Orica Australia Pty Ltd
13-Nov-2013

Kooragang Island Modification Environmental Assessment

Modification of Project Approval 08_0129

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Certification

Submission of Environmental Assessment (EA) prepared under the *Environmental Planning and Assessment Act 1979* Section 75F

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in respect of	Ammonia Flaring and Nitric Acid Tank Modification Environmental Assessment	
Project application Applicant name	AECOM Australia Pty Ltd (AECOM)	
Applicant address	PO Box 73 HRMC NSW 2310	
Land to be developed Proposed project	Lot 3 D.P. 234288 Proposed construction and operation of a nitric acid storage tank. Map(s) attached	
Environmental Assessment	an Environmental Assessment (EA) is attached	
Certification	I certify that I have prepared the contents of this Environmental Assessment and to the best of my knowledge it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.	
	Signature: Name: Simon Murphy Date: 13 November 2013	Signature: Name: Date: 13 November 2013

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Executive Summary

Introduction

This Environmental Assessment (EA) has been prepared by AECOM Australia Pty Ltd (AECOM) on behalf of Orica Australia Pty Ltd (Orica), relating to proposed modifications to Major Project Approval (MP08_0129) for Orica's facility on Kooragang Island, Newcastle. The proposed modification is seeking approval for:

- A modification to the location and storage capacity of the approved site expansion nitric acid tank; and
- The construction and operation of three ammonia flaring stacks located in the ammonia storage, nitrates and ammonia plant areas.

Modification approval is being sought under section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Minister for Planning and Infrastructure is the approval authority for this application under the transitional arrangements of Part 3A of the EP&A Act. AECOM has prepared an EA in accordance with the provisions of the former Part 3A of the Act and the *Environmental Planning and Assessment Regulation 2000*, The EA addresses the Director-General's Requirements previously prepared for the expansion project issued to Orica in 2009.

Project Description

The modification comprises of two different components being; the relocation and increase in storage capacity of the approved expansion project nitric acid tank; and the construction and operation of three ammonia flares.

Nitric Acid Tank

Orica proposes to build a 10,000 tonne nitric acid storage tank and associated infrastructure in the north western corner of Orica's KI facility. This tank would replace the approved 2,000 tonne Nitric Acid tank detailed in the expansion project Environmental Approval.

The tank is to be utilised for import of additional nitric acid via the existing nitric acid import line in order to fully utilise existing ammonium nitrate operations ahead of a major expansion. The nitric acid tank would utilise water from Hunter Waters recycled water project for the dilution of nitric acid prior to further use onsite.

Ammonia Flaring Stacks

Orica also proposes to install three ammonia flares on self-supported flare stacks, and including ancillary piping and infrastructure required to connect the flare stacks to the existing ammonia collection systems located in the ammonia storage, nitrates and ammonia plant areas.

The flares are to be used for the treatment of non-routine process relief-valve ammonia discharges which are currently in general vented to high-points. The existing scrubbing systems are to treat routine ammonia emissions.

Statutory Planning

The Site is located within the Newcastle Local Government Area on land governed by Newcastle Local Environmental Plan (LEP 2012). The proposed modification to a declared Major Development can be assessed through section 75W of the *Environmental Planning and Assessment Act 1979.* This was confirmed in consultation with the NSW department of Planning and Infrastructure.

The Project is consistent with the provisions of local, regional and State planning instruments which would otherwise apply to the proposal, including:

- *Newcastle LEP 2012*;
- *State Environmental Planning Policy (Major Development) 2005; and*
- *State Environmental Planning Policy 33 – Hazardous and Offensive Development*.

Environmental Assessment

A preliminary environmental risk assessment identified air quality, noise, hazard and risk and visual impacts as being a medium risk commensurate with the size and nature of the project relative to its natural and human environment.

Air Quality and Odour

An assessment of the potential operational air quality impacts of the proposed modification were quantitatively assessed against the existing site air quality management framework and criteria as specified in the Project Approval (08_0129), EPL 828 and in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005). Pollutants of interest in relation to the proposed modification are oxides of nitrogen (NO_x) (as nitrogen dioxide NO_2) associated with the nitric acid tank scrubber operation and ammonia (NH_3) associated with the proposed flares. Modelling concluded that under the operational scenarios anticipated by Orica for the ammonia flares, and with the scrubber and vent stack on the nitric acid tank, predicted emissions would meet the annual and 1 hour NSW EPA criteria for both NO_2 and NH_3 during both routine and non-routine scenarios.

Noise and Vibration

Based on the predicted construction and operational noise levels, noise management levels would not be exceeded at the nearest noise-sensitive receivers during construction phase for both the nitric acid tank and the flares. Operational assessment of the nitric acid tank pump found that it would not result in an exceedance of the project specific noise management levels during operation at any time of the day or night.

Assessment of the operation of the flare stacks found that use of the flares generally complies with the noise limits. Operation of Flare C, which operates for a short period of time, was found to cause minor exceedances (0-2 dB(A)) at receiver locations during neutral weather conditions. Receivers are predicted to exceed by 6 dB(A) during the operation of Flare C during adverse weather conditions at night. However, due to the infrequent operation of Flare C, the short duration in operation and the safety function for which the flares serve, these exceedances are deemed to be acceptable.

It was also found that, should the extremely unexpected event occur of all three flares operating simultaneously, the noise impacts would be 1-2 dB(A) higher than that of the Flare C activated by itself for both neutral and adverse weather conditions. These noise levels would only be experienced by the receivers for a period less than 15 mins – after this period of 15 mins, flares A and C would cease operation and the remaining noise contribution of the flares would be solely due to Flare B. Flare B has been shown to be generally compliant with the noise criteria.

Hazard and Risk

The Preliminary Hazard Analysis (GHD, 2008) prepared previously for the Orica site was updated to incorporate the potential hazard and risk impacts of the proposed ammonia flares. The risk assessment has shown that the site risk results for the project case did not change significantly from the results detailed in the existing facility and that risk continue to be within the requirements of the Hazardous Industry Planning Advisory Papers 4 risk criteria for “intensification of hazardous activities in an existing complex”.

A Preliminary Hazard Analysis was undertaken by Pinnacle Risk Management (2013) to examine the hazards and risks associated with the proposed nitric acid tank. This assessment also concluded that the risk associate with the nitric acid tank also comply with the requirements of the Department of Planning and Infrastructure’s Hazardous Industry Planning Advisory Papers.

Visual

An assessment of the potential visual impacts was undertaken utilising the nearest sensitive receivers located on Stockton as indicative receivers for assessment purposes. Artist’s impressions of the proposed flare stacks and nitric acid tank were prepared to allow examination of the likely visual impacts. This assessment concluded that there would be an overall low level of visual impact resulting from the proposed modification due to: the size and scale of the proposed infrastructure; its consistency with the industrial setting of KI; and the offset distances that exist between the site and sensitive receivers. Should the flares be required to operate the flame produced would have a low viability due to the flaring of ammonia and the blue colour of the flame. The flame however may be visible at night. Given the expected limited need for flaring, visual impacts due to flaring would be infrequent.

Other environmental aspects

Other environmental aspects were considered to be of low, or very low, risk including:

- Soil and water;
- Greenhouse gas;
- Transport;
- Waste;
- Flora and fauna; and
- Heritage.

In relation to the other environmental aspects assessed in the EA, no significant environmental impacts were predicted and where relevant, reasonable and feasible management measures and safeguards have been recommended to mitigate potential impacts.

Statement of Commitments

A Statement of Commitments has been prepared in respect of the construction and operation of the proposed tank and ammonia flares. Orica commits to the update/preparation and implementation of the environmental management and monitoring plans and environmental mitigation measures detailed in the Statement of Commitments for the proposed modification. This includes the preparation and implementation of a Construction Environment Management Plan during construction, and the update and implementation of operational management plans as necessary.

Justification and Conclusion

Environmental, biophysical, economic and social considerations have been addressed during the preparation of the Environmental Assessment. The assessments of each of these factors has demonstrated that the proposed modification will not have a significant impact on the surrounding environment or community provided that appropriate management and mitigation measures are implemented as identified in this Environmental Assessment.

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1.0 Introduction

1.1 Overview

This Environmental Assessment (EA) has been prepared by AECOM Australia Pty Ltd (AECOM) on behalf of Orica Australia Pty Ltd (Orica) for proposed modifications to Project Approval 08_0129.

Orica operates a manufacturing facility on Kooragang Island (KI), Newcastle, which produces ammonia, nitric acid and ammonium nitrate. An EA (AECOM, 2009) was prepared in 2009 for the expansion of the facility and was approved under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 1 December 2009 (DA 08_0129). A description of DA 08_0129 is provided in **Section 2.1**.

As a result of review of the detailed design against operational requirements, the plant and equipment layout was amended with a modification to the Project Approval sought (AECOM, 2011) and approved on 11 July 2012 (DA 08_0129 MOD 1). MOD 1 elements are described in **Section 2.1**.

Orica is proposing a further modification to 08_0129 relating to site improvement works including implementing measures designed to improve safety and reduce risk associated with the use of ammonia at the site. The modification proposed in this EA has two discrete elements being:

- A modification to the location and storage capacity of the approved site expansion nitric acid tank; and
- The construction and operation of three ammonia flaring stacks located in the ammonia storage, nitrates and ammonia plant areas.

In this EA reference to the proposed modification refers to both the nitric acid tanks and the ammonia flares. Commentary on the individual elements and characteristics of the nitric acid tank or the flare/s is provided throughout as necessary.

1.2 Approval Pathway

In accordance with Clause 3 of Schedule 6A of the EP&A Act, section 75W of the Act (as in force immediately before its repeal on 1 October 2011 and as modified by Schedule 6A) continues to apply to transitional Part 3A projects. The proposed modification can therefore be assessed under s75W of the EP&A Act, which states that:

2) The proponent may request the Minister to modify the Minister's approval for a project. The Minister's approval for a modification is not required if the project as modified will be consistent with the existing approval under this Part.

3) The request for the Minister's approval is to be lodged with the Director-General. The Director-General may notify the proponent of environmental assessment requirements with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.

4) The Minister may modify the approval (with or without conditions) or disapprove of the modification.

This EA has been prepared to address the potential environmental issues associated with the proposed modification. As agreed with Department of Planning and Infrastructure (DP&I) (refer to **Section 4.1**), AECOM have used the Director General's Requirements (DGRs) previously issued for the 2009 EA, to guide the assessment of the potential impacts resulting from the proposed modification.

1.3 The Proponent

The proponent for the approved project and the modification is Orica Australia Pty Ltd (Orica). Orica is an independent, Australian-owned company with a global reach in more than 100 countries worldwide

Orica is the largest provider of commercial explosives and blasting systems to the mining and infrastructure markets, the global leader in the provision of ground support in mining and tunnelling, and the leading supplier of sodium cyanide for gold extraction.

Orica also supplies general chemicals across a diverse range of markets, including agriculture, building and construction, food and beverage, pharmaceutical and personal care, plastics, pulp and paper and water treatment industries.

Orica has a strong portfolio of manufacturing and distribution assets strategically located across Australia Pacific, Asia, Europe, Middle East, Africa, Latin America and North America which enables it to provide valuable supply chain capabilities for its customers.

The KI manufacturing site primarily supplies Orica's Mining Services division, providing ammonium nitrate which is utilised in the manufacture of commercial explosives for the mining and quarry industries.

1.4 Site Overview

The Orica manufacturing site is located on KI which lies near the mouth of the Hunter River within the Port of Newcastle, approximately 3.5 km north of Newcastle CBD in New South Wales. **Figure 1** shows the regional location of the facility.

Neighbouring land uses to the Orica site consist of:

- **North** - The Incitec Pivot Fertiliser distribution centre is located to the north and adjoins the AN Plant at the northern boundary;
- **North West** – Kooragang Berth No.2, used for the unloading of cement, vegetable oil, woodchip and bulk products (fertiliser, ammonia, and ammonium nitrate);
- **West** – Saw-millers exports Pty. Ltd. Operates a major export point for woodchips directly to the west of the AN Plant, across Heron Road;
- **South West** – an agri-terminal is located to the south west, which is used for the storage and loading of cotton seed, other seed grains woodchips and sand;
- **South** – Patricks Warehousing and Despatch Facility operates a warehouse adjacent to the southern boundary of the AN Plant;
- **South** – Walsh Point is located across Heron Road (i.e. the southern end of KI); and
- **East** – the thin strip of land between Greenleaf Road and the AN Plant is currently vacant, apart from two disused bulk storage tanks.

The nearest residential areas are located at Stockton, approximately 760 m to the south east and Fern Bay, approximately 1.5 km to the north east. There are also residential properties 2 km to the south at Carrington and 2.2 km to the south west at Mayfield.

The site is topographically flat and includes a range of existing buildings, plant and machinery and supporting infrastructure associated with the production of ammonia, nitric acid and ammonium nitrate at the site.

Orica's KI facility consists of:

- An Ammonia Plant;
- Three Nitric Acid Plants, NAP1, NAP2 and NAP3 (nitric acid is used in the production of ammonium nitrate);
- Two Ammonium Nitrate (AN) Plants, namely AN1 which manufactures Nitropril (a porous prilled ammonium nitrate product) and AN2 which manufactures Opal (a granulated ammonium nitrate product) and 88% ammonium nitrate solution;
- Bagging and bulk dispatch facilities for anhydrous ammonia, solid ammonium nitrate, AN solution, nitric acid and granulated material; and
- Offices and amenities located adjacent to Greenleaf road on the eastern side of the plant.

The main elements of the facility are detailed on **Figure 2**.

The land to which the proposed modification relates is identified as Lot 3 DP DP234288. The land is owned by Orica.

G:\ENV\GIS\Projects\603\60306451 Orica Kooragang Island Flare Modification\Figures\AQIA\60306451 F1 Site Location 17 10 2013 TO

AECOM

SITE LOCATION

Proposed Modification, Greenleaf Road, Kooragang Island

FIGURE 1

2.0 Proposed Modification

2.1 Approved Project

In 2009, approval was gained for the expansion to the ammonium nitrate facility located on KI. The expansion included:

- An additional Nitric Acid Plant (NAP4);
- An additional Ammonium Nitrate Plant (ANP3);
- Modification of the existing Ammonia Plant;
- Additional storages for nitric acid (including a 2,000 tonne nitric acid storage tank), solid ammonium nitrate and ammonium nitrate solution; and
- Upgrades to existing infrastructure such as cooling towers, air compressors, loading facilities, electrical systems, effluent treatment systems and the steam system.

The project was approved with the following production limits:

- 360 kilotonnes per annum (ktpa) of ammonia product;
- 605 ktpa of nitric acid product; and
- 750 ktpa of ammonium nitrate product.

In July 2012 the plant and equipment layout for the site was amended. No changes to the productions limits were made as part of the modification. The layout of the project as approved, and modified (DA 08_0129 MOD 1) is shown in **Figure 2**.

2.2 Modification Description

As described in **Section 1.1** this modification includes two discreet elements:

- A modification to the location and storage capacity of the approved site expansion nitric acid tank; and
- The construction and operation of three ammonia flaring stacks located in the ammonia storage, nitrates and ammonia plant areas.

The approval does not seek to alter the approval production limits. Each modification is described in detail in **Sections 2.2.1** and **2.2.2** and details on **Figure 2**.

2.2.1 Nitric Acid Tank

Orica proposes to build a 10,000 tonne nitric acid storage tank and associated infrastructure which includes the following elements:

- 10,000 tonne nitric acid tank;
- Overhead pipe gantry to connect the proposed tank to existing import pipeline;
- Tank secondary containment;
- Venting systems and scrubber; and
- Associated lighting and security.

The proposed tank would be constructed in place of the 2,000 tonne storage tank previously approved as part of Project Approval 08_0129. The proposed tank would be used to store imported nitric acid, or provide additional storage capacity for nitric acid produced on site. The proposed location for the 10,000 tonne storage tank is on the western property boundary (as shown on **Figure 2**).

The additional nitric acid storage and import capacity would allow the site to realise additional production of ammonium nitrate within approved production capacities prior to constructing the additional nitric acid and ammonium nitrate plants as approved under Project Approval 08_0129.

The tank would be used for the importation of 68% w/w nitric acid via the existing nitric acid import/export line. Following dilution to 60%, it is expected that the imported nitric acid combined with available on-site ammonia could raise production within the existing ammonium nitrate plants from a current average of 430ktpa to approximately 505 ktpa. As noted in **Section 2.1**, the Project Approval for the KI site currently allows for production of up to 750 ktpa of ammonium nitrate. This modification therefore does not seek to increase existing production capacity limits, but would increase production through increase of existing plant utilisation, to within existing approved limits.

Nitric acid would be unloaded from a ship to the new tank utilising the ship's pump via the existing approved nitric acid import/export pipeline. It is expected that there would be approximately 14 ship deliveries of nitric acid per year. It would then be transferred from the new tank to the existing Nitric Acid Tank 1 (refer **Figure 2**) using the eastern section of the existing nitric acid import/export pipeline. The nitric acid import infrastructure would be modified to incorporate the new storage tank. This would include connections for nitric acid, demineralised water, and other services which already exist at Orica's site. These connections would primarily involve the extension of piping systems which are already in close proximity to the tanks. All connections would be fully contained within the Orica site.

A system to dilute the nitric acid from 68% w/w to 60% w/w would be included, and would be located between the new tank and Tank 1. This dilution system would utilise process condensate which would be supplemented by demineralised water.

The new nitric acid storage tank area would include secondary containment measures, scrubber and venting systems.

General arrangement plans detailing the proposed tank and associated infrastructure are attached at **Appendix A**.

2.2.2 Ammonia Flares

Central to the approval of the expansion project were a series of design improvements to the site's existing ammonia management infrastructure. These improvements were aimed at reducing the risk associated with the use of ammonia on site, to both the community and site personnel.

Following a non-routine ammonia release at the site on the 9 November 2011, Orica made several changes to the site's ammonia management systems and committed to undertaking a programme of work, in consultation with the EPA and WorkCover, aimed at further improving the site's ammonia handling systems, to further reduce the risk associated with the use of ammonia onsite. The focus of the Ammonia Management Improvement (AMI) programme is to:

a. Simplify the ammonia distribution network;

b. Improve the integrity of ammonia feed tanks;

c. Improve the site's ammonia collection and scrubbing capability;

d. Ensuring that ammonia treatment systems are capable of adequately managing larger ammonia release scenarios through the construction and operation of three ammonia flares located in the ammonia.

The design improvements associated with (a), (b) and (c) are considered by Orica as consistent with the commitments previously detailed in the existing Project Approval (DA 08_0129) and as such do not require modification to the Project Approval. The design improvements associated in achieving (d) is considered beyond the scope of the existing Project Approval, and therefore require further assessment and modification to the Project Approval.

To date the site's existing ammonia management system has been designed to prevent a fatality or serious injury to either onsite personnel or in the community by non-routine ammonia releases discharged at height and routine ammonia emissions directed to ammonia scrubbers where practicable. Orica has undertaken a review of alternative ammonia treatment options for large non-routine release scenario's at the site.

This review included the evaluation of the two ammonia treatment options being:

- New larger ammonia wet scrubber/s to absorb ammonia from process streams forming a weak aqueous ammonia solution; or
- The use of ammonia flares to thermally oxidise released ammonia prior to being discharged to the atmosphere.

The feasibility review identified that a flaring system is the preferred option due to the reduced reliance on existing site systems, greater reliability, increased operational simplicity (which can improve effectiveness during emergency events), reduced aqueous ammonia formation and lower capital cost. Orica is therefore proposing to use flares to treat non-routine process relief valve discharges from the ammonia, nitrates and the ammonia storage area.

The three proposed flares are to be used to treat non-routine process relief valve discharges, while the existing scrubbing system would continue to treat routine planned ammonia emissions.

The feasibility study also assessed the most appropriate configuration of flares (e.g. one flare servicing a large pipe interconnecting all plant areas or several smaller flares for each central process area). The study considered issues such as flare radiation and impact on adjacent plant, dispersion modelling for flare combustion products, potential visual amenity impacts, and aesthetics to minimise potential community impact. The size of the three flares was dependant on the potential ammonia volume that could be managed in each ammonia collection system as detailed in **Table 1**.

Table 1 Proposed Flares

Flare	Approximate Design Throughout (tph)*	Approximate Stack Height (m)	Approximate Flame Height (m)
Ammonia Plant Flare	60	20	36
Ammonia Storage Tank Flare	5	5	10
Nitrates Plants Flare	12	8	18

**tph = tonnes per hour.*

The location of the three proposed flares is shown in **Figure 2**.

The flares would be installed on self-supported flare stacks including ancillary piping and infrastructure required to connect the flare stacks to existing plant and machinery.

2.3 Modification to Project Approval 08_0129

A review of the existing Project Approval was undertaken to examine which conditions would require amendment as a result of the proposed modification.

Condition 2, Schedule 2, would need the following modification. Proposed additions to conditions are shown in **bold** and deletions shown as ~~strikethrough~~:

2. The proponent shall carry out the project generally in accordance with the:

a) EA;

b) Statement of commitments;

c) Submissions Report;

d) Modification Application (08_0129 MOD 1) with supporting documentation titled Kooragang Island Facility Uprate Modification Request, prepared by AECOM for Orica Australia Pty Ltd and dated 2A April 2011;

e) Report titled Orica Mining Services Report for Kooragang Island Uprate PHA MOD1 Report, prepared by GHD for Orica Australia Pty Ltd and dated March 2012; ~~and~~

f) Modification Application (08_0129 MOD 2)with supporting documentation titled, Kooragang Island Modification Request Environmental Assessment, prepared by AECOM for Orica Australia and dated 13 November 2013;

g) Report titled Orica Mining Services Report for Kooragang Island Uprate PHA MOD Report, prepared by GHD for Orica Australia Pty Ltd and dated October 2013; and

h)** Conditions of this approval**.

2.4 Project Benefits

2.4.1 Nitric Acid Tank

The proposed nitric acid tank would allow Orica to meet the short term ammonium nitrate market demand during the transition period, prior to constructing the additional approved Nitric Acid and Ammonium Nitrate plants. This will reduce the quantity of ammonium nitrate required to be imported into the Port of Newcastle during this transition period.

In addition, the 10,000 tonne capacity of the tank will provide a buffer storage capacity for the existing Nitric Acid Plants on site. This would have a secondary benefit of allowing excess production from the site's existing nitric acid plants to be stored in the proposed tank for later use, when not immediately required. This will have the advantage of maintaining more stable plant operations, with potential reduction in the number of market-driven plant start-ups and shutdowns and the associated environmental benefits.

2.4.2 Ammonia Flares

The AMI programme of work, of which the proposed flares is one of several components, is aimed at reducing the risk associated with the use of ammonia at the KI facility. A key objective of the programme is that the community is not adversely impacted by ammonia operations, including potential safety and operational related ammonia releases to the environment.

Risk reduction will be achieved through the transition of the site's ammonia management systems to a new design philosophy in which potential ammonia release points are captured, reused or recycled through the process where practicable, or treated via a flare or larger scrubber systems capable of managing non-routine ammonia release volumes, prior to being discharged.

Orica's assessment of options for treatment of non-routine ammonia discharges indicated that flares are preferable compared to the installation of a new scrubbing system. A flare is less complex than a scrubbing system, would have greater availability, does not require site power or cooling water systems and is inherently more reliable. Overall the operation of the proposed flares would see a reduction in the hazard and risk associated with the ongoing operation of the KI facility.

2.5 Alternatives

2.5.1 Nitric Acid Supply and Storage

The alternatives considered in relation to nitric acid supply and storage are:

- Do nothing;
- Increase nitric acid imports; and
- Increase nitric acid production via installation of the new nitric acid plant as per the expansion approval

Do Nothing

The do nothing alternative would continue to see a business as usual situation exist and no improvements to the operational capacity of the facility achieved. If the 'do nothing' alternative continued, none of the project benefits would be realised.

Increase nitric acid imports

Without the proposed storage tank, smaller shipments would be required at a higher frequency due to the lack of storage capacity at the site. This would be an inefficient alternative as the economies of scale of larger shipments could not be achieved.

Increase nitric acid production via installation of the new nitric acid plant as per the expansion approval

Given the slow-down of market growth in the region tied to mining demand, there is not presently an economic case to construct the planned Nitric Acid Plant (NAP4) given what would be the high cost of capital for limited utilisation. The nitric acid tank provides an interim step in meeting demand via full utilisation of existing assets prior to a major expansion of capacity.

Secondary Containment Alternatives

In addition to assessment of available alternatives to the tank itself consideration has also been given to the suitability of secondary containment systems that will be integrated into the final tank design. Two alternatives for secondary containment of the proposed tank were considered. These are 'Tank in Tank' and 'Concrete Bunding'. For the proposed nitric acid tank, these secondary containment options are detailed below and the advantages of each system are considered in **Table 2**.

- **Tank-in-Tank**: This means that a tank sits within an outer tank. Both would be made entirely of 304 stainless steel (corrosion resistant, heat resistant, excellent welding properties), complete with double floor but with only one roof covering both. The distance between the two cylindrical shells will be between 1m to 2.0m (approximately) giving a total tank diameter of approximately 25 m and overall footprint of approximately 490 m^2. In the space between the two tanks it is proposed to install an emergency isolation valve, together with liquid and gas detecting instrumentation.
- **Concrete Bund**: This is a traditional circular concrete bund about 31 m diameter and 12 m high (approximately). The bund will be lined with a nitric acid resistant coating such as vinyl ester.

Table 2 Secondary Containment Alternative Comparison

Advantages of Alternative Secondary Containment Systems	
Tank-in-Tank	**Concrete Bund**
Storm water and effluent – The secondary containment will not collect rainwater and therefore does not require rain water to be pumped out to effluent after every rain event.	*Access* – In both options, the access to the secondary containment will be highly restricted. However, it will be easier with the concrete bund. Despite this, access into the Tank-in-Tank secondary containment will be less frequent compared to the 'Concrete Bund' design.
Containment Integrity -, The secondary stainless steel tank offers a potentially improved form of secondary containment for nitric acid. This also means that if the inner tank fails the Tank-in-Tank recovery can be more orderly, less hazardous and will not damage the secondary containment integrity.	*Visual Leak Verification* – In the event of an overflow or major leak the 'Concrete Bund' design offers leak verification due to visual or odour means. In the Tank-in-Tank design this warning will be via instrumentation located in the secondary containment annular space.
Foot-Print –The smaller foot-print will more efficiently use the limited space.	-
Foundation Cost – the smaller foot-print will produce a smaller pipe cap and fewer piles compares to a bund.	-
Fume – In the event of an acid spill, the nitrogen oxides (NO_x) fume from the spilled acid will be significantly reduced as the secondary containment will be roofed Recovery of any spilled acid can be carried out in a safe and controlled environment, this acid will not be contaminated and can be reused. Spilled nitric acid in a bund would be exposed and potentially hazardous.	-
Tank Breathing – The outer tank would provide a degree of thermal insulation that would reduce the maximum temperature swings of the acid and also reduce the breathing rates of the inner tank, therefore potentially reducing NO_x fumes.	-

With consideration to the benefits listed in above, Orica has determined to proceed with the tank in tank secondary containment design option. Further consideration of the final secondary containment measures have been considered during the review of the projects Preliminary Hazard Assessment (PHA). Further discussion of hazards and risks is provided in **Section 6.3**.

2.5.2 Ammonia Flares

The ammonia flares proposed as part of the overall AMI programme of works aim to rationalise the sites ammonia management and handling systems in order to reduce the risk profile of the facility as described in **Section 2.2.2**.

There are a number of activities which form a part of the AMI programme, with the proposed flares being a central component for the improved management of ammonia release site scenarios. Several alternatives have been considered. These are:

- Do nothing;
- Increase ammonia scrubbing capability/capacities; and
- Improving other 'layers of protection' to reduce the likelihood of large releases.

Do Nothing

The do nothing option would continue to see releases of ammonia vented directly to the atmosphere. The do nothing option would not reduce the potential for ammonia to adversely impact neighbouring receivers.

Increase Ammonia Scrubbing Capacity

The use of a new scrubber compared to flares to treat major ammonia releases was assessed by Orica. It was concluded that the installation of a flare was preferential due to the reduced reliance on existing site systems, greater reliability and operational simplicity and lower capital cost.

The existing scrubbing systems would continue to treat routine planned emissions from all nitrates plants including Nitric Acid Plant 1 and Ammonia Nitrate 1 and will generate weak ammonia solution (or "aqua") which will be sent to the Ammonia Bottling Plant for processing.

Improving other layers of protection

As part of the AMI programme a series of plant upgrades and works are proposed of which the ammonia flares are one component. Other components include:

- Improving ammonia scrubbing capability, as described above;
- Improving ammonia monitoring and detection systems; and
- Simplifying the ammonia handling systems to reduce potential for errant releases.

The proposed flares represent a complimentary element of the AMI programme and not an alternative to these other layers of protection which are being implemented. These other elements either reduce the potential for ammonia release or manage small scale ammonia releases. The proposed flares provide additional management capacity for non-routine release scenarios and are therefore an additional layer of protection for the facility and the community.

2.6 Proposed Construction Activities

Due to the varying nature and differing lead-in times of both the nitric acid tank and the flares Orica does not anticipate that the construction of either element will occur at the same time. As the projects are separate there will be no interdependency on the construction schedules. Therefore the following construction detail considers each element in isolation where necessary.

2.6.1 Construction Methodology

Nitric Acid Tank

The main activities, schedule and plant requirements for the construction of the nitric acid tank are detailed in **Table 3**.

Table 3 Proposed construction activities and schedule – Nitric Acid Tank

Task	Approximate Timeline (weeks)	Indicative Equipment list
Site Establishment	1 – 2	- Light vehicles - Hand tools - Backhoe - Flatbed truck
Civil Works and Bund construction	2 – 18	- Bulldozer - Backhoe - Excavator (40 tonne) - Concrete truck

Task	Approximate Timeline (weeks)	Indicative Equipment list
		- Concrete pump truck - Small truck - Hand tools - Impact piler
Tank Installation	18 – 34	- Truck - Low loader - Mobile electric welding sets
Connection of pumps, piping and safety equipment	34 – 38	- Light vehicles - Hand tools - Mobile electric welding sets
Testing and commissioning.	38 – 42	- Light vehicles - Hand tools

The tank will be supported on a concrete pile cap which in turn would sit on a series of piles to achieve the necessary stability for the site's geotechnical conditions.

Ammonia Flares

The main activities, schedule and plant requirements for the construction of the ammonia flares are detailed in **Table 4**.

Table 4 Proposed construction activities and schedule – Ammonia Flares

Task	Approximate Timeline (weeks)	Indicative Equipment list
Site Establishment	1 – 4	- Light vehicles - Hand tools - Backhoe - Flatbed truck
Civil Works, flare foundation construction.	4 – 20	- Bulldozer - Backhoe - Excavator (40 tonne) - Concrete truck - Concrete pump truck - Small truck - Hand tools - Impact piler
Flare and support superstructure construction/installation.	20 – 38	- Truck - Low loader - Mobile Crane - Tower Crane - Mobile electric welding sets
Connection of pumps, piping and safety equipment	38 – 50	- Light vehicles - Hand tools - Mobile electric welding sets
Testing and commissioning.	50 – 60	- Light vehicles - Hand tools

2.6.2 Construction Workforce and traffic

The maximum onsite workforce at any time for both the nitric acid tank and the ammonia flares would be approximately 20 personnel. There would be approximately 10 light vehicles (20 light vehicle movements) and five heavy vehicles (10 heavy vehicle movements) required per day during the peak of construction activities.

2.6.3 Material Import/Export

Construction of the proposed tank and flares would give rise to minimal fill or spoil. Some spoil may be generated during the installation of the concrete cap and piling works for the tanks and foundation works for the flares. Spoil would be stockpiled on site with appropriated environmental mitigation controls and subject to testing and classification in accordance with the waste classification guidelines prior to reuse or disposal.

Top soils removed during construction would be used in landscaping elsewhere onsite where appropriate.

2.6.4 Land Acquisition and Access Agreements

All land required for the construction and operation of the tank and flares is under the ownership of Orica (Lot 3 DP234288). No land acquisition is required for the construction of the proposed tank or flares.

2.6.5 Ancillary Works and Equipment

Nitric Acid Tank

Located immediately at the base of the proposed tank would be a bunded pad containing the pumps and NO_x scrubber. In order to connect the proposed tank to the existing site pipeline system, an elevated pipe bridge will traverse from the tank to the existing pipe bridge located approximately 10m from the proposed tank location.

Ammonia Flares

The three proposed flares will be located onsite immediately adjacent to the plant that they will service. In order to incorporate the flares into the site's existing systems, additional piping will be required to control the flow of products from existing systems and via the proposed flares when required.

2.6.6 Services and Utilities

No public owned utilities are expected to be relocated as a result of either the proposed tank or flares. Service connections from Orica's existing onsite services will be extended to the tank and flare systems for power and control functions.

2.6.7 Construction Hours and Schedule

Pursuant to Condition 33 of the Project Approval, standard working hours for the construction of both the Nitric Acid Tank and the Ammonia Flares would be between:

- 7am and 6pm Monday to Friday; and
- 8am and 1pm Saturdays.

No works would be undertaken on Sundays or Public Holidays. Works outside of these hours are unlikely to be required and would be avoided where possible.

2.7 Hunter Water Corporation Recycled Water Project

Associated with the expansion projects Conditions of Consent Orica has been exploring opportunities to reduce the site's reliance of potable water through the use of recycled water in the site's cooling water and demineralisation plants.

Hunter Water Corporation (HWC) have partnered with Orica and the surrounding industry on KI to develop the Kooragang Industrial Water Scheme (KIWS). The KIWS will contribute to sustainable water cycle management for the Hunter region by conserving drinking water resources. At present Orica's KI plant uses approximately 8.3 ML/d of potable water supplied by HWC. Approximately 99% of this water is used for high quality industrial uses such as make-up to cooling water systems, nitric acid dilution and feed for the production of demineralised water.

In preparation to ready the site to be capable of receiving recycled water, additional storage infrastructure is required to be constructed. This additional infrastructure consists of a water storage tank and associated pipe and pump infrastructure for movement of water to site systems. Whilst the recycled water may be used together with the nitric acid for dilution, the construction and operation of the proposed recycled water infrastructure is considered to be consistent with the expansion project approval and therefore has not been assessed further in this environmental assessment. Neither project would present an impediment to the ability for the other to be successfully implemented.

Existing Infrastructure Key

1	Ammonia Plant	5	Nitric Acid Plant 2	9	AN Plant 2
2	Utilities Area	6	Nitric Acid Plant 1	10	AN Plant 1
3	Acid Storage (Dilution infrastructure will be contained in the Tank 1 bund)	7	Boiler Plant	11	AN Bulk Storage
4	Nitric Acid Plant 3	8	ANS	12	Bagged Product Storage

Infrastructure Key (1 - 16)

1	New demin water system	5	New NA storage	9	Cooling water supply pumps	13	New NAP4 plant
2	New ammonia storage nitrate pumps	6	New pipe rack	10	New cooling water treat,emt skids	14	Ammonia compressor
3	New instrument air compressor and dryer	7	11kV trident switchroom	11	New cooling towers	15	Contaminated condensate tank
4	Extension to No.2 11kV substation	8	New boiler	12	New NAP4/AN3 switchroom and transformer	16	Clean process condensate tank

Infrastructure Key (17 - 32)

17	New No.6 ammonia bullet	21	New workshop	25	New concentrator plant	29	New bag store
18	New emergency generator and switchroom	22	New entry security gate	26	New ANS/WANS loadout	30	New AN road bulk loadout and weighbridges
19	New control room	23	New office	27	New first flush pi	31	2x 1.05/1.2t bag lines and 1x 25/40kg bag line
20	New entry	24	New weighbridge	28	New dispatch office and amenities	32	Switchroom

Infrastructure Key (33 - 38)

33	Transformers	39	New FEL workshop and forklift parking	45	Proposed Recycled Water Tank (consistent with existing site approvals)
34	Container bag loading area	40	Transtank		
35	New bulk store	41	Proposed AN# plant		
36	New weighbridge	42	New container storage		
37	New office	43	Nitrogen tie in		
38	New exit security gate	44	New ammonia plant nitrates pump		

Key

- Site boundary
- Existing infrastructure location
- OBL Stage 1A
- OBL Stage 1B
- OBL Stage 2
- NAP4 & ANS
- AN3

Note:
Information derived from Hatch EMA plan HEN2561-0000-00-014-0012 (**05/04/2011**)

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AECOM

APPROVED FACILITY PLAN

Proposed Modification, Greenleaf Road, Kooragang Island

FIGURE 2

3.0 Statutory Assessment

3.1 Environmental Planning and Assessment Act 1979 (EP&A Act)

The approved project was declared to be a major project and approval was granted under Part 3A of the *Environmental Planning and Assessment Act 1979* (the EP&A Act) in 2009.

On 1 October 2011, Part 3A of the EP&A Act was repealed. At the same time, savings and transitional arrangements were put in place for projects that are classified as 'transitional Part 3A projects'. A transitional Part 3A project is defined in clause 2 of Schedule 6A of the EP&A Act, which includes projects which were approved prior to the repeal of Part 3A of the EP&A Act. For these types of projects, Part 3A of the EP&A Act (as in force immediately before the repeal of that Part and as modified under Schedule 6A after that repeal) continues to apply.

This project is defined as a transitional Part 3A project as it was approved prior to the repeal of Part 3A of the EP&A Act. As such, any modification to the approval is to be considered under section 75W of the EP&A Act.

Under section 75W of the EP&A Act, a proponent may request that the Minister modify the Project Approval if the project, as modified, would not be consistent with the project as approved.

As the proposed modifications would not be consistent with the existing approval, the Proponent requests that the Minister modify the 2009 Project Approval as outlined in this assessment.

Section 75W(3) of the EP&A Act also states that the Director-General may notify the proponent of environmental assessment requirements. As detailed in **Section 4.1**, DP&I agreed that the original project DGRs would be suitable to use for the proposed modification as applicable.

3.2 Environmental Planning Instruments

3.2.1 Newcastle Local Environmental Plan 2012

The Site is located within the Newcastle City Local Government Area where the relevant Local Environmental Planning instrument is the Newcastle Local Environmental Plan 2012 (LEP 2012). However, the proposed Site is within the boundary of the Three Ports Site as shown on the Newcastle Port Site – Land Zoning Map – LZN 001 and thus falls under the provisions of the *State Environmental Planning Policy (Major Development) 2005* (Major Development SEPP). By virtue of Part 20(4) of Schedule 3 Major Development SEPP, environmental planning instruments other than State Environmental Planning Policies do not apply to the Site as it is located within Three Ports land. Therefore the provisions of the LEP 2012 do not apply to the Site.

Newcastle Development Control Plan

The planning controls within the Newcastle Development Control Plan (DCP) have been reviewed as they relate to the proposed development. Due to the nature of the proposed modification, no specific controls from the DCP apply to the proposal. Regardless, by virtue of Part 20(4) of Schedule 3 Major Development SEPP, the provisions of the DCP do not apply to the proposed modification.

3.2.2 State Environmental Planning Policy (Major Development) 2005

The Major Development SEPP was used to identify developments that were considered to be Major Developments under the EP&A Act before the EP&A Act was amended to remove this definition. However, the approved Facility and any subsequent modifications continue to be assessed and determined under Part 3A transition provisions. The proposed development thus retains its ability to seek modification as a Major Development as originally approved under the Major Development SEPP.

The proposed modification would be in keeping with the characteristics of the site and surrounding land with its historical and current usage as an industrial area.

3.2.3 State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33)

SEPP 33 was designed to ensure that sufficient information is provided to consent authorities to determine whether a development is hazardous or offensive. Conditions can then be imposed on the development to reduce or minimise adverse impacts. Any development application for a potentially hazardous development must be supported by a Preliminary Hazard Analysis (PHA).

As the proposed modification is not introducing any new materials or processes to the site, and will be undertaken in a manner which includes appropriate safety systems, it does not constitute an additional hazardous or offensive development that would require further consideration under SEPP 33. Further consideration of project specific hazards and risk is provided in **Section 6.3**.

3.3 Commonwealth Matters

3.3.1 Environment Protection and Biodiversity Conservation Act 1999

In addition to State-based approvals, actions that may significantly affect matters of National Environmental Significance (NES) require assessment and/or approval from the Commonwealth under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. The EPBC Act lists eight matters of NES that must be addressed when assessing the environmental impacts of a proposal.

A review of the potential for the proposed modification to impact on NES matter was undertaken. Due to the proposed location of the tank and flares within the boundaries of the already highly modified site, it is considered highly unlikely that any NES matters would be impacted by the proposed modification. No referral to the Commonwealth Department of Environment is considered necessary.

3.4 Other Approvals Required

Orica's KI facility currently operates under Orica's existing Environmental Protection License (EPL) No. 828.

The proposed modification would not seek to increase annual approved production limits, discharge limits or impact monitoring requirements. However Orica would consult with the Environment Protection Authority regarding the need to license the flares and nitric acid tank stack as discharge points on EPL 828. Subject to approval Orica would prepare a revised premises map to provide new site details to the EPA.

4.0 Consultation

4.1 Department of Planning and Infrastructure

Prior to the preparation of this Environmental Assessment, Orica met with DP&I to discuss the proposed modification and the likely approval path as well as environmental assessment requirements. DP&I confirmed that the proposal could be assessed as a modification to the existing Project Approval (08_0129) and that the Director General Requirements (DGRs) issued for the existing approval could be used to guide the environmental assessment for the proposed modification, as relevant to both the nitric acid tank and Ammonia Flares construction and operation.

The DGRs for Project Approval 08_0129, where relevant to the proposed nitric acid tank and flares have been addressed in this EA is detailed in **Table 5**.

Table 5 Director General's Requirements (08_0129)

Assessment Requirements	Addressed in this EA
General requirements	
An executive summary;	Executive Summary
A detailed description of the following: - historical operations on the site; - existing and approved operations/facilities, including any statutory approvals that apply to these operations/facilities; and - the existing environmental management and monitoring regime.	Section 2.1 and original EA (2009).
A detailed description of the project, including the: - need for the project; - alternatives considered; - likely staging of the project; and - plans of any proposed building works.	 Section 2.4 Section 2.5 Section 2.6 Section 2.6
A risk assessment of the potential environmental impacts of the project, identifying the key issues for further assessment;	Section 4.0
A detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment (see above), which includes: - a description of the existing environment, using sufficient baseline data; - an assessment of the potential impacts of all stages of the project, including any cumulative impacts, taking into consideration any relevant guidelines, policies, plans and statutory provisions (see below); and - a description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate, monitor and/or offset the potential impacts of the project, including detailed contingency plans for managing any potentially significant risks to the environment.	Section 5.0 Descriptions of the existing environment, potential project impacts and recommended mitigation measures in relation to each environmental aspect is provided in Section 6.0.
A statement of commitments, outlining all the proposed environmental management and monitoring measures;	Section 8.0
A conclusion justifying the project on economic, social and environmental grounds, taking into consideration whether the project is consistent with the objects of the *Environmental Planning & Assessment Act 1979*;	The social environmental and economic justifications and consistency with the objects of the EP&A Act for the modification are consistent with those presented in Section 19 of the Project EA,

Assessment Requirements	Addressed in this EA
	as applicable. Furthermore the project benefits, in particular the improved risk outcome for the community as described in Section 2.4.
A signed statement from the author of the Environmental Assessment, certifying that the information contained within the document is neither false nor misleading.	Certification page
Hazards	
- A Preliminary Hazard Analysis (PHA) of the project including the combined existing and proposed operations and a detailed assessment of the potential off-site risks; - Details of the receipt, transfer and storage of chemicals on site such as ammonia and ammonium nitrate.	Section 6.3 and Appendix C Section 2.2
Air Quality and Odour	
- An assessment of all air pollutants from all sources during construction and operation and from road, rail and sea transport, including any potential volatile organic compounds, particulates, odour, NO_X, N_2O and NH_3; - Details of all control measures including NO_X and N_2O abatement and start-up venting controls for NO_X and NH_3 for the Nitric Acid Plant; - Cumulative impacts of the proposal in relation to existing and - approved developments in the area.	Section 6.1 addressed as applicable to the proposed modification.
Noise	
Construction, operational and on-site and off-site road, rail and sea transportation noise;	Section 6.2
Soil and Water	
- An assessment of the potential soil, groundwater and surface water impacts including impacts on Newcastle Harbour; - Water supply including options for reuse of process water; - Proposed erosion and sediment controls (during construction) and the proposed stormwater management system (during operation); - An assessment of contaminated groundwater and soils, and acid sulfate soils, and proposed mitigation and management measures; - Potential impacts of flooding, with consideration of climate change and projected sea level rises.	Section 6.5 as applicable to proposed modification. Site contamination assessment details are included in the original EA (2009) and have not been reinvestigated in this EA.
Greenhouse Gas	
Quantitative analysis of the Scope 1 and 2 greenhouse gas emissions of the project and a qualitative analysis of the impacts of these emissions; details of measures to improve energy efficiency.	Section 6.5 as applicable to the proposed modification. No quantitative assessment considered necessary as the proposal primarily relates to increasing storage space and improving the sites risk profile, not increasing or modifying manufacturing.

Assessment Requirements	Addressed in this EA
Transport	
Details of all transport types and impacts on the safety and capacity of the local road network in particular Cormorant Road roundabout and Tourle Street Bridge; details of the site access, internal roads and car parking.	Section 6.5 as applicable to the proposed modification and the original EA (2009).
Waste	
Classification of all potential sources of liquid and non-liquid wastes, quantities, storage, treatment and disposal or re-use.	Section 6.5 as applicable to the proposed modification and the original EA (2009).
Visual	
Impacts on nearest sensitive receivers.	Section 6.4 as applicable to the Ammonia Flares.
Flora and fauna	
Impacts on critical habitats, threatened species or populations or ecological communities and their habitats in the region.	Section 6.5 as applicable to the nitric acid tank.
Heritage	
Aboriginal and non-Aboriginal.	Section 6.5 as applicable to the nitric acid tank.

4.2 Community Consultation

Orica uses the site Community Reference Group (CRG) as a forum to keep the community regularly updated with site activities including project work. A briefing on the AMI project, including describing the function and operation of ammonia flaring, was presented to group on the 26 August 2013. The presentation was also uploaded onto the site's website. Orica will continue to update the CRG, including the broader community regularly during the approval assessment process including at quarterly CRG meetings Scheduled during 2014.

Due to the limited size of this component of the project, no specific community consultation has been undertaken in relation to the proposed Nitric Acid Tank. However following exhibition of this modification application, Orica will provide a briefing to the community Reference Group (CRG) regarding the project.

Orica regularly consults with regulatory authorities regarding site improvement projects and site performance. A specific briefing were held with EPA, WorkCover and Department of Planning during June 2013, regarding progress made to date in implementation of the different stages of the AMI programme.

5.0 Prioritisation of Issues

A risk analysis was completed to rank potential environmental risks associated with the proposed modification.

5.1 Risk Matrix

The prioritisation of issues for the Proposed Project was based on the need to recognise that a higher degree of assessment is required for the issues with the highest severity and greatest possible consequences. **Table 6** shows the issues prioritisation matrix used to identify priorities.

Each issue was given a ranking between one and three for the potential severity of risks and the perceived consequence of those effects if left unmanaged. These two numbers were added together to provide a numerical ranking for the issue that was used to categorise each issue into high, medium and low priorities.

Potential Consequences:

1) Broad scale environmental impact.

2) Regional environmental impact.

3) Local environmental impact.

4) Minor environmental impact.

5) Insignificant environmental impact.

Likelihood of adverse impact:

A) Almost certain.

B) Likely.

C) Possible.

D) Unlikely.

E) Rare.

Table 6 Issues Prioritisation Matrix

		Likelihood of adverse impact				
Potential Consequence		A	B	C	D	E
	1	High	High	Medium	Low	Very Low
	2	High	High	Medium	Low	Very Low
	3	Medium	Medium	Medium	Low	Very Low
	4	Low	Low	Low	Low	Very Low
	5	Very Low	Very Low	Very Low	Very Low	Very Low

5.2 Assessment

The prioritisation of environmental issues related to the Proposed Project is provided in **Table 7**.

This environmental risk analysis prioritises environmental issues in the absence of appropriate safeguard measures to manage environmental effects. This analysis was then used to inform the environmental assessment and the engineering and environmental design of the Project and in the identification of appropriate safeguards.

Table 7 Prioritisation of Environmental Issues

Issue	Potential Environmental Issue	Severity	Consequence	Priority
Air Quality and Odour	Dust and vehicle emissions during construction. Odours and emissions during operation.	3	B	Medium
Noise and Vibration	Construction and operational noise and vibration impacts. Flare noise impacts.	3	C	Medium
Hazards and Risk	Material leaks/spills and interaction with materials and equipment of materials on Orica's or neighbouring sites.	3	C	Medium
Visual	Visual impacts of the proposed flare stacks	3	B	Medium
Soils and water	Erosion, sedimentation and contamination during construction and contamination during operation.	4	C	Low
Greenhouse Gas	Increased emissions from construction plant and electricity required for the modification	4	C	Low
Transport	Construction traffic generation.	4	C	Low
Waste	Waste generated by the construction.	4	B	Low
Flora and fauna	Grass clearing.	4	E	Very Low
Heritage	Impacts to unidentified indigenous or non-indigenous heritage items.	4	E	Very Low

5.3 Final Assessment

In summary, the final prioritisation of issues identified for the Proposed Project is:

Medium:

- Air Quality and Odour;
- Noise and Vibration;
- Hazard and Risk; and
- Visual;

Low:

- Soil and water;
- Greenhouse Gas;
- Transport;
- Waste;

Very Low:

- Flora and fauna; and
- Heritage.

Environmental issues identified as either 'low' or 'very low' have been addressed in **Table 23** in **Section 6.5**.

6.0 Environmental Assessment

6.1 Air Quality

An Air Quality Impact Assessment (AQIA) was prepared to examine potential impacts of the proposed modification. The AQIA provides a quantitative assessment of the predicted air quality impacts associated with the proposed modification. The AQIA is summarised below and attached at **Appendix B**.

Two modelling scenarios were selected for the assessment: routine operations (routine operating conditions at the site with no flaring) and non-routine operations (routine operating conditions at the site with flaring (all three flares operating at once as a conservative measure). Both scenarios include existing background emissions and the addition of scrubber emissions from the proposed nitric acid tank.

6.1.1 Existing Conditions

Air quality in Newcastle is dominated by motor vehicle emissions and major industry located around the port of Newcastle. Nearby industrial facilities likely to be contributing to the existing air quality include Incitec Pivot, Tomago Aluminium, OneSteel, Koppers Coal Tar facility and Cargill grain terminals and seed processing.

The closest residential premises to Orica are located at Stockton, approximately 800 m east of Orica's property boundary. There are also residential properties 1.5 km to the southwest at Carrington and 2 km to the west at Mayfield.

There are a number of industrial facilities on KI and in the neighbouring Mayfield East and Mayfield West. According to the National Pollutant Inventory, the main sources of Oxides of Nitrogen or NO_x (incorporating nitrogen oxide (NO) and Nitrogen dioxide (NO_2)) in the area are Orica, motor vehicles, OneSteel, Koppers and Pacific Carbon. For the purposes of this assessment Oxides of Nitrogen will be measured using NO_2, as all nitric oxides emitted into the atmosphere are eventually oxidised to NO_2.

Orica operates an ambient air quality and meteorological station at Fullerton Street Stockton. The station continuously monitors general air quality as well as wind speed and direction. Air quality parameters measured are dust (PM_{10} and $PM_{2.5}$), NO_x and ammonia (NH_3). The data is publically available at the following web address http://www.stocktonairqualitymonitoring.com/.

A summary of the currently available data for the period October 2012 to August 2013 for NO_2 and NH_3 is provided in **Table 8**.

Table 8 Stockton Monitoring Station Ambient Air Quality Data; October 2012 to August 2013

Parameter	NO_2 (ug/m3)	NH_3 (ug/m3)
Minimum recorded	0	0
Average recorded	15	11
Maximum recorded	91	391
95th Percentile	49	52
70th Percentile	20	8

6.1.2 Potential Impacts

Potential air quality impact may occur during construction as a result of dust and machinery emission. Due to the natural of the project most works will be limited to existing hardstand areas minimise the potential for dust generation. Emissions from plant and machinery would be temporary in nature and are not deemed significant in the context of the wider industrial and transport operations on and around KI.

Potential air quality impacts during the operation of the proposed modification may occur from the importation and transfer of nitric acid in to the proposed nitric acid tank and from the operation of the proposed ammonia flares. Therefore the pollutants of interest are:

- Oxides of nitrogen (NO_x) (to be measured as nitrogen dioxide or NO_2); and
- Ammonia (NH_3).

Section 3.0 of the AQIA (**Appendix B**) provides a detailed review of the modelling inputs and parameters used to examine the potential air quality impacts of the proposed modification. A brief summary is provided below.

Assessment Methodology

In order to model the potential impacts of the proposed modification, Ausplume modelling software was used in accordance with the *Approved Methods for Modelling and Assessment of Air Pollutants published by NSW EPA (DEC, 2005).* This document prescribes calculation methods to account for terrain effects, building wake effects, horizontal and vertical dispersion curves, buoyancy effects, surface roughness, plume rise, wind speed categories and wind profile exponents. Six categories of input data were required for input into the air model:

- Meteorology;
- Terrain effects;
- Building wake effects;
- Modelling scenarios;
- Source characteristics; and
- Emissions inventory.

Full details of all model inputs are described in Section 3.0 of the AQIA.

Assessment Criteria

Facility Assessment

Based on the existing air quality of the site (**Table 8**), project specific air quality criteria were derived in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005). These criteria apply to the air impacts from the facility alone (isolation) and the combined impacts of the facility and background values (cumulative). The project specific assessment criteria are presented in **Table 9**.

Table 9 Air Quality Impact Assessment Criteria

Air Emission	Averaging Period	Regulatory Limit (µg/m^3)	Assessment Percentile
Nitrogen Dioxide (NO_2)	1 hour	246	100th
	Annual	62	100th
NH_3	1 hour	330	99.9th

Cumulative Assessment Input - Incitec Pivot Limited

Cumulative assessments seek to look more broadly at how the predicted impacts of a proposed modification interact with the impacts of the surrounding industries both current and proposed. For a cumulative assessment the background air quality accounts for the existing industries, however this does not account for any known future or proposed development.

Orica is not the sole emitter of the pollutants of concern in the vicinity of KI. Incitec Pivot Limited (IPL) has previously submitted an application to the Department of Planning and Infrastructure for the expansion of its ammonium nitrate facility which adjoins the Orica site to the immediate north. An assessment of the potential cumulative impacts of the proposed IPL facility and Orica's proposed modification was undertaken. However we do note that publically available information (i.e. local media) suggests that the IPL expansion project is not expected to proceed.

A review of IPL's environmental assessment documentation (URS, 2012) predicted impacts for both routine and non-routine operations of the existing facility and expansion. The results of the routine (normal plant) operations have been used in this assessment of cumulative air quality assessments as routine operation is the most likely scenario when a flaring event may be happening at the Orica site.

The IPL incremental data (IPL site operations alone) has been used in the assessment. By doing this the current impacts from the IPL site would be double counted as part of the background values resulting in conservative results for this current assessment. A summary of the maximum IPL routine incremental impacts at a discrete receptor are presented in **Table 10**. Theses have been incorporated into the impact assessment results and reported as part of this cumulative assessment.

Table 10 Predicted IPL Routine Discrete Receptor Results (from URS 2012)

Pollutant	1 Hour Impact (µg/m3)	Annual Average Impact (µg/m3)
NO_2	25	0.4
NH_3	1.2	NA

Impact Assessment

Nitrogen Dioxide (NO_2)

The Ausplume model produced maximum predicted ground level concentrations of NO_2 for the 1 hour average and annual average. These are presented in **Table 11** and **Table 12** respectively. The impact from the facility alone (incremental) and cumulatively with the Stockton monitoring data and IPL impact are provided.

Table 11 Maximum Sensitive Receptor 1 Hour Average Predicted Ground Level Concentrations – NO_2

Scenario	1 Hour Maximum NO_2 (µg/m^3)			
	Orica Incremental	Stockton Background	IPL Routine Impact	Cumulative
1 – Routine Operations	91	49	25	165
2 – Non-routine operations	130	49	25	204
Criteria	**246**			

The 1 hour average NO_2 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criterion. The highest predicted NO_2 1 hour average concentrations occurred at industrial receptors on KI located in proximity to the Orica site.

Table 12 Maximum Annual Average Predicted Ground Level Concentrations – NO_2

Scenario	Annual Maximum NO_2 (µg/m^3)			
	Orica Incremental	Stockton Background	IPL Routine Impact	Cumulative
1 – Routine Operations	7	15	0.4	22
2 – Non-routine operations	9	15	0.4	24
Criteria	**62**			

The annual average NO_2 results for both the routine and non-routine (with flaring) operations are also predicted to meet the NSW EPA criterion. The highest predicted cumulative NO_2 annual average concentrations occurred at industrial receptors on KI located in proximity to the Orica site.

Ammonia (NH_3)

The maximum predicted sensitive receptor ground level concentrations of NH_3 for the 1 hour average are presented in **Table 13**. The impact from the facility alone (incremental) and cumulatively with the Stockton monitoring data and IPL impact are provided.

Table 13 Maximum Sensitive Receptor 1 Hour Predicted Ground Level Concentrations – NH_3

Scenario	1 Hour Maximum NH_3 ($\mu g/m^3$)			
	Incremental	Stockton Background	IPL Routine Impact	Cumulative
1 – Routine Operations	58	52	1.2	111
2 – Non-routine operations	91	52	1.2	144
Criteria	**330**			

The 1 hour average NH_3 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criterion. The highest predicted NH_3 1 hour average concentrations occurred at industrial receptors on KI located in proximity to the Orica site.

6.1.3 Conclusion and Environmental Safeguards

Based on a review of previous AQIA's undertaken for the Orica KI site against the proposed modification, it is unlikely there would be any significant impacts from either NO_X or NH_3 emissions associated with the proposed modification.

Two modelling scenarios were selected for the assessment: routine operations (routine operating conditions at the site with no flaring) and non-routine operations (routine operating conditions at the site with flaring (all three flares operating at once)). Both scenarios include the addition of NOx scrubber emissions from the 10,000 t NA tank.

This flaring non-routine operations scenario is considered highly conservative due to the following:

- It is unlikely that the plant will remain running at full operational capacity if the flaring event occurs;
- The three flares are for separate operational sections of the site and are unlikely to be utilised or required at the same time; and
- It is expected that a flaring event would only occur under exceptional circumstances, with a predicted occurrence frequency of once every two years.

The 1 hour average NO_2 and NH_3 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criteria.

The annual average NO_2 and NH_3 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criteria.

6.2 Noise

A Noise Impact Assessment (NIA) was prepared to assess the potential noise impacts of the construction and operation of the proposed modification. The NIA is summarised below and attached at **Appendix C**.

6.2.1 Existing Conditions

The existing noise environment surrounding the site is dominated by industrial operations and land uses on KI. The closest residential premises to Orica are located at Stockton, approximately 800 m east of Orica's property boundary. There are also residential properties 1.5 km to the southwest at Carrington and 2 km to the west at Mayfield.

The nearest residential receiver (R1) in proximity to the study area is located approximately 800 metres to the east of the Orica site boundary. Other nearby receivers have been selected to demonstrate the noise contribution due to the proposed modification. These receivers are presented in **Table 14** and shown on **Plate 1**.

Table 14 Receiver locations assessed within this report

ID	Address	Type	Distance from site boundary
R1	284 Fullerton Road, Stockton	Residential - Suburban	750 m
R2	218 Fullerton Road, Stockton	Residential - Suburban	730 m
R3	38 Elizabeth Street, Carrington	Residential - Urban	1080 m
I1	39 Heron Road, Kooragang Island	Industrial	Adjacent

Plate 1 Receiver Locations

In order to determine background noise levels associated with the operation of the Orica facility, previous noise assessments undertaken by Atkins Acoustics (2013) and Wilkinson Murray (2010) have been reviewed. These assessments included both attended and unattended noise measurements. **Table 15** details the existing site noise levels, based on the findings of these previous noise assessments, at the identified receivers. This includes noise contributions from Orica's existing operations.

Table 15 Logged Noise Levels, attended noise measurements and observations

ID	Measurement location	Night			Comments
		RBL* L_{A90}	Ambient L_{Aeq}	Orica Site contribution L_{Aeq}	
R1	284 Fullerton Road, Stockton	45	54	50	Stockton Beach Surf Ammonia Plant Pumps and Converter Valves General industrial noise Intermittent passing road traffic
R2	218 Fullerton Road, Stockton	49	53	53	
R3	38 Elizabeth Street, Carrington	39	40	39	Industrial noise in the direction of the Orica plant Passing heavy road traffic
I1	39 Heron Road, Kooragang Island	56	61	56	Ammonia plant Ammonia plant pipe noise (convertor valves) Pumps (500 Hz) Steam pipes

**RBL= Rating Background Level*

6.2.2 Potential Impacts

Construction Noise

Construction plant and machinery has the potential to generate noise impacts that are audible at the receivers. In order to examine the potential impact of this construction noise, an assessment was made of the existing noise environment to determine background noise levels.

Construction Noise Management Levels - Construction Noise Criteria

Utilising the methodology for calculating Noise Management Levels (NML) as described in Table 2 of the *Interim Construction Noise Guidelines* (ICNG) (OEH, 2009), the construction NMLs detailed in **Table 16** have been determined for the proposed modification based on the existing noise conditions at the identified receivers as detailed in **Table 15**.

Table 16 Construction noise management levels (NML) – Residential receivers

Residential receivers	Recommended standard hours RBL[1] dB(A[2])	Recommended standard hours NML[1], $L_{Aeq, 15min}$ dB(A)
R1	50	60
R2	47	57
R3	44	54
	NML, $L_{Aeq,15min}$ (applies when properties are being used)	
I1	External noise level 75 dB(A)	

1 Calculated in accordance with Section 2.2 of Appendix C.

2 Refer Appendix A of Appendix C.

Construction Noise Impact Assessment

Using the NMLs listed in **Table 16** modelling was undertaken of the likely noise output from typical construction plant and machinery that could be used during the construction scenarios. Full details of the modelling can be found in Section 5.0 of the NIA. The results of the construction noise assessment modelling are detailed in **Table 17**.

Table 17 Construction noise assessment results

Receiver	Noise management level $L_{Aeq\ (15min)}$, dB(A)	Predicted noise level $L_{Aeq,15min}$, dB(A)	Exceedance dB(A)
		Neutral weather	Neutral weather
Nitric Acid Tank			
R1	60	37	-
R2	57	38	-
R3	54	36	-
I1	75	55	-
Flare A – Nitrates Flare			
R1	60	41	-
R2	57	43	-
R3	54	34	-
I1	75	46	-
Flare B – Ammonia Storage Tank Flare			
R1	60	38	-
R2	57	38	-
R3	54	33	-
I1	75	60	-
Flare C – Ammonia Plant Flare			
R1	60	39	-
R2	57	39	-
R3	54	32	-
I1	75	61	-
Cumulative Noise Levels			
R1	60	45	-
R2	57	49	-
R3	54	47	-
I1	75	64	-

Based on the modelling outcomes, it was concluded that no exceedances of the project specific NMLs are expected to occur as a result of the construction works associated with the proposed modification.

While construction works involving both the nitric acid tank and the flares are not expected to occur simultaneously, and would be staged where possible to minimise noise impacts, an assessment of the potential cumulative noise impacts was also undertaken. As detail in **Table 17** no exceedance of the project specific NMLs is expected to occur as a result of cumulative construction noise should concurrent construction of either the flares or nitric acid tank occur.

Construction would be undertaken during recommended standard hours in accordance with Condition 22 of the Project Approval. Therefore the impacts of construction activities out-of-hours and on sleep disturbance do not need to be assessed.

Section 6.5 of the NIA also includes an assessment of the potential construction traffic noise impacts. This assessment concluded that construction traffic is likely to result in less than a 2dB(A) increase to the existing traffic noise on the local road network. Construction traffic noise would therefore result in a negligible impact.

Operational Noise

Operational Noise Criteria

Operational noise criteria for the Orica facility have been derived pursuant to Conditions 30 – 32 of the Project Approval as described in Section 3.1 of the NIA, with Orica having undertaken a noise verification program as per Condition 31.

Based on night-time attended noise measurements, the project specific operational noise limits as shown in **Table 19** are applicable to the proposed modification. The proposed modification will be assessed against the most conservative night-time criteria, thus verifying compliance with the less stringent day and evening noise levels.

Table 18 Project specific noise limits for assessment receivers

ID	Assessment receiver address	Noise limits, $L_{Aeq,\ 15\ minute}$
		Night
R1	284 Fullerton Road (Residential)	40
R2	218 Fullerton Road (Residential)	43
R3	38 Elizabeth Street, Carrington	29
I1	39 Heron Road, Kooragang Island	70

Nitric Acid Tank

The potential noise source during operation of the nitric acid tank would be the operation of a pump used to move nitric acid out of the tank and around the facility. The pump may operate at any time of the day or night as required by operations.

Orica's proposed pump for the NA tank has a Sound Power Level (SPL) of 82dB(A) at 1m. A pump of 90dB(A) was modelled to add a level of conservatism when determining operational noise impacts

The modelling incorporated the existing background noise levels which include the noise contribution of the existing Orica operations. Meteorological parameters were also used in the model to determine noise impacts during average and adverse meteorological conditions. The results of the operational noise modelling for the most stringent night time criteria are shown in **Table 19**.

Table 19 Normal Operation Assessment Results

ID	Location	Type	Criteria, $L_{Aeq\ (15min)}$, dB(A)	Predicted Noise Level $L_{Aeq,15min}$, dB(A)		Exceedance, dB(A)	
				Neutral Met[1]	Adverse Met[2]	Neutral Met[1]	Adverse Met[2]
Night Period							
R1	284 Fullerton Road, Stockton	Residential	40	23	30	-	-
R2	218 Fullerton Road, Stockton	Residential	43	24	30	-	-
R3	38 Elizabeth Street, Carrington	Residential	29	21	28	-	-
I1	39 Heron Road, Kooragang Island	Industrial	70	38	40	-	-

1) *Neutral Meteorology = stable or average conditions.*

2) *Adverse Meteorology = conditions which may trap or increase noise at receiver's (i.e. temperature inversion).*

The results of the operational noise model indicate that the proposed tank pump would meet the night time noise criteria for the nearest sensitive receivers. As the day and evening criteria are higher than the night-time level, the pumps would also meet the day and evening criteria.

Ammonia Flares

In the event that the flares become operational, gas flares would activate to burn the released ammonia and relieve pressure build up in the ammonia distribution system. Flare noise associated with the proposed flares is derived from three sources:

i) Relief valve;

ii) The vent gas exit velocity at the stack;

iii) Combustion noise from the reaction between the vent gas, oxygen and ammonia.

These potential sound sources and the SPLs that they equate to are detailed in Table 16 of the NIA. The SPLs for these sources have been incorporated into the operational noise model for the flares.

It is highly unlikely the three flares would be activated simultaneously as each of the three flare systems operate independently of another and thus activation of one does not lend itself to increase the chances of another being activated. Despite this both individual and simultaneous flare operation was assessed to determine the likely and worst case noise impacts of the flares.

Modelling of potential noise impacts was undertaken using the SPLs for the noise sources associated with the operation of the flares. The $L_{Aeq\ 15\ minutes}$ noise levels due to operation of the three ammonia flares are presented in **Table 20**.

A 5 dB addition, in accordance with the INP, was added to the final predicted noise levels due to the potentially impulsive (short lived or sudden) nature of the pressure relief valve. This 5 dB is included in **Table 20**.

Table 20 Operational Flare Assessment Results

ID	Type	Night Time Noise Criteria $L_{Aeq,15\ minute,}$ dB(A)[1]	Predicted Noise Level $L_{Aeq,15\ minute,}$ dB(A)		Exceedance, dB(A)	
			Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Flare A – Nitrates Flare						
R1	Residential	58	53	57	-	-
R2	Residential	56	54	59	-	3
R3	Residential	49	45	50	-	1
I1	Industrial	75	58	61	-	-
Flare B – Ammonia Storage Tank Flare						
R1	Residential	53	49	54	-	1
R2	Residential	51	49	54	-	3
R3	Residential	44	44	49	-	5
I1	Industrial	75	71	73	-	-
Flare C – Ammonia Plant Flare						
R1	Residential	58	57	62	-	4
R2	Residential	56	57	62	1	6
R3	Residential	49	51	55	2	6
I1	Industrial	75	80	81	5	6
Cumulative Noise Levels (all three flares simultaneously)						
R1	Residential	58	59	64	1	6
R2	Residential	56	59	64	3	8
R3	Residential	49	53	57	4	8
I1	Industrial	75	81	82	6	7

1) *Night-time noise criteria calculated in accordance with Section 3.2 of Appendix C.*

The results of the operation of the flares can be summarised as:

Flare A

- Noise levels are expected to comply during both neutral wind and adverse weather conditions with R1 and R2 experiencing minor 1 dB(A) and 3 dB(A) exceedances respectively.

Flare B

- Flare B, which could operate for a duration of a few seconds up to several weeks, complies with the noise limits for all receivers during neutral weather conditions.
- R1 and R2 may exceed by 1-3 dB(A) during adverse weather conditions. A level of 2 dB(A) is considered barely perceptible to the human ear and therefore is considered marginally acceptable.
- R3 may exceed by 5 dB(A) during adverse weather conditions. The predicted noise level is 49 dB(A) during these adverse weather conditions, which will result in an approximate internal noise level of 39 dB(A) with windows open and 29 dB(A) with windows closed. These levels are within the acceptable ranges of noise level for bedrooms located near major roadways, according to '*Australian Standard 2107:2001 – Recommended design noise levels for internal noise levels and reverberation times for building interiors'*.

Flare C

- During neutral weather conditions noise levels experienced by the industrial receiver are likely to exceed by 5 dB(A) and residential receivers R2 and R3 are likely to exceed by 1 dB(A) and 2dB(A) respectively. These exceedances at R2 and R3 would be barely perceptible to the human ear.
- During adverse weather conditions, receivers R1 exceeds by 4 dB(A) and R2, R3 and I1 exceed by 6 dB(A).
- It should be noted that the flare C will only operate for a period of 5 minutes, and thus the receiver will only experience the noise level quoted for this period.
- The emergency use of the flare is predicted to occur once in every two years.
- It should also be noted that these noise levels were assessed against a night time RBL. The emergency flare systems have the equal potential to activate within the day, evening or night.

Cumulative Impact

- The noise levels demonstrate the highly unlikely worst case scenario with all three flares being activated simultaneously.
- The noise impact of all three flares operating simultaneously would be 1-2 dB(A) higher than that of the Flare C activated by itself, for both neutral and adverse weather conditions.
- These noise levels would only be experienced by receivers for a period less than 15 mins – after this period of 15 mins, flares A and C will cease operation and the remaining noise contribution of the flares would be solely due to Flare B. Flare B has been shown to be generally compliant with the noise criteria.
- The likelihood of this occurrence is extremely low considering the frequency of operation and duration at which the flares are activated.

The modelling results show that the night-time non-routine operation of the three flares would generally comply with the criteria during neutral meteorological conditions at the sensitive residential locations, with only a small number of minor exceedances and an exceedance of 5dB(A) – 6dB(A) only occurring during adverse weather conditions. This is a conservative comparison as the flares have the equal potential to operate during the day and evening to the night. Therefore the overall cumulative operational noise impact of the flares is expected to be low.

Sleep Disturbance

A sleep disturbance assessment was conducted to predict the impact to receivers. The results of this assessment are detailed in **Table 21**.

Table 21 Sleep disturbance results

ID	Type	Criteria $L_{A1,1min}$ dB(A)	Predicted noise Level $L_{A1,1min}$ dB(A)		Exceedance, dB(A)	
			Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Flare A						
R1	Residential	65	66	70	1	5
R2	Residential	65	67	72	2	7
R3	Residential	65	58	63	-	-
Flare B						
R1	Residential	65	57	62	-	-
R2	Residential	65	57	62	-	-
R3	Residential	65	52	57	-	-
Flare C						
R1	Residential	65	70	75	5	10
R2	Residential	65	70	75	5	10
R3	Residential	65	64	68	-	3

The sleep disturbance findings can be summarised as:

- The sleep disturbance assessment reveals that the criterion will be triggered due to flares A and C. Both flares are expected to operate for a period of 5 minutes each, approximately every two years.
- Flare A only exceeds the criteria during neutral weather conditions by 2 dB(A), which is a minor exceedance and generally not discernible. Under adverse conditions this exceedance would be 5 dB(A) and 7dB(A) for receiver's R1 and R2 respectively.
- It should also be noted that these noise levels were assessed against a night time RBL. The emergency flare systems have equal potential to activate within the day, evening or night.
- Flare B, which operates for a significantly longer period of time, is not expected to trigger awakening reactions and thus disturb the sleep of receivers indoors.
- Flare C may experiences exceedances of up to 10 dB(A) under adverse meteorological conditions. Due to this being assessed as the worst case scenario, the short lived nature of the noise source and the additional attenuation provided by a dwelling, it is unlikely such an exceedance would occur.

The flares will operate at a significantly lower flow rate during maintenance and thus are deemed to comply. Flares should be tested during the day to reduce the noise impact on nearby receivers.

6.2.3 Conclusion and Environmental Safeguards

Typical construction scenarios have been assessed against the requirements of the ICNG. The construction noise assessment demonstrated that the criteria would be met at all assessed receivers, which included residential and industrial receivers.

Noise generated from light and heavy construction traffic due to the modification of the plant was assessed. It was found that noise caused by these vehicles will not increase road noise levels by more than 2 dB and hence will comply with the established Road Noise Policy criteria.

The operation of the nitric acid tank pump was assessed against the criteria prescribed by the Project Approval 08_0129. The assessment demonstrated that the noise at all assessed receivers complied against the operational noise criteria.

The assessment demonstrates that the use of the flares generally complies with the noise limits under neutral meteorological conditions. Operation of Flare C, which would operate for a short period of time, was found to cause minor noise exceedances (0-2 dB(A)) at receiver locations during neutral weather conditions. Noise levels are predicted to exceed noise criteria by up to 6 dB(A) during adverse weather conditions during the operation of Flare C. However, due to the infrequent use Flare C, the short duration it operates and the safety function for which the flares serves, these exceedances are deemed to be acceptable.

In the extremely unlikely event that all three flares would operate simultaneously, the noise impacts would be 1-2 dB(A) higher than that of the Flare C activated by itself, for both neutral and adverse weather conditions. These noise levels would only be experienced by the receivers for a period less than 15 mins – after this period of 15 mins, flares A and C would cease operation and the remaining noise contribution of the flares would be solely due to Flare B. Flare B has been shown to be generally compliant with the noise criteria.

Flare A was found to comply with the criteria set for all receivers during neutral meteorological conditions. During adverse conditions, noise levels would exceed the criteria at R2 and R3 by 3 and 1 dB(A) respectively during adverse meteorological conditions. Flare B complied with the criteria during neutral weather conditions at all receiver locations and had marginal exceedances of between 1 and 5 dB(A) during adverse weather conditions at receivers R1, R2 and R3..

The sleep disturbance assessment revealed that Flare B, which would operate for a long term, complied at all receiver locations and weather conditions. Flares A and C were found to trigger the sleep disturbance criteria , however exceedances were considered acceptable owing to the short duration of operation (expected to be 15 minutes) and the frequency at which these flares would be activated (two yearly intervals).

It is recommended that where possible nearby (e.g. scheduled maintenance flaring or testing) potentially affected receivers are kept informed of likely times of flaring through Orica's website and through the provision of regular updates to the KI Community Reference Group. Orica's community hotline (1800 789 044) is also available for community member to obtain information or raise concerns.

In order to manage construction and operational noise the following measure would be applied during the project:

- All construction works would be undertaken during hours as specified by Condition 33 of the Project Approval;
- All reasonable and feasible construction noise mitigation measures would be implemented during construction to minimise noise impacts;
- The final pump specification would comply with a Sound Power Level of 82dB(A) at 1m; and
- Maintenance and testing of the flare would be limited to standard working hours.

6.3 Hazard and Risk

The existing site Preliminary Hazard Analysis (PHA) was prepared by GHD in 2009 as part of the approval for upgrades and expansions of the Orica facility as part of DA 08_0129. GHD has undertaken further assessment of the potential hazards associated with the proposed ammonia flares by undertaking an update of this PHA. The outcomes of this assessment are summarised below. The GHD PHA is attached at **Appendix D**.

In relation to the proposed nitric acid tank Pinnacle Risk Management (PRM) has prepared a standalone PHA to assess the potential hazards and risk associated with the operation of the proposed 10,000t nitric acid tank. This is attached at **Appendix E**.

6.3.1 Existing Conditions

The PHA (GHD 2009) for the expansion of the KI facility was undertaken in accordance with DP&I's Hazardous Industry Planning Advisory Papers (HIPAP) No 6 – *Guidelines for Hazard Analysis.* The PHA determined the development was "hazardous" under the State Environment Planning Policy No. 33 (SEPP 33) and provides recommendations that allowed risk to be managed to acceptable levels. The PHA found that the risks associated with the plant as proposed at the time complied with all risk criteria for individual fatality, injury, irritation and societal risk in accordance with the requirements of HIPAP 4.

A further PHA update was undertaken by GHD in April 2011 to check the consistency of the then modifications to the site layout with the hazard analysis undertaken for the existing site in the 2009 PHA, and to ensure that HIPAP No. 4 criteria would continue be met. The new risk contours incorporating the revised plant and equipment layout complied with all of the risk criteria given in HIPAP No. 4.

In summary all existing plant and equipment within the Orica site is deemed to operate in accordance with the necessary hazard and risk requirements.

6.3.2 Potential Impacts

Ammonia Flares

As described in **Section 2.0** Orica has undertaken a review of alternative ammonia treatment options for large non-routine release scenario's at the site. The review identified that a flaring system is the preferred option. The flares will provide the site with a final layer of ammonia treatment capability, with the three new ammonia flares being able to thermally oxidise ammonia released from relief valves located in the Ammonia Plant, Nitrates and Ammonia Storage tank areas. In order to examine the potential risks associated with the proposed flares Orica engaged GHD to update the site's existing PHA. This includes updating the risk model and the associated documentation to accurately reflect the proposed changes associated with the proposed flares.

The PHA (GHD 2013) revision was undertaken in accordance with the Hazardous Industry Planning Advisory Paper No. 4 (HIPAP 4) and examined the risks associated with the following scenarios:

- The individual fatality risk (IFR);
- Societal risk;
- Toxic Injury and Irritation risk;
- Thermal radiation; and
- Ammonium nitrate explosion overpressure (injury and property damage and accident propagation).

The results presented in the PHA (GHD 2013) include the results of the previous modifications assessment for the above scenarios.

The results from GHD (2013) have shown that with the proposed ammonia flares incorporated into the existing operations of the site there would not be a significant increase in the levels of risk associated with the facility. Importantly all risk contours remain outside residential areas.

Nitric Acid Tank

PRM (2013) undertook a separate assessment of the risk associated with the proposed nitric acid tank. Again the assessment was undertaken in accordance with the relevant HIPAP guidelines. The following scenarios where assessed as part of the PRM PHA:

- Nitric acid spill – safety and health risk;

- Pipe failures;
- Nitric acid tank overflow;
- Nitric acid tank failure;
- Scrubber failure pump failures;
- Assessment of risk to the biophysical environment;
- Cumulative risk; and
- Societal risk.

The results of the PRM PHA show that the risks associated with the proposed nitric acid tank and associated systems comply with the DP&I guidelines for tolerable fatality, injury, irritation and societal risk. Also, risks to the biophysical environment, the risk of propagation and the impact on cumulative risk in the Kooragang Island area from releases are acceptable.

It is noted that previous hazard assessments (GHD, 2009) have taken into consideration risks associated with the nitric acid transfer pipeline that will connect to the proposed tank to allow for importation of nitric acid. This infrastructure was also found to be designed with the necessary HIPAP criteria.

Cumulative Risk

Both GHD (2013) and PRM (2013) included assessment of cumulative risks of each of the flaring components and nitric acid tank against the existing background conditions. These cumulative risk assessments concluded that risks are within acceptable limits. Furthermore, as each component of the proposed modification is for separate systems within the site, an event in one element would not result in an overall increased risk from the other.

6.3.3 Conclusion and Environmental Safeguards

The risks associated with the proposed ammonia flares, nitric acid tank and associated systems at the Orica Kooragang Island have been assessed and compared against the DP&I risk criteria.

In relation to the proposed ammonia flares, GHD (2013) has shown that the site risk results for the proposed flares would not change significantly from the existing base case. The risks associated with the Orica facility operating the proposed flares would continue to comply with HIPAP 4 risk criteria for “intensification of hazardous activities in an existing complex”. Risk contours were shown to not encroach into residential areas and the cumulative risks remain acceptable.

In relation to the nitric acid tank, PRM (2013) concluded that the risks associated with the proposed nitric acid tank and systems comply with the DP&I guidelines and that risks are acceptable provided the following recommendations are implemented:

- Include the tank level instrumentation in a Layers of Protection Analysis (or similar) to determine the required level of reliability to reduce the risk of tank overflow to an acceptable level;
- Perform a Layers of Protection Analysis (or similar) during the design phase of the project to ensure the risk of liquid releases to the environment is acceptable. Preferably, the bund sump pump system should be designed using the principles of inherent safety, i.e. design out the hazard. For example to prevent an accidental release of nitric acid due to pipe and pumping arrangements.
- Perform a HAZOP study and a construction safety study on the proposed changes; and
- Update the existing safety management system, including the emergency response plan, for the proposed new tank and equipment.

6.4 Visual Impacts

A Visual Impact Assessment (VIA) was undertaken to examine the potential impacts of the proposed modification. The VIA assessed the existing visual catchment, identified potential sensitive receivers and assesses the potential visual impact of the proposed modification on those receivers. The VIA is attached at **Appendix F**.

6.4.1 Existing Conditions

The area surrounding the site is predominantly heavy industrial, chemical plants, and port related activities. The nearest residential area is Stockton. The closest residential homes are located approximately 800 metres from the site, on the opposite side of the north arm of the Hunter River.

The overall character in the area immediately surrounding the site is industrial with a range of industrial operations being undertaken on KI, dominated by coal loading facilities located to the north west of Orica's site. In the vicinity there are heavy trucks using Cormorant Road to the northwest; freight ships passing along the Hunter River, and loading and unloading activities occurring on KI to the west.

Access to the Orica site is via Greenleaf Road from Heron Road and Cormorant Road. Do to the sites location on a peninsular of the island, traffic does not pass the site frontage directly. Due to the presence of other industrial operations and buildings the site is mostly out of view for commuters traveling along Cormorant Road. The exception to this is for commuters when traveling over the Stockton Bridge, the height of which allows visibility of the Orica site. Due to the height of the bridge however the site does not dominate views from this vantage point.

The nearest sensitive visual receivers to the site are located at Stockton, approximately 800m to the east of the site. For the purposes of this assessment two sensitive receivers have been identified on Stockton as;

- Receiver S1 – In proximity to the Fullerton St – Griffith St intersection, Stockton; and
- Receiver S2 – In proximity to the Fullerton St – Hereford St intersection.

A photo record of these locations is provided in Section 4.0 of the VIA.

6.4.2 Potential Impacts

The proposed modification involves the construction of 3 flare stacks and a nitric acid tank. Ancillary works would also require piping and connection of electrical control, safety and security systems. These ancillary works would be located at ground level and would not be visible offsite due to shielding from existing plant. Therefore the potentially visible elements of the proposal would be the flare stacks and nitric acid tanks as detailed in **Table 22**.

Table 22 Proposed Infrastructure Heights

Flare / Tank	Approximate Height* (m)
Ammonia Plant Flare	20
Ammonia Storage Tank	5
Nitrates Plants	8
Nitric Acid Tank	25

**above existing ground level.*

The appearance of the proposed infrastructure consists primarily of painted metals consistent with the existing plant and stacks on the site. The nitric acid tack would be stainless steel.

In order to determine the potential impacts of the flare stacks and nitric acid tanks as a result of their size and appearance, a series of artist's impressions were prepared for receivers S1 and S2. These are presented in the VIA.

These artists' impressions indicated that:

- The flare stacks would have a negligible visual impact due to:
  - The size of the smaller stacks not protruding above other site infrastructure; and
  - The large (ammonia plant flare) stack would be lower than other existing stacks onsite and be silhouetted against existing stacks from the receiver locations limiting visual impacts.

- The nitric acid tank would have a low visual impacts as:
  - It will be partly visible where it extends above the existing plant and the vegetated screen that extends along the eastern boundary of the site; and
  - While it may be visible, due to the offset distances to receivers the tank is not of a scale that produces a significant visual impact; and
  - The appearance of the tank would be consistent with existing tanks on KI.

6.4.3 Conclusion and Environmental Safeguards

The proposed modification represents development associated with an existing industrial operation that is consistent with the historical land uses of the site and surrounding area. Although having only a small development footprint and being located wholly with the existing Orica site, the heights of the proposed infrastructure have potential to cause visual impacts to nearby residents.

The assessment of the potential visual impacts of the project concludes that overall, a low level of visual impact is expected to occur, due to:

- The scale of the proposed flares and their shielding by existing site infrastructure;
- The shielding of much of the nitric acid tank by existing plant and vegetation;
- The project being consistent with the industrial context of the site and surrounding land;
- The offset distances between the site and the sensitive receivers; and
- The anticipated limited use of the flaring, and short duration of flaring events.

The project would be compatible with the surrounding industrial development along the Hunter River, and is consistent with the nature of the port infrastructure. The appearance of the project would fit well within the existing industrial landscape of the area.

Despite this it is recommended that the following measures be implemented to minimise ongoing visual impacts:

- All lighting design should be undertaken in accordance with *AS 4282(INT)-Control of Obtrusive Effects of Outdoor Lighting*;
- All infrastructure, would be maintained to a high standard and appearance with a focus on the external skin of the nitric acid tank; and
- The existing landscaping and vegetation screens of the Orica site be subject to ongoing upkeep to maintain the effectiveness of the vegetated screen, while not impaction on security concerns.

6.5 Other Environmental Issues

A number of other environmental factors require assessment in relation to the proposed modification. **Table 23** provides a summary of other environmental aspects that have been considered for the proposed modification.

Table 23 Other Environmental Issues

Issue	Summary of Potential Impact
Soil and Water	The proposed modification would result in a minor increase in hardstand area on the site and therefore some additional runoff. Runoff from impacted areas would drain to the existing site water management systems. Water for use in the various project elements will be sourced from existing site supplies. Notably Orica is reducing its dependency on potable water supplies through the use of recycled water as described in **Section 2.7**. Mitigation measures outlined in the 2009 EA would be used to manage potential soil and water impacts during construction and operation. This includes a review of stormwater management during the detailed design phase. All safeguards outlined in the 2009 EA regarding potentially contaminated soil or groundwater would be applicable to the proposed modification.
Greenhouse Gas	Greenhouse gases (GHGs) are gases found in the atmosphere that absorb outgoing heat that is reflected from the sun. The primary GHG is carbon dioxide (CO_2). Different GHGs have different heat absorbing capacities. In order to achieve a basic unit of measurement, each GHG is compared to the absorptive capacity of CO_2, and measurements and estimates of GHG levels are reported in terms of CO_2 equivalent emissions (CO_2-e). Estimation of the GHG emissions associated with the proposed modification operations was undertaken using the emission factors and methods outlined in the National Greenhouse Accounts (NGA) Factors[1]. The NGA Factors provide three types of assessment categories: - **Scope (1)**, which covers direct emissions from sources within the boundary of an organisation, such as fuel combustion and manufacturing processes; - **Scope (2)**, which covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation; and - **Scope (3)**, which includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation; that is, emissions associated with the production or consumption of fuels, and emissions associated with the transmission and distribution of purchased electricity. The main operations likely to generate GHGs at the proposed terminal are electricity consumption to run pumps, flaring, shipping and plant lighting (Scopes 2 and 3). Overall the proposed modification would have minor impacts in regards to GHG generation.
Transport	Transport of construction personnel and equipment would be required throughout the construction phase. Construction traffic is expected to generate approximately: - 5 heavy vehicles; and - 10 light vehicles, per day during the peak of construction activities. All access to the site would be from Heron Road via Cormorant Road. These roads are designed for large vehicles and industrial traffic and have the capacity to absorb these low volumes. Operationally the tank would result in a negligible level of traffic generation with only occasional access required by light vehicles for periodic maintenance activities. Construction traffic would be managed by a Construction Traffic Management Plan.

[1] DECCEE. (2012). Australian National Greenhouse Accounts - National Greenhouse Accounts Factors, July 2012. Commonwealth of Australia (Department of Climate Change and Energy Efficiency).

Issue	Summary of Potential Impact
	Nitric Acid will be transported to the tank via ship and the existing transfer pipeline from the nearby wharf. Ship movements are expected to number approximately 1 per month. Operational shipping would be managed via the existing systems of the Port of Newcastle and Orica.
Waste	Some minor construction waste may be generated during construction including: - Spoil – from footing excavation; - Wood – from formwork; - Steel – from reinforcement, piping and flare structure offcuts; and - Plastics from materials packaging. Where possible components of the tank and flares will be prefabricated offsite and brought to the site for installation, minimising waste generation. No additional solid waste is expected to be generated by the operation of the proposed modification. The waste management measures outlined in the 2009 EA would be adequate to manage construction and operational waste where applicable.
Flora and Fauna	The proposed modification is unlikely to impact upon flora and fauna. The KI site is on reclaimed land and is highly disturbed. The proposed location for the 10,000 tonne nitric acid tank is a grassed, former rail corridor. Potential impacts to flora and fauna as a result of the proposed modification would be managed through the mitigation measures specified in the 2009 EA.
Heritage	The site is on reclaimed land that is highly disturbed. The 2009 EA did not identify any indigenous or non-indigenous heritage constraints across the Orica site. It is highlight unlikely that any indigenous or non-indigenous heritage items would be present within the construction disturbance footprint or the wider area. Despite the low likelihood of heritage items being present, in the event a heritage item is uncovered, works would cease and the NSW Office of Environment and Heritage or Local Aboriginal Land Council contacted for advice.

6.6 Cumulative Impacts

A cumulative assessment the potential impacts of the proposed modification in relation to air quality and noise impacts was undertaken in **Sections 6.1** and **6.2** respectively. These assessments look at both the cumulative impacts of the existing Orica facility and the proposed infrastructure collectively, as well these same components with background air and noise impacts from nearby industrial operations.

The assessment concluded that impacts would generally be minor with some low level acoustic impacts occurring during flare operation. Due to the infrequent nature of the flare operation and the low level of anticipated impacts, they are not considered significant.

7.0 Residual Risk Analysis

The Environmental Risk Analysis for the proposed modification is based on a process adapted from *Australian Standard AS 4369:1999 Risk Management*. The process is qualitative and is based on the Residual Risk Matrix shown in **Table 26**.

Residual Environmental Risk is assessed on the basis of the significance of environmental effects of the Proposed Project and the ability to confidently manage those effects to minimise the risk of harm to the environment.

The significance of environmental effects is given a numerical value between one and five, based on:

- The receiving environment (its sensitivity and values).
- The level of understanding of the type and extent of impacts.
- Likely community response to the environmental consequences of the Project.

The manageability of environmental effects is similarly given a numerical value between one and five based on the complexity of mitigation measures, the known level of performance on the safeguards proposed, and the opportunity for adaptive management. The numerical value allocated for each issue is based upon the following prescription.

Table 24 Significance of Effects

No	Significance	Receiving Environment
5	Extreme	Undisturbed receiving environment, type or extent of impacts unknown, substantial community concern.
4	High	Sensitive receiving environment, type or extent of impacts not well understood; high level of community concern.
3	Moderate	Resilient receiving environment, type and extent of impacts understood; community interest.
2	Minor	Disturbed receiving environment; type and extent of impacts well understood; some local community interest.
1	Low	Degraded receiving environment; type and extent of impacts fully understood; uncontroversial project.

Table 25 Manageability of Effects

No	Significance	Mitigation Measures
5	Complex	Complicated array of mitigation measures required; safeguards or technology are unproven; adaptive management inappropriate.
4	Substantial	Significant mix of mitigation measures required; past performance of safeguards is understood; adaptive management feasible.
3	Straightforward	Straightforward range of mitigation measures required; past performance of safeguards is understood; adaptive management easily applied.
2	Standard	Simple suite of mitigation measures required; substantial track record of effectiveness of safeguards; adaptive management unlikely to be required.
1	Minimal	Little or no mitigation measures required; safeguards are standard practice; adaptive management not required.

The chosen numbers are added together to provide a result which provides a ranking of potential residual effects of the Project when the safeguards identified in this EA are implemented.

Table 26 Residual Risk Matrix

Significance of Effects	Manageability of Effects				
	5 Complex	4 Substantial	3 Straightforward	2 Standard	1 Minimal
1 Low	6 Medium	5 Low/Medium	4 Low/Medium	3 Low	2 Low
2 Minor	7 High/Medium	6 Medium	5 Low/Medium	4 Low/Medium	3 Low
3 Moderate	8 High/Medium	7 High/Medium	6 Medium	5 Low/Medium	4 Low/Medium
4 High	9 High	8 High/Medium	7 High/Medium	6 Medium	5 Low/Medium
5 Extreme	10 High	9 High	8 High/Medium	7 High/Medium	6 Medium

7.1 Analysis

The analysis of residual environmental risk for issues related to the Proposed Project is shown in **Table 27**. This analysis indicates the environmental risk profile for the Proposed Project based on the assessment of environmental effects, the identification of appropriate safeguards, and the Statement of Commitments shown in this EA.

Table 27 Risk profile – proposed modification

Issue	Significance	Manageability	Residual Risk
Air Quality and Odour	2	1	3 Low
Noise and Vibration	2	2	4 Low/Medium
Hazards and Risk	2	2	4 Low/Medium
Visual	2	2	4 Low/Medium
Soils and water	1	1	2 Low
Greenhouse Gas	1	1	2 Low
Transport	1	1	2 Low
Waste	1	1	2 Low
Flora and fauna	1	1	2 Low
Heritage	1	1	2 Low

7.2 Conclusion

The above residual risk analysis indicates that the proposed modification, including appropriate safeguards as outlined in this EA, would give rise to predominantly a low risk in relation to the identified environmental issues.

8.0 Statement of Commitments

Table 28 provides a summary of the safeguards which will be implemented during the construction and operation of the proposed modification. Unless otherwise stated, the Statement of Commitments included in the 2009 EA will be implemented as applicable to the construction and operation of both the nitric acid tank and the ammonia flares.

Table 28 Summary of environmental mitigation measures

Aspect	Mitigation measure
Air Quality and Odour	- All construction works will be undertaken in accordance with Conditions 25 and 26 of the Project Approval. - Operational air quality verification will be undertaken for the proposed modification in accordance with Condition 23 of the Project Approval. - Ongoing operational air quality monitoring would be undertaken in accordance with Condition 22 of the Project Approval.
Noise and Vibration	- All construction works will be undertaken during hours as specified by Condition 33 of the Project Approval; - All reasonable and feasible construction noise mitigation measures will be implemented during construction to minimise noise impacts; - The final pump specification will comply with a Sound Power Level of 82dB(A) at 1m; and - Maintenance and testing of the flare will be limited to standard working hours.
Hazards and Risk	- A Layers of Protection Analysis (or similar) will be implemented for the nitric acid tank level instrumentation to determine the required level of reliability to reduce the risk of tank overflow to an acceptable level; - A Layers of Protection Analysis (or similar) will be undertaken during the design phase of the project to ensure the risk of liquid releases to the environment is acceptable; - A HAZOP study and a construction safety study will be undertaken in relation to the proposed modification; and - The existing safety management system, including the emergency response plan will be updated.
Visual	- All lighting design will be undertaken in accordance with *AS 4282(INT)-Control of Obtrusive Effects of Outdoor Lighting* pursuant to Condition 46 of the Project Approval; - The existing landscaping and vegetation screens of the Orica site will be subject to ongoing upkeep to maintain the effectiveness of the vegetated screen in accordance with the Landscape Plan prepares under Condition 45 of the Project Approval; and - All infrastructure will be maintained to a high standard and appearance with a focus on the external skin of the nitric acid tank.
Soils and water	- In accordance with Condition 44 of the Project Approval, a Construction Sediment and Erosion Control plan will be prepared in accordance with the 'Managing Urban Stormwater; Soils and Construction' (Landcom, 2004).
Greenhouse Gas	- Construction plant and equipment not be left idling for prolonged periods and will where feasible be turned off.
Transport	- Orica will ensure that the movement of oversized loads to the site during the construction phase is undertaken in accordance with the standard procedures documented by the Roads and maritime Services (RMS) and with appropriate approval from the RMS. - In accordance with Condition 36 of the Project Approval a Construction Traffic Management Plan will be prepared for the construction of both the nitric acid tanks and ammonia flares.

Aspect	Mitigation measure
Waste	- Construction waste will be managed in accordance with the waste hierarchy and the conditions of the Project Approval. - The Operational Waste Management Plan prepared under Condition 48 of the Project Approval will be updated to incorporate potential waste streams from the proposed modification.
Flora and fauna	- Sediment and erosion controls will be implemented to control runoff into, and ecological impact to, nearby water bodies. - Other potential impacts to flora and fauna will be managed through the implementation of the mitigation measures specified in the 2009 EA where applicable.
Heritage	- Any indigenous or on-indigenous objects that are uncovered during the remediation works should be left undamaged and in situ. Construction works should cease and an assessment be conducted by a qualified archaeologist in consultation with Aboriginal stakeholders and the OEH for direction as to its preservation, historical recording and / or removal if such items are uncovered.

9.0 Conclusion

In 2009, Project Approval 08_0129 was granted for the expansion of Orica's KI facility under Part 3A of the EP&A Act. As a result of changes to the site layout, the Project Approval was modified in 2012 under s75W of the EP&A Act (DA 08_0129 MOD 1). Orica is now proposing to build:

- A 10,000 tonne nitric acid storage tank instead of the 2,000 tonne tank previously approved; and
- three ammonia fares as part of the Ammonia Management Improvement programme.

The proposed modification application is to be assessed under s75W of the EP&A Act.

This EA has been prepared in consultation with DP&I to address the potential environmental issues associated with the proposed modification. Key environmental issues associated with the proposed modification include air quality, noise, hazard and risk and visual impacts. Other environmental issues addressed include soil and water, GHG emissions, transport, waste, visual amenity, flora and fauna, and heritage impacts.

The assessments of each of these factors in relation to both the Nitric Acid Tanks and the Ammonia Flares have shown that the proposed modification would not have a significant impact on the environment or community provided that the appropriate management and mitigation measures are implemented as identified in this EA.

10.0 References

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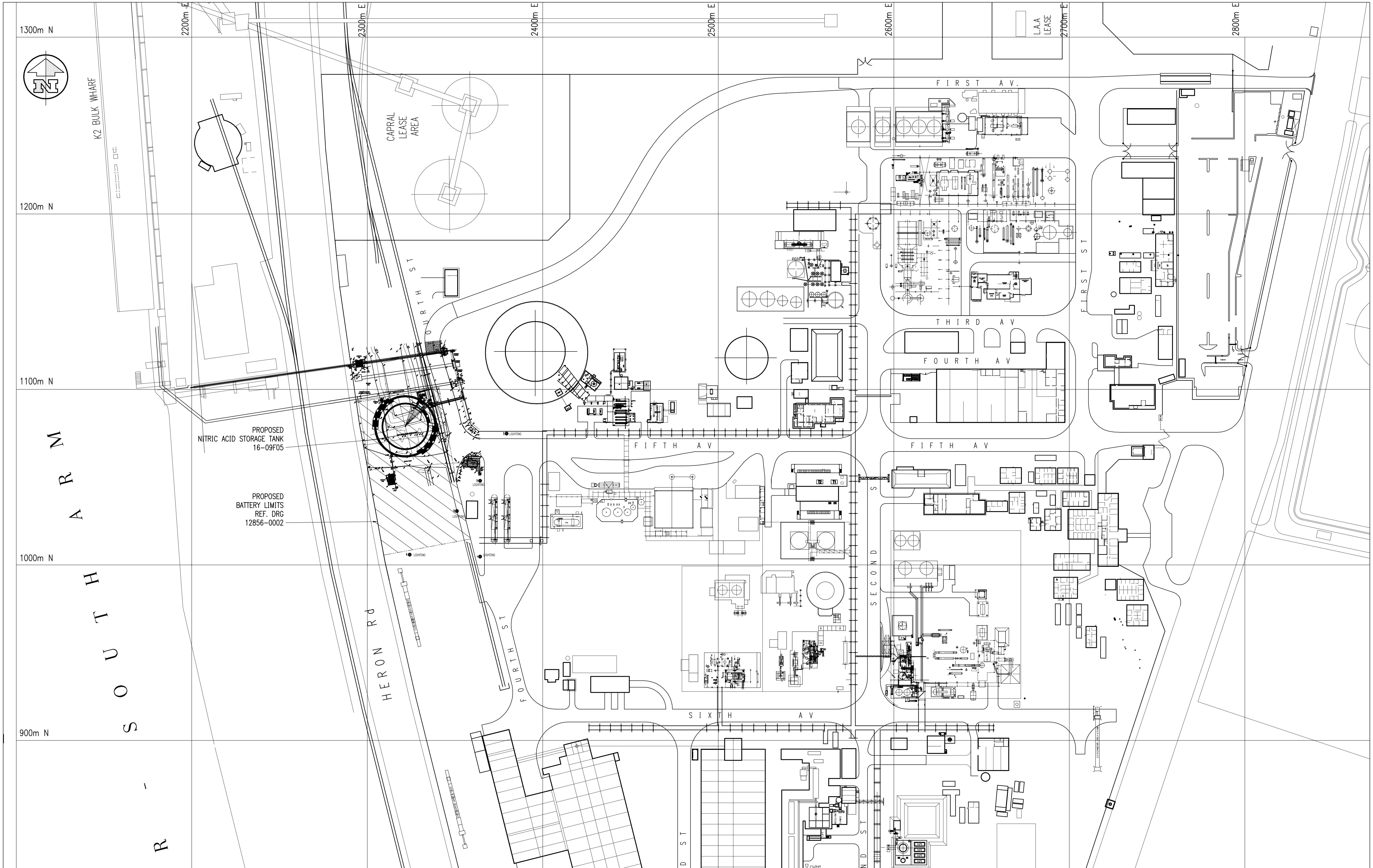
Appendix A

General Arrangement

Appendix A General Arrangement



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DESIGNED:	DATE	PLANT SITE SERVICES	
CHECKED:	DATE	SECTION ARCH , CIVIL	
PASSED:	DATE	PROJECT - WO No	
AUTHORISED:	DATE	SCALE 1:1000	

ORICA MINING SERVICES
Kooragang Island
Newcastle N.S.W

TITLE
ORICA SITE SERVICES
NITRIC ACID IMPORT TANK
PROPOSED SITE LOCATION
GENERAL ARRANGEMENT

SHEET SIZE	DWG No	REV
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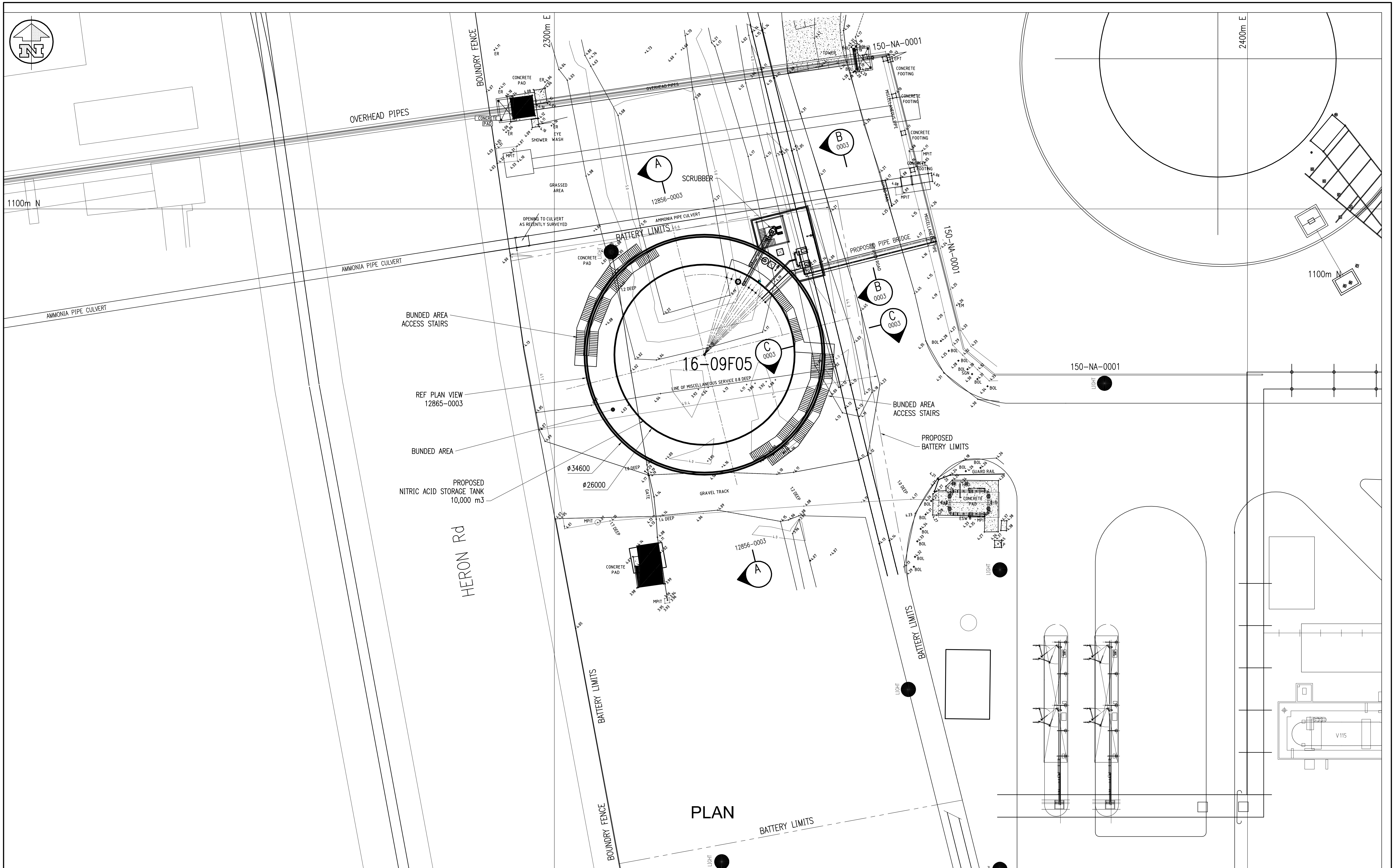
STATUS	PRELIMINARY	INDEX 15.01.10.00



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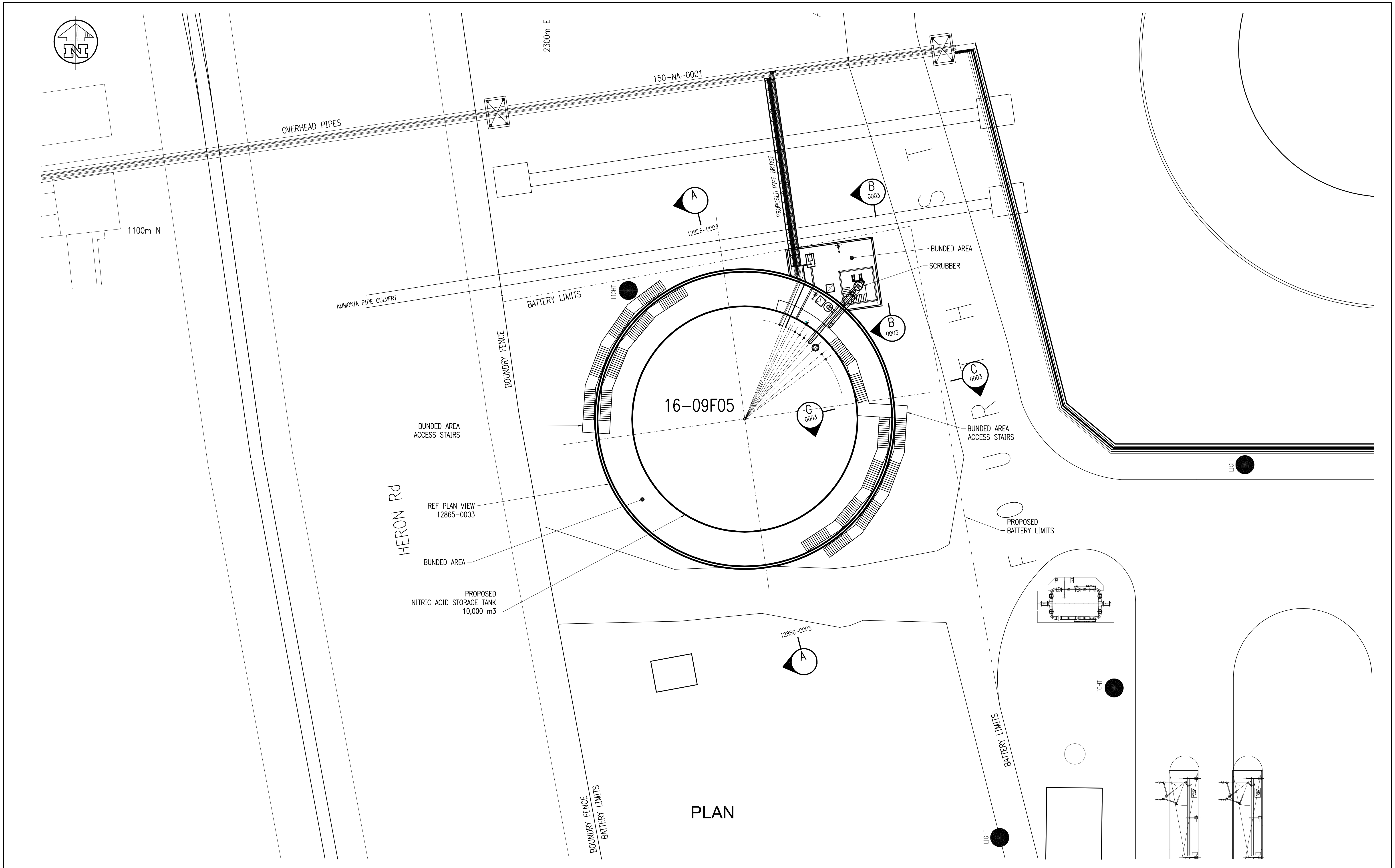
ORICA MINING SERVICES — Kooragang Island, Newcastle N.S.W

TITLE: ORICA SITE SERVICES
NITRIC ACID IMPORT TANK
PROPOSED BUNDED AREA
GENERAL ARRANGEMENT

SHEET SIZE A1 (841 x 594) | DWG No 12856-0002 | REV P1
STATUS PRELIMINARY | INDEX 15.01.10.00



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GENERAL ARRANGEMENT

SHEET SIZE	DWG No	REV
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Appendix B

Air Quality Impact Assessment

Appendix B Air Quality Impact Assessment

AECOM

Orica Australia Pty Ltd
12-Nov-2013

Air Quality Impact Assessment

Modification of Project Approval 08_0129

Air Quality Impact Assessment

Modification of Project Approval 08_0129

Client: Orica Australia Pty Ltd

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Document Air Quality Impact Assessment

Ref 60306451

Date 12-Nov-2013

Prepared by Adam Plant

Reviewed by David Rollings

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			Name/Position	Signature
A	15-Oct-2013	Draft	Simon Murphy Senior Environmental Planner	
B	1-Nov-2013	Draft for Review	Simon Murphy Senior Environmental Planner	
C	12-Nov-2013	Final	Simon Murphy Senior Environmental Planner	

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Table of Contents

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Executive Summary

Orica Australia Pty Ltd (Orica) commissioned AECOM Australia Pty Ltd (AECOM) to conduct an air quality impact assessment (AQIA) as part of the expansion and modification of its Kooragang Island (KI) facility. Specifically this AQIA has been prepared to assess the potential air quality impacts associated with:

- Three flares proposed for the ammonia plant, ammonia storage tank and nitrates plants; and
- The operation of a proposed 10,000 tonne nitric acid import tank (NA import tank) and associated scrubber.

Nitrogen dioxide (NO_2) and ammonia (NH_3) were identified as the pollutants of interest and were assessed as part of this AQIA

Modelling for the site was initially undertaken by AECOM in 2009 (ENSR 2009) using CALPUFF. The NO_2 results from the assessment were compared to the measured values at the Stockton monitoring station and indicated the potential for significant over estimations at the monitoring site (a factor of 2 over observed results). On this basis, the Ausplume model was investigated using the same emissions inputs and representative meteorological data and predicted results closer to the observed results, although still conservative. Given the conservative nature of the emissions data, this difference was considered to be more acceptable than the CALPUFF results and the Ausplume model was adopted for the study with discussions and approval from the NSW EPA. Ausplume was, therefore, used in this current AQIA.

Meteorological data used in this study consisted of 12 months' worth of hourly averaged meteorological data collected in 1995 and used in past Orica modelling assessments. The data has been used on a number of impact assessments in the Newcastle Harbour and has previously been accepted by the NSW EPA. The data was also used in order to provide a clear comparison with past dispersion modelling undertaken for the site. To further establish the data's appropriateness for use in the assessment, the data was reviewed against long-term data from the Williamtown BoM weather station and the Stockton monitoring station. All three sets of data show a strong correlation with respect to distribution of wind direction and speed and confirmed that the 1995 data are appropriate for use in this assessment.

The assessment utilised background pollutant data to cumulatively asses the site's impacts. The closest ambient air quality station to the facility is at Fullerton Street Stockton NSW. The current available data on the website is for the period October 2012 to August 2013 and has been used in the assessment. It was noted that Orica already contributes to the background air quality against which it is to be assessed, resulting in a "double counting" of pollutant concentrations; this is likely to result in conservative predicted air quality impacts.

In order to adequately assess the potential background concentration of pollutants in the future, measures were taken to review the potential contribution from the Incitec Pivot Limited (IPL) expansion proposed for land to the north of the Orica site. The inclusion of the IPL expansion air quality assessment data provides a conservative estimate of future potential impacts.

Two modelling scenarios were selected for the assessment: routine operations (routine operating conditions at the site with no flaring) and non-routine operations (routine operating conditions at the site with flaring (all three flares operating at once)). Both scenarios include the addition of scrubber emissions from the 10,000 t NA import tank.

The non-routine operation (flaring) scenario is considered highly conservative due to the following:

- It is unlikely that the plant would continue to operate at full operational capacity if the flaring was to occur i.e. a flaring event would occur when a problem arises at the site and other operations would be inhibited;
- The three flares are for separate operational sections of the site and are unlikely to be utilised at the same time, although this is a possibility; and
- It is expected that a flaring event would only occur under exceptional circumstances, with a predicted occurrence frequency of once every two years.

The 1 hour average NO_2 and NH_3 results for both routine operations and non-routine operation (with flaring) are predicted to meet the NSW EPA criteria.

The annual average NO_2 and NH_3 results for both the routine operation and non-routine operation (with flaring) are predicted to meet the NSW EPA criteria.

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1.0 Introduction

1.1 Overview

Orica Australia Pty Ltd (Orica) commissioned AECOM Australia Pty Ltd (AECOM) to conduct an air quality impact assessment (AQIA) as part of the expansion and modification of its Kooragang Island facility, specifically regarding additional ammonia flaring infrastructure. Orica operates a manufacturing facility on Kooragang Island (KI) near Newcastle, which produces ammonia, nitric acid and ammonium nitrate. An Environmental Assessment (EA) (AECOM, 2009) was prepared for the expansion of the site's ammonium nitrate manufacturing capability from 500ktpa to 750ktpa, and was approved by the Minister under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 1 December 2009 (DA 08_0129). A full project description is provided in Section 2 of the EA, while a site location and facility plan are provided in **Figure 1** and **Figure 2** respectively.

Central to the approval of the expansion project were a series of design improvements to the site's existing ammonia management infrastructure (AMI). The AMI programme of work is aimed at improving the management of ammonia at the KI facility. A key objective of this programme is that the community is not adversely impacted by the use of ammonia onsite, including potential releases to the environment.

Risk reduction will be achieved through the transition of the site's ammonia management systems to a new design philosophy for which potential ammonia release points are captured and reused, or recycled through the process where practicable, or treated via a flare capable of managing non-routine ammonia release volumes, prior to being discharged. These improvements are further described in Section 2 of the EA.

Orica's assessment of options for treatment of non-routine ammonia discharges indicated that flares were preferable compared to the installation of a new larger scrubbing system. A flare is less complex than a scrubbing system, would have greater availability, does not require site power or cooling water systems and is inherently more reliable. Overall the operation of the proposed flares would see a reduction in the hazard and risk associated with the ongoing operation of the KI facility.

Orica is also seeking approval for an additional modification of the approved project to install a new 68% nitric acid import tank with a capacity of 10,000 tonnes (t). The nitric acid import tank (NA import tank) would be filled by ship utilising the existing wharf pipeline. The venting of vapours from the head space of the NA import tank would be mitigated using a new wet nitric acid fume scrubber.

This AQIA has been prepared to assess the potential air quality impacts associated with the Ammonia Plant, Nitrates and Ammonia Storage ammonia flares, together with the site's existing operations including a 10,000 t NA import tank and appropriate background pollutant concentrations. The report describes the approach taken in assessing the potential effects of the project and provides a quantitative assessment of the air quality impacts of the development on the surrounding receivers in accordance with the applicable guidelines and the specific project requirements of the various government agencies.

1.2 Development Location

Kooragang Island is located within the Port of Newcastle, approximately 3 km north of Newcastle CBD and is shown in **Figure 1**. The Island was developed in 1951 as part of the Hunter River Islands Reclamation Scheme, which joined islands within the Hunter River with dredged sand and fill material. The manufacture of ammonia, nitric acid and ammonium nitrate has occurred at the site since the facility was commissioned in 1969. Existing industrial developments on the Island include Port Waratah Coal Service, wharf facilities, coal and woodchip loaders, Incitec Pivot Ltd, Sims Metal Ltd, Cargill, Cleanaway, Boral and Transfield Pty Ltd. The Hunter Estuary National Park is located approximately 1.5 km north of the site.

The nearest residential premises are located at Stockton, approximately 760m east of the Orica property boundary. There are also residential properties 1.5 km to the southwest at Carrington and 2 km to the west at Mayfield.

The land adjacent to the Orica site is used for industrial and port related activities including the following:

- North: Incitec Pivot Limited operates a fertiliser storage and despatch facility.
- West: Newcastle Port Corporation and its lessees operate bulk goods importing/exporting operations on the western side of Heron Rd.
- South: Patricks and Bulk Grain Terminals operate storage and despatch facilities.
- East: whilst the land to the east of the site is currently vacant there is a proposed development for the storage of hydrocarbon products proposed on a portion of this land.

G:\ENV\GIS\Projects\603\60306451 Orica Kooragang Island Flare Modification\Figures\AQ\A\60306451 F1 Site Location 17 10 2013 TO

AECOM

SITE LOCATION

Proposed Modification, Greenleaf Road, Kooragang Island

FIGURE 1

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Existing Infrastructure Key

1	Ammonia Plant	5	Nitric Acid Plant 2	9	AN Plant 2
2	Utilities Area	6	Nitric Acid Plant 1	10	AN Plant 1
3	Acid Storage (Dilution infrastructure will be contained in the Tank 1 bund)	7	Boiler Plant	11	AN Bulk Storage
4	Nitric Acid Plant 3	8	ANS	12	Bagged Product Storage

Infrastructure Key (1 - 16)

1	New demin water system	5	New NA storage	9	Cooling water supply pumps	13	New NAP4 plant
2	New ammonia storage nitrate pumps	6	New pipe rack	10	New cooling water treat,emt skids	14	Ammonia compressor
3	New instrument air compressor and dryer	7	11kV trident switchroom	11	New cooling towers	15	Contaminated condensate tank
4	Extension to No.2 11kV substation	8	New boiler	12	New NAP4/AN3 switchroom and transformer	16	Clean process condensate tank

Infrastructure Key (17 - 32)

17	New No.6 ammonia bullet	21	New workshop	25	New concentrator plant	29	New bag store
18	New emergency generator and switchroom	22	New entry security gate	26	New ANS/WANS loadout	30	New AN road bulk loadout and weighbridges
19	New control room	23	New office	27	New first flush pi	31	2x 1.05/1.2t bag lines and 1x 25/40kg bag line
20	New entry	24	New weighbridge	28	New dispatch office and amenities	32	Switchroom

Infrastructure Key (33 - 38)

33	Transformers	39	New FEL workshop and forklift parking
34	Container bag loading area	40	Transtank
35	New bulk store	41	Proposed AN# plant
36	New weighbridge	42	New container storage
37	New office	43	Nitrogen tie in
38	New exit security gate	44	New ammonia plant nitrates pump

Key

- Site boundary
- Existing infrastructure location
- OBL Stage 1A
- OBL Stage 1B
- OBL Stage 2
- NAP4 & ANS
- AN3

Note:
Information derived from Hatch EMA plan HEN2561-0000-00-014-0012 (05/04/2011)

0 100 200m

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AECOM

APPROVED FACILITY PLAN
Proposed Modification, Greenleaf Road, Kooragang Island

FIGURE 2

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2.0 Pollutants of Interest and Existing Air Quality

2.1 Pollutants of Interest

The pollutants of interest for this modification are oxides of nitrogen (NOx) (as nitrogen dioxide NO_2) and ammonia (NH_3). These pollutants are expected to be contributors to the local atmosphere from the site's operations, specifically the flare operations and NA import tank scrubber. A brief description of the health and environmental effects of the two pollutants is provided in **Appendix A**.

2.2 Existing Air Quality

The closest ambient air quality and meteorological station to the facility is at Fullerton Street Stockton NSW. The station continuously monitors general air quality as well as wind speed and direction for the Stockton community. Air quality parameters measured are dust (PM_{10} and $PM_{2.5}$), Oxides of Nitrogen (NO_x) (including NO_2) and NH_3 levels. The data is publically available at the following web address http://www.stocktonairqualitymonitoring.com/ .

The currently available data on the website is for the period October 2012 to August 2013. The following table presents a summary of the monitored data for NO_2 and NH_3 for the data period October 2012 to August 2013.

Table 1 Stockton Monitoring Station Ambient Air Quality Data; October 2012 to August 2013

Parameter	NO_2 (ug/m3)	NH_3 (ug/m3)
Minimum	0	0
Average	15	11
Maximum	91	391
95th Percentile	49	52
70th Percentile	20	8

The 95th percentile data provided in the above table has been used as the background values in the assessment. The 95th percentile has been selected to remove any peaks in background caused by episodic events (such as bush fires, dust storms and accidental industrial incidents) while still maintaining a high quality set of data representative of typical ambient conditions. The 95th percentile is well above the annual average, over three times higher, so is likely to be higher than that typically present in the environment. EPA Victoria recommends the use of the 70th percentile for this function, so using the 95th percentile is considered conservative, particularly given that the 70th percentile is less than half the 95th percentile used in this assessment.

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3.0 Assessment Methodology

The following sections outline the models used and their inputs, modelling scenarios assessed, emissions estimation methodology and emission rates entered into the models. The modelling was prepared and conducted in accordance with the NSW EPA Approved Methods (DEC 2005).

3.1 Dispersion Model Selection

The Orica site is located in a coastal environment with relatively flat terrain. Typically for air quality assessments in coastal locations the CALPUFF dispersion model is used. CALPUFF is a non steady-state three dimensional Gaussian puff model developed for the US Environmental Protection Agency (US EPA) for use in situations where basic Gaussian plume models are not effective, such as areas with complex meteorological or topographical conditions, including coastal areas with re-circulating sea breezes. Modelling for the site was initially undertaken by AECOM in 2009 (ENSR 2009) using CALPUFF. The NO_2 results from the assessment were compared to the measured values at the Stockton monitoring station. The results from the 2009 CALPUFF model indicate the potential for significant over estimations at the monitoring site (a factor of 2 over observed results).

On the basis of the results from CALPUFF, the Ausplume model was investigated using the same emissions inputs and representative meteorological data. The Ausplume model predicted results approximately 25% higher than the observed results (full details of the study are provided in ENSR 2009). Given the conservative nature of the emissions data (assumed constant operation and the likelihood of double counting on background NO_2 concentrations), this difference was considered to be more acceptable than the CALPUFF results and the Ausplume model was adopted for the study. The study's conclusion was discussed with the NSW EPA, who confirmed that the use of Ausplume for site assessments was acceptable.

As a result of the previous study's findings, all subsequent dispersion modelling has been undertaken using Ausplume, including this current assessment.

Ausplume is an advanced Gaussian plume dispersion model with algorithms based on the Industrial Source Complex – Short Term (ISCST3) model approved by the US EPA for use in regulatory assessments undertaken within the United States. Ausplume was developed by the Victorian EPA to enhance the ISCST3 model and make it applicable to Australian conditions. Ausplume is approved by the NSW EPA for use in regulatory assessments undertaken in NSW. A complete description of the model is provided in the Ausplume user manual, which is available upon request.

The model uses the Gaussian dispersion model equation to simulate the dispersion of a plume from point, area or volume sources. Mechanisms for determining the effect of terrain on plume dispersion are also provided. Ausplume operates on an hourly time step, and therefore, requires hourly wind speed, wind direction and other dispersion parameter data. The dispersion of each pollutant plume is determined for each hour using conventional Gaussian model assumptions.

Input parameters used for the Ausplume dispersion modelling is summarised in **Table 2**.

Table 2 Summary of Ausplume Input Parameters

Parameter	Input
Ausplume Version	6.0
Modelling Domain	15 km x 15 km
Ausplume Modelling Grid Resolution	0.15 km
Number of Sensitive Receptors	40
Terrain Data	Not incorporated
Building Wake Data	Entered via Ausplume's Building Profile Input Program (BPIP)
Dispersion Algorithm	PG (rural ISC curves) & MP Coeff. (Urban)
Hours Modelled	8736 hours (364 days)
Meteorological Data Period	Jan 1995 – Dec 1995

All dispersion modelling was undertaken in accordance with the Approved Methods for Modelling and Assessment of Air Pollutants published by NSW EPA (DEC, 2005). The document prescribes calculation modes to account for terrain effects, building wake effects, horizontal and vertical dispersion curves, buoyancy effects, surface roughness, plume rise, wind speed categories and wind profile exponents.

3.2 Model Inputs

AUSPLUME requires six main categories of data to determine the dispersion of air emissions:

- Meteorology;
- Terrain effects;
- Building wake effects;
- Modelling scenarios;
- Source characteristics; and
- Emissions inventory.

The above inputs are addressed separately in the following sections.

3.2.1 Meteorology

Meteorology in the area surrounding KI is affected by several factors such as terrain and land use. Wind speed and direction are largely affected by topography at the small scale, while factors such as synoptic scale winds (which are modified by sea breezes near the Newcastle coast in the daytime) and complex valley drainage flows that develop during night hours, affect wind speed and direction on the larger scale.

Meteorological data used in this study consisted of 12 months' worth of hourly averaged meteorological data collected in 1995 and used in the past Orica modelling air quality assessments. The data was used in order to provide a clear comparison with past dispersion modelling undertaken for the site and has previously been accepted by the NSW EPA for modelling at the site.

Despite the historical acceptance of the data by NSW EPA, questions may arise as to whether the year is representative of long-term average meteorological conditions and representative of expected regional behaviour. Selected long-term parameters for the Williamtown Bureau of Meteorology (BoM) weather station have been compared with the same parameters from the meteorological data set. In addition, the Stockton monitoring station has also been compared against the assessment data set. All three sets of data show a strong correlation with respect to distribution of wind direction and speed and confirmed that the 1995 data is appropriate for use in this assessment. The review is provided in **Appendix B**.

3.2.2 Terrain Effects

Katabatic drainage flow (or valley drainage flow) occurs under light winds and stable meteorological conditions. As air cools at night, it tends to fall and move down-hill in areas of significant topographic relief. As this air moves it tends to create a bulk movement of air, which can cause winds to blow in areas influenced strongly by topography.

Due to the low relative relief in the region surrounding the proposed Orica site, no significant katabatic drainage flows are expected. The regional climatic patterns, which are governed by the coastal meteorological conditions, are likely to dominate the wind patterns in the Newcastle Harbour area. Subsequently, terrain effects were not incorporated into the Ausplume model.

3.2.3 Building Wake Effects

The dispersion of air emissions around the Orica facility are likely to be affected by aerodynamic wakes generated by winds having to flow around buildings and plant equipment. Building wakes generally decrease the distance downwind at which the stack plumes comes into contact with the ground. This may result in higher air emission ground level concentrations closer to the emission source.

PRIME is the US EPA's preferred building wake algorithm. Ausplume includes the PRIME building wake algorithm and uses the Building Profile Input Program (BPIP) for entering the location and dimension of buildings. The location and dimensions of buildings located within a distance of 5L (where L is the lesser of the height or width of the building) from each release point for buildings with a height greater than 0.4 times the stack height were entered in the BPIP and aerodynamic wakes calculated.

3.2.4 Modelling Scenarios

The following modelling scenarios were examined to determine the likely air quality impacts resulting from proposed routine and non-routine operations; specifically addressing the impacts of flaring operations.

Table 3 Modelling Scenarios

ID	Name	Description
1	Routine Operation	Assessment of the sites routine manufacturing operations without flaring
2	Non-routine Operation	Assessment of the sites routine manufacturing operations together with constant operation of all three flares

Scenario 1 was selected to assess the routine operating conditions at the site with all emission sources constantly operational. This scenario assumes that the site is operating as routine with no flaring operations occurring. The scenario includes the addition of scrubber emissions from the 10,000 t NA import tank.

Scenario 2 was selected to assess the non-routine operating conditions at the site that considers all routine emission sources constantly operational **whilst** flaring is simultaneously occurring. The flaring involves all three flares operational at once. The scenario includes the addition of scrubber emissions from the 10,000 t NA import tank. This scenario is considered highly conservative due to the following:

- It is unlikely that the plant will be running at full operational capacity if the flaring is occurring i.e. a flaring event would occur when a problem arises at the site and other operations would be inhibited;
- The three flares are for separate operational sections of the site and are highly unlikely to be utilised at the same time, although there is a slight possibility; and
- It is expected that a flaring event would only occur under exceptional circumstances, with a predicted occurrence frequency of once every two years.

All modelling scenarios outlined above assumed the plants routine operations were at full capacity, running continuously (24 hours per day, 365 days per year). Scenario 2 assumed that the flares were also running 24 hours per day, 7 days per week. The facility is unlikely to operate at this level due to operational restrictions (such as breakdowns, maintenance and scheduled cleaning). The scenarios, therefore, represent worst-case conditions for the facility's operation, and are likely to overestimate the actual short and long-term impacts experienced by receptors surrounding the facility.

3.3 Emissions Inventory

The routine operation emission sources modelled are shown in **Table 4**. These sources are included in the model for both Scenario 1 and 2. The emissions inventory data were gained from the Orica document 'Ammonia Management Improvement Project – Comparison of Stack Discharge Data – EN2690-00-AA-002'; dated 21/10/13.

Table 4 **Modelled Routine Operation Emission Sources (Scenarios 1 and 2)**

Stack ID	Modelling Stack Description
BS1	Boiler Stack
1NA1	Nitric Acid Plant Stack (NAP1)
2NA1	Nitric Acid Plant Stack (NAP2)
3NA1	Nitric Acid Plant Stack (NAP3)
1AN5	CDC Evaporator Scrubber Stack
1AN6	Prill Tower
2AN4	Granulator Scrubber Stack
A8G2	Reformer Flue Stack
PRF	Pre-Reformer Furnace
E1	Nitric Acid Plant Stack (NAP4)
E5	NFG Boiler Stack
NAITS	NA Import Tank Scrubber

The flare emission sources are provided in **Table 5**.

Table 5 **Modelled Flare Emission Sources (Scenario 2)**

Stack ID	Modelling Stack Description
FLRS	Ammonia Storage Tank Flare Stack
FLRN	Nitrates Plant Flare Stack
FLRA	Ammonia Plant Flare Stack

3.3.1 Source Parameters

Stack characteristics for the Orica facility routine operations are summarised in the following table. This data has been gained from previously modelled assessments, with the addition of the NA import tank scrubber (NAITS) data that was supplied by Orica in document EN2690-00-AA-002 dated 21/10/13.

Table 6 Routine Operation Stack Characteristics

Stack ID	Stack Gas Flow Rate (Nm^3/s)	Stack Tip Area (m^2)	Stack Height (m)	Stack Internal Diameter (m)	Stack Velocity (m/s)	Gas Temp. (°C)
BS1	3.5	1.6	39.47	1.43	3.2	131.0
1NA1	16.7	0.73	83.82	0.965	33.9	133.0
2NA1	10.0	0.44	54.86	0.746	27.1	50.0
3NA1	11.1	0.43	55.1	0.74	41.9	170.0
1AN5	17.3	1.65	19.0	1.448	12.5	52.4
1AN6	8.6	10.31	48.15	3.6	0.9	37.3
2AN4	24.0	1.77	27	1.5	15.3	36.0
A8G2	46.4	5.60	47	2.67	11.1	93.0
PRF	5.3	1.43	27	1.35	5.2	110.0
E1	33.5	2.01	55	1.6	25.5	145.0
E5	19.3	2.01	40	1.6	16.6	200.0
NAITS	0.18	0.07	25.5	0.3	2.79	25

The design characteristics of the three flares are provided in **Table 7** and were provided by Orica. Of these parameters only the stack temperature were inputted directly into the model; the other parameters were modified to better represent flare characteristics; **Section 3.3.1.1** explains the modifications made to the flare parameters.

Table 7 Design Flare Stack Characteristics

Stack ID	Stack Gas Flow Rate (Am^3/s)	Stack Gas Flow Rate (Nm^3/s)*	Stack Tip Area (m^2)	Stack Height (m)	Stack Internal Diameter (m)	Initial Gas Temp. (°C)	Flame Temp. (°C)
FLRS	2.0	2.2	0.07	5	0.305	30	800
FLRN	4.8	5.4	0.16	8	0.458	30	800
FLRA	24.1	26.8	1.02	20	1.142	30	800

* Calculated using the initial gas temperature provided in the table.

Assist gas is not required for the flare operation so no additional natural gas flow is needed during flaring. A constant purge gas may be used to prevent the back migration of air into the flare header. If required the flow of natural gas is expected to be minor (0.0004 to 0.03 m3/s) and is not considered a significant source. Potential purging of the flare has therefore been omitted from this assessment.

3.3.1.1 Calculation of Flare Parameters

Flares are considered a special type of elevated source that may be modelled as a point source. In a flare, the velocity of the waste stream and the flare temperature are not used to determine the plume rise; rather, the Texas Commission on Environmental Quality (2006) (TCEQ) suggests use of the parameters and formula explained below to calculate the effective stack diameter based upon the net heat release and the average molecular weight of the compounds being burnt. Enclosed vapour combustion units should not be modelled with the provided parameters, but instead with stack parameters that reflect the physical characteristics of the process unit (Orica use open units).

If a flare is to be treated as a point source, accurate determination of all stack parameters is not possible. Since combustion occurs at or beyond the flare tip in the atmosphere, appropriate values for stack exit temperature and exit velocity cannot be accurately determined. The diameter of the pipe leading to the flare tip is not a factor in determining plume rise. The point source algorithm should be used with arbitrary values assigned for stack exit velocity (20 m/s) and temperature (1,000C) to predict dispersion for flare type sources. As the physical Orica flare temperature has been estimated and is less than the arbitrary value provide by the TCEQ, the temperature values presented in **Table 7** have been used in the assessment.

A stack height equal to the height of the flare tip is recommended for flares by TCEQ. The effective flare tip diameter is determined using the following equation (TCEQ 2006):

$$D = \sqrt{((10^{-6})q(1-0.048\sqrt{(MW)}\,))}$$

where

D = effective flare tip diameter, meters

q = net or lower heat release, cal/sec

MW = volume average molecular weight, g/g-mole

The net heat release (q) from each stack has been calculated based on the Orica document “Ammonia Flares – Design Selection and Operation” (document number EN2690-00-08-009). The document provides the heat release per megawatt (MW) for the three stacks; 20.6 MW for FLRS, 51.5 MW for FLRN and 288.6 MW for FLRA. The heat release values were calculated based on design capacity feed rates, whereas this assessment has been undertaken on slightly inflated values in order to provide a buffer (see **Section 3.3.2**). The heat release values provided in the document have therefore been proportionally increased to account for the inflated values. The net heat release values, converted to calories per second (cal/sec), are provided in **Table 8**. These values were applied to the TCEQ formula above (as q), together with the molecular weight values provided in the table, to calculate the modelling stack diameters.

Table 8 Flare Stack Parameters for Modelling

Stack	Net Heat Release (cal/sec) q	Molecular Weight (g/g-mole)	Calculated Stack Diameter (m)	Physical Stack Height (m)*	Estimated Flare Flame Length (m)*	Calculated Stack Height (m)
FLRS	6,154,393	17	2.22	5	10	15
FLRN	14,770,543	17	3.44	8	18	26
FLRA	73,852,717	17	7.70	20	36	56

* Stack height and estimated flame length data supplied by Orica

3.3.2 Source Emission Rates

The routine operational emission rates for the Orica site are provided in **Table 9**. The data has been based on previous site assessments (AECOM 2011), with the addition of the nitric acid import tank data supplied by Orica, and represent the worst case stack emissions based on the maximum individual unit capacities.

The NA import tank scrubber NO_X emission rate has been based on the maximum allowable NO_2 equivalent concentration appropriate for the category ‘general activities and plant’ for Group 6 activities from the Protection of the Environment Operations (Clean Air) Regulation 2010 (POEO). This stipulates a maximum concentration of 350 mg/Nm^3. The expected routine operation NOx (as NO_2) value is expected to be 200 mg/Nm^3, with a maximum design value of 350 mg/Nm^3. The use of the maximum POEO limit is therefore considered a conservative approach to modelling the scrubber’s emissions.

Table 9 Routine Emissions Characteristics

Stack ID	Pollutant Concentration (mg/Nm^3)		Pollutant Emission Rates (g/s)	
	NO_x	NH_3	NO_x	NH_3
BS1	49.5	-	0.17	-
1NA1	559	-	9.31	-
2NA1	431	-	4.31	-
3NA1	381	-	4.23	-
1AN5	-	12	-	0.21
1AN6	-	11	-	1.14
2AN4	-	29	-	0.69
A8G2	234	16	10.9	0.74
PRF	234	-	1.2	-
E1	286	-	9.6	-
E5	234	-	4.5	-
NAITS	350	-	0.063	-

The emission rates for the flares have been generated from the design information provided by Orica. In order to create a buffer for the flare operations and provide a conservative assessment of potential impacts, the design feed rates were increased from 4 t/hr to 5 t/hr for FLRS, 10 t/hr to 12 t/hr for FLRN and 56 t/hr to 60 t/hr for FLRA. The increased rates were applied in the emissions calculations. The information provided to generate the emission rates is provided in **Table 10**.

Table 10 Flare Design Information

Stack ID	NH_3 Feed Rate (kg/hr)	Destruction Efficiency (%)	Ratio of remaining NO_X/NH_3	NOX Release Rate (kg/hr)	NH3 Release Rate (kg/hr)
FLRS	5,000	97	50/50	75	75
FLRN	12,000	97	50/50	180	180
FLRA	60,000	97	50/50	900	900

The emission rates for the flares are provided in **Table 11**. The estimated emission rates have been calculated based on the data provided by Orica presented above.

Table 11 Flare Emissions Characteristics

Stack ID	Pollutant Concentration (mg/Nm^3)		Pollutant Emission Rates (g/s)	
	NO_x	NH_3	NO_x	NH_3
FLRS	9,339	9,339	21	21
FLRN	9,339	9,339	50	50
FLRA	9,339	9,339	250	250

3.4 Conversion of NO_X to NO_2 – Ozone Limiting Method (OLM)

Nitrogen oxides are produced in most combustion processes and are formed during the oxidation of nitrogen in the fuel and nitrogen in the air. During high-temperature processes a variety of nitrogen oxides are formed including nitric oxide (NO) and nitrogen dioxide (NO_2). Generally, at the point of emission, NO will comprise the greatest proportion of the emission with 95% by volume of the NO_x. The remaining NO_x will consist of NO_2.

Ultimately, however, all nitric oxides emitted into the atmosphere are oxidised to NO_2 and then further to other higher oxides of nitrogen. The rate at which this oxidisation takes place depends on prevailing atmospheric conditions including temperature, humidity and the presence of other substances in the atmosphere such as ozone. It can vary from a few minutes to many hours.

The rate of conversion is important because from the point of emission to the point of maximum ground level criteria there will be an interval of time during which some oxidation will take place. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low it is unimportant that the oxidation has taken place. However, if the oxidation is rapid and the dispersion slow then high concentrations of NO_2 can occur.

The USEPA's Ozone Limiting Method (OLM) has been used to predict ground-level concentrations of NO_2. The OLM is based on the assumption that approximately 10% of the initial stack NO_x emissions are emitted as NO_2. If the ozone (O_3) concentration is greater than 90% of the predicted NO_x concentrations, all the NO_x is assumed to be converted to NO_2, otherwise NO_2 concentrations are predicted using the equation $NO_2 = 46/48 * O_3 + 0.1 * NO_x$. This method assumes instant conversion of NO to NO_2 in the plume, which overestimates concentrations close to the source as conversion usually occurs over periods of hours. This method is described in detail in the Approved Methods.

OLM has been applied in the assessment using the maximum predicted NO_x impact and the annual 0_3 value from the Stockton monitoring station.

3.5 Assessment Criteria

Table 12 presents the impact assessment criteria specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005). These criteria apply to the air impacts from the facility alone (isolation) and the combined impacts of the facility and background values (cumulative).

Table 12 Relevant Air Quality Impact Assessment Criteria

Air Emission	Averaging Period	Regulatory Limit ($\mu g/m^3$)	Assessment Percentile
Nitrogen Dioxide (NO_2)	1 hour	246	100^{th}
	Annual	62	100^{th}
NH_3	1 hour	330	99.9^{th}

Applying the annual average criterion against Scenario 2 (non-routine operations that include flaring) modelling results is considered extremely conservative, as the emissions from the flares are expected to be short-term events, however they have been modelled as constant emissions for the entire modelling period.

3.6 Sensitive Receptors

The Ausplume modelling domain incorporates a 15 km by 15 km grid with a resolution was 0.15 km, centred over the Orica facility. Within this gridded modelling domain, discrete sensitive receptors were modelled in addition to the gridded receptors placed over the entire modelling domain. The NSW EPA considers sensitive receptors to be areas where people are likely to either live or work, or engage in recreational activities. On this basis, representative sensitive receptors were positioned at 40 locations surrounding the Orica facility. A summary of the approximate sensitive receptor locations is presented in **Appendix C**.

3.7 Cumulative Assessment Methodology

It needs to be noted that Orica already contributes to the background air quality against which it is to be assessed. Using the methodology described by the NSW EPA Approved Methods results in a "double counting" of pollutant concentrations; the degree to which this double counting influences the cumulative results has not been addressed by this report. As this increases the level of conservativeness in the modelling, it has been included in the assessment.

In order to adequately assess the potential background concentration of pollutants in the future, measures were taken to review the potential contribution from the proposed Incitec Pivot Limited (IPL) expansion on the land to the north of the Orica site. IPL propose to build an ammonia nitrate facility at 39 Heron Road, Kooragang Island as detailed in URS 2012. The lot of land currently includes the existing operations of the IPL fertilizer facility as well as mainly vacant land on which the development would be built. As confirmed in a press release dated 26 September 2012 from IPL, the feasibility study has been suspended, with a likely decision made on whether to proceed with the plant deferred for at least two years (from date of press release).

The IPL report provided predicted impacts for both routine and non-routine operations of the existing facility and expansion. The results of the routine (normal plant) operations have been used in the Orica assessment as this is the most likely scenario when a flaring event may be happening at the Orica site. The IPL incremental data (IPL site operations alone) has been used in the assessment; by doing this the current impacts from the fertiliser portion of the site would be double counted by the background values applied resulting in conservative results. A summary of the maximum IPL routine incremental impacts at a discrete receptor are presented in **Table 13**. Note that the IPL NO_2 data conservatively assumes total conversion of NO_X from the facility to NO_2. The IPL NO_2 result provided is for the 99.9^{th} percentile and the NH_3 is for the 100^{th} percentile.

Table 13 Predicted IPL Routine Discrete Receptor Results (from URS 2012)

Pollutant	1 Hour Impact (µg/m3)	Annual Average Impact (µg/m3)
NO_2	25	0.4
NH_3	1.2	NA

3.8 Limitations of Dispersion Modelling

The atmosphere is a complex, physical system, and the movement of air in a given location is dependent on a number of variables, including temperature, topography and land use, as well as larger-scale synoptic processes. Dispersion modelling is a method of simulating the movement of air pollutants in the atmosphere using mathematical equations. The model equations necessarily involve some level of simplification of these very complex processes, based on our understanding of the processes involved and their interactions, available input data, processing time and data storage limitations.

These simplifications come at the expense of accuracy, which particularly affects model predictions during certain meteorological conditions and source emission types. For example, the prediction of pollutant dispersion under low wind speed conditions (typically defined as those less than 1 m/s) or for low-level, non-buoyant sources, is problematic for most dispersion models. To accommodate these known deficiencies, the model outputs tend to provide conservative estimates of pollutant concentrations at particular locations.

While the models contain a large number of variables that can be modified to increase the accuracy of the predictions under any given circumstances, the constraints of model use in a commercial setting, as well as the lack of data against which to compare the results in most instances, typically precludes extensive testing of the impacts of modification of these variables. With this in mind, model developers typically specify a range of default values for model variables that are applicable under most modelling circumstances.

The results of dispersion modelling, therefore, provide an indication of the likely level of pollutants within the modelling domain. While the models, when used appropriately and with high quality input data, can provide very good indications of the scale of pollutant concentrations and the likely locations of the maximum concentrations occurring, their outputs should not be considered to be representative of exact pollutant concentrations at any given location or point in time.

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4.0 Impact Assessment

4.1 Predicted Nitrogen Dioxide Modelling Results

The maximum predicted sensitive receptor ground level concentrations of NO_2 for the 1 hour average and annual average are presented in **Table 14** and **Table 15** respectively. The impact from the facility alone (incremental) and cumulatively with the Stockton monitoring data and IPL impact are provided.

Table 14 Maximum Sensitive Receptor 1 Hour Average Predicted Ground Level Concentrations – NO_2

Scenario	1 Hour Maximum NO_2 ($\mu g/m^3$)			
	Incremental	Stockton Background	IPL Routine Impact	Cumulative
1 – Routine operations	91	49	25	165
2 – Non-routine operations	137	49	25	212
Criteria	**246**			

The 1 hour average NO_2 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criterion. The highest predicted NO_2 1 hour average concentrations occurred at industrial receptors on KI located in proximity to the Orica site.

Table 15 Maximum Annual Average Predicted Ground Level Concentrations – NO_2

Scenario	Annual Maximum NO_2 ($\mu g/m^3$)			
	Incremental	Stockton Background	IPL Routine Impact	Cumulative
1 – Routine operations	7	15	0.4	22
2 – Non-routine operations	9	15	0.4	24
Criteria	**62**			

The annual average NO_2 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criterion. The highest predicted cumulative NO_2 annual average concentrations occurred at industrial receptors on KI located in proximity to the Orica site.

4.2 Predicted Ammonia Modelling Results

The maximum predicted sensitive receptor ground level concentrations of NH_3 for the 1 hour average are presented in **Table 16**. The impact from the facility alone (incremental) and cumulatively with the Stockton monitoring data and IPL impact are provided.

Table 16 Maximum Sensitive Receptor 1 Hour Predicted Ground Level Concentrations – NH_3

Scenario	1 Hour Maximum NH_3 ($\mu g/m^3$)			
	Incremental	Stockton Background	IPL Routine Impact	Cumulative
1 – Routine operations	58	52	1.2	111
2 – Non-routine operations	91	52	1.2	144
Criteria	**330**			

The 1 hour average NH_3 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criterion. The highest predicted NH_3 1 hour average concentrations occurred at industrial receptors on KI located in proximity to the Orica site.

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5.0 Conclusion

This AQIA has been prepared to assess the potential air quality impacts primarily from the flares proposed for the ammonia plant, ammonia storage tank and nitrates plants, together with the sites routine operations including a 10,000 t NA import tank and associated scrubber and appropriate background pollutant concentrations.

Two modelling scenarios were selected for the assessment: routine operations (routine operating conditions at the site with no flaring) and non-routine operations (routine operating conditions at the site with flaring (all three flares operating at once)). Both scenarios include the addition of scrubber emissions from the 10,000 t NA import tank.

This flaring scenario is considered highly conservative due to the following:

- It is unlikely that the plant will be running at full operational capacity if the flaring is occurring i.e. a flaring event would occur when a problem arises at the site and other operations would be inhibited;
- The three flares are for separate operational sections of the site and are highly unlikely to be utilised at the same time, although this is a possibility; and
- It is expected that a flaring event would only occur under exceptional circumstances, with a predicted occurrence frequency of once every two years.

The 1 hour average NO_2 and NH_3 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criteria.

The annual average NO_2 and NH_3 results for both the routine and non-routine (with flaring) operations are predicted to meet the NSW EPA criteria.

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6.0 References

DEC (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales,* Department of Environment and Conservation, Sydney, NSW, Australia.

ENSR. (2009). Air Quality Impact Assessment, Kooragang Island NSW. Appendix E of AECOM. (2009). Proposed Ammonium Nitrate Facility Expansion Environmental Assessment, June 2009.

Texas Commission on Environmental Quality (2006); Air Permits Division; New Source Review (NSR) Emission Calculations; Sample Calculations for Flares.

URS (2012). Air Quality Impact Assessment for Proposed Ammonium Nitrate Facility, Kooragang Island.

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Appendix A

Description of Pollutants of Interest

Appendix A Description of Pollutants of Interest

The pollutants of interest for the project are NO_x (as NO_2) and NH_3. These pollutants are expected to be contributors to the local atmosphere from the sites operations, specifically the flare operations and NA import tank scrubber. A brief description of the two pollutants is provided below:

Nitrogen Dioxide

Nitrogen dioxide is a brownish gas with a pungent odour. It exists in the atmosphere in equilibrium with nitric oxide. The mixture of these two gases is commonly referred to as NO_x. NO_x is a product of combustion and oxidation processes. In urban areas, motor vehicles and industrial combustion processes are the major sources of ambient NO_x.

Health Effects

NO_2 may be inhaled or absorbed through the skin. People who live in areas of high motor vehicle usage may be exposed to higher levels of nitrogen oxides. Acute exposure to low levels of NO_2 can irritate eyes, nose, throat and lungs, possibly leading to coughing, shortness of breath, tiredness and nausea. Exposure can also result in a build-up of fluid in the lungs for 1-2 days after exposure. Breathing high levels of NO_2 can cause rapid burning, spasms and swelling of tissues in the throat and upper respiratory tract, reduced oxygenation of tissues, a build-up of fluid in the lungs, and in extreme cases death.

Environmental Effects

Excessive levels of the NO_x, particularly NO_2, can cause death in plants and roots and damage the leaves of many agricultural crops. NO_2 is the damaging component of photochemical smog. Excessive levels increase the acidity of rain (lower the pH), and thus lower the pH of surface and ground waters and soil. The lowered pH can have harmful effects, possibly even death, on a variety of biological systems.

In the atmosphere, NO_x are rapidly equilibrated to NO_2, which eventually forms acid rain. In the stratosphere, oxides of nitrogen play a crucial role in maintaining the levels of ozone. Ozone is formed through the photochemical reaction between nitrogen dioxide and oxygen.

Ammonia

Ammonia is released during intensive livestock production, and from humans and pets. Other sources of ammonia emission include the manufacture of basic chemicals, metals, leather products, cement, lime, plaster and concrete products, glass products, ceramics, beverages, cars and car parts, textile products and paper and paper products. Ammonia is also produced from mining, electricity supply and petroleum refining activities.

Health Effects

Exposure to typical environmental concentrations of ammonia will not affect humans. Ammonia has been used for a long time in human and veterinary medicine and in smelling salts. Exposure to high levels of ammonia can cause irritation and serious burns on the skin, and in the mouth, throat (laryngitis), lungs (pulmonary oedema) and eyes (conjunctivitis). Exposure at very high levels of ammonia can lead to death. Swallowing concentrated solutions of ammonia can cause burns in the mouth, throat and stomach. Splashing ammonia into the eyes can cause burns and blindness. Individuals that may be more sensitive to ammonia are those with reduced liver function, corneal disease, glaucoma or respiratory diseases (e.g. asthmatics).

Environmental Effects

Nitrogen is essential for all forms of life, and ammonia is one of the many forms that nitrogen exists in the environment. At high levels of ammonia, toxic effects can be observed. These may include the death of animals, birds, fish and death or low growth rate in plants.

Long-term effects may include shortened lifespan, reproductive problems, lowered fertility, and changes in appearance or behaviour. These may be seen long after the first exposure to ammonia. Under normal temperature and pH conditions, ammonia has moderate long-term toxicity to aquatic

Appendix B

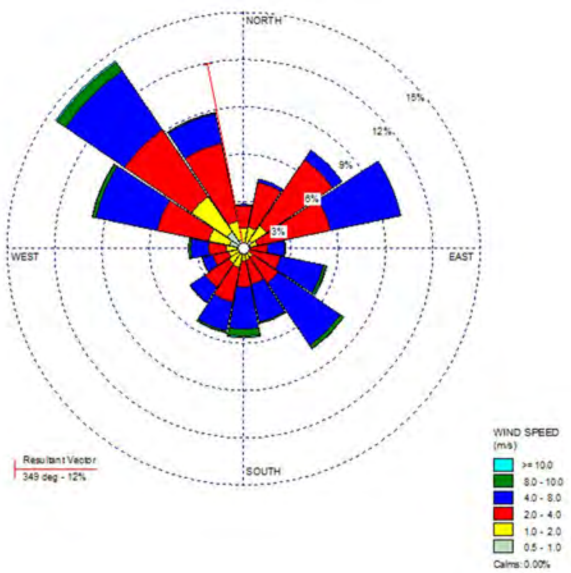
Meteorological Data Comparison

Appendix B Meteorological Data Comparison

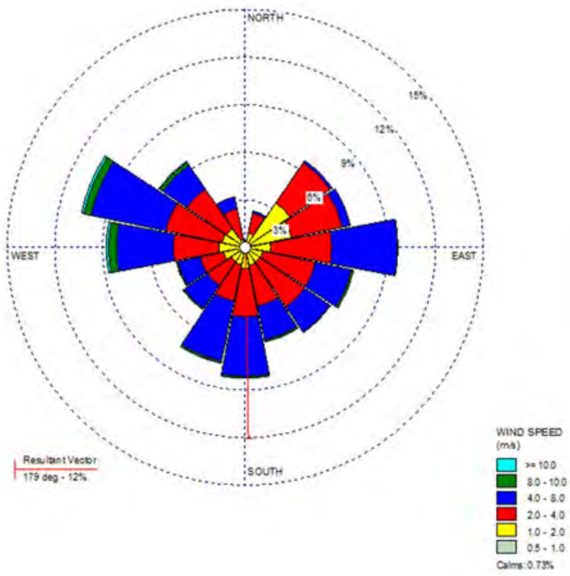
Wind roses show the frequency of occurrence of winds by direction and strength. Each wind rose arm represents a wind blowing from the direction it is projected i.e. arm pointing up represents northerly winds. The length of the bar represents the frequency of occurrence of winds from that direction, and wind speed categories are defined by different colours.

A comparison of the wind rose diagrams prepared for the BHP 1995 monitoring data against the Stockton Monitoring Station data for October 2012 to August 2013 (available data at http://www.stocktonairqualitymonitoring.com/) are shown below. The data are presented for the annual average, 9am average and 3pm average.

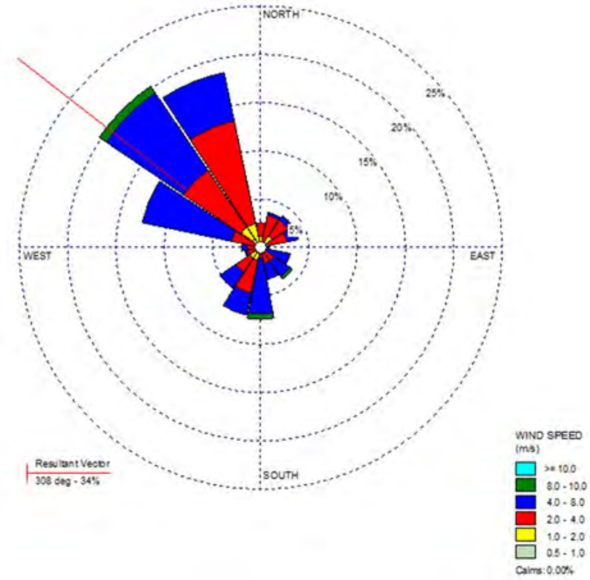
The data shows that a good correlation exists between the BHP data set used in the assessment and the Stockton monitoring Station data. Both sets of data show annual winds from most directions, with higher tendencies towards the north west and east north-east. Both sets of data also show 9am wind distribution dominated from the north west and 3pm wind distribution dominated from the north north-east to south east winds. This aligns with the common wind patterns seen in the lower hunter.



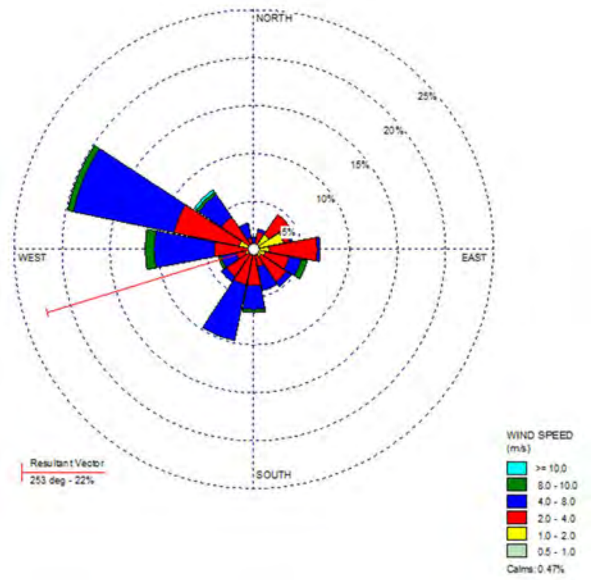
BHP 1995 Data Set – Annual



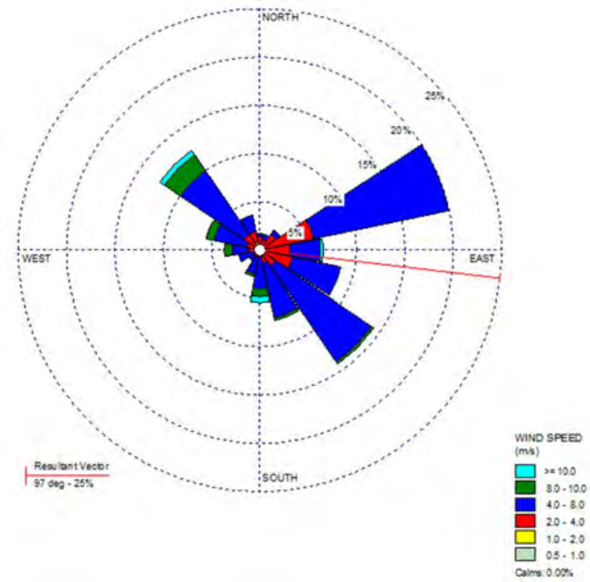
Stockton Monitoring Station October 2012 to August 2013 – Annual



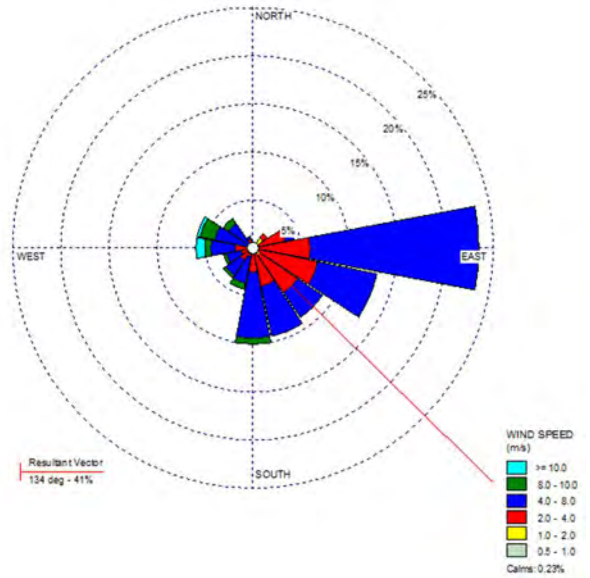
BHP 1995 Data Set – 9am



Stockton Monitoring Station October 2012 to August 2013 – 9am



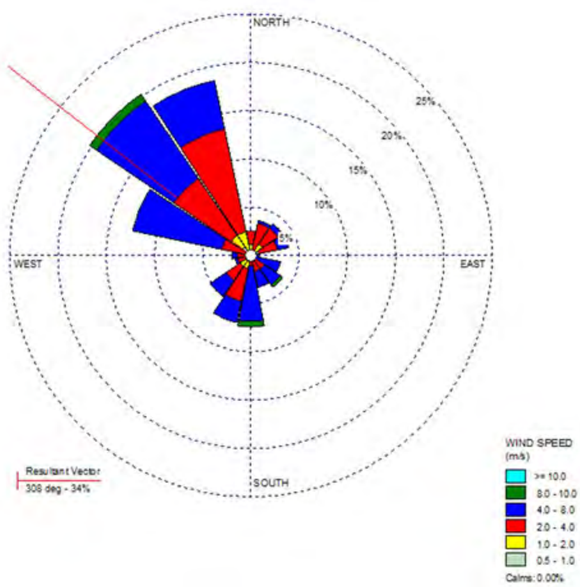
BHP 1995 Data Set – 3pm



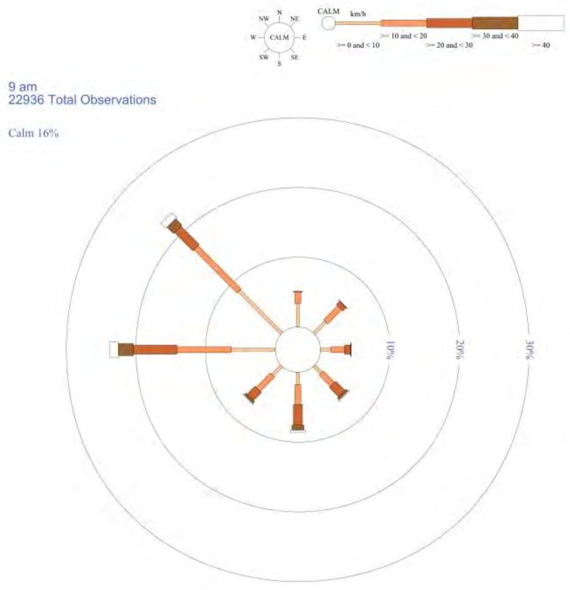
Stockton Monitoring Station October 2012 to August 2013 – 3pm

A comparison of the wind rose diagrams prepared for the BHP 1995 monitoring data against the Bureau of Meteorology (BoM) Williamtown monitoring station long-term data for 1942 to 2010 are shown below. The data presented is the 9am average and 3pm average.

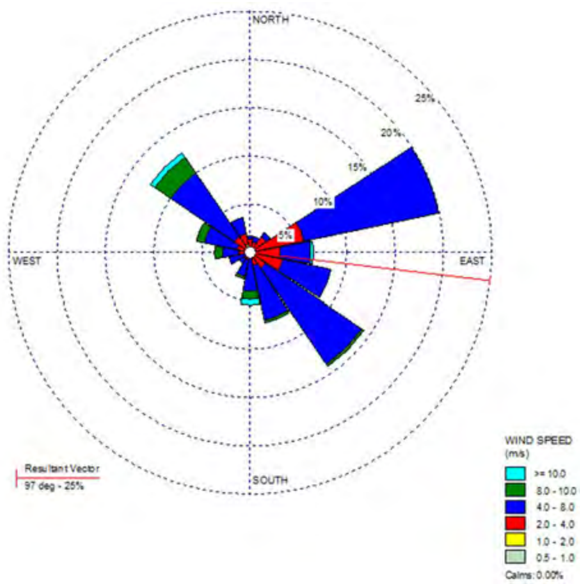
The data shows that a good correlation exists between the BHP data set used in the assessment and the BoM Williamtown long-term data. Both sets of data show 9am wind distribution dominated from the north west and 3pm wind distribution dominated from the north north-east to south east winds. This aligns with the common wind patterns seen in the lower hunter.



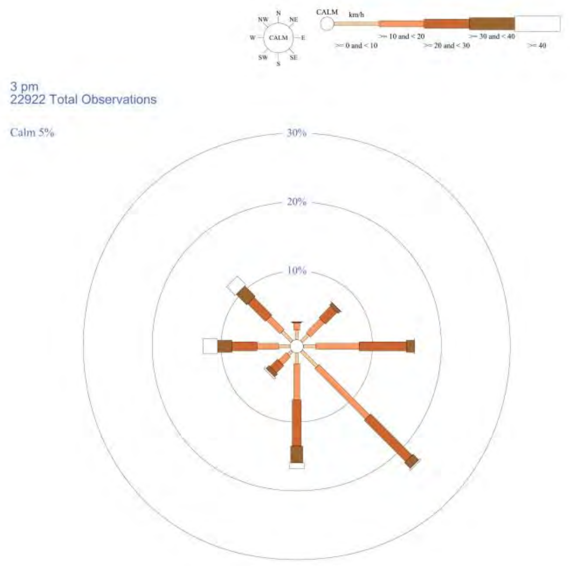
BHP 1995 Data Set – 9am



BoM Williamtown 1942 to 2010 – 9am



BHP 1995 Data Set – 3pm



BoM Williamtown 1942 to 2010 – 3pm

The distribution of wind speeds was also reviewed for the assessment. The below tables present the data for the BHP data set and the Stockton Monitoring Station data in that order. The two data sets show an excellent correlation in wind speed distribution. The dominate wind range was 2-4 m/s for both sites, with both showing a 41% contribution. The next dominate ranges, in order, were 4-8, 1-2, ≤1 and >8 m/s for both data sets. The BHP data set showed a higher percentage of low wind speeds less than 1 m/s (8% verse 5% for the Stockton data).

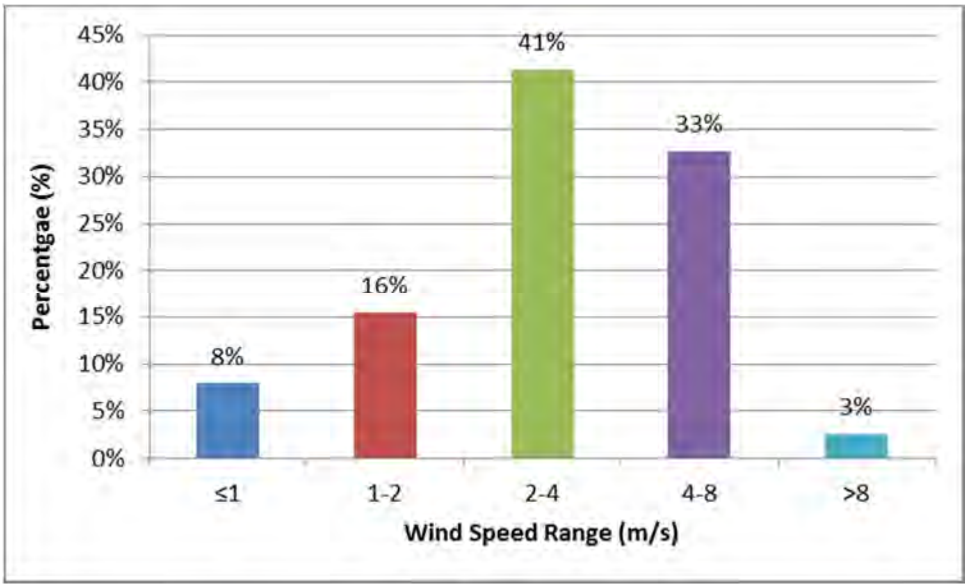


Figure BHP 1995 Data Set Wind Speed Range Contribution

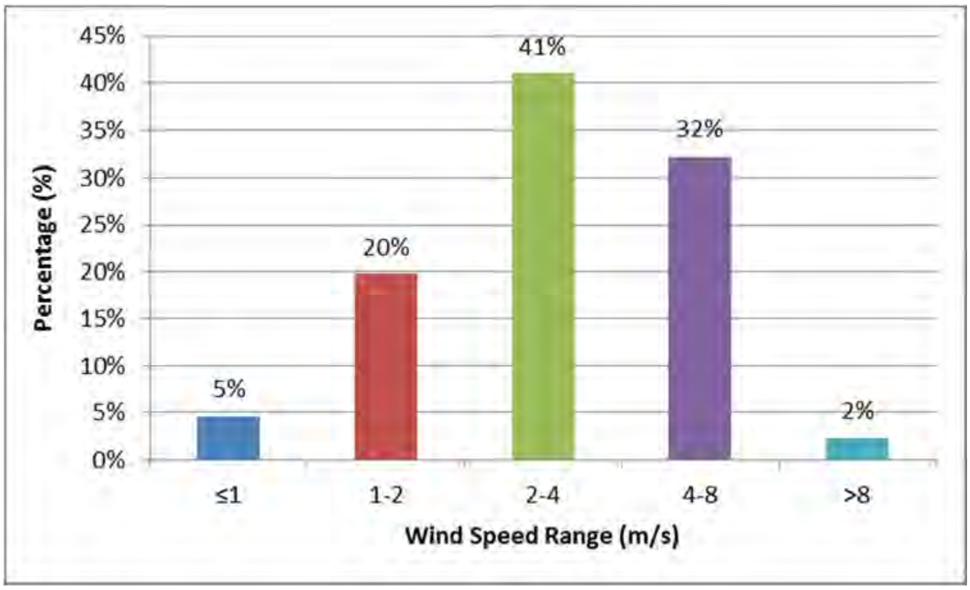


Figure Stockton Monitoring Station October 2012 to August 2013 Wind Speed Range Contribution

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Appendix C

Sensitive Receptor Locations

Appendix C Sensitive Receptor Locations

A summary of the approximate sensitive receptor locations is presented below in **Table 17**. The receptors have been defined as residential, industrial or sporting to help identify the sensitivity of the receptor.

Table 17 Sensitive Receptor Locations

Sensitive Receptor No.	Sensitive Receptor Description	Type
1	Corner of Meredith Ave & Fullerton Streets, Stockton	Residential
2	Corner of Griffith Ave. & Fullerton Streets, Stockton	Residential
3	Corner of Stone & Fullerton Streets, Stockton	Residential
4	Corner of Flint & Fullerton Streets, Stockton	Residential
5	Corner of Cardigan & Fullerton Streets, Stockton	Residential
6	Corner of Pembroke & Fullerton Streets, Stockton	Residential
7	Corner of Hereford & Fullerton Streets, Stockton	Residential
8	Corner of Monmouth & Fullerton Streets, Stockton	Residential
9	Corner of Griffith Ave. & Dunbar Streets, Stockton	Residential
10	Corner of Stone & Dunbar Streets, Stockton	Residential
11	Corner of Cardigan & Dunbar Streets, Stockton	Residential
12	Corner of Pembroke & Douglas Streets, Stockton	Residential
13	Corner of Roxburgh and Hereford Streets, Stockton	Residential
14	Corner of Forfar & Monmouth Streets, Stockton	Residential
15	Corner of Mitchell & Pembroke Streets, Stockton	Residential
16	Corner of Dunbar & Hereford Streets, Stockton	Residential
17	Corner of Dunbar & Monmouth Streets, Stockton	Residential
18	Corner of Scott & Elizabeth Streets, Carrington	Residential
19	Corner of Scott & Hargrave Streets, Carrington	Residential
20	Corner of Robertson & Scott Streets, Carrington	Residential
21	Corner of Coe and Bourke Streets, Carrington	Residential
22	Corner of Gipps & Hargrave Streets, Carrington	Residential
23	Corner of Young & Robertson Streets, Carrington	Residential
24	Corner of Young & Victoria Streets, Carrington	Residential
25	Corner of Denison & Cowper Streets, Carrington	Residential
26	Corner of Fitzroy & Tully Streets, Carrington	Residential
27	Corner of Harrison & Hannell Streets, Maryville	Residential
28	Corner of William Streets, & Industrial Dr. Maryville	Residential
29	Corner of Elizabeth Streets, & William Streets, Maryville	Residential
30	Corner of Graham Bridge & Lewis Streets, Maryville	Residential
31	Corner of Harrison & Lewis Streets, Maryville	Residential
32	Corner of Downie & Estell Streets, Maryville	Residential

Sensitive Receptor No.	Sensitive Receptor Description	Type
33	Corner of The Avenue & Lewis Streets, Maryville	Residential
34	Port Hunter Commodities Administration Building	Industrial
35	Port Waratah Coal Service Administration Building	Industrial
36	No. 3 Kooragang Berth	Industrial
37	No.2 Kooragang Berth	Industrial
38	Greenleaf Rd. Kooragang Island	Industrial
39	Corner of Oval Dr. & Riverview Rd. Stockton	Sporting
40	Oval Dr. opposite Stockton Cemetery	Sporting

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Appendix C

Noise Impact Assessment

Appendix C Noise Impact Assessment

Orica Australia Pty Ltd
13-Nov-2013

Noise Impact Assessment

Modification of Project Approval 08_0129

Noise Impact Assessment

Modification of Project Approval 08_0129

Client: Orica Australia Pty Ltd

ABN: 24 004 145 868

Prepared by

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13-Nov-2013

Job No.: 60306451

AECOM in Australia and New Zealand is certified to the latest version of ISO9001, ISO14001, AS/NZS4801 and OHSAS18001.

Quality Information

Document Noise Impact Assessment

Ref 60306451

Date 13-Nov-2013

Prepared by David Chau

Reviewed by Patrick Martinez

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
1	17-Oct-2013	For client review	Simon Murphy Senior Environmental Planner	
2	1-Nov-2013	Revised Draft	Simon Murphy Senior Environmental Planner	
3	13-Nov-2013	Final	Simon Murphy Senior Environmental Planner	

Table of Contents

1.0 Introduction

1.1 Background

Orica Australia Pty Ltd (Orica) has commissioned AECOM Australia Pty Ltd (AECOM) to provide an environmental noise impact assessment for the construction and operation of a nitric acid tank and the construction and operation of three ammonia nitrate flares at its Kooragang Island plant. Kooragang Island is zoned SP1 (Special Activities) under the State Environmental Planning Policy (Major Development) 2005 (SEPP (Major Development)). In accordance with the Environment Protection Authority (EPA) *'NSW Industrial Noise Policy'* (INP) (EPA 2000); this zone is considered to be an industrial setting. The plant has approval to operate 24 hours a day, 7 days a week.

The following activities as part of the expansion and modification are addressed in this report:

- Construction activities including equipment and traffic;
- Operation of a pump associated with the nitric acid tank; and
- Non-routine operation of three ammonia flares located in the ammonia storage, nitrates and ammonia plant areas.

Previous acoustic assessments, associated with the operation of the Orica facility, have been conducted by Atkins Acoustics (Atkins). Atkins' recent noise audit report, detailing the quarterly noise data collected over a 12 month period, has been utilised as the referenced background noise levels in this report. The report is titled 'Orica Australia Pty Ltd Environmental Noise Audit' and referenced as 43.67 19.R3:GA/DT/2013 Rev 00, dated July 2013.

1.2 Scope

The scope of the environmental noise assessment was to:

- Identify potentially affected receivers, both residential and non-residential as a result of the proposed additional nitric acid tank and flaring infrastructure;
- Determine representative background noise levels at affected receivers, using previous unattended noise monitoring data collected between 2011 and 2013;
- Establish noise management levels (NML) for construction activities in accordance with the EPA's '*Interim Construction Noise Guidelines*' (ICNG) (DECC, 2009);
- Establish normal and non-routine operational noise limits in accordance with Orica Ammonium Nitrate Expansion Project '*Specific Environmental Conditions*' within the Project Approval (08_0129) – Schedule 1 (DoP, Dec 2009) and the EPA's *'NSW Industrial Noise Policy'* (INP) (EPA 2000);
- Undertake modelling to determine construction operational and non-routine operational noise impacts at nearby receivers and to determine compliance of proposed activities with the established acoustic requirements; and
- Provide mitigation measures to minimise and manage any exceedances of the acoustic requirements for construction, operational or non-routine operational noise (if required).

Note that due to the large offset distances to sensitive receivers and the proposed construction and operational equipment being used, vibration levels during construction and operation are not expected to impact nearby sensitive receivers, therefore vibration levels have not been assessed in this report.

The modifications to the plant will not generate any additional operational traffic and thus traffic will only be assessed for a construction scenario. Definitions of the acoustic nomenclature used in this report are presented in Appendix A.

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2.0 Existing Environment

2.1 Receivers

The nearest residential receiver (R1) assessed in this assessment is located approximately 800 metres to the east of the industrial site boundary. Sensitive noise receivers were selected to demonstrate the noise contribution due to the Orica ammonia plant modification works. These receivers are presented in Table 1. The locations of these receivers relative to the Orica plant are shown in Figure 1. Receivers R1 and R2 are similar to those assessed previously within the Atkin's acoustic report. Residential receiver R3 has been included in this assessment to represent residential receivers located in the south-western direction, Carrington. Industrial receiver I1 has been included to take into consideration the nearest industrial receiver within the Kooragang Island industrial area.

Table 1 Receiver locations assessed within this report

ID	Address	Type	Distance from site boundary
R1	284 Fullerton Road, Stockton	Residential - Suburban	750 m
R2	218 Fullerton Road, Stockton	Residential - Suburban	730 m
R3	38 Elizabeth Street, Carrington	Residential - Urban	1080 m
I1	39 Heron Road, Kooragang Island	Industrial	Adjacent

Figure 1 Receiver locations assessed within this report

2.2 Ambient and background noise levels

Ambient and background noise levels for nearby receivers are presented below. Background and ambient noise levels for receivers R1, R2 and I1 have been acquired from Atkins' Report. Background and ambient noise levels for receiver R3 have been acquired from a previous assessment performed by Wilkinson Murray (Mayfield Site Port-Related Activities Concept Plan EA, Revision F, July 2010).

Table 2 shows that the ambient noise levels at night for all receivers are equal or lower than day-time levels, and are not too dissimilar from the evening levels. At receiver I3, the night-time level is above the evening noise level by 1 dB.

Table 2 Ambient and background noise levels at the assessed receivers

ID	Measurement location	RBL, L_{A90}			Ambient noise levels, L_{AEq}		
		Day	Evening	Night	Day	Evening	Night
R1	284 Fullerton Road (Residential)	50	49	48	65	61	59
R2	218 Fullerton Road (Residential)	47	46	46	58	54	54
R3	38 Elizabeth Street, Carrington	44	43	39	57	54	46
I1	39 Heron Road, Kooragang Island	57	58	59	64	63	64

2.2.1 Attended noise measurements

The Orica nitrate ammonia plant noise contributions to each receiver have been quantified via attended noise measurements. Noise measurements and notes have been partially acquired from Atkins' report (R1,R2 and I1) and recent measurements conducted by AECOM personnel (R3).

During the day-time determining the site contribution was found to be difficult given the myriad of noise sources within such an industrialised area. Atkins (May, 2013) conducted measurements in the night-time to confirm that there was minimal influence from other industrial sources at these locations. The below text has been extracted from the Atkins' report:

> *"Night-time attended noise audits reported for the reference monitoring locations on Kooragang Island (2011) confirmed that there was minimal influence from other industrial sources at those locations. Attended and unattended measurements on Kooragang Island have shown that other than from the immediate noise activities and prevailing winds there is minimal variation between the LA90 and LAeq levels and noise from Orica would be described as steady state".*

Table 3 presents the levels, including the estimated Orica plant site contribution and observations during measurement.

Table 3 Logged Noise Levels, attended noise measurements and observations

ID	Measurement location	Night			Comments
		RBL, L_{A90}	Ambient, L_{Aeq}	Site contribution, L_{Aeq}	
R1	284 Fullerton Road, Stockton	45	54	50	Stockton Beach Surf Ammonia Plant MDEA Pumps and Converter Valves General industrial noise Intermittent passing road traffic
R2	218 Fullerton Road, Stockton	49	53	53	
R3	38 Elizabeth Street, Carrington	39	40	39	Industrial noise in the direction of the Orica plant Passing heavy road traffic
I1	39 Heron Road, Kooragang Island	56	61	56	Ammonia plant Ammonia plant pipe noise (convertor valves) MDEA pumps (500 Hz) Steam pipes

3.0 Noise Limits

3.1 Operational noise limits

The operational noise limits for this project has been established in accordance with the Project Approval issued by the Department of Planning, referenced as 08_0129, dated 1 December 2009.

The specific noise conditions applicable to the Orica plant have been replicated below.

NOISE

Noise Limits

30. The proponent shall ensure that noise levels from the operation of the Project are at least 10 dB(A) below noise levels from Orica's Existing Operations as specified by conditions 31 & 32 below.

Existing Operations – Noise Verification Program

31. Prior to the commencement of construction the Proponent shall prepare and implement an Existing Operations Noise Verification Program to the satisfaction of the Director-General. The Program shall:

- *a) be undertaken by a suitably qualified and experienced person;*
- *b) identify future reference points that will be used to demonstrate compliance;*
- *c) collect new or review existing data, and report on the seasonal background levels for the noise catchment; and*
- *d) confirm the noise levels from Orica's Existing Operations*

Note: Some construction activities may occur under the Project Approval provided that such activity are not undertaken during the monitoring period or that Orica can demonstrate that the activity would not contribute to the background noise level, to the satisfaction of the Director-General.

Noise Management Plan

32. Prior to the commencement of operations of the Project, the Proponent shall prepare and implement a Noise Management Plan in consultation with DECCW and to the satisfaction of the Director-General. The Plan shall:

- *a) be undertaken by a suitably qualified and experienced expert;*
- *b) demonstrate how noise levels from the Project would be managed to ensure noise levels would be 10 dB(A) below noise levels from Orica's Existing Operations (see conditions 30 & 31);*
- *c) include a detailed monitoring program for reporting on ongoing compliance. The monitoring program shall:*
  - *outline the proposed receiver sites at Stockton and sites on Kooragang Island that would be monitored;*
  - *include both attended and unattended noise monitoring;*
  - *verify that actual noise levels from the Project are consistent with the predictions made in the EA; and*
  - *verify that noise levels from the Project are 10 dB(A) below the noise levels identified in condition 31 for Orica's Existing Operations;*
- *d) provide details of any complaints received in the preceding year relating to noise generated by the Project, and action taken to respond to those complaints;*
- *e) detail procedures for implementing additional reasonable and feasible noise mitigation measures for the Project in response to exceedance of limits and/or noise complaints; and*
- *f) be updated annually, unless otherwise agreed to by the Director-General.*

The resultant environmental noise limits have been derived from the night-time attended measurements discussed in Section 2.2 and detailed in Table 4. Considering that the operation of the plant will involve relatively constant noise emissions during the various assessment periods, the night-time noise limits represent the governing noise level and will therefore have been used as the project specific background noise limits. Compliance with the night-time noise limits will ensure compliance with the day and evening noise limits.

A noise limit for the industrial receiver has been based on the acceptable noise level specified within the EPA's INP.

Table 4 Project specific noise limits for assessment receivers

ID	Assessment receiver address	Noise limits, $L_{Aeq, 15\ minute}$
		Night
R1	284 Fullerton Road (Residential)	40
R2	218 Fullerton Road (Residential)	43
R3	38 Elizabeth Street, Carrington	29
I1	39 Heron Road, Kooragang Island	70

3.2 Sleep disturbance criteria

The INP has recently been updated with application notes which discuss sleep disturbance and its objective assessment.

To minimise the risk of sleep disturbance as a result of industrial type operations during the night-time period, the INP application notes recommend that the $L_{A1(1\ minute)}$ noise level outside a bedroom window should not exceed the L_{A90} background noise level by more than 15 dB(A) during the night-time period (10.00 pm to 7.00 am). The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The EPA's Interim Construction Noise Guideline (ICNG) and Industrial Noise Policy (INP) recommend reference to the EPA's '*NSW Road Noise Policy*' (RNP) (DECCW, 2011) some guidance in assessing the potential for sleep disturbance.

The RNP contains an assessment of sleep disturbance which represents EPA's advice on the subject of sleep disturbance due to noise events. Section 5.4 of RNP concludes, having considered the results of four research papers by *Pearson et al (1995)*, *Bullen et al (1996)*, *Griefahn (1992)* and *Finegold et al (1994),* with the statement, *'Maximum internal noise levels below 50 - 55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides 10 dB(A) noise attenuation from outside to inside, external noise levels of 60 - 65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance screening level and awakening reaction for the nearest residential receivers are presented in Table 5.

Table 5 Night-time sleep disturbance criteria

Location	RBL $L_{A90\ (15\ min)}$ dB(A)	Sleep disturbance criteria $L_{A1\ (1\ minute)}$ dB(A)	
		Screening level	Awakening reaction
R1	48	63	60 - 65
R2	46	61	60 - 65
R3	39	54	60 - 65

The night-time noise emissions from the plant would generally be associated with relatively constant pumping activities. Therefore no significant peak noise events would be expected. Compliance with the operational noise limits will ensure compliance with the sleep disturbance criteria.

3.3 Maintenance and non-routine flare operational noise limits

The proposed flares may operate in an non-routine mode, that is, as a safety component when high gas pressures pose a risk to the integrity of the systems. During an event resulting in a non-routine release of ammonia, flares will activate. Three flare systems have been assessed in this noise impact assessment.

The utilisation of the ammonia flares is characterised by events which occur at low frequency, can have crucial consequences if not activated and may emit higher noise levels. There are no noise limits for non-routine operation specified within Orica plant's EPL.

The frequencies and durations of operations are presented in Table 6 which will form a basis to justify appropriate non-routine operation noise limits. These values are justified with incident report data from Incitec Pivot Limited, who currently has a similar flare proposal under consideration with the Department of Planning and Infrastructure.

Table 6 Duration and frequency of each flare

Designation	A	B	C
System description	**Nitrates**	**Storage**	**Ammonia**
Duration	5 minutes	Extended period of time depending on the circumstance	5 minutes
Frequency of event	1/2 years	1/10 years	1/2 years

Flare A and C may operate at a higher frequency to Flare B, however, they have a significantly lower duration. Therefore, two noise limits have been set which cater for the differing durations – one which caters for short-term noise (Flares A and C) and another which caters for continuous long-term noise (Flare B).

For each flare, there will also be the base (constant) noise and impulsive noise sources. These are expanded on in the section 5.1. To cater for the varying types of noise occurring from these flares, the following noise limits have been determined:

- Short-term noise (Flare A and C)
- Long-term noise (Flare B)

3.3.1 Short-term noise limits *(Flare A and C)*

The short-term noise limits for each period and receiver type are shown in Table 7. Due to the short-term nature of Flares A and C, the noise limits have been set higher than the long-term criteria.

The industrial receiver noise limits have been based off the recommended maximum noise level for this type of receiver as specified in Table 2.1 of the INP. The short-term noise limits for each period and receiver type are shown in Table 7.

Table 7 Short-term criteria, $L_{Aeq,\ 15minute}$ dB(A)

Receiver type	Noise limits short-term, $L_{Aeq,\ 15minute}$ dB(A)		
	Day	Evening	Night
Residential	RBL + 20	RBL + 10	RBL + 10
Industrial	75	75	75

3.3.2 Long-term noise limit (Flare B)

The long-term noise limits are more stringent than the short-term noise limits. The long-term noise limits for each period and receiver type are shown in Table 8.

Table 8 Long-term criteria, $L_{Aeq\ 15min}$ dB(A)

Receiver Type	Criteria Long-term, $L_{Aeq\ 15min}$ dB(A)		
	Day	Evening	Night
Residential	RBL + 10	RBL + 5	RBL + 5

Receiver Type	Criteria Long-term, $L_{Aeq\ 15min}$ dB(A)		
	Day	Evening	Night
Industrial	75	75	75

3.3.3 Summary of the non-routine noise limits

The night-time noise limits have been selected for assessment as they represent the most stringent noise compliance levels of the three categories and thus if the predicted noise levels complies with these night-time noise limits then by default they will satisfy the evening and day noise limits for all residential receivers.

A summary of the night-time non-routine noise limits is presented in Table 9.

Table 9 Night-time non-routine assessment noise limits

Location	Night-time RBL $L_{A90\ (15\ min)}$ dB(A)	Night-time noise limits, $L_{Aeq\ 15min}$ dB(A)	
		Short-term RBL + 10	Long-term RBL + 5
R1	48	58	53
R2	46	56	51
R3	39	49	44

Table 10 Industrial receiver non-routine noise limits

Receiver Type	Non-routine noise limits, long and short-term, $L_{Aeq\ 15\ minutes}$ dB(A)		
	Day	Evening	Night
Industrial	75	75	75

3.4 Construction noise management levels

The ICNG aims to manage noise from construction works regulated by the EPA.

The Guideline seeks to promote a clear understanding of ways to identify and minimise noise generated during construction. The guideline focuses on applying all 'reasonable and feasible' work practices to minimise construction noise impacts. Depending on the extent of impact and the scale of the works, managing noise impacts may involve community engagement.

The ICNG defines what is considered to be feasible and reasonable as follows:

> *Feasible*
>
> > *A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*
>
> *Reasonable*
>
> > *Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.*

The ICNG recommends that a quantitative assessment is carried out for all *'major construction projects that are typically subject to the EIA process'*. A quantitative assessment, based on a likely 'reasonable' worst case construction scenario, has been carried out for the development.

Predicted noise levels at nearby noise sensitive receivers (residential and industrial premises) are compared to the management levels provided in Section 4 of the ICNG. Where an exceedance of the noise management levels (NMLs) is predicted the ICNG advises that the proponent should apply all feasible and reasonable work practises to minimise the noise impact.

NMLs for residential receivers are derived using the information in Table 11 (excerpt from Table 2 of the ICNG).

Table 11 Noise management levels at residences

Time of day	Management level $L_{Aeq\ (15min)}$*	How to apply
Construction hours: *Monday to Friday 8 am to 5 pm* *Saturday 8 am to 1 pm* *No work on Sundays or public holidays*	*Noise affected* *RBL + 10 dB*	- The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected *75 dB(A)*	- The highly noise affected level represents the point above which there may be strong community reaction to noise. - Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences

Time of day	Management level $L_{Aeq\ (15min)}$*	How to apply
		• if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times. The community's preference on these matters will need to be gauged through community consultation.
Outside recommended standard hours	*Noise affected RBL + 5 dB*	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see section 7.2.2 (ICNG).

Table 12 Construction noise management levels – Residential receivers

Residential receiver	Recommended standard hours RBL dB(A)	Recommended standard hours NML, $L_{Aeq,\ 15min}$ dB(A)
R1	50	60
R2	47	57
R3	44	54
Residential receiver	**Outside recommended hours RBL dB(A)**	**Outside recommended standard hours NML, $L_{Aeq,\ 15min}$ dB(A)**
R1	48	43
R2	46	51
R3	39	44

The proposed development will occur within close proximity to industrial premises. The NML for these receivers, as defined in the ICNG, are presented in Table 13.

Table 13 Noise at land uses (other than residences) using quantitative assessment

Land use	NML, $L_{Aeq,15min}$ (applies when properties are being used)
Industrial premises	External noise level 75 dB(A)

3.5 Construction Traffic Noise Criteria

The EPA's Interim Construction Noise Guideline (ICNG) does not provide direct reference to an appropriate criterion to assess the noise arising from construction traffic on public roads.

Given the relative short duration of most construction activities and taking into consideration the recently released EPA's Road Noise Policy (RNP) which provides guidance when assessing relative increases in criteria, namely:

'*In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person'.*

Thus, the criterion applied to traffic movements on public roads generated during the construction phase of the project is an increase in existing road traffic noise of no more than 2 dB(A). This criteria is similar to the one applied for operational traffic generated noise.

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4.0 Normal Operational Assessment

4.1 Operational noise sources

The potential noise sources during the operational scenario of the nitric acid tank are associated with the nitric acid tank transfer pump and the NOx Scrubber recirculation pump. As the pumps are to be designed so that noise generated during normal operation does not exceed a maximum noise level of 82 dB(A) at 1 metre, corresponding to the site's OH&S protective hearing area requirement. The derived total sound power of the two pumps is shown in Table 14. The installed pumps must have an overall sound power level that is equal or less than this sound power level and not contain any annoying noise characteristics as described in the INP (i.e. tonality, low frequency, etc.) to remain consistent with the conclusions within this report. The pumps are expected to operate 24 hours a day, 7 days a week.

Table 14 Pump sound power level

Equipment	Sum of A-weighted Overall, dB(A)
Tank transfer pump and NOx recirculation pump	90

Figure 2 Location of pump relative to receivers

4.2 Modelling

The operational noise levels were predicted using an implementation of the CONCAWE algorithms in the SoundPLAN (V7.1) noise propagation software.

The noise model takes into account significant noise source sound level emissions and locations, receiver locations, and noise attenuation due to geometrical spreading, air absorption, ground absorption and the effects of the worst-case weather conditions. Screening due to buildings and ground topography were not included within this model adding conservatism to the assessment.

The noise model was based on the proposed location of the plant and the sound power levels detailed in Table 14.

4.3 Adverse meteorological conditions

Certain meteorological conditions may increase noise levels by focusing sound-wave propagation paths at a single point. Such refraction of sound waves will occur during temperature inversions and where there is a slight breeze with wind direction from the source to receiver. The INP details a method for assessing the increase in noise levels caused by temperature inversions.

Wind velocity of 2 m/s is modelled in the direction of source to receiver for all source and receiver locations. This represents a conservative assessment since it is not possible for the wind to be travelling in multiple directions at the same time. The effect of F-class temperature inversions have also been applied within this assessment.

4.4 Operational assessment results

The proposed nitric acid pumps may operate 24 hours per day, 7 days a week, with similar capacity during the day, evening and night-time periods. The night-time noise limits are the most stringent and therefore the assessment has been undertaken against the night-time noise limits.

The results as shown in Table 15 demonstrate compliance against the established criteria.

Table 15 Normal Operation Assessment Results

ID	Location	Type	Noise limit, $L_{Aeq,(15 minute)}$, dB(A)	Predicted noise level $L_{Aeq,15 minute}$, dB(A)		Exceedance, dB(A)	
				Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Night Period							
R1	284 Fullerton Road, Stockton	Residential	40	23	30	-	-
R2	218 Fullerton Road, Stockton	Residential	43	24	30	-	-
R3	38 Elizabeth Street, Carrington	Residential	29	21	28	-	-
I1	39 Heron Road, Kooragang Island	Industrial	70	38	40	-	-

**Meteorology*

5.0 Operation and Maintenance of Ammonia Flares

5.1 Ammonia Flare operational noise sources

In the event that the flares become operational, gas flares will activate to burn gas and relieve pressure build up.

Flare noise derives from four sources:

i) Sonic discharge from the relief valve referred along the header and emanating from the stack;

ii) The vent gas exit velocity at the stack;

iii) Combustion noise from the reaction between the vent gas and oxygen; and

iv) The use of high pressure steam or compressed air to aid combustion efficiency

In the case of ammonia flares there is no steam or air assistance required, leaving the main contributors to noise the first three items listed above.

The noise will be dominated by the sonic discharge at the relief valve (i) and in this respect, will be equivalent to the noise currently experienced on-site when relief valves discharge directly to atmosphere, with the larger relief valves venting to the Ammonia Plant Vent stack. The diversion of ammonia relief valve to a flare system will neither increase nor significantly decrease this existing noise level associated with pressure relief events.

The flare exit velocity (ii) is kept below 20 m/sec which is less than 5% of the speed of sound. There will be some noise associated with this velocity albeit considerably lower than what would be observed from near sonic designed flares, typical with many hydrocarbon processes.

When compared with a typical hydrocarbon, the combustion noise (iv) from ammonia is low. The noise from the reaction is a function of the vent gas lower heating value which, for ammonia is 14.1 MJ/m3 versus 35.6 MJ/m3 for methane.

Estimates for the expected sound power level (SWL) from the discharge point are summarised in Table 16. When flaring vent gas originating from other than relief valves the combustion noise dominates the sound power level emitted.

It is unlikely for the three flares to be activated simultaneously. Therefore, the flares have been modelled to activate at individual times and thus the flares have been assessed operating individually. Further, each of the three flare systems operate independently of one another, and thus triggering one does not lend itself to increase the chances of another being triggered.

Table 16 Different sound sources from flares and their sound power levels

Designation	A	B	C
System Description	**Nitrates**	**Storage**	**Ammonia**
Capacity, t/h	10	4	56
Pressure Release Valve, Lw_A dB(A)	138	133	145
Vent Exit, Lw_A dB(A)	78	75	86
Combustion, Lw_A dB(A)	123	119	133
Frequency	1/2 years	1/10 years	1/2 years
Duration	5 minutes	Extended period of time depending on the circumstance	5 minutes

The pressure release valve has been assumed to activate once per minute within the duration of activation, each pressure relief event will sound for approximately 2 seconds.

The locations of these flares are shown in Figure 3.

Figure 3 Location of flares and assessment receivers

5.2 Operational assessment results

$L_{Aeq\ 15\ minutes}$ noise levels due to operation of the three ammonia flares are presented in Table 17. The levels shown are due to all three sources operating individually.

A 5 dB penalty, in accordance with the INP, was arithmetically added to the final predicted noise levels due to the impulsive (sudden and short-lived) nature of the pressure relief valve.

Table 17 Maintenance and non-routine operational assessment results

ID	Type	Noise limits $L_{Aeq,15\ minute,}$ dB(A)	Predicted Noise Level $L_{Aeq,15\ minute,}$ dB(A)		Exceedance, dB(A)	
			Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Flare A						
R1	Residential	58	53	57	-	-
R2	Residential	56	54	59	-	3
R3	Residential	49	45	50	-	1
I1	Industrial	75	58	61	-	-
Flare B						
R1	Residential	53	49	54	-	1
R2	Residential	51	49	54	-	3
R3	Residential	44	44	49	-	5
I1	Industrial	75	71	73	-	-
Flare C						
R1	Residential	58	57	62	-	4
R2	Residential	56	57	62	1	6
R3	Residential	49	51	55	2	6
I1	Industrial	75	80	81	5	6
Cumulative Impact						
R1	Residential	58	59	64	1	6
R2	Residential	56	59	64	3	8
R3	Residential	49	53	57	4	8
I1	Industrial	75	81	82	6	7

5.2.1 Sleep disturbance assessment

A sleep disturbance assessment was conducted to predict the impact of impulsive noise sources.

Table 18 Sleep disturbance results

ID	Type	Criteria $L_{A1,1min}$ dB(A)	Predicted noise Level $L_{A1,1min}$ dB(A)		Exceedance, dB(A)	
			Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Flare A						
R1	Residential	65	66	70	1	5
R2	Residential	65	67	72	2	7
R3	Residential	65	58	63	-	-
Flare B						
R1	Residential	65	57	62	-	-
R2	Residential	65	57	62	-	-
R3	Residential	65	52	57	-	-
Flare C						
R1	Residential	65	70	75	5	10

ID	Type	Criteria $L_{A1,1min}$ dB(A)	Predicted noise Level $L_{A1,1min}$ dB(A)		Exceedance, dB(A)	
R2	Residential	65	70	75	5	10
R3	Residential	65	64	68	-	3

5.2.2 Discussion

The modelling results show that the night-time operation of the three flares will generally comply with the noise limits. This is a conservative comparison as the flares have the equal potential to operate during the day and evening to the night. Also it is highly unlikely that multiple flares would be operation at the same time.

Flare A

- Noise levels are expected to comply during both neutral wind and adverse weather conditions with R1 and R2 experiencing minor 1 dB(A) and 3 dB(A) exceedances respectively.

Flare B

- Flare B, with an operational duration ranging from a few seconds to several weeks, complies with the noise limits for all receivers during neutral weather conditions.
- R1 and R2 may exceed by 1-3 dB(A) during adverse weather conditions. A level of 2 dB(A) is considered barely perceptible to the human ear and therefore is considered marginally acceptable.
- R3 may exceed by 5 dB(A) during adverse weather conditions. The predicted noise level is 49 dB(A) during these adverse weather conditions, which will result in an approximate internal noise level of 39 dB(A) with windows open and 29 dB(A) with windows closed. These levels are within the acceptable ranges of noise level for bedrooms located near major roadways, according to '*Australian Standard 2107:2001 – Recommended design noise levels for internal noise levels and reverberation times for building interiors*'.

Flare C

- During neutral weather conditions noise levels experienced by the industrial receiver are likely to exceed by 5 dB(A) and residential receivers R2 and R3 are likely to exceed by 1 dB(A) and 2dB(A) respectively. These exceedances at R2 and R3 would be barely perceptible to the human ear.
- During adverse weather conditions, receivers R1 exceeds by 4 dB(A) and R2, R3 and I1 exceed by 6 dB(A).
- It should be noted that the flare C will only operate for a period of 5 minutes, and thus the receiver will only experience the L_{Aeq} quoted for no more than a single 15 minute period.
- The non-routine use of the flare is expected to occur once in every 2 years
- It should also be noted that these noise levels were assessed against a night time RBL. The non-routine flare systems have the equal potential to activate within the day, evening or night.

Cumulative Impact

- These noise levels demonstrate the highly unlikely worst case scenario with all flares being activated simultaneously
- The noise impact of all three flares at the same time are 1-2 dB(A) higher than that of the Flare C activated by itself, for both neutral and adverse weather conditions
- These noise levels will only be experienced by the receivers for a period less than 15 mins – after this period of 15 mins, Flare A and C will cease operation and the remaining noise contribution of the flares will be solely due to Flare B. Flare B has been shown to be generally compliant with the noise criteria.
- The likelihood of this occurrence is extremely low considering the frequency of operation and duration at which the flares are activated

Sleep disturbance

- The sleep disturbance assessment reveals that the criterion will be triggered due to flares A and C. Both flares will operate for a period of 5 minutes each, expected to be every 2 years.
- Flare A only exceeds the criteria during neutral weather conditions by 2 dB(A), which is a minor exceedance.

- It should also be noted that these noise levels were assessed against a night time RBL. The non-routine flare systems have the equal potential to activate within the day, evening or night.
- Flare B, which operates for a significantly longer period of time, is not expected to trigger awakening reactions and thus disturb the sleep of receivers indoors.

Due to the function of the safety ammonia flares and that noise is likely to exceed INP noise criteria over a limited period of time it is recommended that no mitigation measures will be required for the flare system. It should also be noted that Orica has a community consultation hotline which nearby residences should be made aware of, if not already.

The flares will operate at a significantly lower flow rate during maintenance and thus are deemed to comply. Flares should be tested during the day to reduce the noise impact onto nearby receivers.

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6.0 Construction Noise Assessment

6.1 Construction noise sources

The construction noise and vibration assessment has been based on a typical equipment list and phases. The construction of both the ammonia flares and nitric acid tank will be undertaken in compliance with the environmental controls identified in the approved expansion project Construction Environmental Management Plan.

6.2 Construction phases

Two distinct phases of construction have been assumed to occur for the construction of these plant modifications. These phases are defined for each construction site as follows:

- Earthworks and excavation; and
- Construction and installation

The equipment list for these two stages is shown in Table 19.

Construction is assumed to be undertaken from 7 am to 6 pm thus spanning both recommended standard hours and outside of recommended standard working hours. Since the hours are not within 10.00 pm to 7.00 am the impacts of construction activities out-of-hours and on sleep disturbance do not need to be assessed.

Table 19 Activities and plant items used for the installation of the tank and pump

Activity	Plant Items	Qty	Height, m	Unit sound power level, dB(A)
Earthworks and excavations	Flatbed truck with crane	1	1.5	98
	Light delivery vehicles	1	1.5	98
	Cranes	1	1.5	106
	Material and delivery trucks	1	1.5	98
	Excavator (40 tonne)	1	3	105
Construction of tank	Generators	1	0.5	101
	Excavator (40 tonne)	1	3	105
	Mobile crane	1	3	104
	Tower crane	1	3	106
	Concrete mixer	1	3	89
	Concrete truck	1	3	106
	Mobile electric welding sets	1	3	101
	Electric hand tools	1	3	108
	Material and delivery trucks	1	1.5	98

Commissioning works would be carried out following the completion of the main construction phases. Commissioning works would involve running and testing pump systems. Noise generated during commissioning would therefore be similar to operational noise. As described in Section 7.0, there is not expected to be any significant impacts on sensitive receivers from operational noise.

The construction of the nitric acid tank and its associated flare, flare B, may occur simultaneously, however would be staged to minimise impacts.

6.3 Construction noise modelling

The model used for the construction assessment was similar to the model used for the operational scenario. Appropriate sources were used, which are presented in Table 19.

It can be expected that there may be differences between predicted and measured noise levels due to variation in instantaneous operation conditions, plant in operation during the measurement and also the location of the plant equipment. The absence of acoustic shielding from buildings and other civil structures and also ground topology add to the conservativeness of the assessment. The attenuation due to this shielding from these features will serve to reduce the measured levels.

6.4 Construction noise assessment results

Results shown in Table 20 are of the construction noise modelling. It shows that no exceedances are predicted for the construction noise scenarios of the flares or nitric acid tank against the outside of recommended working hours criteria

The cumulative impact of construction works of the nitric acid tank and its associated flare, Flare B, occurring simultaneously has been presented. The results demonstrate that this scenario will still achieve compliance against the established criteria.

Table 20 Construction noise assessment results

Receiver	Noise management level, $L_{Aeq\ (15min)}$, dB(A)	Predicted noise level $L_{Aeq,15min}$, dB(A)	Exceedance, dB(A)
		Neutral weather	Neutral weather
Nitric Acid Tank			
R1	43	37	-
R2	51	38	-
R3	44	36	-
I1	75	55	-
Flare A			
R1	43	41	-
R2	51	43	-
R3	44	34	-
I1	75	46	-
Flare B			
R1	43	38	-
R2	51	38	-
R3	44	33	-
I1	75	60	-
Flare C			
R1	43	39	-
R2	51	39	-
R3	44	32	-
I1	75	61	-
Cumulative Noise Levels of Flare B and Nitric Acid Tank Construction			
R1	43	41	-
R2	51	41	-
R3	44	38	-
I1	75	61	-

6.5 Construction traffic noise assessment

No major earthworks are required for the construction of the nitric acid tank or flares. Daily truck movements, associated with construction works, would be low. This assessment assumed 20 light vehicle and 10 heavy vehicle movements per day during peak construction. The increase in noise level has been assessed conservatively, by assuming that traffic will be consistent 24 hours within a day. Annual average daily traffic (AADT) sourced from the Roads and Maritime Services (RMS). A heavy vehicle percentage of 10% has been assumed for these flows, which is conservative based on AECOM's experience for a highly industrialised area.

As presented in Section 6.5, the criterion applied to traffic movements on public roads generated during the construction phase of the project is an increase in existing road traffic noise of no more than 2 dB(A). Tourle Street and Nelson Bay Road (Stockton Bridge) are the nearest collector roads and as such have been assessed.

Presented in Table 21 are the results of the construction traffic noise assessment.

Table 21 Road traffic noise assessment - construction

Street	Situation	Vehicle volume throughout day		Peak hour		Predicted noise level increase, dB(A)
		Light	Heavy	Light	Heavy	
Tourle Street	Existing	19156	2130	798	89	< 1
	Future[1]	19176	2150	818	99	
Nelson Bay Road	Existing	15621	1736	651	72	< 1
	Future[1]	15641	1746	671	82	

Notes:

1 Includes construction traffic.

Figure 4 Collector road locations used for assessment

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7.0 Conclusion

7.1 Operational noise assessment

The operation of the nitric acid tank would create the need for nitric acid to be pumped at any time of the day. The sound power level of the pump was based on a Work Health and Safety (WHS) requirement of 82 dB(A) at 1 metre.

The operation of the pumps were assessed against the noise limits prescribed by the Department of Planning, Project Approval 08_0129. The assessment demonstrated that the noise at all assessed receivers complied against the operational noise limits.

7.2 Operation and maintenance of Ammonia flares

The assessment demonstrates that the on-routine use of the flares generally complies with the noise limits set in section 3.3. Operation of Flare C, which operates for a short period of time, was found to cause an exceedance at one receiver location during neutral weather conditions. Receivers are predicted to exceed by 5 dB(A) during adverse weather conditions. However, due to the infrequent use Flare C, the short duration in operation and the safety function for which the flares serve, these exceedances are deemed to be acceptable.

Flare A was found to comply with the criteria set for all receiver locations and all weather conditions. Flare B complied during neutral weather condition at all receiver location and had marginal exceedances of 1 and 3 dB(A) during adverse weather conditions.

The sleep disturbance assessment revealed that Flare B, which would operate for the long-term, complied at all receiver locations and weather conditions. Flares A and C were found to trigger the sleep disturbance levels, however the length of operation and the frequency at which these flares would be activated were reasoned to be insignificant.

No mitigation measures were recommended to treat the flares, however, it is recommended that community consultation contact lines are broadcasted to nearby and potentially affected receivers.

7.3 Construction noise assessment

Typical construction scenarios have been assessed across two phases: excavation and earthworks, and construction. Typical plant equipment was also assumed for these phases and assessed against the requirements of the ICNG.

The construction noise assessment demonstrated that the noise management levels would be met at all assessed receivers, which included residential and industrial receivers.

7.4 Construction traffic noise assessment

Noise generated from light and heavy construction traffic due to the modification of the plant was assessed. It was found that noise caused by these vehicles will not increase the $L_{Aeq,\,1\,hour}$ road noise levels by more than 2 dB and hence will comply with the established RNP criteria.

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Appendix A

Acoustic Terminology

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Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Decibel [dB]	The measurement unit of sound.
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:

0dB(A)	Threshold of human hearing
30dB(A)	A quiet country park
40dB(A)	Whisper in a library
50dB(A)	Open office space
70dB(A)	Inside a car on a freeway
80dB(A)	Outboard motor
90dB(A)	Heavy truck pass-by
100dB(A)	Jackhammer/Subway train
110 dB(A)	Rock Concert
115dB(A)	Limit of sound permitted in industry
120dB(A)	747 take off at 250 metres

Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.

Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Industrial Noise Policy and the EPA's Road Noise Policy.

Appendix D

PHA – AMI Flares

Appendix D PHA – AMI Flares

Orica Mining Services

Kooragang Island Uprate

PHA MOD 2

November 2013

Confidential and Sensitive Document - Exempt from Disclosure under the Government Information (Public Access) Act 2009 (NSW)

This complete Preliminary Hazard Analysis Report is provided to the NSW Department of Planning (DoP) by Orica Australia Pty Ltd (Orica) in confidence for use only within DoP. It is submitted on the basis that there is an overriding public interest against disclosure pursuant to section 14(2) of the Government Information (Public Access) Act 2009 (NSW) ("the Act"). The Report is exempt from disclosure under the Act on the grounds that it contains information associated with the manufacture of Security Sensitive Ammonium Nitrate, disclosure of which could:

- *increase the likelihood of, or prejudice the prevention of, preparedness against, response to, or recovery from, a public emergency (including any natural disaster, major accident, civil disturbance or act of terrorism) (s14(2) Table 2(c));*
- *endanger, or prejudice any system or procedure for protecting, the life, health or safety of any person (s14(2) Table 2(d)); or*
- *facilitate the commission of a criminal act (including a terrorist act within the meaning of the Terrorism (Police Powers) Act 2002) (s14(2) Table 2(f)).*

The information which is exempt from disclosure applies specifically to the following parts of the Report:

- *Appendix II: Hazard Identification*
- *Appendix V: Consequences*
- *Appendix VI: Frequency Analysis.*

The Orica Kooragang Island Ammonium Nitrate Expansion Environmental Assessment (2009) has also been submitted as a public document, with these three Appendices withheld, and without this page, but otherwise in the same form as this document.

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DISCLAIMER

This report has been prepared by GHD at the request of Orica Australia Pty Ltd (Orica) and is for the sole purpose of evaluating the risks associated with the proposed changes to the Kooragang Island Facility at Newcastle, NSW.

GHD otherwise disclaims responsibility to any person other than Orica arising in connection with this Report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

This report is not for use by any related or third party or for any other project. The information and recommendations are to be read and considered as a whole and the content is not to be used selectively as this may misrepresent the content of the report and provide erroneous project or decision outcomes.

The recommendations, opinions, assessments, analyses and summaries presented in this report are based on information, data, assumptions and advice provided and verified by Orica at the date of preparation of this Report and the previous 2009 PHA[1] and 2012 PHA MOD 1[2] reports information upon which this is based. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared. GHD disclaims liability arising from any of the assumptions being incorrect.

It must be recognised that QRA is only a tool to assist decision making and not a substitute for suitably experienced and competent engineering input. The results of a QRA are only representative of the potential risks which may exist to the extent that the input data, assumptions and rule sets are representative of reality. The uncertainties in QRA inputs, and therefore in the results, are significant, and the conclusions of a QRA are sensitive to variations in the inputs or modelling assumptions. This is an unavoidable limitation of the technique.

In addition, this QRA is reliant on the ability of the Phast Risk software, supplied by Det Norske Veritas (DNV), to correctly model the data and settings for this exercise. GHD have not conducted an independent verification of the software modelling results and data and disclaims any responsibility for the performance of the Phast Risk program.

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[1] Orica Mining Services, Report for Kooragang Island Facility Uprate, Preliminary Hazard Analysis, May 2009, Rev 8, GHD Document Number 158758.

[2] Orica Mining Services, Report for Kooragang Island Uprate PHA MOD1, March 2012, Rev 5, GHD Document Number 31/24733/00/192842

1. Introduction

Orica Australia Pty Ltd (Orica) operates a manufacturing facility on Kooragang Island (KI) near Newcastle, which produces ammonia, nitric acid and ammonium nitrate.

On the 1st of December 2009, approval (DA 08_0129) was granted for the expansion of the site's ammonium nitrate manufacturing capability from 430ktpa to 750ktpa by the NSW Minister for Planning and Infrastructure under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The site expansion project approval broadly consists of:

- An additional Nitric Acid Plant (NAP4);
- An additional Ammonium Nitrate Plant (ANP3);
- Modification of the existing Ammonia Plant;
- Upgrades to existing infrastructure such as cooling towers, air compressors, loading facilities, electrical systems, effluent treatment systems and the steam system.

To support the site's expansion approval application, GHD was commissioned in 2008 to update the Preliminary Risk Assessment (PHA)[3]. This involved the inclusion of additional infrastructure and changes to existing operational parameters in the Quantitative Risk Assessment (QRA).

In 2011[4] (MOD 1 PHA) an application to modify the 2009 approval was lodged by Orica, following the completion of technology selection and feasibility study design work. The modification mainly related to proposed changes to the post expansion site layout. During the regulatory assessment period, a non-routine ammonia release occurred at the site on the 9th of November 2011. As a result of the incident, Orica made several changes to the site's ammonia handling systems and committed to investigating additional safety measures that could be implemented to further reduce the risk associated with the use of ammonia onsite to both the community and site personnel. Improvements to the ammonia handling systems onsite included in the MOD 1 PHA included:

- Consolidation of pressurised liquid ammonia storage and piping systems to reduce inventories and simplify isolation;
- Implementing additional ammonia detection and isolation systems to reduce the quantity of ammonia released to atmosphere as a result of potential leaks from major pipelines between the Ammonia Plant, Ammonia Storage and ammonia storage tank (Bullet) 6; and
- Continuing to explore additional opportunities to further reduce the risks associate with the use of ammonia in site's current operations.

The MOD 1 approval modification was approved on 11 July 2012 (DA 08_0129 MOD 1).

In 2012, Orica consolidated improvement work on ammonia into the Ammonia Management Improvement programme (AMI), tasked with investigating and identifying further opportunities to reduce the risks associate with existing ammonia handling systems located onsite. Since

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[3] Orica Mining Services, Report for Kooragang Island Facility Uprate, Preliminary Hazard Analysis, May 2009, GHD Document Number 158758, Rev 8.
[4] Orica Mining Services, Report for Kooragang Island Facility Uprate, PHA MOD 1, March 2012, GHD Document Number 192842, Rev 5.

completing this review in early 2013, several ammonia handling and ammonia capture and treatment design improvements have been identified.

The purpose of this PHA update (PHA MOD 2) is to identify the effect of proposed changes in relation to the QRA modelling results detailed in MOD 1 PHA and to establish if compliance to HIPAP 4[5] assessment criteria is maintained. The MOD 2 PHA will be submitted to the NSW Department of Planning and Infrastructure to support a further modification to the expansion project approval.

This report presents the changes to the ammonia handling system design compared to what was detailed in the MOD 1 PHA and the updated risk profiles and references the MOD 1 PHA report. The following appendices have been updated:

Appendix II – Hazard Identification

Appendix V – Consequences

Appendix VI – Frequency Analysis

1.1 Scope of MOD 2 PHA

Orica engaged GHD to update the site's MOD 1 PHA risk model and the associated documentation to accurately reflect the proposed changes associated with the AMI project (MOD 2).

The scope of the MOD 2 PHA includes the following:

- Update the MOD 1 PHA model to reflect the MOD 2 changes as listed in Section 2 (mainly updates to the ammonia transfer pipelines and storage) using Phast Risk v6.7;
- Analyse the consequences and event frequencies associated with the updated and new scenarios;
- Generation of MOD 2 risk contours;
- Comparison of MOD 2 risk contours with the MOD 1 risk contours in the MOD 1 PHA submitted to the DoPI; and
- MOD 2 PHA Report showing the key changes in risk results.

[5] NSW Department of Planning & Infrastructure, Hazardous Industry Planning Advisory Paper No 4, Risk Criteria for Land Use Safety Planning, Jan 2011

2. Description of MOD 2 Changes

2.1 Ammonia Management Improvement (AMI) Programme

Historically the KI site's existing ammonia management system has been designed to prevent a fatality or serious injury to either onsite personnel or in the community, with non-routine ammonia releases discharged at height and routine ammonia emissions directed to ammonia scrubbers where practicable.

In 2011 the KI site experienced a non-routine ammonia release on 9th of November 2011 from one of the site's pressurised ammonia storage tanks. This resulted in ammonia vapour being released directly to atmosphere. In response to this incident, Orica committed to implementing a risk reduction plan which included several changes to plant, processes and systems and evaluation of options for eliminating or reducing ammonia emissions where the risk has been determined to be significant. Part of this work was incorporated into the MOD1 PHA but with Orica continuing to explore additional opportunities.

In May 2012, Orica undertook a review of the similar manufacturing facilities in Europe, South Africa, North America and Australia to investigate the effectiveness of other company's ammonia management systems and to identify potential improvements to the systems at KI.

The review identified four main areas of focus in reducing the site's risk profile, being:

1. Simplifying the ammonia distribution network;
2. Improving the integrity of ammonia feed tanks;
3. Improving the Ammonia Collection and Scrubbing Capability;
4. Ensuring ammonia treatment systems were appropriate in managing large release scenarios.

Identified improvements, including previously planned work, were consolidated into the Ammonia Management Improvement (AMI) programme to develop through an appropriate project, design and risk assessment process.

2.2 Proposed Modification (MOD 2)

From a PHA update prospective, the main changes to the inputs assessed in the MOD 1 PHA relate to the integrity and quantity of ammonia supply feed tanks, changes to the ammonia distribution network and the inclusion of three ammonia flares located in the Ammonia, Nitrates and Ammonia storage plant areas.

2.2.1 Design improvements aimed at improving ammonia feed tank integrity.

A review of the site's existing three ammonia feed tanks was completed, with an improved ammonia feed tank design identified. The focus of the investigation was to further reduce the quantity of ammonia stored in the tanks and to improve the integrity of the remaining ammonia feed tanks. Consistent with the MOD 1 PHA, No. 1 bullet will be decommissioned, however the following changes to the MOD 1 PHA are proposed:

- Consistent with the MOD 1 PHA, a new ammonia feed tank No. 6 will be installed however the design of the tank will be vertical compared to the horizontal design of the existing ammonia feed tanks 1 and 2. This will result in a significantly reduced fire case due to the reduction of the feed tanks ammonia surface area. The vertically designed ammonia feed tank will operate at a reduced ammonia inventory of 8T, compared to 15T as detailed in the MOD 1 PHA, and operating pressure. This will reduce the volume of ammonia that could potentially be released in the event of the tank's relief valve being activated. In the event of the relief valve activating on the tank, released ammonia will now be directed to a flare rather than directly to atmosphere;

- Ammonia transferred from ammonia feed tank No. 6 to the nitrates plants will no longer be via the ammonia side arm heater but rather via five optimally designed ammonia transfer pumps. This will result in greater integrity of the plant ammonia supply system and remove a significant potential ammonia release point from the site. As a result of the introduction of the five ammonia transfer pumps, several changes have been made to the ammonia distribution network, which are listed in Section 2.2.2 below.
- As required by the site's Environmental protection licence (EPL 828), ammonia feed tank No. 5 (ammonia bottling bullet V115) located in the site's aqueous ammonia and ammonia bottling area will be decommissioned. Ammonia supply to the bottling area will now be supplied directly from the Ammonia Plant. Removal of this ammonia feed tank has resulted in an increase in the operating pressure of the ammonia bottling plant supply pipeline;
- Ammonia feed tank No. 2, previously listed in the MOD 1 PHA as an off-line spare bullet to ammonia feed tank No. 6, is to be decommissioned and hence reducing some complexity in the network.

The revised ammonia feed tank site configuration will result in a further reduction of normal working inventory of pressurised liquid ammonia in the bullets from 25 tonnes (in MOD 1) to a future 8 tonnes (in MOD 2) as shown in the table below.

Table 1: Summary of ammonia storage inventories

Bullet	MOD 1 Max capacity (tonnes)	MOD 1 Normal Working Inventory	MOD 2 Max capacity (tonnes)	MOD 2 Normal Working Inventory
No. 1	Decommissioned	Decommissioned	Decommissioned	Decommissioned
No. 2	Spare*	Spare*	Decommissioned	Decommissioned
No. 5	60(30)**	10***	Decommissioned	Decommissioned
New no. 6	30	15****	15	8****
Total	90(60)	25	15	8

* Replacement bullet to be used as an off-line spare for maintenance. The bullet will be of the same capacity as bullet no.6

**high level trip at 30T

***surge capacity of 15T for occasional road tanker filling

**** surge capacity of 15T to allow for Nitrates plant trips

2.2.2 Design improvements aimed at simplifying the ammonia distribution network

A review of the existing and future ammonia distribution network was undertaken with the aim of reducing the distance, pipe diameter and pressure for which ammonia is required to be transferred across the site has been completed. This is aimed at reducing the consequence associated with a potential release. As a result of the review and changes to the ammonia feed tanks the following improvements have been identified.

- Ammonia transfer pipelines from ammonia feed tank no. 6 to:
  - Ammonium Nitrate Plant 2 will be operated at a reduced pressure;
  - Nitric Acid Plant 3 will be replaced with a smaller diameter pipe;
- Ammonia transfer pipelines from ammonia plant to:
  - Ammonia storage vessel (V101) supply pipeline will be operated at a slightly higher pressure and larger pipe diameter;
- Ammonia transfer pipelines from storage vessel (V101) to:
  - Road loading via storage ammonia heaters will be replaced with a new pipeline due to the decommissioning of ammonia feed tank No. 5;
  - Triella Aqua Plant via storage ammonia heaters will be a new pipeline; to Project Trident vaporisers via the Project Trident ammonia heater will be a new pipeline.
- The ammonia back-up line will be decommissioned;
- The ammonia manifold will be decommissioned. A new refrigeration unit will be installed in Nitric Acid Plant 2 with an inventory of 1000 kg ammonia.

Additional consideration has also been given to the complexities associated with the construction and ongoing maintenance associated with the high integrity double piping of major ammonia pipelines. A simpler alternative strategy, designed to achieve a similar risk reduction has been developed. Ammonia pipelines between the Ammonia Plant, Ammonia Storage and ammonia feed tank No. 6 will be fitted with leak detection and automatic remote isolation capable of pipe isolation within two minutes of ammonia leak detection. This will be achieved through the installation of dual flow meters located at each end of the pipeline. Discrepancies in flow between the different ends of the pipe will result in the automatic isolation of the pipe. This will reduce the quantity of ammonia released as a consequence of a rupture or leak ammonia release scenario.

2.2.3 Design improvements aimed at ensuring ammonia treatment systems were appropriate in managing large release scenarios.

Orica has undertaken a review of alternative ammonia treatment options for large non-routine release scenario's at the site. The review identified that a flaring system is the preferred option due to the reduced reliance on existing site systems, greater reliability, increased operational simplicity (which can improve effectiveness during emergency events), reduced aqueous ammonia formation and lower capital cost. The flares will provide the site with a final layer of ammonia treatment capability for the site.

Three flares are to be used to treat major non-routine process relief valve discharges, while the existing scrubbing system would continue to treat routine planned ammonia emissions.

Three new ammonia flares will thermally oxidise ammonia released from relief valves located in the Ammonia Plant, Nitrates and Ammonia Storage tank areas.

3. Risk Results

This section presents a comparison of quantitative risk assessments modelling results associated with MOD 1[6] and MOD 2 (AMI Project). As the HIPAP 4 risk criteria applies specifically to new development, it has not been directly applied to the AMI MOD 2 results as they are minor and do not equate to additional infrastructure at the site. However to enable a more complete understanding of all aspects of the risk profile of the AMI Project, risk contours have been calculated for the AMI Project. The results presented in this section include the site results for MOD 1 and MOD 2 for the following risk results against all of the risk criteria of NSW DoP presented in Hazardous Industry Planning Advisory Paper (HIPAP) No 4:

- The individual fatality risk (IFR);
- Societal risk in the form of FN Curve; and
- Toxic Injury and Irritation risk;

The changes in these results are discussed including an assessment to whether the MOD 2 design changes have made an impact on the risk profile of the overall site.

The following risk results remain the same between the MOD 1 and MOD 2 design as none of the site layout changes have been altered. As such they remain compliant to the relevant HIPAP 4 criteria and therefore have not been presented again in this report. These include:

- Thermal radiation; and
- Ammonium nitrate explosion overpressure (injury and property damage and accident propagation).

3.1 Individual Fatality Risk

The following figures show the Individual Fatality Risk (IFR) Contours for MOD 1 and MOD 2.

[6] Orica Mining Services, Report for Kooragang Island Facility Uprate, PHA MOD 1, March 2012, GHD Document Number 192842, Rev 5

Figure 1: Individual Fatality Risk – MOD 1

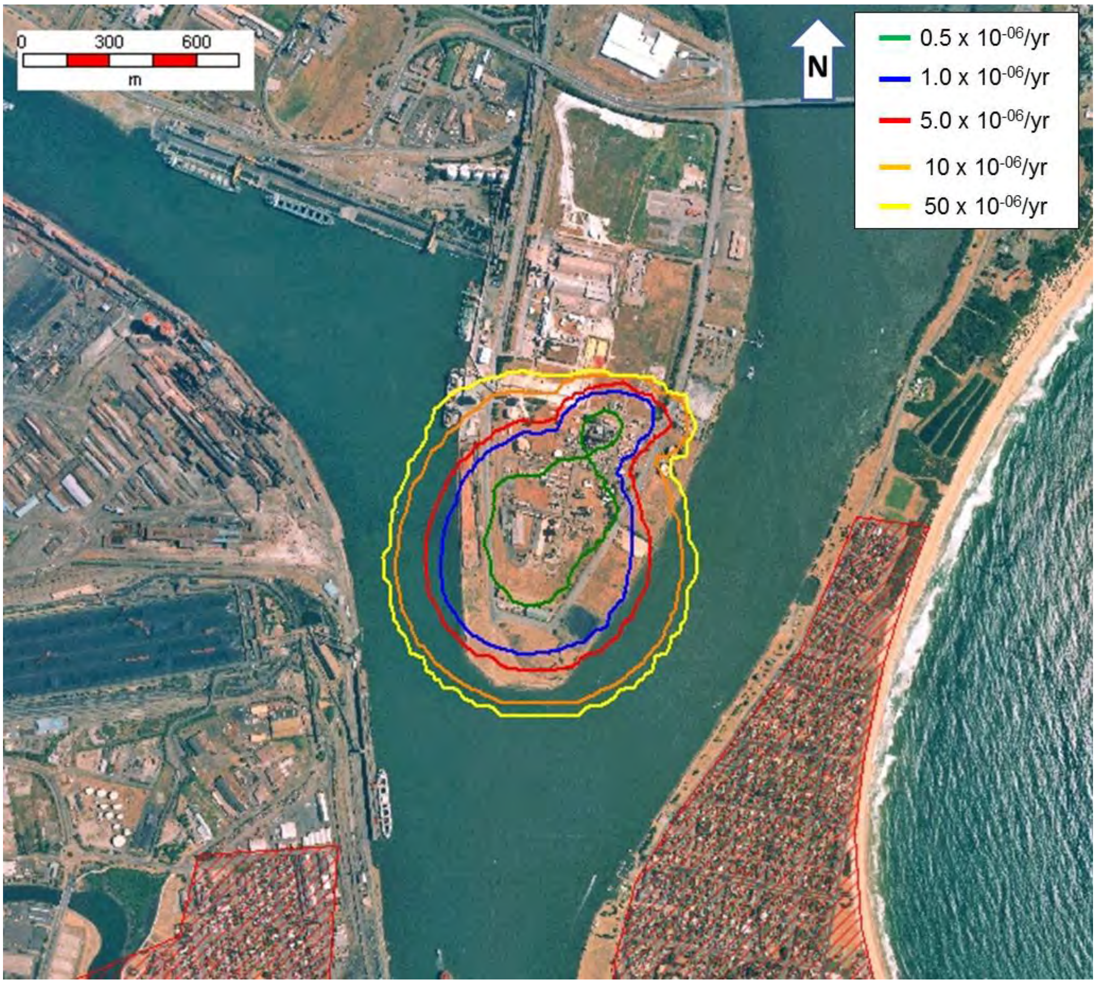
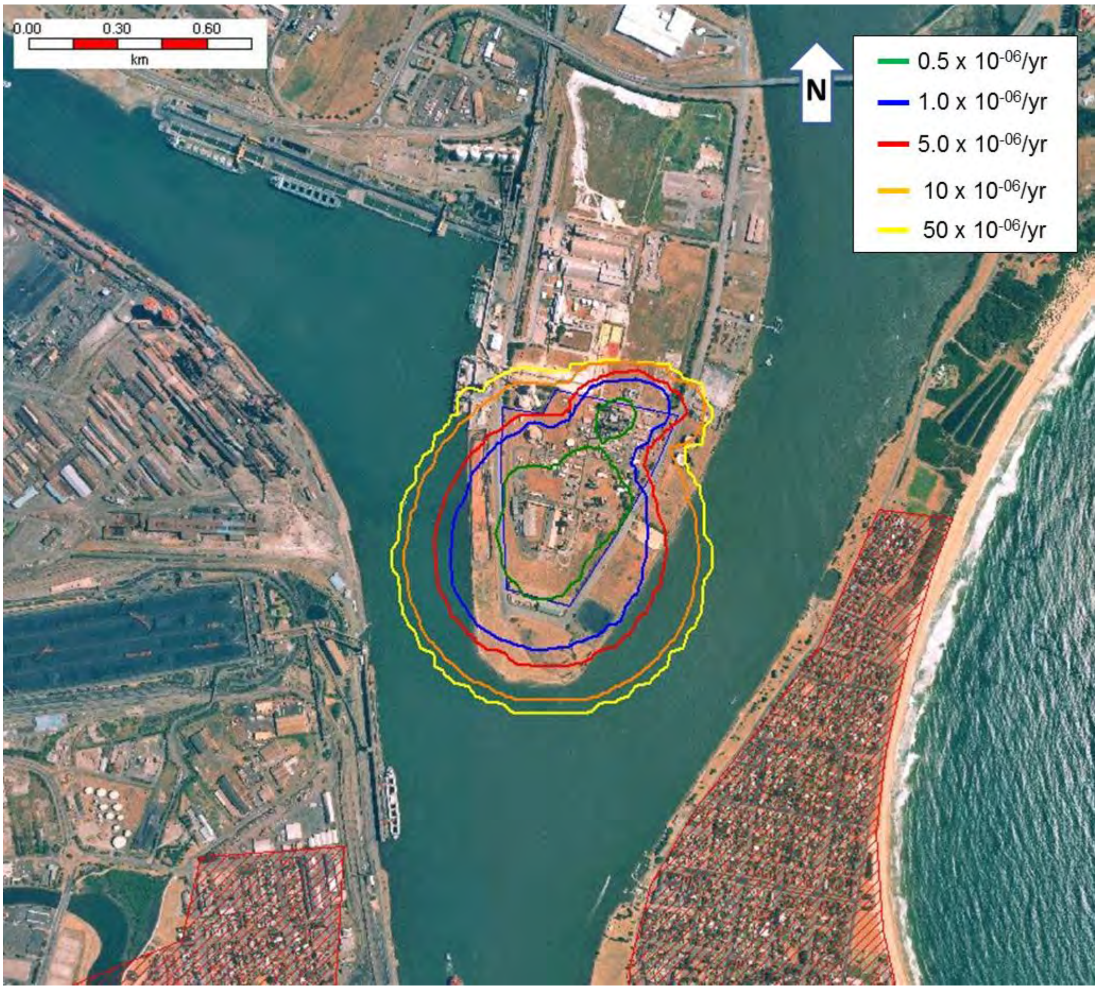


Figure 2: Individual Fatality Risk – MOD 2



Comparing the IFR contours for the MOD 2 case to the MOD 1 case, there have been no significant changes to the inner risk contours. The outer contour (50 x 10^{-6} pa) has contracted slightly in the north-west region. This is expected as there have not been any major changes to the design except for some minor changes to the ammonia storage and distribution system.

The maximum actual IFRs at the Orica site boundary on all sides for the MOD 2 Case and MOD 1 Case are given in Table 2 below. This shows that the actual risk at the northern and western boundaries remain the same between MOD 1 and MOD 2. The actual risk on the eastern side has slightly increased and the actual risk on the southern side has slightly decreased. The HIPAP 4 criterion is 50 x 10^{-6}/yr. This shows that the overall IFR associated with MOD 2 have not increased from the MOD 1 design.

Table 2: Maximum actual IFR at site boundary

Boundary	IFR MOD 1 (x 10^{-6}/yr)	IFR MOD 2 (x 10^{-6}/yr)	Major Contributors
North	56	56	Events in the ammonia plant involving ammonia and gas releases.
East	43	44	Explosion events involving ammonium nitrate
South	81	80	Explosion events involving ammonium nitrate

Boundary	IFR MOD 1 (x 10^{-6}/yr)	IFR MOD 2 (x 10^{-6}/yr)	Major Contributors
West	58	58	Explosion events involving ammonium nitrate

As shown, there has been negligible change in IFR risk due to the design changes made as part of MOD 2. This high level of compliance is due to substantial efforts made to reduce risk, not only in the new plant and equipment but also by modifying existing plant and equipment. These are described in Section 2.

3.2 Societal Risk

The societal risk in the form of a FN-curve for the MOD 1 and MOD 2 cases are shown in Figure 3 and Figure 4 below.

Figure 3: Societal Risk – MOD 1

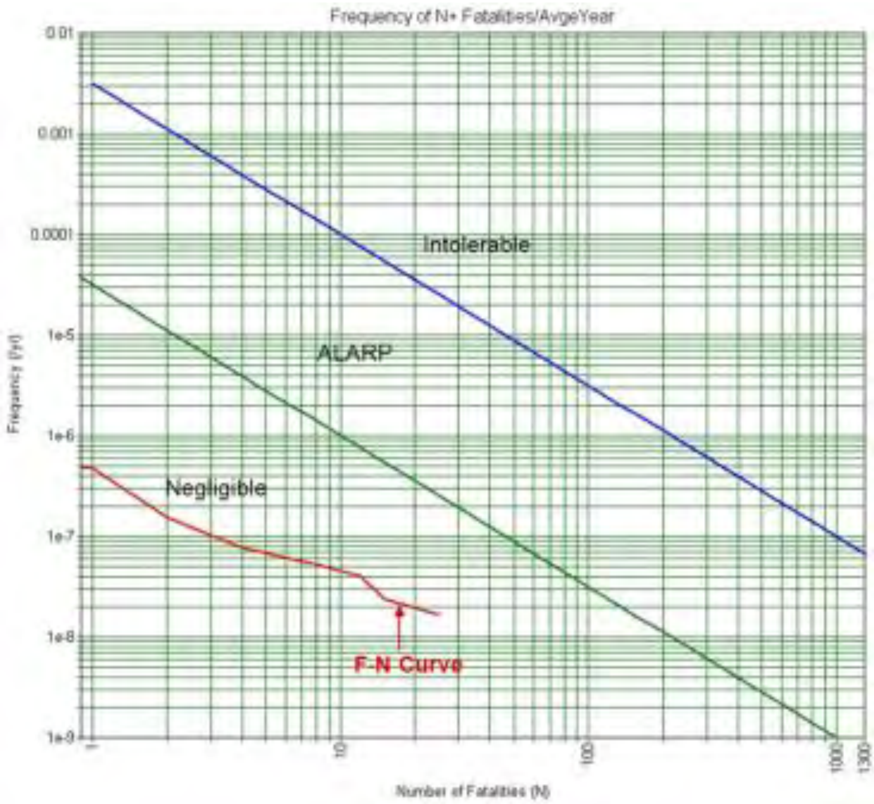
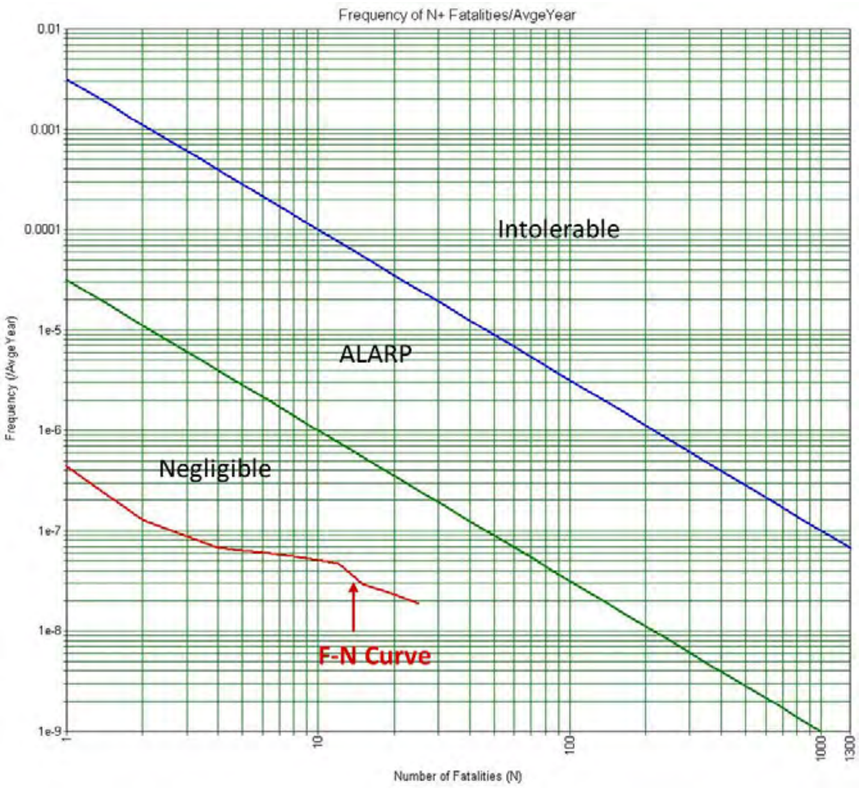


Figure 4: Societal Risk – MOD 2



The FN-curve for the MOD 2 remains entirely within the "negligible" zone.

The risks associated with the Project for the site case remain consistent with the MOD 1 PHA and continue to comply with HIPAP 4 risk criteria for "intensification of hazardous activities in an existing complex", i.e. the $1x10^{-6}$ contour does not encroach into residential areas and the cumulative risks as shown in the Site FN Curve remain acceptable.

3.3 Toxic Risk

3.3.1 Injury

Figure 5 and Figure 6 below show the toxic injury risk contour at 10 in a million per annum for MOD 1 and MOD 2 (AMI Project). These show that the toxic injury risk contour has decreased with MOD 2. This is mainly due to the simplification of the ammonia storage and distribution system. The toxic injury risk associated with the site remains compliant with the suggested criteria specified in HIPAP 4.

Figure 5: Toxic Risk Injury – MOD 1

Figure 6: Toxic Risk Injury – MOD 2

3.3.2 Irritation

Figure 7 and Figure 8 below show the toxic irritation risk contour at 50 in a million per annum for MOD 1 and MOD 2 (AMI Project). This shows that the shape of the toxic irritation contour has changed slightly between MOD 1 and MOD 2 but remains compliant with the suggested criteria specified in HIPAP 4.

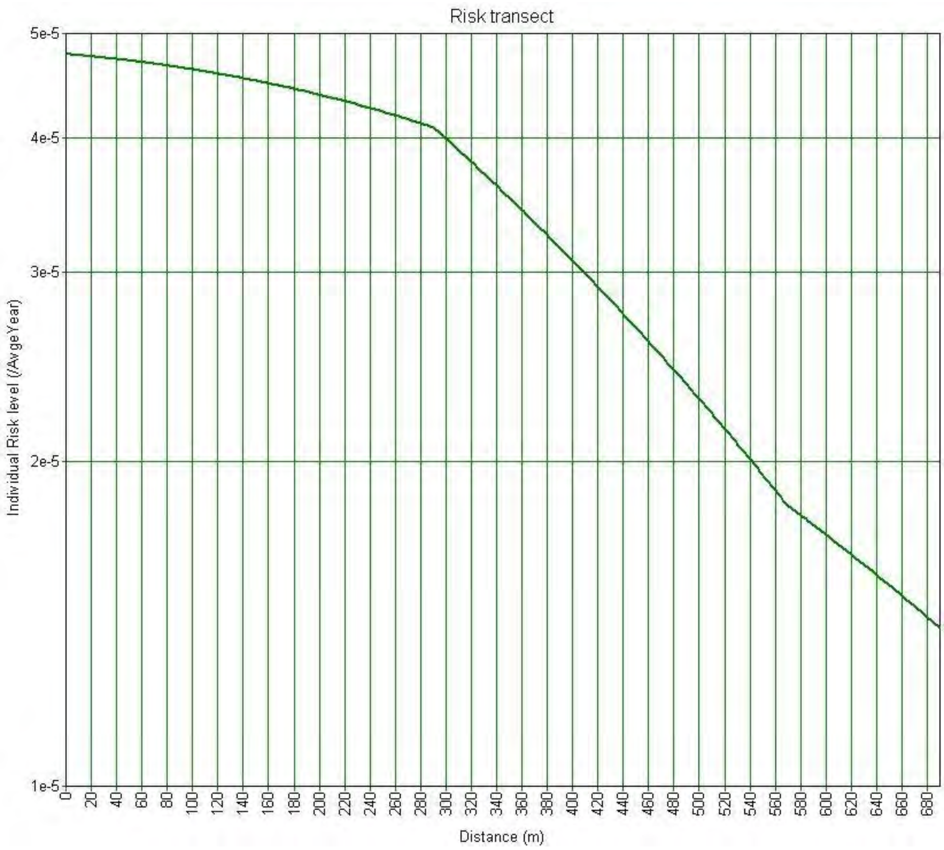
Figure 7: Toxic Irritation Risk – MOD 1

Figure 8: Toxic Irritation Risk – MOD 2

Figure 10 shows the risk transect along the blue line as indicated in Figure 9. This confirms that the risk along the blue line remains below the 50 in a million per year frequency.

Figure 9: Toxic Irritation Risk Close up – MOD 2

Figure 10: Risk Transect Graph



4. Conclusion

Since the preliminary hazard assessment (PHA) update, referred to as PHA MOD 1, was approved by the Minister on 11 July 2012 (DA 08_0129 MOD 1), Orica has undertaken an Ammonia Management system Improvement (AMI) project based on a review of ammonia management practices including benchmarking internationally. These activities have led to a number of variations to the project in relation to the inputs into the preliminary hazard assessment.

The QRA model developed in the PHA MOD 1 was updated to incorporate the changes to the design and layout as part of the AMI project, referred to as PHA MOD 2. The purpose of this was to check the impact of the design changes on the site's risk profiles established during the PHA MOD 1, and produce a MOD 2 Report documenting the changes.

The risk assessment has shown that the site risk results for the MOD 2 case did not change significantly from the results detailed in the MOD 1 design case. The risks associated with the Project continue to comply with HIPAP 4 risk criteria for "intensification of hazardous activities in an existing complex", i.e. the $1x10^{-6}$ contour does not encroach into residential areas and the cumulative risks as shown in the Site FN Curve remain acceptable.

The study has shown that the proposed changes associated with MOD 2 have not resulted in an increase in the risk profile of the site compared to the MOD 1 PHA.

Appendices

Appendix I – Background Data

(Refer to Appendix I in 2009 PHA report Rev 8)

APPENDIX I

A I Background Data

A I.1 Existing Site Layout

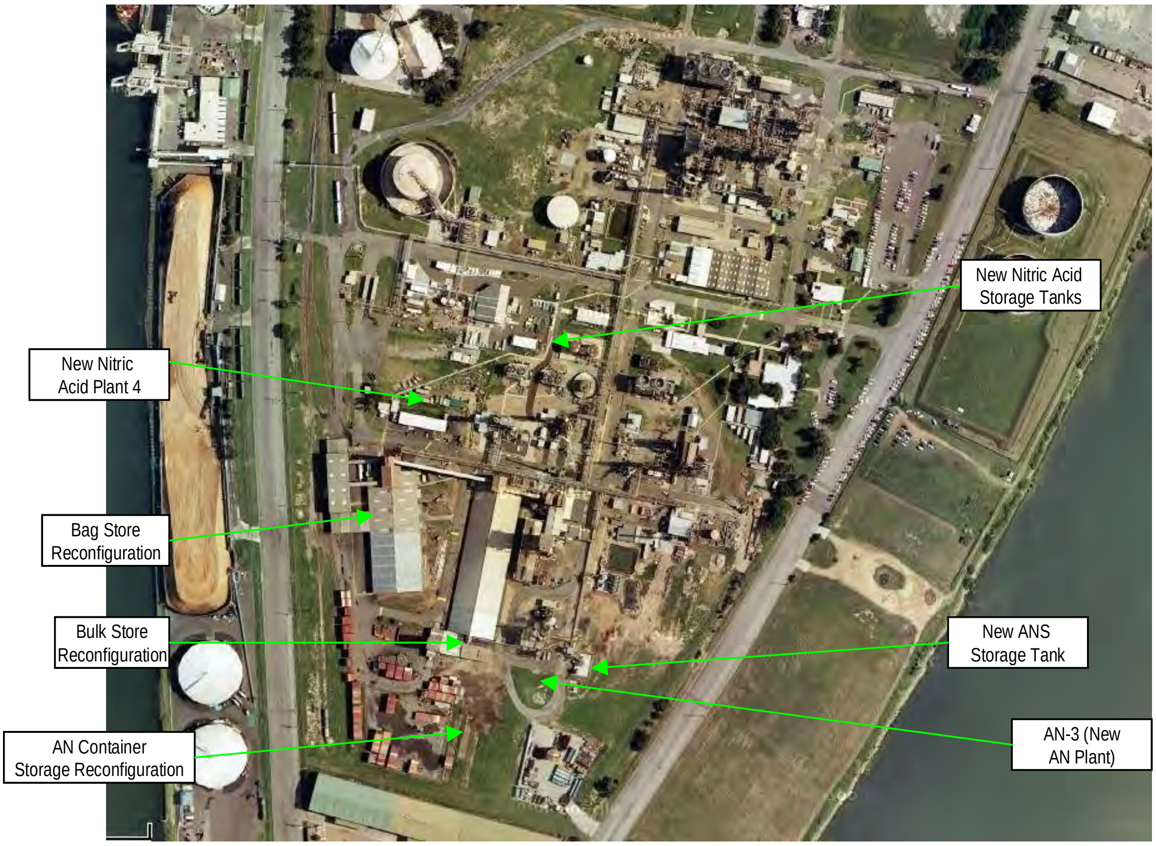
The Kooragang Island existing site layout is shown in Figure AI-1 below.

Figure AI-1: Existing Site Layout

A I.2 Expanded Facility Site Layout

Figure AI-2 shows the proposed plants and modifications as part of the expansion project.

Figure AI-2: Expanded Facility Site Layout



A I.3 Hazardous Material Identification

Hazardous materials identified as being either produced or consumed in the Nitric Acid and Ammonium Nitrate Plants are presented in Table AI-1: Hazardous Materials on Site

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Table AI-1: Hazardous Materials on Site

Hazardous Material	Phase	Class of DG	Produced/Use

Hazardous Material	Phase	Class of DG	Produced/Use
Anhydrous ammonia	Pressurised Liquid and Gas	Toxic	Manufactured on site and used in both plants for the production of acid and ammonium nitrate.
Natural Gas	Gas	Flammable	Feed stock for ammonia.
Ammonium nitrate	Solution and Prill	Oxidising Agent	Produced in Ammonium Nitrate Plant as end product
Nitrogen oxides (monoxide, dioxide, tetroxide, nitrous)	Intermediate Gas	Toxic	Produced in Nitric Acid Plant as part of the production process
Hydrogen	Gas	Flammable	Used as a feedstock for ammonia production.
Nitric acid	Liquid	Highly Corrosive	Produced in Nitric Acid Plant and consumed in Ammonium Nitrate Plant to produce ammonium nitrate.
Alkyl amine (coating agent)	Liquid		Consumed in Ammonium Nitrate Plant for prill coating.
Steam	Liquid and Gas		Produced and consumed by all plants.
Nitrogen	Pressurised Liquid and Gas	Compressed Gas	Consumed by all plants as purge.
Chlorine	Pressurised Liquid and Gas	Toxic	Used in cooling water treatment in the Ammonia Plant

Of the materials mentioned above, only anhydrous ammonia, ammonium nitrate, the nitrogen oxides, chlorine, natural gas and hydrogen were considered capable of having an offsite safety risk impact. These materials are discussed further in the following sections.

A I I.3.1 Ammonia

Ammonia is a toxic gas, which, while flammable, is acknowledged to be extremely difficult to ignite. Considering this, the flammable effects of ammonia were screened from the study with its toxicity being the principal issue considered in this assessment.

Although ammonia is lighter than air, a pressurised or cold release of ammonia may form a dense cloud (due to temperature) after expansion to atmospheric pressure or form a fog resulting from the interaction of ammonia molecules with ambient water vapour.

Ammonia can be readily detected in the atmosphere by smell at concentrations below 20 ppm. It is a powerful irritant to eyes and mucous membranes of the respiratory tract. At low concentrations in air, ammonia vapour irritates the eyes, nose and throat. Inhalation of high concentrations produces a sensation of suffocation, quickly causes burning of respiratory tracts and may result in death.

Table AI-2: Toxicity of Ammonia

Concentration (ppm)	Exposure Effects	Exposure Duration
10-20	Odour detectable by most people.	Prolonged repeated exposure produces no injury.
25	No adverse effects for average workers.	Maximum allowable concentration for 8-hour working day (NIOSH TWA)
35	No adverse effects for average workers.	Exposure should not exceed 15min and there should be no more than 4 periods above 15min, with at least 1 hour between episodes.
300	Nose and throat irritation. Eye irritation with tearing.	NIOSH IDLH, based on statement by AIHA (1971) that 300 – 500ppm for 30 to 60min have been reported as the maximum short exposure tolerance (Henderson and Haggard, 1943).
2000-3000	Convulsive coughing, severe eye irritation.	No permissible exposure.
5000-7000	Respiratory spasm, rapid asphyxia.	No permissible exposure. Rapidly fatal.

"The odour of ammonia can be detected by humans at concentrations >5 ppm; the odour is highly penetrating at 50 ppm (10 min). Human volunteers exposed to ammonia showed slight irritation at 30 ppm (10 min); moderate irritation to the eyes, nose, throat, and chest at 50 ppm (10 min to 2 h); moderate to highly intense irritation at 80 ppm (30 min to 2 hr); highly intense irritation at 110 ppm (30 min to 2 h); unbearable irritation at 140 ppm (30 min to 2 hr), and excessive lachrymation and irritation at 500 ppm. Reflex glottis closure, a protective response to inhaling irritant vapours, occurred at 570 ppm for 21- to 30-year-old subjects, 1,000 ppm for 60-year-old subjects, and 1,790 ppm for 86- to 90-year-old subjects." (Taken from Ref 16.)

A I I.3.2 Natural Gas

Natural gas is a non-toxic, colourless gas at ambient conditions. While it is odourless of itself, an odorant is normally added before it is transported to end-users. Natural gas is lighter than air. It is a highly flammable gas, with flammability ranging from 5 to 15% volume in air. If it does not immediately ignite upon release, it can form an explosive mixture with air. If it is burned in limited supply of air, carbon monoxide may be produced. While it is regarded as being stable, it is not compatible with strong oxidising agents.

A I I.3.3 Hydrogen

Hydrogen is a highly flammable gas. Its density is much below that of ambient air, so that in a release it rises rapidly. Its flammability range in air extends from 4% to 75% and because of this it will rapidly form an explosive mixture with air. It burns with a pale blue, almost invisible flame, making hydrogen fires more dangerous.

A I I.3.4 Ammonium Nitrate

Ammonium Nitrate (AN) is a strong oxidising agent that will support combustion of organics and metal powders as it produces oxygen as one of its decomposition products. It is not flammable or combustible in itself. When subjected to heat, ammonium nitrate undergoes a series of complex decomposition reactions that produce low levels of nitrogen oxides (namely nitrous oxide) at atmospheric pressure. If the reaction is confined and the gases are maintained at the temperature at which they were formed, further gas phase reactions can occur giving off nitric oxide and nitrogen dioxide gases. Nitrogen dioxide is the most toxic product that may form under these conditions and is discussed in Section A I I.3.5.

The plume of combustion products resulting from an ammonium nitrate fire have been shown to be buoyant due to the high temperatures involved, and disperse to non-hazardous concentrations before returning to grade.

The sensitivity of ammonium nitrate to detonation is largely dependent on three variables; temperature, confinement and contamination. Without any of these three being present, ammonium nitrate would require a strong initiation charge (ie high explosive) to detonate at all.

Variables in the calculation of overpressure consequences from an ammonium nitrate explosion include the proportion of the sensitised material that actually detonates in the explosion (efficiency), and an equivalency of the sensitised material to that of TNT (equivalency). This technique is used because of the significant quantity of information on the consequences of explosions involving TNT.

A I I.3.5 Nitrogen Oxides

Nitrogen oxides (nitrogen monoxide, dioxide, tetroxide, di-nitrogen oxide (nitrous oxide), etc) are produced in the Nitric Acid Plant in the production of acid and by the high-temperature decomposition reaction of ammonium nitrate.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a respiratory irritant, however its main danger lies in the delay before its full effects upon the lungs occur. Symptoms include feelings of weakness and coldness, headache, nausea, dizziness, abdominal pain and cyanosis. In severe cases, convulsions and death by asphyxia may follow. Table AI-3 overviews the toxicity of nitrogen dioxide.

Table AI-3: Toxicity of Nitrogen Dioxide

Concentration (ppm)	Exposure Effects
1	NIOSH REL Short Term Exposure Limit (STEL)
3	Recommended Time Weighted Average (TWA) for continued workplace exposure with no adverse effect for an 8hr day, 5 days per week.
5	OSHA PEL (Permissible Exposure Limit)
20	NIOSH IDLH

The exposure limits for nitrogen dioxide as per Acute Exposure guidelines Limit (AEGL) are given below.

Table AI-4: Exposure Limits for Nitrogen Dioxide

	Exposure Duration				
	10 min	30 min	1 hr	4 hr	8 hr
AEGL-1 (Non disabling)	0.5 ppm	0.5 ppm	0.5 ppm	0.5 ppm	0.5 ppm
AEGL-2 (Disabling)	20 ppm	15 ppm	12 ppm	8.2 ppm	6.7 ppm
AEGL-3 (Lethal)	34 ppm	25 ppm	20 ppm	14 ppm	11 ppm

Nitrous Oxide

Nitrous oxide (N_2O) is a non-toxic anaesthetic. However, it may result in a fatality due to an asphyxiation effect by displacing oxygen. Populations exposed to nitrous oxide are likely to feel light-headed and anaesthetised before asphyxiation occurs. Concentrations of approximately 150,000 ppm of gas are required to reduce the oxygen concentration in air to a level, which is considered as the starting point for asphyxiation (18%). Nitrous oxide was therefore screened from the analysis, as concentrations leading to asphyxia will not be reached beyond the site boundary.

Nitric Oxide (NO)

Nitric Oxide is a colourless gas but in high concentrations it changes to brown in colour. It has a sharp sweet odour. Nitric oxide changes to nitrogen dioxide in air. Nitrogen dioxide, NO2, is 5 times more toxic than nitric oxide (NO).

NIOSH Recommended Exposure Limit (REL) for NO is 25 ppm (30 mg/m3) averaged over a work shift of 10 hours per day, 40 hours per week.

A I I.3.6 Chlorine

Chlorine (Cl_2) is a greenish-yellow gas or clear amber liquid (under pressure) with a pungent suffocating odour. It is shipped in 920 kg drums as a compressed liquefied gas under a pressure of approximately 650 kPa at 21.1 deg C. The exposure limits to chlorine based on AEGL and NIOSH recommendations are given in Table AI-5. The Immediately Dangerous to Life and Health (IDLH) value is 30 ppm and is ‘based on the statement by ILO (1971) that exposure to 30 ppm will cause intense coughing, fits, and exposure to 40 to 60 ppm for 30 to 60 minutes or more may cause serious damage’.

Table AI-5: Toxicity Effects of Chlorine

Classification	Exposure Duration				
	10 min	30 min	1 hr	4 hr	8 hr
AEGL-1 (Non disabling)	0.5 ppm	0.5 ppm	0.5 ppm	0.5 ppm	0.5 ppm
AEGL-2 (Disabling)	2.8 ppm	2.8 ppm	2.0 ppm	1.0 ppm	0.71 ppm
AEGL-3 (Lethal)	50 ppm	28 ppm	20 ppm	10 ppm	7.1 ppm
NIOSH Recommended Exposure Limit (REL)	0.5 ppm (max 15 minute ceiling)				
OSHA Permissible Exposure Limit (PEL)	1.0 ppm				
IDLH – Immediately Dangerous to Life or Health	10 ppm				

A I I.3.7 Miscellaneous Chemicals

The remainder of materials mentioned above are considered to only have localised effects.

- Nitric acid and Steam will cause severe burns with bodily contact however will not travel sufficient distances upon release to affect an offsite populations.
- The coating agent (alkyl amine) may cause localised pool fires that likewise were considered unable to affect an offsite population. Toxic smoke plumes will not affect offsite populations due to the separation distance of the storage / production facilities from the site boundary.
- Nitrogen poses both an asphyxiation and frostbite hazard however will rapidly disperse to safe concentrations, before reaching the site boundary.

A I I.3.8 Storage and Quantity

Table AI-6 lists the full range of dangerous goods stored on Orica's KI site, along with their storage method, quantity and throughput.

Table AI-6: List of Dangerous Goods Stored Onsite

DG Storage Description	Proper Shipping Name	UN Number	Class	PG	Product / Common Name	Current			New		
						Max storage capacity	Typical Quantity	Annual Throughput (per annum)	Max storage capacity	Typical Quantity	Annual Throughput
AN Bag Store	Ammonium Nitrate	1942	5.1	III	Ammonium Nitrate	2500 t	2 000 t	100 000 t	No change	No change	150 000 t
AN Bulk Store	Ammonium Nitrate	1942	5.1	III	Ammonium Nitrate	15 500 t	9 200 t	220 000 t	No change	9 200 t	400 000 t
Ammonium Nitrate Container Storage	Ammonium Nitrate	1942	5.1	III	Ammonium Nitrate	4 800 t	3 250 t	95 000 t	No Change	No Change	150 000 t
CPAN Store	Ammonium Nitrate	1942	5.1	III	Ammonium Nitrate	300 t	200 t	8 000 t	600 t	200 t	No Change
AN Solution Tanks	Ammonium Nitrate Liquid	2426	5.1	II	88.5% Ammonium Nitrate Solution	375 t	350 t	110 000 t	1 375 t	1200 t	200 000 t
60% AN Solution Tanks	Dilute Ammonium Nitrate Liquid	3098	5.1	II	60% Ammonium Nitrate Solution	-	-	-	250 t	200 t	50 000 t

DG Storage Description	Proper Shipping Name	UN Number	Class	PG	Product / Common Name	Current			New		
						Max storage capacity	Typical Quantity	Annual Throughput (per annum)	Max storage capacity	Typical Quantity	Annual Throughput
Chlorine Cylinder – NH3 Cooling Tower	Chlorine	1017	2.3	-	Chlorine	4 t	3 t	16 t	No change	No change	No change
Refrigerated Ammonia Storage Tank (V101)	Anhydrous Ammonia	1005	2.3	-	Anhydrous Ammonia	12 000 t	8 000 t	100 000 t	No change	No change	50 000 kt
Pressurised Ammonia Bullets	Anhydrous Ammonia	1005	2.3	-	Anhydrous Ammonia	183 t	100 t	200 kt	100 t	50 t	350 kt
Cylinder Store	Acetylene Dissolved	1001	2.1	-	Acetylene Dissolved	270 kL	150 kL	288 m^3	No change	No change	No change
Nitric Acid Tanks	Nitric Acid	2031	8	I	Nitric Acid	2930 t	1663 t	345 000 t	5022 t	2682 t	605 000 t
Nitrogen Tank	Nitrogen Refrigerated Liquid	1977	2.2	-	Nitrogen Refrigerated Liquid	40 kL	30 kL	690 000 m^3	No change	No change	No Change

DG Storage Description	Proper Shipping Name	UN Number	Class	PG	Product / Common Name	Current			New		
						Max storage capacity	Typical Quantity	Annual Throughput (per annum)	Max storage capacity	Typical Quantity	Annual Throughput
MDEA Solution Tank	Amine Liquid Corrosive N.O.S – 40%.	2735	8	II	M.D.E.A.	400 kL	0 kL	40 kL	No Change	No Change	No Change
MDEA Solution Tank	Amine Liquid Corrosive N.O.S – 100%	2735	8	II	M.D.E.A.	40 kL	30 kL	40 kL	No Change	No Change	No Change
Aqua Ammonia Tanks	Ammonia Solution	2672	8	III	Ammonia Solution	220 kL	125 kL	904 t	No Change	No Change	No Change
Caustic Soda Tank	Sodium Hydroxide Solution	1824	8	II	Sodium Hydroxide Solution	30 t	25 t	460 t	No Change	No Change	No Change
Sulfuric Acid Tank	Sulfuric Acid <51%	1830	8	II	Sulfuric Acid <51%	30 t	25 t	300 t	No Change	No Change	No Change
R407C ISOTainer	Pentafluoroethane,1,1,1-Trifluoroethane & 1,1,1,2-Tetrafluoroethane azeotropic mixture	3340	2.2	-	Refrigerant Gas R407C	16 t	15 t	36 t	No Change	No Change	No Change

DG Storage Description	Proper Shipping Name	UN Number	Class	PG	Product / Common Name	Current			New		
						Max storage capacity	Typical Quantity	Annual Throughput (per annum)	Max storage capacity	Typical Quantity	Annual Throughput
R134A ISOTainer	1,1,2-Tetrafluoroethane	3159	2.2	-	Refrigerant Gas R134A	16 t	15 t	194 t	No Change	No Change	No Change

A I.4 Weather Data

Weather is classed according to wind speed and weather stability class. Table AI-7 below shows the different weather stability classes.

Table AI-7: Weather Stability Classes

Class	Type	Description
A	Very Unstable	Daytime – sunny, light winds (strong insolation)
B	Unstable	Daytime – moderately sunny, light to moderate winds
C	Unstable / Neutral	Daytime – moderate winds, overcast or windy and sunny
D	Neutral	Daytime – windy, overcast or Night-time - windy
E	Stable	Night-time - moderate winds with little cloud or light winds with more clouds
F	Very Stable	Night-time - light wind, little cloud (strong temperature inversion)

To ensure consistency, GHD have used meteorological data provided by Orica, which was used by ENSR for stack plume modelling. The wind/weather data set obtained covers the period of 2006 and was divided into four classes based on wind speed and weather class as follows:

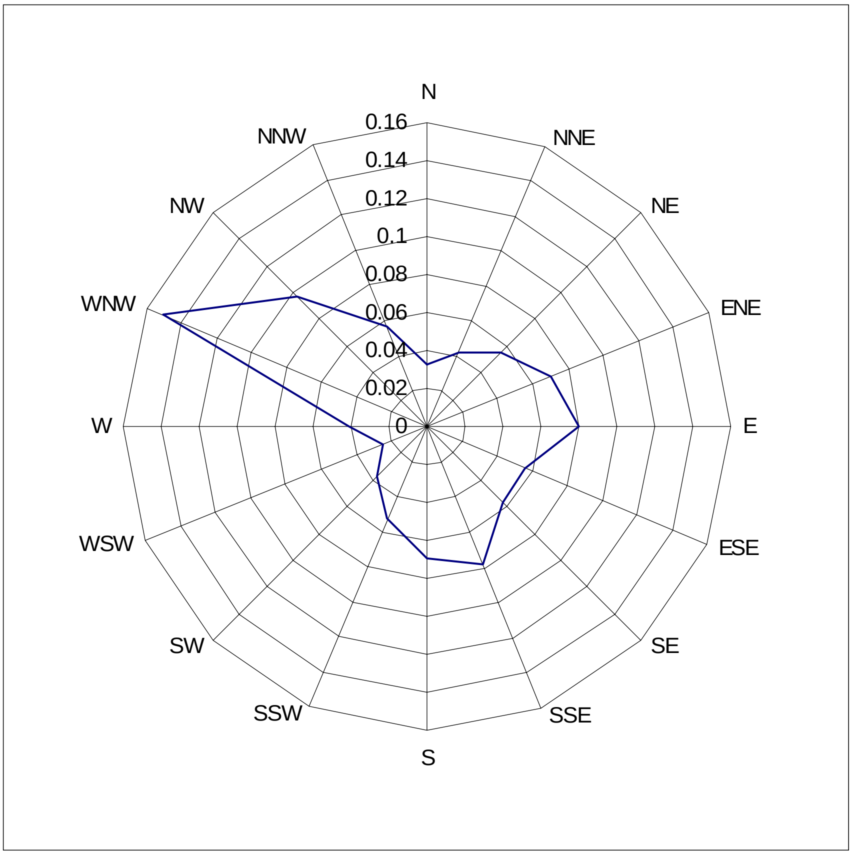
- Wind 1 m/s, weather stability class C;
- Wind 3 m/s, weather stability class D;
- Wind 7 m/s, weather stability class D; and
- Wind 1.5 m/s, weather stability class F.

The combined wind rose for all wind speeds and weather classes is shown in Figure AI-3 below.

The annual average ambient weather conditions identified for the site are as follows;

- 18^{o}C
- 70% humidity.

Figure AI-3: Annual Average Wind Rose



A I.5 Population Data

The population data for the residential areas used in the model was obtained from the ABS 2006 census. The population of the surrounding industrial sites is not included in the model.

The cut off for the population count was based on the distance to 1% fatality (4 km from KI).

Table AI-8: Population Data Used in QRA

Area	Population
Stockton	4200
Suburban (Tighes Hill, Islington, Carrington, Mayfield, Wickham, Maryville, Newcastle)	12418

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Appendix II – Hazard Identification

This Appendix has been withheld from the publicly exhibited Environment Assessment as it is an "exempt document" for the purposes of the Government Information (Public Access) Act 2009 (NSW).

Appendix III – Consequence Models

(Refer to Appendix I in 2009 PHA report Rev 8)

APPENDIX III

A III Consequence Modelling

One part of the risk assessment process involves generating consequences for the release events identified. The steps involved in determining consequences are:

- Determine release conditions based upon materials involved, process conditions and available inventory etc;
- Based on release conditions, determine the types of events which will occur (eg jet fire, toxic cloud, evaporating pool or explosion etc);
- Calculate the extent of the consequences; and
- Establish the impact of the consequence (e.g. proportion of people killed when exposed to a toxic dose)

The consequences are calculated using empirically derived models, which can then be used to determine which release cases generate offsite effects and should be included in the risk model. The level at which fatal consequences are considered to occur will directly influence the risks.

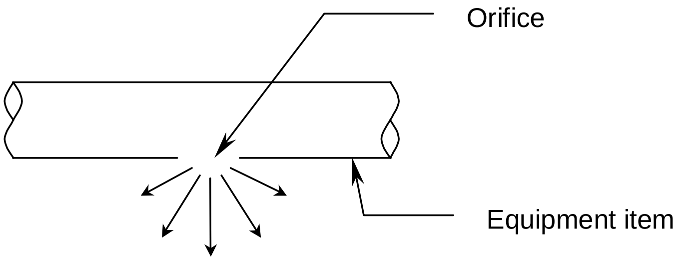
This Appendix discusses basic concepts and theory behind the various consequence models used in the analysis. The models discussed are:

- Discharge Modelling
- Dispersion
- Flammable Effects - Jet Fire
- Toxic Effects
- Ammonium Nitrate Explosions

A III.1 Discharge Modelling

If there is a hole in a pipeline, vessel, flange or other piece of process equipment, the fluid inside will be released through the opening, provided the process pressure or static head is higher than ambient pressure. The properties of the fluid upon exiting the hole play a large role in determining consequences, eg, vapour or liquid, velocity of release etc. Figure AIII-1 illustrates an example scenario.

Figure AIII-1: Typical Discharge



The discharge can be considered to occur in two stages, the first is expansion from initial storage conditions to orifice conditions, the second from orifice conditions to ambient conditions.

The conditions at the orifice are calculated by assuming isentropic expansion, i.e., entropy before release equals entropy at orifice. This allows enthalpy and specific volume at the orifice to be calculated.

The equations for mass flow rate ($\dot{m}$) and discharge velocity (u_0) are then given by:

$$\dot{m} = C_d A_o \rho_o \sqrt{-2(H_0 - H_i)}$$

AND

$$u_0 = C_d \sqrt{(-2(H_0 - H_i)}$$

Where

– C_d = Discharge coefficients

– A_o = Area of the orifice

– ρ_o = density of the material in the orifice

– H_o = Enthalpy at the orifice

– H_i = Enthalpy at initial storage conditions

The discharge parameters passed forward to the dispersion model are as follows:

- Release height (m) and orientation;
- Thermodynamic data: release temperature (single phase) or liquid mass fraction (two-phase), initial drop size;
- Other data:
  - for instantaneous release: mass of released pollutant (kg), expansion energy (J)
  - for continuous release: release angle (degrees), rate of release (kg/s), release velocity (m/s), release duration (s).

A III.2 Dispersion

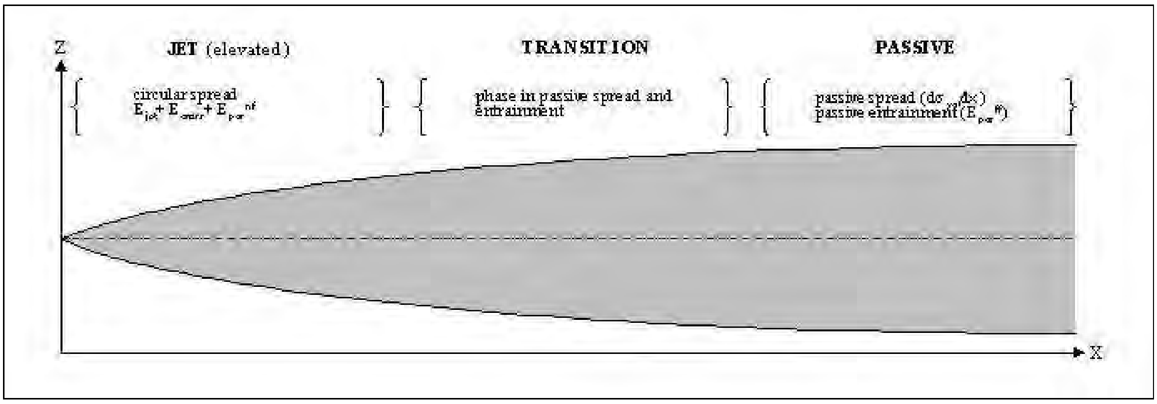
When a leak occurs, the material will be released into the atmosphere. Upon being released, it will start to disperse and dilute into the surrounding atmosphere. The limiting (lowest) concentration of interest is related to flammable and toxic limits for flammable and toxic substances respectively. The model used to determine extent of release is described below, along with some of the key input parameters.

PHAST is a consequence-modelling package that utilises the Unified Dispersion Model (Witlox *et al*, 1999). This models the dispersion following a ground level or elevated two-phase unpressurised or pressurised release. It allows for continuous, instantaneous, constant finite duration and general time varying releases. It includes a unified model for jet, heavy and passive two phase dispersion including possible droplet rain out, pool spreading and re-evaporation.

A III.2.1 Jet Dispersion

For a continuous, pressurised release, the material is released as a jet, i.e., high momentum release. The jet eventually loses momentum and disperses as a passive cloud. Figure AIII-2 below shows a typical release and the various phases involved.

Figure AIII-2: Jet Dispersion



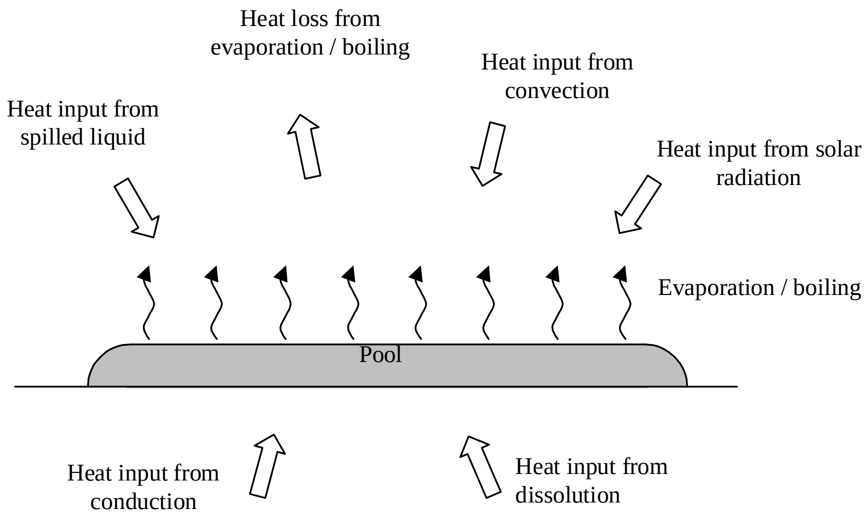
The cloud is diluted by air entrainment until it eventually reaches the lower limit of concern. During the jet phase, the mixing is turbulent and much air is entrained. In the passive phase, less air is potentially entrained, and it occurs via a different mechanism to the turbulent jet phase. The calculation of the plume therefore depends on many factors, the key parameters being:

- Material released, specifically molecular weight;
- Discharge conditions including phase(s) of release, velocity, etc.;
- Atmospheric conditions (a cloud will generally travel further in more stable conditions with lower wind speeds).

A III.2.2 Dispersion from Pool Evaporation

If a rupture occurs from a refrigerated tank or vessel such as the refrigerated ammonia tank V101, the refrigerated liquid product will leak out and form a pool on the ground. (This may also occur to some extent with pressurised liquids stored at ambient conditions such as liquid chlorine, due to ‘self-refrigeration’ ie evaporative cooling, where much of the liquid will vaporise immediately on vessel rupture but some will not vaporise, or will condense and rain out, and form a pool.) This pool will evaporate and the resulting vapour cloud disperses as a low momentum cloud. Due to the low momentum, the cloud is not turbulent, which is a significant factor in air entrainment and dilution of the cloud. Figure AIII-3 below shows a typical release and some of the inputs into the calculation.

Figure AIII-3: Pool Evaporation Heat Balance



The rate of the evaporation depends on numerous factors, the most important ones being:

- Surface it is released onto (eg. its thermal properties and temperature);
- Atmospheric conditions (a cloud will generally travel further in more stable conditions with lower wind speeds).
- Boiling point of the liquid;
- Pool size.

The concentration of interest is normally related to the flammable or toxic limits set for the hazardous material.

A III.3 Flammable Effects

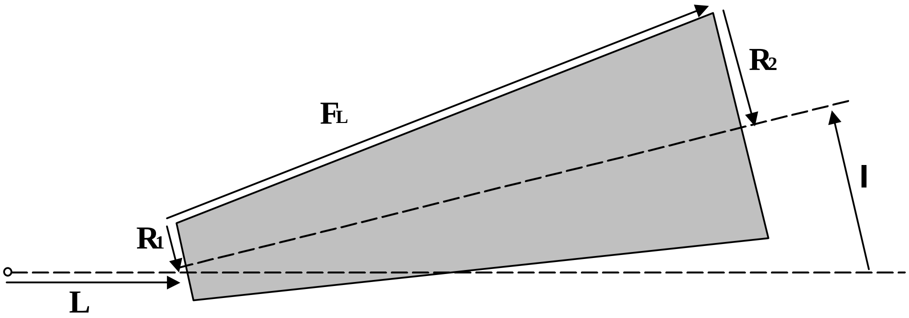
If the release is of a flammable material, it is possible for the release to be ignited. The resulting type of fire (eg. jet, pool, explosion etc) depends on the physical properties of the release and whether the ignition is immediate or delayed. For Orica’s Kooragang Island facility, only jet fire is of interest for flammable effects due to the nature of the materials that can be released.

A III.3.1 Jet Fire

Jet fires are a result of high momentum releases. If a flammable release is ignited instantaneously, a jet fire will result. The flame will have a degree of 'lift off' as the flammable mixture has to dilute to be within the flammable limits. This section briefly discusses the model used for jet fires as well as key parameters in the calculation.

The jet fire calculation utilises the Chamberlain model (Chamberlain 1987). In this model, jet fires are modelled as a conical flame, with the ignited portion lift off, inclination and shape being determined by the material being released, the pressure at which it is being released and the hole size that it is being released through. These release parameters are the main inputs to the jet fire radiation calculations. Figure AIII-4 below shows a graphical representation of the jet fire model.

Figure AIII-4: Truncated Cone Jet Fire Model



Where;

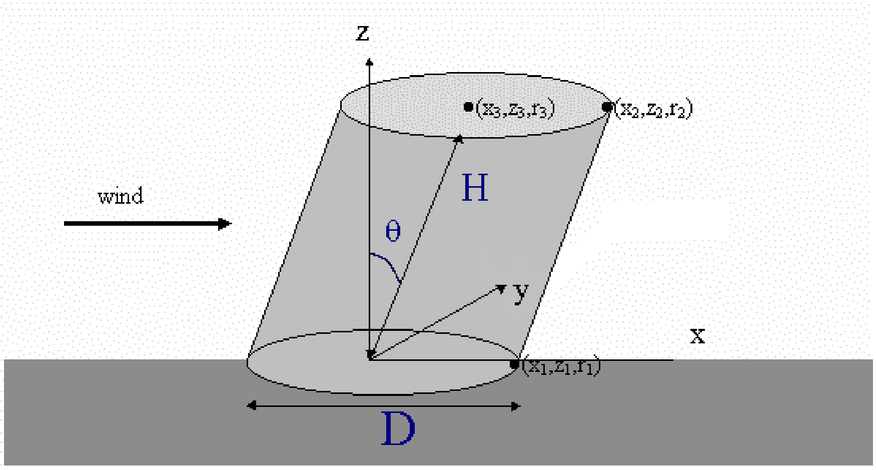
- L = Lift off
- I = Flame Inclination
- R_1 = Flame Base Radius
- R_2 = Flame End Radius
- F_L = Flame Length

The jet fire calculations model radiation from the entire surface of the ignited portion of the jet. This includes radiation from the cone forming the body of the flame, as well as from the ends of the cone. The amount of radiation that a nearby receiver is exposed to is determined by its distance from the flame surface, as well as by the orientation of the flame relative to the receiver. The key parameters in the calculation of the radiation exposure of a receiver are therefore the flame lift off, the flame inclination, and the dimensions of the ignited portion of the jet (i.e. flame length and end radii).

A III.4 Pool Fire

Pool fire flames are modelled as cylinders sheared in the direction of the wind, with diameter *D*, height *H* and tilt angle *q* (measured from the vertical). The flame is described by three circles (c1, c2, c3) arranged along the centreline of the flame, each defined by the downwind co-ordinate *x* and elevation *z* of the centre of the circle, and by the radius *r*. These flame-circle co-ordinates are the main input to the radiation calculations.

Figure AIII–5: “Sheared Cylinder” Pool Fire Model



With these three circles, the radiation calculations will model radiation from two surfaces: from the side of the flame between c1 and c2, and from the top of the flame between c2 and c3. This approach ensures that the bottom of the pool fire is not treated as a radiating surface.

The flame length *H*, flame diameter *D* and tilt angle θ are used to calculate three co-ordinates of the flame, as follows:

$$
\begin{array}{lll}
x_1 = 0.0 & x_2 = H\sin\theta & x_3 = H\sin\theta \\
z_1 = d_{elev} & z_2 = H\cos\theta + d_{elev} & z_3 = H\cos\theta + d_{elev} \\
r_1 = D/2 & r_2 = D/2 & r_3 = 0.0 \\
\phi_1 = 0.0 & \phi_2 = 0.0 & \phi_3 = 0.0
\end{array}
$$

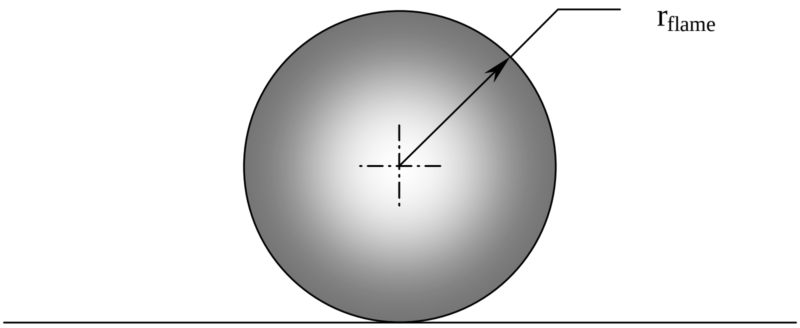
ϕ is the inclination of the circle with respect to the horizontal. For pool fires, this is set to zero for all three circles, but for jet flames each circle may have a different, non-zero inclination.

A III.5 BLEVE

A BLEVE is a ‘Boiling Liquid Expanding Vapour Explosion’ and refers to the release of energy when a vessel of liquefied gas erupts due to flame impingement. If there is direct flame impingement beneath the liquid line on the vessel, the evaporating liquid will provide cooling to the vessel walls. If designed correctly, the vessel pressure relief ensures that the pressure inside the vessel does not rise above design limits. If the flame impingement is on the vapour space, the pressure will also increase but there is inadequate cooling of the vessel wall. The metal temperature will rise to an extent where the mechanical strength is reduced. A point will be reached where the mechanical integrity of the vessel is insufficient for the pressure inside the vessel and the vessel erupts in a BLEVE. The BLEVE itself is the explosion resulting from rapid evaporation of the liquefied gas as it is released to atmospheric pressure. This section describes the equations used to determine BLEVE properties and key input parameters.

BLEVEs are modelled as spheres as shown below, with the shape described by ten circles. The method of using circles is also used for pool and jet fires. These circles are equally spaced along the flame diameter. Each circle is defined by the elevation z of the centre of the circle and the radius r. The centre of the fireball is located immediately above the point of release, at a height equal to the radius of the fireball.

Figure AIII-6: BLEVE Model



The radius of the BLEVE is calculated from:

$$r_{flame} = 2.9 M_{BLEVE}^{\frac{1}{3}}$$

Where M_{BLEVE} is the flammable mass involved in the BLEVE. This is a function of the total mass released and the vapour fraction.

The duration of the BLEVE is important as it gives the time for which personnel are exposed to the effects of the fireball. It is a function of the BLEVE mass, and is given by the equations below:

$$t_{flame} = \begin{cases} 0.45 M_{BLEVE}^{\frac{1}{3}}, & M_{BLEVE} < 37000kg \\ 2.59 M_{BLEVE}^{\frac{1}{6}}, & M_{BLEVE} \geq 37000kg \end{cases}$$

The amount of radiation that a person receives is dependent not only on the duration of exposure but also on their distance from the fireball and the heat emitted by the fireball. The emissive power of the flame surface is a function of M_{BLEVE}, heat of combustion of the material and fire ball size and duration.

A III.6 Overpressure

The overpressure from an explosion can lead to much damage due to the pressure wave which results from the explosion. Generally with an explosion, the pressure wave causes more damage than the fireball. This is because the size of the pressure wave is larger than the fireball.

The TNT equivalence model is used to calculate explosion overpressure. This compares the heat of combustion of the material to the value for TNT, and thus calculates an equivalent mass of TNT. This mass is reduced by a factor for the explosion efficiency.

The explosion overpressure is then calculated according to the relationship developed by Kingery & Bulmash:

$$\log_{10} P = a(\log_{10} z)^2 + b\log_{10} z + c$$

Using the efficiency and equivalence factors, a mass of ammonium nitrate is equated to a mass of TNT. The distances to defined overpressures of interest are calculated using the 'TNT overpressure vs. scaled distance' relationship.

Z is a scaled distance and is calculated according to $z = \frac{R'}{m_{TNT}^{1/3}}$

Where m_{TNT} is the mass equivalence of TNT and R' is the explosion radius.

In calculating the overpressure distance for ammonium nitrate the equation is represented as:

$R' = m_{TNT}^{1/3} \times 10^{(2.061-1.092\log10(P) + 0.158(\log10(P)^2))}$

A III.7 Toxic Impact

The toxic effects of an on-site toxic release are evaluated using a probit equation in SAFETI. The probit uses dispersion data from the consequence modelling to determine the probability of fatality for a person at a given distance from the release, over the entire duration of the release.

The probit function, generally used for calculating fatality consequences from toxic releases is a measure of time dependent probability of fatality from exposure to toxic chemicals. For toxicity it is a function of concentration of exposure and time exposed to this concentration. The general form of the function is:

$$\Pr = k_1 + k_2 \ln\left[C^n t\right]$$

Where Pr = Probit value

C = Concentration of interest

t = time exposed to concentration, C

k_1, k_2, n = constants specific to each material

It is converted to a probability of fatality via the function:

$$P(death) = \frac{1}{2}\left[1 + erf\left(\frac{\Pr - 5}{\sqrt{2}}\right)\right]$$

The Probit functions used are shown in Table AIII-1 below.

Table AIII-1: Toxic Probits

Material	Probit Function Used	Source
Ammonia	-9.82 + 0.71ln[C^2 x t]	DCMR 19853, C3399
Nitrogen Dioxide	-13.79 + 1.4ln[C^2 x t]	Harris DSM78
Chlorine	-10.1 + 1.11ln[C1.65 x t]	Van Heemst

A III.8 Ammonium Nitrate Explosion

The following sections detail the scenarios that can result in the detonation of ammonium nitrate, the modelling of the resultant overpressure and fatalities and finally the risk that this poses on the facility and offsite.

Since completion of the 1992 study, there has been increased understanding of the risks of ammonium nitrate (AN) explosions. In particular, it is now recognised that it is possible for solid AN explosions to occur in storage as a result of intense and prolonged fires, or following substantial contamination with certain sensitising materials. It has also been found that solid AN may detonate if exposed to sufficiently high energy initiation, such as from a high energy missile or projectile which could be produced in an adjacent plant detonation.

Highly concentrated AN solutions may explode if sufficiently contaminated and acidic, when heated for prolonged periods to abnormally high temperatures.

As a result additional hazardous scenarios have been included in the PHA covering such events.

A III.8.1 Detonability of Ammonium Nitrate

Ammonium nitrate, as prepared by Orica, is classed as an oxidiser and has the following characteristics:

- It cannot burn without a combustible material present;
- It melts at 169ºC;
- It starts to decompose after melting, releasing fumes of NO_X, HNO_3, NH_3 and H_2O;
- At roughly 290ºC decomposition reactions of both exothermic and endothermic types generate an equilibrium keeping the temperature constant at this temperature, noting that this is dependant upon the decomposition gases being able to vent.

The sensitivity of ammonium nitrate to detonation is largely dependant on three variables; temperature, confinement and contamination. Without any of these three being present, ammonium nitrate requires a strong initiation charge (an example being high explosives) to detonate.

Higher temperature makes ammonium nitrate more sensitive to detonation as detailed below:

- Higher temperature causes decomposition. The ammonia, which is evolved, causes the pH of the remaining ammonium nitrate to drop, leading to greater detonation sensitivity.
- High temperature decomposition can lead to bubbles in the molten ammonium nitrate, which reduces the density of the liquid and hence increases sensitivity to detonation.

Confinement makes ammonium nitrate more sensitive to detonation as detailed below:

- Confinement of molten ammonium nitrate increases the sensitivity to detonation by restraining the decomposition gases.
- For ammonium nitrate, typically 80 atmospheres are required for detonation.

Contamination makes ammonium nitrate more sensitive to detonation as detailed below:

- As a pure compound, ammonium nitrate is less sensitive to detonation than if it is contaminated. At 1% contamination with hydrocarbons (eg. oils / diesel, etc.), it is at its most sensitive.
- Other impurities, such as some metals, acids (or low pH from decomposition) and salts, have a strong catalytic effect on the decomposition of ammonium nitrate and hence increase its sensitivity to detonation.

Interactions between heat, confinement and contamination combine together to increase the detonation sensitivity of ammonium nitrate, often resulting in an impact greater than their individual effects.

A III.8.2 Factors Influencing Ammonium Nitrate Explosions

Without any of the three variables previously discussed being present, ammonium nitrate requires a strong initiation charge to detonate. This scenario represents a malicious activity (such as terrorism) which is not assessed numerically as part of a Quantitative Risk Assessment (QRA). The threat of malicious activity is best assessed and mitigated through security assessments and control measures.

There is little value in attempting to quantify the risk of malicious activities due to the uncertainty involved in estimating the frequency of persons being sufficiently disgruntled with an organisation (or the connections to an organisation a disgruntled person may perceive to exist) to actively damage facilities or harm personnel. It should be noted that there may be a portion of the historical accident events included in the data sets used in this study which were malicious activities where the cause was not accurately identified.

Once intentional detonation of ammonium nitrate is excluded from the QRA, only accidental scenarios remain to be assessed for credibility. Assessing the credibility of accidental scenarios is carried out to ensure that alarmist or excessively conservative scenarios are not modelled and that those scenarios that are modelled are considered to be as realistic as possible and reflect the historical record. Accordingly, the characteristic of such accidental detonations is usually the presence of all three contributors; heat, confinement and contamination.

Detonation from Heat

Heat alone has never been recorded to cause detonation of ammonium nitrate, which is not confined or contaminated. However, heat can lead to ammonium nitrate melting and flowing to areas where confinement or contaminants may also be contributors. There, toxic gases can also be emitted due to heating of ammonium nitrate.

A vehicle fire on its own in the ammonium nitrate Bulk Store is unable to cause an ammonium nitrate explosion. However, if burning fuel from the vehicle were to mix with molten ammonium nitrate and an explosion from the vehicle caused high-velocity shrapnel to impact the molten contaminated ammonium nitrate, an explosion is possible, an event borne out by the historical record [Shah, 1996 - Table 4, No. 24].

Detonation from Confinement

Confinement alone has never been recorded to cause detonation of ammonium nitrate, which is not heated or contaminated. However, heated ammonium nitrate will decompose and release vapours which if confined leads to increased pressure and greater sensitivity to detonation. While the pressure required is 80 atmospheres, this can be reduced by the presence of contaminants. This can reduce the pressure required for detonation to 20 atmospheres.

The historical record shows several fatalities caused by maintenance work on screw conveyor shafts, which have become filled with ammonium nitrate over time. The heat from welding causes decomposition of the trapped ammonium nitrate, the pressure increases leading to detonation and injuries or fatalities [Shah, 1996 - Table 4, No. 6, 10, 25, 29, 31, 61].

Detonation from Contamination

Contamination can lead to catalytic decomposition of ammonium nitrate and can also (if a combustible material) lead to fire, which adds heat to the scenario. Accordingly, Australian Standard "AS 4326-2008: The storage and handling of oxidizing agents" directs that the storage of ammonium nitrate be free of contaminants and details the housekeeping requirements to ensure this. In the instance that ammonium nitrate solution is stored in acidic conditions, the decomposition can lead to bubbles forming in the solution. With heating, these bubbles may lead to detonation [Shah, 1996 - Table 4, No. 48, 60, 69].

A III.8.3 Credible Detonation Scenarios

Appendix II details the significant ammonium nitrate inventories on site. Each one is assessed for credible scenarios leading to detonation. Note that potential fire or fumes as an outcome is not detailed here, only detonation. Consequences of an ammonium nitrate explosion were determined according to the following steps.

The plume of combustion products resulting from an ammonium nitrate fire in previous studies (eg. Bunbeg Harbour, etc.) have been shown to be buoyant due to the high temperatures involved, and disperse to non-hazardous concentrations before returning to grade. On this basis, toxic effects from ammonium nitrate fires are excluded from the analysis.

Proportion Sensitised to Detonation

The proportion of material sensitised to detonation helps define the consequences of an explosion. As detailed in Section A III.8.2, the action of higher temperature, confinement and contaminants sensitise ammonium nitrate to explosion. However, the effects of heat, confinement or contamination may not extend to the entire inventory.

Explosion of ammonium nitrate in storage could lead to offsite effects. Bulk ammonium nitrate prill is stored in freestanding piles, hence it is difficult for the influence of heat, confinement and contaminants to carry over the entire inventory. A review of all the known significant ammonium nitrate accidents between 1961 to the present [Shah 1996 and GHD Review] has only resulted in two cases where bulk prill has exploded. These are the Toulouse incident [Dechy, 2004, event occurred in 2001] and the Cherokee incident [Shah 1996, Table 4, Entry 24, event occurred in 1973]. The Toulouse incident involved contamination of prill and the Cherokee incident involved a fire with a front-end loader. In both cases only a small proportion of the ammonium nitrate present was detonated. The proportion of material involved in the explosion is taken in the model as a realistic proportion of the total present.

A III.8.4 Overall TNT Equivalence

The Overall TNT Equivalence of ammonium nitrate provides an estimate of the blast energy of ammonium nitrate relative to TNT, best represented by the following equation:

Overall TNT Equivalence = Chemical TNT Equivalence x Explosive Yield

The Chemical TNT Equivalence is a ratio based on the relative thermodynamic properties of the two chemicals. Published values ranges from 55% to 32%, depending on the thermodynamic method used. Orica has adopted an "industry" value of 32% chemical equivalence (as referenced e.g. in the Queensland Explosives Inspectorate Information Bulletin 53).

The estimate of Explosive Yield is based on expert judgement within Orica Mining Services (via the Orica AN Expert Panel).

While there are several categories of ammonium nitrate products, the predominant type produced at Orica's Kooragang Island facility is low-density (i.e.< 0.92 g/cc), porous prills/granules, often referred to as technical grade ammonium nitrate (TGAN). For this material, Orica proposed three distinct explosion scenarios, with the corresponding estimates of Overall TNT Equivalence:

- High energy decomposition due to chemical contamination, 16% Overall TNT Equivalence;
- Molten AN decomposition from radiation and confinement, 5% Overall TNT Equivalence;
- Detonation from high energetic impact, 32% Overall TNT Equivalence.

The equivalency and efficiency used in this QRA mutually agreed between Orica and NSW Department of Planning are listed below. These figures are considered more conservative than those figures originally proposed by Orica.

Table AIII-2: Overall TNT Equivalency Values used in QRA

	Bags	Bulk in Bays	Bulk in free Stockpiles
Fire	20%	15%	10%
Contamination	20%	15%	10%
Projectile	32%	32%	32%

A III.8.5 Thermal Decomposition of AN

Fire involving ammonium nitrate and thermal decomposition results in the release of toxic fume, which contains NO_X, typically nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 gas is considered more toxic than NO.

There is limited published data on NOx generation from AN fires. The investigation completed by W. D. Adams for UK HSE estimated NO_2 releases for:

1. Externally applied heat to AN in a pile produced NO_2: 3g/s/m^2 floor space. This is applied to the Bulk Store fire and thermal decomposition.
2. Fire involving AN in bags stacked on timber pallets produced NO_2: 10 g/s/ per 250kg bag AN. This is applied to Bag Store fire and thermal decomposition.

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Appendix IV – Assumptions

(Refer to Appendix I in 2009 PHA report Rev 8)

APPENDIX IV

A IV Key Modelling Assumptions

In the process of undertaking the quantitative risk assessment of Orica's Kooragang Island facility, a number of key modelling assumptions have been identified that are critical to the risk results. This appendix lists the key modelling assumptions along with their assumed operating parameters.

The majority of modelling assumptions are associated with risk mitigation measures and are presented here as essential requirements to the design and operation of the facilities. These measures were developed through discussions with Orica engineers, safety and operations specialists. GHD has recorded these key mitigation measures here to ensure that the operation and performance of key mitigation measures is clearly defined as a key input into the risk results.

A IV.1 General Assumptions

The following assumptions are applicable to the risk modelling of all facilities.

- For vessels not connected to a dump system, leaks continue until the whole inventory is lost, but subject to a maximum time limit of 60 minutes. Within a 60 minute period all releases will have reached a steady state in term of hazard distance and potential fatal impacts. Therefore the modelling of consequences beyond the 60-minute period is not required. This assumption is not critical to the risk analysis.
- The study focus is on release events capable of producing an offsite fatality risk and injury / irritation risk; events that pose only an on-site risk are not modelled.
- The time to detect, investigate and isolate a process leak (other than for the ammonia transfer pipeline) using remotely operated valves (ROVs) has been (conservatively) assumed and modelled as ten minutes. The ten-minute response time is estimated from Orica response systems based on the following information from Kooragang Island Operations Specialists: Within two minutes of a major release in the processing plant a leak will be detected. The operators wearing appropriate PPE will investigate the indicated area and identify the point of leakage and initiate the necessary isolation measure(s). The time required for this operation is estimated to be eight minutes.
- Under Orica's operating philosophy, in the event of gas detection, the appropriate response will be decided by the operators on a case-by-case basis. Training in the selection of the appropriate response to different release scenarios is provided to all operators on a regular basis.
- Natural gas is imported to the site via a buried cross-country pipeline. The natural gas feeds the Ammonia Plant.
- The major plant equipment items and vessels containing significant inventories of hazardous materials are modelled. Minor lines and fittings are not modelled, as the consequences of failures of such items will be included in the failure scenarios for the major plant equipment items.
- The compositions of streams in the plant are simplified. For example, this enables natural gas streams typically comprising 90% methane, 8% ethane, 1.5% propane and 0.5% heavier components to be modelled as pure methane, which simplifies the analysis but does not affect the results of the modelling.

A IV.2 Ammonia Plant

- Liquid ammonia (99.88% concentration) is transported via pipeline to the Ammonia Storage Tank. The ammonia transfer pipelines can by isolated remotely by actuated valves. For the base case (existing operation) in the event of loss of containment from the pipeline ammonia will be released for up to 30 minutes at the normal production feed rate.
- A major leak in the Ammonia Plant will be detected and isolated in 10 minutes.
- The failure of the flash drums and receiver containing ammonia in the Ammonia Plant will result in loss of total inventory of the vessel involved.

A IV.3 Ammonia Transfer and Storage

- The atmospheric Ammonia Storage Tank, V101, is surrounded by a bund (4m in height) designed to contain the full content of the tank. The bund will not fail during rupture of the tank.
- In the event of a release of refrigerated ammonia within the storage tank bund, the spill surface temperature will drop rapidly as the cold ammonia moves across the surface.
- All potential liquid spills from the tank and associated plant equipment are located within the bund.
- In the event of a release of ammonia from the tank all liquid droplets are assumed to be contained within the bund.
- The ammonia pipeline from the ship is mostly underground. Pipe failure and ammonia release is considered only for the exposed section of the pipeline. The underground section 100m approx is located within a secondary containment pipe – a failure from NH3 pipe in this section could result in NH3 emitting from either end of the containment pipe.
- An ammonia release at the wharf involving the pump or pipe is assumed to result in 50% of the ammonia falling into the water and 50% onto dry land. Ammonia ending up in the water is assumed to result in 60% of ammonia being absorbed by the water and 40% evolved into the air.
- Ammonia bullets supply the Nitric Acid and Ammonium Nitrate Plants.
- In the event of a major leak involving the ammonia transfer pipeline from Ammonia Plant to other users, the time to detect and isolate the pipeline is estimated to take 30 minutes for the Existing case. There will be some delay in isolating the pipeline including the time it takes to detect the leak depending upon the location of the leak. Currently there are no gas detectors to warn the control room in the event of a leak.
- For the ammonia transfer pipelines for the Expanded Facility the time to detect and isolate a leak has been assumed to be 5 minutes based on appropriate means of leak detection (combination of gas detection and flow detection). Trevor Kletz in Lees Vol 2, page 17/154, suggests that ‘if a remotely controlled emergency isolation valve is fitted, it may be assumed that it will be operated within 5 minutes’.

A IV.4 Ammonium Nitrate Production and Storage

- Explosions of ammonia nitrate (AN) have been identified as a hazard associated with the production and storage of ammonium nitrate.

- Explosions involving AN solution is considered for solutions greater than 85% strength. Explosions involving AN solution lower than 85% strength is considered extremely unlikely and has not been modelled.
- Explosion involving dry ammonium nitrate in production is considered for the unit operations with greater than 1 tonne inventory.
- The separation distance, to be determined by Orica, between the bulk stock piles in the Bulk Store and bag stacks in the Bag Store are assumed to be sufficient to prevent sympathetic explosion.

Reference:

1. Lees F.P, Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, Vol 2, 2nd Edition, 1996.

Appendix V – Consequences

This Appendix has been withheld from the publicly exhibited Environment Assessment as it is an "exempt document" for the purposes of the Government Information (Public Access) Act 2009 (NSW).

Appendix VI – Frequency Analysis

This Appendix has been withheld from the publicly exhibited Environment Assessment as it is an "exempt document" for the purposes of the Government Information (Public Access) Act 2009 (NSW).

Appendix VII – Methodology

(Refer to Appendix I in 2009 PHA report Rev 8)

APPENDIX VII

A VII Individual Fatality Risk

Location Specific Individual Risk (LSIR) is a measure of the level of risk an individual would be exposed to, if continuously present in a particular location for a whole year (or for the full duration of the activity). It does not take into account any actions that people might take in the area to escape from an event, or the actual time that people are present. It is also independent of land use and exposed population type. The risk exposure is calculated for all relevant hazards and summed to give the overall level of risk in each location.

The LSIR for any given location, failure case and associated consequence outcomes (e.g. pool fire, jet fire, flash fire, vapour cloud explosion (VCE), toxic exposure) can be represented as:

$$LSIR = R \times I \times \sum (M \times C \times F)$$

where:

> $\sum$ = Sum of probability of fatalities for each alternate type of consequence (jet fire, toxic release etc) for the location for which the LSIR is calculated.
>
> R = Release frequency.
>
> I = Ignition probability (not relevant for toxic releases).
>
> M = Fractional probability of each alternate type of consequence occurring (governed by the SAFETI MPACT parameter file(s)).
>
> C = Consequence result for each type of consequence in terms of level of toxic gas, radiant heat or explosion overpressure, experienced at the location.
>
> F = Fractional probability of fatalities for each alternate type of consequence result, based on exposure level / event duration, experienced at the location.

The <u>total</u> LSIR at any location may be calculated by summing the frequency of fatalities for all release events and consequence outcomes for that location.

NSW Individual Risk Criteria

The New South Wales Government requires that new potentially hazardous developments comply with the risk criteria defined and published by NSW DoP *Hazardous Industry Planning Advisory Paper No. 4 – Risk Criteria for Land Use Safety Planning* (HIPAP 4). The criteria covers public fatality, injury, and irritation risk criteria to which all new potentially hazardous industrial developments must adhere. The fatality criteria are summarised in Table AVII-1.

Table AVII-1: Risk Criteria published in HIPAP 4

Exposure Type	Risk Levels
Hospitals, schools, child-care facilities and old age housing developments	Half in a million per year (0.5 x 10^{-6} per year)
Residential developments and places of continuous occupancy (hotels/resorts)	One in a million per year (1 x 10^{-6} per year)
Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres	Five in a million per year (5 x 10^{-6} per year)
Sporting complexes and active open space areas	Ten in a million per year (10 x 10^{-6} per year)
Industrial sites	Fifty in a million per year (50 x 10^{-6} per year)

The risk contours generated by SAFETI provide a means to determine whether the risk presented by the facility exceeds any of the defined criteria.

For an industrial site, the risk of fatality should, as a target, be contained within its boundary at a level of fifty-in-a-million (50x10^{-6}) per year. HIPAP 4 does however allow for some flexibility in the interpretation of this criterion. In particular, it indicates that “where an [adjacent] industrial site … involves only the occasional presence of people, such as in the case of a tank farm, a higher level of risk may be acceptable”. The neighbours around the KI facility that would meet this definition are:

- Grain storage with occasional presence of people;
- Vacant space that could be occupied in the future;

A VII Societal Risk

Societal risk sets out how risks to the public vary with changing levels of hazard severity. It is generally represented graphically as a curve on log-log axes, called an FN-curve, with the frequency (F) on the vertical axis plotted against the cumulative fatalities (N) on the horizontal axis.

The FN-curve is often plotted against two regulatory risk limits; the unacceptable and tolerable risk limits, therefore defining three zones on the FN-curve. By convention, the tolerable risk limit is taken as two orders of magnitude below the unacceptable risk limit.

The three risk zones defined on a typical FN-curve are:

a) Above the upper risk limit, where the risk level is unacceptable;

b) Between the upper and lower risk limits, where the risk level is deemed tolerable . In this zone, the risk level should be "as low as reasonably practicable" (ALARP), i.e. any further risk reduction is not commensurate with the cost of achieving that risk reduction. The ALARP principle arises from the fact that it would be possible to spend an inordinate amount of time, effort and/or money attempting to reduce a negligible risk to near to zero.

c) Below the lower risk limit, where the risk level can be considered to be acceptable and therefore there is no need to consider any risk reduction measures.

By applying tests (a), (b) and (c), a series of tolerability limits can be proposed for incidents involving a defined number of casualties.

FN-curves allow a visual interpretation of the effectiveness of proposed risk reduction measures as significant changes in the frequency of large-fatality events may not easily be detected in risk assessments due to high frequency / low impact events dominating an analysis.

International Experience

Major hazardous incidents involving multiple fatalities (e.g. Seveso 1976, Flixborough 1978 and Bhopal 1984) were key drivers for the development of societal risk criteria. Leaders in the development of criteria for societal risk have been the UK, Netherlands and Hong Kong.

The UK HSE (UK Health and Safety Executive) has undertaken fundamental development work over many years in establishing appropriate values of societal risk. The UK HSE work has been used as the basis for developing societal risk criteria in some other European countries and in other parts of the world.

Guidance on societal risk was first developed in the province of Groningen in the Netherlands, primarily in response to several major hazardous incidents in Europe. In the Asian region, societal risk criteria have been published in Hong Kong and it is understood that these are based on modification of the UK criteria. The development of societal risk criteria in Hong Kong was proposed as a result of pressure for residential developments close to petrochemical facilities.

Australian Experience

The values for the societal risk limits were established by DNV (Det Norske Veritas) in 1984 (believed to be based on work from the Netherlands).

The NSW Department of Planning has published FN criteria for societal risk assessment in its Land Use Planning Safety Studies for Port Botany (1996) and for the Botany Randwick Industrial Area (2001), and the values are given in Table AVII-2 below. These were a 'composite of some typical criteria adopted elsewhere.'

Table AVII-2: Published DoP FN-Curve Limits

Number of Fatalities	Frequency of N or more fatalities	Frequency of N or more fatalities
10	$1x10^{-4}$	$1x10^{-6}$
1000	$1x10^{-7}$	$1x10^{-9}$

A VII Fatality Impact Levels

A VII.1 Heat Radiation Criteria

The heat radiation fatality probability is based on the effects of heat radiation in the *Hazardous Industry Planning Advisory Paper (HIPAP) No's 4 and 6* by the NSW Department of Planning. Table AVII-3 is an extract from the HIPAP 4 and 6 guidelines.

Table AVII-3: Effects of Thermal Radiation

Heat Radiation kW/m^2	Effect
1.2	Received from the sun at noon in summer
2.1	Minimum required to cause pain in 1 minute
4.7	Will cause pain in 15 – 20 seconds and injury after 30 second exposure (2nd degree burns)
12.6	Significant chance of fatality for extended exposure. High chance of injury. After long exposure causes the temperature of wood to rise to a point where it can be readily ignited by a naked flame. Thin steel insulation on the side of the fire may reach a thermal stress level high enough to cause structural failure.
23	Likely fatality for extended exposure and chance of fatality for instantaneous exposure. Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures which can cause failures. Pressure vessel needs to be relieved or failure will occur.
35	Cellulosic material will pilot ignite within one minutes exposure. Significant chance of fatality for people exposed instantaneously.

SAFETI uses a probit function to calculate the fatality rate from thermal radiation. The probit function uses exposure time and thermal radiation level to estimate a fatality rate. The probit function used for the KI model is:

$$Y = -36.38 + 1.56 \ln(I^{1.33} \times t)$$

Where I = thermal dose in W/m^2 and t is time in seconds.

This probit is used for pool fires, jet fires and fireballs from explosions or BLEVES.

A VII.2 Flash Fire Criteria

In terms of consequence criteria the hazard distance relating to the dispersion distance is taken at less than the Lower Flammable Limit (90% of LFL). This distance defines the size of the flash fire engulfed region from which escape is not possible, ie 100% fatality inside this envelope. Modelling flammable clouds to 90% LFL is conventionally assumed to account for longer than anticipated dispersion anomalies (incomplete mixing, ground effects, building wake effects etc). Outside the cloud the fatality probability is assumed to be zero.

A VII.3 Boiling Liquid Evaporating Vapour Explosion (BLEVE) / Fireball Fatality Criteria

Exposure to a thermal dose of 250 kJ/m^2 is taken to be fatal. For a radiant heat level of 23 kW/m^2 this would correspond to a duration of 11 seconds.

A VII.4 Explosion Overpressure Fatality Criteria

The explosion overpressure fatality rate criteria used is also based on the only consequence effects publicly documented in Australia, the Hazardous Industry Planning Advisory Paper (HIPAP) No. 6, by the NSW Department of Planning. is an extract from the HIPAP guideline.

Table AVII-4: General Overpressure Consequence Levels

Overpressure level (kPa)	Consequence of Overpressure
3.5	90% glass breakage. No fatality and very low probability of injury from overpressure.
7	Steel frame of a clad building slightly distorted. Associated with an injury probability of 10%, but a 0% chance of fatality.
14	Partial collapse of timber framed buildings. Buildings may become uninhabitable (again no fatalities are expected).
21	Storage tanks may buckle and fail. Can result in a 20% chance of fatality among people in a building but still no fatalities among those outside.
35	Timber framed buildings become uninhabitable, plant items may be overturned. There is a 50% chance of a fatality for a person in a building and 15% chance of a fatality for a person in the open.
70	100% chance of fatality for a person in a building or in the open. Complete demolition of buildings.

From the above table of overpressure effects, consequence impacts were assumed based on the level of overpressure received. Therefore the assumed fatality levels were conservatively assumed and used in the risk assessment as follows:

- At 70 kPa overpressure, 100% chance of fatalities for outdoor population.
- At 35 kPa overpressure, 15% chance of fatalities for outdoor population
- At 21 kPa overpressure, 1% chance of fatalities for outdoor population.

A VII.5 Toxic Criteria

If the release is a toxic material, it is necessary to attempt to relate the specific atmospheric concentrations and durations of exposure following a release to the level of toxicity produced within the surrounding population. The impact is determined from reports of accidental single exposure of humans to the airborne substance, or generated in single exposure inhalation studies in animals. All the data available in this area relates to toxic effects, which become apparent soon after exposure (acute impact).

Other effects, including mutagenicity, carcinogenicity and teratogenicity, may also arise as a result of a single exposure. These chronic impacts are not considered in this study.

For most substances, existing reliable data on acute effects arising from a single exposure in humans are sparse. For a few substances some information is available from their use in warfare (e.g., chlorine). Nevertheless, for most substances the data is limited to a few reports of accidental exposures, often involving only a few people and rarely containing accurate measurements or even estimates of exposure concentrations and times.

Consequently, heavy reliance needs to be placed on the results of experiments on animals, in attempting to predict the responsiveness of a human population. In general, extrapolation from laboratory animals to humans with any degree of accuracy and reliability is difficult, principally because of the inadequate information. Even so, for most substances it is necessary to make the assumption that results from animal experiments will be representative of effects on the human population, in terms of both the nature of the effects produced and the dose-effect relationships observed.

For some substances the scarcity of toxicity data will make any analysis extremely tenuous, and in these situations further experimental work by manufacturers or their trade associations would be advisable if important decisions depend on the results. For Orica, the public domain information available for the toxic materials assessed is suitable to base this study on.

Toxicity of a material can be measured against criteria for either fatality or survivability. Fatality criteria can be presented in terms of probits or dangerous dose. A probit is a mathematical system for estimating the probability of fatality based on the concentration and time exposed to a particular material. A dangerous dose is a single criterion that defines a certain level of dosage received over any time period that will result in fatality. Survivability criteria are those that, if a person is exposed to levels below the criteria, there is strong confidence that he or she will survive. There can be considerable separation between survivability and fatality criteria, which makes them difficult to compare.

A VII.6 Ignition Probabilities

Ignition can be either immediate or delayed. This section discusses the ignition probabilities for both immediate and delayed ignition.

A VII.6.1 Immediate Ignition Probability

Immediate ignition and explosion probabilities are used in this study. These are derived from Cox, Lees and Ang data (1990). Cox Lees & Ang ignition probabilities are based on historical offshore data, in particular the North Sea and Gulf of Mexico data (i.e. process leaks, blow-outs etc). The likelihood of immediate ignition takes into account all causes including the initiating mechanism for a release. Table AVII-5: shows, the immediate ignition probability as a function of the phase of the material released (liquid or gas / aerosol) and the release rate.

Table AVII-5: Immediate Ignition Probabilities

Release	Immediate Ignition Probability	
	Gas / Aerosol	Liquid Spill (pool evaporation)
Small	0.5%	3%
Medium	4%	4%
Large	10%	6%
Full-bore	30%	8%

A VII Injury and Irritation Risk Assessment Methodology

Different people have different levels of tolerance to toxic chemicals depending upon the physiological condition, weather condition, exposure level and duration. The exposure levels that can cause injury or irritation are reported in various sources, some of the common exposure levels reported are given in Appendix I.

The toxic risk criteria of NSW DoP as given in the 'Hazardous Industry Planning Advisory Paper HIPAP No 4' for injury risk requires assessment for:

1. Injury Risk:

   Toxic concentrations in residential area should not exceed a level, which would be seriously injurious to sensitive members of the community following a relatively short period of exposure at a maximum frequency of 10 in a million per year.

2. Irritation Risk:

   Toxic concentrations in residential area should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year.

This section describes the criteria adopted for the assessment of injury and irritation risk associated with toxic chemicals.

A VII.1 Acute Exposure Guidelines Limits (AEGL)

The US EPA have developed the AEGL primarily to provide guidance in the event of accidental exposure to a particular chemical from the release or spill of a particular chemical that can involve the general public. They are designed to protect the general population including the elderly and children.

The AEGL have been developed for short term exposure to the hazardous chemicals. The AEGLs are defined as:

AEGL-1: is the airborne concentration (expressed as parts per million or milligrams per cubic meter (ppm or mg/m^3)) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2: is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3: is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

AEGLs are defined for 10 minute, 30 minute, 60 minute, 4 hour and 8 hour exposures.

A VII.2 Emergency Response Planning Guideline (ERPG)

The Emergency Response Planning Guideline (ERPG), developed by AIHA Emergency Response Planning Committee, are based on concentrations at which some adverse effect on people can be expected. ERPG are based on exposure for 1 hour duration. The definitions of ERPG are:

> ERPG-1: is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.
>
> ERPG-2: is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
>
> ERPG-3: is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

The ERPG approach is based on 1 hour exposure duration whereas the NSW DoP HIPAP No 4 injury risk criteria requests assessment based on short term exposure.

A VII.3 UK HSE

The UK HSE has developed a method, Specified Level of Toxicity (SLOT), for assessing the exposure to toxic material for land use planning (LUP). UK HSE has defined SLOT as:

- Severe distress to almost every one in the area;
- Substantial fraction of exposed population requiring medical treatment;
- Some people seriously injured, requiring prolonged medical treatment;
- Highly susceptible people possibly being killed.

SLOT is based on concentration and exposure time given by the formulae:

SLOT = C^nT

Where:

- C =concentration in ppm;
- T = time in minutes.
- n = constant specific to each material (can be obtained from the UK HSE website)

SLOT values for:

- Ammonia: 3.78×10^8 ppm^n.min (n=2);
- Chlorine: 1.08×10^5 ppm^n.min (n=2); and
- Nitrogen Dioxide: 9.6×10^4 ppm^n.min (n=2).

The SLOT approach is on the borderline of fatality and does not meet the NSW DoP injury and irritation risk criteria.

A VII.4 Method Selected

The AEGL approach developed by the US EPA has been selected to assess the injury risk and irritation risk for Kooragang Island plant expansion.

- The 10 minute AEGL-1 will be used to assess the off site irritation risk from exposure to ammonia (30 ppm), chlorine (0.5 ppm) and nitrogen dioxide (0.5 ppm).
- The 10 minute AEGL-2 will be used to assess the off site injury risk from exposure to ammonia (220 ppm), chlorine (2.8 ppm) and nitrogen dioxide (20 ppm).

The main reasons for selection are:

- The definition of AEGL-1 is reasonably similar to the definition of the HIPAP 4 irritation criterion, in particular odour is not included, but is conservative compared to HIPAP4 in that it does not refer to 'coughing' or 'acute physiological responses'. The HIPAP 4 definition also does not mention the AEGL-1 phrase 'transient and reversible';
- The definition of AEGL-2 is reasonably similar to the definition of the HIPAP 4 injury criterion, taking 10 minutes as 'a relatively short period of exposure'. It may be conservative for some chemicals in that it also includes the phrase 'or the impaired ability to escape' which is not specifically mentioned in the HIPAP4 injury definition;
- It is specifically developed for assessing the risk to the general population including sensitive (susceptible) individuals, the elderly and children;

It should be noted for the three toxic materials considered here, the AEGL-1 values are constant with time ie AEGL-1 (10 minutes) is the same AEGL-1 (8 hours).

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Appendix E

PHA – Nitric Acid Tank

Appendix E PHA - Nitric Acid Tank

PRELIMINARY HAZARD ANALYSIS
NITRIC ACID TANK,
ORICA AUSTRALIA PTY LTD
KOORAGANG ISLAND, NSW

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13 November 2013

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Preliminary Hazard Analysis, Nitric Acid Tank, Orica, Kooragang Island

Disclaimer

Rev	**Date**	**Description**	**Reviewed By**
A	1/11/13	Draft for Comment	Orica
B	13/11/13	Comments on Draft Version Included	Orica

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EXECUTIVE SUMMARY

Orica Australia Pty Ltd (Orica) is proposing to build a nitric acid storage tank on the western boundary of the Kooragang Island facility. The tank is proposed to replace the nitric acid tank originally approved in the site's expansion project approval (08_0129), which has yet to be constructed. The proposed modifications to the site are summarised as follows:

- A 10,000 nitric acid storage tank;
- New pipelines and pipe bridge to connect the new tank to the existing nitric acid import / export pipeline;
- A tank vent scrubber with associated pumps and piping; and
- An additional nitric acid transfer pump.

To assess the risk associated with the nitric acid tank changes, a preliminary hazard analysis (PHA) has been performed.

The risks associated with the proposed nitric acid tank and associated systems at the Orica Kooragang Island have been assessed and compared against the Department of Planning and Infrastructure (DoPI) risk criteria.

The results of this PHA indicate that the risks associated with the proposed nitric acid tank and systems comply with the DoPI guidelines for tolerable fatality, injury, irritation and societal risk. Also, risks to the biophysical environment, the risk of propagation and the impact on cumulative risk in the Kooragang Island area from releases are acceptable (subject to the recommendations below).

Reviews of historical incidents associated with nitric acid facilities have shown that the off-site risks relating to losses of containment are acceptable due to the limited impact from releasing a corrosive liquid. This is supported by the findings of the site's existing PHA.

The recommendations from this study are:

1. Include the tank level instrumentation in a Layers of Protection Analysis (or similar) to determine the required level of reliability to reduce the risk of tank overflow to an acceptable level.
2. Perform a Layers of Protection Analysis (or similar) during the design phase of the project to ensure the risk of liquid releases to the environment is acceptable. Preferably, the bund sump pump system should be designed using the principles of inherent safety, i.e. design out the hazard. In this case, do not have a path for pumping any spilt nitric acid to the environment.
3. Perform a HAZOP study and a construction safety study on the proposed changes.
4. Update the existing safety management system, including the emergency response plan, for the proposed new tank and equipment.

GLOSSARY

AEGL	Acute Exposure Guideline Level
ALARP	As Low As Reasonably Practicable
AN	Ammonium Nitrate
ANP	Ammonium Nitrate Plant
ANS	Ammonium Nitrate Solution
AS/NZS	Australian Standard / New Zealand Standard
DoP	Department of Planning
DoPI	Department of Planning and Infrastructure
HAZAN	Hazard Analysis
HAZOP	Hazard and Operability Study
HIPAP	Hazardous Industry Planning Advisory Paper
LTI	Lost Time Injury
MTI	Medical Treatment Injury
NAP	Nitric Acid Plant
NDT	Non-Destructive Testing
NOx	Oxides of Nitrogen
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PHA	Preliminary Hazard Analysis
PPE	Personnel Protective Equipment
QRA	Quantitative Risk Analysis
SH&E	Safety, Health and Environment
SSAN	Security Sensitive Ammonium Nitrate
STEL	Short Term Exposure Limit
TLV - TWA	Threshold Limit Value – Time Weighted Average
TNO	The Netherlands Organisation of Applied Scientific Research

REPORT

1 INTRODUCTION

1.1 BACKGROUND

Orica Australia Pty Ltd (Orica) is proposing to build a 10,000 tonne (te) nitric acid storage tank at the Kooragang Island facility.

In 2012, Orica was granted approval to construct and operate a 2,000 tonne nitric acid storage tank as part of a site expansion project. This project has been delayed; however, additional storage of nitric acid is required to meet market demands for ammonium nitrate.

In lieu of the approved 2000 te tank, Orica is now proposing to construct a 10,000 te tank to store imported nitric acid or extra capacity nitric acid produced on site. The tank will allow Orica to meet the short term ammonium nitrate market demand during the transition period prior to constructing the additional approved Nitric Acid and Ammonium Nitrate plants.

The new tank is proposed to be connected to an existing, approved nitric acid transfer line from the K2 wharf at Kooragang Island.

Originally, this line was proposed to be used for nitric acid export to ships for delivery to overseas markets. This line was assessed in a Preliminary Hazard Analysis (PHA) and HAZOP study in 2004 (Refs 1 and 2) and found to comply with the Department of Planning (DoP) risk criteria in Hazard Industry Planning Advisory Paper (HIPAP) No. 4 (Ref 3).

In 2009, it was proposed to use the transfer line for importing nitric acid. The 2004 PHA was reviewed for any impacts on the conclusions (Ref 4). It was again found that the line operation would comply with the risk criteria in HIPAP No. 4. The import operation was also reviewed via the HAZOP technique (Ref 5).

As part of the project requirements for the new nitric acid 10,000 te storage tank, a Preliminary Hazard Analysis (PHA) is required to be produced in accordance with the guidelines published by the DoP HIPAP No 6 (Ref 6).

Orica has appointed Pinnacle Risk Management Pty Ltd (Pinnacle Risk Management) to produce the PHA.

1.2 OBJECTIVES

The main aims of this PHA study are to:

- Identify the credible, potential hazardous events associated with the new equipment including the proposed 10,000 te storage tank;
- Evaluate the level of risk associated with the identified potential hazardous events to surrounding land users and compare the calculated risk levels with the risk criteria published by the DoP in HIPAP No 4 (Ref 3);

- Review the adequacy of the proposed safeguards to prevent and mitigate the potential hazardous events; and
- Where necessary, submit recommendations to Orica to ensure that the proposed new equipment is to be operated and maintained at acceptable levels of safety and effective safety management systems are used.

1.3 SCOPE

This PHA assesses the credible, potential hazardous events and corresponding risks associated with the proposed new equipment at the Orica Kooragang Island facility with the potential for off-site impacts.

In summary, the assessment includes:

- The new 10,000 nitric acid storage tank;
- The new pipelines connected to the proposed new tank;
- The new tank scrubber and associated pumps; and
- The new nitric acid transfer pump.

As the wharf operations, shipping activities and pipeline transfers do not require changes as a result of the new tank then these areas are not included in this assessment as previous assessments have shown acceptable levels of risk.

1.4 METHODOLOGY

In accordance with the approach recommended by the DoP in HIPAP 6 (Ref 6) the underlying methodology of the PHA is <u>risk-based</u>, that is, the risk of a particular potentially hazardous event is assessed as the outcome of its consequences and likelihood.

The PHA has been conducted as follows:

- Initially, the new equipment and its location were reviewed to identify credible, potential hazardous events, their causes and consequences. Proposed safeguards were also included in this review;
- As the equipment is located at a significant distance from other land users, the consequences of each potential hazardous event were estimated to determine if there are any possible unacceptable off-site impacts;
- Where adverse off-site impacts can occur, the likelihood of each potential hazardous event was reviewed, using appropriate techniques / methods, to check if there is any significant increase to existing risk levels and if the risk levels are within the criteria in HIPAP 4 (Ref 3).

1.5 FINDINGS AND RECOMMENDATIONS

The risks associated with the proposed nitric acid tank and associated systems at the Orica Kooragang Island have been assessed and compared against the DoPI risk criteria.

The results of this PHA indicate that the risks associated with the proposed nitric acid tank and systems comply with the DoPI guidelines for tolerable fatality, injury, irritation and societal risk. Also, risks to the biophysical environment, the risk of propagation and the impact on cumulative risk in the Kooragang Island area from releases are acceptable (subject to the recommendations below).

Reviews of historical incidents associated with nitric acid storage facilities have shown that the off-site risks of losses of containment are acceptable due to the limited impact from releasing a corrosive liquid. This is supported by the findings of the site's existing PHA.

The recommendations from this study are:

1. Include the tank level instrumentation in a Layers of Protection Analysis (or similar) to determine the required level of reliability to reduce the risk of tank overflow to an acceptable level.
2. Perform a Layers of Protection Analysis (or similar) during the design phase of the project to ensure the risk of liquid releases to the environment is acceptable. Preferably, the bund sump pump system should be designed using the principles of inherent safety, i.e. design out the hazard. In this case, do not have a path for pumping any spilt nitric acid to the environment.
3. Perform a HAZOP study and a construction safety study on the proposed changes.
4. Update the existing safety management system, including the emergency response plan, for the proposed new tank and equipment.

2 SITE DESCRIPTION

A map of the area showing the location of the Orica Kooragang Island site is shown in Figure 1.

The Orica facility is surrounded by other industries to the north, south and west and the Hunter River to the east. Stockton is the nearest residential area across the north channel of the Hunter River (approximately 800 metres to the east). There are also residential properties to the west at Carrington and Mayfield, 1.5km and 2km away, respectively. Kooragang Island is an established industrial area with generous spacing between facilities.

Figure 1 – Site Location

The current Orica Kooragang Island manufacturing site consists of:

- An Ammonia Plant;
- Three Nitric Acid Plants: NAP1, NAP2 and NAP3 (nitric acid is used in the production of ammonium nitrate);
- Two Ammonium Nitrate (AN) Plants, namely ANP1 which manufactures Nitropril® (a porous prilled ammonium nitrate product) and ANP2 which manufactures Opal™ (a granulated ammonium nitrate product) and 88.5% ammonium nitrate solution;
- Storage, and bagging and bulk dispatch facilities for solid ammonium nitrate and granulated material;
- Storage facilities for anhydrous ammonia, AN solution and nitric acid;
- Ammonia ship loading / unloading facilities;
- Ammonia truck loading and bottling facility; and
- Ammonium Nitrate Solution (ANS) dispatch facility.

Additional information relating to the site's current infrastructure can be found in the Preliminary Hazard Analysis PHA Mod 1 report (Ref 7).

Existing security measures for the Orica site include:

- Site perimeter fence installed with locked or manned gates;
- The main gate is permanently manned by security staff;
- The plants are permanently manned;
- Patrols by security guards are performed;
- Relevant employees are Security Sensitive Ammonium Nitrate (SSAN) licenced;
- Buildings are locked closed when not in use; and
- There are two control rooms on the site which are occupied 24 hours per day. One of these control rooms has the ability to observe the site via closed circuit television.

There are approximately 200 people during normal business hours and 25 people outside of normal hours on the site. The shifts controlling the relevant plants have a minimum of 5 people per shift.

The site does not lie under a major flight path to any airport. The known natural hazards associated with this location are flooding and earthquake. To date, these events have not caused any significant hazardous events to plant and equipment.

3 PROCESS DESCRIPTION

3.1 OVERVIEW

Orica proposes to build a 10,000 tonne nitric acid storage tank and associated infrastructure. The proposed modification includes the following elements:

- A new 10,000 tonne nitric acid tank;

- A new overhead pipe gantry to connect the proposed tank to the existing import pipeline;
- A new tank scrubber including recirculating pumps;
- A new nitric acid transfer pump to the existing No. 1 Nitric Acid Tank; and
- Bunding for the scrubber system including a new sump pump.

The proposed tank will be constructed in place of the previously approved 2,000 tonne storage tank. The proposed tank will be used to store imported 68 w/w% nitric acid or provide additional storage capacity for nitric acid produced on site. The proposed location for the 10,000 tonne storage tank is on the western property boundary (as shown on Figure 2 and Figure 3).

Nitric acid (68%) will be unloaded from a ship at the K2 berth to the new tank utilising the ship's pump via the existing approved 150 mm diameter nitric acid import / export pipeline (see the drawing shown in Appendix 1). Ship loads of up to 8,000 tonnes will be typical. The acid will be pumped directly from the ship to the nitric acid import tank at a typical flowrate of 300 te/hr.

The nitric acid storage tank area is proposed to be a tank-in-tank design, i.e. the inner tank will be contained within an outer tank. The outer tank is therefore the secondary containment. The storage conditions will be approximately atmospheric pressure and temperature.

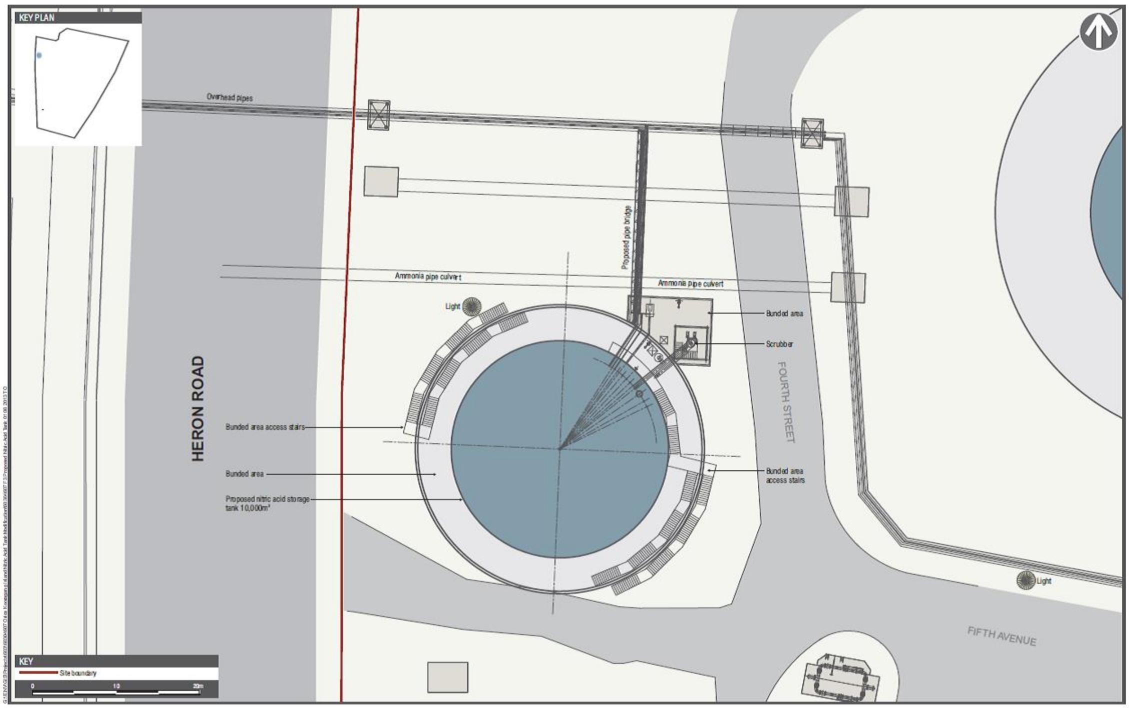
The inner and outer tanks are to include multiple level sensors for both low and high level alarm and trip functions, e.g. to prevent overfill of the inner tank during ship transfers. Should pressure within the inner tank deviate from the design basis, an overpressure / vacuum relief valve is to be installed for mechanical protection. Both the main liquid inlet and outlet lines are to have actuated valves that can be remotely operated in case of an emergency. These valves will be designed to fail closed on loss of instrument gas to the actuator.

Should the inner tank fail and hence release nitric acid into the secondary tank, the secondary tank can vent excess air / vapour to atmosphere to prevent overpressure.

The tank vent will be scrubbed to remove oxides of nitrogen (NOx). The NOx scrubber will be sized to scrub the fumes for ship to tank transfers and diurnal breathing.

Figure 2 – Nitric Acid Tank Location

Figure 3 – Tank Layout Details



The nitric acid will be transferred from the new tank to the existing No. 1 Nitric Acid Tank using the eastern section of the existing nitric acid import / export pipeline. A new pump is to be installed for this transfer process and it will be installed within a bunded area.

The 68% w/w nitric acid will be diluted with process condensate to produce 60% w/w nitric acid prior to entering the No.1 Nitric Acid Tank. The dilution system will utilise demineralised water as a backup to the process condensate.

Following dilution and storage of the 60% nitric acid, it will be reacted with ammonia within the existing ammonium nitrate plants to produce the required ammonium nitrate products.

The existing nitric acid import infrastructure will be modified to incorporate the new storage tank. This will include connections for nitric acid, demineralised water, effluent and other services.

3.2 Scrubber Design Information

A new scrubber will be required to scrub the vent gases of NOx vapours from the head space of the tank.

The scrubber will be operated with demin water as the scrubbing liquid. The demin water will be continuously recirculated around the scrubber system. NOx fumes from the new nitric acid tank vent will be absorbed by the recirculating scrubbing liquor, creating dilute nitric acid. The scrubber liquor will be restricted to a maximum 10% w/w nitric acid by bleeding scrubber liquor back to the new nitric acid tank and refilling the sump of the scrubber with fresh demin water.

The scrubber will be a counter-current packed bed scrubber fabricated entirely from 304L stainless steel (compatible with nitric acid).

The column internals will consist of random packing, a liquid distributer, packing support, a bed limiter and an integral sump with vortex breaker.

The concentration of NOx in the scrubber outlet shall be designed to not exceed 350mg/m^3 NOx.

3.3 IMPORT / EXPORT LINE OPERATIONS

The nitric acid import / export line is existing and has previous approval. The relevant aspects for this proposal associated with the existing import / export line are:

- The import section of the nitric acid import / export line (between the K2 wharf and the tank) will now be flushed with demineralised water and purged with air following each use. The purged liquid will flow into the nitric acid storage tank. The purged line will remain empty between ship transfers;
- The eastern section of the import / export line will be used for the transfer of 68% nitric acid to the existing No.1 Nitric Acid Tank. This section of the line will operate continuously except when the ship unloading operation is being performed; and
- The shipping frequency has not changed but the delivered quantity has increased, increasing the time that the ship is required to be berthed at the wharf as shown below.

Table 1 – Shipping Information

	Original (2008)	This Proposal
Number of ships per year	14 ships / year	14 ships / year
Quantity unloaded	1600 te	8000 te
Unloading duration	6 hours	26 hours

4 HAZARD IDENTIFICATION

4.1 HAZARDOUS MATERIALS

4.1.1 Nitric Acid

Nitric acid is a Class 8, Subsidiary Risk 5.1 Dangerous Good, i.e. it is corrosive. It is highly corrosive to many metals (hydrogen, a flammable gas, is evolved) and is a powerful oxidant. It may cause fire if in contact with organic materials such as wood, cotton or straw. If a fire does occur then highly toxic gases are evolved (nitrogen oxides).

As it is a corrosive liquid, it will cause severe burns to the skin, eyes and mucous membranes. It vapours are also corrosive and may cause pulmonary oedema which could prove fatal.

Nitric acid can be highly reactive, e.g. it can react explosively with metallic powders or when in contact with a powerful reducing agents.

The TLV/TWA is 2 ppm (5 mg/m^3) and the TLV-STEL is 4 ppm (10 mg/m^3). The freezing point for 60% strength is -17^{o}C whilst the same strength boiling point is 120^{o}C.

Nitric acid, being soluble in water, has high mobility in soil. It has a low potential of bio-accumulation. Even at low concentrations, it is harmful to aquatic life due to its acidic nature.

Oxides of Nitrogen

These gases can be liberated as a result of decomposition reactions involving nitric acid.

(a) Nitric Oxide (NO)

Nitric oxide is a Class 2.3, Subsidiary Risks 5.1 and 8, Dangerous Good, i.e. it is a toxic gas.

Nitric oxide is a colourless, permanent gas with a sharp, sweet odour (odour threshold down to 0.3 ppm). It is usually oxidised into nitrogen dioxide (see below) in air and turns brown. High concentrations act on the nervous system and are reported as also affecting the respiratory system. Pulmonary oedema can result. The recommended exposure standard is 25 ppm (permissible exposure limit, PEL). Since this gas will be associated with nitrogen dioxide the precautions listed below should be observed.

Nitric oxide is non-flammable but it is a strong oxidising agent. It will react violently with ammonia and many organic materials.

(b) Nitrogen Dioxide (NO_2)

Nitrogen dioxide is a Class 2.3, Subsidiary Risks 5.1 and 8, Dangerous Good, i.e. it is a toxic gas.

Nitrogen dioxide can be smelt at concentrations of around 5 ppm, however, the currently accepted exposure standard (TLV) is 3 ppm. The STEL is 5 ppm. It is a pungent gas.

At concentrations of 10-20 ppm, the gas is mildly irritating to the eyes and nose. There is little increase in these effects up to concentrations of 100 ppm for short exposures. However, exposure to 100 ppm for 60 minutes can cause death. At this concentration the gas should be visible in good light and have a reddish brown colour.

Exposure to nitrogen dioxide at higher concentrations can lead to pulmonary oedema which may not occur for up to 24 hours or more after exposure. Affected personnel should be kept under observation and treated symptomatically.

Nitrogen dioxide is non-flammable but it is a strong oxidising agent. It will react with ammonia and many organic materials and is corrosive in the presence of water. It has a boiling point of 21^{o}C.

Note that the other main oxide of nitrogen which may be present is nitrous oxide (N_2O) which is not harmful.

4.2 Hazardous Incidents Review

In accordance with the requirements of *Guidelines for Hazard Analysis*, (Ref 6), it is necessary to identify hazardous events associated with the reviewed operations. As recommended in HIPAP 6, the PHA focuses on “atypical and abnormal events and conditions. It is not intended to apply to continuous or normal operating emissions to air or water”.

A search of available literature and information was conducted to review the types of historical events that can occur with nitric acid. The search included the following references:

1. Frank Lees, Loss Prevention in the Process Industries (Ref 8);
2. US Occupational Health and Safety Administration statistics;
3. US Chemical Safety and Hazard Investigation Board statistics;
4. Orica’s records and hazard study’s results; and
5. Public sources available via the internet.

There has been a significant number of incidents recorded involving losses of containment of nitric acid. For example, the US Occupational Safety and Health Administration (OSHA) incident database includes 44 losses of containment of nitric acid since 1984. Only a few of these led to on-site fatalities. One fatality occurred some 15 days after exposure to the acid due to organ failure. The majority of injuries were, as expected, chemical burns. Clearly, these records show the need for robust control measures to avoid losses of containment.

It is noted, however, of the 44 recorded incidents, none occurred on a nitric acid production plant.

A summary of the reviewed incidents is included in Appendix 2 and is discussed further in Section 5 of this report.

4.3 HAZARDOUS EVENT IDENTIFICATION WORD DIAGRAM

In keeping with the principles of risk assessments, credible, hazardous events with the potential for off-site effects have been identified. That is, "slips, trips and falls" type events are not included nor are non-credible situations such as an aircraft crash occurring at the same time as an earthquake. The large majority of the specific release scenarios are generic equipment failures, e.g. failures of tanks, pipes etc, from previous industrial incidents. These are supplemented by process incidents due to other abnormal modes of operation, control system failure and human error.

The credible, significant incidents identified for the proposed new equipment are summarised in the Hazard Identification Word Diagram following (Table 2).

The Hazardous Event Word Diagram presents the causes and consequences of the events, together with major preventative and protective features that are proposed to be included as part of the design.

Table 2 – Hazard Identification Word Diagram

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
1.	Losses of containment from the new nitric acid pipes	Corrosion. Piping failure such as flange leak or weld defect. Human error, e.g. valve left open or maintenance error. Thermal expansion of acid due to heating by the sun when isolated in line	Failures lead to varying release rates / quantities. Potential exists for propagation to nearby equipment if the material(s) are not compatible. Potential for injury, environmental and business effects. Large releases have the potential for fatality to people nearby. Contact with combustible material (e.g. wood) is likely to result in a fire with the evolution of toxic vapours with impact on people and the environment	*Prevention Control Measures:* The new pipes are to be run via pipe racks and/or within bunded areas. Signage and pipeline markings. Materials of construction, including flange components, to be compatible with nitric acid. The new pipes are to be fully welded as much as possible to avoid corrosion within any flanges. Preventative maintenance procedures for pipes, e.g. inspection and testing. Pipes will subject to 100% non-destructive testing (NDT) prior to commissioning. Flange covers to be used as required. Training, procedures and audits. Use of checklists. Operations supervised. Thermal protection safety devices to be installed. Drain valves capped.

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
				Pipe and structure to be designed to the Australian Standard for earthquake design requirements. Pipe to be earthed for lightning protection. *Mitigation Control Measures:* Emergency response actions for spills, rescue, First Aid, neutralisation etc. PPE stored on site. Fire water available for cloud suppression. Response from the Fire Brigade
2.	Overflow from the new nitric acid tank	Failure of the tank level measurement. High transfer rate from the ship. Loss of communication with the ship's crew. Reverse flow through the new nitric acid pump and into the tank via the recirculation line	Overflow to the outer tank / secondary containment which could result in an overflow to grade and hence impact to personnel, the environment and equipment	*Prevention Control Measures:* Multiple level sensors on the new nitric acid tank. Multiple sensors to detect the overflow from the inner tank to the secondary containment. Instrumentation maintenance. Tank level sensor to be Safety Integrity Level assessed for the expected level of reliability. Radios used for communication with the ship's personnel. Backup mobile phones can be used. Ship-to-shore transfer procedures to include monitor of tank level, transfer rate and pressure.

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
				Non-return valve to be installed on the discharge of the new nitric acid tank pump to prevent reverse flow. The ship-to-shore transfer procedure is to include the need to isolate the flow path to the new nitric acid pump and the existing No. 1 Nitric Acid Tank *Mitigation Control Measures:* Emergency response actions for spills, rescue, First Aid, neutralisation etc. PPE stored on site. Fire water available for cloud suppression. Response from the Fire Brigade
3.	Failure of the new nitric acid tank	Construction defect, overpressure, e.g. overfilling or from blowing air from the ship, underpressure when pumping out	Loss of containment of the inner tank to the outer tank. This could lead to a release of acidic fumes from the outer tank vent and hence impact to personnel, the environment and equipment	*Prevention Control Measures:* The inner tank is to be designed to AS3780 and API650. 100% radiography on all new tank floor welds to check for construction defects. 100% NDT of tank structure to detect construction defects. The inner tank is to be constructed from 304/304L stainless steel which is compatible with nitric acid.

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
				The inner tank is free-vented via the scrubber for both over and under pressure protection. Sprays installed in the annulus space to absorb fumes. Level detectors in the annulus space. The inner tank is fitted with an over and under pressure relief device. *Mitigation Control Measures:* Emergency response actions for spills, rescue, First Aid, neutralisation etc. PPE stored on site. Fire water available for cloud suppression. Response from the Fire Brigade
4.	Failure of the scrubber	Loss of reflux flow, e.g. pump failure, loss of power	Release of acidic fumes via the scrubber and hence impact to personnel, the environment and equipment	*Prevention Control Measures:* Duty / standby scrubber recirculation pumps with automatic start on the standby. The scrubber recirculation pumps are to be on emergency power. *Mitigation Control Measures:* Scrubber stack is 26 m for improved dispersion. Low flow alarm on the scrubber recirculation liquid.

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
				Ship transfer not to be initiated unless scrubber system is operating. Ship transfer to be stopped on loss of power or other abnormal event. Emergency response actions for spills, rescue, First Aid, neutralisation etc. PPE stored on site. Fire water available for cloud suppression. Response from the Fire Brigade
5.	Loss of containment from the new pump	Seal, shaft or casing failure. Pump deadhead	Failures lead to varying release rates / quantities. Potential exists for propagation to nearby equipment if the material(s) are not compatible. Potential for injury, environmental and business effects. Large releases have the potential for fatality to people nearby. Contact with combustible material (e.g. wood) is likely to result in a fire with the evolution of toxic vapours with impact on people and the environment	*Prevention Control Measures:* The pump is to be included in the prevention maintenance system. Pumps to be fitted with vibration and current monitoring to assist in preventative maintenance. The pump is to be dedicated nitric acid pumps with proven reliability for this liquid. The wetted parts of the pump are to be constructed from 304/304L SS which is compatible with nitric acid. Minimum flow dead head protection for the pump via FO 9111. Operating procedures and training to include the requirement to keep manual isolation valves open to prevent deadhead conditions.

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
				Mitigation Control Measures: The new pump is to be in a bunded area. Low flow alarm on the scrubber recirculation liquid. Emergency response actions for spills, rescue, First Aid, neutralisation etc. PPE stored on site. Fire water available for cloud suppression. Response from the Fire Brigade
6.	Low pH liquid pumped to the River Pit	Failure of the bund sump pump discharge controls, e.g. pH meter failure	Environmental impact due to low pH liquid	*Prevention Control Measures:* Tank-in-tank design provides containment of concentrated acid. Bund system is only exposed to dilute acid. Level detection in the bund to alert operators of a spill. pH measurement with alarms and sampling prior to release to the River Pit. Hard piped lines to effluent neutralisation minimise risk of loss to environment. *Mitigation Control Measures:* In-line pH detection and alarms installed in the downstream effluent transfer lines. Emergency response

4.4 SAFETY MANAGEMENT SYSTEMS

Safety management systems are intended to minimise the risk from potentially hazardous installations by a combination of hardware (i.e. design) and managements systems such as procedures, policies, plans and training. To ensure safe operation of the nitric acid tank and associated equipment, both the hardware and the safety management systems must be of high standard.

Orica personnel, having operated nitric acid plants for up to 40 years at the Kooragang Island site, are well aware of the hazardous nature of nitric acid. However, it is acknowledged that the proposed nitric acid modifications will necessitate changes to the existing safety management system.

In general, the Orica procedures, guidelines etc are modified to suit the local site conditions where required.

The safety management system is built in layers, as shown below:

Vision and Values

Policy

SH&E Standards

SH&E Model Procedures

Local SH&E Procedures

Operating Procedures / Work Instructions

Senior management define the company's Vision and Values, SH&E Policy and Standards. For Orica and its group companies, there are 19 SH&E Standards to be followed. SH&E Model Procedures are developed to further detail key requirements for control of the company's operations and to provide a model for management of SH&E risks and for implementation of the company's SH&E Policy and Standards. There are 121 SH&E Model Procedures.

Local procedures and work instructions are developed to define additional requirements to, as far as practicable, control the risks arising from the operation of each facility and to assure compliance with the company's SH&E Policy and Standards, and the key requirements of the SH&E Model Procedures.

The range and detail of local procedures and work instructions are consistent with the complexity of the activity, the level of risk involved, and the skills and training of the people performing the activity.

Sufficient records of activities and events are retained in a secure, retrievable manner to demonstrate compliance with, and the effectiveness of local procedures and to capture adequate information regarding the company's SH&E impacts.

A Letter of Assurance is prepared annually, detailing the level of compliance with each of the SH&E Standards and action plans to close any gaps.

The suitability, adequacy and effectiveness of the company SH&E Policy, Standards and SH&E Model Procedures and local SH&E management systems is reviewed at least every two years.

Given the existing Orica safety management system, it is expected that modification to accommodate the nitric acid modifications should present little difficulty.

For information, the general procedures associated with the safety management systems at Orica are summarised in Table 3.

Table 3 - Summary of Safety Related Procedures

PROCEDURE	PURPOSE
Operations and Maintenance Manuals	To clearly define the method of operations of the plant. To ensure that accurate information about important aspects of the plant design and its operations are available and up to date. To define for the operators and maintenance team the methods by which sections of the plant may be safely and efficiently withdrawn from service, repaired and restored to safe efficient operating condition. To ensure that protective systems are in a good state of repair and function reliably when required to do so. This includes scheduled testing of trips and alarms and relief devices.
Operator Training, including safety and emergency training	To enable operators to run the plant to meet objectives safely. To enable trades personnel to carry out maintenance work so that they are themselves safe and do not jeopardise the plant safety systems or the safety of others. To provide personnel with an understanding of possible hazardous situations and the ability to respond appropriately. To provide an understanding of and practice in the use of basic emergency equipment that might be needed in tackling an emergency (e.g. self contained breathing apparatus, safety showers).
Permit to Work	To safeguard technicians (and others) and the plant by ensuring than that the plant is safe to work on, that the correct job is done using the right equipment, that any safety procedures are understood and adhered to, that operators know which parts of the plant are being worked on and that the plant is returned to safe condition before being returned to service.
Control of Plant Modifications	To ensure that proposed changes to both equipment and operating methods achieve the desired benefits without any unforeseen and undesirable side effects.
Unusual Incident Reporting and Investigation	To learn from "unusual incidents" that may or may not have had a hazardous outcome, but could have under different circumstances, to be proactive in preventing their occurrence.
Emergency Procedures	To facilitate effective response to emergency situations. To prevent or minimise the effect of potentially hazardous events by being prepared.
Scheduled Management Auditing of Procedures	To ensure that operating management are continually aware of how well the defined procedures and systems affecting safety and loss prevention are being followed in practice. To enable corrective action to be taken to improve adherence to procedures.

4.4.1 Safety Software in Risk Assessment

In risk assessments, incidents are assessed in terms of consequences and frequencies, leading to a measure of risk. Where possible, frequency data comes from actual experience. However, in many cases, the frequencies used are generic, based on historical information from a variety of plants and processes with different standards and designs.

The quality of the management systems in place in these historical plants will vary. Some will have little or no safety management systems, such as work permits and modification procedures, in place. Others will have exemplary systems covering all issues of safe operation. Clearly, the generic frequencies derived from a wide sample represent the failure rates of an "average plant". This hypothetical average plant would have average hardware and safety management systems in place.

If an installation with below average safety management systems is assessed using generic frequencies, it is likely that risk will be underestimated. Conversely, if a plant is above average, the risk will probably be overestimated. However, it is extremely difficult to quantify the effect of safety management systems on plant safety.

Therefore, Pinnacle Risk Management adopts a policy which does not attempt to quantitatively account for the presence of and quality of safety management systems. It is assumed that the generic failure frequencies used apply to installations which have safety management systems corresponding to accepted industry practice. It is believed that this assumption will be conservative in that it will overstate the risk from installations such as the Orica sites. Therefore, any quantitative approach is valid (i.e. conservative) only if safety management within the operation being assessed is of a high standard.

5 RISK ANALYSIS

The risk criteria applying to developments in NSW are summarised in Table 4 below (from Ref 3). Compliance with these criteria is required and is assessed for the identified potential hazardous events below.

Table 4 – Risk Criteria, New Plants

Description	**Risk Criteria**
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year
Fatality risk to residential and hotels	1×10^{-6} per year
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year
Fatality risk to contained within the boundary of an industrial site	50×10^{-6} per year
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50×10^{-6} per year

The assessment of risks to both the public as well as to operating personnel around this industrial development requires the application of the following basic steps:

- Assess the hazard potential of the materials involved;
- Identify the potential hazardous events (including incidents involving the materials and site specific occurrences);
- Evaluate the consequences of the potential hazardous events;
- If the off-site consequences are significant then evaluate the likelihood of the potential hazardous events;
- Assess the risk of the potential hazardous events; and

- Recommend further safeguarding if the existing, proposed safeguards are not deemed adequate.

As per HIPAP 6 (Ref 6), the chosen analysis technique should be commensurate with the nature of the risks involved.

The typical risk analysis methodology attempts to take account of all credible hazardous situations that may arise from the operation of processing plants etc. Possible events that are highly improbable are typically excluded from risk assessments, e.g. a meteor hits a facility.

For a typical quantitative risk analysis (QRA), this is done by first estimating the consequential impacts for the identified potential hazardous events and then, if off-site impact is possible, estimating the corresponding likelihoods. The risk of each event (i.e. consequence multiplied by the likelihood) is then summated to provide the overall levels of risk.

In this risk assessment, however, the approach adopted to assess the risk of the identified hazardous events is scenario based risk assessment. The reasons for this approach are that there are limited potential hazardous events that can lead to off-site impact, the material involved (nitric acid) is a Class 8 Dangerous good, i.e. a corrosive liquid, and off-site fatalities from such facilities do not historically occur as discussed below.

The scenario based risk assessment approach analyses each of the possible hazardous events that contribute to off-site impact individually, in this case via a risk matrix (Refs 9 and 10). A mixture of qualitative and quantitative techniques is used as appropriate to assess imposed risk.

A risk matrix used for risk assessment by Pinnacle Risk Management is shown in Figure 4. This matrix has been derived from a review of relevant Australian and British standards (e.g. AS/NZS 31000).

The risk matrix allows the combination of consequence and likelihood (i.e. risk – the likelihood of any defined adverse outcome) to be shown clearly and quickly on a graphical basis.

The position in the matrix of estimated risk allows an assessment of the magnitude of each risk contributor to the overall level of risk. That is, the higher the combination of likelihood and consequence, the higher the contribution to overall risk. This provides a basis for development of appropriate risk reduction strategies. Through inspection of the major risk contributors and an understanding of the cost associated with particular risk reduction strategies, cost-effective risk reduction strategies can be developed.

Figure 4 – Risk Matrix

Frequent >1/yr	II	II	I	I	I	I
Probable $>10^{-1}$ to 1/yr	III	II	II	I	I	I
Possible $>10^{-2}$ to 10^{-1}/yr	III	III	II	II	I	I
Unlikely $>10^{-4}$ to 10^{-2}/yr	III	III	III	III	II	I
Very Unlikely $>10^{-6}$ to 10^{-4}/yr	III	III	III	III	III	II
Extremely Unlikely $<=10^{-6}$/yr	III	III	III	III	III	III
Likelihood **Consequence**	Minor	Significant	Severe	Serious	Extremely Serious	Catastrophic

The generic form of the matrix allows its use for various risk categories, e.g.:

- Safety and health;
- Environment; and
- Business impact.

For the risk matrix shown in Figure 4, there are three broad categories of risk.

The Class I area indicates a high level of risk which is intolerable and where risk reduction is required. This requires the reduction of frequency and/or consequence.

The Class II area indicates a moderate level of risk. Whilst the risk is not unacceptable, there should be practical measures taken to lower the risk if economically viable. For risks where further mitigation is not economically viable, judgement needs to be exercised as to whether the level of risk is acceptable or not. This area is the beginning of the ALARP region (i.e. as low as reasonably practicable).

The Class III area indicates a low level of risk and is broadly considered to be acceptable. Further risk mitigation may not be required / appropriate. However, low and accepted risks should be monitored and routinely reviewed to ensure that they remain acceptable. Few risks remain static. This area includes ALARP as well as what are known as trivial or negligible risks.

Consequential impact can take many forms, e.g. impacts on safety and health, environment, public relations, financial, operations, competitive nature, social well-being, clients, cultural significance, security and legal issues. Consequence ratings can be determined for the selected area of interest and then applied to a risk matrix. Consequential impacts used in this report are given in Table 5.

Table 5 – Consequence Ratings

	Minor	Significant	Severe	Serious	Extremely Serious	Catastrophic
Safety and Health	One minor injury, First Aid	Recordable or single MTI	Multiple MTI or one LTI	Permanent disability casualty or multiple LTI	Multiple permanent disabilities or one fatality	Multiple fatalities
Environment	Very minor pollution. No offsite escape of material (contained within the operational areas). Onsite nuisance value only	Minor local pollution. Nuisance offsite effect, typically of short duration, e.g. noise, odours, dust and/or visible plumes for less than one hour	Evident pollution, local concern. Minimal duration offsite effects (e.g. waterway slightly discoloured, turbid etc around the point of release with no or very few fish killed)	Significant local pollution. For example, waterways discoloured 10s of metres, fire or smoke affecting people near to the site	Major local pollution. Observable offsite effect (e.g. waterways discoloured 10s to 100s of metres for a few weeks with a significant number of aquatic life adversely affected)	Extremely severe pollution. Ecosystems at high risk of destruction. Only resolved via long term solutions (potentially taking years)
Public Relations	Minor issue, one complaint	Local issue, 10 complaints	Local media, 100 complaints	Regional or state media	Wide media national coverage	Headlines, corporate damage
Financial Impact	< $25,000	$25,000 to $100,000	> $100,000 to $1 million	> $1 million to $20 million	> $20 million to $100 million	> $100 million

5.1 NITRIC ACID SPILLS – SAFETY AND HEALTH RISK

Identified potential hazardous events 1, 2 and 5 shown in Table 2 will result in a spill of nitric acid (the quantity will vary) whilst events 3 and 4 will result in emissions of acidic mist. Spills of nitric acid have occurred previously from industrial facilities and therefore the results of historical spills are used in this analysis to determine to most credible outcome.

As discussed in Section 4.2, there has been a significant number of incidents recorded involving losses of containment of nitric acid. A review of approximately 100 nitric acid spills of various quantities, e.g. ranging from a few kilograms to 75 tonnes, was performed in the preparation of this PHA. The results are shown in Appendix 2. In summary:

- There were no off-site fatalities for the incidents reviewed. Presumably due to limited consequential impact from releasing a corrosive liquid, early warning by the acidic mist / NOx odour and emergency response;
- There were on-site fatalities for some incidents;
- The off-site impacts are better described as 'irritation' rather than 'injury'; and
- There were no major accident events involving production facilities in the recorded incidents.

These findings are appropriate to the proposed nitric acid tank and associated systems at the Orica Kooragang Island facility.

These findings are also supported by the conclusions made in the quantitative risk assessment for the site (Ref 7), i.e.:

"*Nitric acid will cause severe burns with bodily contact however will not travel sufficient distances upon release to affect offsite populations*" (Section 1.3.7).

Given the above historical data and the existing site quantitative risk assessment, off-site fatalities due to nitric acid releases are not expected. Therefore, the fatality risk criteria presented in Table 4 to both residential areas (the nearest being approximately 800 m to the east) and nearby industry are expected to be satisfied.

Similarly, given the above historical data, injury and irritation impact at the nearest residential area (800 m from the site) is not expected. Therefore, the injury and irritation risk criteria presented in Table 4 to residential areas is expected to be satisfied.

As nitric acid is not itself a flammable or combustible material, the criteria applying to radiant heat and explosive overpressure impacts is not relevant. It is noted, however, that small local fires have occurred following some nitric acid releases given the oxidising potential of the acid. For this facility, there are to be no combustible materials kept within the bunded area as per the existing site practices.

5.2 PIPE FAILURES (EVENT NO. 1)

The new pipes conveying nitric acid will be located within the Orica site boundary. Where the pipes run outside of bunded areas, these are to be fully welded to minimise the likelihood of a loss of containment.

The low likelihoods for pipe failure events are supported by the following data.

For piping failures, frequencies have been estimated either from data compiled and published by ICI (Ref 11) or from frequency estimates published by the Institution of Chemical Engineers (Ref 12).

Table 6 - Piping Failure Frequencies

Type of Failure	Failure Rate per year
Pipelines	
13 mm hole	3×10^{-6} / m
50 mm hole	0.3×10^{-6} / m
3 mm gasket (13 mm hole equivalent)	5×10^{-6} / joint
Guillotine fracture (full bore):	
< 50 mm	0.6×10^{-6} / m
> 50 mm but < 100 mm	0.3×10^{-6} / m
> 100 mm	0.1×10^{-6} / m

The new nitric acid piping is expected to be 50 mm or greater in diameter.

Assuming, say, 100 m of new pipe for these diameters, the frequency of catastrophic pipe failure is 100 m x 3×10^{-7} times / yr.m, i.e. 3×10^{-5} times / yr. Given a conditional modifier of a person being present in the tank area when the pipes fail in the order of 5% then the likelihood of adverse impact to a person on-site is therefore approximately 1.5×10^{-6} times / yr. From the risk matrix shown in Figure 4, this is a low level of risk and not considered intolerable.

5.3 NITRIC ACID TANK OVERFLOW (EVENT NO. 2)

For these types of events, the adequacy of the safeguards, including the reliability of the instrumented protected systems, is best analysed via a Layers of Protection Analysis (or similar). These studies review the initiating event likelihood and then the probability of failure on demand of each of the protective safeguards, including the level sensors and the actuated valve on the tank liquid inlet line to prevent tank overflow. As Orica perform Layers of Protection Analyses then the reliability of the protective safeguards is best reviewed during the detailed design stage to confirm the risk of this event is acceptable. Therefore, it is recommended in this PHA to include this scenario in a Layers of Protection Analysis (or similar) during the design phase of the project to ensure the risk of tank overflow is acceptable.

5.4 NITRIC ACID TANK FAILURE (EVENT NO. 3)

Double-walled atmospheric storage tanks have a typical failure frequency of $1x10^{-6}$ / yr, e.g. Ref 13. Given the design of these tanks, the secondary (outer) tank is expected to contain the material from the inner tank.

An influx of nitric acid into the outer tank may result in the release of acidic mist into the environment. Given the results of the review of the 100 historical releases of nitric acid then the impact of this elevated mist release will be limited.

From the risk matrix shown in Figure 4 this is a low level of risk given a likelihood of approximately $1x10^{-6}$ / yr and there the risk is not considered intolerable.

5.5 SCRUBBER FAILURE (EVENT NO. 4)

Design information for the scrubber includes the following:

- The scrubber vent height is 26 m; and
- The design flowrate is 650 m^3/hr with a NOx concentration not exceeding 350 milligrams/m^3.

Based on tank NOx design levels 0f 0.9% and a flow of 650 m^3/hr through the scrubber, the maximum NOx release rate is 0.002 kg/s or 2 grams/s, i.e. a relatively low release rate for dispersion cases.

This potential emission rate was modelled using TNO's EFFECTS program to determine if there could be irritation and injury impact at ground level. As per the existing QRA for the site (Ref 7), the AEGLs for a 10 minute exposure were used in the modelling, i.e. AEGL-1 for irritation and AEGL-2 for injury. These values are 0.5 and 20 ppm, respectively.

Modelling of the low release rate from a 26 m stack height for both F2 and D3 atmospheric conditions showed that the expected ground level concentrations of NOX would be less than 0.5 ppm, i.e. adequate dispersion will take place and no irritation or injury impact is expected for this scenario.

5.6 PUMP FAILURES (EVENT NO. 5)

Typical frequencies for pump failures are as follows (Ref 11):

- Large seal failure = 0.005 times / year;
- Shaft failure = 1×10^{-4} times / year; and
- Casing failure = 1×10^{-5} times / year.

As discussed in Section 5.1, the most credible outcome is impact to people close to the point of release. Again, given a conditional modifier of a person being present in the tank area when the pumps fail in the order of 5% then the approximate likelihood of adverse impact to a person on-site is:

- 2.5×10^{-4} times / yr for a seal failure (this will be the smallest quantity of material lost for the three possible pump losses of containment scenarios and hence limiting the impact, i.e. fatality would not be expected);

- 5 x 10-6 times / yr for a shaft failure; and
- 5 x 10^{-7} times / yr for a casing failure.

From the risk matrix shown in Figure 4, this is a low level of risk and not considered intolerable.

5.7 RISK TO THE BIOPHYSICAL ENVIRONMENT

The main concern for risk to the biophysical environment is generally with effects on whole systems or populations.

Whereas any adverse effect on the environment is obviously undesirable, the results of this study show that the risks of the potential incident scenarios for losses of containment affecting the environment are limited by using a tank-in-tank design and bunding for the associated equipment, e.g. the scrubber and the pumps.

Scenario 6 in Table 2 shows the possibility of environmental impact due to incorrectly pumping a loss of containment of nitric acid from the new bunded area to the River Pit and hence the potential flow off-site.

As per the tank overflow scenario, the reliability of the protective safeguards is best reviewed during the detailed design stage to confirm the risk of this event is acceptable. Therefore, it is recommended in this PHA to include this scenario in a Layers of Protection Analysis (or similar) during the design phase of the project to ensure the risk of liquid releases to the environment is acceptable.

Preferably, the bund sump pump system should be designed using the principles of inherent safety, i.e. design out the hazard. In this case, do not have a path for pumping any spilt nitric acid to the environment.

5.8 CUMULATIVE RISK

Cumulative risk at Kooragang Island was considered by the Department of Urban Affairs and Planning (now the DoPI) in 1993. As shown in this PHA, the proposed nitric acid tank and associated equipment will have negligible impact on the cumulative risk results for Kooragang Island as the material involved is a corrosive liquid, i.e. the impacts of releases is largely local to the point of release. This is supported by anecdotal evidence from the spills reviewed in Appendix 2.

5.9 SOCIETAL RISK

The criteria in Table 4 for individual risk do not necessarily reflect the overall risk associated with any proposal. In some cases for instance, where the 1 pmpy contour approaches closely to residential areas or sensitive land uses, the potential may exist for multiple fatalities as the result of a single accident. One attempt to make comparative assessments of such cases involves the calculation of societal risk.

Societal risk results are usually presented as F-N curves, which show the frequency of events (F) resulting in N or more fatalities. To determine societal risk, it is necessary to quantify the population within each zone of risk surrounding a facility. By combining the results for different risk levels, a societal risk curve can be produced.

In this study of the proposed nitric acid tank and associated system, the credible risk of fatality does not extend off the site and is therefore well away from the residential areas. In fact, the nearest house is approximately 800 m away. The concept of societal risk applying to residential population is therefore not applicable for the proposed modifications.

6 CONCLUSION AND RECOMMENDATIONS

The risks associated with the proposed nitric acid tank and associated systems at the Orica Kooragang Island have been assessed and compared against the DoPI risk criteria.

The results of this PHA show that the risks associated with the proposed nitric acid tank and systems comply with the DoPI guidelines for tolerable fatality, injury, irritation and societal risk. Also, risks to the biophysical environment, the risk of propagation and the impact on cumulative risk in the Kooragang Island area from releases are acceptable (subject to the recommendations below).

Reviews of historical incidents associated with nitric acid facilities have shown that the off-site risks of losses of containment are acceptable due to the limited impact from releasing a corrosive liquid. This is supported by the findings of the site's existing PHA.

The recommendations from this study are:

1. Include the tank level instrumentation in a Layers of Protection Analysis (or similar) to determine the required level of reliability to reduce the risk of tank overflow to an acceptable level.
2. Perform a Layers of Protection Analysis (or similar) during the design phase of the project to ensure the risk of liquid releases to the environment is acceptable. Preferably, the bund sump pump system should be designed using the principles of inherent safety, i.e. design out the hazard. In this case, do not have a path for pumping any spilt nitric acid to the environment.
3. Perform a HAZOP study and a construction safety study on the proposed changes.
4. Update the existing safety management system, including the emergency response plan, for the proposed new tank and equipment.

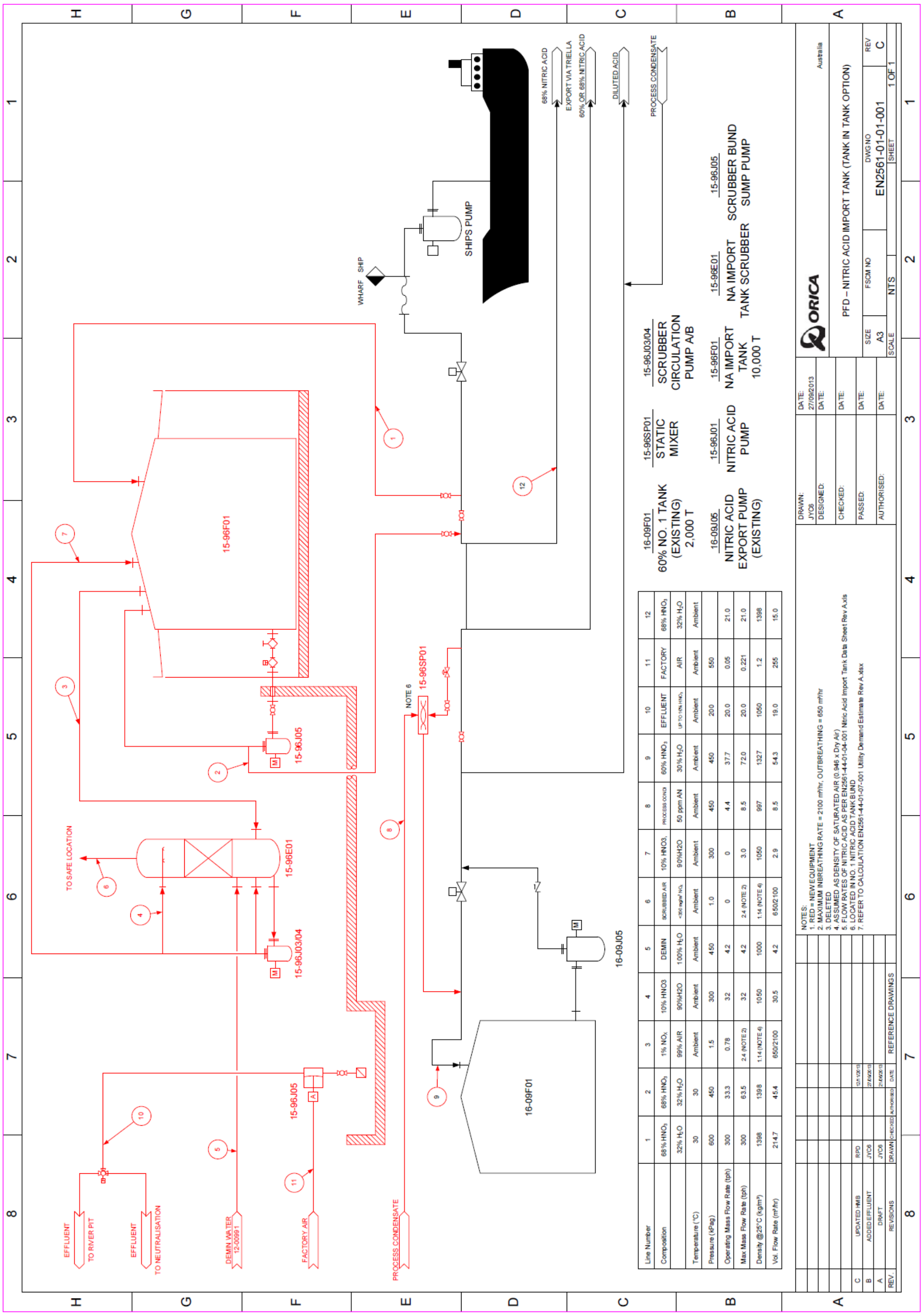
Appendix 1

Process Flow Diagram

Preliminary Hazard Analysis, Nitric Acid Tank,

Orica, Kooragang Island

Appendix 1 – Process Flow Diagram.



Appendix 2

Nitric Acid Releases Summary

Preliminary Hazard Analysis, Nitric Acid Tank,

Orica, Kooragang Island

Appendix 2 – Nitric Acid Releases Summary.

Year	Location	Amount	Number of Fatalities	Comments on Incident	Number of People Requiring Medical Treatment	Company
2012	Bad Fallingbostel, Germany	Unknown	0	Nitric acid poured into a caustic tank and hence reacted causing NOx. 1,800 people evacuated	Unknown	Kraft Foods
2012	Erwin	4,200 kg	0	Incompatible materials of construction in a flow meter caused the leak into a bund	0	NFS
2009	Singapore	Unknown	4	Nitric acid used to clean a fouled heat exchanger and, under pressure, the nitric acid was released with 4 workers killed	Unknown	Chemic Industries
2006	Source: OHSA	Unknown	0	Nitric acid released when transferring to a road tanker	2	Canton Rail Company
2005	Salt Lake City, USA	Unknown	0	Leaking rail car	0	Union Pacific
2002	Oshkosk, WI, USA	Unknown	0	Hydrochloric acid (4 m^3) mistakenly delivered into a nitric acid tank that fumed. Tank had a scrubber and bunding	0	Hydrite Chemical Company
1998	Carson, USA	6 kg	0	Leak from a 1,000 litre drum. NOx cloud approximately 13 m wide and 20 m high	0	Prime Wheel (plating company)
1997	Source: OHSA	840 kg	0	4 m^3 tank leaked from a failed nylon fitting	Several	Alcoa Memory Products
1997	Source: OHSA	Unknown	1	Employee mixed alcohol with nitric acid yielding NOx. Employee who was exposed died 15 days later from pulmonary oedema		Lg Epitaxy

Year	Location	Amount	Number of Fatalities	Comments on Incident	Number of People Requiring Medical Treatment	Company
1995	Source: OHSA	Unknown	0	Release of nitric acid from a hose during a transfer	1	General Dynamics Convair Division
1995	Source: OHSA	Unknown	1	Workers respirator dislodged when vat containing nitric acid ruptured and he was exposed to NOx (soaking drill bits in the vat)	o	Mine Tools
1995	San Diego, USA	Unknown	0	Nitric acid release from a hose and sprayed two workers	2	Moore Printed Circuits
1995	Source: OHSA	6 kg	0	Nitric acid leak onto cardboard causing fumes and a fire	8	United Parcel Service
1994	Anaheim, USA	170 kg	0	120 L of nitric acid added to a 205 L ‘empty’ drum which contained another material. Reaction generated NOx. Minor injuries only	16	Leach Corporation
1994	Ogden, UT, USA	Unknown	0	Worker suffered burns when he waded through 500 mm deep nitric acid in a bund wearing PPE that leaked	1	Dyce Chemical
1992	California, USA	550 kg	0	400 L spill caused 60 people (on and off site) to be affected (irritation only) and requiring treatment	60	(chrome plating company)
1991	Source: OHSA	280 kg	0	Drum leaked and reacted with the concrete causing NOx	9	Everco Industries
1991	Source: OHSA	Unknown	0	10 m^3 of nitric acid pumped into a 34 m^3 hydrochloric acid tank causing fumes	0	General Electric International

Year	Location	Amount	Number of Fatalities	Comments on Incident	Number of People Requiring Medical Treatment	Company
1991	Source: OHSA	220 kg	0	Drum lid opened when the drum was dropped splashing two workers	2	Dixie Trucking Company
1990	Source: OHSA	Unknown	0	Worker fell into a tank containing 10% nitric acid and 2% hydrofluoric acid	1	Avesta
1998	Glendale, California	1,100 kg	0	800 L of nitric acid mixed with other chemicals	5	American Metaseal
1998	Paramount, LA, USA	1,700 kg	0	Spill of nitric acid followed by a toxic cloud	0	STI
1987	Azle, Texas	“Thousands of kgs”	0	Truck leak on a road “slightly” injuring more than 50 people (Source: LA Times), i.e. irritation impact	50	-
1987	Lynwood, LA, USA	1,700 kg	0	1,200 L tank ruptured	Unknown	Chrome Nickel Plating
1985	Toronto, Canada	Unknown	0	Alcohol mixed with nitric acid – all 45 affected people were company employees	45	-
1983	USA	75,000 kg	0	Release of nitric acid from a rail wagon due to impact causing small fires and a large NOx cloud, 9,000 people evacuated from a 5 km^2 area	34	-

Notes:

1. Approximately 100 incidents were reviewed; a significant number of which involved laboratory incidents and cleaning activities. Hence small quantities were involved, i.e. a few litres.
2. There were no off-site fatalities for the incidents reviewed. Presumably due to limited consequential impact from releasing a corrosive liquid, early warning by the NOx odour and emergency response.

3. There were on-site fatalities for some incidents.
4. The off-site impacts are better described as ‘irritation’ rather than ‘injury’.
5. There were no major accident events involving production facilities in the reviewed incidents.

7 REFERENCES

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Appendix F

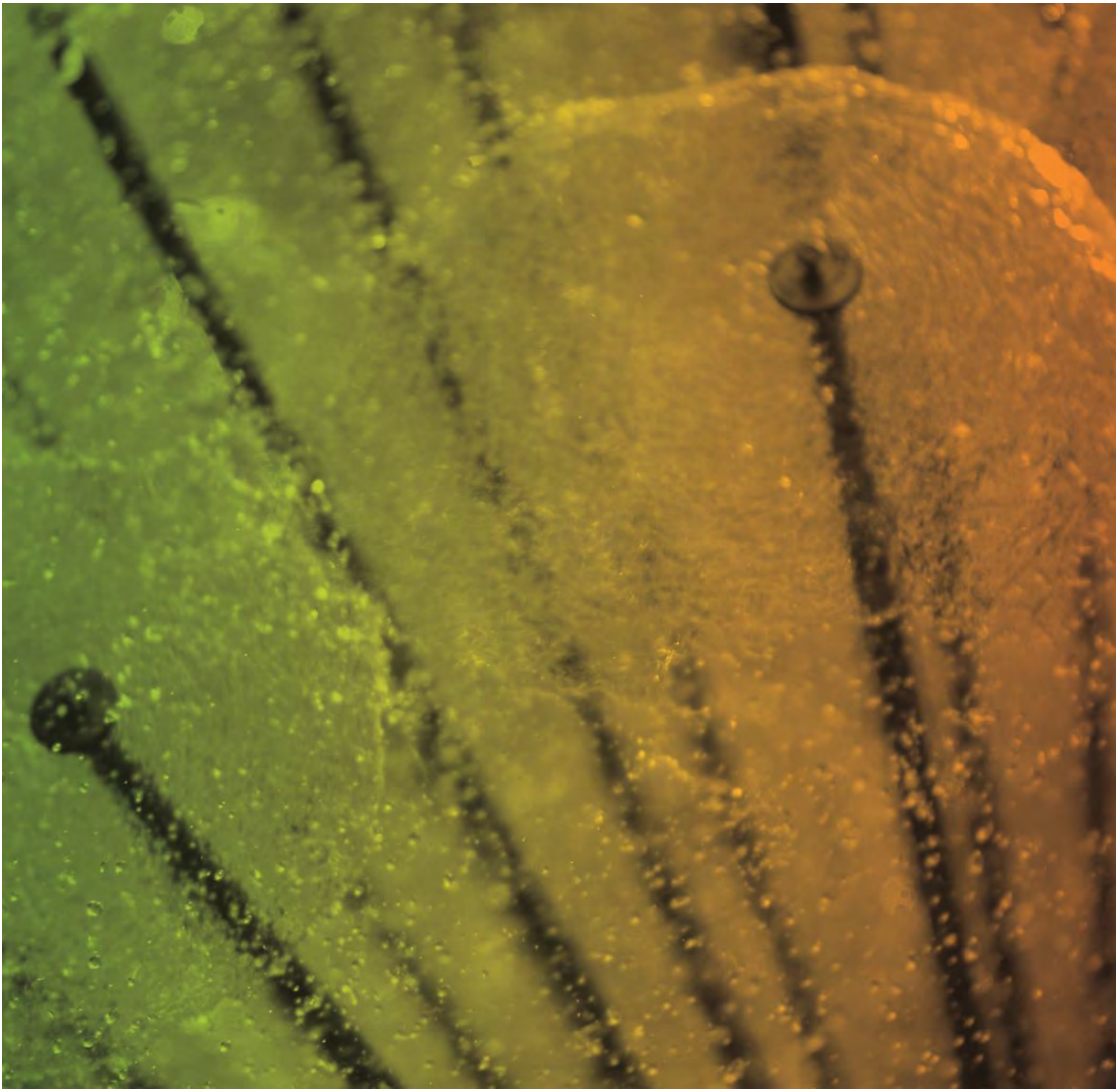
Visual Impact Assessment

Appendix F Visual Impact Assessment

Orica Australia Pty Ltd
11-Nov-2013

Visual Impact Assessment

Modification of Project Approval 08_0129



Visual Impact Assessment

Modification of Project Approval 08_0129

Client: Orica Australia Pty Ltd

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Prepared by

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Quality Information

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Date 11-Nov-2013

Prepared by Simon Murphy

Reviewed by Catherine Brady

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
1	01-Nov-2013	Draft for client review	Simon Murphy Senior Environmental Planner	
2	11-Nov-2013	Final	Simon Murphy Senior Environmental Planner	

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1.0 Introduction

1.1 Overview

This Visual Impact Assessment (VIA) has been prepared by AECOM Australia Pty Ltd (AECOM) on behalf of Orica Australia Pty Ltd (Orica) for its proposed nitric acid tank and Ammonia Management Improvements (AMI) projects, to be undertaken on Orica's existing Kooragang Island (KI) facility (the site). The existing facility is located approximately 3km north of the Newcastle Central Business District (CBD).

The project involves the construction and operation of:

- Three flaring stacks; and
- A nitric acid storage tank.

The tank and flare stacks are referred to collectively in this report as the project. A detailed description of the project is provided in **Section 3.0**.

This VIA has been prepared to examine the potential visual impacts of the proposal on those sensitive (residential) receivers that have the potential to be impacted by the project.

1.2 Methodology

This report describes the existing environment of the KI site, the proposed activity, and the visual transformation that may result from the project. The assessment is based on the preliminary design information provided by Orica.

In addition to desktop assessment, field investigations were undertaken from sensitive receiver locations and computer simulation of view corridors prepared to determine visual impacts from the proposal.

The VIA undertakes consideration of the following:

1) Existing site conditions:
    - Site Context and Topography;
    - Site Description;
    - Visual context; and
    - Statutory considerations.
2) The nature of proposed activities:
    - Height;
    - Scale;
    - Materials and colour; and
    - Flaring.
3) Visual Impact:
    - A description of the existing environment of the identified sensitive receivers; and
    - A review of the potential impacts on the visual amenity of the identified sensitive receivers.
4) A review of measures that could be implemented to mitigate adverse visual impacts and conclusion.

2.0 Existing Environment

2.1 Site Context and Topography

The area surrounding the site is predominantly heavy industrial, chemical plants, and port related activities. The nearest residential area is Stockton. The closest residential homes are located approximately 800 metres from the site, on the opposite side of the north arm of the Hunter River.

The overall character in the area immediately surrounding the site is industrial with a range of industrial operations being undertaken on KI, which is dominated by coal loading facilities located to the north west of Orica's site. In the vicinity there are heavy trucks using Cormorant Road to the northwest; freight ships passing along the Hunter River, and loading and unloading activities occurring on KI to the west.

Access to the Orica site is via Greenleaf Road from Heron Road and Cormorant Road. Owing to the sites location on a peninsula, traffic does not pass the site frontage directly. The presence of other industrial operations and buildings means that the site is mostly out of view for commuters travelling along Cormorant Road. The exception to this is for commuters when travelling over the Stockton Bridge, the height of which allows visibility of the Orica site. Due to the height of the bridge however, the site does not dominate views from this vantage point.

Reference is made to **Figure 1** showing the site in context of the wider KI and Stockton areas.

2.2 Site Description

The Orica KI facility is situated on a large, flat site which is flanked to the east and west by the North and South arms of the Hunter River respectively. The site contains a variety of plant associated with the production of ammonia, nitric acid, ammonium nitrate and ammonium nitrate emulsion. Detail of the site including all major pieces of existing and proposed infrastructure are shown on **Figure 2**.

2.3 Visual Context

The area around the site is dominated by industrial development located adjacent to the Hunter River.

The closest viewing locations to the site are from existing industrial lots within KI's industrial area to the north.

The other well-trafficked publicly accessible road from which views to the site are possible is Cormorant Road on KI. Cormorant Road is approximately 600 metres from the site at its closest point. Views from Cormorant Road are intermittent as a result of the Coal Loaders and associated conveyor systems which operate on the northern side of the south arm of the Hunter River.

The nearest residential areas with views to the site are located on Stockton with the nearest dwelling being approximately 800m from the site.

2.4 Statutory Considerations

Project approval 08_0129 includes conditions relation to visual aspects of the original approval. Specifically conditions 45 and 46 relate to visual impacts and lighting respectively:

Condition 45, Visual:

> *Prior to the commencement of operations of the project, the proponent shall submit to the Director General a landscape plan providing details of native screening plants to be planted along the eastern boundary of the project site. The plan shall demonstrate that the landscaping does not compromise onsite security and shall include a program for implementation.*

Condition 46, Lighting:

> *The proponent shall ensure that lighting associated with the Project:*
>
> *a) Complies with the latest version of Australian Standard AS 4282(INT)-Control of Obtrusive Effects of Outdoor Lighting; and*
>
> *b) Is mounted, screened and directed in such a manner that it does not create a nuisance to surrounding properties or the public road network.*

Although condition 45 relates to the mitigation of visual impacts, the landscaping works were previously undertaken in accordance with the project approval. The project would not impact on any of the existing landscaping works undertaken to satisfy this condition. As this conditions has already been satisfied no further landscaping is required. In relation to Condition 46, lighting for the project would be designed in accordance with AS 4282.

Although not a statutory requirement, and despite Development Control Plans not being enforceable in relation to Part 3A projects, consideration was undertaken in regards to the Newcastle Development Control Plan 2005 (DCP 2005). The DCP 2005 has provisions relating to visual impact that may concern the site namely Element 4.4 '*Landscaping*' and Element 7.1 '*Industrial Development'*.

Under Element 4.4 '*Landscaping', industrial development with a cost higher than $2 million is classified with a Landscape Category of '3'*. Developments within this category require a landscape plan for the site.

As per Condition 45 of the project approval a landscaping plan was developed for the site. The project would not impact on the existing landscaping of the site.

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SITE LOCATION

Proposed Modification, Greenleaf Road, Kooragang Island

FIGURE 1

G:\ENV\GIS\Projects\60306451 Orica Kooragang Island Flare Modification\FIGURES\AQ\A60306451 F2 Approved Facility Plan 17 10 2013 TO

Existing Infrastructure Key

1	Ammonia Plant
2	Utilities Area
3	Acid Storage (Dilution infrastructure will be contained in the Tank 1 bund)
4	Nitric Acid Plant 3
5	Nitric Acid Plant 2
6	Nitric Acid Plant 1
7	Boiler Plant
8	ANS
9	AN Plant 2
10	AN Plant 1
11	AN Bulk Storage
12	Bagged Product Storage

Infrastructure Key (1 - 16)

1	New demin water system
2	New ammonia storage nitrate pumps
3	New instrument air compressor and dryer
4	Extension to No.2 11kV substation
5	New NA storage
6	New pipe rack
7	11kV trident switchroom
8	New boiler
9	Cooling water supply pumps
10	New cooling water treat,emt skids
11	New cooling towers
12	New NAP4/AN3 switchroom and transformer
13	New NAP4 plant
14	Ammonia compressor
15	Contaminated condensate tank
16	Clean process condensate tank

Infrastructure Key (17 - 32)

17	New No.6 ammonia bullet
18	New emergency generator and switchroom
19	New control room
20	New entry
21	New workshop
22	New entry security gate
23	New office
24	New weighbridge
25	New concentrator plant
26	New ANS/WANS loadout
27	New first flush pi
28	New dispatch office and amenities
29	New bag store
30	New AN road bulk loadout and weighbridges
31	2x 1.05/1.2t bag lines and 1x 25/40kg bag line
32	Switchroom

Infrastructure Key (33 - 38)

33	Transformers
34	Container bag loading area
35	New bulk store
36	New weighbridge
37	New office
38	New exit security gate
39	New FEL workshop and forklift parking
40	Transtank
41	Proposed AN# plant
42	New container storage
43	Nitrogen tie in
44	New ammonia plant nitrates pump

Key

- Site boundary
- Existing infrastructure location
- OBL Stage 1A
- OBL Stage 1B
- OBL Stage 2
- NAP4 & ANS
- AN3

Note:
Information derived from Hatch EMA plan HEN2561-0000-00-014-0012 (**05/04/2011**)

0 100 200m

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APPROVED FACILITY PLAN

Proposed Modification, Greenleaf Road, Kooragang Island

FIGURE 2

3.0 Description of Proposal

The proposed project involves the construction of three flare stacks and a nitric acid tank. Ancillary works would also require piping and connection of electrical control, safety and security systems. These ancillary works would be located at ground level and would not be visible offsite due to shielding from existing plant. A general description of the plant that may be visible from offsite is provided below.

3.1 Height

The heights of the main pieces of project infrastructure are detailed in **Table 1**.

Table 1 Proposed Flare Stack Heights

Flare / Tank	Approximate Height* (m)
Ammonia Plant Flare	20
Ammonia Storage Tank	5
Nitrates Plants	8
Nitric Acid Tank	25
Nitric Acid Tank Scrubber Stack	25.5

**above existing ground level.*

The locations of the three proposed flare stacks and Nitric Acid tank are shown in **Figure 2**.

3.2 Scale

As detailed in **Table 1**, the highest proposed stack is 25.5m, and the nitric acid tank is 22m above the existing ground level of the site. By comparison, the highest pieces of infrastructure that currently exist on the site are approximately:

- Nitric Acid Plant 1 Stack – 84m;
- Nitric Acid Plant 2 Stack – 55m; and
- Nitric Acid Plant 3 Stack – 55m.

A range of existing infrastructure on industrial operations that neighbour the Orica site include infrastructure which are of similar heights to both existing and proposed infrastructure on the Orica site. Whilst exact heights of infrastructure on neighbouring sites are not known, visual inspections have identified the highest infrastructure on neighbouring sites as:

- Kooragang Bulk Facilities (KBF) storage tanks located to the west;
- Boral storage tanks located to the north; and
- Kooragang Wharfs 1, 2, and 3 cranes located to the west.

Approximately 500m to the northwest of the site is a number of other pieces of infrastructure of varying heights. This primarily consists of coal handling (conveyors systems, bins and reclaimers) infrastructure.

3.3 Materials and Colour

All materials associated with the project that will be visible offsite will be metallic. The nitric acid tank will have a stainless steel appearance.

The flare stacks and supporting structures will be made from metals which have been designed to have non-reflective surfaces or be painted.

3.4 Flaring

The proposed flares would not be used during the day to day operation of the facility. Flares are designed to be used during certain non-routine releases of ammonia which cannot be managed through other onsite systems such as scrubbers.

When the flares are required to operate they would produce flame height to the levels listed in **Table 2**.

Table 2 Proposed Flares

Flare	Approximate Stack Height (m)	Approximate Flame Height (m)	Approximate Flame Tip Height (m)
Ammonia Plant Flare	20	36	56
Ammonia Storage Tank	5	10	15
Nitrates Plants	8	18	24

For comparative purposes a typical hydrocarbon flame produces a bright yellow to red flame. The flame associated with the ammonia flaring is different to a typical hydrocarbon flame as it would produce a less visible blue coloured flame. The flare flame would be visible if activated in the night.

Flares would only operate during non-routine releases of ammonia with a flaring event expected to occur on average once every two years. A flaring event would typically involve a single flare in operation as each flare would manage non-routine releases in a different part of the facility. It is highly unlikely that circumstances would require all three flares to operate at any given time.

4.0 Visual Impact Assessment

Following an analysis the nearest sensitive receivers who may be visually impacted by the project, two typical receiver locations where identified for detailed analysis as part of this VIA. These locations are in **Table 3**.

Table 3 Identified Sensitive Receivers

Receiver Name	Receiver type	Distance from facility (m)	Receiver Location Description[1]
Stockton 1 (S1)	Residential	800	Fullerton St – Griffith St intersection
Stockton 2 (S2)	Residential	900	Fullerton St – Hereford St intersection

[1]Location descriptions are approximate with exact locations determined to avoid local obstacles.

The receiver locations are listed in **Table 3**, and shown on **Figure 3**, along with the site line distances between the receivers and the proposed infrastructure.

It is noted that other receiver locations within approximately 5km of the KI site would also have visual access to Orica's facility. These locations include:

- Carrington industrial and residential receivers (approx. 1500m) – residential receivers in Carrington would be largely shielded by industrial facilities along the Hunter River water front;
- Certain viewpoints from the Newcastle CBD (approx. 3000m+) – commercial and residential receivers;
- Elevated Areas of Mayfield (approx. 3500m) – residential receivers; and
- Kooragang Island – adjacent industrial receivers.

In additional elevated areas at greater distances from the site may also have visual access to the site.

No further analysis is considered necessary for these other locations due to their distance. It is considered that the worst case examples analysed in the visual impact assessment in **Section 4.0** provide the greatest benefit when determining potential visual impacts.

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PHOTOGRAPH VIEWPOINT LOCATIONS
Proposed Modification, Greenleaf Road, Kooragang Island

FIGURE 3

4.1 Stockton 1

4.1.1 Existing Environment

The Stockton 1 (S1) indicative receiver location is nominally located at the intersection of Fullerton Street and Griffith Street, Stockton and represents the nearest sensitive receivers to the project. From this location there is a view due west to Orica's facility. This location consists of residential land uses with open space maintained grassland along the Hunter River Foreshore. The sensitive receiver location views to the facility are partially filtered by a low density planting of trees along the foreshore area. The area immediately surrounding S1 is topographically flat with the ground level being approximately the same as that at the KI facility.

Plate 1 shows the existing environment in the vicinity of S1. In the foreground is a car park on the Hunter River shoreline, and then across Fullerton Street are the nearest receivers to Orica.

Plate 2 details the typical foreshore arrangement in the vicinity of S1. The mixture of clustered vegetation along the foreshore allows broken views from residential properties along Fullerton Street towards the site.

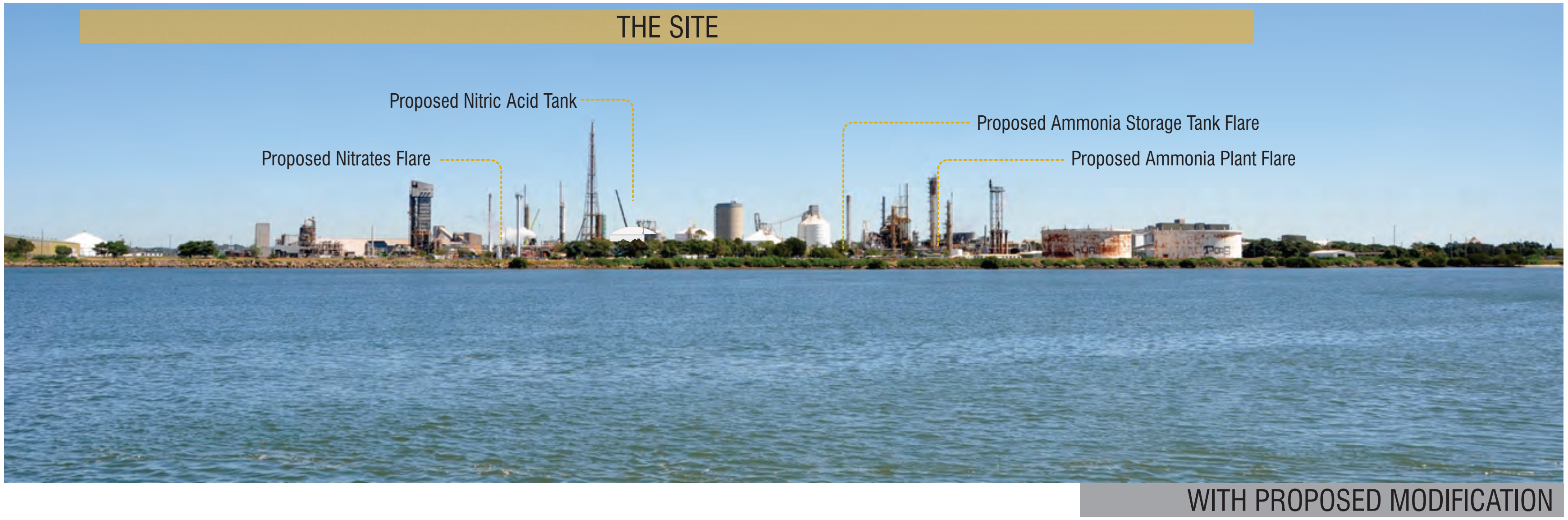
4.1.2 Visual Impact

An artist's impression of the Orica facility as viewed from S1 with the proposed stacks included is shown in **Figure 4**. As can be seen from S1 the flare stacks are largely shielded by existing infrastructure or are at heights which place them within the silhouette of existing infrastructure blending them with the background. Overall the flares when viewed from S1 have a negligible visual impact.

When viewed from S1 less than half of the nitric acid tank can be seen where it protrudes above the existing plant and screening vegetation. Whilst the tank is visible, its height is consistent with other tankage on both Orica and adjoining sites. The tank is therefore within the visual context of the site and has an overall low visual impact.

Plate 1 View towards S1 from Hunter River foreshore

Plate 2 Typical foreshore treatments near S1



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OBSERVER LOCATION S1 ARTISTS IMPRESSION

Proposed Modification, Greenleaf Road, Kooragang Island

Note: It is anticipated that the Proposed Ammonia Storage Tank Flare and Ammonia Plant Flare locations will be obstructed from view due to existing infrastructure providing a screening effect.

FIGURE 4

4.2 Stockton 2

4.2.1 Existing Environment

The Stockton 2 indicative receiver is located at the intersection of Fullerton Street and Hereford Street and is representative of receivers to the south of the Orica facility. From this location the Orica facility can be viewed directly north. In the immediate vicinity of S2 are a church and the Boatrowers Hotel. The area surrounding S2 is predominantly residential. The topography of S2 and surrounding areas is generally flat.

Plate 3 shows the intersection of Fullerton Street and Hereford Street, beyond which are dwellings in all surrounding directions that are representative of residential receivers in the vicinity of S2.

Plate 4 details the typical foreshore treatments along the Hunter River in proximity to S2. Similar to S1, the foreshore near S2 contains a mix of broken vegetation although S2 has a higher density of vegetation obscuring views from receivers to the harbour.

4.2.2 Visual Impact

An artist's impression of the Orica facility as viewed from S2 with the project included is shown in **Figure 5**. From S2 the flares are largely shielded by existing infrastructure or are at heights which place them within the silhouette of existing infrastructure, blending them with the background. Overall the flares when viewed from S1 have a negligible visual impact.

When viewed from S2 less than half of the nitric acid tank can be seen where it protrudes above the existing plant and screening vegetation. Due to the increased distance and greater amount of shielding from existing plant, the nitric acid tank is less visible from S2 than it is from S1. Whilst it is visible, its height is consistent with other tankage on both the Orica and adjoining sites. The tank is therefore within the visual context of the site and has an overall low visual impact.

Plate 3 View toward S2 from Hunter River Foreshore

Plate 4 **Typical foreshore treatments near S2**

G:\ENV\GIS\Projects\603\60306451 Orica Kooragang Island Flare Modification\Figures\EA\60306451 F5 Observer Location S2 13 11 2013 TO Rev A

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OBSERVER LOCATION S2 ARTISTS IMPRESSION

Proposed Modification, Greenleaf Road, Kooragang Island

Note: It is anticipated that the Proposed Ammonia Storage Tank Flare, Ammonia Plant Flare and Nitrates Flare locations will be obstructed from view due to existing infrastructure providing a screening effect.

FIGURE 5

5.0 Conclusion and Recommendations

The proposed project represents development associated with an existing industrial operation that is consistent with the historical land uses of the site and surrounding area. Although having only a small development footprint and being located wholly with the existing Orica site, the heights of the proposed infrastructure have potential to cause visual impacts to nearby residents.

The assessment of the potential visual impacts of the project concludes that overall, a low level of visual impact is expected to occur, due to:

- The scale of the proposed flares and their shielding by existing site infrastructure;
- The shielding of much of the nitric acid tank by existing plant and vegetation;
- The project being consistent with the industrial context of the site and surrounding land; and
- The offset distances between the site and the sensitive receivers.

The project would be compatible with the surrounding industrial development along the Hunter River, and is consistent with the nature of the port infrastructure. The appearance of the project would fit well within the existing industrial landscape of the area.

Despite this it is recommended that the following measures be implemented to minimise ongoing visual impacts:

- All lighting design should be undertaken in accordance with *AS 4282(INT)-Control of Obtrusive Effects of Outdoor Lighting*.
- All infrastructure should be maintained to a high standard and appearance with a focus on the external skin of the nitric acid tanks.
- The existing landscaping and vegetation screens of the Orica site should be subject to ongoing maintenance to maintain the effectiveness of the vegetated screen.