at Port Botany, NSW on behalf of Sydney Ports Corporation (SPC).

The existing Bulk Liquids Berth (BLB1) is owned and managed by SPC. As with BLB1, BLB2 will be an open access/common user facility for the use of all potential bulk liquids customers. In order to minimise the duplication of facilities between BLB1 and BLB2, the proposal for BLB2 will augment existing BLB1 infrastructure for access control, administration and port officers accommodation, together with a new berth structure and ancillaries (user pipelines, fire protection system, hose handling gantries, berthing and mooring equipment).

BLB2 development would take place adjacent to SPC land at the privately accessed Fishburn Road side (western) of the Site B Terminal, adjacent to the boundary with the Elgas Caverns.

Aspects of the BLB2 proposal consist of the following main elements:

- Central working platform providing a work area, with berthing face (including bollards and fenders) and pipe manifold/ marine loading arm (MLA) arrangements;
- Adjacent berthing dolphins on each side of working platform designed to accommodate up to the maximum length vessel;
- Two mooring dolphins on each side of the working platform (four in total). Mooring dolphins would be required on the northern side of the working platform, instead of the existing land based mooring point arrangement used for the BLB1 due to the geometry of the existing shoreline.
- Walkways (catwalks) connecting the dolphins and working platform;
- An access bridge structure connecting the working platform with the shore and providing for vehicle access and pipeline support structures;
- Support infrastructure including fire control facilities (pumps, foam/water monitors and associated tanks, gatehouse and amenities (the need for a gatehouse is dependant on site security arrangement); and

- Berth fitout, including fire fighting monitors, services such as water, sewer, electrical and communications, amenities and blastproof Operator Shelter.

1.2 Study Objectives

The objective of this air quality study is to review existing air quality in the Port Botany area and to provide an assessment of the likely impacts on air quality during construction and operation of the proposed BLB2. To achieve these objectives the following tasks have been undertaken:

- A review of air quality issues relevant to the construction and operation of the proposed BLB2;
- An outline of the ambient air quality objectives relevant to the project;
- Description of prevailing meteorology and existing air quality in the Port Botany area;
- Quantification of emissions and assessment of air quality impacts once the BLB2 becomes operational; and
- Provision of general recommendations for the mitigation of any adverse air quality impacts.

2. Air Quality Issues

2.1 Overview

This section of the report provides a summary of the characteristics and health effects of pollutants associated with shipping and port operations.

2.2 Project Air Quality Issues

The main air pollutants emitted due to ship activities are nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and particulates. Emissions of sulphur oxides (SO_x) from shipping due to combustion of marine fuels with high sulphur content contribute to air pollution in the form of sulphur dioxide and particulate matter. Volatile organic compounds are also generated during loading operations, these are addressed in the report but considered minimal.

Construction emissions are considered localised and minimal, predominantly comprising particulate dust emissions. Construction emissions are considered qualitatively in **Section 6**.

2.3 Air Quality Effects

2.3.1 Oxides of Nitrogen

The production of NO_x occurs in most combustion processes due to the oxidation of nitrogen in fuel and air. A number of nitrogen oxides are formed including nitric acid (NO) and NO_2. Generally at the point of emission NO to NO_2 ratio is 90:10 by volume of NO_x. Ultimately all the NO emitted into the atmosphere is oxidised to NO_2 and to other oxides of nitrogen. The rate at which this conversion occurs depends on a number of factors including temperature, topography, local meteorological circulation patterns, the presence of an inversion, and the presence of ozone. This conversion rate is important because the rate of conversion can affect ground level concentrations of NO_2.

2.3.2 Ozone

Ozone is a secondary pollutant, formed by a complex series of chemical reactions between NO_x and reactive organic compounds in the presence of sunlight. Ozone is a major constituent of photochemical smog. As such ozone is an accepted indicator of smog level.

2.3.3 Sulphur Dioxide

SO_2 is generated during the combustion process of fuels containing sulphur, e.g. coal, oil or diesel. Emissions of SO_2 in the metropolitan area are generally low, with emission sources including petroleum refining, chemical manufacturing, shipping and motor vehicles.

SKM

2.3.4 Air Borne Particulate Matter

Air borne particulate matter is any material, except uncombined water, that exists in a solid or liquid state in the atmosphere or gas stream at standard condition. Air borne particles generally range in size from 0.001-500μm, with the bulk of the particulate mass in the atmosphere ranging from 0.1-10 μm.

Common size related terms are the classes Total Suspended Particulate Matter (TSP) and PM_{10}. TSP refers to the concentration of all particles in the atmosphere, while PM_{10} refers to all particles with aerodynamic sizes less than 10 μm. Particulate matter is generated by industry, motor vehicles, refuse disposal, ocean salt, volcanic ash, products of wind erosion, roadway dust, bush fires and plant pollen and seed.

2.3.5 VOCs

Benzene, toluene, ethylebenzene and xylenes are among a wide range of toxic organic compounds that typically exist in relatively low concentrations in ambient air. They are of concern because of their potentially significant effects on the health of humans and the environment at low concentrations that may be found in the ambient environment.

Air toxics are emitted from a wide range of sources including combustion sources such as vehicle engines, coal fired power plants, incinerators, industry, domestic solid fuel heaters, cigarette smoking, and bushfires. Non-combustion sources includes industry, vehicle fuels, cleaning products, paints and solvents.

2.4 Health Effects Associated with Various Air Pollutants

A summary of health hazards associated with the pollutants emitted or produced as a result of the emissions from ships are listed in **Table 2-1**.

- **Table 2-1: Health hazards from air pollutants associated with the port activities**

Pollutant	Health Effect
Oxides of Nitrogen	Can contribute to problems with heart and lungs; links to decreased resistance to infection. Has harmful effects on plants by decreasing the rate of photosynthesis.
Ozone	Coughing and wheezing, eye irritation, respiratory problems (particularly for those with conditions such as asthma). Has harmful effects on plants, and damages materials and textiles.
Sulphur Dioxide	Effects include respiratory problems, illness and cardiovascular disease, with asthma sufferers or people with chronic lung or heart disease being the most susceptible. At high levels it may result in the burning of the nose and throat. It also can damage trees and crops, and can be a precursor to acid rain.
Particulate Matter	Particulate enhances chemical reactions in the atmosphere, reduces visibility, increases the possibility of precipitation, fog and clouds and reduces solar radiation. Particulate matter also represents a health hazard to the lungs.
VOCs	Eye irritation; respiratory problems; some compounds are carcinogens.

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3. Local Environmental Setting

3.1 Overview

This section of the report provides a description of the geography and topography of the surrounding area, as well as a study of the meteorological and air quality conditions in the Port Botany area.

3.2 Local Setting

The BLB2 site would be located on the southern side of the port area at Port Botany. Sydney (Kingsford Smith) Airport is located north-west of the port, with the Parallel Runway situated 1 km due west of the Patrick Terminal. The proposed BLB2 would be situated to the south of the existing BLB1 (refer to **Figure 3-1**).

- **Figure 3-1: Location of the Proposed BLB2 at Port Botany**

Botany Bay is located on the eastern fringe of the Sydney Basin, with the Sydney Central Business District (CBD) located approximately 11 km north of the Port. The location lends itself to morning westerly winds (particularly during the cooler months) associated with morning drainage flows from the higher regions west of Sydney and across Parramatta. In the afternoon, winds reflect the sea breeze, and come on shore.

The local topography is generally flat with surrounding suburban areas rising to 20-30 m above sea level. There is however, an elevated area at the northern head of Botany Bay, with relatively sharp land inclination rising up to the NSW Golf Club. There are some small coastal cliffs with slight elevation in land around Little Bay, Tupia Head and Boora Point, which may provide some protection from off-shore winds heading to the site from the east and south-east.

3.3 Local Land Use

The predominant land use in the vicinity of the port facilities is the Sydney (Kingsford Smith) Airport located within 5 km from the Port. The Botany Freight Rail line is located to the north and north-east of the proposed development area. Botany Road (a major arterial road) passes the rail line at the Beauchamp Road intersection at the north-east of the existing Patrick Terminal.

The major land use of the northern Botany Bay region around Banksmeadow and Matraville is predominantly industrial. The main industries within this area are:

- Orica Australia, Banksmeadow;
- Amcor Paper Mill, Botany;
- BP Oil Terminal, Botany;
- Exxon Mobil Oil Terminal, Botany;
- Caltex Terminal, Banksmeadow;
- Metal Recyclers;
- A.C Hatrick;
- Johnson & Johnson;
- Kelloggs;
- Port-Air Industrial Estate, Botany; and
- Caltex Refineries, Kurnell (southern shore of Botany Bay), and associated wharf/shipping operations.

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Other land uses within the area include:

- Commercial - mainly along the western shores of the Bay around Brighton Le Sands; and
- Recreational - such as fishing (including beach fishing), picnicking, sight-seeing and bird watching in the reserves around Phillip Bay and the Botany Bay National Park on the north head, boating, swimming, golf courses, water sports, and cycling.

There are also residential areas around Port Botany. The suburb of Botany is located closest to the Port, located 0.5-1 km to the north. East Botany is approximately 2.5 km to the north of the port. Approximately 2.5 km to the east of the site, and extending to the coast, is a relatively large residential area consisting of Hillsdale, Matraville and Maroubra. This area is approximately 2.5 km from the proposed development area.

Sensitive receivers such as schools, hospitals, and sensitive populations within residential areas include:

- Banksmeadow Primary School (800 m north);
- Botany Nursing Home (1.2 km north-west);
- Matraville Primary School (1.8 km north-east);
- Chifley Public School (2.5 km east);
- St Agnes Primary School, Matraville (2.6 km east-north-east);
- Matraville High School (2.7 km east);
- Matraville Soldiers' Settlement Public School, Matraville (2.8 km east-north-east);
- Botany Primary School (2.8 km north-west);
- St Spyridon High School, Matraville (2.9 km east);
- Malabar Primary School (3 km east);
- Long Bay Correctional Centre, Malabar (3 km east-south-east);
- La Perouse Primary School (3.2 km south-east);
- University of NSW, Chifley campus (3.4 km south-east); and
- Prince Henry (The Coast) Hospital and Primary School, Little Bay (3.5 km south east).

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3.4 Climatology and Dispersion Meteorology

The Bureau of Meteorology (BoM) operates an Automatic Weather Station (AWS) at Sydney Airport (Kingsford Smith) (BoM station ID 066037). It is located at 33°56' S, 151°10' E and at an elevation of 6 m. The following sections provide a summary of the climatic conditions recorded at this station since 1929, with a summary table provided in **Table 3-1**.

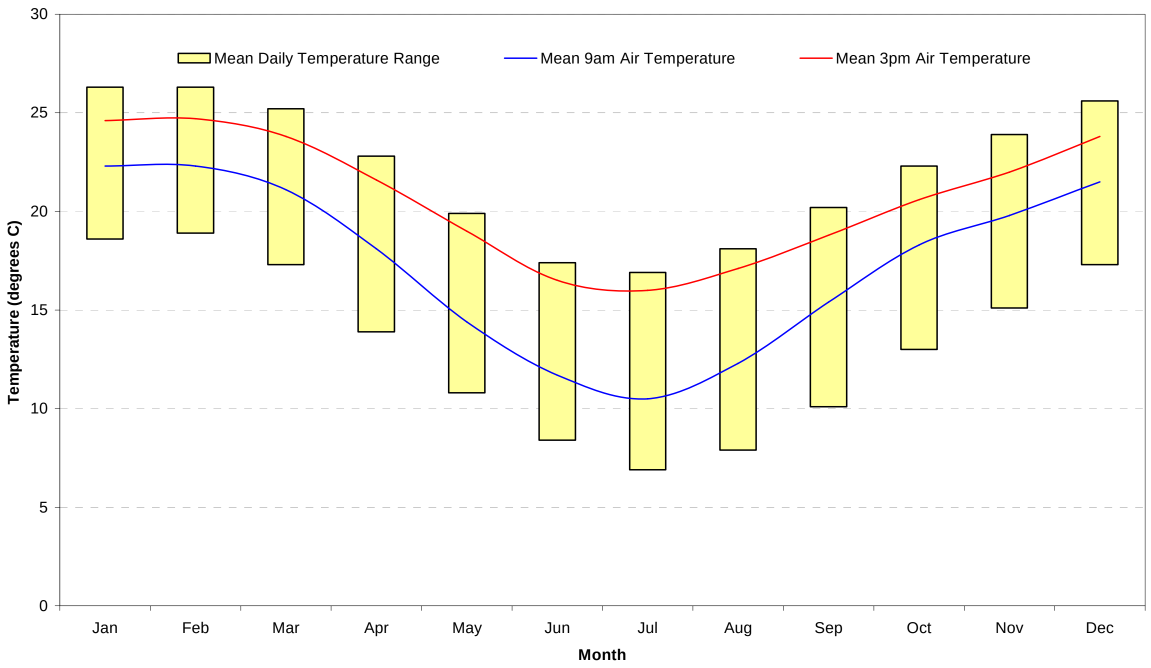
3.4.1 Temperature

The BoM has recorded temperature at Sydney Airport over a period of at least 65 years. As shown in **Figure 3-2** the Botany area experiences a warm to mild climate with quite a mild range in temperatures throughout the year.

The 9am mean daily temperature range between 22.3°C in January to 10.5°C in July. The 3pm mean temperature range is between 24.7°C in February and 16.0°C in July. Overall, the warmest months of the year are January and February, which receive mean daily maximum temperatures of 26.3°C.

July is the coolest month, experiencing a mean daily maximum temperature of 16.9°C. These daily temperature ranges are indicative of a relatively mild climatic conditions experienced within the Botany area.

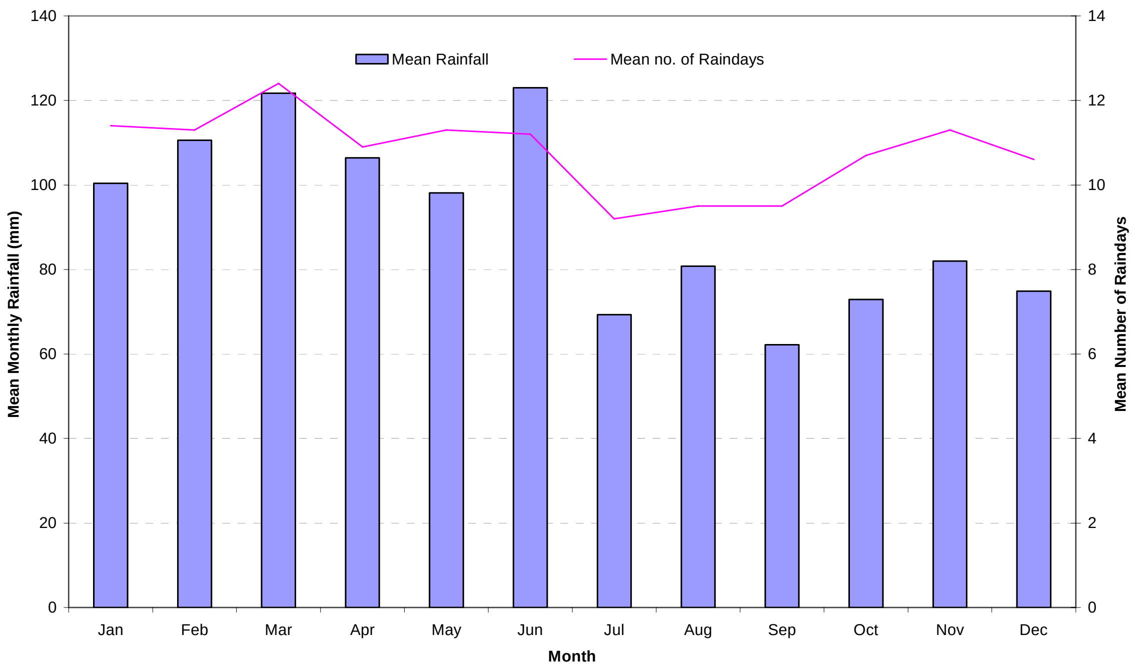
- **Figure 3-2: Mean Monthly Temperature at Sydney Airport**



3.4.2 Rainfall

The rainfall data presented in **Figure 3-3** shows that the Botany area experiences a mild seasonal variation in the distribution of rain, with most rain falling during the late summer and autumn months. The mean annual rainfall at Sydney Airport is approximately 1,106 mm, which occurs over an average of approximately 129 days. The driest month is September, which receives a mean monthly rainfall of 62 mm. The wettest months of the year are March and June, receiving 122 mm and 123 mm respectively. Rain typically falls on at least 9 days per month throughout the year, with the highest number of rain days (12) occurring during March.

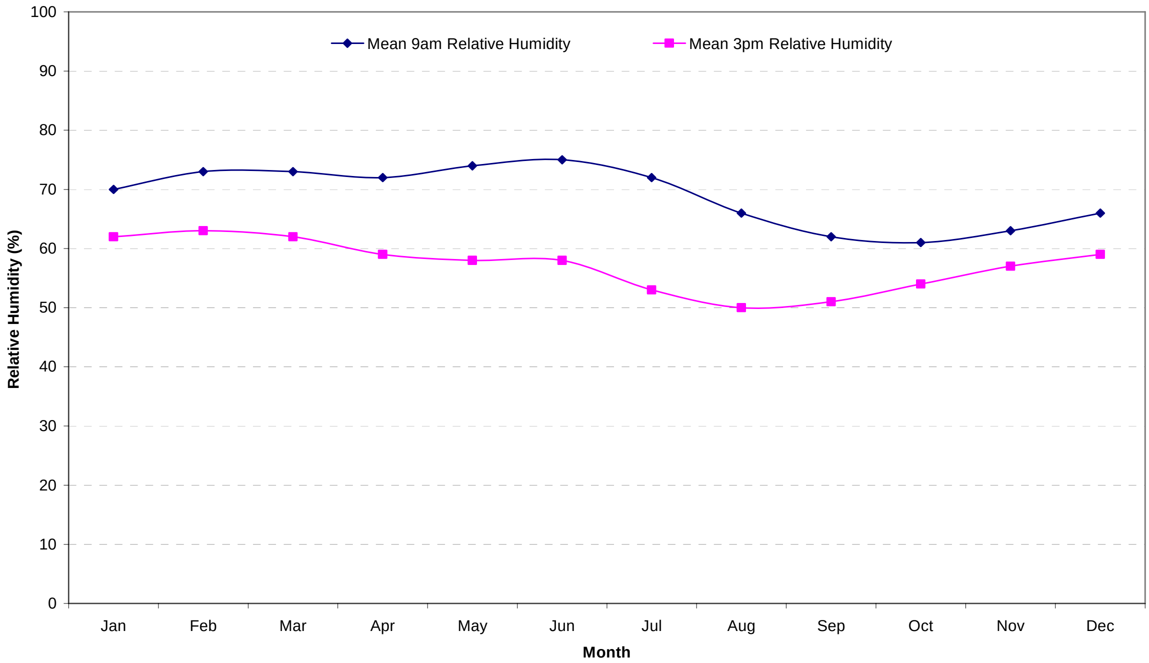
- **Figure 3-3: Mean Monthly Rainfall at Sydney Airport**



3.4.3 Relative Humidity

The 9am and 3pm relative humidity readings recorded at Sydney Airport are shown in **Figure 3-4**. Relative humidity varies on both a daily and seasonal cycle. At 9am humidity is highest during the cooler months from April to July. The annual range in 9am humidity is between 75% in June to 61% in October. The 3pm relative humidity readings are typically lower than the 9am values, and are generally greatest during the warmer summer months. The 3pm readings range between 63% in February to 50% in August.

■ **Figure 3-4: Mean Monthly Relative Humidity at Sydney Airport**



3.4.4 Wind Speed and Direction

A description of wind speed and direction is provided in windroses generated from data collected at the Sydney Airport station since 1939. The 9am windroses are presented in **Figure 3-5** and the 3pm windroses are in **Figure 3-6**.

Summer 9am winds are predominantly from the south (approximately 27% occurrence), however a full range of directions can be experienced. By mid afternoon (as seen from the 3pm windroses) winds tend to move to more easterly directions.

Late autumn and winter 9am windroses show a very high percentage of winds from the west (35% in July) and north-west (40%), with afternoon winds coming from a variety of directions but predominantly from the south to west. There are some afternoon winds that begin to come from the north-east by late winter.

The percentage of winds from the north-east during the afternoon increases to approximately 27% in spring, and then by summer this direction represents the highest percentage of wind directions during the afternoon.

Afternoon winds during autumn are from the north-east through to the south, with only a very small percentage of winds blowing from westerly directions. By late autumn, afternoon wind directions from these westerly (and other) directions increase in percentage occurrence, however winds from the south still dominate.

During winter, afternoon winds are generally either from the south or west, however winds from all directions are often experienced.

Wind speeds are greatest during spring, with the highest monthly mean 9am wind speed occurring during October of 4.4 m/s. November and December experience the highest mean 3pm wind speed, being 6.8 m/s. For all months of the year, wind speeds are lower in the morning, and then pick up in speed by the afternoon. This is as expected with air differentials increasing throughout the day due to heating of the land surface.

3.4.5 Meteorological Data used in Modelling

The BoM AWS at Sydney Airport is located 5 km north-west of the study area. The study site is in a similar topographical and geographical location as Sydney Airport. Both sites are located on the northern shoreline of Botany Bay. As such, the meteorological conditions experienced at Sydney Airport can be used to sufficiently describe the conditions expected at the proposed BLB2.

Meteorological data used in dispersion modelling has been obtained from the BoM, generated from data collected at Sydney Airport for the period January to December 2000.

The seasonal 9am and 3pm windroses 2000 are shown in **Figure 3-7** and **Figure 3-8** respectively. Analysis of the windroses indicate that the 2000 meteorological data collected at Sydney Airport generally compares well with the longer-term data. Summer 9am winds during 2000 showed 31% of all winds were from the south to south-east, comparing to similar proportions for the longer-term windroses. Autumn 9am winds are comparable, except that the high proportion of southerlies evident during March (long-term) did not occur to the same extent in 2000. Winter 9am and spring winds correlate well with the longer term conditions, although the high proportion of 9am winds from the north-north-east during spring 2000 are not experienced to the same extent under normal spring conditions.

Seasonal 3pm windroses plotted from 2000 conditions correlate very well with the longer-term conditions, except that the longer-term spring windrose shows an approximate 18% occurrence of southerly winds for all spring months that only represent 4.4% occurrence during 2000.

The 2000 windroses are generally a very good representative of longer-term meteorological conditions expected at Sydney Airport and Port Botany. As such, the use of the 2000 data is sufficient for the purpose of undertaking the air dispersion modelling and impact assessment.

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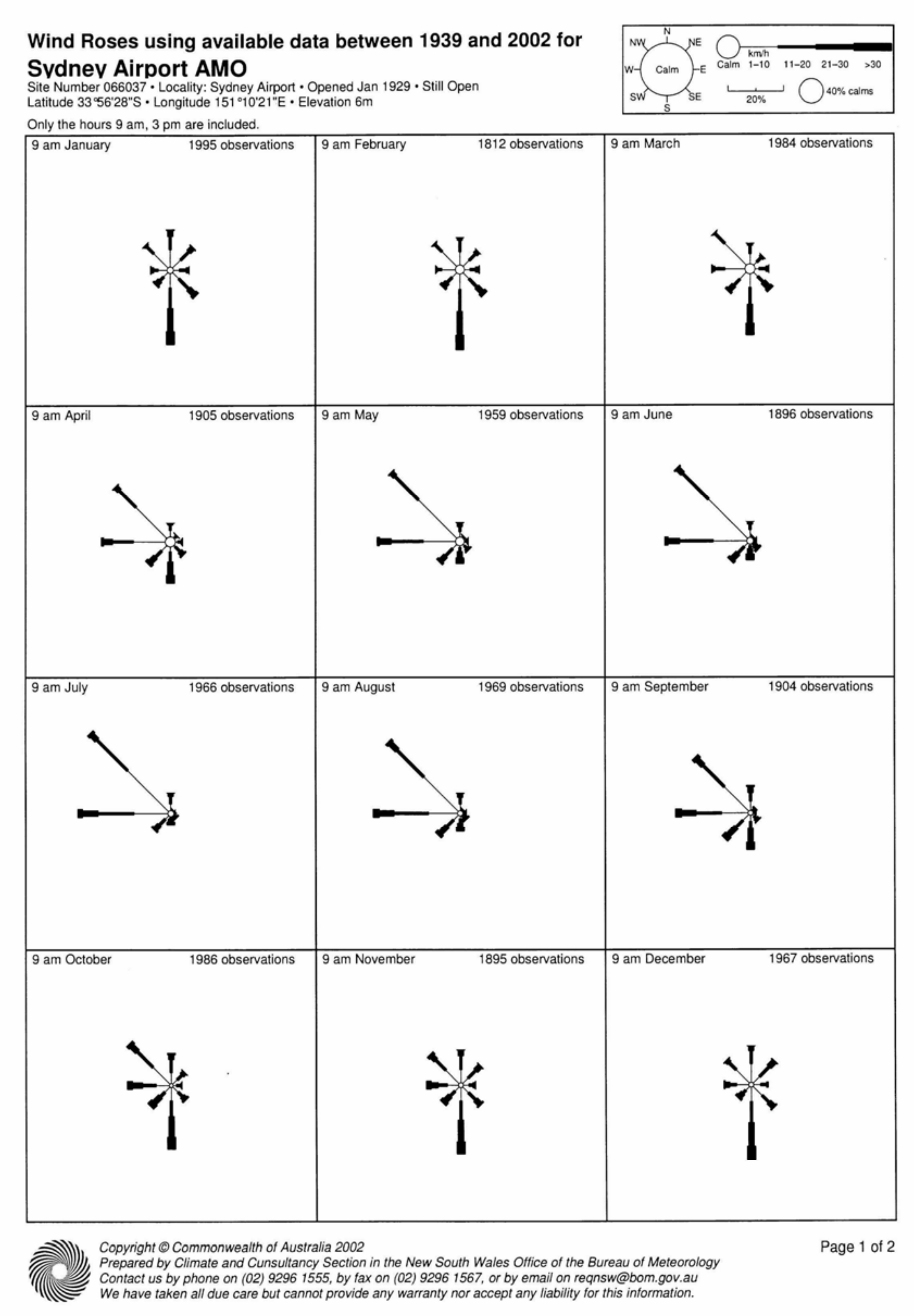
- **Figure 3-5: Long Term 9am Windroses for Sydney Airport**



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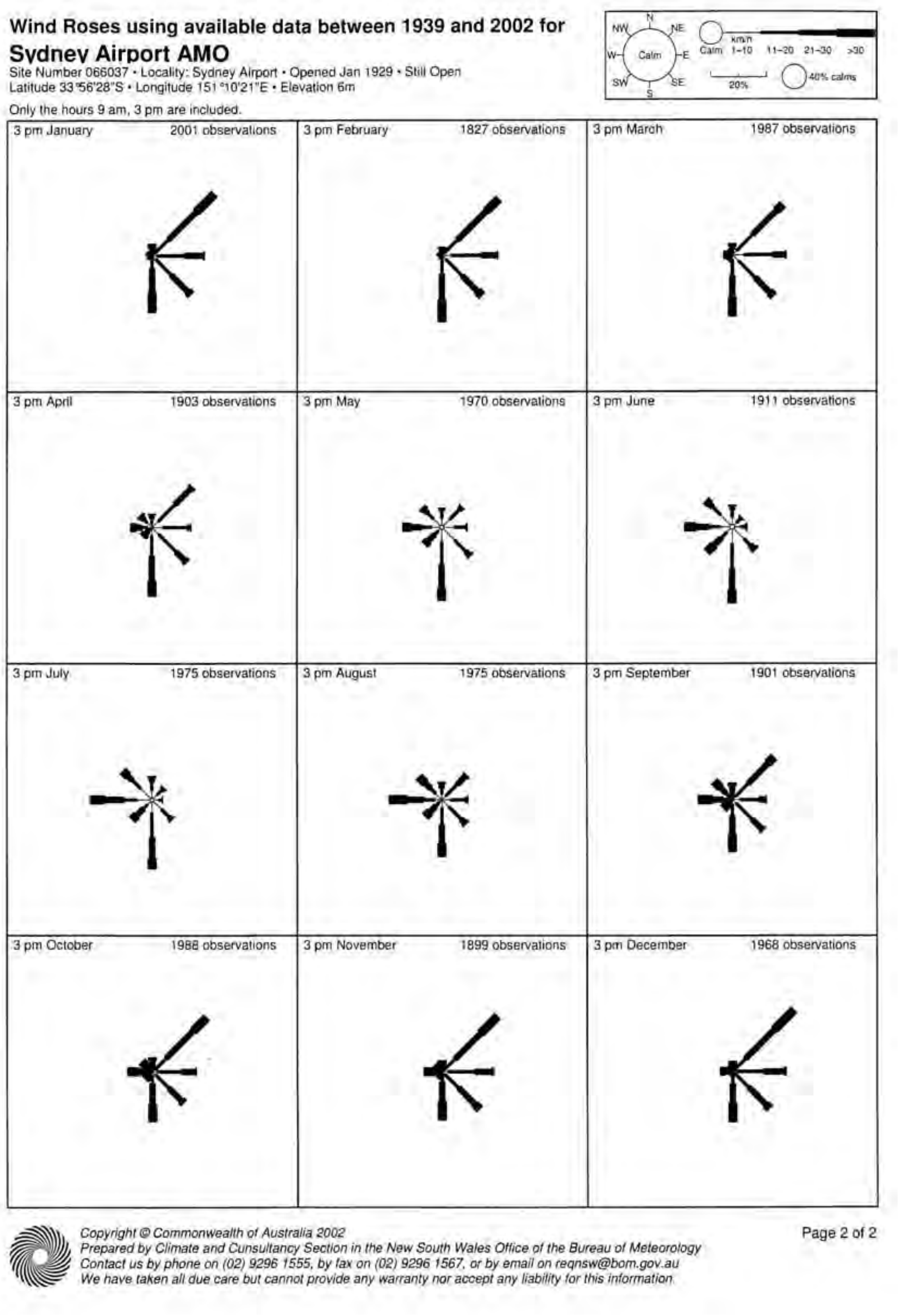
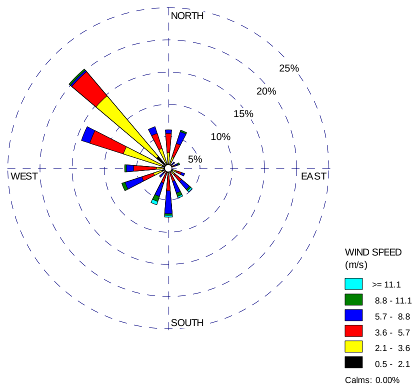
- **Figure 3-6: Long Term 3pm Wind Roses for Sydney Airport**

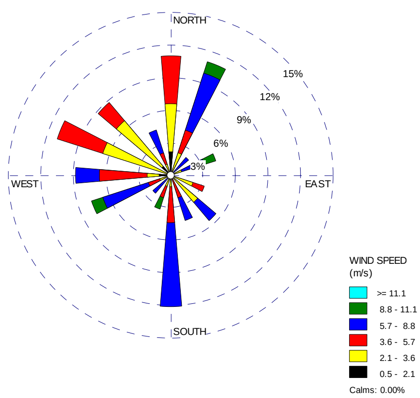


■ **Figure 3-7: Annual and Seasonal 9am Windroses for Sydney Airport (2000)**

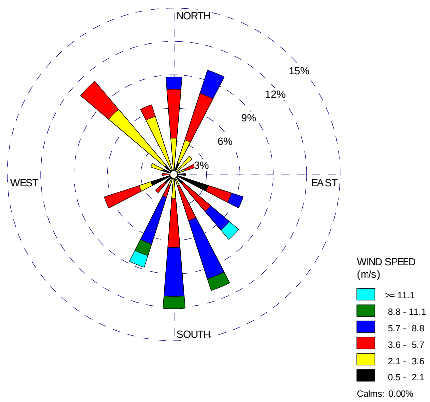
Annual



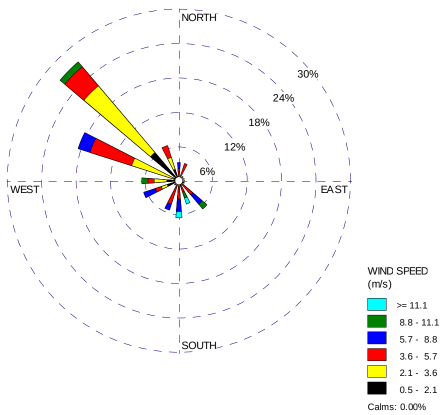
Spring



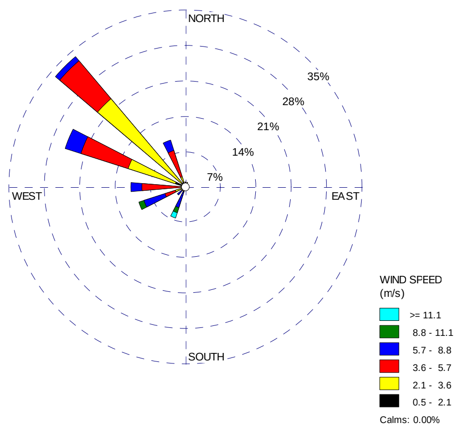
Summer



Autumn



Winter



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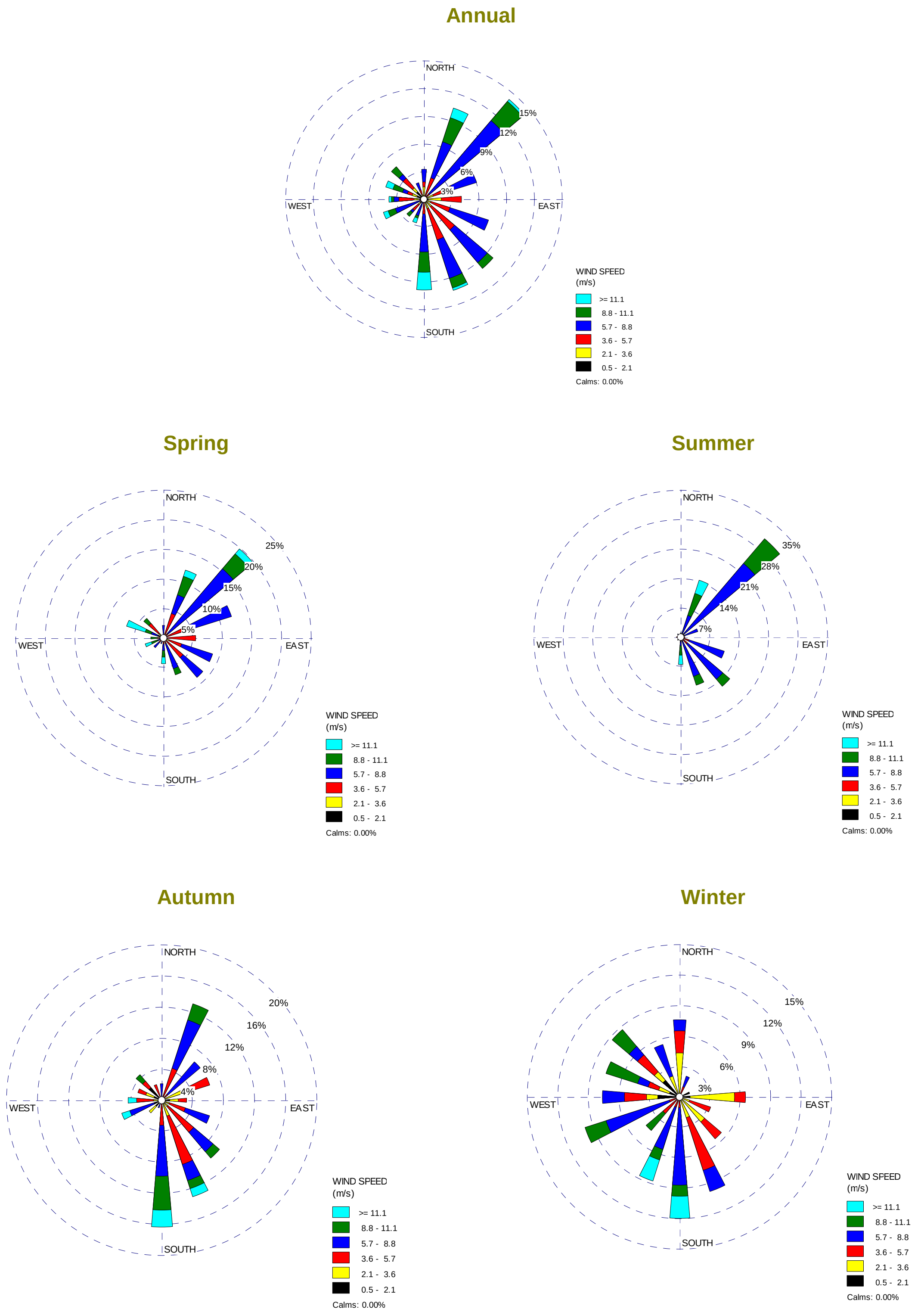
- **Figure 3-8: Annual and Seasonal 9am Windroses for Sydney Airport (2000)**



- **Table 3-1: Climate Summary for Sydney Airport**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Daily Max Temp (°C)	26.3	26.3	25.2	22.8	19.9	17.4	16.9	18.1	20.2	22.3	23.9	25.6	22.1
Highest Max Temp (°C)	43	42.6	41.2	35.7	30	26.8	26.7	31.1	35.6	38.2	43.4	43.2	43.4
Mean Daily Min Temp (°C)	18.6	18.9	17.3	13.9	10.8	8.4	6.9	7.9	10.1	13	15.1	17.3	13.2
Lowest Min Temp (°C)	9.7	11.2	7.4	6.1	3	1	-0.1	1.2	2.3	4.8	5.9	8.2	-0.1
Mean 9am Air Temp (°C)	22.3	22.3	21.1	18.1	14.4	11.7	10.5	12.3	15.4	18.3	19.8	21.5	17.3
Mean 9am Dew Point Temperature (°C)	16.2	16.9	15.8	12.6	9.6	7.2	5.4	5.8	7.7	10.2	12.1	14.6	11.2
Mean 9am Relative Humidity (%)	70	73	73	72	74	75	72	66	62	61	63	66	69
Mean 9am Wind Speed (m/s)	3.9	3.7	3.5	3.4	3.3	3.5	3.5	3.8	4.1	4.4	4.3	4	3.8
Mean 3pm Air Temp (°C)	24.6	24.7	23.8	21.6	19	16.5	16	17.1	18.8	20.6	22	23.8	20.7
Mean 3pm Dew Point Temp (°C)	16.2	16.7	15.5	12.6	9.9	7.6	5.6	5.6	7.5	9.9	12.1	14.4	11.1
Mean 3pm Relative Humidity (%)	62	63	62	59	58	58	53	50	51	54	57	59	57
Mean 3pm Wind Speed (m/s)	6.5	6.2	5.8	5.1	4.5	4.8	4.9	5.6	6.2	6.6	6.8	6.8	5.8
Mean Rainfall (mm)	100.4	110.6	121.7	106.4	98.1	123	69.3	80.8	62.2	72.9	82	74.9	1102.4
Mean no. of Raindays	11.4	11.3	12.4	10.9	11.3	11.2	9.2	9.5	9.5	10.7	11.3	10.6	129.4
Highest Monthly Rainfall (mm)	400.4	596.9	393	476.2	421.7	465.9	253.7	387.8	249.4	271.3	396.1	359.2	-
Lowest Monthly Rainfall (mm)	5.4	2.5	6.4	8	2.9	2.5	0	0.2	1.6	0	5.7	4.8	-
Highest Daily Recorded Rain (mm)	157	216.2	202	174	165.9	151.2	132.6	207	115.4	112.3	143.3	182.1	216.2
Mean no. of Clear Days	6.5	5.7	7.6	8.8	8.8	8.9	11.9	13	10.8	7.9	6.2	6.3	102.4
Mean no. of Cloudy Days	13.4	12.2	12.2	10.6	11.2	10.8	8.4	8	8.6	11.3	11.7	12.4	130.7
Mean Daily Evaporation (mm)	7.1	6.5	5.3	4.1	2.9	2.5	2.7	3.7	4.7	5.7	6.5	7.4	4.9
Mean Daily Sunshine (hrs)	7.4	7.3	6.9	6.8	5.8	5.9	6.6	7.8	7.8	7.9	7.7	8	7.2
Maximum Wind Gust (km/hr)	151.9	107.6	127.8	122.4	129.6	129.6	109.4	114.8	111.2	126	151.9	126	151.9

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3.5 Existing Air Quality

Air quality within the area surrounding Port Botany is influenced by both local and regional pollutant sources, including road traffic, domestic sources, aircraft and a variety of industrial emissions. The proximity to local pollutant sources and the influence of sea breezes play significant roles in the dispersion of pollutants around Botany Bay.

As part of the NSW DECC's air quality monitoring network, PM_{10} (1-hour, TEOM), SO_2 (1-hour), ozone (1-hour) and NO_2 (1-hour) are monitored at Randwick station, located approximately 5.3 km north-east of Port Botany at the Randwick Barracks.

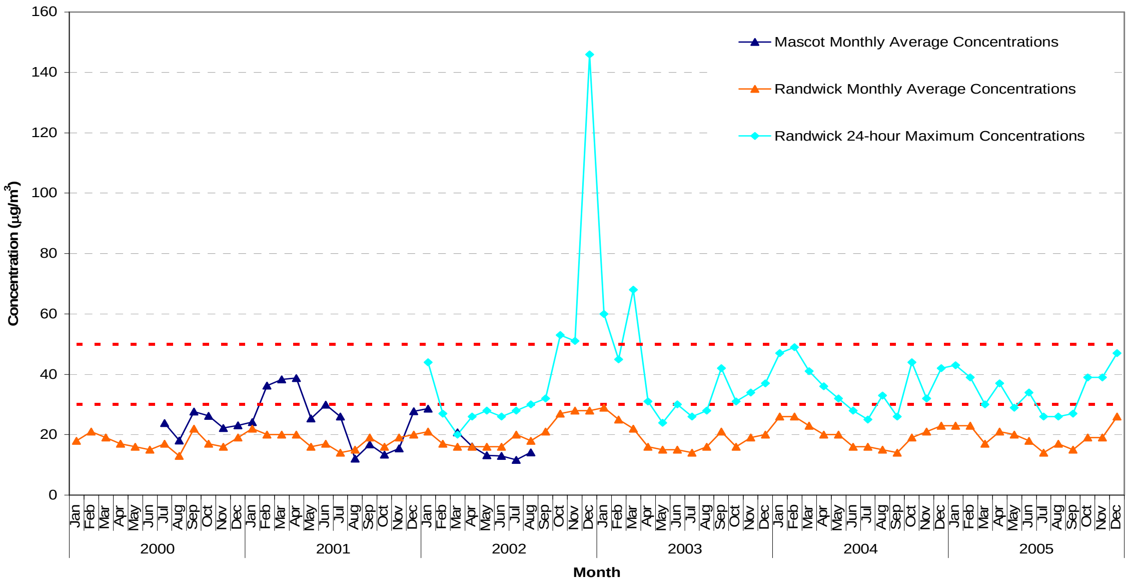
An AQMS is also located at Sydney Airport located approximately 4.9 km to the north west of the site. The site monitors a number of air pollutants including PM_{10} (1-hour, TEOM), SO_2 (1-hour), ozone (1-hour) and NO_2 (1-hour). VOCs are not monitored at either station.

3.5.1 Particulate Matter

Maximum 24-hour and monthly average PM_{10} concentrations are presented graphically in **Figure 3-9**. Generally higher concentrations of particulate matter are experienced during the summer months, often due to the hot dry conditions which leads to airborne dust. In particular, the annual average DECC criteria of 30 µg/m^3 is reached at the Randwick site during the October to January 2002/2003 reflecting bushfire smoke from fires in the Sydney as well as Canberra region.

Mean monthly concentrations are similar between the two sites, with the exception being February, March and April 2001 where much higher PM_{10} concentrations were recorded at the Mascot site.

- **Figure 3-9: Maximum 24-hour and Mean Monthly PM_{10} Concentrations**



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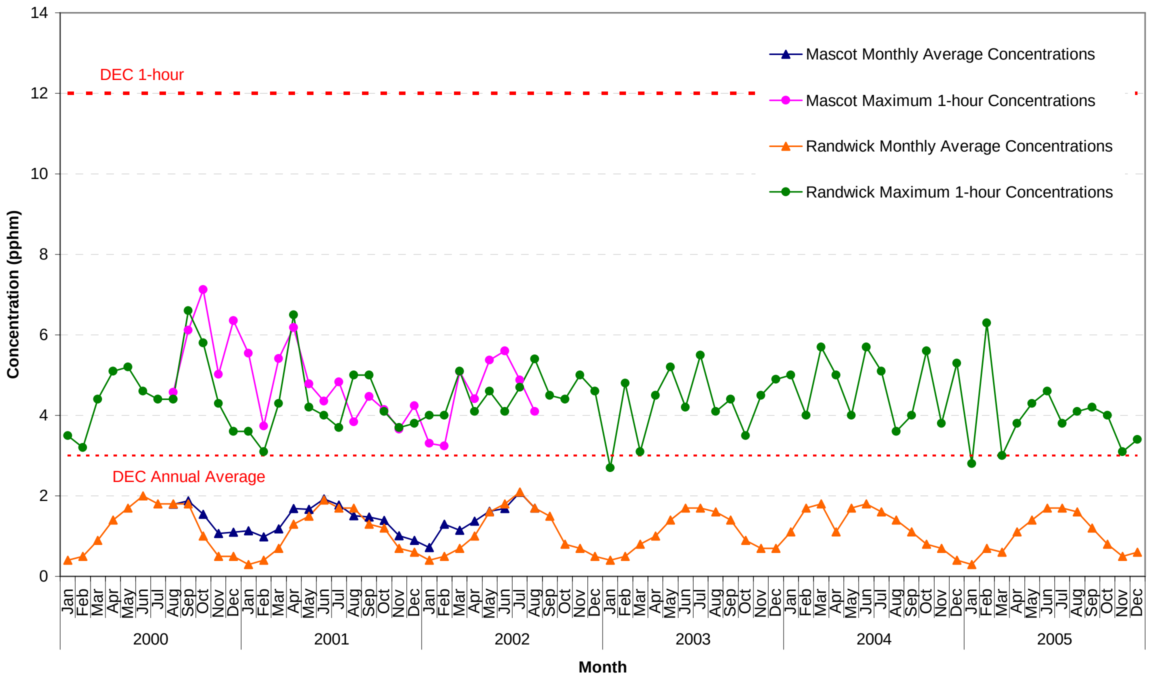
3.5.2 Nitrogen Dioxide

Mean monthly average and maximum 1-hour NO_2 concentrations are displayed graphically in **Figure 3-10**. Here it can be seen that mean monthly NO_2 concentrations vary on a seasonal basis, with higher NO_2 concentrations being recorded during the warmer months of the year. Maximum 1-hour concentrations are well below the DECC criteria of 12 pphm at both sites. Mean monthly average concentrations and maximum 1-hour concentrations are similar at both sites and are also below the relevant DECC criteria.

- **Figure 3-10: Maximum 1-hour and Mean Monthly NO_2 Concentrations**

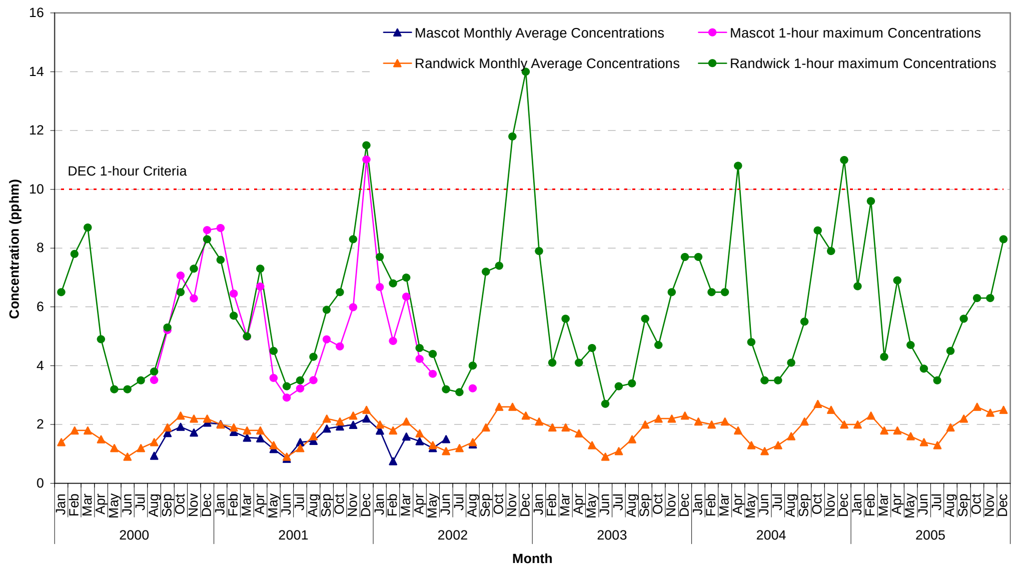


3.5.3 Ozone

Mean monthly ozone concentrations are displayed graphically in **Figure 3-11**. Ozone concentrations vary on a seasonal basis, with higher concentrations being recorded during the warmer months of the year.

Maximum 1-hour ozone concentrations at both sites are generally below the DECC criteria of 10 pphm. However, exceedances were recorded at both sites between 2000 and 2005. These were up to 14 pphm at Randwick, and 11 pphm at Sydney Airport.

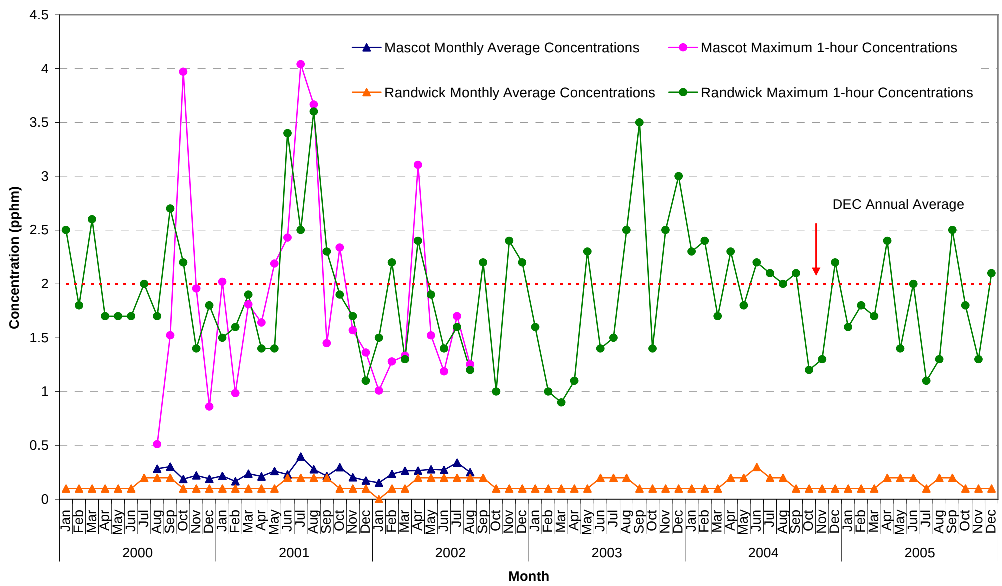
- **Figure 3-11: Maximum 1-hour and Mean Monthly O_3 Concentrations**



3.5.4 Sulphur Dioxide

Mean monthly and maximum 1-hour SO_2 concentrations recorded at Randwick and Sydney Airport are presented graphically in **Figure 3-12**. Mean monthly average concentrations are well below the annual average DECC criteria of 2 pphm. Maximum 1-hour concentrations are also well below the DECC criteria of 20 pphm.

- **Figure 3-12: Maximum 1-hour and Mean Monthly SO_2 Concentrations**



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A summary of background data for Randwick is provided in **Table 3-2**.

- **Table 3-2: Summary of Background Air Quality Monitoring Data (bold represent exceedances)**

Pollutant	Ave Period	2000		2001		2002		2003		2004		2005	
		µg/m³	pphm	µg/m³	pphm	µg/m³	pphm	µg/m³	pphm	µg/m³	pphm	µg/m³	pphm
Randwick													
PM_{10}	24-hour	-	-	-	-	**146**	-	**68**	-	49	-	47	-
	Annual	18	-	18	-	20	-	19	-	20	-	19	-
NO_2	1-hour	124	6.6	122	6.5	102	5.4	103	5.5	107	5.7	118	6.3
	Annual	23	1.2	21	1.1	21	1.1	21	1.1	24	1.3	19	1.0
SO_2	1-hour	71	2.7	94	3.6	63	2.4	92	3.5	63	2.4	65	2.5
	24hour	-	-	-	-	13	0.5	18	0.7	18	0.7	16	0.6
	Annual	3	0.1	3	0.1	3	0.1	3	0.1	5	0.2	3	0.1
Ozone	1-hour	171	8.7	**226**	11.5	**275**	**14**	155	7.9	**216**	**11**	188	9.6
	4-hour	-	-	-	-	**239**	**12.2**	139	7.1	**165**	**8.4**	151	7.7

Overall it was considered that use of the local Sydney Airport air monitoring data for this study would be representative of the background air quality in the Port Botany area, and is comparable to the NSW DECC monitoring data.

4. Air Quality Criteria

4.1 Overview

This section of the report outlines the relevant air quality criteria as described by the Department of Environment and Climate Change (DECC) in their *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales* (2005). Emission standards which are relevant to shipping are also discussed.

4.2 Ambient Air Quality Objectives

The DECC regulates air quality objectives in NSW to ensure that air quality is maintained at an acceptable level for health and the environment. Air quality impact assessment criteria quoted below have been sourced from the DECC publication - *Approved Methods and Guidance for the Modelling of Air Pollutants in New South Wales* (DECC, 2005).

The key air emissions relating to this project that have potential to impact on the local environment are from ship exhausts including fine particulate matter, NO_x and SO_2. Emissions of volatile organic compounds (VOCs) may also be emitted when liquids are being discharged. Air quality objectives relevant to the project are provided in **Table 4-1**.

- **Table 4-1: Ground Level Impact Assessment Criteria (DECC, 2005)**

Pollutant	Averaging Period	Concentration (pphm)	Concentration (μg/m^3)
Sulphur Dioxide	10 minutes	25	712
	1 hour	20	570
	24 hours	8	228
	Annual	2	60
Nitrogen Dioxide	1 hour	12	246
	Annual	3	62
PM_{10}	24 hours	50	50
	Annual	30	30
TSP	Annual	90	90
		ppm	**mg/m^3**
Benzene	1 hour	0.009	0.029
Toluene	1 hour	0.09	0.36
Ethylbenzene	1 hour	1.8	8
Xylenes	1 hour	0.04	0.19

It should be noted that this criteria refers to the total impact from all sources in the area i.e. emissions from the port as well as emission from motor vehicles, airport activities and other industry.

4.3 Ship Emission Standards

The *Protection of the Environment Operations (Clean Air) Regulation 2002* (POEO) replaces the *Clean Air (Domestic Solid Fuel Heaters) Regulation 1997*, *Clean Air (Motor Vehicles and Motor Vehicle Fuels) Regulation 1997* and *Clean Air (Plant and Equipment) Regulation 1997*.

The POEO regulation covers emissions from a variety of sources including stack emissions from power stations, industry, motor vehicle exhaust etc, but does not cover ship emissions. Ship emissions are covered in Marine Air Pollution 1973/1978 (Marpol 73/78), the International Convention for the Prevention of Pollution From Ships, and covers ship emissions for NO_x. Marpol 73/78 is one of the most important international marine environmental conventions and is designed to minimise pollution of the seas, including dumping, oil and exhaust pollution.

Annex VI, the Prevention of Air Pollution from Ships, came into force in 2005. The regulations in this annex sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances. The annex includes a global cap of 4.5% m/m on the sulphur content of fuel oil and calls on IMO to monitor the worldwide average sulphur content of fuel.

Regulation 13 of Annex VI represents the NO_x Technical Code: *Technical Code on Control of Emissions of Nitrogen Oxides from Marine Diesel Engines*. The Code applies to all engines installed on ships constructed after 1 January 2000 or engines which undergo a major conversion after 1 January 2000. Ship engines are required to operate such that NOx emissions are within the following limits:

- 17.0 g/kWh for engines less than 130 rpm (slow speed engines);
- $45.0*n^{-0.2}$ g/kWh, when 130 < n (engine rating) < 2,000 rpm; and
- 9.8 g/kWh for engines greater than 2,000 rpm (high speed engines).

5. Current and Proposed Activities

5.1 Current Activities at BLB1

BLB1 is located west of the P&O terminal, and is adjacent to Brotherson Dock which services the containerised import and export sector.

The three main product groups which are imported and exported at the BLB1 are:

- Hydrocarbons, such as LPG;
- Chemical products, such as organic chemicals, caustic soda; and
- Petroleum products, such as petroleum, diesel, naphtha and jet fuel.

Biodiesel products are expected to be handled in the future.

Currently BLB1 provides facilities to import products into:

- Vopak terminals Site A and Site B for petroleum and chemical products;
- Exxon Mobil terminal at Stephens Road Port Botany (“Mobil Site”) for petroleum products;
- Terminals Pty Ltd site at 43-45 Friendship Road and 11-13 Simblist Road, at Port Botany (“Terminals Site”) for petroleum and chemical products;
- Elgas Pty Ltd site at 30 Friendship Road, Port Botany (“Elgas Site”) for LPG;
- Qenos Australia Pty Ltd at 39 Friendship Road, Port Botany (“Orica Site”) for LPG; and
- Origin Energy site at 47 Friendship Road, Port Botany (“Origin Site”) for LPG.

It also provides facilities to export products from the following locations:

- Vopak Sites A and B for petroleum and chemical products;
- Exxon Mobil Site for petroleum products;
- Terminals Pty Ltd Site for chemical products;
- Elgas Pty Ltd Site for LPG;
- Origin Energy for Py-Gas and ethylene; and
- Qenos Australia Pty Ltd for LPG (small amounts).

Exports (with the exception of gas exports) currently form only a small portion of the BLB throughput. Based on time at the berth, the major products influencing the berth time are petroleum products and LPG. The expected total import and export volumes for BLB1 for 2007-2009 are provided in **Table 5-1**.

- **Table 5-1: BLB1 Expected Total Import and Export Volumes for 2007-2009 (kL)**

Product	2007	2008	2009
Chemicals	140,918	140,918	140,918
Gas	1,000,538	1,034,830	1,054,820
Biodiesel	65,625	112,500	288,719
Refined Petroleum	1,116,603	1,234,053	1,445,652
Total	2,323,684	2,522,301	2,930,109

5.2 Proposed Activities at BLB2

The expected volumes of chemicals, biodiesel and petroleum to pass through BLB2 up to 2022 are provided in **Table 5-2**. The respective number of ship movements at BLB2 are provided in **Table 5-3**.

- **Table 5-2: Expected Volumes through BLB2 (kL)**

Type	2010	2011	2012	2020	2021	2022
Chemical						
DG Class 3	14 092	14 092	14 092	14 092	14 092	14 092
DG Class 6	3 523	3 523	3 523	3 523	3 523	3 523
DG Class 8	3 523	3 523	3 523	3 523	3 523	3 523
Combustibles	49 321	49 321	49 321	49 321	49 321	49 321
Total Chemical	70 459	70 459	70 459	70 459	70 459	70 459
Biodiesel						
Import	144 710	176 219	176 219	176 219	176 219	176 219
Export	0	48 780	48 780	48 780	48 780	48 780
Total Biodiesel	144 710	224 999	224 999	224 999	224 999	224 999
Petroleum						
DG Class 3	661 611	680 061	903 435	1 333 361	1 427 287	1 523 091
Combustibles	283 547	291 455	387 186	571 441	611 694	652 753
Total Petroleum	945 158	971 516	1 290 621	1 904 802	2 038 981	2 175 844
TOTAL	1,160,327	1,266,974	1,586,079	2,200,260	2,334,439	2,471,302

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- **Table 5-3: Expected Ship Arrivals at BLB2**

2010	2011	2012	2020	2021	2022
Chemical					
30	31	31	31	31	31
Biodiesel					
25	38	38	38	38	38
Petroleum					
32	35	35	61	75	79

Facilities to import/export gas are expected to come on line in 2016. The volume of gas expected to be imported/exported through BLB2 are summarised in **Table 5-4**. The number of ship arrivals associated with gas imports/exports are provided in **Table 5-5**.

- **Table 5-4: Expected Gas Volumes for BLB2 (kL)**

Ship Type	2016	2017	2018	2020	2021	2022
Import	502 587	501 125	517 777	533 427	541 429	544 850
Export	155 975	158 315	160 690	165 546	168 029	170 550
Total	658 562	668 440	678 467	698 973	709 458	715 400

- **Table 5-5: Expected Number of Gas Ship Arrivals**

Chemical Type	2016	2017	2018	2020	2021	2022
Import – small ship	13	14	14	14	14	15
Import – large ship	5	6	6	6	6	6
Export	39	40	40	42	42	43
Total	57	60	60	62	62	64

5.3 Future Expected Throughput for BLB1 and BLB2

Expected throughput for BLB1 and BLB2 combined are listed in **Table 5-6** and **Table 5-7**.

- **Table 5-6: Expected Chemical, Petroleum and Biodeisel Volumes at BLB1 and BLB2 (kL)**

Type	2010	2011	2012	2020	2021	2022
Chemical						
DG Class 3	28 184	28 184	28 184	28 184	28 184	28 184
DG Class 6	7 045	7 045	7 045	7 045	7 045	7 045
DG Class 8	7 046	7 046	7 046	7 046	7 046	7 046
Combustibles	98 643	98 643	98 643	98 643	98 643	98 643
Total Chemical	140 918	140 918	140 918	140 918	140 918	140 918
Petroleum						
DG Class 3	1 102 685	1 113 435	1 290 621	2 666 722	2 854 573	3 046 182
Combustibles	472 579	485 758	553 123	1 142 881	1 223 389	1 305 506
Total Petroleum	1 575 264	1 619 193	1 843 744	3 809 603	4 077 962	4 351 688
Biodiesel						
Import	288 719	352 438	352 438	352 438	352 438	352 438
Export	0	97 560	97 560	97 560	97 560	97 560
Total Biodiesel	288 719	449 998	449 998	449 998	449 998	449 998
TOTAL	2,004,901	2,210,109	2,434,660	4,400,519	4,668,878	4,942,604

- **Table 5-7: Expected Gas Volumes at BLB1 and BLB2 (kL)**

Type	2016	2017	2018	2020	2021	2022
Import	929 287	933 934	938 603	948 013	952 753	957 517
Export	193 014	198 804	204 768	217 239	223 756	230 469
Total	1 122 301	1 113 738	1 143 371	1 165 252	1 176 509	1 187 986

6. Construction Air Quality Impact Assessment

6.1 Overview

It is anticipated that construction of the BLB2 will take approximately 18 months for maritime structures and 12 months for users infrastructure.

Specialist over-water construction and specialist waterfront contractors would undertake the work. The type of plant required to construct BLB2 include:

- jack-up platform / barge;
- barge-mounted cranes;
- work barges;
- work boats;
- dive boats;
- mobile cranes;
- fork lifts; and
- compressors.

It is possible that both the offshore maritime work and land-based pipeline work could be undertaken concurrently as they are generally independent. Construction of the miscellaneous landbased facilities are minor and would not have a significant impact on the overall construction program.

The pipelines and MLAs would be installed after the structures are completed. This work would be no different to the landside works. To save time and difficulties associated with on site welding, field welds could be minimised by pre-assembling two pipe lengths to form 18 metre lengths that would be transported to the site and then lifted onto the pipe supports. The construction and installation phases for the pipe infrastructure has been estimated to require around 22 months in total. However, this time period is dependant on a more detailed cost estimate being prepared during design development where a closer assessment of the contracting philosophy can be made to identify the number of sub-contract groups that could be effectively used and managed during the construction period. This has a major bearing on the amount of time that would be needed to complete the construction and installation of the new pipelines.

6.2 Air Quality Impacts

Given the nature of construction works (i.e. pipe laying) impacts are expected to be minimal and localised, and there are no sensitive receivers within 1.5 km of the site. There is potential for dust generation during excavation works, however this can be kept to a minimum by implementing the following mitigation measures:

- Stabilising earthworks as soon as possible;
- Watering earthworks in dry or windy conditions; and
- Keep vehicles to sealed roads to ensure dust is not trafficked onto public roads. If this is not possible, wheels should be washed prior to leaving the site.

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7. Operational Air Quality Impact Assessment

7.1 Overview

Air quality in Port Botany is currently impacted by industry, motor vehicles, airport activities, ship movements and dock side equipment. The main air quality impact from the BLB2 would be from an increase in the number of ship visiting the port. Increases in truck movements and dockside equipment are expected to be minimal, as such are not included in the proposed development scenario.

Air dispersion modelling in this assessment builds on modelling previously conducted by SKM as part of the Port Botany Expansion air quality assessment commissioned by SPC (SKM, 2003).

7.2 Emission Estimation and Modelling Methodology

Modelling has been conducted using the AUSPLUME v6.0 dispersion model in accordance with the DECC guidelines as set out in their "*Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*" (DECC, 2005). A meteorological file for the year 2000 has been used based on data collected by the BoM at Sydney Airport. This year was chosen as it is consistent with previous modelling undertaken for the expansion of Sydney Ports.

A variable background file for pollutants PM_{10}, NO_2 and SO_2 has been used. Hourly average data were missing from the year 2000 dataset, gaps were filled in with the corresponding hours in 2001, and similarly, some data from 2002 was used to fill in the final gaps.

VOC impacts are assessed separately in **Section 7.6**.

7.2.1 Ship Emission Estimations Technique

Ship emissions for existing and future scenarios have been determined using the *National Pollutant Inventory Emission Estimation Manual for Maritime Operations* (DEH, 2001), based on a study undertaken by Lloyd's Register (1995). Where by emissions from the main engines were calculated using the following equation:

$$\mathbf{E_{Main} = 0.001 * q * P^r * N}$$

Where:

E_{Main} = emissions from the main engine (kg/hr)
q = emission coefficient
r = emission coefficient
P^r = engine power (kW)
N = number of engines

Emissions from auxiliary engines were calculated using the following equation:

$$E_{Aux} = 0.0001 * s * A^{t} * C$$

Where:
E_{Aux} = emissions from auxiliary engines (kg/hr)
s = emission coefficient
t = emission coefficient
A = auxiliary power (assume 600 kW for all vessels)
C = factor to account for sulphur content in fuel

Emission coefficients and sulphur fuel content correction values are provided in **Table 7-1** and **Table 7-2** respectively. All values are sourced from the *National Pollutant Inventory Emission Estimation Manual for Maritime Operations* (DEH, 2001).

- **Table 7-1: Emission Coefficients**

Substance Emitted	Main Engines		Auxiliary Engines	
	q	r	s	t
Oxides of nitrogen	Medium - 4.25	Medium - 1.15	4.25	1.15
	Slow - 17.5	Slow - 1.00		
Carbon monoxide	Medium - 15.32	Medium - 0.68	15.32	0.68
	Slow - 0.68	Slow - 1.08		
Sulphur dioxide	Medium - 2.31[a]	Medium - 1.00	2.36	1.00
	Slow - 11.34	Slow - 1.00		
PM_{10}	Medium - 0.11	Medium - 1.00	0.11	1.00
	Slow - 0.93	Slow - 1.00		
VOCs	Medium - 4.86	Medium - 0.69	4.86	0.69
	Slow - 0.28	Slow - 1.00		

[a] for engine <2000 kW, otherwise use 12.47

- **Table 7-2: Sulphur Fuel Content**

Gross Tonnage of Vessel	C Correction Factor
<1000	1
1000-5000	2
5000-10000	3
10000-50000	4
>50000	5

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7.2.2 Ship Inventory

An inventory of ships that visited BLB1 in 2006 has been used as an example of ships likely to visit the bulk liquid terminal in the future. Intertek recorded BLB1 berth occupancy for 2006, with information including:

- Ship name;
- Pilot;
- Time all fast;
- Time off berth; and
- Bunkers.

Further information was collected for each of the ships from the Lloyd’s Register Fairplay (Register). The Register maintains a database of over 80,000 ships, including movements, casualties, vessel characteristics, owners and consultancy services. Additional information relevant to this assessment that is recorded by the register include:

- Year of build;
- Ship type;
- Dead weight;
- Gross tonnage;
- Prime mover detail; and
- Auxiliary engines.

The ship information, in particular engine size (kW), was used to estimate ship air pollution emission rates using the equations provided in **Section 7.2.1**. A summary of main and auxiliary engine parameters and emission rates for ships visiting BLB1 in 2006 are provided in **Appendix A**.

7.2.3 NO_x to NO_2 Estimation

An important consideration when assessing impacts of NO_2 is the rate at which nitric oxide (NO) is converted to NO_2, as discussed in **Section 2.3.2**. For this assessment NO to NO_2 conversion is assessed using the method of Janssen et al (1988) which is approved by the DECC methods for assessing NO_2 impacts.

NO_x is mostly emitted in the form of NO (approximately 90%), and is typically less than 10% in the form of NO_2. As the plume disperses and reacts with the surrounding atmosphere, in particular ozone (O_3), more of the NO is converted to NO_2.

Janssen et al (1988) Methodology

Janssen et al (1988) provide a relation for the development of a NO_2/NO_x ratio for each season of the year that predicts the conversion of NO_x emissions to NO_2 over a downwind distance from the source of emission. In order to be conservative, an initial 10% NO_2 is assumed at the release point. This is added to the extra NO_2 formed from oxidised NO as the plume travels downwind. As such, the following NO_2/NO_x ratios were calculated for each season of the year, and used in the dispersion modelling of operational NO_x emissions for all wind speeds:

- Summer – 0.21
- Autumn – 0.22
- Winter – 0.20
- Spring – 0.22

These ratios are predicted for a 2 km downwind distance from the source, based on the average O_3 background concentration in the Port Botany region being 1.0 – 2.5 pphm. A distance of 2 km represents a reasonable distance that encompasses nearest sensitive receivers likely to receive maximum NO_2 impacts.

The emissions inventories for each of the source group are summarised in the following sections. The emissions tables present total NO_x emissions. In the AUSPLUME modelling NO_x emission rates have been converted to NO_2 by applying the seasonal NO_2/NO_x ratios listed above.

7.3 Model Scenarios

On the basis that air quality impacts associated with existing and expanded operations at Port Botany were previously assessed as part of the expansion EIS, this assessment considers the incremental impacts of BLB2 and cumulative impacts including BLB2 operations.

Two operational scenarios have been modelled in this assessment and include:

1) Scenario 1 – Incremental Impacts from BLB2; and
2) Scenario 2 – Total Impacts from all Port Activities, BLB1 and BLB2: impacts have been modelled assuming that the proposed Port Botany Expansion has been finalised and is operating at an expected throughput capacity of 3.2 million twenty foot equivalent containers (TEU) and include the impacts from BLB1 and BLB2 future operations. The modelling scenario includes contemporaneous hourly meteorological and background pollution data as recorded at Sydney Airport in 2000. In this way a full cumulative assessment of impacts is provided.

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7.4 Assessment Approach

Impacts were assessed by assuming a worst case scenario in any given hour, and a worst case positioning of ships while at berth at Port Botany (in terms of ship TEU size). As modelled in the PBE EIS (SKM, 2004), peak emissions for the Port have been determined assuming that there would be ten ships docked amongst the three terminals with auxiliary engines operating continuously at 100% MCR, and two of the ships operating their main engines at 30% MCR. This was to represent the scenario of a ship just arriving and a ship simultaneously just ready to depart.

For Scenario 2, it has been assumed that BLB1 and BLB2 are occupied, with the ship's auxiliary engines operating at 100% MCR and the main engine for one ship operating at 30% MCR.

For simplicity annual impacts have been assessed for the worst case scenario, and therefore are considered highly conservative as all berths would not be occupied 100% of the time. In reality 60% utilisation of the BLBs is considered more appropriate.

A summary of the ship inventory used to estimate appropriate ship parameters, and emission scenarios used in this assessment are provided in the following sections.

7.4.1 Scenario 1 – BLB2 Impacts

This scenario models the incremental impact from BLB2 only. A ship emissions inventory was developed by assuming all ships operate their auxiliary engines continuously whilst at berth at 100% MCR, with the main engine operating at 30% MCR. Main engines have been assumed to be slow speed engines using Marine Diesel Oil (MDO) whilst at berth. MDO generally has a fuel sulfur content of approximately 1.5% w/w and below (Rauta, Port Technology International). The Lloyd's Register study has estimated emission factors that are based on main and auxiliary engines using fuel of 2.7% w/w sulfur content.

For this assessment the emissions from the Berge Trader have been used as it represents one of the largest ships to visit the BLB in 2006, thus provide a conservative assumption of emissions. **Table 7-3** provides a summary of the Berge Trader emissions rates.

- **Table 7-3: BLB Emission Estimations**

Ship	Peak Emission Scenario (g/s)			Hours at Berth (60% of year)	Annual Emission (tonnes/year)		
	SO_2	NO_x	PM_{10}		SO_2	NO_x	PM_{10}
BLB (Main)	15.1	23.3	1.2	5,256	22.0	34.0	1.8
BLB (Auxiliary)	1.6	7.4	0.07	5,256	2.3	10.8	0.1

Refer to **Appendix A** for a complete list and emission calculations of ships to visit BLB1 in 2006.

Ship stack parameters were difficult to source. The stack parameters provided in **Table 7-4** represent a “best estimate” of parameters based on the air quality assessment for the port expansion (SKM, 2004). These parameters are the same as those used in the Port Botany Expansion EIS for the relevant main engine size (SKM, 2004).

- **Table 7-4: Ship Stack Parameters**

Parameter	Value
Main Engine	
Stack height (m)	37
Stack diameter (m)	1.75
Stack exit velocity (m/s)	26.6
Stack temperature (°C)	350
Auxiliary Engine	
Stack height (m)	37
Stack diameter (m)	1
Stack exit velocity (m/s)	39.7
Stack temperature (°C)	350

7.4.2 Scenario 2 – Total Impacts from the Port, BLB1 and BLB2

This emission scenario assumes that the Port Botany upgrade has been completed at operating at the expected throughput of 3.2 million TEU. This modelling is based on work previously conducted by SKM for Sydney Ports Corporation (SKM, 2004). Refer to the SKM, 2004 report for full details of this emission scenario. Background concentrations of the pollutants were also included in the modelling, with data sourced from Sydney Airport.

It has been assumed that there would be a ship at both BLB1 and BLB2 for this model scenario. In this instance emissions from BLB2 are the same as those used in Scenario 1 (refer to **Table 7-3**), while emissions from the ship at BLB1 would be from the auxiliary engine only.

The net impact on traffic movements associated with BLB2 operations is expected to be minimal. As such no additional port side traffic has been included in the modelling.

A summary of emissions for this scenario are presented in **Table 7-5**.

- **Table 7-5: Summary of Emissions for All Source Groups**

Source Group	Peak Model (g/s)			Annual Emission (tonnes/year)		
	NO_x	PM_{10}	SO_2	NO_x	PM_{10}	SO_2
Ships	381	3.9	162	927.10	9.49	394.20
Trains	2.5	0.08	0.01	6.08	0.19	0.02
Trucks	4.5	0.15	0.03	10.95	0.37	0.07
Dockside	21.1	4.8	21.2	51.34	11.68	51.59
TOTAL	409.1	8.93	183.24	995.48	21.73	445.88

7.5 Results of Air Dispersion Modelling

This section of the report provides an overview of modelling results for the two emissions scenarios listed above. The results are presented for a model domain of 6 km × 5 km, at a grid resolution of 150 metres. Four discrete receptors are identified and air pollution impacts at these locations are compared to DECC criteria. The discrete receptor locations are shown on the locality plan provided in **Figure 3-1**.

7.5.1 Modelled NO_2

Modelled impacts of NO_2 for Scenario 1, using Janssen (1988) methodology are well below the DECC criteria for both 1-hour and annual averaging time periods. Modelled impacts for Scenario 2 also do not result in exceedances of the maximum 1-hour or annual average DECC criteria. Maximum modelled 1-hour impacts in Scenario 2 are 232 µg/m^3 at receptor 3. Annual average modelling for Scenario 2 also show compliance with the DECC criteria beyond the port boundary. The highest modelled annual average concentration at a sensitive receiver was 41 µg/m^3 at receptor 1.

Modelled NO_2 concentrations are displayed graphically in **Appendix B.1**.

- **Table 7-6: Modelled NO_2 Concentrations at Discrete Receptors ($\mu g/m^3$)**

Discrete Receptor	Scenario 1	Scenario 2
1-hour		
1	12.3	162
2	12.6	215
3	11.8	232
4	11.0	218
5	10.5	204
Annual		
1	0.3	41
2	0.2	38
Discrete Receptor	**Scenario 1**	**Scenario 2**
3	0.2	37
4	0.2	37
5	0.3	39

7.5.2 Modelled SO_2

Incremental impacts of SO_2 concentrations (Scenario 1) are well below the DECC criteria for all averaging periods.

For Scenario 2 modelled maximum 10-minute SO_2 concentrations are below the DECC criteria of 712 $\mu g/m^3$ at all residential locations, with a maximum at a discrete receptor in the order of 355 $\mu g/m^3$ at receptor 4.

Maximum 1-hour SO_2 concentrations are below the DECC criteria of 570 $\mu g/m^3$ at the residential locations for Scenario 2. The maximum modelled 1-hour SO_2 concentration at a discrete receptor is 336 $\mu g/m^3$ at receptor 4.

Modelled 24-hour SO_2 concentrations for Scenario 2 are below the DECC criteria of 228 $\mu g/m^3$ beyond the Port Botany boundary. At the discrete receptors the maximum modelled SO_2 concentration occurred under Scenario 2 at receptor 2 (115 $\mu g/m^3$).

Conservative modelled annual average SO_2 concentrations show that the DECC criteria of 60 $\mu g/m^3$ is not exceeded beyond the port in Scenario 2. The maximum modelled concentration at a discrete receptor is 27 $\mu g/m^3$ at receptor 1.

Results of SO_2 modelling are displayed in **Appendix B.2**.

- **Table 7-7: Modelled SO_2 Concentrations at Discrete Receptors (µg/m^3)**

Discrete Receptor	Scenario 1	Scenario 2
10-minute		
1	56	247
2	78	352
3	89	319
4	53	355
5	75	267
1-hour		
1	43	203
2	43	275
3	40	302
4	37	336
5	36	308
24-hour		
1	8	87
2	7	115
3	7	99
4	7	79
5	9	84
Annual		
1	1	27
2	1	24
3	1	21
4	1	22
5	1	26

7.5.3 Modelled PM_{10}

Modelled incremental impacts in Scenario 1, are well below the DECC criteria for both 24-hour and annual time periods i.e. <1 µg/m^3, at all receptor locations outside of Port Botany area (refer to **Table 7-8**).

Modelled cumulative PM_{10} impacts i.e. including background air quality, all port operations, BLB1 and BLB2 result in exceedances of the DECC 24-hour criteria at residential locations. However, the incremental impacts due to BLB2 are very low i.e. <1 µg/m^3 and are unlikely to result in additional exceedances at the residences near the port. Modelled impacts are large due to existing days where PM_{10} 24-hour criteria is already exceeded. Annual average PM_{10} concentrations comply with the DECC criteria, although this compliance is marginal. Again, this impact is due to existing activities in the area, with an incremental impact of less then 1 µg/m^3.

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Table 7-8: Modelled PM_{10} Concentrations at Discrete Receptors ($\mu g/m^3$)

Discrete Receptor	Scenario 1	Scenario 2
24-hour		
1	0.6	72
2	0.5	70
3	0.5	70
4	0.5	70
5	0.7	71
Annual		
1	0.1	28
2	0.1	27
Discrete Receptor	**Scenario 1**	**Scenario 2**
3	0.1	27
4	0.1	27
5	0.1	27

7.6 Assessment of VOC Emissions

This assessment considers VOC emissions and potential impacts from the BLB. The proposed Site B3 Bulk Liquids Storage Terminal (i.e. storage tanks) has been assessed previously by GHD (GHD, 2006) and this will be summarised below. Small amounts of vapour will be generated when discharging liquids from the ships to shore based storage tanks. A summary of activities undertaken when pumping from ships to tanks is provided below, and discussion of vapour recovery is given where possible.

7.6.1 Bulk Liquids Storage Terminal Air Quality Assessment Summary

GHD have assessed the air quality impacts from the proposed Site B3 Bulk Liquids Storage Terminal (GHD, 2006). This expansion would allow for an increase in annual throughput from from 2,100, 000 kL to 3,950,000 kL. The assessment considered the following sources of fugitive emissions:

- Storage tank losses – the TANKS v4.09 model was used to estimate hydrocarbon emissions from fixed and floating roof tanks. Emissions were estimated for unleaded petrol as it represents the most volatile products handled at the facility from the existing B1 tank farm, B2 tank farm, and proposed B3 tank farm. Ten turnovers per year were assumed. Estimated annual emissions were in the order of 58,726 kg.
- Pipeline losses – fugitive emissions were estimated from flanges, valves, pump seals and other pipeline fitting, it was assumed that pipeline would carry light fuel (e.g. ULP). Annual emissions were in the order of 822 kg.

- Emissions during truck loading – the assessment considered 1,900 ML to be distributed by road per annum. A vapour recovery unit would be used during loading operations with a removal efficiency of greater than 99.9%. A total loss factor was assumed to be 512 kg per year.
- Transport vehicle emissions – Predicted emission rates from vehicles movements associated with existing and proposed tank farms is in the order of 42,388 kg per year.

Total emissions from the four source type listed above were in the order of 102,448 kg per year.

Dispersion modelling using AUSPLUME v6.0 was undertaken by GHD to predict the maximum ground level concentrations resulting from the transfer and storage of liquids at the storage facility. The 99.9th percentile concentration was modelled using an averaging period of 1 hour. Two scenarios were modelled:

1) Scenario 1 – Current Emissions i.e. emissions from the existing B1 and B2 tank farms; and

2) Scenario 2 – Future Emissions i.e. emissions from existing B1, B2 and proposed B3 tank farms.

Modelled impacts focused on benzene as it was predicted to have the smallest margin of compliance compared to the other critical constituents of petrol vapour. Other background sources of benzene were also included in the modelling. Scenario 2 modelling showed benzene concentrations were in the order of 0.00608 mg/m^3 at the site boundary, which is approximately 21% of the DECC criteria.

Scenario 2 represents an annual throughput of approximately 3,950,000 kL, which is approximately the throughput anticipated for 2012 (refer to **Section 5**). Throughput in 2022 is anticipated to be in the order of 6,130,590 kL, i.e. an increase by 55%. In order to understand the significance of this increase the modelling results have been scaled up accordingly to examine the potential impact in 2022. These impacts are anticipated to be in the order of 0.0094 mg/m^3, which represent 32% of the relevant criteria.

7.7 BLB2 VOC Emissions and Management

7.7.1 Chemical Transfers

Chemicals (which includes VOCs) will be discharged to the Chemical Terminals from BLB2 via flexible hoses connecting the Terminal pipelines at BLB2 to the Ship Manifold discharge pipework. The ship's pumps provide the means of transfer.

Following connection of the hoses, and prior to commencement of pumping, a small amount of nitrogen is released to atmosphere during the pressure test. This test is carried out at every hose connection to ensure that there are no leaks at the hose flanges or wharf/ship connection flanges. Prior to the disconnection of the hoses at the end of the discharge, another small amount of nitrogen together with a small amount of product vapour is released when the hoses are depressurised to atmosphere following purging of the hoses back to the respective Vopak Site A or Terminals Pty Ltd terminals. This operation ensures minimal risk of residual product spillage when the hoses are disconnected and then blanked off prior to removal from the ship and wharf area.

When the Ship is pumping chemicals to the respective Chemical Terminal the volume of product in the ship tank decreases and either the ship tank masthead vents will open to allow air to ingress to prevent a vacuum occurring in the ship tank; or if the product has an inert gas blanketing requirement then the ship's inert gas generator will supply inert gas to the ship tank to prevent a vacuum occurring in the ship tank. Ship tanks are not designed to withstand any significant level of vacuum. A vacuum could cause structural damage (collapse) to the ship tank. In either case there is no significant air emission resulting from the ship discharge operation.

Pigging operations are carried out from the wharf to the terminal using compressed nitrogen supplied to the wharf. Any associated air emissions are controlled at the Terminal end via DECC approved vapour emission controls (usually a carbon bed adsorption system, a vapour return to ship system or a Scrubber designed for the specific chemical).

When there is a chemical export to the ship from a terminal, a relatively rare occurrence, then there is a potential for the ship tank to breathe to atmosphere via its masthead vents. Again, depending on the chemical, a vapour return system (back to the terminal tank) may be utilised.

7.7.2 Petroleum Transfers

Petroleum products (which includes VOCs) will be discharged to the existing Petroleum Terminals from BLB2 via Marine Loading Arms (MLA's) connecting the Terminal pipelines at BLB2 to the Ship Manifold discharge pipework. The ship's pumps provide the means of transfer.

Following connection of the MLA, and prior to commencement of pumping, a small amount of Nitrogen is released to atmosphere during the pressure test. This test is carried out at every MLA connection to ensure that there are no leaks at the MLA to ship connection flange. Prior to the disconnection of the MLA from the ship at the end of the discharge, another small amount of Nitrogen together with a small amount of Product vapour is released when the MLA is depressurised to atmosphere following pumping down of the MLA back to the respective terminals. This operation ensures that the MLA is left empty and thereby effects minimal risk of cross contamination with the next product to be discharged.

When the Ship is pumping petroleum product to the respective petroleum terminal the level of product in the ship tank decreases and the ship tank masthead vents will open to allow air to ingress

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to prevent a vacuum occurring in the ship tank. Ship tanks are not designed to withstand any significant level of vacuum. A vacuum could cause structural damage (collapse) to the ship tank. In this case there is no significant air emission resulting from the ship discharge operation.

Pigging operations are carried out from the wharf to the terminal using compressed nitrogen supplied to the wharf. Any air emissions associated with the pigging operation are controlled at the Terminal end via a de-pressuring vessel to atmosphere.

When there is a petroleum product export to the ship from a terminal, a relatively rare occurrence, then there is a potential for the ship tank to breathe to atmosphere via its masthead vents.

7.7.3 Bulk Liquids Transfer Emission Control

LPG ships generally have vapour return systems which provide good emissions controls. Petroleum ships have no vapour emission control systems on board. Vapour return systems (from Shore Tanks) are not used. When a ship tank is emptied the hatches are closed, the vessel will go out to sea and either air blow the tanks dry or it will water wash each tank, drain and then air blow dry so any remaining vapour is left in the ship tank after discharge will one way or the other, be released to atmosphere.

Chemical ships generally do not have any on board vapour emission control/recovery systems other than simple Pressure/Vacuum Vents on each tank. For some products (propylene oxide and hexene) a vapour return system is used and this is usually for product quality maintenance reasons (i.e. not letting moist air into ship/shore tanks). Similar to petroleum ships, any product/vapours left in a ship tank after discharge are removed when the vessel is at sea.

At the completion of Chemical discharges at the BLB, the normal operational practice is to clear the hoses of residual product by blowing with nitrogen (from the ship end to the shore end of the hose). Generally this results in the hose being almost free of liquid which means that minimal vapours are emitted when hoses are disconnected. The hoses are then disconnected from both the Ship Manifold and the Shore Manifold and blank flanges are immediately attached to both the ends of the hoses and blank flanges are re-attached to both the Ship Manifold and Shore Manifold flanges. This process results in minimal vapour emissions at the BLB.

After pipelines are pigged to the respective Terminals the resulting nitrogen/vapour mix remaining in the pipeline can be directed to the Terminal Vapour Emission Control Systems which results in minimal emissions.

7.7.4 VOC Emissions Calculations at BLB2

VOC emissions have been estimated for the valves and flanges associated with BLB2 operations. Emissions were estimated using the *Emission Estimation Technique Manual for Petroleum*

Refining (DEH, 1999). Screening information was not available, and as such average emission factors were used. This methodology involves applying the following generic algorithm to estimate emissions from all sources in a stream, for a particular equipment type:

$E_{VOC} = F_A * WF_{VOC} * N$

Where:

E_{VOC} = Emission rate of VOC from all sources grouped in a particular equipment type and service (kg/hr);
F_A = Applicable average emission factor for the particular equipment type;
WF_{VOC} = The average weight fraction of VOC in the stream;
N = The number of pieces of equipment grouped in the relevant category according to equipment type, service and weight fraction of VOC.

In this case is has been conservatively assumed that all steams are approximately 100% VOCs, thereby making WF_{VOC} = 1. The emission factor for gas has been used for these calculations as it represents the most conservative emission rate compared to light liquids and heavy liquids.

Table 7-9 provides parameters used to estimate VOC emission rates, and **Table 7-10** provides emission estimates for VOCs from valves and flanges.

- **Table 7-9: Pipeline Parameters**

Product	2022 Throughput (kL)		Average Pumping Rate (kL/hr)	Average Pipe Utilisation Time (hrs)	
	BLB2	BLB1 + BLB2		BLB2	BLB1 + BLB2
Gas	593992	1187986	691	860	1719
Chemicals	70459	140918	171	412	824
Biodiesel	224999	449998	171	1316	2632
Petroleum Product	2175844	4351688	1875	1160	2321

- **Table 7-10: Fugitive VOC Emission Factors and Calculations**

Product	Equipment Type	Number of Sources	Emission Factor (kg/hr/source)	Emission Rate (kg/hr)	Annual Emission Rate (kg)	
					BLB2	BLB1 + BLB2
Light Liquids	Valve	92	0.0109	1.0028	2896	5793
	Flange	208	0.00025	0.052	150	300
Gas	Valve	7	0.0268	0.1876	161	323
	Flange	16	0.00025	0.004	3	7
Total					3211	6423

As discussed previously in **Section 7.6.1**, GHD modelled impacts (from tank farms, associated infrastructure and activities) have been scaled up to include a throughput of 6,130,590 kL. In this case predicted impacts are in the order of 0.0094 mg/m^3, which represent 32% of the relevant criteria.

Impacts have been further scaled to include emissions from BLB1 and BLB2 in 2022 i.e. an annual emission rate of 6423 kg. In this case impacts are calculated to be in the order of 0.0098 mg/m^3, which equates to approximately 34% of the DECC criteria.

8. Conclusion

SPC are proposing to construct a second Bulk Liquids Berth (BLB2) adjacent to the existing Bulk Liquids Berth No. 1 (BLB1) at Port Botany. This new berth is proposed to handle the predicted increase in imported petroleum and gas products into Port Botany.

A brief qualitative assessment of impacts during construction has been provided in this assessment. It is concluded that impacts from construction would be minimal and localised. Any dust generated is unlikely to impact upon residences given the distance from the site to residential locations. Any potential dust emissions can be minimised using appropriate dust control measures as listed in **Section 6**.

Operational impacts have also been assessed. Ship and dockside equipment emissions of PM_{10}, NO_2 and SO_2 were calculated using the *NPI Emission Estimation Technique Manuals* and modelled using AUSPLUME v6.0. This modelling indicates that incremental and cumulative NO_2 and SO_2 impacts comply with the DECC criteria for all averaging periods.

Modelled cumulative 24-hour PM_{10} impacts exceed the DECC criteria due to high background concentrations included in the modelling. Incremental PM_{10} impacts from bulk liquid berth activities however are very low for 24-hour averaging periods i.e. <1 µg/m^3 and do not result in additional exceedances of the DECC criteria at residential locations. Annual average PM_{10} concentrations comply with the DECC criteria.

In terms of vapour emissions when transferring liquids from ships to holding tanks, emissions are generally controlled at the terminal end. As chemicals are drawn out of the holding tanks of the ships, air will need to enter the ship holding tanks, and be released from the terminal tanks. Any associated air emissions are controlled at the Terminal end via DECC approved vapour emission controls (usually a carbon bed adsorption system, a vapour return to ship system or a Scrubber designed for the specific chemical). When products are exported, a relatively rare occurrence, then there is a potential for the ship tank to breathe to the atmosphere via its masthead vents. Again, depending on the chemical, a vapour return system (back to the terminal tank) may be utilised. In terms of petroleum transfers any air emissions associated with the pigging operation are controlled at the terminal end via a de-pressuring vessel to the atmosphere.

The GHD assessment of the proposed Site B3 Bulk Liquids Storage Terminal (GHD, 2006) has been used to further quantify potential VOC impacts. In this instance the potential impacts were scaled up to represent throughput in 2022 as well as emissions associated with BLB pipework. Impacts are predicted to be approximately 34% of the relevant DECC criteria.

Overall, operational impacts from the proposed BLB2 would be small for all pollutants modelled as well as potential vapour releases. As such the additional berth is considered acceptable in terms of potential air quality impacts in Port Botany and surrounding suburbs.

9. References

DECC (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in new South Wales*, ISBN 1 74137 488 X

DECC, *Quarterly Air Quality Monitoring Reports*, 2000-2005

GHD (2006) *Vopak Terminals Sydney Pty Ltd – Proposed Expansion to Site B Bulk Liquids Storage Terminal – Air Quality Study*

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Department of Environment and Heritage (2001) *National Pollutant Inventory Emission Estimation Technique Manual for Maritime Operations v1.1*

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Department of Environment and Heritage (1999) *Emission Estimation Technique Manual for Petroleum Refining*

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SKM (2004) *Port Botany Upgrade EIS – Air Quality Impact Assessment Commission of Inquiry*

Appendix A Ship Emission Inventory

A.1 Main and Auxiliary Engine Parameters and Emission Estimates

Ship Name	Ship Type	Year of build	No. Engines	Gross Tonnage	Main Engine Power (kW)	Main Engine Power @ 30% (kW)	Main Engine Emission Rate (kg/hr)			Main Engine Emission Rate (g/s)			Auxiliary Engine Emission rate (assume 600 kW) (kg/hr)			Auxiliary Engine Emission rate (assume 600 kW) (g/s)		
							NOx	PM10	SO2	NOx	PM10	SO2	NOx	PM10	SO2	NOx	PM10	SO2
BARRINGTON	Products Tanker	1989	1	21,718	6,032	1,810	31.7	1.7	20.5	8.8	0.5	5.7	26.6	0.3	5.7	7.4	0.07	1.6
BERGE SPIRIT	LPG Tanker	1980	1	44,076	17,247	5,174	90.5	4.8	58.7	25.2	1.3	16.3	26.6	0.3	5.7	7.4	0.07	1.6
BERGE TRADER	LPG Tanker	2006	1	46,632	15,970	4,791	83.8	4.5	54.3	23.3	1.2	15.1	26.6	0.3	5.7	7.4	0.07	1.6
BOUGAINVILLE	LPG Tanker	2001	1	4,229	3,089	927	16.2	0.9	10.5	4.5	0.2	2.9	13.3	0.1	2.8	3.7	0.04	0.8
BOW DE FENG	Chemical/Products Tanker	2002	1	6,843	3,900	1,170	20.5	1.1	13.3	5.7	0.3	3.7	20.0	0.2	4.2	5.5	0.06	1.2
BOW DE JIN	Chemical/Products Tanker	1999	1	6,294	3,884	1,165	20.4	1.1	13.2	5.7	0.3	3.7	20.0	0.2	4.2	5.5	0.06	1.2
BOW DE RICH	Chemical Tanker	2003	1	6,861	3,906	1,172	20.5	1.1	13.3	5.7	0.3	3.7	20.0	0.2	4.2	5.5	0.06	1.2
BOW MASTER	Chemical/Products Tanker	1999	1	4,667	3,600	1,080	18.9	1.0	12.2	5.3	0.3	3.4	13.3	0.1	2.8	3.7	0.04	0.8
BOW MATE	Chemical/Products Tanker	1999	1	4,667	3,600	1,080	18.9	1.0	12.2	5.3	0.3	3.4	13.3	0.1	2.8	3.7	0.04	0.8
BOW WALLABY	Chemical Tanker	2003	1	6,976	4,200	1,260	22.1	1.2	14.3	6.1	0.3	4.0	20.0	0.2	4.2	5.5	0.06	1.2
BOW WEST	Chemical/Products Tanker	2002	1	6,837	3,883	1,165	20.4	1.1	13.2	5.7	0.3	3.7	20.0	0.2	4.2	5.5	0.06	1.2
BRITISH COURTESY	Chemical/Products Tanker	2005	1	29,214	11,626	3,488	61.0	3.2	39.6	17.0	0.9	11.0	26.6	0.3	5.7	7.4	0.07	1.6
BRITISH FIDELITY	Chemical/Products Tanker	2004	1	29,335	9,466	2,840	49.7	2.6	32.2	13.8	0.7	8.9	26.6	0.3	5.7	7.4	0.07	1.6
BRITISH LIBERTY	Chemical/Products Tanker	2004	1	29,335	9,480	2,844	49.8	2.6	32.3	13.8	0.7	9.0	26.6	0.3	5.7	7.4	0.07	1.6
BRITISH UNITY	Chemical/Products Tanker	2004	1	29,335	9,466	2,840	49.7	2.6	32.2	13.8	0.7	8.9	26.6	0.3	5.7	7.4	0.07	1.6

BRO ALBERT	Chemical/Products Tanker	1995	1	28,226	7,466	2,240	39.2	2.1	25.4	10.9	0.6	7.1	26.6	0.3	5.7	7.4	0.07	1.6
BRO ALEXANDRE	Products Tanker	1995	1	28,226	7,460	2,238	39.2	2.1	25.4	10.9	0.6	7.0	26.6	0.3	5.7	7.4	0.07	1.6
BRO ARTHUR	Products Tanker	1995	1	28,226	7,460	2,238	39.2	2.1	25.4	10.9	0.6	7.0	26.6	0.3	5.7	7.4	0.07	1.6
CHANG CHI	Products Tanker	2003	1	27,155	8,580	2,574	45.0	2.4	29.2	12.5	0.7	8.1	26.6	0.3	5.7	7.4	0.07	1.6
CITRUS EXPRESS	Products Tanker	2006	1	31,433	10,591	3,177	55.6	3.0	36.0	15.4	0.8	10.0	26.6	0.3	5.7	7.4	0.07	1.6
DA CHI	Products Tanker	2005	1	26,955	8,580	2,574	45.0	2.4	29.2	12.5	0.7	8.1	26.6	0.3	5.7	7.4	0.07	1.6
DA QING 452	Products Tanker	2001	1	29,288	8,520	2,556	44.7	2.4	29.0	12.4	0.7	8.1	26.6	0.3	5.7	7.4	0.07	1.6
DEAUVILLE	LPG Tanker	1995	1	3,617	2,648	794	13.9	0.7	9.0	3.9	0.2	2.5	13.3	0.1	2.8	3.7	0.04	0.8
DEAUVILLE	LPG Tanker	1995	1	3,617	2,648	794	13.9	0.7	9.0	3.9	0.2	2.5	13.3	0.1	2.8	3.7	0.04	0.8
FEI CHI	Products Tanker	2005	1	27,235	8,580	2,574	45.0	2.4	29.2	12.5	0.7	8.1	26.6	0.3	5.7	7.4	0.07	1.6
GAN-SURE	Chemical/Products Tanker	2006	1	30,029	9,480	2,844	49.8	2.6	32.3	13.8	0.7	9.0	26.6	0.3	5.7	7.4	0.07	1.6
GAS FRIEND	LPG Tanker	2005	1	46,129	12,356	3,707	64.9	3.4	42.0	18.0	1.0	11.7	26.6	0.3	5.7	7.4	0.07	1.6
GAS TAURUS	LPG Tanker	2001	1	46,021	12,357	3,707	64.9	3.4	42.0	18.0	1.0	11.7	26.6	0.3	5.7	7.4	0.07	1.6
GOLDEN AKANE	Chemical/Products Tanker	1998	1	5,357	3,089	927	16.2	0.9	10.5	4.5	0.2	2.9	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN DENISE	Chemical/Products Tanker	2006	1	7,142	3,900	1,170	20.5	1.1	13.3	5.7	0.3	3.7	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN FUMI	Chemical/Products Tanker	1996	1	6,253	3,604	1,081	18.9	1.0	12.3	5.3	0.3	3.4	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN GEORGIA	Chemical/Products Tanker	1996	1	9,597	5,296	1,589	27.8	1.5	18.0	7.7	0.4	5.0	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN JANE	Chemical/Products Tanker	1996	1	9,599	5,296	1,589	27.8	1.5	18.0	7.7	0.4	5.0	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN KAORI	Chemical/Products Tanker	1998	1	5,819	3,604	1,081	18.9	1.0	12.3	5.3	0.3	3.4	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN TAKA	Chemical Tanker	2004	1	11,594	6,230	1,869	32.7	1.7	21.2	9.1	0.5	5.9	26.6	0.3	5.7	7.4	0.07	1.6
GOLDEN TIFFANY	Chemical/Products Tanker	1998	1	9,599	9,487	2,846	49.8	2.6	32.3	13.8	0.7	9.0	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN WAVE	Chemical/Products Tanker	2002	1	5,359	3,640	1,092	19.1	1.0	12.4	5.3	0.3	3.4	20.0	0.2	4.2	5.5	0.06	1.2
GOLDEN YASAKA	Chemical/Products Tanker	1998	1	5,360	3,089	927	16.2	0.9	10.5	4.5	0.2	2.9	20.0	0.2	4.2	5.5	0.06	1.2
HELIX	Crude/Oil Products Tanker	1997	1	28,810	8,840	2,652	46.4	2.5	30.1	12.9	0.7	8.4	26.6	0.3	5.7	7.4	0.07	1.6
HIGH CONSENSUS	Products Tanker	2005	1	28,059	9,267	2,780	48.7	2.6	31.5	13.5	0.7	8.8	26.6	0.3	5.7	7.4	0.07	1.6

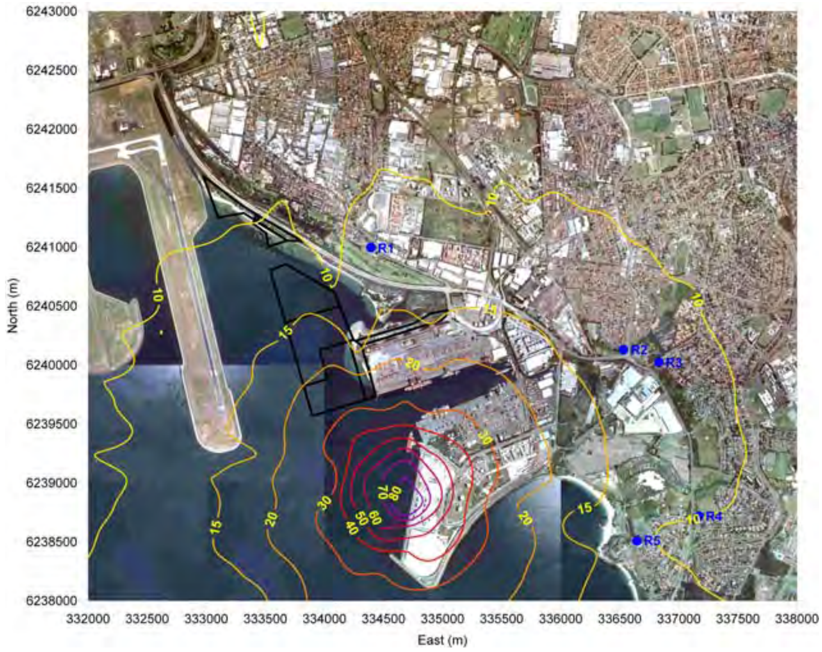
HIGH VALOR	Chemical/Products Tanker	2005	1	30,048	9,488	2,846	49.8	2.6	32.3	13.8	0.7	9.0	26.6	0.3	5.7	7.4	0.07	1.6
IVER EXPORTER	Chemical/Products Tanker	2000	1	29,289	8,560	2,568	44.9	2.4	29.1	12.5	0.7	8.1	26.6	0.3	5.7	7.4	0.07	1.6
JASMINE	Chemical/Products Tanker	2002	1	27,335	8,580	2,574	45.0	2.4	29.2	12.5	0.7	8.1	26.6	0.3	5.7	7.4	0.07	1.6
JEANNE-MARIE	LPG Tanker	2005	1	46,632	14,410	4,323	75.7	4.0	49.0	21.0	1.1	13.6	26.6	0.3	5.7	7.4	0.07	1.6
KINNA	LPG Tanker	1989	1	3,901	2,346	704	12.3	0.7	8.0	3.4	0.2	2.2	13.3	0.1	2.8	3.7	0.04	0.8
LA FORGE	LPG Tanker	1981	1	42,501	11,180	3,354	58.7	3.1	38.0	16.3	0.9	10.6	26.6	0.3	5.7	7.4	0.07	1.6
LIZZIE KOSAN	LPG Tanker	1996	1	3,540	2,427	728	12.7	0.7	8.3	3.5	0.2	2.3	13.3	0.1	2.8	3.7	0.04	0.8
MAEA	LPG Tanker	2005	1	3,759	3,398	1,019	17.8	0.9	11.6	5.0	0.3	3.2	13.3	0.1	2.8	3.7	0.04	0.8
MARCELA LADY	Chemical/Products Tanker	2004	1	27,505	8,730	2,619	45.8	2.4	29.7	12.7	0.7	8.2	26.6	0.3	5.7	7.4	0.07	1.6
NAMHAE GAS	LPG Tanker	1991	1	4,236	3,089	927	16.2	0.9	10.5	4.5	0.2	2.9	13.3	0.1	2.8	3.7	0.04	0.8
PACIFIC SERENITY	Products Tanker	2003	1	28,822	9,487	2,846	49.8	2.6	32.3	13.8	0.7	9.0	26.6	0.3	5.7	7.4	0.07	1.6
PING CHI	Products Tanker	2003	1	27,155	8,561	2,568	44.9	2.4	29.1	12.5	0.7	8.1	26.6	0.3	5.7	7.4	0.07	1.6
RESOLVE	Products Tanker	2004	1	30,032	9,480	2,844	49.8	2.6	32.3	13.8	0.7	9.0	26.6	0.3	5.7	7.4	0.07	1.6
STOLT AQUAMARINE	Chemical/Products Tanker	1986	1	23,964	9,179	2,754	48.2	2.6	31.2	13.4	0.7	8.7	26.6	0.3	5.7	7.4	0.07	1.6
STOLT AYAME	Chemical/Products Tanker	1991	1	4,987	3,604	1,081	18.9	1.0	12.3	5.3	0.3	3.4	13.3	0.1	2.8	3.7	0.04	0.8
STOLT AZALEA	Chemical/Products Tanker	1988	1	4,740	2,720	816	14.3	0.8	9.3	4.0	0.2	2.6	13.3	0.1	2.8	3.7	0.04	0.8
STOLT JADE	Chemical/Products Tanker	1986	1	23,964	9,179	2,754	48.2	2.6	31.2	13.4	0.7	8.7	26.6	0.3	5.7	7.4	0.07	1.6
STOLT JASMINE	Chemical/Products Tanker	2005	1	6,868	3,640	1,092	19.1	1.0	12.4	5.3	0.3	3.4	20.0	0.2	4.2	5.5	0.06	1.2
STOLT KIKYO	Chemical/Products Tanker	1998	1	6,426	3,884	1,165	20.4	1.1	13.2	5.7	0.3	3.7	20.0	0.2	4.2	5.5	0.06	1.2
STOLT LILY	Chemical/Products Tanker	1988	1	4,740	2,720	816	14.3	0.8	9.3	4.0	0.2	2.6	13.3	0.1	2.8	3.7	0.04	0.8
STOLT ORCHID	Chemical/Products Tanker	2003	1	5,376	3,900	1,170	20.5	1.1	13.3	5.7	0.3	3.7	20.0	0.2	4.2	5.5	0.06	1.2
STOLT RINDO	Chemical/Products Tanker	2005	1	6,944	3,515	1,055	18.5	1.0	12.0	5.1	0.3	3.3	20.0	0.2	4.2	5.5	0.06	1.2
STOLT SEA	Chemical/Products Tanker	1999	2	14,900	2,320	696	29.2	1.6	18.9	8.1	0.4	5.3	26.6	0.3	5.7	7.4	0.07	1.6
					3,240	972												
STOLT SPRAY	Chemical Tanker	2000	2	14,900	2,427	728	29.7	1.6	19.3	8.25	0.439	5.35	26.6	0.26	5.66	7.40	0.07	1.57

										9		2	3					
					3,236	971												
STOLT SUISEN	Chemical/Products Tanker	1998	1	6,426	5,280	1,584	27.7	1.5	18.0	7.70 0	0.409	4.99 0	19.9 7	0.20	4.25	5.55	0.06	1.18
VICTOIRE	LPG Tanker	2005	1	3,759	3,398	1,019	17.8	0.9	11.6	4.95 5	0.263	3.21 1	13.3 1	0.13	2.83	3.70	0.04	0.79
YAYOI EXPRESS	Products Tanker	2006	1	28,844	9,480	2,844	49.8	2.6	32.3	13.8 25	0.735	8.95 9	26.6 3	0.26	5.66	7.40	0.07	1.57

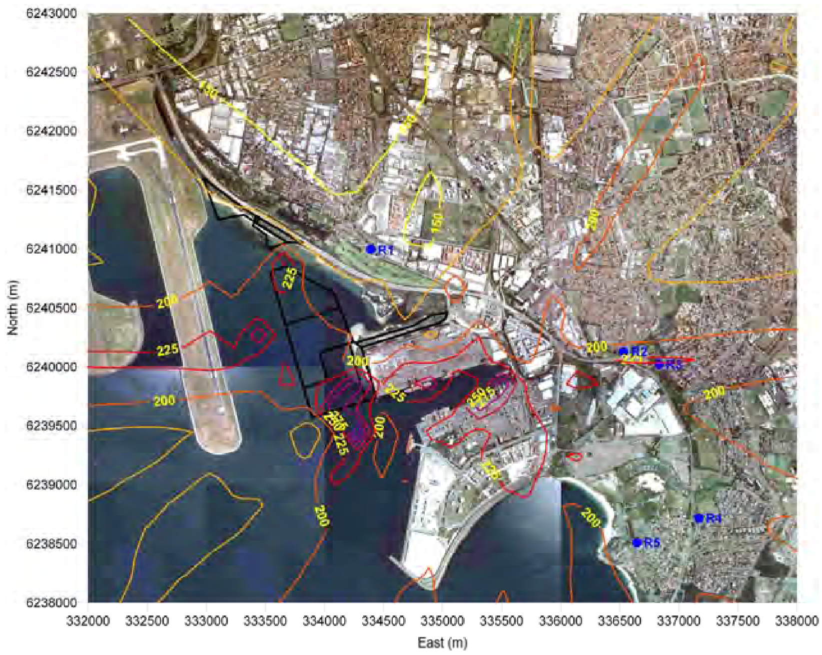
Appendix B Modelling Results

B.1 NO_2 Modelling Results

B.1.1 Scenario 1 – Modelled 1-hour NO_2 Concentrations (µg/m^3)



B.1.2 Scenario 2 – Modelled 1-hour NO_2 Concentrations (µg/m^3)



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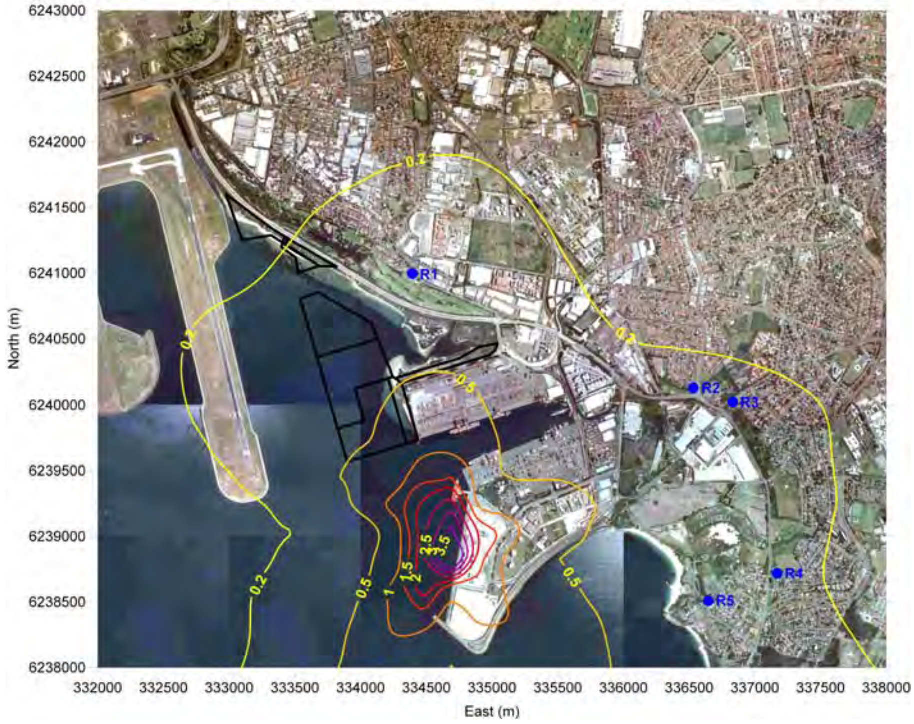
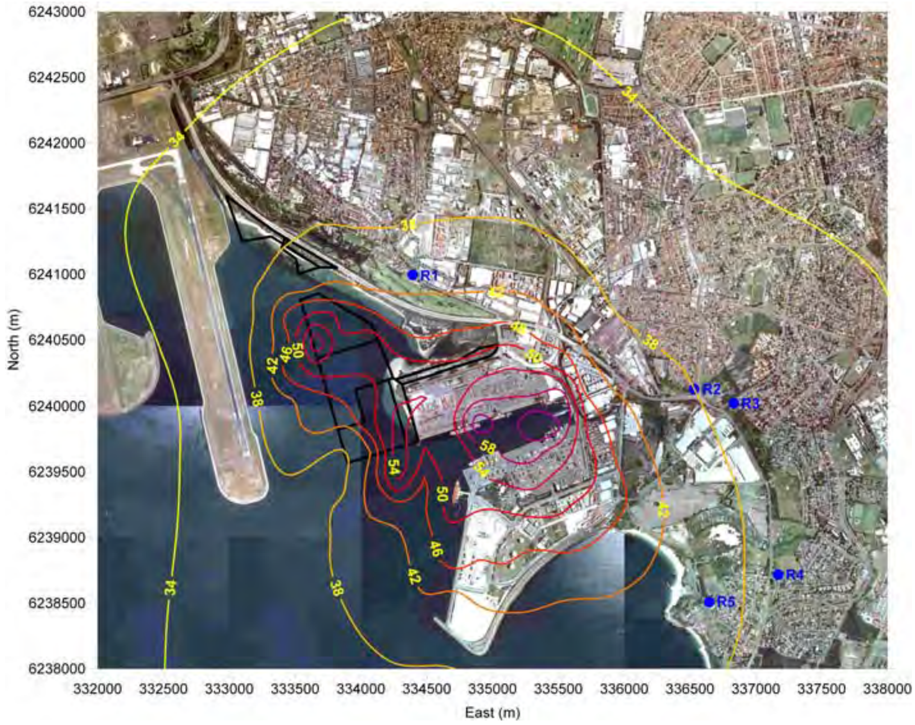
B.1.3 Scenario 1 – Annual NO_2 Concentrations (µg/m³)

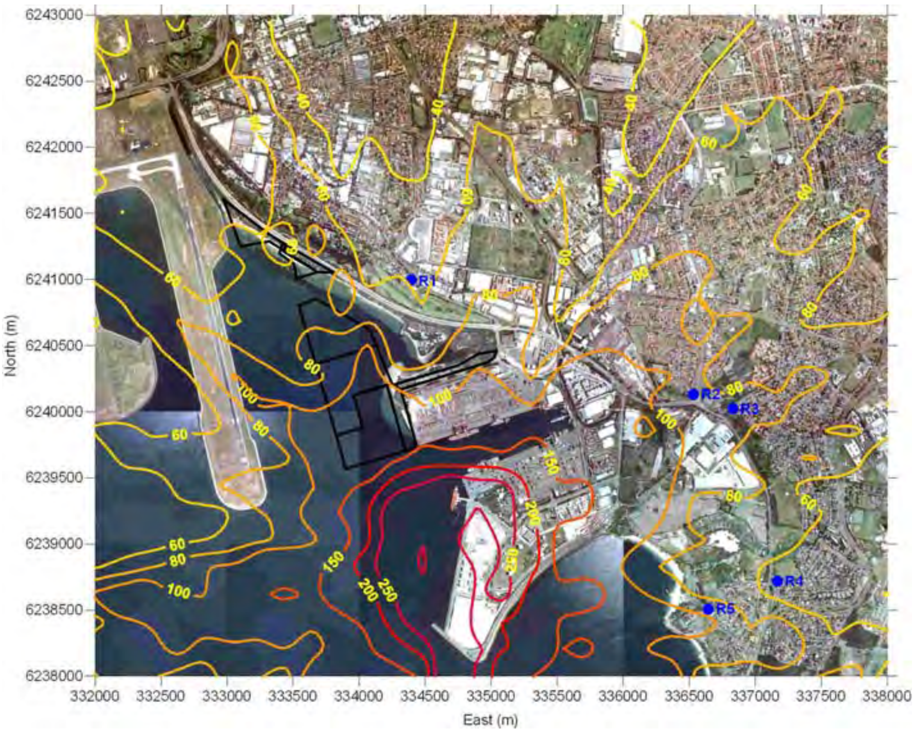


B.1.4 Scenario 2 – Annual NO_2 Concentrations (µg/m³)

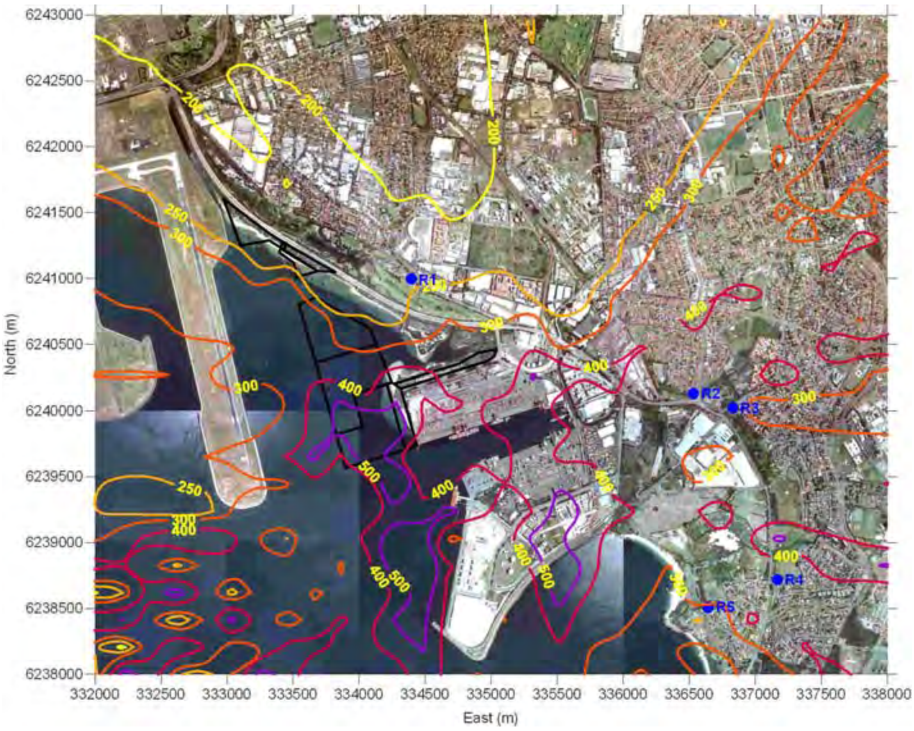


B.2 SO_2 Modelling Results

B.2.1 Scenario 1 – Modelled 10-minute SO_2 Concentrations

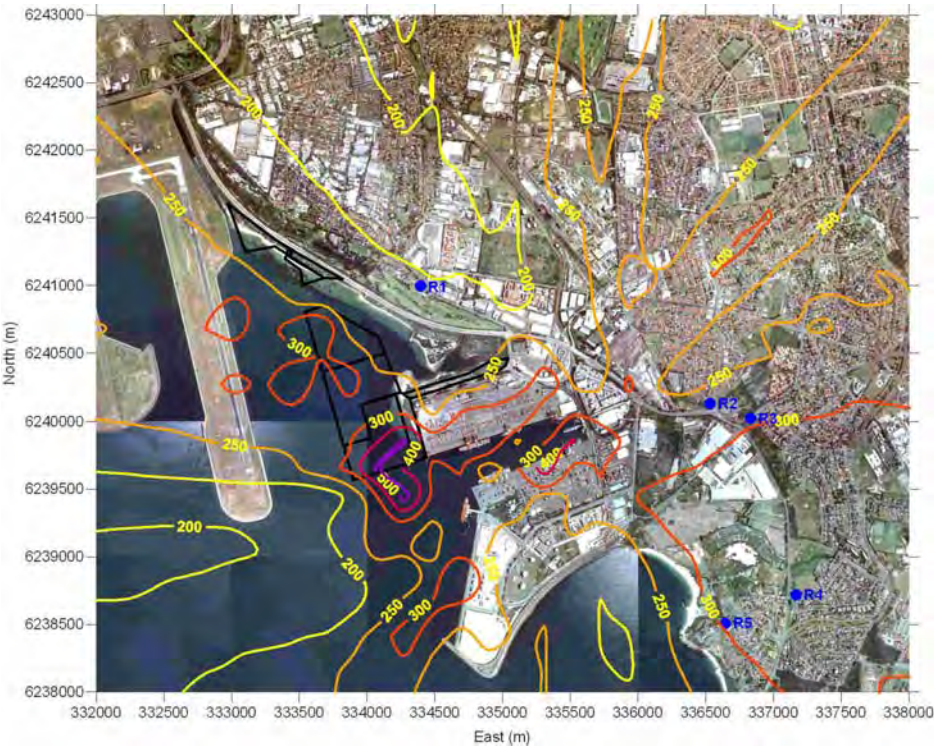


B.2.2 Scenario 2 – Modelled 10-minute SO_2 Concentrations



B.2.3 Scenario 1 – Modelled 1-hour SO_2 Concentrations

B.2.4 Scenario 2 – Modelled 1-hour SO_2 Concentrations



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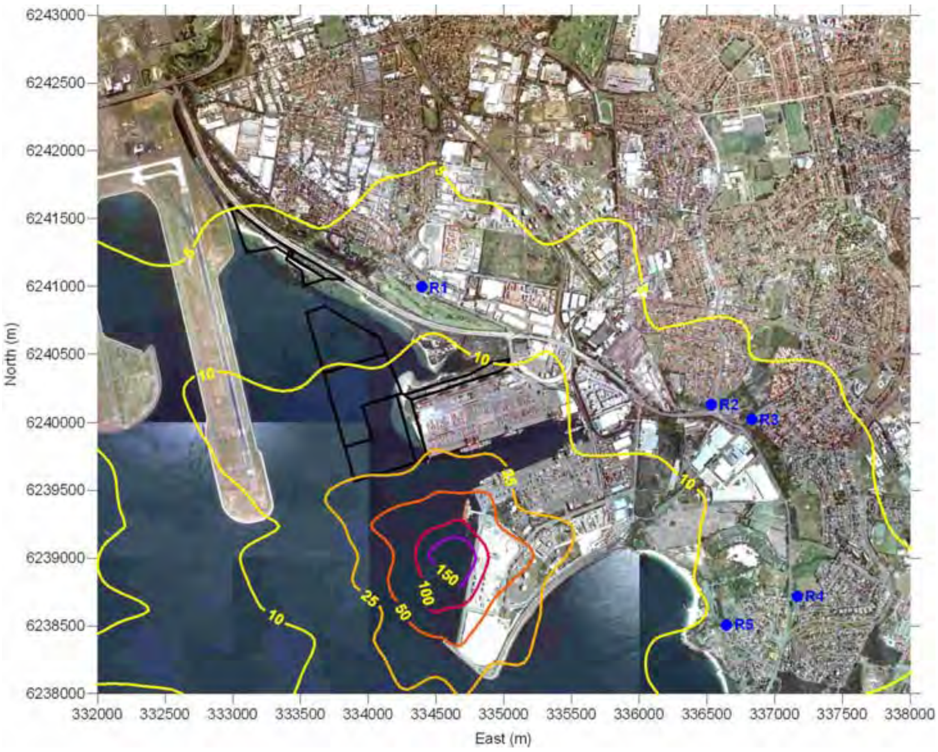
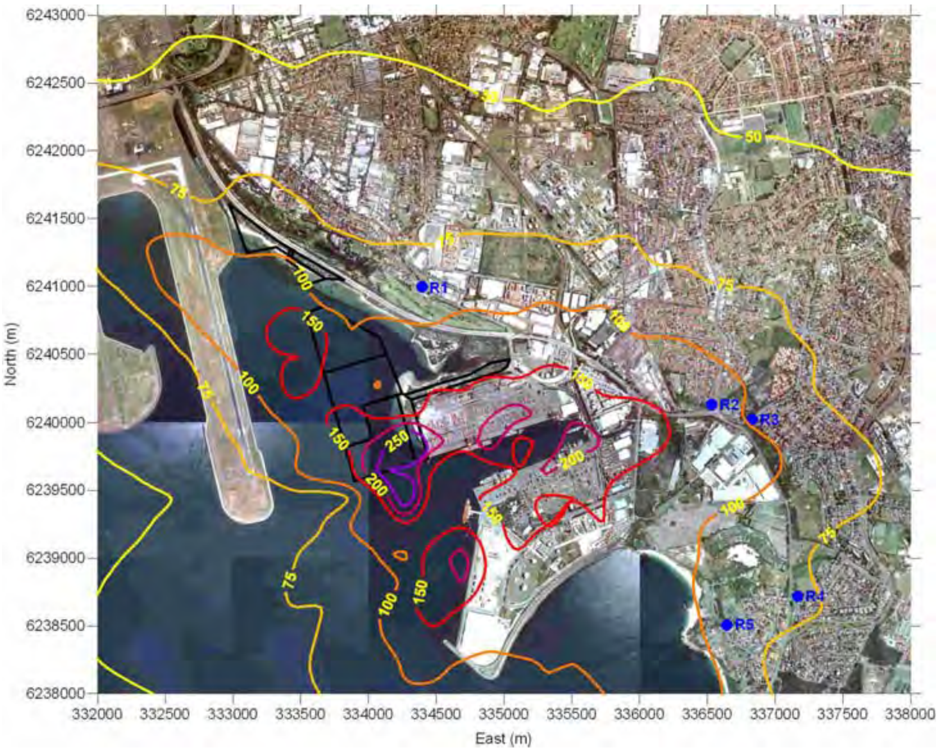
B.2.5 Scenario 1 – Modelled 24-hour SO_2 Concentrations



B.2.6 Scenario 2 – Modelled 24-hour SO_2 Concentrations



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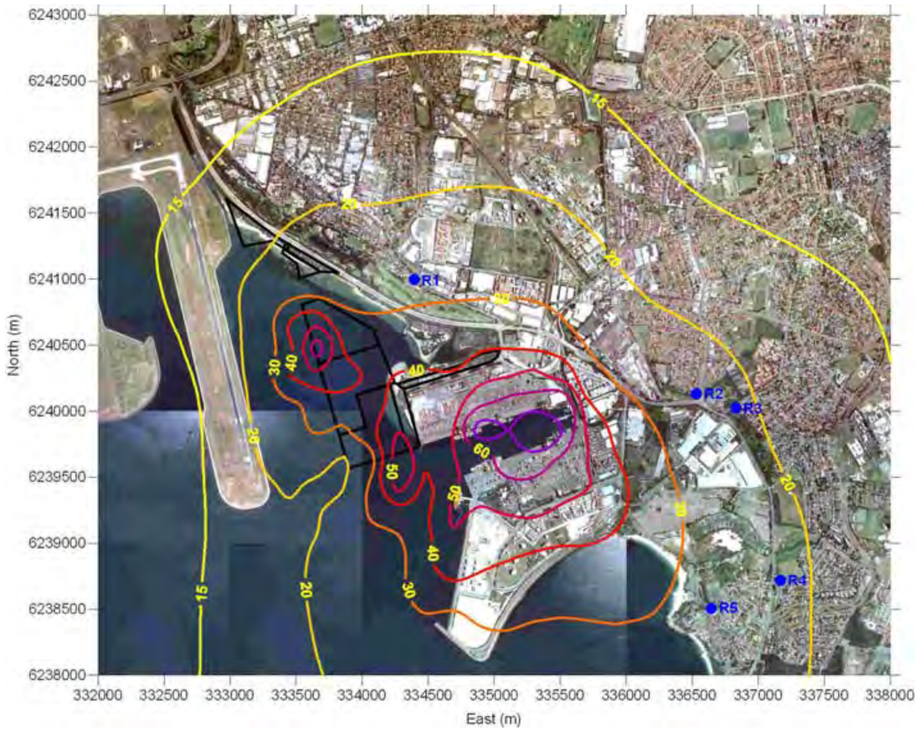
B.2.7 Scenario 1 – Modelled Annual SO_2 Concentrations

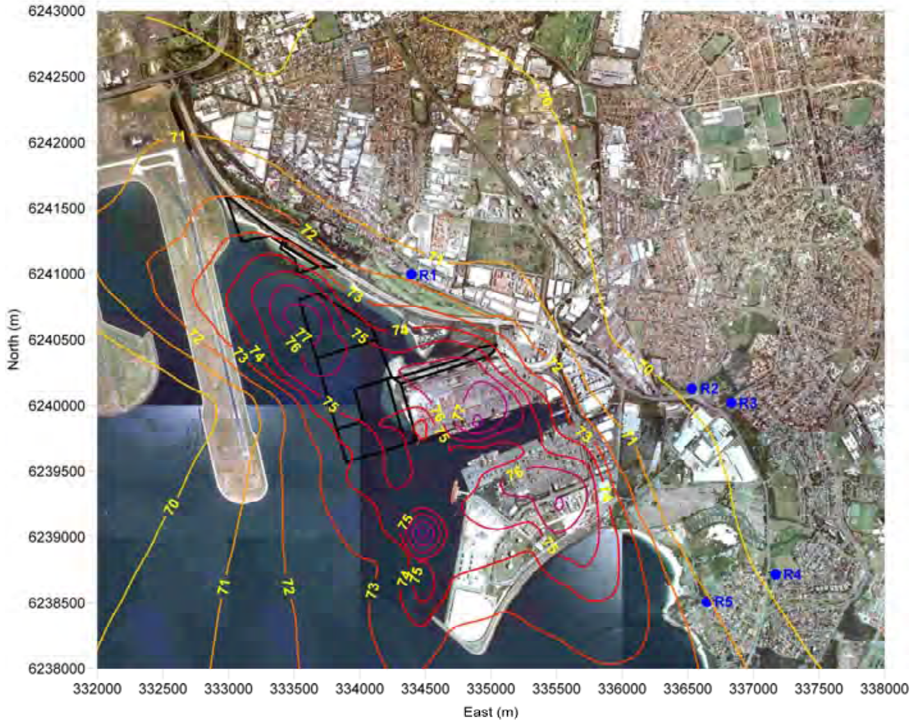
B.2.8 Scenario 2 – Modelled Annual SO_2 Concentrations



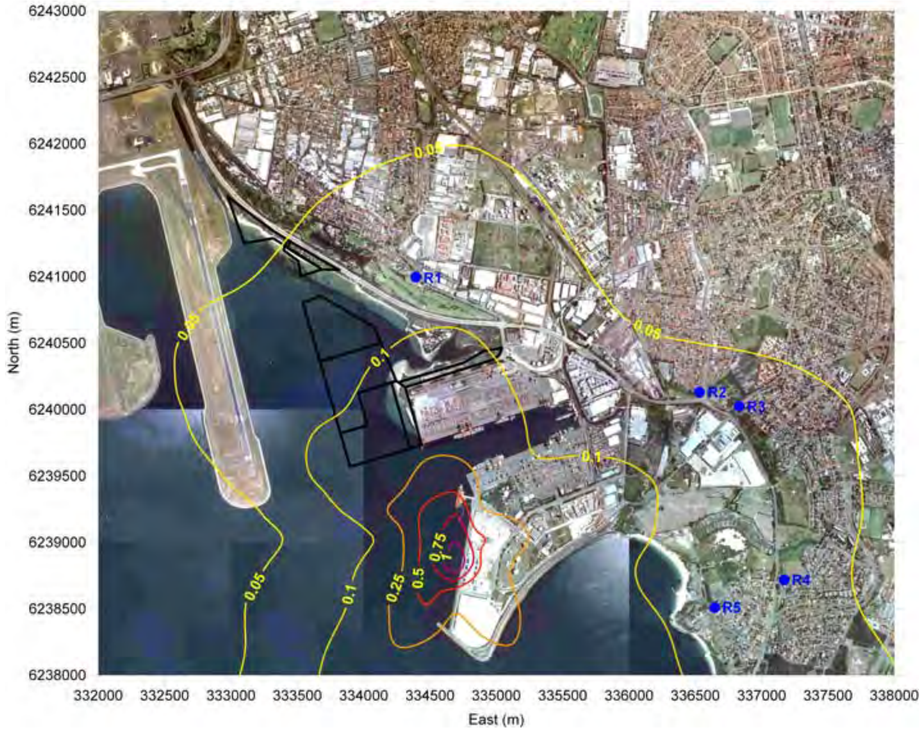
B.3 PM$_{10}$ Modelling Results

B.3.1 Scenario 1 – Modelled 24-hour PM$_{10}$ Concentrations

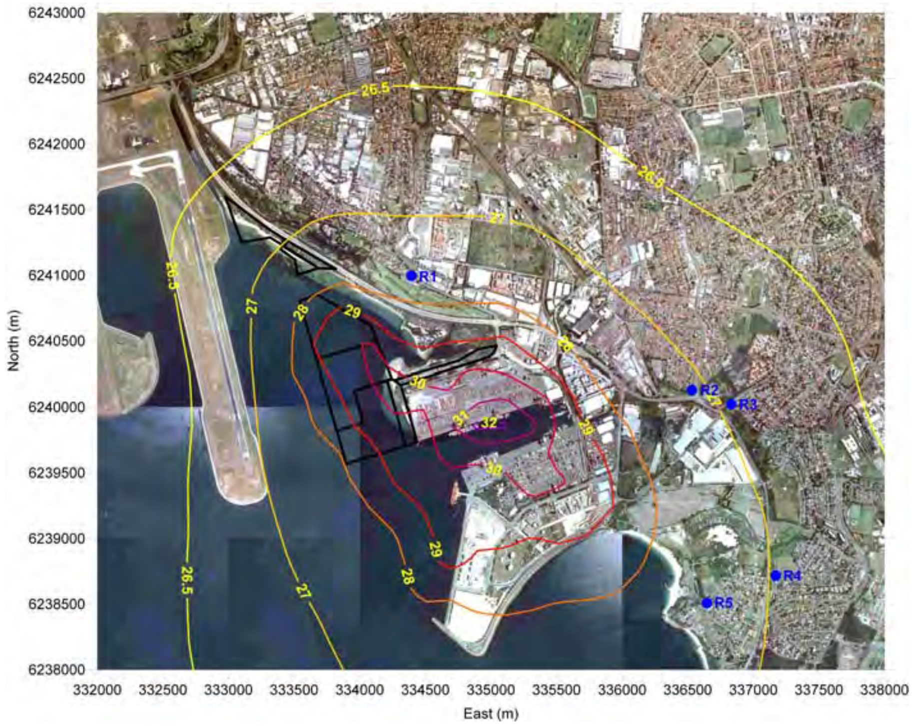
B.3.2 Scenario 2 – Modelled 24-hour PM$_{10}$ Concentrations



B.3.3 Scenario 1 – Modelled Annual PM_{10} Concentrations



B.3.4 Scenario 2 – Modelled Annual PM_{10} Concentrations



Appendix F Noise Assessment

Bulk Liquids Berth No. 2 - Port Botany

NOISE ASSESSMENT REPORT

- Final
- 7 November 2007

Bulk Liquids Berth No. 2 - Port Botany

NOISE ASSESSMENT REPORT

- Final
- 7 November 2007

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Contents

1. Introduction

1.1 General Introduction

Vopak Terminals Sydney Pty Ltd (Vopak) on behalf of Sydney Ports Corporation (SPC) is proposing to construct a second Bulk Liquids Berth (BLB2) facility at Port Botany NSW. Sinclair Knight Merz have been engaged to assess the potential for noise from additional shipping and unloading activities and the potential to affect the amenity of residential and other sensitive receivers near the Port. The assessment of noise impacts includes operational scenarios as well as the construction activities related to the new berth.

1.2 Study Objectives

The objectives of the noise study are as follows:

- to establish background noise levels at nearby residential locations;
- identify operational noise limits at receiver locations;
- predict noise levels resulting from the operation of the bulk liquid berth;
- compare predicted operational noise levels to the noise limits at receiver locations;
- predict noise levels from construction noise impacts; and
- identify any mitigation requirements for the proposed facility to meet the required noise limits.

1.3 Overview of the Proposal

The BLB provides services such as storage, transport, bulk handling, packaging and distribution and access to distribution facilities to independent operators and large corporations. These bulk liquids include fuel-based products used for energy and transport functions throughout NSW. Vopak operates two bulk liquid storage terminals in Port Botany, approximately 13 km south of the Sydney CBD. The first is known as the Site A Terminal and is located at 49 Friendship Road. The second facility, known as the Site B Terminal, is located at 20 Friendship Road.

The existing BLB, owned and operated by SPC, is an open access/common user facility available for all potential bulk liquids customers. In order to minimise the duplication of facilities for the two BLB, BLB2 will share some common components of the existing BLB1 infrastructure for access control, administration and port officers accommodation. BLB2 would require a new berth structure and ancillaries (user pipelines, fire protection system, hose handling gantries, berthing and mooring equipment).

BLB2 development would take place adjacent to SPC land on the privately accessed Fishburn Road side (western) of the Site B Terminal, adjacent to the boundary with the Elgas Caverns. Aspects of the BLB2 proposal consist of the following main elements:

- A central working platform providing a work area, with berthing face (including bollards and fenders) and pipe manifold/marine loading arm (MLA) arrangements;
- Adjacent berthing dolphins on each side of working platform designed to accommodate up to the maximum length vessel;
- Two mooring dolphins on each side of the working platform (four in total). Mooring dolphins will be required on the northern side of the working platform, instead of the existing land based mooring point arrangement used for the BLB1 due to the geometry of the existing shoreline.
- Walkways (catwalks) connecting the dolphins and working platform;
- An access bridge connecting the working platform with the shore and providing for pipeline support structures and vehicle access;
- Support infrastructure including fire control facilities (pumps, foam/water monitors and associated tanks, gatehouse and amenities (the need for a gatehouse is dependant on site security arrangement);
- Berth fit out, including fire fighting monitors, services such as water, sewer, electrical and communications, amenities and blast proof Operator Shelter.

Figure 1-1 is an example of the MLA, pipelines and other infrastructure that currently services BLB1 which would be duplicated for BLB2. **Figure 1-2** shows the position of the proposed BLB2 in relation to the existing BLB1 and Elgas site. The ship outline shows the footprint of the maximum 256 metres overall length, LR Class Tankship proposed for the berth.

Figure 1-1 View of equipment infrastructure at BLB1

Figure 1-2 Location of BLB 1 and Proposed BLB2 sites at Port Botany Terminal

2. Existing Noise Environment

The area around Port Botany is subject to high traffic numbers due to the port and nearby industrial activities and as a result, nearby residential locations experience elevated ambient noise levels. In addition to the existing noise in the vicinity of the port, recent approval for an expansion of the port operations by the Department of Planning will produce additional freight movements and therefore a corresponding increase in existing noise levels.

In October 2005, a 51 hectare expansion of the Brotherson Dock North to accommodate additional berths was approved. This expansion included additional dock space, four new berths, container storage and handling, an extension of the Botany Freight Line, two new rail sidings, and a dedicated road link from the new terminal to the heavy truck route on Foreshore Road. In August of 2005, the Department of Planning also approved Stage 2 of the Port Botany expansion, which involves the construction and operation of a fifth shipping berth and associated infrastructure.

Vopak has recently received approval in February 2007 for the construction of additional storage facilities as part of its B3 expansion works. These works include the construction of additional storage tanks, pipelines and a water treatment plant. The proposed BLB2 works include the berthing structure associated with the additional storage capacity generated from the B3 site and as such carry no additional capacity requirements with the proposal. Operational and traffic noise relating to the B3 site were considered as part of the approval for that project.

These recent projects have generated background noise studies as part of the approval process. The assessment of the BLB2 has utilised information from previous background noise levels in the vicinity of the port. **Figure 2-1** shows the areas of future expansion around the port with respect to the proposed BLB2.

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Figure 2-1 Expansion in Port Botany

2.1 Background Noise Measurements

When measuring noise levels, the use of statistical descriptors is necessary to understand and describe how variations in the noise environment occur over any given period. A list of common descriptors and their meanings that have been used in this noise assessment are given below.

- L_{A90} – the noise level exceeded for 90 percent of the fifteen minute interval. This is commonly referred to as the background noise level and represents the quietest 90 seconds in a fifteen minute period;
- L_{Aeq} – the noise level having the same energy as the time varying noise level over the fifteen minute interval; and
- L_{Amax} – maximum noise level measured at a given location over the fifteen minute interval.

The Rating Background Level (RBL) is the overall, single-figure, background level representing each of the day, evening or night assessment periods over the whole monitoring period. This level is the tenth percentile of the background noise environment evaluated in the absence of noise from the proposed development, and is the level used for assessment purposes when referring to background noise.

The most detailed information available for noise monitoring studies was identified from a noise monitoring assessment undertaken by Wilkinson Murray (WM) in June 2003, for the Port Botany Expansion[1]. Additional information was also sourced from SPC for a residential location in La Perouse.

Not all locations identified in the WM report are relevant for the assessment of noise impacts in relation to the Vopak BLB2 site due to the distance and the proximity of other noise sources such as aircraft and road traffic. **Table 2-1** lists the locations of the unattended surveys while **Table 2-2** presents the results of attended measurements. These measured noise levels have been used to quantify the existing noise environment at residential receiver locations near the port. **Table 2-3** presents selected results of the unattended background noise monitoring results at residential locations near the proposed BLB2.

[1] Wilkinson Murray Noise report - Report No 02053 Version I, June 2003

Table 2-1 Noise Monitoring Locations

ID	Location Description	Position on the site
• Location 4	Botany Golf Course	Northern boundary
• Location 5	74 Australia Avenue	Centre of front lawn
• Location 6	Eastern Suburbs Crematorium Military Road	North western boundary
Location A[1]	21 Elaroo Avenue, La Perouse	Front Yard

Source: Wilkinson Murray Noise report
[1] Source: Sydney Ports

Table 2-2 Summary of Attended Noise Monitoring

Location	Noise Level dB(A)		Survey Period	Comment
	L_{Aeq}	L_{A90}		
Location 4	51	42	Night	Industrial noise from port operations audible approx. 48
Location 5	49	47	Night	Industrial noise from port operations audible approx. 48
Location 6	-	-	Night	-
Location A[1]	49	36	Night	No audible industrial noise sources

Source: Wilkinson Murray Noise report
[1] Source: Sydney Ports

Table 2-3 Summary of Background Noise Monitoring

ID	Location Description	RBL dB(A)		
		Daytime (7am – 6pm)	Evening (6pm – 10pm)	Night Time (10pm – 7am)
Location 4	North of Golf Course	57	50	43
Location 5	Australia Avenue	42	40	42
Location 6	Military Road	46	46	45
Location A[1]	Elaroo Avenue	38	37	36

Source: Wilkinson Murray Noise report
[1] Source: Sydney Ports

Figure 2-2 shows the unattended noise monitoring locations from **Table 2-2** in relation to the Vopak site that have been adopted for the BLB2 noise assessment.

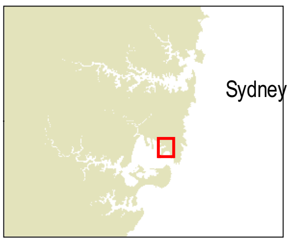

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Figure 2-2 Proposed BLB2 and Sensitive Receiver Locations

GDA 94 MGA Zone 56

Bulk Liquid Berth 2

August 16, 2007
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3. Project Specific Noise Limits

3.1 Assessment Guidelines

The Department of Environment and Climate Change (DECC, formerly EPA) NSW *Industrial Noise Policy* (INP), 2000, provides an assessment process for both scheduled and unscheduled premises under the *Protection of the Environment and Operations Act 1997*. The DECC guidelines provide a method of determining if noise emissions from industrial sources are likely to cause an intrusive noise impact or longer term planning issues concerning noise. These guidelines cover impacts from any industrial noise source to any other potentially affected noise sensitive receiver.

The guidelines are based on an assessment of the pre-existing background noise levels in the absence of industrial noise or a zone based noise goal where industrial noise is already part of the existing environment. The Intrusive Criteria considers the existing environmental or "background" noise when determining the appropriate noise levels for a project, the zone based noise assessment is known as the Amenity Criteria. When assessing noise impacts the more stringent of the Intrusive or Amenity Criteria is used to set project noise limits. The existing noise environment plays an important role in the determination of noise criteria for any new developments, which is quantified by undertaking measurements of background noise levels.

3.2 Intrusive Noise Criteria

A noise source is considered to be non-intrusive if:

- the $L_{Aeq,\ 15\ minute}$ level does not exceed the RBL by more than 5 dB(A) for each of the day, evening and night-time periods,
- the subject noise does not contain tonal, impulsive, or other modifying factors as detailed in Chapter 4 of the INP.

From **Table 2-3,** the RBL noise levels for day, evening and night at each location are to be used in the calculation of the intrusive noise limits. The corresponding intrusive noise criteria for the day, evening and night time periods are presented in **Table 3-2**.

3.3 Amenity Noise Criterion

The amenity criteria apply to the L_{Aeq} noise level determined for the period of assessment of day, evening or night being 11, 4 and 9 hours respectively. The definition of the noise amenity classification for the area surrounding the port is urban based on the description for this type of location in the DECC Industrial Noise Policy. An acceptable amenity criteria for an urban area is given in the INP as $L_{Aeq\ (Period)}$ of 60, 50 and 45 dB(A) for day, evening and night periods respectively.

Residential areas across the bay would have lower amenity criteria that would reflect a suburban situation. The INP recommends that for a residences located in a suburban area, an acceptable amenity criteria would be an $L_{Aeq\ (Period)}$ of 55, 45 and 40 dB(A) for day, evening and night periods respectively.

3.4 Cumulative Noise Impact Criteria

The INP aims to control cumulative noise impacts resulting from the combined effects of a proposed project and existing industrial noise sources by modifying the amenity criteria depending on the level of existing impact. Where there is an existing industrial noise influence, the amenity criteria are decreased in accordance with Table 2.2 of the INP.

To account for cumulative noise impacts resulting from the combined effects of existing and new projects, the INP recommends modifying the above amenity criteria where there is an existing industrial noise influence. The amenity criteria are decreased in accordance with Table 2.2 of the INP. Based and attended measurements from **Table 2-3** and the estimate of existing industrial noise at these locations, the Amenity Criteria noise levels for Locations 4, 5 and 6 will be reduced by 10dB(A). For the residential areas represented by Location A, there was no industrial noise influence identified and therefore there will be no penalty applied to the Amenity Criteria.

3.5 Construction Noise Guidelines

For the construction phase of the project, noise objectives documented in the DECC *Environmental Noise Control Manual* (ENCM, 1994), Chapter 171 Construction Site Noise, are used for assessing the potential impacts. The noise criteria are dependent on the existing background noise levels and the expected duration of the works. The conditions of operation (for construction activity) are expressed in terms of L_{A10} noise levels above the nominated background level and are detailed in **Table 3-1**.

Table 3-1 DECC Construction Criteria Guidelines

No.	Duration Of Works	DEC Noise Guidelines
1	Construction period of 4 weeks and under	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).
2	Construction period greater than 4 weeks and not exceeding 26 weeks	The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).
3	Construction period greater than 26 weeks	The EPA does not provide noise control guidelines for construction periods greater than 26 weeks duration, however, it is generally accepted that provided L_{A10} noise levels from the construction area do not exceed a level of 5 dB(A) above background, then adverse (intrusive) noise impacts are not likely to be experienced at nearest sensitive receptor locations.

The following time restrictions apply to construction activities:

- Monday to Friday, 7 am to 6 pm;
- Saturday, 7am to 5pm;
- Sunday and Public Holidays (only as the construction schedule requires); and
- No audible work outside these hours unless approval is obtained from the DECC prior to works being undertaken.

3.6 Proposed Works

Construction works would generally follow the program below:

- Preparation of the site;
- Berth construction;
- Pipe work and instrumentation.

The overall BLB2 project would take approximately 22 months in total. Construction of the BLB2 is expected to take approximately 18 months for maritime structures and 10 months for users infrastructure. Offshore maritime work and land-based pipeline work could be undertaken concurrently as they are generally independent. Noise from the works would be generated by activities such as piling, excavators, cranes and truck movement onsite. Piling is to be carried out using bored piles, which is quieter operation than driven piling construction. Other construction activities related to the proposed BLB are not expected to generate significant noise emissions at residential locations.

Based on the berth construction taking 22 months, **Table 3-1** identifies the appropriate L_{A10} noise limit for construction activities, when measured in the vicinity of the most affected noise sensitive receiver, as background +5 dB(A) in accordance with the ENCM.

3.7 Project Specific Noise Criteria

Table 3-2 summarises the noise criteria that would be applicable to the locations to the north and the east of the BLB2 site.

Table 3-2 Derivation of Project Specific Noise Criterion

	Day	Evening	Night-time
Intrusiveness Criteria	**$L_{Aeq15\ min}$**	**$L_{Aeq15\ min}$**	**$L_{Aeq15\ min}$**
Project Intrusiveness Criteria	RBL + 5 dB(A)	RBL + 5 dB(A)	RBL + 5 dB(A)
Project Specific Intrusiveness Criteria			
Location 4	62 dB(A)	55 dB(A)	48 dB(A)
Location 5	47 dB(A)	45 dB(A)	47 dB(A)
Location 6	51 dB(A)	51 dB(A)	50 dB(A)
Location A	43 dB(A)	42 dB(A)	41 dB(A)
Amenity Criteria	**$L_{Aeq\ 11hr}$**	**$L_{Aeq\ 4hr}$**	**$L_{Aeq\ 9hr}$**
Acceptable Amenity Criteria Urban	60 dB(A)	50 dB(A)	45 dB(A)
Acceptable Amenity Criteria Suburban	55 dB(A)	45 dB(A)	40 dB(A)
Project Amenity Criteria			
Location 4 (Modified)	50 dB(A)	40 dB(A)	35 dB(A)
Location 5 (Modified)	50 dB(A)	40 dB(A)	35 dB(A)
Location 6 (Modified)	50 dB(A)	40 dB(A)	35 dB(A)
Location A (Non-Modified)	55 dB(A)	45 dB(A)	40 dB(A)
Project Specific Noise Criteria			
Location 4 Modified Amenity Criteria	50 dB(A) $_{11hr}$	40 dB(A) $_{4hr}$	35 dB(A) $_{9hr}$
Location 5	47 dB(A) $_{11hr}$	40 dB(A) $_{4hr}$	35 dB(A) $_{9hr}$
Location 6	51 dB(A) $_{15\ min}$	40 dB(A) $_{4hr}$	35 dB(A) $_{9hr}$
Location A	43 dB(A) $_{15\ min}$	42 dB(A) $_{15\ min}$	40 dB(A) $_{9hr}$

Construction noise objectives at residential locations for day time construction activities are given in **Table 3-3**.

Table 3-3 Construction Noise Objectives

ID	Location Description	L_{A10} Construction Noise Objectives dB(A)
		Daytime (7.00am – 6.00pm)
Location 4	North of Golf Course	62
Location 5	Australia Avenue	47
Location 6	Military Road	51
Location A	Elaroo Avenue	43

4. Assessment

4.1 Assessment Methodology

A noise model developed using SoundPLAN modelling software was used to predict the noise levels at residential locations resulting from the operations of BLB2. Noise impacts have been predicted using two meteorological scenarios, which represent noise propagation under both neutral and adverse weather conditions with modelling parameters as follows:

1. Neutral weather conditions D class stability conditions winds < 0.5m s^{-1}; and
2. Adverse weather conditions, i.e. F class stability conditions and winds at $2ms^{-1}$ in the direction of a receiver.

A complete assessment of local weather conditions has not been undertaken for the project as the assessment includes neutral conditions which have no impact on the predicted noise levels and default adverse conditions that are essentially a worst case scenario as identified by the INP.

Predicted noise levels at the receiver locations from the BLB2 activities are not expected to be tonal or impulsive and therefore will not attract an additional penalty for noise impacts with these characteristics.

4.2 Predicted noise levels

The noise levels predicted at receiver locations have been assessed using noise data obtained from the existing operations at BLB1. The noise levels from a ship unloading were measured during a visit to the BLB1 site in July 2007, and incorporated noise from the auxiliary engines and product pumps that were operational during the survey. The noise measurements were converted to a Sound Power Level (SWL) and used as validation for the predictive noise model. The noise level used in the assessment is presented in **Table 4-1**.

Table 4-1 Ship Unloading Sound Power Level

Description	SWL	Comments
MV Jasmine	108 dB(A)	Auxiliary engines audible during the survey. Dominant noise source was from product pumps (gear pumps) operating in the ships hold.

The noise level represents a L_{Aeq} measurement over a 15 minute period however, the operational noise from the Jasmine was observed to be generally constant for the monitoring period. The constant nature of the noise source means that the predicted levels may be taken as either the L_{Aeq}

15 minute intrusiveness or the L_{Aeq} period amenity noise level. The night time noise criteria are used to determine compliance for the BLB2 project as these are the most stringent noise goals throughout the 24 hour period. **Table 4-2** presents the results of noise modelling for the operation of the BLB2 at the selected sensitive receiver locations.

Table 4-2 Predicted Noise Levels BLB2 Only

Residential Location	BLB 2 Neutral Weather	BLB2 Adverse Weather	Night Time Criteria
	$L_{Aeq\ Period}$	$L_{Aeq\ Period}$	$L_{Aeq\ Period}$
Botany Road (north of Golf Club)	23 dB(A)	27 dB(A)	35 dB(A) $_{9hr}$
Australia Avenue	23 dB(A)	28 dB(A)	35 dB(A) $_{9hr}$
Military Road	26 dB(A)	30 dB(A)	35 dB(A) $_{9hr}$
Elaroo Avenue	23 dB(A)	28 dB(A)	40 dB(A) $_{9hr}$

Table 4-3 presents the predicted noise levels resulting from the simultaneous operations of both berths.

Table 4-3 Predicted Noise Levels BLB1 and BLB2 Combined

Residential Location	BLB 1 and BLB2 Neutral Weather	BLB1 and BLB2 Adverse Weather	Night Time Criteria
	$L_{Aeq\ Period}$	$L_{Aeq\ Period}$	$L_{Aeq\ Period}$
Botany Road (north of Golf Club)	28 dB(A)	32 dB(A)	35 dB(A) $_{9hr}$
Australia Avenue	28 dB(A)	32 dB(A)	35 dB(A) $_{9hr}$
Military Road	30 dB(A)	34 dB(A)	35 dB(A) $_{9hr}$
Elaroo Avenue	26 dB(A)	31 dB(A)	40 dB(A) $_{9hr}$

The modelling results indicate that the noise levels from the BLB2 only are lower than the night time noise criteria for both neutral and adverse weather conditions. When the combined operations for the existing berth and the proposed berth are assessed at the nearest sensitive receivers, noise levels are expected to be below the most stringent night time noise criterion of 35 dB(A) at all locations.

Noise levels from road traffic and other nearby industrial noise sources would provide a large contribution to the overall noise environment in the vicinity of the port and therefore the predicted levels from the operation of BLB2 would be inaudible against the background noise levels when observed at the nearest residential locations. **Figure 4-1** shows the noise contours for BLB2 under Neutral conditions and **Figure 4-2** presents the noise contours from the modelling scenario for BLB2 under adverse meteorological conditions. **Figure 4-3** and **Figure 4-4** present the predicted noise contours for the combined operation of BLB1 and BLB2 for neutral and adverse weather conditions.

Legend

- 25dB(A)
- 30dB(A)
- 35dB(A)
- 40dB(A)
- 45dB(A)
- 50dB(A)
- 55dB(A)
- 60dB(A)
- 65dB(A)

0 265 530
Metres

1:25,773 At A4

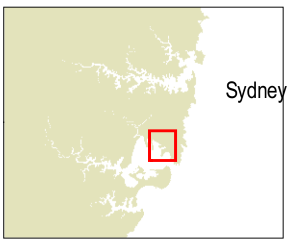

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Figure 4-1 Predicted Noise Levels from BLB2

Neutral Weather Conditions

GDA 94 MGA Zone 56

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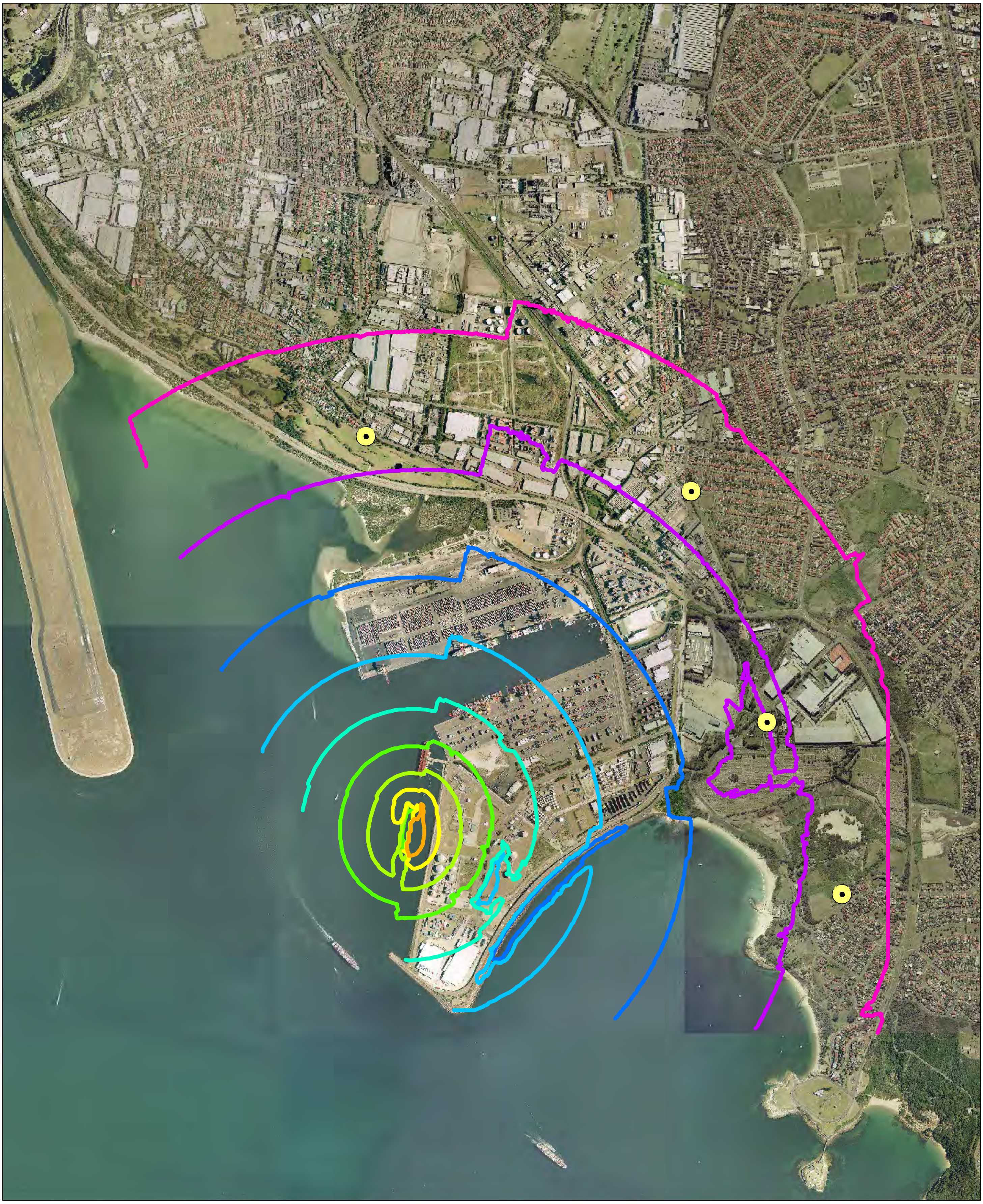

Legend

- 25dB(A)
- 30dB(A)
- 35dB(A)
- 40dB(A)
- 45dB(A)
- 50dB(A)
- 55dB(A)
- 60dB(A)
- 65dB(A)

0 250 500
Metres

1:25,000 At A4

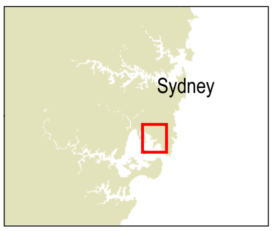

Figure 4-2 Predicted Noise Levels from BLB2

Adverse Weather Conditions

GDA 94 MGA Zone 56

August 16, 2007
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Legend

- 30dB(A)
- 35dB(A)
- 40dB(A)
- 45dB(A)
- 50dB(A)
- 55dB(A)
- 60dB(A)
- 65dB(A)

0 250 500

Metres

1:25,452 At A4

SKM

Figure 4-3 Predicted Noise Levels from BLB 1 and 2

Neutral Weather Conditions

GDA 94 MGA Zone 56

November 7, 2007

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Figure 4-4 Predicted Noise Levels from BLB 1 and 2

Adverse Weather Conditions

GDA 94 MGA Zone 56

November 7, 2007
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4.3 Construction Impacts

The sound power levels assumed for the noisiest construction equipment are shown in **Table 4-4**. These levels have been extracted from our in-house database and reflect typical L_{A10} noise emissions from similar equipment.

Table 4-4 Sound Power Levels for Construction Activities

Description	Quantity	Sound Power Level L_{A10} dB(A)
Drilling Barge (Compressor, Crane)	1	115
Excavator	1	112
Concrete Pump	1	108

The estimated $L_{A10\ 15\ min}$ noise levels at residential locations from construction activities are presented in **Table 4-5** and show the worst case scenario when all equipment from **Table 4-4** is operational. The predicted noise levels for construction activities is largely due to the use of the drilling barge for piling activities, however noise levels, are expected to be below measured background noise levels at the nearby residential locations.

Table 4-5 Predicted Construction Noise Levels

ID	Location Description	Predicted L_{A10} Construction Noise Levels dB(A)	L_{A10} Construction Noise Objectives dB(A)
		Daytime (7.00am – 6.00pm)	Daytime (7.00am – 6.00pm)
Location 4	North of Golf Course	35	62
Location 5	Australia Avenue	34	47
Location 6	Military Road	36	51
Location A[1]	Elaroo Avenue	35	43

4.4 Mitigation Measures

Operations of the BLB2 are predicted to be below the project specific noise levels which have been determined with respect to existing industrial noise influences. Construction noise levels are predicted to be below the background noise environment at all nearby residential locations. Although noise impacts are not expected to result for the construction activities, noise minimisation strategies during the construction period should be considered for the project and should include the practices listed in **Table 4-6**.

Table 4-6 Management Practices for Construction Activities

Item	Action
1	Ensure compliance with the construction hours identified in Section 3.5
2	Equipment having directional noise characteristics (emits noise strongly in a particular direction) are to be oriented such that noise is directed away from sensitive areas
3	Avoid the coincidence of noisy plant working at the same time where possible
4	Plant with the lowest noise rating which meets the requirement of the task would be selected
5	Ensure that internal combustion engines (all mobile and stationary equipment) are fitted with a suitable muffler in good repair
6	Ensure that tailgates on trucks are securely fitted to avoid unnecessary “clanging” noise, particularly during movement of empty trucks
7	Where using pneumatic equipment, select silenced compressors or use quieter hydraulic equipment
8	Conduct regular inspections and effective maintenance of both stationary and mobile plant and equipment (including mufflers, enclosures etc)
9	Equipment not being utilised as part of the work would not be left standing with engines running for extended periods

5. Conclusions

An assessment of operational and construction noise impacts has been undertaken by Sinclair Knight Merz, for the proposed Bulk Liquid Berth 2. Noise modelling was conducted to assess the potential for impacts from the proposed BLB2 noise emissions.

The noise assessment has considered the effect of noise sources from the BLB2 project at the nearest residential locations by comparing predicted levels to the noise criteria in the DECC INP. The results of noise modelling predictions indicate that the proposed operation of BLB2 will not significantly add to the noise environment at the nearest residential locations. The predicted noise levels at these residential locations are expected to be below the identified noise criteria for operations of an industrial noise source. As predicted noise levels from the BLB2 are within the INP criteria, no noise mitigation measures are expected to be necessary for the operation of BLB2. The noise emissions from the combined operations of BLB1 and BLB2 are below the night time noise criteria at all locations.

The predicted construction noise levels are based on typical impacts from marine piling and land based construction activities associated with the proposed berth. Construction noise during working hours is expected to be below the nominal noise goals for a 22 month construction period.