Chlorine Liquefaction Plant

SUBMISSIONS REPORT

Prepared for IXOM Operations Pty Ltd | 30 March 2026



element.



Chlorine Liquefaction Plant

MODIFICATION TO STATE SIGNIFICANT DEVELOPMENT CONSENT | SUBMISSIONS REPORT

Prepared for IXOM Operations Pty Ltd
30 March 2026

PR329

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Date	30 March 2026	30 March 2026

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Revision	Date	Description	Prepared by	Reviewed by
1	30 March 2026	For review	Element Environment	IXOM Operations Pty Ltd

Executive summary

Background

IXOM Operations Pty Ltd (IXOM) owns and operates the Chlor-Alkali Plant (CAP) at Botany Industrial Park, Banksmeadow, NSW. The site is an established industrial facility that produces chlorine and other chemicals for use in essential services, including drinking water treatment, wastewater disinfection and industrial processes across New South Wales and Australia.

IXOM is seeking approval under section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to modify State significant development consent DA35/98 (MOD 6) to allow for the construction and operation of a chlorine liquefaction plant within the existing CAP. The modification would provide chlorine liquefaction capability to improve the resilience, reliability and security of chlorine supply in Australia, particularly in the event of major operational disruptions to existing interstate liquefaction infrastructure.

A modification application was submitted to the NSW Department of Planning, Housing and Infrastructure (DPHI) and placed on exhibition from 3 September 2025 to 23 September 2025. During exhibition, the modification application received a total of 42 submissions.

Following exhibition, DPHI requested the preparation of a Response to Submissions (RTS) in accordance with DPHI's (2024) State Significant Development Guidelines, including Appendix C: Preparing a Submissions Report.

The purpose of this RTS is to transparently summarise the feedback received during exhibition, identify the key issues raised, and explain how those issues have been considered and addressed to support DPHI's assessment of the modification.

Analysis of submissions

Submissions were received from a broad range of stakeholders, reflecting both the local context of the site and the state and national significance of the facility.

These included submissions from:

- 12 government agencies, including federal, state agencies and local councils;
- 19 public submissions from individual members of the community and community groups; and
- 11 submissions from utilities, public organisations and industry bodies that rely on the continued availability of chlorine for essential services.

Government agency and council submissions primarily focused on risk and hazard management, contamination, traffic and transport, greenhouse gas emissions, emergency management and planning considerations. Public submissions raised concerns relating to safety, risk perception, transport, amenity and cumulative impacts. Submissions from federal and state government departments responsible for water and critical supply chains, water utilities and service providers, as well as private organisations, expressed support for the proposal, highlighting the importance of increased supply security, operational resilience and public health outcomes, particularly given Australia's reliance on chlorine for safe drinking water.

Actions since receipt of submission

Since exhibition, IXOM has undertaken additional targeted work to respond to matters raised in submissions and through DPHI's post-exhibition review. This has included:

- additional clarification and supplementation of the Quantitative Risk Assessment (QRA);

- updates to the Dangerous Goods Transport Risk Assessment (DG TRA), including consideration of alternative routes and confirmation of conservative assumptions;
- clarification of the Greenhouse Gas (GHG) assessment;
- progression of an independent site audit process to confirm the proposed remediation plan is sufficient to make the land suitable for the proposed industrial use; and
- further discussions and meetings with Bayside Council, Randwick City Council and other relevant agencies, as well as clarification correspondence with DPHI regarding biodiversity assessment requirements.

In addition, DPHI issued a Request for Further Information (RFI) following its review of submissions and supporting documentation. The matters raised in the RFI have been addressed through this RTS and associated updated technical information.

All post-exhibition work has been undertaken to improve clarity and responsiveness and does not change the scope, scale or nature of the modification.

Response to submissions

This RTS report demonstrates that issues raised during public exhibition have been carefully considered and addressed through a combination of targeted technical updates, further stakeholder engagement and refinement of supporting assessments, without altering the scope of the modification.

Project justification

The post-exhibition work confirms that the modification remains within the limits of the exhibited proposal and continues to meet the relevant assessment criteria under the EP&A Act.

The submissions received from utilities and public service providers and private organisations highlight the strategic importance of the proposal in maintaining secure and reliable chlorine supply for essential services, including drinking water and wastewater treatment. This context is relevant to the consideration of the proposal in the public interest.

Overall, the RTS supports the conclusion that the modification is necessary, environmentally acceptable and in the public interest.

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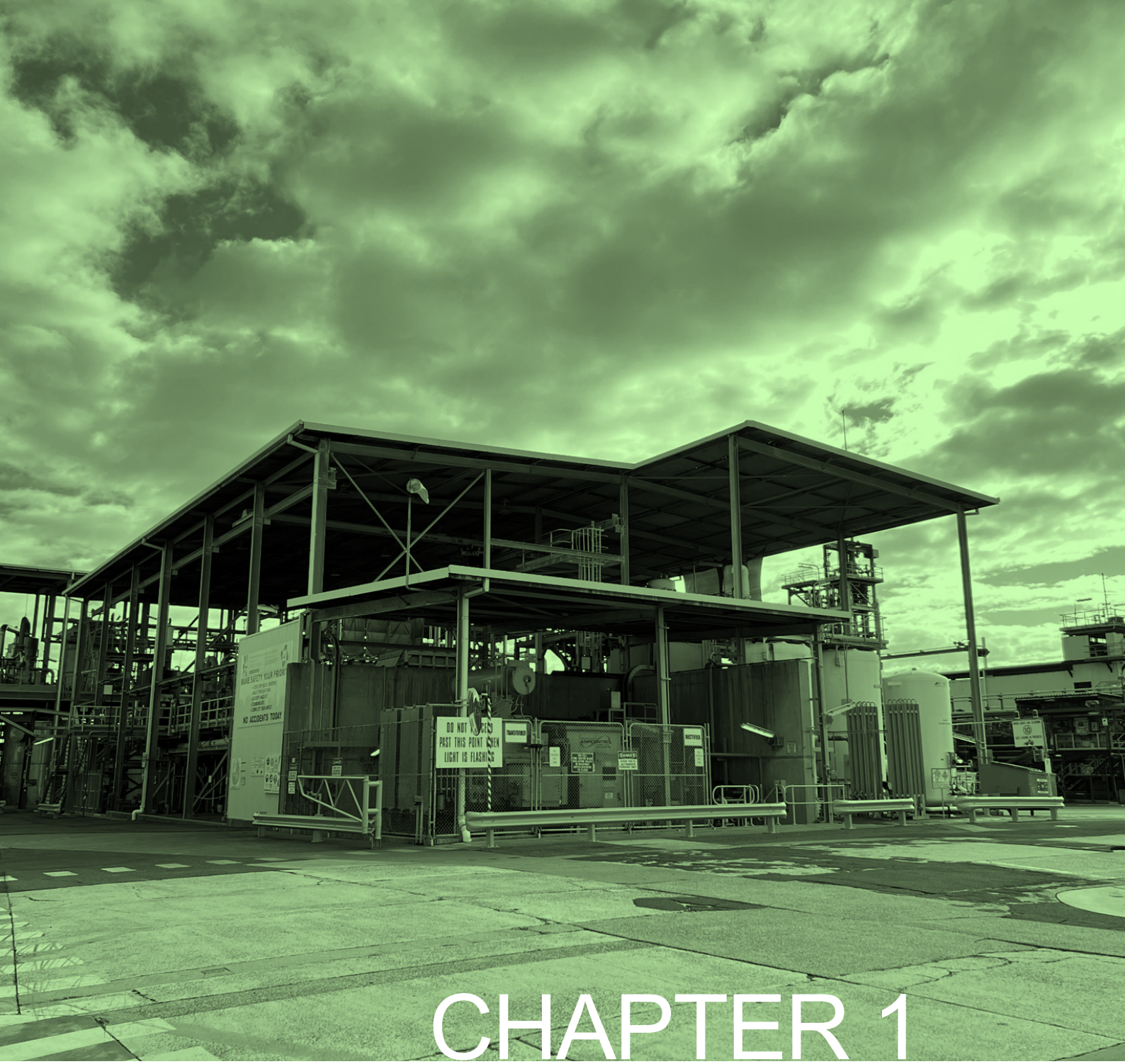
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CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 Overview

This response to submissions (RTS) report has been prepared by Element Environment Pty Ltd (Element) on behalf of IXOM Operations Pty Ltd (IXOM) to provide a written response to submissions received during the exhibition of the modification application (DA35/98-Mod-6) for the proposed construction and operation of a new chlorine liquefaction plant (CLP; the modification) at 16-20 Beauchamp Road, Banksmeadow NSW 2019 (the site).

1.2 Background

IXOM currently operates the Botany Chlor-alkali Plant (CAP) at the site which was granted consent in 1998 (DA35/98; the consent) by the former Minister for Urban Affairs and Planning under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Water Services Association of Australia (WSAA) has identified potential liquefied chlorine supply constraints as a significant risk. On 13 December 2023, the WSAA applied, on behalf of itself and current and future members, for authorisation to engage in conduct for the purpose of improving the resilience of the supply chain of chlorine in Australia.

The proposed CLP will be integrated into existing IXOM operations, with all chlorine gas being sourced from the existing CAP. The modification intends to ensure the contingent supply of liquefied chlorine in Australia as it will provide redundancy if the existing CLP at Laverton, Victoria becomes non-operational or is no longer able to meet market demands.

For this scenario, the proposed Botany CLP would produce liquefied chlorine as required to compensate for any loss of production volume at the Laverton liquefaction plant. During normal operation, the CLP will operate at a reduced rate to supply bulk liquefied chlorine throughout NSW. By servicing NSW clients locally, the transport of bulk chlorine by road from Victoria would no longer be required, resulting in shorter overall freight distances.

1.3 Status of the modification

Element Environment Pty Ltd (Element) prepared a modification report (the modification report) on behalf of IXOM**,** which was submitted to the NSW Department of Planning, Housing and Infrastructure (DPHI) on 18 August 2025 to seek approval for a modification to the existing State significant development consent (DA35/98) under Section 4.55(2) of the EP&A Act**.**

The modification application was placed on public exhibition on the NSW Major Projects portal from 3 September 2025 to 23 September 2025 (the exhibition period)**.**

1.4 Purpose of the report

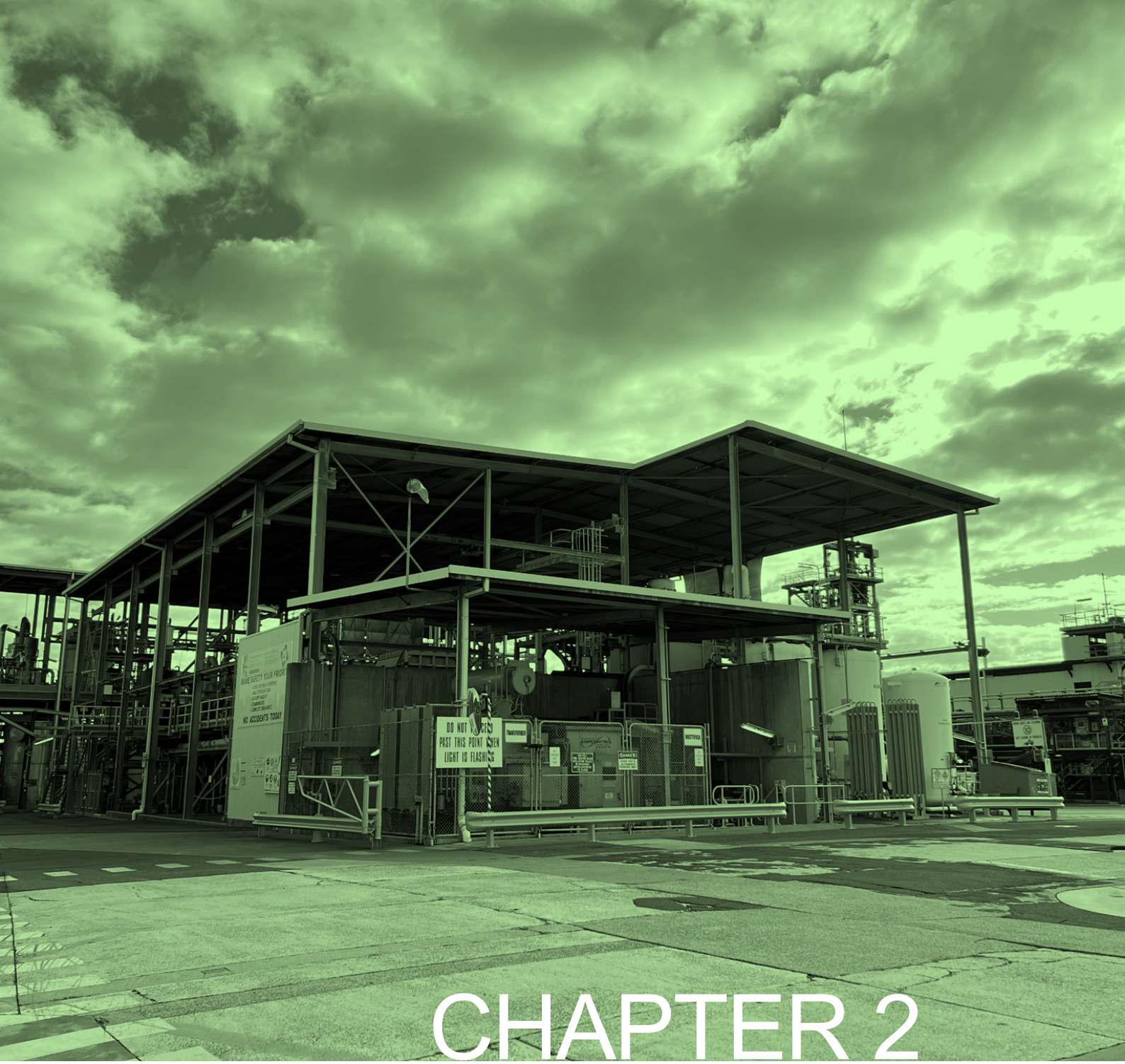
Exhibition of the modification ended on 23 September 2025, and on 26 September 2025 DPHI wrote to IXOM requesting the preparation of a RTS report to address the matters raised by government agencies and the public. This RTS has been prepared in accordance with DPHI's (2024) State Significant Development Guidelines including Appendix C: Preparing a Submissions Report and provides a response to submissions received during exhibition of the modification.

The purpose of this document is to consider and respond to advice and submissions received from government agencies and members of the public during the public exhibition of the modification (DA35/98-Mod 6), to provide clarification and additional information on relevant

components of the modification, and to address matters raised by DPHI in its correspondence requesting further information.

1.5 The modification

The modification is described in Chapter 3 of the modification report and seeks to construct and operate a new CLP at the site to ensure the contingent supply of liquefied chlorine in Australia.



CHAPTER 2

ANALYSIS OF SUBMISSIONS

2 ANALYSIS OF SUBMISSIONS

2.1 Summary of submissions

During the exhibition period, submissions were received from a range of stakeholders, reflecting both regulatory review and broader community interest in the proposal.

A total of 42 submissions were received from government agencies, local government, public organisations, special interest groups and individuals. The submissions included technical advice from state agencies and policy/operational advice from local government, as well as comments, objections and suggestions from community groups and individual members of the public. A summary of the submissions is provided below.

2.1.1 Government agencies

A total of 12 submissions were received from the following federal, state and local government agencies (see Appendix A):

- DPHI
- Sydney Trains
- Airservices Australia
- Fire and Rescue NSW
- Transport for NSW (TfNSW)
- Bayside Council
- Randwick Council
- NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) – Conservation Programs, Heritage and Regulation (CPHR) Group
- Federal Department of Climate Change, Energy, the Environment and Water – Water Policy Division
- Department of Industry, Science and Resources
- NSW Environment Protection Authority (EPA)
- SafeWork NSW

2.1.2 Special interest groups, organisations and individuals

A total of 19 public submissions were received from individual members of the community and community groups, which raised comments, concerns and objections relating to issues such as risk, amenity, transport and public safety.

A further 11 submissions were received from public organisations, utilities and industry bodies that rely on the continued availability of chlorine for essential services, including drinking water disinfection and wastewater treatment. These submissions expressed support for the modification and provided context regarding the strategic importance of increased supply security, operational resilience and public health outcomes (see Section 6.1). These submissions were received from:

- Sydney Water
- Melbourne Water
- Gippsland Water
- TasWater
- SA Water
- Water Corporation (Western Australia)
- Power and Water Corporation (Northern Territory)

- SeqWater (South-East Queensland)
- Suez Water Pty Ltd
- Veolia (Veolia Water Operations and Veolia Water Technologies)
- Water Services Association of Australia (WSAA)

2.1.3 Locality of submissions

Submissions received during the exhibition period were provided by a broad range of stakeholders at local, state and national levels, reflecting the important nature of the proposal and the role of the Botany facility in supporting essential service infrastructure across Australia.

The public submissions received were largely from residents and local organisations from Bayside Council and Randwick Council and other individual members of the community residing within the surrounding areas.

The majority of submissions, however, were received from state government agencies, public authorities and service providers, many of which operate at a state or national scale and are not geographically local to the site. These include regulatory agencies and essential service providers responsible for water supply, environmental protection, critical supply chains, safety, transport, and emergency response.

Submissions were received from all major state water utilities and their industry organisation, who rely on the continued availability of chlorine for drinking water disinfection and wastewater treatment. These submissions reflect the strategic, regional and national significance of the proposal rather than localised impacts.

2.1.4 Submissions objecting, supporting or commenting on the modification

A broad summary of submissions categorised as either comments, objections or support is provided in Table 2.1.

Table 2.1 Overview of submissions

Position	Residents/community groups	Government agency	Public/private organisations	Total
Comment	1	3	0	4
No comment	0	4	0	4
Objection	18	1	0	19
Recommendation	0	2	0	2
Support	0	2	11	13

2.2 Submission categories

The key themes of the matters raised in the submissions are summarised in Table 2.2. Many submissions commented on multiple themes. The themes are grouped into categories as shown in Table 2.2.

Each individual government agency submission is addressed in Chapter 4, while public submissions are addressed in Chapter 5.

Table 2.2 Key submission categories

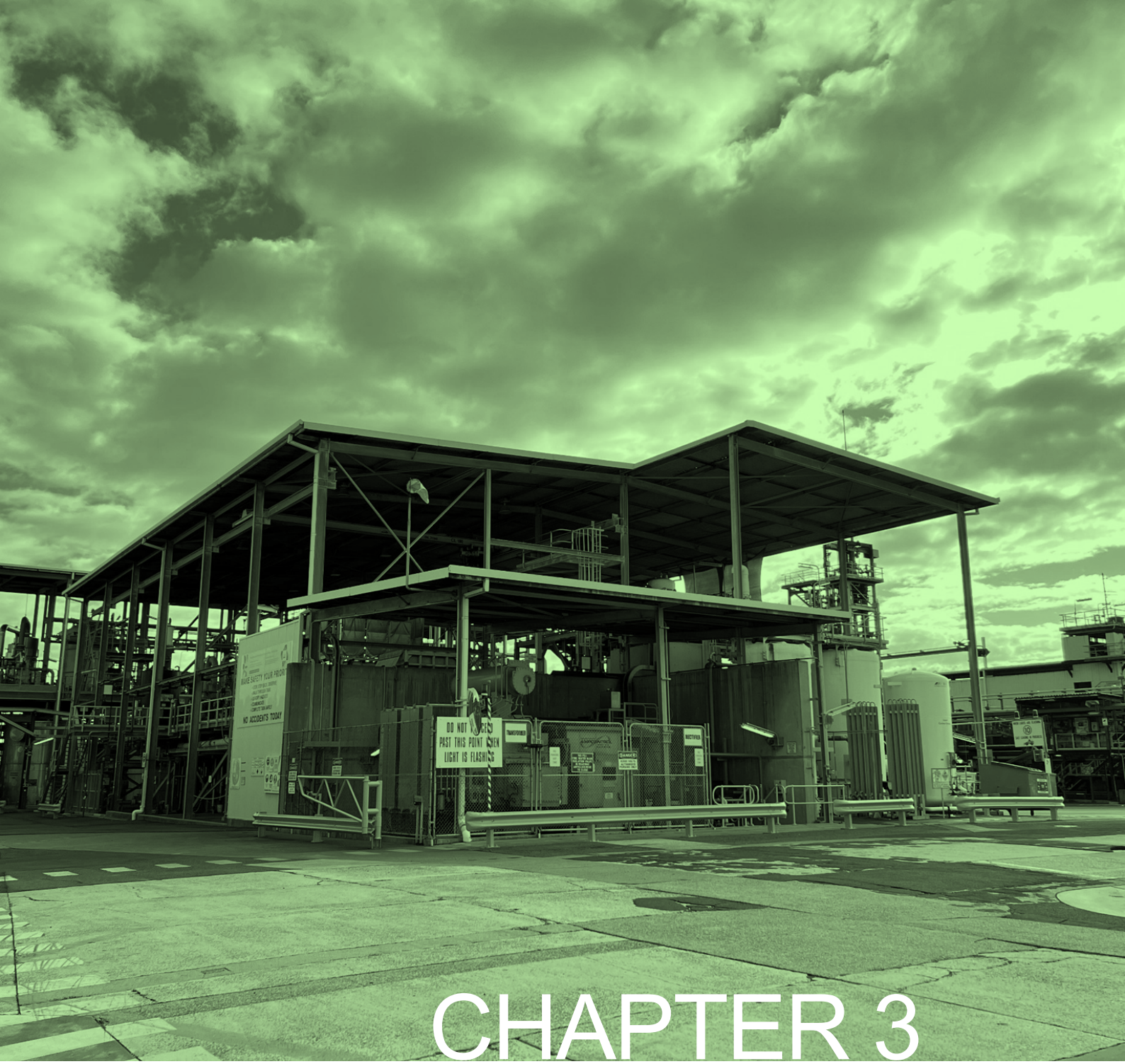
Category	Sub-category	Aspect	Total comments or recommendations
Environmental, economic and social impacts	Environmental management	Air	2
		Biodiversity	1
		Contamination	1
		Design	2
		Flooding	1
		Hazards	2
		Risk	2
		Social	4
	General	Biodiversity	1
		Hazards	7
		Land use and zoning	1
	Health and safety	Hazards	1
		Risk	3
	Operations	Air	1
		Design	1
		Risk	1
		Social	1
	Planning considerations	Cumulative	2
		Hazards	3
	Risk	Air	2
		Contamination	3
		Cumulative	6
		Design	5
		Flooding	1
		Hazards	10
		Heritage	1
		Risk	22
	Transport	Hazards	5
		Risk	8
		Traffic	9
	Waste management	Hazards	1
Issues beyond the scope of the project	Health and safety	Risk	1
	Planning considerations	Design	1
		Hazards	7
		Risk	1
	Risk	Design	1
		Hazards	49
		Risk	2
		Social	1
	Transport	Risk	2
Justification and evaluation	Health and safety	Risk	1
	Risk	Design	1
		Risk	1

Category	Sub-category	Aspect	Total comments or recommendations
	Support	Economic security and resilience	54
	Transport	Risk	2
Procedural matters	Environmental management	Biodiversity	1
		Noise	1
		Permitting	1
		Social	1
	General	Social	1
	Health and safety	Risk	2
	Planning considerations	Aviation	3
		Contamination	2
		Cumulative	1
		Hazards	2
		Rail	1
		Risk	1
		Social	2
	Risk	Design	1
		Hazards	8
		Permitting	1
		Risk	1
	Transport	Traffic	1
The project	Environmental management	Social	1
	General	Hazards	2
	Health and safety	Risk	13
	Operations	Design	2
	Planning considerations	Design	1
		Rail	1
	Risk	Cumulative	1
		Design	2
		Hazards	4
		Social	2

Table 2.2 indicates that the key themes of the submissions are:

- Risk and hazard management, including major hazard facility considerations, accident scenarios, cumulative risk and emergency response arrangements.
- Health and safety, particularly community safety, worker safety and risk management controls during operation.
- Design and operational matters, including facility design, containment systems, operational processes and interface with existing operations.
- Environmental management, with submissions addressing air quality, contamination, flooding, biodiversity and waste management.
- Traffic and transport, including road traffic, rail interfaces and transport-related risk.
- Planning and procedural considerations, such as consistency with planning controls, cumulative impacts and approval pathways.
- Social and amenity impacts, including community concerns and perceived risks.

- Project justification, including submissions supporting the proposal on the basis of economic security, supply resilience and public benefit.



CHAPTER 3

ACTIONS TAKEN SINCE EXHIBITION

3 ACTIONS TAKEN SINCE EXHIBITION

The DPHI State Significant Development Guidelines: Preparing a Submissions Report (2024) requires the proponent to summarise the actions taken since the public exhibition period to address the issues raised in submissions. In particular, the submissions report must describe how the applicant has:

- refined or amended the modification;
- undertaken further engagement with the community and key stakeholders; and
- undertaken further assessment of the impacts of the modification.

This section summarises the actions undertaken by IXOM since the exhibition of the modification report. This section is limited to actions that are relevant to the RTS, which include refinements, commitments, additional environmental assessment commissioned post-exhibition, and community and stakeholder engagement undertaken specifically to inform this report.

3.1 Refinements to the modification

No material refinements to the scope of the modification proposal have been made since exhibition.

IXOM continues to seek approval for the construction and operation of a chlorine liquefaction plant within the existing Chlor-Alkali Plant at the Botany Industrial Park, as described in the modification application and supporting documentation. There has been no change to the nature or scale of the proposed development, including the approved site footprint, building envelopes, operational capacity, operating hours or the extent of physical works proposed under the modification.

Post-exhibition work has been limited to technical clarification and validation undertaken in response to issues raised in submissions and agency consultation. This work has included:

- refinement and validation of risk and hazard assessment inputs, including updates and clarifications of assumptions used in the quantitative risk assessment and transport risk assessment;
- engaging an EPA-accredited site auditor to prepare interim site audit advice;
- updates and clarification to traffic aspects, including consideration of operational traffic movements and access arrangements;
- updates and clarification to the existing greenhouse gas assessment; and
- further consultation with relevant agencies and stakeholders, to confirm consistency with existing management and response frameworks.

These post-exhibition activities have been undertaken to address matters raised in submissions and improve clarity, and do not alter the scope, scale or intent of the modification. All refinements remain within the limits of the modification description as exhibited and do not result in any additional environmental impacts or changes to the development sought to be approved.

3.2 Additional environmental impact assessment

Following the exhibition of the modification application, additional technical clarification and assessment work was undertaken to respond to matters raised in submissions from government agencies and the public.

3.2.1 Quantitative Risk Assessment

The Quantitative Risk Assessment (QRA) (Appendix B) was reviewed and supplemented to provide further detail and clarity regarding:

- the identification and assessment of all credible major hazard incidents associated with the proposed chlorine liquefaction plant, including both normal and contingent operating scenarios;
- worst-case and cumulative risk scenarios, including the interaction between the existing Chlor-Alkali Plant and the proposed liquefaction facility;
- further explanation of changes in individual and societal risk contours resulting from the revised site layout and consolidation of chlorine storage within the containment building; and
- additional detail regarding the role, performance and availability of key engineered safeguards, including the containment building and chlorine scrubber system, and the approach to verification, commissioning and ongoing assurance of these safeguards through detailed design and operation.

The supplementary information does not change the scope, scale or nature of the modification, nor does it materially alter the conclusions of the exhibited QRA. The assessment continues to demonstrate that the proposed modification does not result in a material increase in off-site individual or societal risk and remains consistent with the NSW Hazardous Industry Planning Advisory Paper (HIPAP) risk criteria.

3.2.2 Dangerous Goods Transport Risk Assessment (DG TRA)

In response to matters raised in submissions and issues identified by the DPHI during its post-exhibition review, the Dangerous Goods Transport Risk Assessment (DG TRA) was reviewed and updated to provide additional clarification and assurance regarding transport-related risks associated with the modification.

The updated DG TRA (Appendix C) addresses specific matters raised by DPHI, including:

- clarification of consequence modelling assumptions;
- alignment and consistency between transport-related release scenarios assessed in the DG TRA and those considered in the QRA;
- extension of the transport risk assessment coverage to include the Wentworth Avenue and Denison Street intersection; and
- consideration of alternative access gate options and associated transport routes minimising the use of Denison Street (Appendix D), including assessment of feasibility and risk implications.

The updated DG TRA confirms that chlorine transport risks along Denison Street associated with the modification are compliant with the relevant NSW land-use safety planning individual risk criteria. Further, the cumulative DG transport risk (which accounts for flammable dangerous goods such as LPG and gasoline that are not associated with IXOM operations) is lower than previously published DG transport risks along Denison St but that reduction is driven by a reduction in non-chlorine DG tankers along Denison St

3.2.3 Greenhouse Gas (GHG)

In response to submissions from the NSW Environment Protection Authority, the Greenhouse Gas (GHG) assessment was reviewed and updated (Appendix E) to clarify the basis for the Scope 1 and Scope 2 emissions estimates associated with the modification, including the applicability of the NSW EPA Guide for Large Emitters.

Further review confirmed that the electrical load previously applied to this scenario represented the maximum operating load of the chlorine liquefaction plant, rather than a production-scaled emissions intensity. This assumption resulted in an overstatement of total Scope 1 and Scope 2 emissions when extrapolated to maximum annual production.

The GHG assessment has been updated to reflect the actual operating characteristics of the proposed modification and updated data for existing approved operations. The revised assessment confirms that the modification would generate approximately 2,550 tonnes of CO_2 equivalent Scope 1 and Scope 2 emissions per annum and does not trigger the assessment requirements under the NSW EPA Guide for Large Emitters. These clarifications and revised calculations are documented in the updated GHG assessment provided in Appendix E and are addressed in Chapter 4.

3.2.4 Interim audit advice

The submission from Randwick City Council requested independent verification that contamination risks at the site have been appropriately assessed and that the site can be made suitable for the proposed industrial use.

In response, IXOM engaged an independent NSW EPA-accredited Site Auditor to provide interim audit advice in relation to the detailed site investigation and remediation action plan submitted as part of the modification application. The interim audit advice is provided in Appendix F and supports the conclusions of the investigations and confirms that the site can be made suitable for the proposed use subject to remediation in accordance with the remediation action plan.

A formal Section A2 Site Audit Statement and Site Audit Report will be obtained following completion of the remediation works in accordance with the NSW EPA Guidelines for the NSW Site Auditor Scheme (2017). The site audit will verify outcomes and, if appropriate, confirm that the site is suitable for the approved industrial use.

The interim audit advice provides an additional level of independent assurance regarding contamination management and land suitability. It does not alter the scope, scale or nature of the modification, nor does it introduce any new environmental impacts. Rather, it provides a statutory verification mechanism to support the consent authority's consideration of land suitability under the *Environmental Planning and Assessment Act 1979.*

3.2.5 Request for Further Information from DPHI

Following its review of the modification application, supporting technical documentation and the submissions received during public exhibition, DPHI issued a request for further Information (RFI) dated 3 November 2025 in relation to the modification.

The RFI was issued following DPHI's detailed assessment of:

- the submissions received;
- the modification report;
- the QRA; and
- the DG TRA, having regard to the issues raised in submissions from government agencies, councils and the community.

The RFI sought additional clarification and justification in relation to:

- the assessment of alternatives and justification for the modification in terms of broader safety, transport and public benefit considerations;
- confirmation of consultation outcomes with the Local Emergency Management Officer (LEMO);

- clarification of QRA assumptions and modelling, including consequence modelling, safeguard availability and verification, and the interpretation of individual and societal risk results; and
- further assessment of dangerous goods transport risk, including consideration of alternative transport routes and confirmation that the adopted assumptions represent a conservative worst-case scenario.

The matters raised in the RFI have been addressed through:

- additional clarification and explanation provided in this RTS report;
- updates and supplementary information to the QRA and DG TRA; and
- further targeted consultation with relevant stakeholders, where required.

The response to the RFI does not result in any change to the scope, scale or nature of the modification, but provides clarifications regarding the assessment of safety and transport matters to inform DPHI's determination of the application.

3.3 Additional stakeholder engagement

Targeted consultation and engagement was undertaken to further understand matters raised in submissions and to provide further clarification to stakeholders, as described below.

3.3.1 Community engagement

Direct correspondence was undertaken with individual submitters where detailed questions or concerns were submitted directly to IXOM, such as Mr Robert Driscoll, who sought clarification on matters including chlorine risk, safety controls, transport arrangements and potential impacts on the surrounding area. A written response was provided to Mr Driscoll to address these questions, clarify the findings of the risk and transport assessments, and explain the regulatory controls and safeguards applicable to the proposal (see Section 5.8).

3.3.2 Randwick City and Bayside councils

Further engagement included post-exhibition discussions and in-person meetings with Randwick City Council and Bayside Council, undertaken to clarify matters raised in their submissions and to provide additional information regarding contamination management, risk and safety considerations, traffic and transport, and the proposed environmental management framework. Through these discussions the scope of post-exhibition technical work was confirmed and agreed upon, including the progression of independent site audit arrangements and clarification of assessment assumptions.

3.3.3 DCCEEW (CPHR)

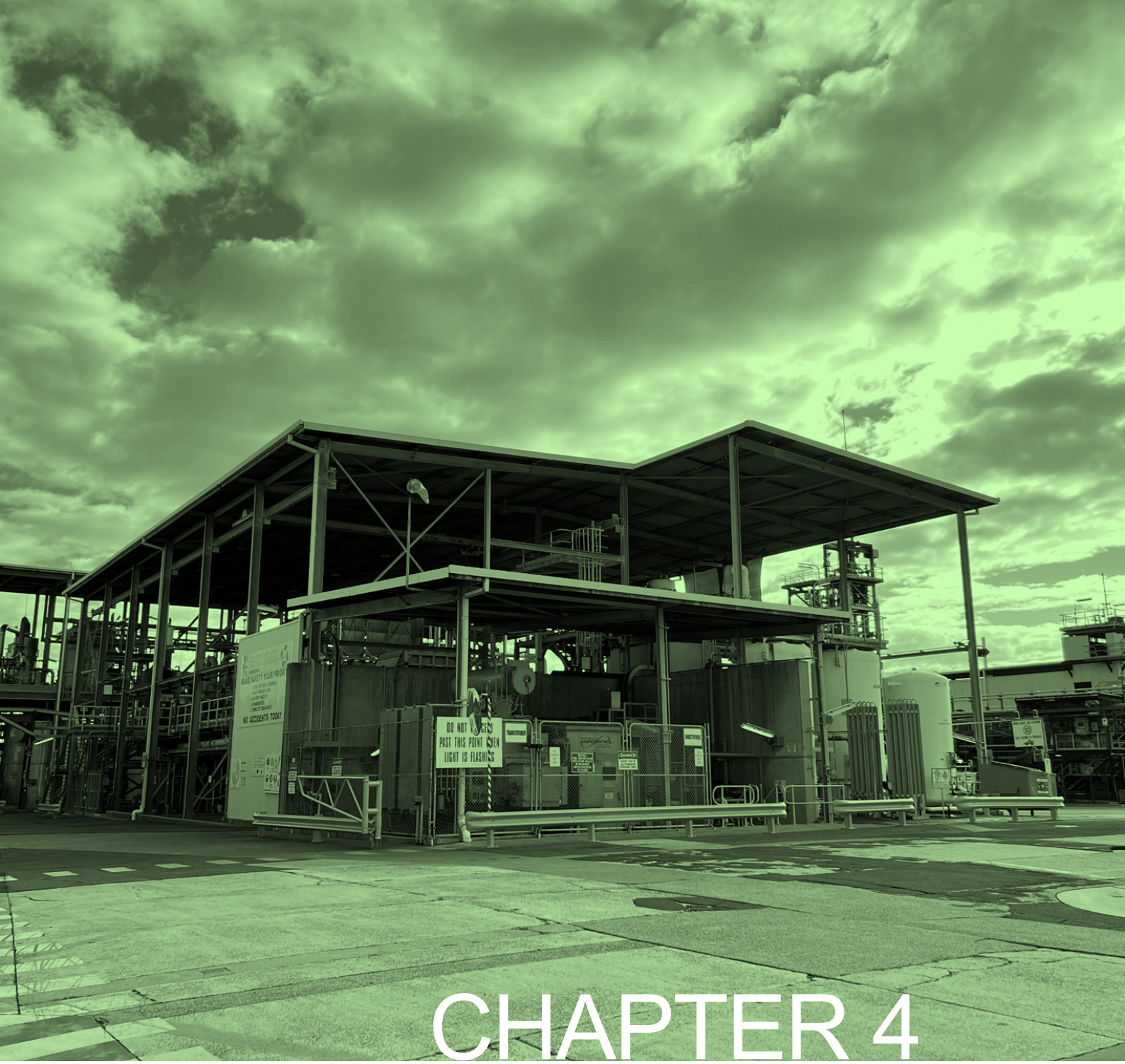
Following receipt of the submission from DCCEEW (CPHR), post-exhibition correspondence was undertaken with the DPHI to clarify the biodiversity assessment requirements applicable to the modification.

This correspondence focused on confirming the application of section 7.17 of the *Biodiversity Conservation Act 2016* and clause 30A of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* to the modification, noting that the development is located entirely within an existing industrial site and does not involve vegetation clearing or increased impacts on biodiversity values.

Through this clarification, it was confirmed that, consistent with the SEARs and the preliminary position adopted by DPHI, the modification does not trigger the requirement for a Biodiversity

Development Assessment Report (BDAR), provided the modification clearly demonstrates that biodiversity impacts would not increase.

The outcomes of this correspondence have been addressed in the RTS through additional contextual information and clarification of the relevant legislative framework. No changes to the scope of the modification or additional biodiversity assessment were required.



CHAPTER 4

RESPONSE TO AGENCY SUBMISSIONS

4 RESPONSE TO GOVERNMENT AGENCIES

The government agency submissions are addressed in this chapter. **Bold** text is an exact reproduction of the submissions received, while normal text is IXOM's response to submissions.

4.1 Sydney Trains

Item 1 - Thank you for referring this application to TfNSW- Sydney Trains. Please be advised that we have no comments regarding this application as the site is not in proximity to Sydney Trains operated rail lines.

Noted.

Item 2 - The proposal may impact on ARTC operated lines, and you may wish to reach out to them if you have not done so already.

The modification will not extend past the site boundary and will have no impact on the operations of ARTC-operated lines during normal or contingent operations.

4.2 Airservices Australia

Item 3 - At this time, Airspace Development Protection has no comments on the proposed development. However, should the development and any associated equipment infringe on the Obstacle Limitation Surface (OLS) of a certified aerodrome, this would typically trigger an assessment of potential impacts on Procedure for Air Navigation Systems Operation (PANS-OPS) or Communication, Navigation, and Surveillance (CNS).

Noted. Consultation with the Civil Aviation Safety Authority (CASA) confirmed that both the stack and plume height sit well below the OLS and therefore do not trigger assessment under the Airspace Regulations. CASA advised that no aviation-related marking, lighting or additional assessment is required.

Item 4 - For reference, the OLS may extend up to an 8.1NM (15km) radius from the airport's Aviation Reference Point (ARP), depending on the runway category.

Noted.

Item 5 - To ensure compliance with aviation safety regulations, it is recommended that a development application be submitted directly to the airport operator. The airport will typically conduct the initial assessment of obstacles within this designated area and refer the matter to Airservices if a penetration is identified in their evaluation

As noted above, CASA confirmed that the proposal will not penetrate the OLS, presents an acceptable level of safety, and requires no mitigation measures, charting or further aviation assessment. Details of the modification were also provided to Sydney Airport Corporation Limited (SACL) as part of consultation undertaken during preparation of the modification. SACL confirmed that they had no comments from an Airspace Protection or planning perspective.

4.3 Fire & Rescue NSW

Item 6 - FRNSW have reviewed the Modification report with particular focus to Hazards and Risks and note that this site operates as an existing licenced Major Hazard Facility. FRNSW submit no additional comments or recommendations for consideration, nor any requirements beyond that specified by applicable legislation at this stage.

Noted.

Item 7 - FRNSW submit no additional comments or recommendations for consideration, nor any requirements beyond that specified by applicable legislation at this stage.

Noted.

4.4 TfNSW

Item 8 - TfNSW has reviewed the submitted information and raises no objection as the proposed modifications are not expected to have a significant impact on the state classified road network.

Noted.

4.5 Bayside Council

4.5.1 Contaminated land, remediation and long-term environmental management

Item 9 - There are no ASS-related requirements for the proposed development. The DSI and RAP were prepared to sufficient detail in order to characterise, assess, and manage the site appropriately. While it is not Council's preference that a LTSEMP will be prepared, given the need for long-term management of the site, it will be required in order to monitor the proposed below ground marker layer and below building vapour barrier, given the nature of contamination at the site. Mercury and chlorinated hydrocarbons were detected in soil vapour at potentially unacceptable levels, along with surface asbestos and inferred subsurface asbestos. No soil contamination was identified. Groundwater was not tested, however, given the proposed cut and fill plans and depth of groundwater found, groundwater is not expected to be intercepted during the proposed works. Council agrees with the justifications that this is the most preferred remediation strategy and that the site will be made suitable upon implementation of the RAP methodologies and recommendations, and the preparation of a LTSEMP.

Noted.

Item 10 - The following condition is recommended: Conveyancing Act Registration. Should the remediation require residual contamination at the site to be managed, a restriction as to use under Section 88B of the Conveyancing Act 1919 is to be registered on the title of [insert Lot and DP/SP] with the following terms of restriction on use: The registered proprietor must not use or otherwise undertake development on the land hereby burdened except in accordance with the provisions of the Long-Term Environmental Management Plan [Enter Name of Plan] ref: [Enter Details], prepared by [Enter Details], dated [Enter Details]. The name of the person or authority empowered to release, vary or modify the restriction will be Bayside Council

As part of preparing the RTS, the proponent has reviewed this recommendation and sought legal advice on appropriate mechanisms to ensure long-term environmental management obligations are secured. Two alternative mechanisms have been identified that would achieve the same regulatory outcome – ensuring ongoing compliance with the LTEMP – without requiring registration of a restriction on the land title:

- A condition of development consent requiring compliance with the LTEMP; or
- Inclusion of the LTEMP on the Section 10.7 Planning Certificate issued under the *Environmental Planning and Assessment Act 1979*.

Both alternatives provide an appropriate and enforceable pathway for ensuring long-term environmental management of the site. These approaches also avoid the need for landowner consent that would otherwise be required for a title restriction.

Item 25 - Contaminated Land Management Act 1997: The site at Banksmeadow is located within an area with a history of industrial land use and potential legacy contamination. While the proposal involves the construction of a new building, a comprehensive assessment of the risk posed by disturbing any pre-existing contaminated land should be provided. The Proponent must have a detailed plan for the management of excavated soil and an Unexpected Finds Protocol to address the discovery of any previously unknown contamination. The Council should request confirmation that this aspect has been addressed in consultation with the EPA.

Item 40 - Historical Context and Cumulative Risk 4.3.1 The Site's Industrial Legacy The Banksmeadow site and the broader Botany Industrial Park have a long history of industrial operations and associated environmental contamination. Orica, a former operator, had manufacturing activities at Botany for over 80 years, during which soil and groundwater contamination with chlorinated hydrocarbons (CHCs) and elemental mercury occurred. A ban on domestic bore water use has been in effect for a 20km radius since 2003, and an ongoing, multi-million-dollar groundwater cleanup project has been operating since 2005 to prevent contaminated plumes from reaching Botany Bay. The contamination is not fully remediated, with "residual contaminants" remaining in source areas.

Noted.

Item 57 - Site-Specific Cumulative Risk Assessment: A study that explicitly acknowledges the site's environmental history and recent incidents, demonstrating how the new plant will not exacerbate pre-existing risks or interfere with ongoing remediation efforts.

The QRA includes a cumulative risk assessment considering the modified development (CAP and CLP). As noted in the QRA, other former BIP operators (Qenos and Indorama) are no longer operating and were therefore excluded from the cumulative profile. A Detailed Site Investigation, Remedial Action Plan and interim audit advice from a NSW EPA accredited site auditor has been provided to confirm the site can be made suitable for the intended land use.

4.5.2 Environmental health, major hazard facility (MHF), risk, QRA, PIRMP and regulatory compliance

General adequacy and high-risk nature of development:

Item 11 - Council's Environmental Health officers concluded that the information provided for the project of this scale and nature is inadequate to conduct an accurate assessment for environmental health and public safety implications.

IXOM, Element and Sherpa Consulting Pty Ltd (Sherpa) met with Bayside City Council in-person on 25 November 2025 to discuss Council's submission in detail. During the meeting, IXOM re-presented the project background, scope, design and objectives, and Element re-outlined the full suite of technical studies and assessments that accompanied the modification application.

Through this discussion, it was clarified that a number of matters raised in Council's submission are addressed within the documentation provided as part of the modification package. The modification application was prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) and informed by consultation with SafeWork NSW and other relevant agencies. On this basis, the environmental assessment is considered appropriate to the scale and nature of the modification. Council was invited to raise any specific information they

consider outstanding, and further discussions were offered should they wish to examine any aspect of the assessment in more detail. No further discussion was requested by Council.

Item 12 - The proposed modification by IXOM to construct a new chlorine liquefaction and packaging plant at Banksmeadow is a development of significant environmental and safety risk, particularly given its location in a densely populated area with a documented history of industrial incidents. The preliminary documentation provided by the proponent is critically insufficient to justify consent. It fails to address legally mandated requirements for high-risk chemical facilities and provides a superficial account of the project's implications.

The existing CAP is already a licensed Major Hazard Facility (MHF) regulated by SafeWork NSW, and operates in accordance with the established legislative framework applicable to a MHF. Any future operation of the modification would continue to be subject to these requirements, with the existing MHF Safety Case to be updated to incorporate the modification at the appropriate time in consultation with SafeWork.

DPHI issued SEARs for this modification, which set out all matters to be addressed in the environmental assessment. The modification application was prepared in response to those SEARs and includes detailed assessments of safety, risk, environmental impacts and regulatory compliance. This included consultation with SafeWork NSW, the EPA, DPHI Hazards team, and other relevant agencies, as required.

All information requested through both the SEARs and extensive engagement with the DPHI Hazards team and SafeWork NSW has been provided in the modification report and supporting technical studies, which provides a robust and legally compliant assessment of the modification.

Item 13 - The best interest of Bayside Council and its community is to ensure that all potential risks are not merely acknowledged but are fully quantified, mitigated, and managed in a transparent manner. The recommendation to DPHI to halt the assessment until a comprehensive and legally compliant submission is provided is a necessary and responsible course of action to protect the public and the environment.

The potential risks associated with the modification have been fully quantified in accordance with the SEARs. A detailed QRA, prepared in line with the relevant Departmental planning advisory papers (HIPAP 4 and HIPAP 6), is included as Appendix D to the modification report.

The QRA provides a transparent assessment of risk, outlines the control and mitigation measures embedded in the design, and demonstrates that risks have been evaluated using established and accepted methodologies. Key information on risk controls and mitigation measures is set out in Section 3.9 and Appendices F and G of the QRA report.

Quantitative Risk Assessment (QRA) and required scope:

Item 14 - Given the highly hazardous nature of chlorine, a comprehensive Quantitative Risk Assessment (QRA) is critical. The Modification report must be rigorously reviewed to ensure it adequately assesses all potential risks to the community and environment.

As outlined in the response to Item 13, a comprehensive QRA has been prepared in accordance with the SEARs and is included as Appendix D to the modification application. The assessment was prepared in consultation with SafeWork NSW and other relevant agencies and provides a detailed evaluation of potential risks to the community and environment.

Item 15-20 - The QRA must: •

- **Identify all potential Major Hazard Incidents (MHIs) such as leaks, spills, fires, or explosions.**
- **Quantify the likelihood and consequences of these events, including off-site impacts.**

- **Model the worst-case scenario release and its potential impact on the surrounding industrial and residential areas, including impacts on public transport routes and critical infrastructure.**
- **Consider the cumulative risk posed by the new facility in conjunction with other existing industries in the Banksmeadow/Botany Industrial Park area**
- **Assess the adequacy of the proposed containment building, scrubbing system, and other safety measures. The report should detail how these measures align with the principles of inherent safety and best practice.**
- **The Pollution Incident Response Management Plan (PIRMP), a mandatory requirement under the Protection of the Environment Operations Act 1997 (POEO Act), must be reviewed for its effectiveness and for how it would be integrated with Council's own emergency management procedures and those of other emergency services like Fire and Rescue NSW (FRNSW). The PIRMP must be regularly tested and include clear communication protocols to inform the community in the event of an incident.**

The matters listed in Items 15–19 are addressed in the QRA prepared for the modification. As noted in earlier responses, the QRA has been completed in accordance with the SEARs and the relevant Departmental guidance, including HIPAP 4 and HIPAP 6. The assessment was prepared in consultation with SafeWork NSW and other relevant agencies.

The QRA identifies all credible Major Hazard Incidents, quantifies their likelihood and consequences, and includes modelling of potential off-site impacts, including worst-case release scenarios. Cumulative risk has been assessed, with the QRA incorporating both the existing CAP and the proposed CLP.

The control and mitigation measures incorporated into the design of the CLP are outlined in the QRA, including in Section 3.9 and Appendices F and G, and have been assessed against recognised principles of inherent safety and industry best practice.

In regard to Item 20, the site has an existing Pollution Incident Response Management Plan (PIRMP), prepared in accordance with the *Protection of the Environment Operations Act 1997*. This plan includes established communication protocols for notifying the community and relevant authorities in the event of an incident and is tested at least annually. The PIRMP will be reviewed and updated as required, including to reflect any development consent conditions associated with the modification.

Regulatory compliance (EP&A Act, POEO Act, WHS, dangerous goods, hazardous chemicals):

Item 21 - Environmental Health and Regulatory Compliance From an environmental health perspective, the proposed development must comply with numerous legislative instruments as follows: Environmental Planning and Assessment Act 1979 (EP&A Act): As a State Significant Development (SSD), the project is assessed under this Act. The consent authority's role is to provide expert advice on local impacts and should confirm that the proposal aligns with the principles of ecologically sustainable development and the Bayside Local Environmental Plan (LEP). The consent authority should specifically seek confirmation that potential off-site impacts (e.g., from emissions or spills) have been thoroughly considered and mitigated.

The modification has been prepared in accordance with the EP&A Act, including the requirement to consider ESD. Section 4.3.5 of the modification report details mandatory matters for consideration and includes an assessment of the project against the ESD principles set out in the POEA Act. This includes consideration of the precautionary principle, inter-generational equity, conservation of biodiversity and ecological integrity, and improved valuation and pricing mechanisms.

The Bayside LEP 2021 does not apply to the site, as the land is not identified on the LEP land application map. Land use and development controls for the site are instead established under Chapter 5 of the TISEPP. Notwithstanding this, the environmental assessment has considered the potential for off-site impacts, including air emissions, water quality, hazards, traffic and other relevant matters, and the mitigation measures proposed ensure compliance with applicable legislation and policy frameworks.

Item 22 - Protection of the Environment Operations Act 1997 (POEO Act): This Act is the primary piece of legislation governing environmental protection in NSW. The Proponent (IXOM) will require an Environment Protection Licence (EPL) from the NSW Environment Protection Authority (EPA) for the operation of the new plant, as chlorine production is a "scheduled activity." The consent authority should confirm that the Proponent has engaged with the EPA and that the application for a license is progressing. Also request that the EPL conditions are consistent with the Council's environmental health objectives, particularly regarding air quality, water pollution, and waste management.

Under section 48 of the POEO Act, an EPL is required for premises-based activities listed in Schedule 1. The site currently operates under EPL 20547, which will continue to apply as the following scheduled activities will remain applicable to the modified development:

- Clause 8 – chemical production: production of more than 25,000 t of dangerous goods
- Clause 9 – chemical storage: storage of more than 2,000 t of chemicals
- Clause 41 – waste processing (non-thermal treatment): more than 200 kg of hazardous waste on site at any one time
- Clause 42 – waste storage: storage of more than 5 t of hazardous waste at any one time

IXOM has engaged with the EPA regarding the modification. A variation to EPL 20547 may be required to reflect the final approved scope; however, any EPL variation cannot be issued until after determination of the modification. IXOM will continue to consult with the EPA so that the EPL reflects the approved activities under the modified development and is consistent with relevant environmental objectives, including air quality, water, and waste management requirements.

Item 23 - Work Health and Safety Regulation 2017: While SafeWork NSW is the primary authority for on-site health and safety, the Council has an interest in ensuring the safety of workers and the public. Under this regulation, a hazardous chemical manifest and a site plan are required for facilities storing hazardous chemicals above certain threshold quantities. Given the scale of the proposed plant, the consent authority should seek confirmation that these documents have been prepared and lodged with SafeWork NSW and local emergency services (FRNSW). The consent authority should also inquire about how the project, which significantly reduces the need for road transport of chlorine from Victoria, will adhere to the Dangerous Goods (Road and Rail Transport) Act 2008 and the Australian Dangerous Goods Code (ADG Code) for the local distribution of chlorine. The movement of dangerous goods through the Bayside LGA poses a risk, and the Proponent's claim of reduced overall risk must be supported by a robust transport risk assessment.

A Dangerous Goods (DG) Transport Risk Assessment (TRA) (Appendix B to the Modification report) has been completed to assess the potential impacts on Denison Street from DG transport to and from the modified facility, including both the CAP and proposed CLP operations. The TRA was prepared in accordance with SEARs requirements and relevant guidance and compares cumulative transport risk against previous TRA studies for Denison Street.

The TRA demonstrates that the modification does not materially increase overall transport risk along Denison Street. HIPAP 4 risk criteria compliance has been assessed, and conclusions remain consistent with previous findings. Transport movements assessed include flatbed trucks

carrying chlorine drums and cylinders, and bulk tankers, with associated risk evaluated against NSW HIPAP 4 criteria.

A hazardous chemical manifest and site plan exists for the site and will be updated as required, along with other relevant safety and operational documents such as standard operating procedures, compliance registers, site environmental plans and the PIRMP. These updates will occur prior to the commencement of operations and will be included in an updated MHF licence application to SafeWork NSW at the appropriate time.

FRNSW was provided details of the modification during preparation of the modification application and invited to provide comments for inclusion in the modification report.

Item 24 - Environmentally Hazardous Chemicals Act 1985: This Act is administered by the EPA and regulates the use, storage, and transport of environmentally hazardous chemicals. Chlorine is a substance likely to be subject to a Chemical Control Order. The Proponent must demonstrate compliance with any such orders and prove that the facility's design and operational procedures will prevent environmental harm.

Chlorine is not subject to a Chemical Control Order under the *Environmentally Hazardous Chemicals Act 1985*, and no such orders currently apply to the Botany site. Compliance with this Act is therefore not applicable for this modification. This has been confirmed and recorded in the Botany Site Compliance Register.

Conclusions/recommendations about risk information deficits:

Item 26 - Conclusion and Recommendations In conclusion, the Proponent's application for a new chlorine liquefaction and packaging plant at Banksmeadow is a high-risk proposal that requires an extremely detailed and rigorous assessment. While the Proponent's intention to provide local redundancy and reduce long-distance freight is commendable, Council's primary concern is the protection of its community and local environment.

Noted. The modification application has been prepared in accordance with the SEARs issued by DPHI and includes detailed assessments of safety, risk, environmental impacts, and regulatory compliance. The assessment has been informed by extensive consultation with SafeWork NSW, the DPHI Hazards team, and other relevant agencies, and is supported by a suite of quantitative technical studies, including, but not limited to, the QRA, TRA, air quality and greenhouse gas assessments, noise and vibration impact assessments, traffic and transport assessments, a detailed site investigation, remediation action plan and flood risk assessments. These measures ensure that the modification has been subject to a comprehensive and rigorous evaluation in line with the requirements for a high-risk chemical facility.

Item 27-30 - Council recommends that the DPHI require the Proponent to provide:

- **A fully detailed Quantitative Risk Assessment (QRA) that includes a worst-case scenario and a cumulative risk analysis for the entire Banksmeadow industrial area.**
- **Evidence of consultation and compliance with all relevant regulatory authorities, including the NSW EPA for the EPL, and SafeWork NSW for hazardous chemical storage and handling.**
- **A comprehensive PIRMP that is integrated with local emergency services and includes a clear community communication strategy.**
- **A robust Transport Risk Assessment for the distribution of chlorine within the Bayside LGA, demonstrating full compliance with the *Dangerous Goods (Road and Rail Transport) Act 2008* and the ADG Code. Councils' recommendation and conclusion on the Advisory report is attached in Appendix A and provides greater detail or requirements.**

The modification application addresses the matters raised by Council in items 27–30.

A QRA has been prepared in accordance with the SEARs, including worst-case scenario analysis and cumulative risk considerations. A TRA has also been undertaken to assess chlorine transport within the Bayside LGA in line with relevant guidelines. Consultation with SafeWork NSW, the DPHI Hazards team, and other relevant agencies informed both the QRA and TRA, and evidence of this consultation is included in the modification report. The site has an existing PIRMP, which is tested and includes community communication protocols, and will be updated as required to incorporate the modification.

The QRA and TRA have since been updated (see Appendix B and C, respectively) to include further detail and clarification. Section 3.2 of the updated TRA (Appendix C) now also includes further description of relevant regulatory requirements associated with DG transport in NSW and the ADG code.

Detailed risk characterisation (hazards of chlorine, exposure risk, dispersion modelling):

Item 31 - Detailed Assessment of Implications for Bayside Council 4.1 Environmental Health and Safety Implications 4.1.1 The Hazards of Chlorine: Physicochemical and Health Risks Chlorine is a highly hazardous chemical with severe health and physicochemical risks. The Safety Data Sheet (SDS) for chlorine classifies it as "Fatal if inhaled" (H330), as well as causing "severe skin burns and eye damage" (H314) and "serious eye damage" (H318). It is also highly toxic to aquatic life (H400) and can cause or intensify fires as a potent oxidizer (H270). The potential for a release of this toxic gas is a primary concern for any community located near a facility that manufactures or stores it.

Noted. The modification relates solely to the liquefaction and packaging of chlorine at the existing CAP and does not change the types of chemicals produced or stored on site. The site continues to operate under its existing MHF licence and associated regulatory obligations, with safety and risk management measures maintained in accordance with legislative requirements. The modification application includes a detailed QRA and TRA prepared in consultation with SafeWork NSW, DPHI Hazards team, and other relevant agencies, which comprehensively assesses the potential hazards associated with the liquefaction of chlorine, including health, environmental, and physicochemical risks. The existing safety systems, control measures, and emergency response protocols, including the PIRMP, are designed to manage these risks effectively, and will be updated as required to reflect the modified development. These assessments and controls demonstrate that the potential risks to the surrounding community have been fully considered and appropriately managed.

Item 32 - The proponent's summary mentions a containment building with a scrubbing system. While this is a baseline control measure, a complete assessment requires detailed documentation of its design specifications, effectiveness, and capacity to handle a worstcase scenario. The ability of the scrubber to effectively neutralize a large-scale, rapid release of chlorine gas must be proven with engineering analysis and dispersion modelling. The reliance on a scrubbing system alone is insufficient without a detailed explanation of fail-safe mechanisms and a formal risk assessment that quantifies the probability of system failure and the magnitude of a resulting off-site consequence.

Detailed design specifications for the containment building and scrubbing system were provided to DPHI (Planning and Hazards teams) and SafeWork NSW for review but were not included in the publicly exhibited modification due to commercial sensitivity. The QRA incorporates the scrubber’s design and assesses potential failure scenarios through an event tree to evaluate risks. Refer to Appendix F of the updated QRA (Appendix B) for a detailed description of the scrubber and potential failure modes.

Item 33 - Proximity to Sensitive Receivers: Assessment of Off-Site Risk The location of the proposed facility, while within an industrial area, is a critical vulnerability due to its close

proximity to a dense urban population and several sensitive receivers. The nearest residential dwellings are approximately 480m to the east , and of much greater concern are the numerous schools within a potential impact zone. Matraville Public School is located just 0.63km from the site. Other nearby schools include St Agnes' Catholic Primary School (0.82km) and Champagnat Catholic College (1.36km).

The site is an existing MHF, and the QRA undertaken for the modification indicates that the proposed CLP will not result in a material increase to off-site risk. A cumulative risk assessment, which considers both the existing CAP and the new CLP, demonstrates that the modification does not materially change the overall risk profile to nearby sensitive receivers.

Item 34 - A major incident, such as a large-scale release of liquefied chlorine gas, could have catastrophic off-site consequences for these vulnerable populations. Chlorine has an "Immediately dangerous for life and health" (IDLH) concentration of 10 parts per million 8 (ppm). A study on chlorine dispersion modelling notes that a large release from a 1-ton cylinder could produce "severe health effects" at distances of at least 1,000 meters. The distance to Matraville Public School (630m) is well within this potential impact zone. The proponent has not provided any dispersion modelling to demonstrate the extent of the affected area in a worst-case scenario. The existing noise assessment from a previous SSD application (DA35/98) is insufficient for this purpose as it only addresses noise related amenity, not the life-threatening consequences of a toxic gas release.

The NVIA (Appendix E of the modification report) assessed potential noise and vibration impacts from the CLP on nearby receivers. The assessment considered a conservative operational scenario with all plant and equipment operating simultaneously, in accordance with the Noise Policy for Industry (NPI, 2017). Sound power levels were based on measurements from the Botany site for existing plant and from the Laverton North site for the CLP. The predictive model was validated with attended measurements, ensuring the assessment is robust and aligned with relevant policy requirements. The NVIA does not assess potential air quality impacts from accidental releases of chlorine gas, as this is outside its scope.

Potential off-site consequences of a chlorine release have been assessed through the QRA (see updated version in Appendix B), which includes dispersion modelling for all credible scenarios involving the CLP (see Appendix H of QRA). The QRA applies conservative toxicity endpoints based on US EPA acute exposure guideline levels (AEGLs), which are internationally recognised for emergency planning and land use safety assessment. These endpoints are designed to protect sensitive populations, including children and the elderly, and start from 2.8 parts per million (ppm, AEGL2, 10-minute exposure). The QRA demonstrates that the modification does not materially increase off-site risk relative to the existing CAP operations.

For clarification, the IDLH value is intended for determining respiratory protection requirements for workers and is not directly applicable to land use safety planning. Modelling assumptions and endpoints used in the QRA are consistent with the QRA studies previously carried out in accordance with HIPAP 6 for the overall BIP and the CAP which have been periodically submitted to and approved by DPHI

Item 35 - A proper risk assessment must be based on a quantitative, scientifically backed dispersion model that maps the potential extent of the hazard zone under various meteorological conditions. The proponent's failure to provide such an assessment, particularly given the site's proximity to schools, is a profound and unacceptable deficiency in the application.

The QRA includes quantitative dispersion modelling of chlorine releases using GEXCON Effects, a commercially validated software model. The results, including effect distances to various concentration endpoints, are provided in Appendix H of the QRA report. This modelling is consistent with DPHI guidance and provides a scientifically robust assessment of potential off-

site impacts under credible release scenarios, including those relevant to sensitive receivers such as schools.

Historical industrial incident and cumulative risk environment:

Item 40 - Historical Context and Cumulative Risk 4.3.1 The Site's Industrial Legacy The Banksmeadow site and the broader Botany Industrial Park have a long history of industrial operations and associated environmental contamination. Orica, a former operator, had manufacturing activities at Botany for over 80 years, during which soil and groundwater contamination with chlorinated hydrocarbons (CHCs) and elemental mercury occurred. A ban on domestic bore water use has been in effect for a 20km radius since 2003, and an ongoing, multi-million-dollar groundwater cleanup project has been operating since 2005 to prevent contaminated plumes from reaching Botany Bay. The contamination is not fully remediated, with "residual contaminants" remaining in source areas.

Noted.

Item 41 - Analysis of Past Incidents at Banksmeadow The historical context of the site is not merely a background detail; it is a fundamental consideration for any new high-risk development. A recent incident in February 2023 at a chemical manufacturing plant on Denison Street, Banksmeadow, serves as a stark reminder of the inherent risks of such operations in this area. A fault in a cooling tower led to a controlled burn of ethylene gas and the risk of a structural collapse that could have impacted six trailers storing highly flammable hydrogen. The incident required a multiagency emergency response from Fire and Rescue NSW (FRNSW), NSW Police, NSW Ambulance, the NSW EPA, and SafeWork NSW, and resulted in a precautionary evacuation order for an 800m zone.

Noted. The area surrounding the IXOM Botany site has a long history of industrial operations and historical incidents are noted to have occurred in the past. While the incident in February 2023 event on Denison Street involved a separate facility and unrelated chemicals, it underscores the importance of robust risk management. In recognition of this, the modification application includes a full, quantitative QRA, and TRA, and extensive engagement with SafeWork NSW and other relevant agencies to ensure that the modification is designed and operated to the highest safety standards and that all potential risks are understood and appropriately mitigated.

Item 42 - The proposed CLP must not be assessed in a vacuum. It represents an addition to an already high-risk environment with a documented legacy of environmental contamination and a recent history of a major incident that required community evacuation. The proponent’s summary, which makes no mention of this historical context, fails to address the critical question of how the new plant will contribute to or be impacted by the overall cumulative risk of the Botany Industrial Park. The proposal's integrity is severely compromised by its failure to explicitly address how the project will be safely integrated into a site with ongoing remediation and a demonstrated potential for major incidents.

The ongoing remediation of contamination at the site relates to historical contamination and will not be impacted by the modification. A detailed site investigation (DSI) and Remediation Action Plan (RAP) have been prepared to confirm current site conditions, and interim audit advice from an independent NSW EPA-accredited site auditor has been provided to confirm that that the land can be made suitable for the intended use (Appendix F). A site audit statement and site audit report will be obtained from a NSW EPA-accredited site auditor following remediation, prior to construction.

The QRA for the modification includes a comprehensive cumulative assessment of the CAP and CLP, considering all relevant hazards at the site. The assessment notes that other industrial operators in the BIP, including Qenos and Indorama, have ceased operations and are therefore

not included in the cumulative risk profile. This ensures that the cumulative risk implications of the modification have been fully considered in the context of current site operations.

Adequacy of Mod Report / Safety Case requirements:

Item 43 - Adequacy of the Submitted Modification report Based on the proponent's summary provided for review, the Modification report is manifestly inadequate for a project of this nature and scale. A project that is highly likely to be an MHF and is located in an area with documented environmental and safety risks cannot be assessed based on a high-level description of its purpose and equipment.

The site is an existing MHF and the modification application has been prepared in accordance with the SEARs issued by DPHI. The modification report includes detailed assessments of safety, risk, environmental impacts, and regulatory compliance, supported by quantitative technical studies and extensive consultation with SafeWork NSW, DPHI, and other relevant agencies. The modification application is comprehensive and proportionate to the scale and nature of the modification.

Item 44 - Gap Analysis of the Modification report. The submitted summary is notably deficient in several key areas. It fails to provide any details on: • Total Maximum Storage Quantity: The document mentions a stock tank and 13 tonne tankers but provides no total quantity, a fundamental piece of information for determining MHF status and assessing on-site risk.

The site is an existing MHF and is licensed to store chlorine, the modification has been designed and assessed with consideration to IXOMs obligations under the MHF licence. The modification report describes two stock tanks, each with a capacity of up to 50 tonnes of liquefied chlorine at -34°C and atmospheric pressure. One tank will be kept in service and the other on standby.

Item 45 - Formal Risk and Safety Assessments: The summary is silent on the preparation of a formal Safety Case, a Safety Assessment, or a Safety Management System (SMS), all of which are mandatory for an MHF. The absence of a quantitative risk assessment, including dispersion modelling for a toxic gas release, is a critical gap that prevents any meaningful evaluation of the off-site risk.

A formal QRA has been prepared for the modification, including detailed dispersion modelling for potential toxic gas releases. The QRA provides a comprehensive and quantitative assessment of both on-site and off-site risks. The existing MHF licence will be updated to incorporate a revised Safety Case and associated safety management documentation in accordance with MHF requirements. It should be noted that updates to the MHF licence are managed through a separate regulatory process and are not part of the modification application.

Item 46 - Pollution Incident Response Management Plan (PIRMP): There is no mention of a PIRMP, which is a legal requirement for an EPL holder. A complete application must include a detailed plan outlining procedures for immediate notification and coordinated response with emergency services and authorities.

A PIRMP is maintained for the site in compliance with legal obligations as an EPL holder and will be updated as necessary to reflect the modification, including any changes arising from the varied EPL once the modification is approved. The updated plan will ensure ongoing coordination with emergency services and other relevant authorities.

Item 47 - Transport Risk Assessment: The statement about "shorter freight distances" is a qualitative claim without any supporting quantitative analysis of the risks of daily transport on local roads.

The statement regarding “shorter freight distances” reflects a factual change in the supply chain, whereby bulk tankers transporting chlorine will transition from Laverton, Victoria, to distribution from Botany, New South Wales. This represents a genuine reduction in overall freight distance for NSW customers. This statement is not intended to represent a quantitative assessment of transport risk.

Item 48 - Emergency Planning and Consultation: The summary lacks any detail on a site-specific emergency plan and makes no mention of consultation with key stakeholders such as Bayside Council, NSW Health, or local emergency services, which is a mandatory requirement for MHF operators.

The site emergency plan will be updated as required, with any material changes arising from the modification to be conveyed to relevant agencies, including SafeWork NSW, DPHI, and local emergency services. Any updates to the MHF licence or associated safety documentation will be completed through the appropriate statutory processes.

Item 49 - Review of the Proponent's Safety and Risk Management Documentation The proponent’s statement that the project will integrate "proven IXOM processes currently used at the Laverton facility" and "inherent safety features" is a claim that cannot be validated without the submission of formal, auditable documents. While IXOM claims to be an industry leader in chemical risk management and emergency response, such general claims are not a substitute for the site-specific, legally mandated documentation required by NSW law. The absence of a Safety Case and other formal risk management documents in the application summary suggests a fundamental failure to comply with the regulatory expectations for a project of this kind.

A Safety Case and associated Safety Management documentation are statutory requirements under the MHF provisions of the Work Health and Safety Regulation 2017. These documents form part of IXOM’s existing MHF licence and are assessed and approved by SafeWork NSW, separate from and independent of the modification planning pathway under Section 4.55(2) of the EP&A Act. For this reason, a Safety Case is not submitted with, or assessed as part of, a planning modification application.

IXOM will update the existing Safety Case and other MHF documentation following planning approval, in accordance with the WHS Regulation. SafeWork NSW will review and approve any updates prior to commissioning of the modified facility.

The modification application includes all risk assessments required under the SEARs, including the formal QRA and supporting technical work. Preparation of the modification, including the QRA and TRA, has involved extensive consultation with the DPHI Hazards team and SafeWork NSW to ensure the planning-phase risk assessment meets the relevant regulatory expectations for an MHF facility.

Item 50 - Evaluation of Proposed Emergency Planning and Community Engagement The submitted summary provides no details on emergency planning beyond a mention of a scrubbing system. This is a major deficiency. Under the WHS Regulation, an MHF operator must prepare a detailed emergency plan in consultation with emergency services and the local council. The plan must be tested to ensure its workability and must include a strategy for communicating with the community in the event of an incident. Given the recent history of a precautionary evacuation in the area , the community's need for transparent and effective emergency communication is critical. The proponent's application is inadequate in its current form as it does not demonstrate a commitment to these necessary safety and community engagement measures.

Emergency planning for the site is governed by the Major Hazard Facility provisions of the WHS Regulation 2017, which require a comprehensive, site-specific Emergency Plan to be prepared, maintained and tested as part of the facility’s existing MHF licence. This Emergency Plan is

already in place for the current IXOM operation and will be updated, where required, following planning approval of the modification. Any material changes will be communicated to the relevant agencies, including local emergency services and Bayside Council, in accordance with the consultation requirements of the WHS Regulation.

As part of preparing the modification application, consultation was undertaken with a wide range of government and public agencies, including SafeWork NSW and the DPHI Hazards team. These agencies did not request submission of the full MHF Emergency Plan as part of the planning modification, as it is more appropriately required in conditions of consent prior to commissioning, consistent with the established separation between the EP&A Act process and the WHS regulatory framework.

The modification does not alter IXOM's obligations regarding emergency preparedness, community notification or engagement. These requirements continue to be managed through the MHF licence and will be reviewed and updated, as required, during the Safety Case revision process prior to commissioning of the modified facility.

Requests for further mandatory documents:

Item 51 - Preliminary Advice and Recommendations Based on the detailed analysis of the proposed modification and the provided documentation, Bayside Council's preliminary advice to DPHI is to not proceed with the determination of this application until the proponent submits further comprehensive and legally mandated information. The current submission is insufficient to allow for a proper assessment of the project's risks and its implications for the Bayside community.

A detailed and robust modification application has been prepared, supported by comprehensive technical assessment and extensive consultation. The modification report outlines the applicable Commonwealth and NSW regulatory and policy framework relevant to a Section 4.55(2) modification of an existing State Significant Development approval under the EP&A Act.

All relevant planning considerations under relevant Federal and State planning legislation have been addressed, and the SEARs have been addressed in full. The submission is supported by detailed technical studies, including a QRA, TRA and environmental assessments, and has been informed through extensive consultation with government agencies and the community.

On this basis, the modification application provides the consent authority with the information necessary for a proper and informed assessment under the EP&A Act.

Item 52-57 - Request for Further Information and Technical Studies Bayside Council formally recommends that DPHI requires the proponent to submit the following documents as a prerequisite for any further assessment:

- **Formal MHF Notification and Status: The proponent must provide the formal notification to SafeWork NSW and the subsequent determination of MHF status.**
- **MHF Safety Case: A complete and detailed Safety Case that includes a Safety Assessment, Safety Management System, and Emergency Plan, all prepared in accordance with the Work Health and Safety Regulation 2017.**
- **Chlorine Gas Dispersion Model: A quantitative model that maps the off-site consequences of a worst-case scenario chlorine gas release, demonstrating the potential impact on nearby residential areas, schools, and other sensitive receivers.**
- **Transport Risk Assessment: A detailed analysis of the daily road transport risks, including proposed local routes, risk mitigation measures, and a formal analysis of the trade-off between reduced interstate travel and increased local transport frequency.**
- **Pollution Incident Response Management Plan (PIRMP): A complete PIRMP prepared in accordance with the *Protection of the Environment Operations Act 1997*.**

- **Site-Specific Cumulative Risk Assessment: A study that explicitly acknowledges the site's environmental history and recent incidents, demonstrating how the new plant will not exacerbate pre-existing risks or interfere with ongoing remediation efforts.**

A meeting was held with Bayside Council on 25 November 2025 in which the proponent outlined the scope of the modification, the proposed assessment methodology, and the technical studies to be included in the submission. The matters now raised by Council have already been addressed in the modification application or will be addressed through the appropriate regulatory pathway, as summarised below.

Formal MHF Notification and Status: The existing IXOM Chlor-Alkali Plant is already a licensed Major Hazard Facility under the Work Health and Safety Regulation 2017. Formal MHF notification and licencing for the facility has already occurred. Any changes to the risk profile resulting from this modification will be reflected through an updated MHF Safety Case submitted to SafeWork NSW following planning approval, consistent with standard MHF regulatory practice.

MHF Safety Case: A Safety Case, Safety Assessment, Safety Management System and Emergency Plan are required under the MHF provisions of the WHS Regulation and are assessed exclusively by SafeWork NSW. These documents do not form part of a Section 4.55(2) planning modification and are not submitted to DPHI. The Safety Case will be updated after planning determination in accordance with MHF legislative requirements.

Chlorine gas dispersion modelling: Comprehensive dispersion modelling for potential chlorine releases has been completed as part of the QRA. The QRA includes dispersion distances for all CLP scenarios modelled. As noted in Section 6.2 of the QRA, there is no change in the worst-case consequence distance compared to the existing CAP operations: *"the addition of the CLP to the IXOM facility does not affect the maximum consequence impact as the existing parked road tanker release scenario has the greatest consequence effect for both the current CAP operational case (parked road tanker at ambient conditions) and the liquefaction plant (road tanker within the CLP building). Therefore, the CLP does not result in an increase in the maximum consequence effect distance."*

This modelling provides a quantitative assessment of on-site and off-site consequences, demonstrating compliance with relevant risk criteria, including individual fatality and societal risk thresholds, and confirming that the modification does not materially increase the potential impact of chlorine releases on surrounding sensitive receivers.

Transport Risk Assessment: A TRA has been completed, which demonstrates that the modification does not result in any material increase in risk associated with the transport of chlorine product along Denison Street. The transition from interstate tanker deliveries (Victoria to NSW) to shorter intra-state transport distances reduces the overall transport distance. The TRA focuses on relevant NSW road movements and confirms that risks are low and manageable.

Pollution Incident Response Management Plan (PIRMP): The facility already operates under an Environment Protection Licence and maintains a PIRMP in accordance with the *Protection of the Environment Operations Act 1997*. The PIRMP will be updated as required following the variation of the EPL at completion of the planning process. Any material changes will be communicated to relevant agencies.

Site-Specific Cumulative Risk Assessment: The QRA includes a cumulative risk assessment considering the modified development (CAP and CLP). As noted in the QRA, other former BIP operators (Qenos and Indorama) are no longer operating and were therefore excluded from the cumulative profile. A Detailed Site Investigation, Remedial Action Plan and interim audit advice from a NSW EPA-accredited site auditor has been provided to confirm the contamination status of the site and that the proposed plan of management is adequate, and an independent Site Audit Statement will be provided prior to operations to confirm the site has been made suitable for the intended land use.

Recommended conditions (if approved):

Item 58-60 - Recommended Conditions of Consent for DPHI If the proponent's revised submission is deemed adequate and the project proceeds, Bayside Council recommends the following conditions be attached to any future consent:

- **Licensing Prerequisite: Construction and operation must be conditional upon the proponent obtaining all necessary licences from the NSW EPA (EPL) and SafeWork NSW (MHF licence) prior to the commencement of works. Emergency Plan Testing: The on-site emergency plan must be formally and regularly tested in collaboration with Fire and Rescue NSW and Bayside Council**
- **Transport Route Restrictions: Consent should mandate the use of specific, preapproved heavy vehicle routes within the LGA that minimise transit through sensitive community areas.**
- **Community Communication: The proponent must establish and maintain a proactive and transparent communication protocol with the Bayside community, including regular updates on site operations and an accessible process for reporting concerns.**

IXOM acknowledges Bayside Council's recommendations for conditions of consent and is generally supportive of measures that ensure the development aligns with Council objectives and regulatory requirements.

- Licensing Prerequisite: IXOM confirms that all necessary licences from the NSW EPA (EPL) and SafeWork NSW (MHF licence) are required prior to commencement of construction and operation. Any updates to the existing MHF licence or EPL will be carried out in accordance with legislative requirements.
- Emergency Plan Testing: IXOM will continue to maintain and update the site emergency plan in consultation with relevant agencies. Any material changes to the plan will be communicated to the appropriate authorities, including FRNSW and Bayside Council, and formally tested as required under MHF legislation.
- Transport Route Restrictions: Chlorine transport currently follows pre-approved Dangerous Goods routes within the Bayside LGA and will continue to do so. Vehicles must not deviate from these designated routes.
- Community Communication: While routine operational notifications are not considered necessary given the low frequency of transport movements under the proposed normal operational scenario, IXOM supports the preparation of a notification plan to be implemented only in the event that the contingent operational scenario of the modification is triggered. This ensures that community engagement is proportionate and relevant, providing timely information should the contingent operational scenario occur.

4.5.3 Transport and logistics risk – on-site storage and road transport of chlorine

Item 23 - Work Health and Safety Regulation 2017: While SafeWork NSW is the primary authority for on-site health and safety, the Council has an interest in ensuring the safety of workers and the public. Under this regulation, a hazardous chemical manifest and a site plan are required for facilities storing hazardous chemicals above certain threshold quantities. Given the scale of the proposed plant, the consent authority should seek confirmation that these documents have been prepared and lodged with SafeWork NSW and local emergency services (FRNSW). The consent authority should also inquire about how the project, which significantly reduces the need for road transport of chlorine from Victoria, will adhere to the *Dangerous Goods (Road and Rail Transport) Act 2008* and the Australian Dangerous Goods Code (ADG Code) for the local distribution of chlorine. The movement of dangerous goods through the Bayside LGA poses a risk, and the

Proponent's claim of reduced overall risk must be supported by a robust transport risk assessment.

A Dangerous Goods (DG) Transport Risk Assessment (TRA) (Appendix B to the Modification report) was prepared in accordance with SEARs requirements and relevant guidance and compares cumulative transport risk including the CLP against previous TRA studies for Denison Street. The TRA has been updated to include an additional section on regulatory requirements associated with DG transport in NSW and the ADG code, see Section 3.2 of Appendix C.

The TRA demonstrates that the modification does not materially increase overall transport risk along Denison Street. HIPAP 4 risk criteria compliance has been assessed, and conclusions remain consistent with previous findings. Transport movements assessed include flatbed trucks carrying chlorine drums and cylinders, and bulk tankers, with associated risk evaluated against NSW HIPAP 4 criteria.

A hazardous chemical manifest and site plan exists for the site and will be updated as required, along with other relevant safety and operational documents such as standard operating procedures, compliance registers, site environmental plans and the PIRMP. These updates will occur prior to the commencement of operations and will be included in an updated MHF licence application to SafeWork NSW at the appropriate time.

FRNSW was provided details of the modification during preparation of the modification application and invited to provide comments for inclusion in the modification report.

Item 36 - Transport and Logistics Analysis 4.2.1 On-Site Storage and Handling The project summary specifies that liquefied chlorine will be stored on-site in a stock tank and distributed via 13-tonne tankers, drums, and cylinders. The on-site management of chlorine, a dangerous good, must adhere to strict protocols to prevent incidents, including the segregation of incompatible chemicals. A chemical reaction between chlorine-based products (like sodium hypochlorite, which is handled on-site) and acids can release toxic and corrosive chlorine gas. The proposed project involves the relocation of the existing sodium hypochlorite loading bay, which requires a detailed safety review to ensure that it does not increase the risk of cross contamination or an incident.

Plant design has undergone detailed design review and a hazard and operability study (HAZOP). The chlorine stock tank will be installed within a bunded containment building to capture any potential leaks. The chlorine tanker loading apron, as well as drums and cylinders, will also be housed within the containment building. No other chemicals or products will be stored within the Chlorine Liquefaction Building.

A hazardous chemical manifest exists for the site and will be updated as required, alongside other operational and safety documentation, including standard operating procedures, compliance registers, site environmental plans, and the PIRMP. The sodium hypochlorite loading bay will be relocated on-site to accommodate construction of the new CLP building. This loading bay remains dedicated solely to sodium hypochlorite, with bunding and spill retention capacity in accordance with AS3780, ensuring no risk of cross-contamination.

Item 37 - Assessment of Road Transport Risks and Local Network Impact The proponent’s claim that the project will lead to "shorter freight distances" for bulk chlorine is a statement that misrepresents the full extent of the transport risk. The reduction in a single, long-distance trip from Victoria is being traded for a higher frequency of shorter-distance, high-risk trips on the local Bayside road network. An incident involving a 13-tonne chlorine tanker on a local road, in a densely populated urban area, carries a significantly higher risk to the public than an incident on a major inter-state highway.

It is noted that transport risk for dangerous goods is influenced by multiple factors, including route selection, vehicle safety features, driver training, and emergency response capability, rather than

trip distance alone. Local deliveries can be conducted along designated routes with lower speed limits, proximity to emergency services, and infrastructure suited to dangerous goods transport. Chlorine tankers are designed and operated in accordance with the ADG Code and include multiple safety features such as underrun protection, protected valves, tyre pressure, temperature and tread monitoring, GPS tracking, speed limitation to 50 km/hr in residential areas and are operated by trained drivers.

While local roads have higher population density, they also allow for rapid response in the event of an incident. In the event of a leak on a nearby local road, a tanker could be returned to the containment building on-site, where any release would be safely contained. The modification eliminates long-distance bulk chlorine transport journey from Victoria through remote areas with significantly longer emergency response times.

Item 38 - The transport of such a hazardous substance within the local government area would pose an extreme and immediate risk to public health, property, and the environment in the event of an accident. This critical shift in the risk profile has not been addressed in the proponent's summary. Bayside Council must request a formal Transport Risk Assessment that models potential routes, traffic conditions, and the off-site consequences of an accident. The assessment must demonstrate how these daily transport risks will be 9 mitigated to an acceptable level, including proposing specific, low-risk routes within the LGA that avoid schools and other sensitive areas.

Chlorine transport to and from the IXOM Botany site already occurs along approved DG transport routes in accordance with NSW legislation. The transport of dangerous goods in NSW is regulated under an integrated framework administered jointly by the EPA and SafeWork NSW. The EPA regulates the road and rail transport of dangerous goods, including route approvals and transport infrastructure, while SafeWork NSW regulates activities prior to transport, such as classification, packaging, and labelling.

These agencies work in coordination with other regulators, including the National Heavy Vehicle Regulator, the Office of the National Rail Safety Regulator, and NSW Police, to ensure compliance and safety for both routine operations and emergency response. Transport vehicles and equipment are designed and approved to meet stringent safety standards, and transport movements are restricted to designated routes to minimise potential impacts on sensitive areas, including schools and residential zones.

The existing regulatory and operational framework, combined with these approved DG routes, ensures that daily chlorine transport risks are appropriately managed and mitigated.

Item 39 - Consistency with NSW and Bayside Freight Strategies While the National Heavy Vehicle Regulator (NHVR) manages the national road network, the management of local roads falls under Bayside Council's purview. Any significant increase in the volume of dangerous goods transport must be planned in coordination with Council’s transport strategies. The submitted summary is silent on the specific local routes that would be used, and this information is essential for Bayside Council to properly assess the project’s impact on local infrastructure and community safety.

Chlorine transport will continue to follow existing DG approved routes, as described in Section 8.3.3 of the modification report.

Item 55 - Transport Risk Assessment: A detailed analysis of the daily road transport risks, including proposed local routes, risk mitigation measures, and a formal analysis of the trade-off between reduced interstate travel and increased local transport frequency.

A TRA has been completed, which demonstrates that the modification does not result in any material increase in risk associated with the transport of chlorine product along Denison Street. The transition from interstate tanker deliveries (Victoria to NSW) to shorter intra-state transport

distances reduces the overall transport distance. The TRA focuses on relevant NSW road movements and confirms that risks are low and manageable.

Item 59 - Transport Route Restrictions: Consent should mandate the use of specific, preapproved heavy vehicle routes within the LGA that minimise transit through sensitive community areas.

Chlorine transport currently follows pre-approved Dangerous Goods routes within the Bayside LGA and will continue to do so. Vehicles must not deviate from these designated routes.

4.5.4 Heritage and Aboriginal cultural heritage

Item 61 - Heritage The subject site at 16-20A Beauchamp Road, Banksmeadow is not identified as a heritage item on Schedule 5 of the Bayside Local Environmental Plan 2021. It is however located in the vicinity of a heritage item listed on the SEPP (Transport and Infrastructure) 2021. The description on Part 5.5, Clause 5.31 of the SEPP (Transport and Infrastructure) 2021 is as follow: Banksmeadow Main Administration Building—"Orica" and Mature Ficus Corner of Denison and Beauchamp Streets Lot 11, DP 1039919. The extent of the proposal is confined to the subject site, which is shown to be entirely outside the lot boundary of the heritage listed property identified at the corner of Denison and Beauchamp Streets. There are no anticipated negative impacts to the European heritage item in the vicinity of the subject site. An AHIMS basic search has revealed no Aboriginal sites or Aboriginal places declared or recorded within 1km area of the subject site. In addition, the site is already significantly altered and highly disturbed. Although unlikely, it remains unknown if there are potential buried Aboriginal artefacts or objects within the extent of the site. It is suggested that a management protocol is in place during the site works should the event of unexpected finds arise.

Noted. The proposed modification is entirely outside the boundary of the identified heritage item and no known Aboriginal sites have been recorded within 1 km of the site. Standard management protocols for unexpected finds during site works will be implemented as a precaution.

4.5.5 Stormwater management, Kamay (Botany Bay) and marine environmental protection

Item 62-66 - Environmental Strategy The following comments are provided by Council's Environment Team. Relating to stormwater, the proposal will need to address:

1. **Compliance with *Fisheries Management Act 1994* and not cause any harm to the conservation of key fish habitat in Kamay (Botany Bay) located 1km south of the site, see image below**

Noted. The modification is confined to the site and will not result in impacts to Key Fish Habitat in Kamay (Botany Bay), located approximately 1 km south of the site.

2. **Compliance with the *NSW Protection of the Environment Operations Act 1997* (POEO Act) which aims to protect, restore and enhance the quality of the environment in the context of ecologically sustainable development and to reduce risks to human health and prevent degradation of the environment.**

Noted. The modification will comply with the requirements of the POEO Act (see Section 4.4 of the modification report), which seeks to protect, restore, and enhance the quality of the environment in the context of ESD, which has been considered and addressed in Section 4.3.5 of the Modification report.

3. **No stormwater flows (including excess flows) are permitted to be discharged to Springvale Drain and/or Kamay Botany Bay that would 'cause pollution and/or cause adverse impacts' on Kamay Botany Bay ecosystems. This measure is necessary to protect the sensitive Kamay Botany Bay ecosystems including NPWS Towra Point Reserve, Posidonia, Halophila and Zostera seagrasses, corals, sponges, ascidians, 14 nudibranches, kelp, sea squirts, sea fans, Endangered White seahorses Hippocampus whitei, sea dragons, pipehorses, fish, turtles, Australian Fur-seal, Dugong, Southern Right Whale, Humpback whale, shorebird habitat and migratory and endangered birds, Wandering Albatross and White-bellied Sea Eagle. This measure is also required to protect the public who access the bay for both primary (swim, snorkel, dive) and secondary (boating) contact. This protection measure is consistent with Bayside's position with Sydney Water, that Bayside objects to wastewater overflows being discharged into the Mill Stream which is connected to Kamay Botany Bay.**

Noted. As summarised in the Flood Impact and Risk Assessment (Appendix G of the Modification report), the modification will not result in any changes to existing flood patterns, stormwater drainage infrastructure, or its capacity. Consequently, the modification will not result in discharge of stormwater flows, including excess flows, into Springvale Drain or Kamay Botany Bay that could cause pollution or adversely impact sensitive ecosystems.

4. **Protection and regeneration of Kamay Botany Bay is a priority, being delivered through partnerships between Bayside Council, NSW & Federal government, SSROC, Sydney Coastal Councils Group, Georges Riverkeeper, Cooks River Alliance, Gamay Rangers, universities and institutions, Sydney Ports, Sydney Airport and others.**

Noted. The proponent acknowledges that the protection and regeneration of Kamay Botany Bay is a priority and recognises the collaborative efforts of Bayside Council, NSW and Federal agencies, regional alliances, universities, Sydney Ports, Sydney Airport, and other stakeholders.

5. **The Proposal has an opportunity to consider and align itself with the La Perouse Gamay Rangers 'GAMAY SEA COUNTRY PLAN MARCH 2025 – 2035', in particular Part 3 Sea Country Planning which includes management priorities and objectives, and PART 4 Implementation.**

Noted. The proponent acknowledges the La Perouse Gamay Rangers 'GAMAY SEA COUNTRY PLAN 2025–2035' and recognises its objectives for sea country management. While the modification is confined to the existing site and is not expected to directly or indirectly impact marine or coastal areas, the proponent will continue to ensure that all works are undertaken in a manner consistent with relevant environmental protection and management frameworks.

Item 73 - Stormwater management All areas used for the storage and handling of bulk chemical liquids or any other materials which may pollute stormwater shall be isolated from the site's stormwater system, located undercover, and fully bunded so that no spills or chemicals are directed to the public stormwater system. Bunding shall be in accordance with the latest NSW Government guidelines. The storage of hazardous and chemical liquids shall meet the latest requirements of the NSW EPA and WorkCover Authority. The chemical storage shall be protected from inundation by floodwaters in all flood events.

The CLP containment building is fully bunded, with each stock tank independently bunded and designed to contain the maximum potential release from a stock tank rupture. Chlorine drums and cylinders are stored in a bunded area ensuring that no chemicals can enter the site's stormwater system. The design and layout comply with relevant NSW Government guidelines, EPA requirements, and Work Health and Safety standards, and are protected from inundation under all flood events.

Within the CLP building, any liquid effluent, including condensate generated during de-icing of drums and cylinders or any potential loss of product from drums or cylinders, will be captured via

low-point blind sumps. Each sump is fitted with a dedicated pump that transfers collected liquids to the site's effluent treatment system for appropriate management. No internal building drainage is connected to the site's stormwater system.

4.5.6 Landscape and public domain

Item 67 - Landscape Any landscape works on site should comply with the landscape requirements outlined in the Bayside Landscape Technical Specification and Sections 3.7 and 6.1/6.4 of the Bayside DCP unless specified otherwise by Bayside Council, the Department of Planning NSW or other authority.

The modification area is highly disturbed with concrete hardstand surface within an established industrial complex. No vegetation will be removed or disturbed as part of the modification, and no landscaping is proposed given the industrial setting and the absence of public viewpoints. Further, the Bayside Development Control Plan 2022 (BDCP) does not apply to the land as per Section 2.4 of the BDCP, which states that the plan applies to land within the Bayside LGA but excludes land subject to Chapter 5 of the TISEPP.

4.5.7 Traffic, parking and road safety

Item 68-70 - Traffic, Parking and Road Safety The following comments are provided by our Traffic Engineering department:

1. **How many employees are expected on-site in Scenario 2 (when the VIC plant is not operational)?**

Up to 11 employees could be mobilised from Laverton to perform drum and cylinders degassing and filling functions in the contingent operating mode if the Laverton CLP became non-operational for an extended period. These employees would return to the Laverton plant once it became operational again.

1. **How many spaces would they take up on-street and off-street?**

Shared travel would be organised by IXOM, this would generate two additional light vehicle movements in the AM peak and two in the PM peak. These vehicles would enter via the Beauchamp Road gate and park on site.

1. **If Scenario 2 intended to be a temporary or permanent measure, should it occur?**

Scenario 2 (the contingent operating scenario) is intended to provide redundancy in the unlikely event that the Laverton CLP becomes non-operational. If this occurs, the contingent operating scenario would be in effect until such a time that the Laverton CLP resumes operations.

Item 71-72 - Council is concerned that if scenario 2 is intended to be either permanent or long-term temporary, or the number of employees, even on a short-term temporary basis, is too high, then using Beauchamp Road is not appropriate. The following information is required:

1. **Swept path diagrams that show: a. Semis or tall rigids entering the Repack facility b. B-Doubles entering the Ferrous Loading Bay**
2. **Where on Second Street are B-Doubles to wait to enter the Hypo Load Bay? How can the likelihood of conflicts be reduced?**

As noted in our response to Item 70, the contingent operating scenario is intended solely to provide temporary redundancy in the unlikely event that the Laverton CLP becomes non-operational and would remain in effect until the Laverton CLP resumes normal operations.

Further, during discussions with Bayside Council on 25 November 2025, it was agreed that additional swept path diagrams were not required as the modification does not involve any changes to the existing traffic routes or vehicle types manoeuvring within the site, and the current arrangements continue to accommodate safe and efficient site access and operations as per the existing approval.

4.5.8 Community submissions and concerns (HERAG)

Item 74 - Objection from community members Council received a submission from a community group Hillsdale Eastgardens Resident Action Group (HERAG) which has previously been sent through to the DPHI for consideration. The objection from community member group identified that the Orica replacement chlorine plant was unlawfully approved in November 1998. This has not been substantiated by Council. The objection stressed the requirement of a proper risk assessment of the chlorine transport route and notification to the affected residents. The objection reiterates the point that the Orica replacement chlorine plant was unlawfully approved in November 1998. Thus, the application for the proposed modification (Mod 6) should not be considered. The objection provides details about the grounds on which the claim of unlawful approval is made. It is recommended that the DPHI considers and assesses SEPP (Resilience and Hazards) 2021, SEPP No. 33, HIPAP No.6 and note the concerns expressed by HERAG.

The submission from the Hillsdale Eastgardens Resident Action Group (HERAG) raises concerns regarding the historical approval of the Orica replacement chlorine plant in November 1998. IXOM notes that the validity or legality of historical approvals is a matter for the Department of Planning and Housing to consider and determine.

The current modification (Mod 6) has been prepared and submitted in accordance with the requirements under Section 4.55(2) of the EP&A Act and relevant SEARs. The proposal includes a comprehensive quantitative risk assessment, transport assessment, and all other technical studies to address current regulatory obligations, planning considerations, and community safety requirements.

While IXOM notes the concerns raised by HERAG regarding transport risks and community notification, the modification addresses these matters in line with applicable planning instruments and statutory guidance, including SEPP (Resilience and Hazards) 2021, SEPP No. 33, and the NSW HIPAP framework.

4.6 Conservation Programs, Heritage and Regulation (CPHR) Group

Item 75 - CPHR have reviewed the Flood Impact Risk Assessment report (FIRA) prepared by Kellog Brown & Root dated 6 February 2025. The FIRA has demonstrated that the site is low flood risk and flood impacts are within the values allowable in the Bayside Council Local Government Area (LGA). The proposed building floor level meets the required Probable Maximum Flood level and protection to the flood planning level is proposed to be achieved by use of a low bund wall. No further information is considered necessary.

Noted.

Item 76 - CPHR recommends that the Modification report is updated to demonstrate that there will not be an increased impact on biodiversity values pursuant to section 7.17 of the *Biodiversity Conservation Act 2016* and clause 30A of the Biodiversity Conservation (Savings and Transitional) Regulation 2017.

The requirements of section 7.17 of the *Biodiversity Conservation Act 2016* and clause 30A of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 have been considered in relation to the modification.

Clause 30A provides that, for a modification of a planning approval granted before the commencement of the *Biodiversity Conservation Act 2016*, a Biodiversity Development Assessment Report (BDAR) is not required where the consent authority is satisfied that the modification will not increase impacts on biodiversity values (clause 30A(2)(c)).

The SEARs for the modification were issued by DPHI having regard to the scoping report, which identified negligible potential for biodiversity impacts. Consistent with this, the SEARs did not require the preparation of a BDAR or a BDAR waiver, indicating that DPHI (being the consent authority) had formed the preliminary view that it was satisfied the modification would not increase impacts on biodiversity values.

This position has since been confirmed through consultation with DPHI and CPHR, who advised that DPHI can be satisfied that the modification will not increase impacts on biodiversity values where supporting contextual information is provided, including a location map and satellite imagery showing the existing and proposed development in the context of surrounding land uses, landscape features and any biodiversity values, together with an explanation addressing the relevant legislative framework.

The Modification report includes mapping and contextual information demonstrating that the modification is wholly confined to an existing, highly disturbed industrial site and will not involve any vegetation removal or habitat disturbance. Figure 2.3 provides satellite imagery identifying surrounding biodiversity values, while Figure 3.1 and 3.2 show the location of the proposed development within the existing industrial complex. Further, Figure 2.1 shows the site in the context of surrounding land uses and Figure 1.1 and Figure 1.2 provide regional and local context for the site, respectively.

Accordingly, the modification will not result in any increased impacts on biodiversity values, and no BDAR is required in accordance with clause 30A(2)(c) of the Biodiversity Conservation (Savings and Transitional) Regulation 2017.

4.7 NSW EPA

Item 77 - The EPA has reviewed the modification report and notes that it does not provide the information required to allow us to complete our assessment. The EPA has the following comments and recommendations:

Matters to be addressed prior to determination:

- **Greenhouse Gas Assessment**
- **Environmental Management Plan**

Please find the EPA's request for further information in Attachment A and recommended conditions of consent in Attachment B, should the project be approved. This response addresses the Greenhouse Gas Assessment, Air Quality Assessment and Environmental Management Plan. The EPA advises the proposal is still being reviewed for several issues and will provide further advice to DHPI addressing Major Hazards Facility, Dangerous Goods and Contaminated Land Management (CLM), once the review has been completed.

Noted, see responses to items 78 and 79 below.

Item 78 - The EPA reviewed the Greenhouse Gas component in the 'Modification report' and 'Air Quality Impact and Greenhouse Gas Assessment' concluding that the Scope 1 and Scope 2 greenhouse gas (GHG) estimates for the 'maximum production capacity' is

expected to generate more than 25,000 tonnes per annum (tpa) of Scope 1 and Scope 2 emissions. Based on these estimates, the proposal will trigger the assessment requirements outlined in the NSW EPA Guide for Large Emitters (Large Emitters Guide). The EPA recommends that DPHI request a revised GHG assessment which is prepared consistent with the principles in the NSW EPA Guide for Large Emitters.

The original greenhouse gas assessment conservatively estimated emissions for a theoretical maximum production scenario, which resulted in an overstatement of Scope 1 and Scope 2 emissions. This overestimation arose from an assumption that the electricity demand provided for the chlorine liquefaction plant represented a production-scaled intensity (kWh per tonne), when in fact it represents the maximum operating electrical load. When this load was incorrectly extrapolated to the maximum annual production rate, total emissions were overstated and appeared to exceed the Large Emitter threshold.

This assumption has since been clarified and corrected. Greenhouse gas emissions have been recalculated to reflect the actual operating characteristics of the modification and updated data for existing approved operations. The revised assessment demonstrates that the modification will generate 2,550 tonnes of CO2-equivalent of scope 1 and scope 2 emissions per annum, which does not trigger the assessment requirements under the NSW EPA Guide for Large Emitters. The updated greenhouse gas assessment, along with a letter explaining the revised assumptions and calculations, is available in Appendix E.

Item 79 - The Environmental Management Plan (EMP) dated 21 September (2021) is outdated and does not include information regarding the proposed Chlorine Liquefaction Plant and the impacts of onsite stormwater, effluent drainage locations and capacity. The EPA recommends that an updated EMP be provided detailing: a) the current installed systems, environmental risks and mitigation measures at the premises. b) the current effluent management system, stormwater, effluent drainage locations and capacity, layout plan, operational procedures and responsibilities. c) the proposed Chlorine Liquefaction Plant and layout plans for the stormwater and effluent treatment system installed at the premises including any internal drains that will be installed and directed to the existing effluent treatment system.

IXOM acknowledges the EPA's comment that the existing Environmental Management Plan (EMP), dated 21 September 2021, does not reflect the proposed CLP or the detailed stormwater and effluent drainage arrangements associated with the modification.

The EMP will be updated to incorporate the CLP and to document any changes to the existing systems, environmental risks and mitigation measures at the premises, as well as the operational management of stormwater and effluent systems, including drainage locations, capacity, layout plans, procedures and responsibilities. The updated EMP will also include the finalised layout and management arrangements for stormwater and effluent infrastructure associated with the CLP, including internal drainage directed to the existing effluent treatment system.

Noting that detailed design of the CLP, including final stormwater and effluent drainage configurations, will be completed during the detailed engineering phase, IXOM considers that preparation and submission of the updated EMP is most appropriately addressed via a condition of consent, to be provided to the relevant regulatory authorities prior to commissioning of the CLP. This approach is consistent with standard practice and will ensure the EMP accurately reflects the final design and operational arrangements.

Item 80 - The EPA reviewed the Modification report and Environmental Management Plan and there is no information regarding an Environmental 'Mass Balance' assessment. The maximum estimated daily production capacity of liquified chlorine for the Proposal is 50 Tonnes – or, 18,250 Tonnes per annum and that no impact on the existing production capacity of the Chlor-Alkali Plant will occur, however there is no information provided on

the existing production capacity of the plant other than a maximum production limit of 35,000 tonnes of Chlorine Products per annum.

The EPA recommends that DPHI requests the Applicant to conduct an environmental 'Mass Balance' assessment detailing inputs and outputs of the development, both at normal and maximum operating capacity.

The proposed CLP does not increase the production capacity of the existing CAP and does not change the approved maximum chlorine production limit of 35,000 tonnes per annum. The CLP simply provides an alternative processing pathway for chlorine that is already produced at the site. Gaseous chlorine generated by the CAP may be redirected, as required, to the CLP for liquefaction and packaging (up to a maximum of 50 tonnes per day), with the remaining chlorine continuing to be supplied to existing downstream product plants.

Accordingly, the total chlorine production remains unchanged from the existing approval. As the proposal involves a change in the form and handling of chlorine rather than an increase in production, a separate environmental mass balance assessment is not considered necessary.

Item 81 - The Modification report outlines that the process of scrubbing air emissions will generate sodium hypochlorite as a by-product. There is a lack of information provided regarding the management of sodium hypochlorite as a by-product and the storage location. The EPA recommends that DPHI requests the Applicant to provide further information on the waste management, including storage location, for waste Sodium Hypochlorite generated during both normal operations and in the event of an incident, noting that up to 350,000 Litres of sodium hypochlorite would be generated in the event of a chlorine stock tank rupture.

The EPA's comments regarding the management of sodium hypochlorite generated as part of the air emissions scrubbing process are noted.

Sodium hypochlorite generated during normal operations, or in the event of a chlorine release, is not a waste product. It is a saleable product that is routinely manufactured and managed as part of existing CAP operations at the site.

In a worst-case chlorine stock tank rupture scenario, approximately 112 tonnes of 50 per cent caustic solution (81.5 cubic metres, assuming a specific gravity of 1.52 at 20 degrees Celsius) would be required for scrubbing. The site is equipped with two 50 percent caustic storage tanks with a combined capacity of approximately 3,366 tonnes (2,200 cubic metres). A minimum inventory of at least 112 tonnes is maintained to ensure availability for this scenario.

The reaction of chlorine with sodium hydroxide produces sodium hypochlorite solution. In the worst-case scenario, approximately 370 tonnes (315 cubic metres) of sodium hypochlorite would be generated over an eight-day period, with approximately 115 tonnes (98 cubic metres) generated within the first 12 hours. The site has four sodium hypochlorite storage tanks with a total capacity of approximately 640 tonnes (540 cubic metres).

Under normal operating conditions, the Botany CAP produces up to approximately 350 tonnes per day (298 cubic metres per day) of sodium hypochlorite. The volumes generated in the worst-case scenario can be safely managed using existing on-site storage infrastructure and the established product supply chain.

Accordingly, sodium hypochlorite generated as part of the scrubbing process does not constitute a waste stream, and no additional waste management measures or storage facilities are required.

4.8 SafeWork NSW

Item 82 - With regards to the IXOM Chlorine Liquefaction Plant Modification, the below mentioned points should be verified in the detail design:

- **Liquefaction Building Scrubber design to ensure and verify that scrubber will work even with containment building normal ventilation working (ventilation not shutdown on demand) the claim made in Appendix F (Event tree) of QRA;**
- **Evaluation of sensitivity of leakages in the building to performance of liquefaction Building Scrubber;**
- **Design to incorporate measures to identify any leakages in the building with appropriate alarms and response; and**
- **Relevant studies to be conducted to thoroughly investigate the claims of availability and effectiveness of entire Liquefaction Scrubber System elements (SIL, Fault tree, Event tree etc.)**

SafeWork's comments regarding verification of the liquefaction building scrubber design and associated safety systems are noted.

The liquefaction building scrubber system has been designed with redundancy and resilience, informed by hazard studies undertaken during the design phase. Key critical equipment, including scrubber pumps and extraction fans, have been identified through hazard studies and are provided with appropriate redundancy to ensure continued availability and effectiveness.

Verification of scrubber performance under relevant operating conditions, including scenarios where normal building ventilation remains operational, will be undertaken during detailed design and commissioning. The design incorporates measures for the detection of chlorine releases within the liquefaction building, including appropriate monitoring, alarms and response systems to enable timely detection and management of any leaks.

Further detailed verification activities, including confirmation of system availability will be undertaken during detailed design, commissioning and ongoing operation.

The QRA report has been updated to include information on the approach to verification of design during commissioning and associated ongoing assessment and verification works (Appendix F of the QRA, specifically Section F3).

Item 83 - Mentioned below are the proposed conditions of consent for modification

1. All chlorine inventory to be stored inside Chlorine Liquefaction Building for all modes of operation,

This is achievable for the normal operating scenario and the facility has been designed accordingly. However, during the contingent operating scenario, it may be beneficial to have additional space for drum and cylinder filling functions, including associated piping and equipment. This may result in a limited and temporary overflow of filled drums and cylinders, which would be stored within the existing approved outdoor storage area while awaiting transportation.

To ensure the site can operate effectively during all modes of operation, it is recommended that the proposed condition requires the final hazard analysis to include an assessment on the maximum volume of chlorine drums and cylinders that can be stored outside without materially affecting risk. The number of containers and duration of any temporary outdoor storage would need to be determined and agreed upon, however any outdoor storage would be managed in accordance with existing site procedures and would not exceed the site's licence limits.

2. IXOM will ensure that quantity of chemicals required for Liquefaction Building Scrubber is always maintained at site to treat worst case chlorine leakage;

IXOM notes that the site will maintain an inventory of 112 tonnes of 50% caustic solution to ensure availability for the scrubber in the unlikely event of a potential chlorine release.

3. IXOM will ensure that required capacity is always available at site to store the chemicals that are produced Liquefaction Building Scrubber operation for worst case chlorine leakage scenario;

Chlorine scrubbed (reacted) with sodium hydroxide will produce sodium hypochlorite solution which is a normal product produced at the site through existing CAP operations. The total amount produced will be approximately 370 t (315 m^3) over the course of 8 days for the worst-case scenario with 115 t (98 m^3) being generated in the first 12 hours. The site has four sodium hypochlorite storage tanks with a total capacity of 640 t (540 m^3). During normal operations, the CAP can produce a maximum of 350 t/day (298 m^3/day) of sodium hypochlorite. Therefore the volume of sodium hypochlorite that would be generated in this worst-case scenario can be managed with the existing stock tanks and supply chain.

4. During operation one chlorine tank will remain empty and standby to accommodate any chlorine storage tank leak;

IXOM confirms that by design, one 50 t stock tank will be in use whilst the other remains on standby to accommodate any chlorine storage tank leak.

5. The Chlorine liquefaction system, building, ventilation and scrubber is designed minimum to the standards of "AS 2977, The storage and handling of liquefied chlorine gas".

IXOM confirms design will meet relevant Australian Standards.

6. Liquefaction Building Scrubber will be installed with necessary instrumentation to evaluate the performance of scrubber against design at any time, including but not limited to chlorine monitor in the scrubber exhaust stream.

Instrumentation, including level, pressure and flow transmitters, will allow for continuous remote monitoring of scrubber operations in addition to continuous chlorine monitoring in the scrubber exhaust stream. Calculations and performance warranty will be provided by the scrubber vendor verifying that the scrubber is appropriately sized to account for the maximum chlorine release scenario.

In addition to the scrubber vendor documentation, commissioning activities such as instrument calibration, scrubber fan suction pressure and speed checks, stack velocity check, and potential stack emission testing will be completed. Testing of the scrubber with chlorine will also be completed during commissioning with the demand/ rate to be confirmed when the commissioning plan/instructions are developed to ensure it occurs in a safe and controlled manner.

The scrubber column, tank, fans, instrumentation and chlorine detectors will be subject to a preventative maintenance regime under the site's maintenance management system. In addition, the scrubber may be subject to annual stack testing to validate its performance.

7. Controls measures, performance standards developed for entire scope of modification and integrated with Safety Management System before commissioning of the modification.

IXOM will update existing safety management system to incorporate all relevant control measures and performance standards associated with the modification.

4.9 Randwick Council

4.9.1 Application pathway – “substantially the same” test and appropriateness modification pathway

Item 84 – Development not substantially the Same

Council is concerned that the installation of a new chlorine liquefaction plant may represent a substantial departure from the terms and content of the original development consent. Any modification to a development application in NSW must meet the "substantially the same" development test as provided under the Environmental Planning and Assessment Regulation 2017.

Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* allows an applicant to apply to the consent authority to modify a development consent where the proposed changes are more than minor, but the development would still be substantially the same development as originally approved.

This provision applies to modifications that go beyond correcting minor errors or making changes with minimal environmental impact. While such modifications may involve more substantial alterations-such as changes to the design, layout, or operational aspects-they must not fundamentally alter the nature or purpose of the original development. The consent authority must be satisfied that the development, as modified, remains substantially the same as the one originally approved.

Importantly, Section 4.55(2) does not require the proposed modification to have no or minimal environmental impact-that threshold applies to Section 4.55(1A). Modifications under 4.55(2) may involve more significant environmental impacts and typically require a more detailed assessment, public notification, and a supporting

Statement of Environmental Effects. In this context, Council contends that the proposed modification involves a greater environmental risk than previously assessed, yet lacks the level of detailed risk analysis that would be more appropriately addressed through a new Development Application.

Establishment of a new chlorine liquefaction plant may give rise to cumulative impacts of associated emissions (see relevant comments below) that may need to be fully considered in a development application rather than a modification application especially given potential existing emissions from Port Botany and the adjacent Botany Industrial Park. Furthermore, there may be deficiencies in the proposed modification application that, otherwise, would be subject to a more in-depth and comprehensive assessment under a development application. Listed below are Randwick Council's environmental, safety, risk, amenity and traffic concerns regarding the proposal, which cumulatively suggest that these issues are best addressed through a new development application rather than a modification application.

IXOM, Element and Sherpa met with Randwick Council on 24 November 2025 to discuss Council’s comments and to present the modification in detail, including the statutory basis for assessing the proposal as a modification under section 4.55(2) of the *Environmental Planning and Assessment Act 1979*.

As outlined in the Modification report and discussed at the meeting, the proposal satisfies the legal test that the development, as modified, would remain substantially the same development as that originally approved. The modification does not fundamentally alter the nature, purpose or character of the approved development and is consistent with the established industrial use of the site.

In particular:

- Chlorine is already produced, handled and stored on the site. The modification does not introduce a new chemical, new land use or a change to the underlying purpose of the facility.
- Liquefied chlorine is already stored onsite and transported from the site. The modification changes the source of liquefied chlorine from offsite production at Laverton to onsite liquefaction, rather than introducing a new activity or materially changing operational outcomes.
- The scale and nature of operations remain materially unchanged. The modification does not increase approved production capacity, inventory limits, truck movements, or the physical footprint of development beyond what is already permitted under the existing consent.
- The risk profile does not materially increase. Quantitative hazard and risk assessment demonstrates compliance with relevant HIPAP criteria and confirms that the modification does not result in a material increase in individual or societal risk. In some respects, risk is reduced by internalising liquid chlorine storage and handling within purpose-designed containment infrastructure.

While section 4.55(2) expressly allows for modifications that involve more than minimal changes and may require detailed environmental assessment, the test is whether the development remains substantially the same, rather than whether it is free from environmental impact. The Modification report includes a comprehensive suite of technical assessments addressing potential environmental, safety and amenity impacts, supported by agency consultation and public exhibition. The Modification report determined that the modification will not have significant environmental impacts and is unlikely to exceed applicable environmental standards and criteria.

Having regard to the above, the modification meets the “same essence or materiality” test established by planning law and is appropriately assessed as a modification under section 4.55(2) of the EP&A Act rather than requiring a new development application.

4.9.2 Environmental risk, public safety and hazard profile

Item 85 – Environmental and risk impacts

Chlorine gas plants inherently involve risk; however, the introduction of liquefied chlorine presents additional safety, transport, and storage hazards, including bulk storage and the potential for catastrophic release scenarios. Where liquefaction fundamentally alters the form, risk profile, and potential impacts of a chlorine plant, the development may no longer be regarded as "substantially the same."

If the risk and hazard profiles are materially different, the proposal cannot be characterised as substantially the same development. The Land and Environment Court (L&E Court) has previously held that where modifications introduce materially different risks or environmental effects, they are not capable of being considered substantially the same. Accordingly, if the proposal introduces materially greater risks-even where the underlying land use remains unchanged-it will fail to satisfy the "substantially the same" test.

It is acknowledged that chlorine production and handling is a hazardous activity and is subject to stringent regulatory controls. However, the proposed chlorine liquefaction plant does not fundamentally alter the form, nature or risk profile of the approved development, nor does it introduce materially different environmental or safety risks such that the development would no longer be regarded as substantially the same.

Chlorine liquefaction is a well-established industrial process that involves the refrigeration of chlorine gas to enable efficient storage and transport. The proposed liquefaction plant does not introduce a new chemical, reaction process or hazard class, but rather a physical phase change of chlorine that is already produced, handled and stored on the site. Liquefied chlorine is currently

stored and dispatched from the site, with the modification changing only the source of liquefaction from offsite to onsite production.

The co-location of the liquefaction plant with the existing CAP provides operational and safety benefits. The site already contains the necessary infrastructure, utilities, and controls to safely manage chlorine, including the readily available caustic soda for emergency scrubbing and neutralisation.

A detailed QRA has been undertaken for the modification. The assessment demonstrates that the introduction of onsite liquefaction does not result in a material increase in individual or societal risk and that all relevant hazard criteria are satisfied. In some respects, the risk profile is reduced through the internalisation of storage and handling of chlorine containers within the proposed containment building. The technical risk assessment confirms that the nature, scale and severity of potential hazards are consistent with those already approved and regulated under the existing consent.

Emergency response and incident management procedures will be reviewed and updated, as required, to specifically address the introduction of onsite liquefaction. These updates will ensure that site personnel, emergency services and relevant authorities continue to be supported by robust emergency response arrangements aligned with best practice and regulatory expectations.

On this basis, the modification does not introduce materially greater or fundamentally different environmental or safety risks and remains capable of being characterised as substantially the same development under section 4.55(2) of the EP&A Act.

4.9.3 Public exposure and extension of irritation injury contours

Item 86 - Public Risk - Extension of Irritation Injury Contours

The Qualitative risk Assessment provided in Appendix D of the report includes a summary table of risks. This Table 9.1 in shows irritation injury risk extending past Ixom Boundary to the south and west. The report notes the extension of the risk contours do not reach the nearest residential areas and do not extend to non-industrial land, so the HIPAP 4 toxic irritation criterion is met.

However, this contour now extends outside of the Botany Industrial Park and reaches 38 McPherson Street Banksmeadow which is the location of the existing Banksmeadow Recycling Yard. This facility is open to the general public six days a week as an independent recycling facility. This extension of the risk contours onto an existing facility with public access clearly qualifies as on offsite risk to the public. The introduction of new publicly accessible receptors within a hazard contour represents a material change in the risk profile of the development.

Under HIPAP 4, land that is publicly accessible is considered sensitive to toxic releases, as occupants are typically untrained and may be unaware of emergency procedures. The extension of a hazard contour onto such land introduces a new offsite risk to the public that was not present under the current configuration of the Chier-Alkali Plant. This change in exposure context is significant in land use safety planning, as HIPAP 4 emphasises the need to protect vulnerable and untrained populations from hazardous incidents.

Accordingly, the introduction of new offsite receptors within a hazard contour may constitute a material change in the risk profile of a development. In this regard, the Land and Environment Court of NSW (L&E Court) has previously found that modifications introducing new public exposure can render a development not "substantially the same" as originally approved. Notably, in Vacik v Penrith City Council {1992} NSWLEC 8 and Mato Projects (No 2) Pty Ltd v North Sydney Council {1999}, the Court held that changes which materially alter the nature or risk profile of a development-particularly by increasing public

exposure-may fall outside the scope of permissible modifications under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979*. Council's draft submission includes this matter.

Council is of the opinion that this modification constitutes a material change in risk profile given the offsite public risk and is no longer comparable to what was originally approved. Accordingly, the proposal does not satisfy the requirements of s 4.55(2) of the EP&A Act 1979, and a full new development application assessment is required to ensure adequate consideration of offsite public safety.

Council's comments regarding the extension of irritation injury contours beyond the IXOM site boundary are noted. However, the interpretation that this represents a new or materially different offsite public risk is not supported when assessed against the applicable risk criteria and land use definitions set out in Hazardous Industry Planning Advisory Paper No. 4 (HIPAP 4).

Under HIPAP 4, land uses that are considered more sensitive than residential are limited to hospitals, schools, child-care facilities and aged-care facilities. Irritation and injury risk criteria (refer Section 2.4.2.2 of HIPAP 4) are specifically applicable to residential and sensitive land uses, as defined above.

The property at 38 McPherson Street, Banksmeadow, which accommodates an existing recycling yard, is characterised by industrial / commercial land use. While the facility is accessible to the public, it does not fall within the definition of a residential or sensitive land use under HIPAP 4. It is therefore not a land use to which the irritation injury risk criteria are intended to apply for the purposes of land use safety planning. It is noted that HIPAP 4 land use definitions are specific to hazardous industry risk assessment and are distinct from receptor definitions used in other environmental assessments (e.g. noise or air quality).

The quantitative risk assessment identifies that irritation injury contours do not extend to residential or sensitive land uses and do not affect non-industrial land in a manner inconsistent with HIPAP 4 criteria. Accordingly, the applicable toxic irritation risk criteria are met. The presence of an industrial or commercial facility within an irritation contour does not constitute a non-compliance with HIPAP 4 nor indicate a material change in the risk profile of the approved development.

Importantly, the modification does not introduce new hazard types, increase chlorine inventory beyond approved limits, or result in exceedance of HIPAP 4 individual or societal risk criteria. The overall risk profile remains consistent with the existing approved operations of the Chlor-Alkali Plant, as confirmed by the updated QRA.

To further clarify the assessment and address Council's concern, the QRA has been updated to clearly identify land use categories on the relevant risk contour figures, including industrial and commercial uses, to demonstrate the applicability of HIPAP 4 criteria to the surrounding land uses.

On this basis, the extension of irritation injury contours onto industrial or commercial land does not represent a new offsite public risk under HIPAP 4, does not materially alter the risk profile of the development, and does not affect the conclusion that the modification remains substantially the same development for the purposes of section 4.55(2) of the EP&A Act.

4.9.4 Contamination, remediation and off-site vapour migration

Item 87 - Contamination/Remediation

The Remediation Action Plan (RAP) prepared by JBS&G Australia Pty Ltd identifies asbestos in near-surface soils and mercury and chlorinated hydrocarbons in soil vapour as key contaminants presenting potential health risks. While a range of remediation

options has been proposed in accordance with National Environmental Protection Council (NEPC) (2013) and EPA (2017) guidelines, Council's environmental health officer notes that the full extent of contamination-particularly vapour impacts-may extend beyond the site boundaries. Accordingly, Council

officers consider that further investigation into these potential off-site vapour impacts is required upfront prior to the determination of the application, along with confirmation of appropriate remediation protocols.

Additionally, Council's officer further recommends that, prior to determination of the modification, verification from an NSW EPA Accredited Site Auditor, via a Site Audit Statement (SAS B), should be provided upfront, confirming that the proposed remediation is appropriate for the identified contamination and will not result in greater environmental or human health risks than leaving the site undisturbed. In addition, the proposed Environmental Management Plan referred to in the proponent's remediation assessment should be developed and reviewed by the NSW EPA Accredited Site Auditor to confirm that the plan is reasonable and feasible in addressing site-specific contamination and health risks.

These deficiencies in the assessment of (a) the off-site vapour impacts and (b) the feasibility and appropriateness of the proposed remediation action represents another cumulative risk arising from the proposal. These deficiencies are considered unacceptable for a proposal of this scale, on a site that is already heavily contaminated from past activities, being a "significance risk of harm site". This suggests that these matters should be comprehensively addressed via a DA submission and not a Modification Application.

As identified in the RAP prepared by JBS&G Australia Pty Ltd, soil vapour impacts are known to extend beyond the site boundary and are a well-established regional issue extending past the boundaries of the Botany Industrial Park. The RAP explicitly considers the implications of these off-site vapour sources in determining the most appropriate remediation strategy. On this basis, installation of a vapour barrier beneath the proposed building has been identified as the only viable and effective remediation measure, as it addresses potential vapour risks from both on-site and off-site sources. Alternative remediation options confined to the site would not mitigate risks associated with off-site vapour migration and were therefore assessed as unsuitable. Accordingly, additional off-site vapour sampling would not materially inform the remediation strategy.

As discussed at the meeting between IXOM, Element Environment, Sherpa and Randwick Council on 24 November 2025, a staged audit-based approach to contamination management has been agreed with both Council and DPHI. A NSW EPA accredited site auditor was engaged to provide interim audit advice prior to determination of the modification application (Appendix F). This interim advice confirms that, subject to remediation being undertaken in accordance with the RAP, the selected remediation approach is appropriate for the identified contamination.

A site audit statement and site audit report will be required following remediation which will be obtained from a NSW EPA-accredited site auditor prior to construction. This pathway was discussed with and accepted by Randwick Council and DPHI. The site auditor will also review the proposed Environmental Management Plan relevant to contamination management to confirm that it is reasonable, feasible and suitable to address site-specific contamination and health risks.

On this basis, contamination and remediation are being addressed through a robust audit framework consistent with EPA guidelines and established regulatory practice. These matters do not represent a deficiency in the modification application nor a cumulative risk that would necessitate assessment via a new development application.

4.9.5 Traffic, transport of Dangerous Goods (DG) and cumulative transport risk

Item 88 – Traffic and Transportation Concerns

A Transport and Traffic Assessment (Appendix B) has been prepared which essentially finds that modelling indicates that, under normal operations scenarios and extreme case scenario (closure of the Laverton CLP site in Victoria), the proposal is likely to have minimal impact on traffic operations and road performance during the traffic peak hours.

Notwithstanding this, Council raises concerns regarding the methodology adopted in the traffic impact assessment, which places disproportionate reliance on the fact that the site's current traffic generation is below the truck movement limits approved in the original Environmental Impact Statement (EIS). This approach overlooks the need to assess the actual impacts of increased traffic volumes on the Level of Service (LoS) at key local intersections. While the LoS may currently remain within acceptable thresholds, even modest increases in truck movements- particularly during peak periods-could exacerbate congestion and compromise road safety.

In this context, Council seeks clarification on whether the community will be notified of the specific timing and scheduling of truck movements, especially under the extreme case scenario involving the closure of the Laverton Chlorine Liquefaction Plant in Victoria. Such transparency is critical to avoid conflicts with residential and school traffic and to ensure that any operational changes are managed in a way that minimises local traffic disruption.

In the worst-case scenario-where the Victorian Chlorine Liquefaction Plant becomes non-operational-truck movements associated with the proposed facility could substantially exceed current projections. Despite this potential increase, the modification application does not outline any mitigation measures to address the corresponding rise in heavy vehicle traffic.

Council stresses that, under such conditions, road tankers must not be permitted to queue or idle within nearby residential streets while awaiting loading or unloading. All tanker movements, including any queuing or holding patterns, must be fully contained within the boundaries of the subject site to prevent negative impacts on local traffic, residential amenity, and road safety.

The submitted Traffic and Transport Assessment fails to consider these operational contingencies, and as a result, no traffic mitigation strategies have been proposed to manage increased vehicle volumes in high-demand scenarios involving the Chlorine Liquefaction Plant.

In New South Wales (NSW), the applicant would be aware that there are strict regulations governing the transportation of liquid chlorine by road tanker trucks. These regulations are part of broader safety measures to protect people, property, and the environment. The Environmental Protection Authority (EPA) and SafeWork NSW are responsible for overseeing the transport of dangerous goods, including liquid chlorine. Key regulations include the designation of specific hazardous goods routes, which are essential for several reasons:

- **Safety: Designated routes are selected to reduce the risk of accidents in densely populated or environmentally sensitive areas.**
- **Emergency Response: These routes are chosen to ensure that emergency services can respond quickly and effectively to any incidents.**

- **Infrastructure: The routes are designed to accommodate the unique needs of hazardous goods transport, including the strength and width of roads suitable for heavy tanker trucks.**
- **Minimising Exposure: By using designated routes, the exposure of the general public to potential hazards is minimized.**

These measures help ensure that the transportation of dangerous goods, such as liquid chlorine, is carried out as safely as possible.

Council notes that the Dangerous Goods Risk Assessment (DGRA) in Appendix N, prepared by Sherpa Consulting, does not rely on the Vopak Port Botany Expansion - Denison Street Transport Quantitative Risk Assessment, July 2016 Update, Revision 4, prepared by Scott Lister and issued in August 2016 for the assessment of cumulative impacts of transportation of dangerous goods. This document was specifically identified as a requirement under the Secretary's Environmental Assessment Requirements (SEARs). Instead, the proponent's risk consultant developed an alternative baseline model from which changes in cumulative transport risk associated with the modification proposal were assessed. Details regarding the development of this baseline risk model are not clearly justified within the DGRA, raising concerns about the validity of the model that underpins the assessment cumulative transport risk.

Additionally, Council notes that no traffic count data for current Dangerous Goods (DG) transport movements along Denison Street were undertaken as part of this study. Instead, the proponent relies on DG truck movement data derived from an outdated 2012 survey (ROAR Traffic Survey 2012). These traffic counts are now significantly outdated and do not reflect current operational conditions. Moreover, the Vopak Site B Expansion Traffic Impact Assessment (2016) alone anticipated an increase of more than 100 additional truck movements per day, representing a conservative 1.7-fold increase in the average hourly traffic volume compared with 2013 levels. In the absence of updated traffic count data, the cumulative impact of the proposed modification cannot be accurately assessed based on the current volume of DG truck movements along Denison Street. Consequently, any determination of cumulative transport risk remains incomplete and potentially unreliable.

In summary, the modification application has not provided details as to how and to what extent the proposal accords with relevant state regulation including dangerous goods routes to ensure safety for people, property, and the environment. These matters should be comprehensively addressed via a DA submission and not a Modification Application.

Transport and traffic concerns

A Transport and Traffic Assessment was prepared for the modification and demonstrates that, under both normal operating conditions and the contingent operating scenario, any potential additional vehicle movements would result in minimal impacts on traffic operations and road performance, including during peak periods.

In practice, the site currently operates well below its approved traffic limits. Of the approved 76 daily heavy vehicle movements, approximately 46 movements are currently utilised. Under the normal operating scenario associated with the modification, truck movements would increase by approximately six movements per week, not per day. As such, heavy vehicle movements generated by the modification can be accommodated within the approved maximum daily heavy vehicle movements established under the original consent.

Under the contingent operating scenario, additional movements would comprise:

- the six movements per week associated with normal operations;
- approximately 31 additional bulk movements per year; and
- up to six movements per week associated with container transport to the Laverton facility.

These estimates are deliberately conservative and do not account for the corresponding reduction in truck movements that would otherwise occur between Laverton and Botany under this scenario. Notwithstanding this, even under the contingent case, total heavy vehicle movements would remain within the limits of the existing approval.

Given that no increase to approved daily truck movements is required, the traffic assessment appropriately considered the proposal in the context of existing consented traffic capacity. Level of Service at surrounding intersections would therefore remain consistent with the approved baseline condition.

With respect to community notification, no changes to traffic patterns or volumes are anticipated under normal operating conditions that would warrant specific notification. However, should the contingent operating scenario be triggered, appropriate communication would be undertaken to inform the community of the minor temporary operational change and the expected nature and frequency of truck movements along Denison Street.

All truck movements, including any staging or holding associated with loading and unloading, will continue to be managed within the boundaries of the site, consistent with existing operational practices and licence requirements. No queuing or idling within surrounding residential streets is proposed or required.

Overall, the modification does not result in a material increase in traffic impacts, does not exceed approved traffic limits, and can be managed within the existing road network and site infrastructure without adverse impacts to road safety or local amenity.

Transport risk concerns

Council's comments regarding the assessment of dangerous goods transport risk, baseline modelling and cumulative impacts are noted.

The SEARs required the preparation of a TRA to evaluate the potential impacts of dangerous goods transport to and from the modified facility, with comparison to the findings of the Transport Risk Assessment undertaken for Major Project approval MP 06_0089 (Vopak Bulk Liquids Storage Facility, MOD 2).

The Scott Lister risk model used to inform the Vopak approval is not available for update, and the original consultant is no longer providing this service. This constraint was discussed with DPHI, and it was agreed that the appropriate approach to meet the intent of the SEARs was to develop a new transport risk model using assumptions as closely aligned as practicable to the Scott Lister study, and to use this model to compare risk outcomes and key findings against those documented in the 2016 Vopak assessment. This agreed approach is described in the Transport Risk Assessment.

While some deviations in modelling assumptions were unavoidable due to changes in risk modelling software and methodology over the past decade, all such deviations are identified and justified within the TRA. Importantly, the comparative assessment demonstrates that the key findings of the Scott Lister study remain unchanged.

Specifically:

- The extent of cumulative individual fatality risk contours generated by the new baseline model is comparable to those presented in the Scott Lister study, including the finding that cumulative dangerous goods transport risk exceeds HIPAP 4 criteria in residential areas along Denison Street.
- In both the Scott Lister study and the updated baseline model, cumulative transport risk is dominated by Class 2.1 (LPG) tanker movements.
- Chlorine transport is not a dominant contributor to cumulative risk and represents only a small fraction of the overall dangerous goods transport risk along Denison Street.

The TRA further assessed the effect of increased chlorine transport associated with the modification and compared the resulting cumulative risk contours against those in the Scott Lister study. This assessment demonstrates that there is no material difference between the cumulative risk contours in the 2016 Scott Lister results and those generated by the updated baseline model incorporating the increased chlorine transport. This outcome reflects the continued dominance of Class 2.1 tankers in the cumulative risk profile.

In addition, the TRA assessed the effect of reduced LPG tanker movements associated with the shutdown of the Qenos facility. This reduction results in a measurable decrease in cumulative transport risk. When the increased chlorine transport associated with the modification is incorporated into this scenario, the cumulative risk remains below historical levels previously assessed. When current industry changes are taken into account, there is a net decrease in cumulative dangerous goods transport risk along Denison Street compared to previously assessed levels even when the increase in chlorine transport associated with the CLP is accounted for.

The TRA also separately assessed chlorine transport risk in isolation. For both current operations and the modified contingent operating scenario, chlorine transport alone meets the relevant HIPAP 4 risk criteria. The incremental increase in chlorine transport associated with the modification is small relative to existing transport volumes and does not materially alter the risk profile.

Council's comments regarding the age of available dangerous goods traffic count data are acknowledged. However, it is noted that comprehensive dangerous goods traffic surveys have never been undertaken for Denison Street, including for the Scott Lister assessment prepared in 2016. Meaningful dangerous goods traffic data would require extended survey periods over long durations, which has not historically been undertaken and was not required under the SEARs for the modification. Notwithstanding this uncertainty, the conclusions of the TRA remain robust, as the dominant contributors to cumulative risk are well understood and unchanged.

All chlorine transport associated with the proposal will continue to utilise existing approved heavy vehicle and dangerous goods routes, consistent with current operations and regulatory requirements. Route selection and traffic management are addressed in the Traffic Impact Assessment and are outside the scope of the Denison Street-focused transport risk assessment required under the SEARs, consistent with the approach adopted for the Vopak project.

Overall, the Transport Risk Assessment demonstrates that:

- the proposal does not materially increase cumulative dangerous goods transport risk;
- chlorine transport remains a minor contributor to overall risk;
- cumulative risk outcomes are consistent with, or improved relative to, previously approved conditions; and
- the modification does not introduce a materially different transport risk profile.

Accordingly, the proposal is appropriately assessed as a modification under section 4.55(2) of the *Environmental Planning and Assessment Act 1979* and does not warrant assessment as a new development application on transport risk grounds.

4.9.6 Operational noise and residential amenity protection

Item 89 - Operational Noise implications

The proponent has submitted a detailed noise assessment with reference to the Environmental Protection Licence (EPL) No. 20547, dated 13 January 2025, and the noise limits specified under condition L4.2. The proposed plant is intended to operate on a continuous 24-hour basis.

While Council recognises the need to balance the competing priorities of industrial and residential land uses, it is essential that this balance is achieved in a fair and reasonable manner that safeguards existing residential amenity. In this regard, Council Environmental Health officer notes that the night-time noise criterion specified in condition L4.2 of the EPL is approximately 7 dB(A) higher than the corresponding residential amenity criteria contained within the Noise Policy for Industry (2017). Council is concerned that reliance solely on the EPL criteria may not provide adequate protection for existing residential receivers, as these residents are likely to perceive and be adversely affected by any increase in background noise when additional plant is introduced to the site. This raises the potential for future complaints, particularly given the sensitivity of residential receivers to night-time noise.

In addition, the acoustic report makes no reference to condition L4.3 of the EPL, which requires consideration of the intrusiveness criterion for active plant. For completeness and robustness of the assessment, the proponent should be required to model the worst-case operating scenario; that is, all significant plant items operating concurrently during the night-time period (10:00 pm to 7:00 am) with assessment undertaken at the most affected noise-sensitive receiver. This would provide greater confidence that the operation of the plant will remain compliant with condition L4.3 under realistic worst-case conditions and minimise the likelihood of amenity impacts for the existing residents.

Thank you for the opportunity to provide comment on this Ixom Mod 6 proposal. Council formally objects to the proposed modification (DA35/98-MOD-6) to the existing Chier-Alkali Plant on the grounds of increased public risk and as a modification the proposal should have no or minimal environmental impact.

As the proposed modification therefore raises material public safety concerns, where the overall hazard and impact profile is no longer comparable to what was originally approved it warrants a full development application assessment, rather than approval as a minor modification. Council recommends that if IXOM wants to proceed with the chlorine liquefaction plant should be pursued as a new State Significant Development and be accompanied by a comprehensive Environment Impact Assessment to ensure all environmental impacts associated with the proposal are properly identified, quantified and assessed.

The NVIA has assessed the potential noise impacts to nearby potentially sensitive receivers against the existing EPL noise limits. The EPL noise limits represent the applicable and enforceable noise criteria for the facility. Hence, the EPL noise limits are the appropriate criteria for this assessment.

Muller Acoustic Consulting Pty Ltd (MAC) acknowledges that the NPI method for determining the project amenity noise levels (PANLs), based on the recommended amenity noise levels (ANLs) only, and without consideration of other factors such as traffic noise levels and existing industrial noise levels, would result in lower PANLs. However, the ANLs, as adopted as the relevant noise limits in the EPL, were determined in accordance with the NSW Industrial Noise Policy (INP) (EPA, 2000).

As per note 8 of the 'Implementation and transitional arrangements for the Noise Policy for Industry', the INP will continue to apply where it is referenced in existing statutory instruments (such as consents and licences). The EPL specifically references the INP, hence, the amenity noise levels in the EPL are the appropriate PANLs for this assessment.

The NVIA assessed a typical conservative (worst-case) operational scenario with all plant and equipment operating simultaneously for the duration of the assessment periods, in accordance with the methodologies of the INP and NPI. The predictive noise model utilised sound power levels from measurements at the IXOM Botany site for existing plant and equipment, and the

IXOM Laverton North site for the chlorine liquefaction plant. The predictive model was validated using attended measurements in accordance with Section 7 of the NPI. The NVIA also considered prevailing meteorological conditions and the potential for annoying noise characteristics.

Condition L4.3 of the EPL states that the intrusive noise criterion for all active plants in the BIP shall be that the $LA_{eq15\ (min)}$ noise levels shall not exceed the amenity LA_{eq} noise levels by more than 5 dB(A). The wording of this condition is incorrect. Assuming amenity LA_{eq} noise levels, the intrusiveness criteria would be less stringent than the PANLs, and the noise limits in L 4.2 would be the controlling criteria. In accordance with the INP and NPI, the intrusive noise criteria should be the background noise levels (LA90) + 5 dBA, not the ambient (LA_{eq}) + 5 dBA.

To inform the NVIA, MAC undertook short-term attended noise measurements at the nearest residential receivers on Denison Street, during the night period (2:14 am on 19 July 2024). The ambient $LA_{eq(15min)}$ and background (LA90) noise levels were measured at 63 dBA and 50 dBA respectively, with existing industrial noise and road traffic noise identified as the dominant noise sources in the locality. Notwithstanding the wording of condition L4.3, the project intrusiveness noise levels (PINLs) during the night period would be 55 dBA (based on background noise level of 5 dBA), which is less stringent then the noise limits in condition L4.2. It is therefore considered that noise limits in condition L4.2 are more stringent than the intrusiveness criteria (condition L4.3) and are therefore the appropriate noise limits.

Notwithstanding Council's concluding objection, the modification has been assessed in accordance with section 4.55(2) of the *Environmental Planning and Assessment Act 1979* and has been demonstrated to remain substantially the same development as originally approved. The Modification report and supporting technical assessments address the relevant environmental, safety and amenity considerations associated with the proposal and do not identify any material increase in impacts beyond those previously assessed and approved.

The level of assessment undertaken for the modification is comprehensive and is equivalent in scope and rigour to that typically required for an environmental impact statement accompanying an SSD. A suite of specialist studies has been prepared to identify, quantify and assess potential impacts associated with the modification, including risk, traffic and transport, noise, air quality and greenhouse gas emissions, flooding, contamination and biodiversity.

On this basis, the assessment does not support the conclusion that the proposal gives rise to new or materially greater public safety or environmental risks such that it would fall outside the scope of a section 4.55(2) modification. Rather, the modification is confined to an established industrial site, is consistent with the approved land use and operational envelope, and has been supported by detailed technical assessment sufficient to inform the consent authority's determination.

Accordingly, the proposal has been appropriately assessed as a modification to the existing consent and does not warrant consideration as a new State significant development application.

4.9.7 Air quality, emissions and community health

Item 90 - Air quality

The air quality assessment undertaken for the proposed modification to the chlorine liquefaction plant advises that the project can operate without causing significant impacts to local air quality or public health. Using conservative assumptions, air dispersion modelling (via the CALPUFF model) assessed both normal and emergency operating scenarios, including potential shifts in chlorine supply due to the non-operation of the Laverton plant.

Results confirm that predicted chlorine concentrations will remain well within relevant air quality criteria at all sensitive receptor locations. During construction, potential dust impacts are assessed as low risk and can be effectively managed through standard

mitigation measures. Additionally, the project's estimated annual greenhouse gas emissions are minimal representing approximately 0.0002% of national and 0.001% of NSW emissions-and are expected to decrease over time as the electricity grid decarbonises. Overall, the assessment advises that the modified plant will implement appropriate air quality management measures to ensure continued compliance and community protection.

It is recommended that ongoing quarterly air quality monitoring be undertaken and included as a condition of the site's NSW EPA Environmental Protection Licence (EPL) issued for the operation of the plant.

We acknowledge the community representations that have been received expressing opposition to the proposed construction of the chlorine liquefaction plant at the site. These concerns have informed and been considered in this submission.

Ongoing air quality management and compliance will continue to be regulated through the site's NSW EPA Environmental Protection Licence, including any monitoring requirements determined by the EPA, ensuring the protection of local air quality and public health.

4.10 DPHI RFI

Item 91 - The alternatives to a new Chlorine Liquefaction Plant (CLP) within the existing Chlor-Alkali Plant (CAP) at Botany Industrial Park (BIP) (i.e. MOD 6) are listed in Section 2.5.2. However, the comparison of these alternatives is brief and as such, MOD 6 has not been fully justified against these alternatives in terms of the wider benefits and costs. Please provide sufficient justification in terms of the wider benefits and costs on why MOD 6 will be the best available option, including minimising chlorine transport distances, avoiding chlorine transport routes within highly populated urban areas and improving overall safety of the community.

The modification involves establishing a chlorine liquefaction plant within the CAP at the Botany Industrial Park, this option was assessed against a range of alternatives, as outlined in Section 2.5.2 of the Modification report. Alternatives considered included:

- Expanding existing safety stock in Australia;
- Importing chlorine and providing additional major hazard facility storage;
- Construction of a new chlorine packaging plant by an existing Australian producer;
- Establishment of a greenfield site by a new producer; and
- Substitution of chlorine with alternative disinfection methods such as sodium hypochlorite or on-site electro-chlorination.

Following review, the modification was considered the safest, most efficient, and economically viable option. Key considerations include:

- Minimising transport distances and public exposure**:** Co-locating the CLP at Botany reduces chlorine transport requirements when compared with sourcing from Laverton or a new greenfield site.
- Existing infrastructure and operational efficiencies**:** The Botany site already has the necessary raw material feed, utilities, transport access, and industrial zoning to safely accommodate a CLP. Leveraging existing infrastructure minimises capital investment and operating costs compared with constructing a new facility elsewhere.
- Operational safety and resilience**:** Co-location allows immediate access to caustic soda for scrubbing and integration with existing safety systems, maintaining high standards of risk management and ensuring continuity of national chlorine supply in the unlikely event of non-operation at Laverton.

- Supply chain reliability and national benefit**:** IXOM is the only operator able to reliably meet national demand for packaged and bulk liquefied chlorine. The modification provides a robust contingency solution, avoiding reliance on international imports, which are subject to shipping volatility and delays.
- Leverage of technical and commercial expertise**:** The existing facility allows efficient expansion using IXOM's established technical, operational, and safety capabilities, providing a controlled and low-risk solution.

A detailed quantitative costing of every alternative was not feasible nor considered necessary, given the clear operational, safety, and supply chain advantages of the Botany site. Instead, a qualitative economic comparison was undertaken, considering capital and operating costs, operational feasibility, and risk exposure. Any detailed commercial and costing information is commercially sensitive and has been treated as confidential.

Overall, the assessment of alternative options demonstrates that the modification is the preferred option in terms of safety, security and efficiency and is the best available option for ensuring a resilient chlorine supply in Australia.

Item 92 - From Section 5.2.2, we note that the Local Emergency Management Committee (LEMO) had been consulted. The LEMO responded that they will review MOD 6 during exhibition. However, no submission was provided by the LEMO and as such, the consultation outcomes remain open. Please reengage with the LEMO to close out the consultation and incorporate their comments and recommendations accordingly, if any.

The consultation response that DPHI refers to is a response from Peter Barber, Director of City Futures from Bayside Council dated 10 September 2024. To clarify the consultation outcomes, Element Environment contacted Mr Peter Barber, Director of City Futures at Bayside Council, on 14 November 2025 who confirmed that his team was involved in preparing the Bayside Council submission lodged in response to the exhibition, which has been addressed in this RTS, and no further input was proposed.

Notwithstanding this, and to ensure the consultation was appropriately closed out, Element also re-engaged directly with Mr Guy Hancock, the Local Emergency Management Officer (LEMO) on 14 November 2025. Mr Hancock confirmed that he had already provided his intended feedback on the proposal via email response on 10 September 2024 and did not intend to provide any additional comments during the exhibition period. Accordingly, no further consultation outcomes or recommendations are outstanding from the LEMO. On this basis, consultation with the LEMO is considered complete.

Item 93 - From Table 3.3, Note (b), based on consequence modelling of 25 ppm chlorine concentration within in the maximum discharge of 10,000 m3/hr from the 18.7 m scrubber stack height (i.e. the scrubber discharge specifications), it is understood that the concentration at ground level will not reach the chlorine toxic fatality, injury or irritation effects concentration (i.e. will not exceed AEGL-2 (10 minutes) = 2.8 ppm). Some details of this consequence modelling was provided by IXOM to the Department through separate correspondence. However, the consequence modelling assumptions and results are not provided in the QRA. To provide clarity to the public, please provide the consequence modelling assumptions and results, and verify that the modelling considers the worst-case weather conditions (i.e. those conditions which result in the furthest consequence distances).

Consequence modelling of the scrubber discharge scenario has been undertaken and is documented in the updated QRA (Appendix B). Dispersion modelling for the scrubber discharge is presented in Appendix H, Section H8 of the updated QRA. The modelling assesses all relevant meteorological conditions defined in Appendix D of the QRA, including worst-case conditions (typically F-stability).

The results demonstrate that, under all modelled meteorological conditions, ground-level chlorine concentrations do not reach toxic fatality, injury or irritation thresholds. The updated QRA has been revised to clearly present the modelling assumptions, meteorological inputs and results to provide further transparency and clarity.

Item 94 - From Appendix F of the QRA, it is understood that the total unavailability of the chlorine liquefaction building with scrubber is estimated to be up to 5% on an annual basis. That is, if a release were to occur within the building, there is a 5% probability that the building with scrubber will not be able to fully mitigate the release to the scrubber discharge specifications. The QRA considers such cases to be unmitigated outdoor ground level releases as though as the building and scrubber are not present. The Department considers this approach to be reasonably conservative, noting that there is still be some degree of mitigation afforded from the building as a passive enclosure compared to unmitigated outdoor releases. In recognising that the building with scrubber is a critical safeguard, further information should be provided to ensure that the maximum total unavailability of this safeguard will not exceed 5% throughout the life of MOD 6. As such, please provide further information and justification on how the 5% total unavailability will be verified in detailed engineering design, validated during construction/installation and tested prior to commissioning (SIL rating, scrubber performance testing, building leak testing, building integrity monitoring, etc.).

The updated QRA (Appendix B) has been revised to include additional detail around commissioning and periodic maintenance in Appendix F, Section F3, outlining how this unavailability will be verified, validated and maintained over the life of the modification. This is in line with the existing recommendations in the QRA, which requires confirmation of availability assumptions, as part of detailed engineering design.

During detailed design, the performance and reliability of the scrubber system, building enclosure and associated control and protection systems will be confirmed through final hazard analysis and supporting engineering studies, including confirmation of relevant instrumented functions where applicable. Commissioning activities will include functional testing of the scrubber system, verification of airflow performance, and building integrity testing under representative operating conditions. Periodic inspection, maintenance and functional testing during operations will be undertaken in accordance with established maintenance and inspection regimes to ensure ongoing performance consistent with the QRA assumptions. It is appropriate that these requirements be secured through conditions of approval, noting that detailed design and commissioning activities will be completed post-approval.

Item 95 - Please provide further information on the engineering design and/or continuous building integrity monitoring of the chlorine liquefaction building to ensure that any release of chlorine gas will not occur through gaps or cracks across the building fabric (i.e. walls, ceiling, and floor) throughout the life of MOD 6. It is understood from MOD 6 report Appendix I: Remediation Action Plan, Section 5.1 that a vapour barrier will be installed below the floor to prevent ground contaminant ingress into the building. Will a similar vapour barrier be installed at the walls and ceiling to prevent chlorine gas egress from the building? Will the pressure difference between indoor and outdoor be constantly monitored to ensure negative pressure within the building? Will chlorine sensors be located appropriately outside the building close to doors, vents and openings to detect leaks from the building?

The vapour barrier referred to in Appendix I to the modification report (Remediation Action Plan, Section 5.1) comprises a spray-applied rubberised bituminous membrane installed beneath the concrete slab of the chlorine liquefaction building. This membrane is specifically intended to mitigate vapour intrusion into the building from underlying soil and groundwater contamination and is not designed to function as a containment measure for chlorine gas. Application of a similar membrane to the walls and ceiling is not practicable nor required for chlorine containment.

Containment of chlorine gas will instead be achieved through a combination of engineered building design, negative pressure operation, active scrubbing, monitoring and ongoing maintenance. The chlorine liquefaction building will be designed and constructed as a containment structure with joints, penetrations and interfaces minimised and appropriately sealed to maintain building integrity and prevent unintended egress pathways over the life of the facility. Liquid chlorine within the building will be stored at atmospheric pressure, with stock tanks bunded to capture any liquid release. The tanker loading bay and other chlorine handling areas will also be bunded.

The building will be maintained under a slight negative pressure relative to ambient conditions at all times during operation. This will be achieved via the liquefaction building scrubber (LBS), such that outside air is continuously drawn into the building and any airborne chlorine released within the building envelope is directed to the scrubber for neutralisation. Scrubber fans will be appropriately sized during detailed design to account for the volume of the building and conservative maximum chlorine release scenarios, with suction pressure set and validated during commissioning. Instrumentation, including pressure and flow transmitters, will continuously monitor fan performance to confirm that negative pressure is maintained.

Negative pressure in the building will be confirmed during commissioning by direct measurement using a manometer. Preventative maintenance routines will be scheduled thereafter to confirm negative pressure in the building is maintained using a manometer.

Negative pressure in the building will be maintained by controls on building openings. These include:

- The state of the building access doors and air intakes louvres will be continuously monitored and will alarm if not in the correct state. Access doors and air intake louvres will fail to the closed state.
- The state of the building ventilation system fan motor and motorised air damper at the fan intake will be continuously monitored and will alarm if not in the correct state. Fan intake air damper will fail to the closed state.
- The state of the liquefaction building scrubber fan motors will be continuously monitored and will alarm if not in the correct state (i.e. running).
- The state of liquefaction building scrubber exhaust ducting dampers will be continuously monitored and will alarm if not in the correct state.
- The state of the liquefaction building scrubber fan air recirculation damper will be continuously monitored and will alarm if not in the correct state.

Chlorine gas detectors will be strategically located within the building in proximity to chlorine inventory and handling points, including stock tanks, tanker loading areas, drum and cylinder storage, and filling stations. Final sensor locations will be confirmed during detailed design. The LBS suction ducting will extend to potential chlorine release points, including near grade and behind stock tanks, with motorised dampers installed on each duct take-off. Detection of chlorine by sensors adjacent to these locations will trigger damper opening to preferentially extract contaminated air to the scrubber.

The scrubber, associated fans, instrumentation and chlorine detectors will be subject to a preventative maintenance regime under the site's maintenance management system. In addition, the building itself will be subject to routine visual inspections to identify any gaps or degradation, with any defects rectified promptly to ensure ongoing containment integrity.

Together, these measures provide a robust, multi-layered containment and monitoring system that ensures any chlorine release would be retained within the building and safely neutralised, thereby preventing off-site impacts over the operational life of the modification.

Item 96 - From the report, it is understood that the risk of the overall IXOM facility comprising of the existing CAP and new CLP up to MOD 6, both normal (excludes chlorine

cylinder and drum filling, only chlorine tanker filling) and contingent (includes chlorine, drum and tanker filling) modes of operation, complies with both the individual risk criteria (fatality, injury and irritation) and societal risk criteria in HIPAP 4. However, when compared to the existing CAP up to MOD 5, it is noted that MOD 6 will still result in an increase in societal risk for both modes of operation and a shift in the individual fatality risk contour towards the southern direction for contingent mode of operation. Please provide reasons why these increase and shift in risks are noted in the results even when the QRA already takes into account the risk reduction benefits of the chlorine liquefaction building with scrubber. Please also describe the major risk contributors leading to these increase and shift in risks and identify additional strategies or safeguards (those not already taken into account in the QRA) which can further reduce the risks from these major risk contributors to as low as reasonably practicable.

The QRA has been updated to provide additional clarity on risk contributors for the contingent case and the implications for societal risk associated with the Chlorine Liquefaction Plant. As described in the updated QRA, changes to the site layout result in a shift in the risk footprint, with the fatality risk contour moving marginally south and contracting to the north. This reflects the relocation of chlorine drum storage from an outdoor area to within the enclosed liquefaction building, which is positioned south of the existing drum and tanker handling areas. Appendix J of the QRA continues to summarise the dominant risk contributors, with additional discussion now provided in Section 8.5 and Appendix J, Section J3.

No additional risk reduction measures beyond those already identified in recommendations 1 and 2 of the QRA, which now explicitly apply to both normal and contingent cases, are proposed. The principal risk reduction mechanisms for both individual and societal risk remain early detection, rapid isolation and effective mitigation, which have been conservatively modelled in the QRA, including for the contingent case as described in Section 8.4 of the QRA.

Item 97 - Please provide the consequence modelling results for the scenarios in Table 5.1 for the worst-case weather conditions (i.e. those conditions which result in the furthest consequence distances) and verify that these results are generally consistent with the chlorine cylinder, drum and tanker release scenarios in the QRA.

The TRA has been updated (Appendix C) to adopt the same meteorological dataset and environmental modelling parameters as used in the QRA. This ensures consistency between the TRA and QRA in the assessment of offsite impacts.

The resulting consequence distances in the TRA are generally consistent with the chlorine cylinder, drum and road tanker release scenarios modelled in the QRA for equivalent hole sizes and release conditions. Minor differences in impact distances reflect updates to the dispersion modelling software (Riskcurves v13 compared to v12) and scenario-specific assumptions, including differences in surface type and maximum pool spreading for releases occurring on road surfaces compared with releases within the enclosed containment building. These differences do not materially change the conclusions of the risk assessment and remain conservative within the context of the overall QRA findings.

Item 98 - In the report, the cumulative individual fatality risk contours for DG transport including future chlorine transport associated with MOD 6 along Denison Street report appears to reach only up to the Corish Circle and Smith Street intersection at the northern-end and not up to the Wentworth Avenue intersection further north. Please extend the scope of the DG TRA to include the entirety of Denison Street up to Wentworth Avenue intersection at the northernend and Beauchamp Road intersection at the southern-end to align with the coverage of DG TRA for the Vopak Bulk Liquids Storage Facility up to MP 06_0089 MOD 2.

The TRA has been updated to extend the scope of assessment along the full length of Denison Street, from the Beauchamp Road intersection at the southern end through to the Wentworth Avenue intersection at the northern end, consistent with the coverage adopted for the Vopak Bulk Liquids Storage Facility (MP 06_0089 MOD 2). Updated individual fatality risk contours are presented in Section 7 of the revised TRA (Appendix C) and associated figures.

In refining the assessment, the updated TRA allocates leak and accident frequencies to intersections rather than distributing them uniformly along Denison Street. This approach reflects observed accident data, which indicates that more than 90% of crashes on Denison Street occur at intersections, with over 60% occurring at the Wentworth Avenue intersection. Chlorine tankers do not utilise the Wentworth Avenue intersection, and as such the revised methodology provides a more realistic representation of transport risk. The updated results do not materially change the overall risk profile or conclusions of the TRA.

Item 99 - 101 - From the report, it is understood that IXOM intends to use existing routes for the transport of chlorine cylinder and drums by flatbed trucks and chlorine bulk tankers. The existing bidirectional route comprises of an internal route within BIP between the IXOM facility to BIP Gate 3 and an external route from BIP Gate 3 entering/exiting Denison Street. The DG TRA is conducted based on this existing route. However, the DG TRA did not investigate alternative routes which may avoid or reduce DG transport risks along Denison Street. For example: a. only using the southern portion between BIP Gate 3 and Beauchamp Road for both trucks and tankers to avoid highly populated areas along Wentworth Avenue; or b. in combination with item C3a above, using a BIP Gate available at the southern-end of Denison Street and closer to the IXOM facility instead of the centrally located BIP Gate 3 to avoid most of Denison Street. The route between the IXOM facility to this southern BIP Gate via Fourth Avenue is also the shortest, most direct internal route within BIP and would avoid future operations along the central and northern portions of BIP.

Given the above, please investigate and report on the feasibility of these alternative routes, including reporting on the consultation with BIP and the future proponents of the formerly operated Qenos and Indorama facilities, especially on the benefits of using the internal Fourth Avenue to avoid undue constraints (e.g. internal traffic) to future operations within BIP.

After investigating the alternative routes in item C3 above and if IXOM still intends to use BIP Gate 3, please provide further justification and verify that the DG transport traffic count assumptions adopted in the DG TRA remains the worst-case scenario up to MOD 6, and that the actual DG transport traffic count in practice including increases associated with MOD 6 remains below the assumptions (i.e. the overall DG TRA remains conservative).

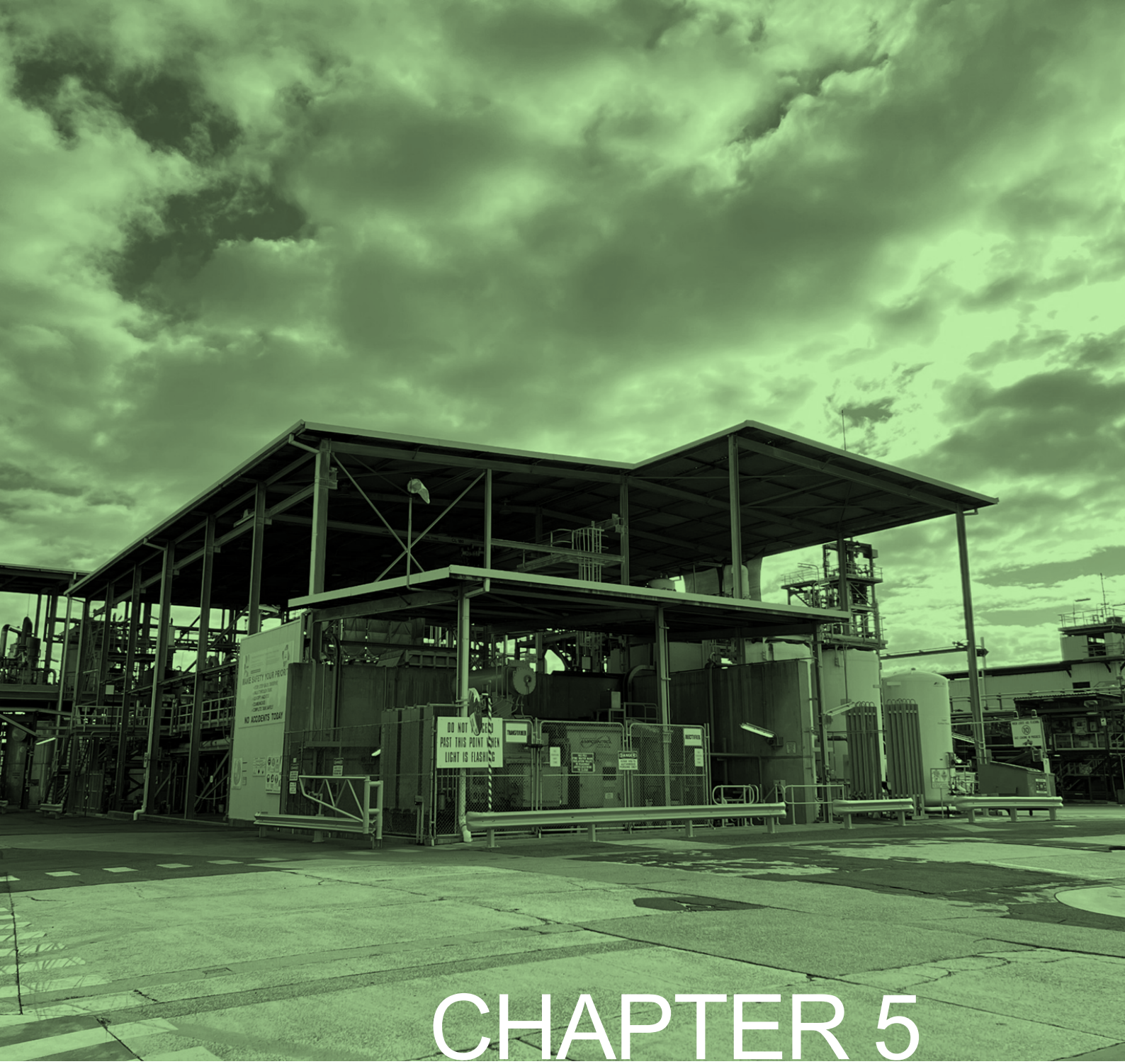
Items 99 – 101 request consideration of alternative transport routes to access and circulate the BIP through the use of alternative BIP gates, and seek confirmation that the TRA is conservative.

As outlined in the Alternate BIP Route and Gate Analysis (Appendix D), a range of alternative internal routes and BIP gate options were investigated, including the use of gates 0, 1, 1.5, 2, 3 and 4. This assessment considered road ownership, load rating, road geometry, intersection safety performance, proximity to residential areas, historical crash data, operational constraints, and the feasibility of required infrastructure upgrades. The assessment found that the alternative routes and gates would either introduce higher safety risk due to increased conflict points and closer proximity to residential areas, or were not practicable due to land ownership constraints, single-lane access, lack of heavy vehicle load rating, and the need for substantial land acquisition / compensation, roadworks, traffic signal modifications, and relocation of critical infrastructure such as weighbridges and security controls.

BIP Gate 3 was identified as the lowest-risk and most practicable option for DG transport associated with the CLP. The gate is purpose-designed for heavy vehicle access, incorporates an existing weighbridge and security controls that reduce vehicle speeds prior to entering Denison Street, and is located opposite industrial and commercial land uses rather than residential properties. Analysis of Transport for NSW crash data indicates no recorded heavy vehicle incidents at the Gate 3 intersection between 2020 and 2024, whereas alternative gate locations would increase exposure at higher-conflict intersections or introduce new heavy vehicle movements closer to residential frontages.

With respect to traffic volumes, the TRA adopts conservative assumptions for chlorine transport associated with MOD 6. The modification results in an average increase of approximately three chlorine truck movements per week, with total heavy vehicle movements remaining well below the approved site limit. The TRA has been updated to confirm that the bases of the assessment includes all chlorine transport up to and including the modification. The TRA confirms that chlorine transport does not materially alter existing individual or societal risk contours along Denison Street and that cumulative transport risk remains dominated by other DG classes, particularly LPG, consistent with previous Scott Lister assessments. On this basis, the DG TRA is conservative and remains valid for the modification, demonstrating compliance with relevant HIPAP No. 4 criteria.

Accordingly, alternative routes and gate options were considered, however their implementation would not reduce overall transport risk and, in several cases, would increase risk or introduce significant practicability constraints. Continued use of BIP Gate 3 and the existing approved transport route therefore represents the safest and most appropriate outcome for DG transport associated with the modification.



CHAPTER 5

RESPONSE TO PUBLIC SUBMISSIONS

5 RESPONSE TO PUBLIC SUBMISSIONS

5.1 Introduction

The public submissions are addressed in this chapter. **Bold** text summarises each key point in the submissions received, while normal text is IXOM's response to submissions.

5.2 Submission 1: Kogarah Bay Progress Association

A submission was lodged by the Kogarah Bay Progress Association (KBPA) objecting to the modification of DA 35/98 for the IXOM CLP within the Botany Industrial Park. The Association raised a consistent set of concerns regarding safety, transport risks and the plant's proximity to residential areas. These concerns were also reflected in individual submissions made separately by several KBPA members through the NSW Major Projects Planning Portal.

5.2.1 KBPA members who submitted individual objections

The following members submitted their own objections in line with the submission by the KBPA, these objections were received by the following members through the NSW Major Projects Planning Portal:

- Name withheld (Beverly Park, NSW)
- Simon Berckelman (Hillsdale, NSW)
- Erin McBean (Hillsdale, NSW)
- Mohammad B. Ghasemian (Hillsdale, NSW)
- Local resident – Grace Campbell Crescent, Hillsdale, NSW
- Yong (Hillsdale, NSW)
- Name withheld (Banksmeadow, NSW)
- Name withheld (Botany, NSW)
- Lynne Salakas (Hillsdale, NSW)
- Aydar Shamsutdinov
- Andrea Jackson

5.2.2 Key issues raised by the association

The association's primary submission outlined the following issues Item 1 – 17:

Inadequate transport risk assessment in the 1998 approval

The association considers the original approval flawed as it did not properly assess chlorine transport risks.

The submission raises concerns regarding the adequacy of the transport risk assessment undertaken as part of the original 1998 approval. IXOM notes that the validity or adequacy of historical approvals is a matter for the Department of Planning, Housing and Infrastructure to consider and determine.

The modification has been prepared and submitted in accordance with the requirements of Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* and the SEARs. The modification is supported by a comprehensive hazard and risk assessment framework, including a quantitative risk assessment and transport risk assessment, prepared in accordance with current DPHI, EPA and SafeWork NSW requirements and hazardous industry guidelines.

These assessments address transport-related risks using up-to-date methodologies and standards, having regard to existing land uses, current traffic conditions and emergency response arrangements. Accordingly, transport risks relevant to the modification have been appropriately identified, quantified and assessed in accordance with current statutory and policy requirements.

Safety risks from daily chlorine transport

Chlorine is described as highly toxic and transported along Denison Street, Wentworth Avenue and Bunnerong Road, which the association believes puts residents, shoppers and road users at risk.

The submission raises concerns regarding the safety of ongoing chlorine transport along Denison Street, Wentworth Avenue and Bunnerong Road, given the hazardous nature of chlorine as a dangerous good. IXOM acknowledges that chlorine transport presents inherent risks and is therefore subject to stringent regulatory controls, approved transport routes and licensing requirements.

In NSW, there are strict regulations governing the transportation of liquid chlorine by road tanker trucks. These regulations are part of broader safety measures to protect people, property, and the environment. The EPA and SafeWork NSW are responsible for overseeing the transport of dangerous goods, including liquid chlorine.

A detailed transport risk assessment for Denison Street was prepared to support the modification in accordance with the SEARs, the NSW HIPAP framework and relevant transport risk guidance. The TRA specifically evaluated the potential impacts of dangerous goods transport associated with the modified facility and compared the results with the findings of the transport risk assessment prepared for the approved Vopak Bulk Liquids Storage Facility (MP 06_0089 MOD 2).

The TRA confirms that the cumulative individual fatality risk contours associated with dangerous goods transport along Denison Street are materially unchanged from those previously assessed and approved. The extent and magnitude of the assessed risk contours remain comparable to those identified in the earlier approved studies and continue to comply with the relevant HIPAP risk criteria. No new or expanded areas of exceedance were identified as a result of the modification.

The assessment also demonstrates that transport risk along Denison Street continues to be dominated by Class 2.1 (liquefied petroleum gas) tanker movements, consistent with the findings of previous studies. Chlorine transport represents a comparatively small contributor to cumulative transport risk, and the increase in chlorine movements associated with MOD 6 does not materially alter the overall risk profile or conclusions of the earlier assessments.

The TRA also confirms that the transport risk associated with chlorine alone, under both current and proposed maximum operating scenarios, meets the applicable HIPAP risk criteria. Even under conservative assumptions, the incremental risk associated with the proposal is negligible when assessed in the context of existing dangerous goods transport along the route.

In addition, chlorine tankers used for transport to and from the site are purpose-designed and constructed to the latest Australian Standards. Safety and protection measures include speed limits of 50 km/h, robust trailer design with underrun protection, recessed and locked valve chests to protect valves and pressure relief devices from impact or tampering, tyre pressure management systems that monitor pressure, temperature and tread depth, GPS tracking, and established emergency response arrangements involving both IXOM and emergency services. In the unlikely event of a leak, tankers are required to return to the site or a suitable containment location in accordance with established emergency procedures.

Unacceptable risks identified in the 2019 assessment

The association notes that a 2019 risk assessment identified unacceptable fatality risks, and that recommended further studies were not undertaken.

The submission refers to a risk assessment undertaken in 2019 which is stated to have identified unacceptable fatality risks and to have recommended further studies. The submission does not specify the particular assessment being referenced, nor does it identify the context, scope or approval pathway under which that assessment was prepared.

Notwithstanding this, the current modification application is supported by a comprehensive and up-to-date suite of technical studies prepared in accordance with regulatory requirements, including a detailed QRA and TRA. These assessments have been undertaken to address the SEARs and have been reviewed against current planning and hazard risk frameworks.

The QRA confirms that the individual and societal risk contours associated with the modification are materially unchanged from those previously approved for the site. The assessed risk levels remain within the relevant HIPAP risk criteria for surrounding residential and sensitive land uses. No new risk exceedances have been identified as a result of the proposed chlorine liquefaction plant.

Similarly, the TRA demonstrates that cumulative transport-related risks along Denison Street are consistent with previously approved assessments and are not materially altered by the modification. The dominant contributors to transport risk remain unchanged, and the incremental risk associated with the proposal is negligible in the context of existing dangerous goods transport.

Where historical assessments may have identified conservative or theoretical risk exceedances, these matters have been comprehensively revisited through the updated assessments prepared for the modification using current data, refined modelling methodologies and conservative assumptions. The outcomes of these studies confirm that the proposal does not result in unacceptable risk to the community and does not introduce materially different hazard outcomes compared to the approved development.

Accordingly, IXOM considers that the concerns raised in relation to earlier or unspecified assessments have been appropriately addressed through the detailed and contemporary risk assessments submitted in support of this modification application.

Absence of buffer zones

It is argued that the facility lacks buffer zones or safeguards comparable to those in place at similar facilities in Victoria.

The submission asserts that the facility lacks appropriate buffer zones or safeguards comparable to those applied to similar facilities elsewhere. IXOM notes that buffer distances are not prescribed as fixed separation distances but are instead assessed through a risk-based framework having regard to surrounding land uses, hazard characteristics and the effectiveness of engineered and operational controls.

The proposed chlorine liquefaction plant is located within the BIP, a long-established and appropriately zoned industrial area. The nearest residential receivers are located approximately 250 metres from the modification, which provides a physical separation distance between the chlorine liquefaction plant and residential areas.

In addition to this physical separation, the modification incorporates significant engineered safeguards that further mitigate potential off-site impacts. The chlorine liquefaction plant will be housed within a purpose-designed containment building equipped with a dedicated chlorine scrubber system. The scrubber will be sized to accommodate all potential chlorine release scenarios within the building, including those associated with the proposed liquefaction plant as

well as all storage and handling activities associated with chlorine containers. This represents a material enhancement to the site's existing risk controls, as chlorine containers are currently stored outside.

The containment building will be maintained under negative pressure, ensuring that any chlorine release within the building is drawn into the scrubber system for neutralisation rather than dispersing to the external environment. This level of engineered containment is a highly effective safeguard and significantly reduces the likelihood of off-site impacts, even in the highly unlikely event of a tank failure.

The adequacy of separation distances and safeguards has been assessed through the QRA, which confirms that individual and societal risk levels remain within the applicable HIPAP criteria for surrounding land uses. Accordingly, the proposal does not rely solely on spatial buffers but instead adopts a layered risk management approach combining land-use separation, engineered containment, active mitigation systems and operational controls.

On this basis, IXOM considers that appropriate buffers and safeguards are in place and that the proposal provides a level of protection that is consistent with regulatory expectations for facilities of this nature.

Opposition to any expansion or modification

The association asserts that the plant should not be expanded or modified, but instead relocated away from nearby residential areas.

The submission asserts that the chlorine liquefaction plant should not be expanded or modified and should instead be relocated away from residential areas. IXOM notes that the proposal does not involve any increase to the approved production capacity at the Botany site, but rather the establishment of a contingency liquefaction capability to support national supply resilience in the unlikely event of disruption at the Laverton facility.

The modification is located within the existing CAP at the Botany Industrial Park, a site that has safely manufactured and handled chlorine for several decades and is appropriately zoned for heavy industrial uses. This option was assessed against a range of alternatives, as outlined in Section 2.5.2 of the Modification report. Alternatives considered included:

- Expanding existing safety stock in Australia;
- Importing chlorine and providing additional major hazard facility storage;
- Construction of a new chlorine packaging plant by an existing Australian producer;
- Establishment of a greenfield site by a new producer; and
- Substitution of chlorine with alternative disinfection methods such as sodium hypochlorite or on-site electro-chlorination.

Following review, the modification was considered the safest, most efficient, and economically viable option. Key considerations include:

- Minimising transport distances and public exposure**:** Co-locating the CLP at Botany reduces chlorine transport requirements when compared with sourcing from Laverton or a new greenfield site.
- Existing infrastructure and operational efficiencies**:** The Botany site already has the necessary raw material feed, utilities, transport access, and industrial zoning to safely accommodate a CLP. Leveraging existing infrastructure minimises capital investment and operating costs compared with constructing a new facility elsewhere.
- Operational safety and resilience**:** Co-location allows immediate access to caustic soda for scrubbing and integration with existing safety systems, maintaining high standards of risk management and ensuring continuity of national chlorine supply in the unlikely event of non-operation at Laverton.

- Supply chain reliability and national benefit: IXOM is the only operator able to reliably meet national demand for packaged and bulk liquefied chlorine. The modification provides a robust contingency solution, avoiding reliance on international imports, which are subject to shipping volatility and delays.
- Leverage of technical and commercial expertise**:** The existing facility allows efficient expansion using IXOM's established technical, operational, and safety capabilities, providing a controlled and low-risk solution.

The proposal has been assessed through comprehensive technical studies, including quantitative risk, transport risk, traffic, air quality and noise assessments, which demonstrate that the modification can be implemented without unacceptable risk to the community or environment. On this basis, IXOM considers that the modification is appropriate for the site.

Request to refuse the modification

The association urges the consent authority to reject the modification in the interest of public safety.

A QRA has been prepared in accordance with the SEARs, including worst-case scenario analysis and cumulative risk considerations. Comprehensive dispersion modelling for potential chlorine releases has been completed as part of the QRA. Appendix H, Section H7 of the QRA includes dispersion distances for all CLP scenarios modelled. This modelling provides a quantitative assessment of on-site and off-site consequences, demonstrating compliance with relevant risk criteria, including individual fatality and societal risk thresholds, and confirming that the modification does not materially increase the potential impact of chlorine releases on surrounding sensitive receivers.

A TRA has also been undertaken to assess chlorine transport within the Bayside LGA in line with relevant guidelines. The TRA demonstrates that the modification does not result in any material increase in risk associated with the transport of chlorine product. The transition from interstate tanker deliveries (Victoria to NSW) to shorter intra-state transport distances reduces the overall transport distance. The TRA focuses on relevant NSW road movements and confirms that risks are low and manageable.

These assessments demonstrate that the modification can be implemented within the existing industrial setting without unacceptable impacts to surrounding land uses, and that the proposal is appropriate to be considered as a modification to the existing approval.

5.3 Submission 2 - Yvonne Stelianidis

Item 18-19: The submission raises concerns that Bayside Council and NSW Planning have not provided the community with adequate reporting on the risks posed by the modification.

The submission strongly opposes the proposal and requests that approval be refused to ensure the community and surrounding facility users are protected from potential toxic gas releases associated with chlorine transport and storage.

It is acknowledged that chlorine production and handling is a hazardous activity and is subject to stringent regulatory controls. However, the proposed chlorine liquefaction plant does not fundamentally alter the form, nature or risk profile of the approved development, nor does it introduce materially different environmental or safety risks.

Chlorine liquefaction is a well-established industrial process that involves the refrigeration of chlorine gas to enable efficient storage and transport. The proposed liquefaction plant does not introduce a new chemical, reaction process or hazard class, but rather a physical phase change

of chlorine that is already produced, handled and stored on the site. Liquefied chlorine is currently stored and dispatched from the site, with the modification changing only the source of liquefaction from offsite to onsite production.

The co-location of the liquefaction plant with the existing CAP provides operational and safety benefits. The site already contains the necessary infrastructure, utilities, and controls to safely manage chlorine, including the ready availability of caustic soda for emergency scrubbing and neutralisation.

A detailed QRA has been undertaken for the modification. The assessment demonstrates that the introduction of onsite liquefaction does not result in a material increase in individual or societal risk and that all relevant hazard criteria are satisfied. In some respects, the risk profile is reduced through the internalisation of storage and handling of chlorine containers within the proposed containment building. The technical risk assessment confirms that the nature, scale and severity of potential hazards are consistent with those already approved and regulated under the existing consent.

Emergency response and incident management procedures will be reviewed and updated, as required, to specifically address the introduction of onsite liquefaction. These updates will ensure that site personnel, emergency services and relevant authorities continue to be supported by robust emergency response arrangements aligned with best practice and regulatory expectations.

On this basis, the modification does not result in materially greater or fundamentally different environmental or safety risks for the surrounding community.

5.4 Submission 3 - Stephen Haigh

Item 20-86: The submission includes a detailed, technical objection to IXOM P/L's application to modify Development Consent DA 35/98 for the Botany chlorine plant and associated chlorine liquefaction and packaging facility.

The submission argues that:

Item 20-26: The original 1998 consent for the Orica replacement chlorine plant was unlawfully approved because SEPP 33 and Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 were not correctly applied in the Environmental Impact Statement, Preliminary Hazard Analysis (PHA) or in the Minister's determination.

The submission raises concerns regarding the adequacy of the transport risk assessment undertaken as part of the original 1998 approval. IXOM notes that the validity or adequacy of historical approvals is a matter for the Department of Planning, Housing and Infrastructure to consider and determine.

The modification has been prepared and submitted in accordance with the requirements of Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* and the SEARs. The modification is supported by a comprehensive hazard and risk assessment framework, including a quantitative risk assessment and transport risk assessment, prepared in accordance with current DPHI, EPA and SafeWork NSW requirements and hazardous industry guidelines.

Item 26-30: In particular, transport risks for chlorine were omitted from the Director-General's Requirements (DGRs) and from the PHA, contrary to SEPP 33 and HIPAP No. 6, meaning cumulative and off-site transport risks along Denison Street, Wentworth Avenue and Bunnerong Road were never properly quantified, and therefore the original application was unlawfully approved.

As above, the validity or adequacy of historical approvals is a matter for the Department of Planning, Housing and Infrastructure to consider and determine. However, A detailed transport

risk assessment was prepared to support the modification in accordance with the SEARs, the NSW HIPAP framework and relevant transport risk guidance. The TRA specifically evaluated the potential impacts of dangerous goods transport associated with the modified facility and compared the results with the findings of the transport risk assessment prepared for the approved Vopak Bulk Liquids Storage Facility (MP 06_0089 MOD 2).

The TRA confirms that the cumulative individual fatality risk contours associated with dangerous goods transport along Denison Street are materially unchanged from those previously assessed and approved. No new or expanded areas of exceedance were identified as a result of the modification.

Item 31-40: For the current IXOM modification, the submission contends that the SEARs issued for the modification are not consistent with SEPP No. 33 and HIPAP No. 6. In particular, it is contended that the SEARs do not clearly require assessment of cumulative hazards and risks associated with the existing chlor-alkali plant, the proposed chlorine liquefaction plant and the transportation of dangerous goods, including chlorine, to and from the site. The submission asserts that, for a modification to an existing potentially hazardous development, cumulative on-site and off-site risks should be assessed against both the qualitative and quantitative criteria in HIPAP No. 4, and that the absence of an explicit requirement to combine fixed facility and transport risks may result in an incomplete assessment of overall risk.

IXOM notes that the preparation and scope of the SEARs is a matter for the Secretary of the Department of Planning, Housing and Infrastructure. Notwithstanding this, the SEARs issued for the modification were comprehensive and required detailed assessment of hazard and risk matters consistent with regulatory practice.

The modification has been supported by a QRA prepared in accordance with HIPAP No. 6. As outlined in Section 2.3 of the QRA, the scope of the hazard analysis includes the proposed CLP and its interaction with the existing CAP and downstream product facilities. The QRA presents both standalone risk results for the CLP and cumulative risk results for the combined facility, with assessment against the quantitative criteria in HIPAP No. 4 provided in Section 8 and the qualitative criteria addressed in Section 9 (Table 9.2).

The submission also raises concerns regarding the consideration of DG transport risks. Chlorine transport risks associated with the modification have been specifically assessed in the Dangerous Goods Transport Risk Assessment (Appendix N of the Modification report), which was prepared in response to the SEARs. This assessment evaluates the potential impacts of chlorine transport to and from the modified facility along Denison Street, consistent with the scope of transport risk assessment undertaken for previous major developments in the precinct.

The SEARs did not require the combination of fixed facility risk and transport risk into a single cumulative assessment, and this approach is consistent with established NSW practice, where fixed facility risks and transport risks are assessed separately using appropriate methodologies. Notwithstanding this, the assessment demonstrates that the contribution of chlorine transport risk associated with the modification is small and does not materially alter the existing risk profile of the area. On this basis, the proposal has been demonstrated to comply with the relevant qualitative and quantitative risk criteria under HIPAP No. 4 and to be consistent with the intent of SEPP No. 33 and HIPAP No. 6.

Item 41-86: The submission refers to findings from a 2018 Arriscar review and a 2019 Quantitative Risk Assessment prepared for the Westfield Eastgardens redevelopment, which assessed dangerous goods transport risks along Denison Street, Wentworth Avenue and Bunnerong Road. The submission highlights individual fatality risk contours, toxic gas dispersion modelling, and recommended building mitigation measures for that redevelopment, and contends that these studies demonstrate extreme transport-related

risk from chlorine and other dangerous goods in the area. It is argued that these risks were not adequately addressed in historical approvals and that similar transport risks should preclude approval of the current modification.

The submission refers to a QRA prepared in 2019 for a separate planning proposal associated with the Westfield Eastgardens redevelopment. That assessment was commissioned to inform site-specific design and mitigation measures for a retail and commercial development and does not form part of the statutory assessment framework for the current modification to the IXOM CLP.

The current modification has been assessed in accordance with the SEARs issued by the Department of Planning, Housing and Infrastructure. Consistent with the SEARs, Dangerous Goods (DG) transport risk associated with the modification has been assessed through a detailed DG TRA, provided as Appendix N to the Modification report. The TRA specifically addresses chlorine transport along Denison Street, consistent with the scope of the referenced Major Project approval MP 06_0089 (Vopak Bulk Liquids Storage Facility).

The detailed matters raised in relation to alternative wind directions, building wake effects, and intersection-specific modelling for Wentworth Avenue and Bunnerong Road arise from risk assessments undertaken for a separate commercial redevelopment and are not relevant to the assessment scope for the current modification. The SEARs for this modification do not require reassessment of transport risk beyond Denison Street, nor retrospective reassessment of unrelated planning proposals.

The TRA and the QRA appropriately addresses cumulative risk within the defined study area and demonstrate that chlorine transport associated with the proposed CLP does not result in any material change to existing risk contours, compliance with HIPAP 4 criteria, or overall cumulative transport risk. The assessments confirm that the dominant contributors to transport risk along Denison Street are Class 2.1 (LPG) tankers, consistent with previous Scott Lister studies, and that chlorine transport represents a relatively small component of the cumulative risk profile. Both the current and proposed chlorine transport scenarios comply with the quantitative and qualitative risk criteria set out in HIPAP No. 4.

It is also noted that delivery of bulk and packaged chlorine from the Botany site is an established operation that has occurred safely for many decades. The modification does not introduce new transport routes and does not require an increase in approved heavy vehicle movements. Average chlorine transport associated with the modification equates to approximately three additional chlorine trucks per week, with total heavy vehicle movements remaining well below the approved daily limit. Accordingly, while the concerns raised in the submission are noted the risks associated with chlorine transport relevant to the modification have been comprehensively assessed within the appropriate statutory scope and are demonstrated to remain acceptable and unchanged in accordance with NSW risk planning criteria.

5.5 Submission 4 – Thomas Buxton

Item 87-88: The submission raises concerns regarding the proximity of the proposed Chlorine Liquefaction Plant (CLP) to surrounding residential areas and community facilities. The submission highlights the hazardous nature of chlorine and expresses concern that a potential leak or accidental release could pose risks to public health, safety, and the environment. It is contended that the location of the plant warrants careful consideration by government due to the perceived potential for widespread community impacts.

The concerns raised regarding the hazardous properties of chlorine and the proximity of surrounding communities are noted. Chlorine is a regulated dangerous good, and its manufacture, storage and transport are subject to stringent planning, safety and environmental controls in New South Wales.

The modification relates to the construction and operation of a CLP within the existing CAP, which has operated as a major chemical manufacturing and storage precinct for several decades. The nearest residential receivers are located approximately 250 metres from the modification, with this separation distance providing an established buffer between the industrial operations and surrounding sensitive land uses.

The modification has been assessed in accordance with the SEARs and is supported by a detailed QRA and TRA. The QRA assesses risks associated with the operation of the CLP within the CAP, while the TRA assesses risks associated with the transport of chlorine to and from the site along Denison Street. These assessments demonstrate that the proposed CLP does not result in any material change to existing off-site risk contours, and that individual and societal risk levels continue to comply with the qualitative and quantitative criteria set out in HIPAP No. 4.

The CLP incorporates robust engineering and operational safeguards, including a fully enclosed containment building and scrubber system designed to accommodate both the proposed liquefaction process and existing outdoor chlorine container storage. These measures represent best-practice risk controls and provide a high level of protection against accidental releases. Accordingly, while the submitter's concerns are acknowledged, the modification has been comprehensively assessed and is demonstrated to be acceptable in terms of public safety and environmental risk.

Item 89-90: The submission raises concerns that residents within the Randwick Council area were not adequately informed or consulted about the proposed modification, despite being located in close proximity to the site. It is argued that the absence of direct engagement with Randwick residents represents a lack of transparency and limits the opportunity for affected communities to understand and comment on a proposal involving hazardous materials.

Consultation for the modification has been undertaken in accordance with the statutory exhibition and notification requirements under the EP&A Act and the SEARs issued by the Department of Planning, Housing and Infrastructure. The consultation approach and outcomes are documented in Sections 5.2.9, 5.2.10 and 5.4.2 of the Modification report.

IXOM has undertaken early and ongoing engagement with the Matraville Precinct Committee (MPC), presenting the project at MPC meetings on 14 April 2025, 12 May 2025 and 11 August 2025. Two community information sessions were also held at the Matraville RSL on 3 and 4 June 2025. These meetings were used to inform residents about the modification, advise of upcoming community information sessions, and outline opportunities to provide feedback during public exhibition via the DPHI Major Projects Portal. The MPC is open to all members of the public, including residents of the Randwick local government area, and Randwick City Councillors were present at these meetings.

In addition, IXOM has implemented a program of direct community notification through letterbox drops to nearby residents and businesses. This included consultation with 670 properties within 500 metres of the site in June 2024, followed by a broader letterbox drop to 2,289 residential properties and 324 businesses in September 2025. These communications provided information on the project, the approval process, upcoming information sessions, and directed the community to the IXOM project website for further information and enquiries.

Accordingly, while the submitter's concerns regarding consultation are acknowledged, engagement for the modification has extended beyond minimum statutory requirements and has included early, targeted and ongoing communication with surrounding communities, including residents within the Randwick Council area, and multiple opportunities for community participation and feedback.

Item 91: The submission objects to the proposed CLP and urges the NSW Government to refuse the modification. The submission cites concerns regarding public safety risks

associated with hazardous materials, alleged inadequacies in community consultation, and the potential for environmental harm. It is argued that these issues render the proposal unsuitable for the local area and that priority should be given to protecting the health and safety of nearby residents.

The request to reject the modification is noted. As outlined in the Modification report, the proposal has been assessed in accordance with the SEARs issued by the Department of Planning, Housing and Infrastructure and the relevant provisions of the EP&A Act. A comprehensive QRA and TRA have been prepared to assess risks associated with the CLP and chlorine transport, and demonstrate compliance with the qualitative and quantitative risk criteria in HIPAP No. 4. These assessments confirm that the modification does not result in any material increase in off-site risk or environmental impact and that existing risk contours remain unchanged.

Community consultation has been undertaken in accordance with statutory requirements and supplemented by early and ongoing engagement with local residents, businesses, precinct committees and councils, as detailed in Sections 5.2 and 5.4 of the Modification report. Environmental impacts, including potential risks to public safety, have been comprehensively assessed in Chapters 7-14 of the Modification report, which determined that the project is unlikely to have significant environmental impacts. On this basis, the modification is considered acceptable within the existing industrial context of the site and consistent with applicable planning and risk management frameworks.

5.6 Submission 5 – Danielle Phair

Item 92-103: The submission expresses strong opposition to the proposed upgrade of the IXOM Chlorine Plant at 16–20 Beauchamp Road, Matraville. The submission raises significant concerns about public health, safety, and a lack of transparent communication with local residents. Each item is reproduced and responded to below.

Item 92: I refer to the Application to NSW Government to upgrade the IXOM Chlorine Plant at 16-20 Beauchamp Road, Matraville, now on exhibition. The proposal is to commence operations to liquefy and package chlorine at 16-20 Beauchamp Road, Matraville. This application has failed to inform residents of the risks the commencement of operations to liquify and package chlorine pose to the densely populated surrounding residents.

Consultation for the modification has been undertaken in accordance with the statutory exhibition and notification requirements under the EP&A Act and the SEARs issued by DPHI, with the consultation approach and outcomes documented in Sections 5.2.9, 5.2.10 and 5.4.2 of the Modification report.

IXOM has undertaken early and ongoing engagement with the Matraville Precinct Committee (MPC), presenting the project at MPC meetings on 14 April 2025, 12 May 2025 and 11 August 2025. Two community information sessions were also held at the Matraville RSL on 3 and 4 June 2025 to explain the proposal, outline potential risks and mitigation measures, and provide opportunities for questions and feedback. The MPC is open to all members of the public, including residents of the Randwick local government area, and Randwick City Councillors were present at these meetings.

In addition, IXOM has implemented multiple rounds of direct community notification through letterbox drops to nearby residents and businesses. This included consultation with 670 properties within 500 metres of the site in June 2024, followed by a broader letterbox drop to 2,289 residential properties and 324 businesses in September 2025 after submission of the Modification report. These communications provided information on the project, the approval process, exhibition timeframes, and directed residents to the IXOM project website for further information. Accordingly, while the submitter’s concerns are noted, consultation for the

modification has extended beyond minimum statutory requirements and has included early, targeted and ongoing engagement with surrounding communities.

Potential risks associated with the CLP and the transport of chlorine have been comprehensively assessed through detailed technical studies, including a quantitative risk assessment and a Dangerous Goods transport risk assessment, prepared in accordance with the SEARs. These assessments demonstrate that the modification does not result in unacceptable risks to surrounding residential areas and complies with relevant NSW risk criteria. Information on these assessments and their findings has been made publicly available through the exhibition of the Modification report and supporting documentation.

Item 93: Chlorine is a highly toxic and reactive chemical. Its production and storage carry significant dangers including the potential for leaks, explosions, and long-term contamination.

IXOM acknowledges the submitter's concerns regarding the hazards associated with chlorine. Chlorine is a toxic gas and a strong oxidising agent; however, it is non-flammable and not inherently explosive. The risks associated with chlorine are well understood and arise primarily under conditions of severe mishandling or contact with incompatible substances. Modern chlorine facilities are conservatively designed to manage these known hazards, incorporating engineered containment systems, bunding, continuous monitoring, automated shutdown systems and established emergency response procedures to minimise the likelihood and consequences of any release.

The proposed CLP has been assessed through a comprehensive QRA and DG TRA, which demonstrate that the facility can be operated in compliance with applicable NSW risk criteria. Chlorine production, storage and distribution facilities, including those owned and operated by IXOM, are subject to strict regulatory oversight and must regularly demonstrate compliance to maintain their operating licences. IXOM has produced, handled and safely distributed chlorine in Australia for over a century. Chlorine remains an essential chemical for public health, particularly for drinking water disinfection, and Australian water utilities rely on a secure and resilient domestic supply to ensure ongoing protection of community health and safety. In this context, the establishment of a second domestic chlorine liquefaction facility has been identified by water authorities and government as an important measure to improve supply resilience and continuity for essential water treatment services.

Item 94 - 95: The threat of accidental exposure to chlorine gas, even in small quantities, can result in severe respiratory damage, skin injuries, and lasting health complications. In the event of a major incident, the consequences could be catastrophic for families living nearby.

The proposal to upgrade the IXOM Chlorine Plant at 16-20 Beauchamp Road, Matraville poses an unacceptable risk to public health, safety, and environmental wellbeing.

The proposed CLP has been subject to a comprehensive QRA and TRA, which evaluated both on-site and off-site risks, including worst-case release scenarios and chlorine transport incidents. The assessments demonstrate that the proposal complies with the quantitative and qualitative risk criteria set out in HIPAP No. 4. Importantly, the assessments confirm that the modification does not result in any material change to existing individual or societal risk contours for the surrounding residential areas.

The modification report and all hazard assessments have been undertaken in close and ongoing consultation with both the DPHI Hazards team and SafeWork NSW, ensuring that the facility design, operational controls and emergency response measures meet current regulatory expectations. Multiple layers of engineered containment, continuous monitoring and emergency management systems are proposed to minimise the likelihood and consequences of any release.

On this basis, the assessed risks to surrounding communities are demonstrated to be low, acceptable and consistent with NSW risk planning criteria.

Item 96-100: Given these risks, I am formally requesting the the NSW Government:

- **Reject the application to commence operations to liquefy and package chlorine at 16-20 Beauchamp Road, Matraville.**
- **Engage independent experts to assess the long-term viability and safety of operating such a plant in close proximity to homes.**
- **Commission independent experts to conduct a full safety and environmental review.**
- **Provide transparent communication to residents regarding current safety protocols, emergency response plans, and monitoring systems.**
- **Explore relocation or repurposing of the facility to eliminate the threat to our community.**

IXOM remains open to addressing any additional requirements that may be determined by the DPHI as part of its assessment of the modification.

The Botany Chlor-Alkali Plant is an established Major Hazard Facility and operates within a highly regulated framework. The facility is subject to ongoing oversight by multiple regulators, including SafeWork NSW, the NSW EPA and Fire and Rescue NSW. As part of this framework, the site is routinely audited by independent third-party environmental auditors in accordance with conditions of the existing development consent and environmental licences. These processes provide for regular external review of operational safety, environmental performance and emergency management arrangements. These independent environmental audits will continue to occur on an ongoing basis and will include any new or modified conditions in relation to the operation of the CLP.

IXOM has also undertaken extensive and ongoing community consultation in relation to the modification, extending beyond minimum statutory requirements. This has included engagement with the Matraville Precinct Committee, multiple community information sessions, direct letterbox notification to surrounding residents and businesses, and provision of accessible project information through the IXOM project website. These activities were undertaken to inform the community of the proposal, outline safety and environmental controls, and provide opportunities for questions and feedback.

In relation to relocation or alternative options, a range of alternatives were considered which included expanding existing safety stock, importing chlorine with additional major hazard storage, construction of new or greenfield facilities, and substitution with alternative disinfection technologies. Following assessment, the modification within the existing Chlor-Alkali Plant at Botany was identified as the preferred option as it leverages existing industrial infrastructure and safety systems, and co-locates the chlorine liquefaction plant with the production of key materials required for its safe operation, including caustic soda used for scrubbing and neutralisation of chlorine. This integration enhances operational safety and efficiency and avoids the additional risks associated with establishing a new standalone facility.

Overall, the modification represents a controlled and well-regulated use of an existing industrial site, supported by established safety systems, regulatory oversight and ongoing community engagement.

Item 101 - 103: The proposed operation of this chlorine plant so close to residential homes is not only dangerous it is unjustifiable.

The application to upgrade the IXOM Chlorine Plant at 16-20 Beauchamp Road, Matraville has been dressed up to hoodwink local residents. I attach a copy of the letter circulated to residents regarding the application designed to placate and deceive residents into failing to identify the clear danger of the proposed application.

I have and will continue to approach other residents to make them aware of the danger this proposal poses to our health and safety, and to voice their concerns and opposition to the application.

Comprehensive risk assessment undertaken for the modification demonstrates that the operation of the chlorine liquefaction plant does not result in any material increase in off-site risk when compared with the existing approved operations. The quantitative and qualitative risk assessments confirm that individual and societal risk levels remain within the relevant NSW risk criteria, and that the existing risk contours are unchanged. Accordingly, while community concern is understood, the modification is supported by detailed technical assessment and regulatory oversight demonstrating that the proposal does not introduce new or increased risk to nearby residential areas and is consistent with long-established industrial operations at the site

5.7 Submission 6 – Name Withheld (Matraville NSW)

Item 104-121: The submission opposes the modification application due to concerns about direct health and safety risks, increased tanker traffic, and perceived inadequate safety transparency. Each item is reproduced and responded to below.

Item 104: Any accidental release of chlorine would place us in immediate danger. We already experience odour and traffic impacts from nearby industrial facilities; adding liquefaction and tanker movements would increase both risk and day-to-day burden on local residents.

Detailed risk and transport assessments demonstrate that the modification does not result in any material increase in risk, odour or traffic impacts to surrounding residential areas, with risk levels remaining within relevant NSW criteria and traffic volumes remaining within approved limits. The assessments confirm that the proposal can operate safely within the existing industrial setting without increasing impacts on nearby residents.

Items 105-110 – Grounds for Objection

Item 105: I object to the MOD-6 chlorine liquefaction and packaging proposal unless major gaps in safety, transparency, and emergency planning are resolved. My concerns are:

Concerns have been addressed in items 106-110 below.

Item 106: Safety Case Transparency – The full Major Hazard Facility (MHF) safety case must be published, including worst-case chlorine release scenarios at 1 ppm (detectable), 10 ppm (IDLH), and 100+ ppm concentrations, with modelling specific to Jennings Street and local weather conditions.

The IXOM Botany site operates as a licensed Major Hazard Facility (MHF) and is regulated by SafeWork NSW. The existing Safety Case will be updated to incorporate the modification, however this documentation contains sensitive security, infrastructure and personnel information and, consistent with NSW MHF regulatory requirements, is not published in full for public release. However, a summary of IXOM Botany's safety case including information regarding safety protocols, emergency response plans and monitoring systems is available to the general public.

The potential consequences of chlorine release scenarios have nonetheless been comprehensively assessed through the QRA, prepared in accordance with HIPAP No. 6 in close consultation with DPHI and SafeWork NSW. Dispersion modelling for chlorine is provided in Appendix H of the QRA and includes concentration endpoints relevant to health effects (including 2.8 ppm and higher), under a range of representative meteorological conditions. Concentrations below 1 ppm represent odour detection only and are not associated with injury thresholds and are therefore not adopted as risk assessment endpoints under NSW hazard planning guidance.

The modelling demonstrates that, for both individual and cumulative risk scenarios, the modification complies with the quantitative criteria in HIPAP No. 4, with no material change to existing off-site risk contours. These results are applicable to nearby residential areas and confirm that the modification does not introduce unacceptable risk to surrounding communities.

Item 107: Emergency Notification & PIRMP – Residents need clear, tested systems for immediate alerts (sirens, SMS, door-knocks). IXOM's Pollution Incident Response Management Plan (PIRMP) should be released publicly and tested with the community.

IXOM Botany operates under an approved Pollution Incident Response Management Plan (PIRMP) in accordance with the requirements of the *Protection of the Environment Operations Act 1997*. The PIRMP is regularly reviewed, maintained and audited by the EPA to ensure it remains current and effective, and will be updated as necessary to incorporate the modification.

A public version of the PIRMP is available on the IXOM website and provides information on incident notification, emergency response arrangements and coordination with relevant authorities. The full internal PIRMP is not publicly released as it contains sensitive operational and personal information, including employee contact details and security-related information, which is not appropriate for public disclosure.

Item 108: Transport Risks – Liquefaction will increase tanker and cylinder transport. Routes, frequency, vehicle safety measures, and restrictions on residential road use must be disclosed and independently reviewed.

Transport of chlorine associated with the modification will continue to occur via existing, approved Dangerous Goods (DG) routes that are designated and regulated for the safe transport of hazardous materials. The modification does not introduce new transport routes or changes to the approved access arrangements to and from the Botany Industrial Park.

The frequency of chlorine transport associated with the modification is low and vehicle movements will continue to be managed in accordance with applicable DG transport legislation, including requirements for vehicle design, driver licensing and training, route selection, speed restrictions, and emergency response preparedness.

Transport safety has been assessed as part of the DG Transport Risk Assessment prepared in accordance with the SEARs. That assessment demonstrates that the modification does not result in a material increase in transport risk and that chlorine transport remains a minor contributor to cumulative DG risk along the approved routes.

Item 109: Cumulative Impacts – Matraville is a growing residential community with existing industrial emissions. This proposal must be assessed for cumulative risks and impacts alongside other facilities.

Cumulative impacts have been considered as part of the assessment for the modification. The quantitative risk and environmental assessments account for existing industrial activities within the Botany Industrial Park and assess the proposed chlorine liquefaction plant in combination with the existing chlor-alkali operations.

It is also noted that a number of major industrial operations within the Botany Industrial Park, including Qenos and Indorama, have ceased operations. These closures have resulted in a reduction in the overall risk profile within the precinct.

Overall, the assessments demonstrate that the modification does not result in a meaningful change to cumulative risk or amenity impacts for surrounding residential areas and remains consistent with applicable NSW risk and environmental criteria.

Item 110: Legacy Contamination Context – The Botany site has a history of contamination and remediation. IXOM should explain how liquefaction interacts with past and ongoing remediation work.

The history of contamination and remediation at the Botany Industrial Park has been considered as part of the assessment for the modification. A Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) have been completed for the site, together with a Remedial Action Plan (RAP), to assess site conditions and ensure the land is suitable for the proposed use.

The proposed chlorine liquefaction plant does not involve disturbance of previously remediated areas in a manner that would compromise remediation outcomes, nor does it introduce new contamination pathways. Operation of the facility is contained within existing industrial areas and infrastructure.

Interim Site Audit Advice has been provided by an independent EPA-accredited Site Auditor (Appendix F) confirming the suitability of the RAP to make the site suitable for the modification and its consistency with relevant remediation and contamination management requirements.

Item 111 – 115 – specific questions needing answer

Item 111: What is the maximum credible release volume, and what distances would be affected under different weather conditions?

The maximum credible release scenarios for the CLP, including release rates, inventories, process conditions and resulting impact distances under a range of meteorological conditions, are documented in Appendix H of the QRA. This appendix presents modelling for all relevant credible scenarios and reports impact distances to established risk and health-based endpoints in accordance with NSW risk assessment guidance. These results demonstrate that impacts remain within acceptable planning criteria.

Item 112: What safety instrumented systems (SIS) exist, what integrity (SIL) levels do they meet, and how are they tested?

The CLP will incorporate safety instrumented systems forming part of the overall process control and protection framework, including automatic trips for conditions such as high pressure, high levels and other abnormal operating parameters. The required safety integrity levels will be determined during detailed design through a formal SIL allocation study. Testing and verification of these systems will be undertaken periodically in accordance with the SIL verification study and existing CAP practices, including full functional testing of the complete trip loop at defined intervals.

Item 113: How quickly would Jennings Street residents be notified of a chlorine release, and by what method?

Comprehensive emergency response arrangements are in place for IXOM's Botany Facility to manage any incident with potential on-site or off-site impacts. In accordance with Part 5.7A of the *Protection of the Environment Operations Act 1997*, IXOM has prepared and maintains a Pollution Incident Response Management Plan (PIRMP), which sets out notification procedures, roles and responsibilities, and mechanisms for timely communication with relevant authorities and the community. A public version of the PIRMP is available on the IXOM Botany webpage at https://www.ixom.com/locations/botany.

The QRA demonstrates that the toxic irritant contour does not extend beyond Denison Street and only marginally crosses Beauchamp Road. The nearest residence on Jennings Street is approximately 550 metres beyond the toxic irritant contour, meaning Jennings Street is around three times further away than the maximum extent of irritation-level impacts. Accordingly, it is extremely unlikely that residents of Jennings Street would be affected by, or require notification for, a chlorine release. In the highly unlikely event of a large-scale incident, IXOM would work

closely with emergency services to notify any residents identified as being at risk as quickly as practicable, using established emergency notification channels.

Item 114: How many tanker movements per week are planned, and which roads will be used?

Under the normal operating scenario associated with the modification, truck movements would increase by approximately six movements per week. As such, heavy vehicle movements generated by the modification can be accommodated within the approved maximum daily heavy vehicle movements established under the original consent.

Under the contingent operating scenario, additional movements would comprise:

- the six movements per week associated with normal operations;
- approximately 31 additional bulk movements per year; and
- up to six movements per week associated with container transport to the Laverton facility.

As discussed in Section 8.3.3 of the modification report, all chlorine transport drivers will continue to follow specific dangerous goods routes when delivering liquefied chlorine from the BIP to the following major customers:

BIP to Prospect water filtration plant:

- Depart BIP right onto Denison Street
- Right onto Beauchamp St
- Right onto Botany Rd/ turns into Foreshore Rd
- Right onto General Holmes Dr/ Joyce Dr/ Qantas Dr/ Marsh St
- Left onto West Botany St
- Right onto Bay St/ The Seven Ways/ Frederick St
- Left onto Watkin St
- Right onto Harrow Rd- Straight onto Bexley Rd
- Left onto M5 Motorway (East)
- Left onto M7 Motorway (Northbound)
- Take The Horsley Dr Horsley Park/ Wetherill Park Exit
- Right onto The Horsley Drive
- Left onto Cowpasture Rd North
- Take first exit at round about staying on Cowpasture Rd
- Take second exit at round about heading straight staying on Cowpasture Rd
- Take first exit at round about onto Cowpasture Rd
- Take third exit at round about heading straight staying on Cowpasture Rd
- Site access at end of street drive straight into site

BIP to Warragamba Dam:

- Depart BIP Right onto Denison St
- Right onto Beauchamp St
- Right onto Botany Rd/ turns into Foreshore Rd
- Right onto General Holmes Dr/ Joyce Dr/ Qantas Dr/ Marsh St
- Left onto West Botany St
- Right onto Bay St/ The Seven Ways/ Frederick St
- Left onto Watkin St
- Right onto Harrow Rd- Straight onto Bexley Rd
- Left onto M5 Motorway (East)
- Take Beech Rd Exit
- Left onto Beech Rd
- Right onto Camden Valley Way
- Straight onto Bringelly Rd

- Right onto The Northern Rd
- Left onto Willmington Rd
- Left onto Park Rd
- Left onto Silverdale Rd
- Turn Right at Warragamba Pipeline Chlorination Plant (opp. 2480 Silverdale Rd)

Item 115: Will real-time chlorine monitoring data at the site boundary be made publicly available?

The Botany site is an existing Major Hazard Facility and is subject to a high level of regulatory oversight, including strict monitoring and reporting requirements under its EPA Environment Protection Licence and Major Hazard Facility obligations. IXOM monitors for chlorine and other gases throughout the plant. These monitoring systems are alarmed, with trained operators available to immediately investigate alarms, validate readings and take appropriate action, ranging from rectifying a minor leak through to activating the site's Emergency Response Plan and engaging emergency services where necessary. Any substantive release is immediately reported to the EPA and the NSW Major Hazard Facility regulator in accordance with licence conditions.

Real-time chlorine monitoring data is not made publicly available. However, as above, any substantial release is reported to the EPA, with any notifiable incident or regulatory action recorded by the EPA and made public via the EPA's public registers. In addition, IXOM reports monitoring and environmental performance data through established statutory processes, including monthly EPL reporting, which is publicly available on the IXOM Botany webpage, as well as annual reporting under CER and NGER frameworks.

Item 116-120 – Requested conditions: If the project is to be considered, I request that at minimum the following conditions be imposed:

• Independent Peer Review: An external expert review of the safety case, dispersion modelling, and emergency systems must be completed and published.

As a Major Hazard Facility IXOM's safety, Emergency Response and monitoring systems are analysed and reviewed on a regular basis by the SafeWork NSW Major Hazard Unit as well as Fire and Rescue NSW and the NSW Police force. A summary of IXOM Botany's safety case including information regarding our safety protocols, emergency response plans and monitoring systems is available to the general public. The complete safety case cannot be released to the general public as it contains IXOM employees personal contact details as well as other information that my present a security risk should it be made available to the general public.

• Community Notification: A dual system of sirens and SMS alerts must be installed and tested with Jennings Street residents prior to operations.

An SMS Notification system for community members is possible and can be considered through an external service provider.

• Transport Restrictions: Chlorine tankers must be restricted from using Jennings Street and other residential roads, especially near schools and shops.

No truck movements are proposed on Jennings Street as part of the modification.

• Transparency: Real-time chlorine monitoring results at the site boundary must be publicly available online.

This approach is unlikely to be practical, as alarms from such monitors are typically triggered by equipment faults and could cause unnecessary public concern. Further, any gas release would be immediately detected by the gas detectors within the chlorine liquefaction building, automatically triggering a comprehensive safety system including a scrubbing system to manage

any potential emissions from within the building as well as initiate the site's emergency response protocol to ensure the operators as well as the surrounding community are kept safe. The safety system can also be manually activated by operators within the building or remotely from the control room.

• Public Hearing: A public meeting/hearing must be held before determination, with IXOM, EPA, and SafeWork NSW required to answer community questions directly.

IXOM has undertaken early and ongoing engagement with the Matraville Precinct Committee (MPC), presenting the project at MPC meetings on 14 April 2025, 12 May 2025 and 11 August 2025. Two community information sessions were also held at the Matraville RSL on 3 and 4 June 2025. These meetings were used to inform residents about the modification, advise of upcoming community information sessions, and outline opportunities to provide feedback during public exhibition via the DPHI Major Projects Portal. The MPC is open to all members of the public, including residents of the Randwick local government area, and Randwick City Councillors were present at these meetings.

In addition, IXOM has implemented a program of direct community notification through letterbox drops to nearby residents and businesses. This included consultation with 670 properties within 500 metres of the site in June 2024, followed by a broader letterbox drop to 2,289 residential properties and 324 businesses in September 2025. These communications provided information on the project, the approval process, upcoming information sessions, and directed the community to the IXOM project website for further information and enquiries.

We encourage any members of the public with any residual concerns to contact DPHI.

Item 121: Until the above information is provided and the conditions are guaranteed, I strongly object to the approval of MOD-6. This is a matter of community safety, environmental protection, and public trust.

Noted. We trust the information provided in this RTS report has provided sufficient confidence that all matters related to community safety, environmental protection and public trust have been considered comprehensively in the preparation of the modification report.

5.8 Submission 7 – Robert Driscoll

Item 122-131: The submission expresses concerns about the reinstatement of chlorine extraction and the modification at the IXOM Botany site. While acknowledging that the plant existed before nearby residential development, it stresses that suburban encroachment has increased the importance of understanding the physical dangers associated with chlorine handling and transport. The submission was also issued directly to IXOM and a response was provided, as summarised below. Each item is reproduced in full and responded to below.

Item 122: I have some concerns with the proposal for the reinstatement of chlorine extraction at the IXOM Botany Site. I have sent these concerns to the IXOM contact directly and was told someone from the project team will get back to me shortly. I understand that they are very busy and have not had time to get back to me yet.

IXOM received your concerns via email on 17 September 2025 and responded on 23 September 2025. IXOM's response has been included in addressing items 125 – 131.

Item 123: I am also aware that the plant preceded suburban development. However suburbia has now encroached on the site to the extent that awareness of the physical dangers is important.

Noted, IXOM has assessed the modification in respect to existing surrounding residential land use. The modification has been subject to a comprehensive QRA and TRA, which evaluated both on-site and off-site risks, including worst-case release scenarios and chlorine transport incidents. The assessments demonstrate that the proposal complies with the quantitative and qualitative risk criteria set out in HIPAP No. 4. Importantly, the assessments confirm that the modification does not result in any material change to existing individual or societal risk contours for the surrounding residential areas.

Item 124: Below I have copied my email to the IXOM team. Here in summary are my concerns:

There was a reason for closing the chlorine liquefaction plant in the past. How have these concerns been addressed?

Their report was not clear in what form chlorine was to be transported out of the plant. Is it in the form of sodium hypochlorite (NaOCl), or would liquefied chlorine (pure dried Cl2) ever be transported? Apparently most chlorine accidents happen when pressure vessels (on road or rail transport) are punctured. When this happens, the chlorine evaporates, but being heavier than air, stays close to the ground. This would result in deaths, severe respiratory casualties and metal corrosion (allowed level for humans is 1 ppm over 8 hours).

I am concerned about the emergency chlorine vent and its use during production accidents. Would chlorine gas ever be vented, and how would this be managed?

The earlier cessation of chlorine liquefaction at Botany approximately 25 years ago was driven by commercial considerations rather than safety concerns. At that time, both the Botany and Laverton Chlor-Alkali Plants were undergoing major technology upgrades, and market demand could be met from Laverton alone. The long-term business strategy always contemplated re-introducing liquefaction at Botany when market conditions required it. The current proposal reflects that anticipated need and is supported by contemporary design standards, modern safeguards and current regulatory requirements.

Chlorine products are already transported from the site in multiple forms, including sodium hypochlorite and liquefied chlorine (pure, dried Cl_2) in cylinders, drums and purpose-built road tankers. Liquefied chlorine transport is an established activity at the site and will continue following completion of the proposal, with a minor increase in tanker movements using a dedicated, highly engineered fleet that complies with the ADG Code and incorporates multiple impact-protection, monitoring and control systems. The hazards associated with chlorine transport are well understood and tightly regulated, and the assessed risks remain acceptable and unchanged in accordance with NSW risk criteria as determined by the TRA.

Emergency scenarios have been comprehensively addressed through the site's long-standing emergency response framework. The Botany chlorine plant has operated safely since 1956 with no recorded offsite community impacts from chlorine releases. In the unlikely event of a chlorine release within the liquefaction building, fixed chlorine detectors activate isolation and ventilation systems that direct contaminated air to a dedicated scrubber. The scrubber neutralises chlorine using caustic soda, preventing uncontrolled discharge to the environment. These systems, together with established emergency response plans developed and exercised with local emergency services, ensure that potential incidents are effectively managed and community safety is maintained.

Item 125-131: Concerning the proposal to modify the plant, I have a few questions that I couldn't easily find answers to. This is partly because I am not sure whether the term 'chlorine' in the plant upgrade documentation refers to liquefied Cl2 or sodium hypochlorite (NaOCl):

See responses to items 126 – 131 below.

Q1. In what form is liquefied chlorine to be stored (as pure liquefied Cl2 or as NaOCl or both).

The chlorine liquefaction project involves the storage and handling of liquefied chlorine gas. Sodium hypochlorite (NaOCl) is already produced on-site and is handled separately as a liquid solution.

Q2. What does the emergency chlorine vent release? Can it release chlorine gas to the environment (I'm a nearby resident)? Has this ever happened before? What safety measures protect us from gas release?

IXOM's Matraville chlorine plant has operated safely in the community since 1956 and adheres to strict standards and is highly regulated. All activity at site is in line with licence conditions. There has been no recorded incidents of chlorine gas release from this site that has impacted the surrounding community. Furthermore, IXOM has safely manufactured and distributed chlorine in Australia for over 100 years and has never had a chlorine incident at a manufacturing site that has impacted the community.

IXOM's chlorine plant in Matraville has a documented emergency response plan which includes emergency response protocols. These protocols are reviewed and approved by the local emergency service organisation and IXOM rehearse these protocols regularly and often involve the emergency services in these exercises.

In the unlikely event that a chlorine release is detected within the liquefaction building by the chlorine detectors, chlorine vent scrubbing isolation valves near the release point will open, and the scrubber fan will evacuate and direct the building air (including chlorine) through to the liquefaction building scrubber. The scrubbing system is designed to treat and neutralise the chlorine using caustic soda and prevent any uncontrolled release of chlorine gas into the environment.

Q3. Is liquefied chlorine gas to be sent by rail, or is NaOCl only transported?

Liquefied chlorine gas will be transported by road as is currently the case with sodium hypochlorite.

Q4. Is liquefied chlorine gas to be sent by tanker (road transport), or is NaOCl only transported?

Liquefied chlorine gas is currently transported in 920 kg drums, 70 kg cylinders and occasionally 13 tonne road purpose-built tankers. Once the proposed development is completed the number of road tanker movements will increase to 8 movements in and out of the site per week (4 extra tankers). These tankers are part of a dedicated fleet designed and built to stringent safety standards. Sodium hypochlorite is also transported by road in separate tankers. Volumes of this product are not impacted by the proposed development.

Q5. Historically incidents of gas release happen when pressurized vessels are ruptured accidentally. What prevents this happening at the plant, and what mitigates this if it does happen?

- Storage tanks are designed and built to stringent pressure vessel design standards and codes.
- Storage tanks are fitted with pressure relief valves and rupture discs.
- Because the liquid is cooled it remains at low pressures.
- Storage tanks are located with a concrete bund.
- Regular inspections and maintenance.
- Chlorine is stored at low temperature and atmospheric pressure.
- Emergency shutdown systems and operator training.

- One storage tank will be in-service and the other kept empty and on standby in case of an unlikely failure.

In the unlikely event of a rupture of the chlorine storage tank, as much liquid as possible will be transferred to the standby tank and any liquid chlorine that is released will drain into the bund. As the liquid chlorine warms it will turn into gas. As these tanks are housed inside the containment building, the gas will be contained withing the sealed building. The gas release will be detected by the gas detectors withing the building which will automatically trigger a comprehensive safety system including a scrubbing system to manage any potential emissions from within the building as well as initiating the site's emergency response protocol to ensure the operators as well as the surrounding community are kept safe. The safety system can also be manually activated by operators within the building or remotely from the control room.

Q6. In the compressed chlorine cooling stage, what is used as the cooling liquid? Do I need to be concerned about this as well? (for example, is water (brine), ammonia or liq nitrogen used?)

The chlorine cooling process utilises liquid CO2 supplied by the refrigeration unit to cool the chlorine. The refrigeration unit has closed cooling circuits. Incoming cooling water cools the glycol circuit which cools the ammonia circuit which cools the CO2 liquid circuit which cools the chlorine in the chlorine liquefier. Only a minor quantity of ammonia is handled in the closed-circuit within the refrigeration system.

5.9 Submission 8 – Maria Poulos (NOPE) residents' group (Maroubra NSW)

Item 132-139: The submission, representing the No Overdevelopment Pagewood and Eastgardens (NOPE) residents' group, strongly opposes the modification to the IXOM chlorine facility. The submission argues that the facility's chlorine production, storage and transport pose unacceptable risks to the surrounding community, particularly given the growing residential population and major activity centres nearby. Each item is reproduced in full and responded to below.

Item 132: This facility poses unacceptable risks to the surrounding community because of its production, storage and transport of toxic chlorine gas. The original approval granted in 1998 was flawed and did not properly assess transport risks, leaving residents, workers and shoppers exposed for more than two decades.

The submission raises concerns regarding the adequacy of the transport risk assessment undertaken as part of the original 1998 approval. IXOM notes that the validity or adequacy of historical approvals is a matter for the Department of Planning, Housing and Infrastructure to consider and determine.

The modification has been prepared and submitted in accordance with the requirements of Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* and the SEARs. The modification is supported by a comprehensive hazard and risk assessment framework, including a quantitative risk assessment and transport risk assessment, prepared in accordance with current DPHI, EPA and SafeWork NSW requirements and hazardous industry guidelines.

Item 133: The modification now sought should not be approved. In the public interest, the NSW Government should instead consider options to relocate the chlorine facility away from residential areas, schools and major shopping centres.

The submission asserts that the chlorine liquefaction plant should not be expanded or modified and should instead be relocated away from residential areas. IXOM notes that the proposal does not involve any increase to the approved chlorine storage or production capacity at the Botany

site, but rather the establishment of a contingency liquefaction capability to support national supply resilience in the unlikely event of disruption at the Laverton facility.

The modification is located within the existing CAP at the Botany Industrial Park, a site that has safely manufactured and handled chlorine for several decades and is appropriately zoned for heavy industrial uses. This option was assessed against a range of alternatives, as outlined in Section 2.5.2 of the Modification report. Alternatives considered included:

- Expanding existing safety stock in Australia;
- Importing chlorine and providing additional major hazard facility storage;
- Construction of a new chlorine packaging plant by an existing Australian producer;
- Establishment of a greenfield site by a new producer; and
- Substitution of chlorine with alternative disinfection methods such as sodium hypochlorite or on-site electro-chlorination.

Following review, the modification was considered the safest, most efficient, and economically viable option. Key considerations include:

- Minimising transport distances and public exposure: Co-locating the CLP at Botany reduces chlorine transport requirements when compared with sourcing from Laverton or a new greenfield site.
- Existing infrastructure and operational efficiencies: The Botany site already has the necessary raw material feed, utilities, transport access, and industrial zoning to safely accommodate a CLP. Leveraging existing infrastructure minimises capital investment and operating costs compared with constructing a new facility elsewhere.
- Operational safety and resilience: Co-location allows immediate access to caustic soda for scrubbing and integration with existing safety systems, maintaining high standards of risk management and ensuring continuity of national chlorine supply in the unlikely event of non-operation at Laverton.
- Supply chain reliability and national benefit: IXOM is the only operator able to reliably meet national demand for packaged and bulk liquefied chlorine. The modification provides a robust contingency solution, avoiding reliance on international imports, which are subject to shipping volatility and delays.
- Leverage of technical and commercial expertise: The existing facility allows efficient expansion using IXOM's established technical, operational, and safety capabilities, providing a controlled and low-risk solution.

The proposal has been assessed through comprehensive technical studies, including quantitative risk, transport risk, traffic, air quality and noise assessments, which demonstrate that the modification can be implemented without unacceptable risk to the community or environment. On this basis, IXOM considers that the modification is appropriate for the site.

Item 134: Original Approval was Unlawful and Incomplete. • In 1998, Orica (the former operator) received consent for a replacement chlorine plant. • Required safety assessments — including a full Preliminary Hazard Analysis and transport risk study — were not carried out in line with SEPP 33 and HIPAP No 6. • This means the risks associated with transporting chlorine through Denison Street, Wentworth Avenue and Bunnerong Road were never properly considered.

As mentioned in our response to Item 132, the validity or adequacy of historical approvals is a matter for the Department of Planning, Housing and Infrastructure to consider and determine.

The modification is supported by a comprehensive hazard and risk assessment framework, including a quantitative risk assessment and transport risk assessment, prepared in accordance with current DPHI, EPA and SafeWork NSW requirements and hazardous industry guidelines.

These assessments address transport-related risks using up-to-date methodologies and standards, having regard to existing land uses, current traffic conditions and emergency response arrangements. Accordingly, transport risks relevant to the modification have been appropriately identified, quantified and assessed in accordance with current statutory and policy requirements.

Item 135: Evidence of Unacceptable Risk: • Independent risk assessments (e.g. the 2015 Scott Lister QRA and 2019 Westfield Eastgardens QRA) have since shown that residents and shoppers are exposed to unacceptable fatality risks from chlorine transport accidents. • Expert reviewers (Arriscar) recommended further studies, particularly around building wake effects and taller developments, but these have never been undertaken. • Safety measures proposed for shopping centres (sealed walls, HVAC pressurisation) do nothing to protect residents living along Wentworth Avenue and Bunnerong Road, who remain highly vulnerable.

The submission refers to a QRA prepared in 2019 for a separate planning proposal associated with the Westfield Eastgardens redevelopment. That assessment was commissioned to inform site-specific design and mitigation measures for a retail and commercial development and does not form part of the statutory assessment framework for the current modification to the IXOM CLP.

The detailed matters raised in relation to alternative wind directions, building wake effects, and intersection-specific modelling for Wentworth Avenue and Bunnerong Road arise from risk assessments undertaken for a separate commercial redevelopment and are not relevant to the assessment scope for the current modification. The SEARs for this modification do not require reassessment of transport risk beyond Denison Street, nor retrospective reassessment of unrelated planning proposals.

The TRA and the QRA appropriately addresses cumulative risk within the defined study area and demonstrate that chlorine transport associated with the proposed CLP does not result in any material change to existing risk contours, compliance with HIPAP 4 criteria, or overall cumulative transport risk. The assessments confirm that the dominant contributors to transport risk along Denison Street are Class 2.1 (LPG) tankers, consistent with previous Scott Lister studies, and that chlorine transport represents a relatively small component of the cumulative risk profile. Both the current and proposed chlorine transport scenarios comply with the quantitative and qualitative risk criteria set out in HIPAP No. 4.

It is also noted that delivery of bulk and packaged chlorine from the Botany site is an established operation that has occurred safely for many decades. The modification does not introduce new transport routes and does not require an increase in approved heavy vehicle movements. Average chlorine transport associated with the modification equates to approximately three additional chlorine trucks per week, with total heavy vehicle movements remaining well below the approved daily limit. Accordingly, while the concerns raised in the submission are noted, the risks associated with chlorine transport relevant to the modification have been comprehensively assessed within the appropriate statutory scope and are demonstrated to remain acceptable and unchanged in accordance with NSW risk planning criteria.

Item 136: Inconsistent with Best Practice: • Chlorine facilities in other states, such as Laverton, Victoria, operate under strict buffer zones to keep residents at a safe distance.• No such protections exist in Botany, despite the much higher population density around the plant.

The submission asserts that the facility lacks appropriate buffer zones or safeguards comparable to those applied to similar facilities elsewhere. IXOM notes that buffer distances are not prescribed as fixed separation distances but are instead assessed through a risk-based framework having regard to surrounding land uses, hazard characteristics and the effectiveness of engineered and operational controls.

The proposed chlorine liquefaction plant is located within the BIP, a long-established and appropriately zoned industrial area. The nearest residential receivers are located approximately 250 metres from the modification, which provides a physical separation distance between the chlorine liquefaction plant and residential areas.

In addition to this physical separation, the modification incorporates significant engineered safeguards that further mitigate potential off-site impacts. The chlorine liquefaction plant will be housed within a purpose-designed containment building equipped with a dedicated chlorine scrubber system. The scrubber will be sized to accommodate all potential chlorine release scenarios within the building, including those associated with the proposed liquefaction plant as well as all storage and handling activities associated with chlorine containers. This represents a material enhancement to the site's existing risk controls, as chlorine containers are currently stored outside.

The containment building will be maintained under negative pressure, ensuring that any chlorine release within the building is drawn into the scrubber system for neutralisation rather than dispersing to the external environment. This level of engineered containment is a highly effective safeguard and significantly reduces the likelihood of off-site impacts, even in the highly unlikely event of a tank failure.

The adequacy of separation distances and safeguards has been assessed through the QRA, which confirms that individual and societal risk levels remain within the applicable HIPAP criteria for surrounding land uses. Accordingly, the proposal does not rely solely on spatial buffers, but instead adopts a layered risk management approach combining land-use separation, engineered containment, active mitigation systems and operational controls.

On this basis, IXOM considers that appropriate buffers and safeguards are in place and that the proposal provides a level of protection that is consistent with regulatory expectations for facilities of this nature.

Item 137: Public Interest and Urban Planning • Thousands of people live, shop, study and work daily within the chlorine transport corridor. • The Eastgardens redevelopment and new high-rise towers will only increase the number of people exposed. • Continuing to approve modifications under a flawed and incomplete 1998 consent is contrary to the public interest.

As outlined in the responses to Items 132–136, the modification does not modify approved chlorine production capacity, storage volumes, transport routes or heavy vehicle movements. The modification has been assessed under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* and is supported by quantitative risk and transport risk assessments prepared in accordance with current DPHI, EPA and SafeWork NSW requirements and relevant hazardous industry planning guidelines. These assessments confirm that the modification does not result in any material increase in off-site risk or environmental impact and that existing risk contours remain unchanged.

Urban renewal and increased residential density in surrounding areas, including Eastgardens, are being progressed through separate planning processes. These processes are required to appropriately consider existing industrial land uses, established transport corridors and cumulative risk frameworks when determining land use compatibility. The existence of future redevelopment proposals does not, of itself, invalidate ongoing operation or modification of an established, lawfully approved hazardous industry within an appropriately zoned industrial precinct.

As mentioned in our response to Item 132, the validity or adequacy of historical approvals is a matter for the Department of Planning, Housing and Infrastructure to consider and determine.

Item 138: Our Position • The 1998 approval for the Orica chlorine plant was unlawful because it failed to consider transport risks.• The current modification request (D/A 35/98 – Mod 8) should be refused. * In the public interest, Council should move to relocate the chlorine plant away from residential and retail areas to reduce unacceptable risks.

As noted in the response to Item 132, the validity or adequacy of historical approvals is a matter for the Department of Planning, Housing and Infrastructure to consider and determine. The current application has been prepared and lodged in accordance with Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* and the SEARs issued for the modification, which require assessment against contemporary statutory and policy requirements rather than retrospective reconsideration of the original consent.

The modification is supported by a comprehensive and up-to-date quantitative risk assessment and transport risk assessment prepared in accordance with the SEARs and current guidelines. These assessments address existing land uses, current traffic conditions and emergency response arrangements, and demonstrate that the modification does not result in a material change to the existing risk profile or exceed the relevant HIPAP risk criteria.

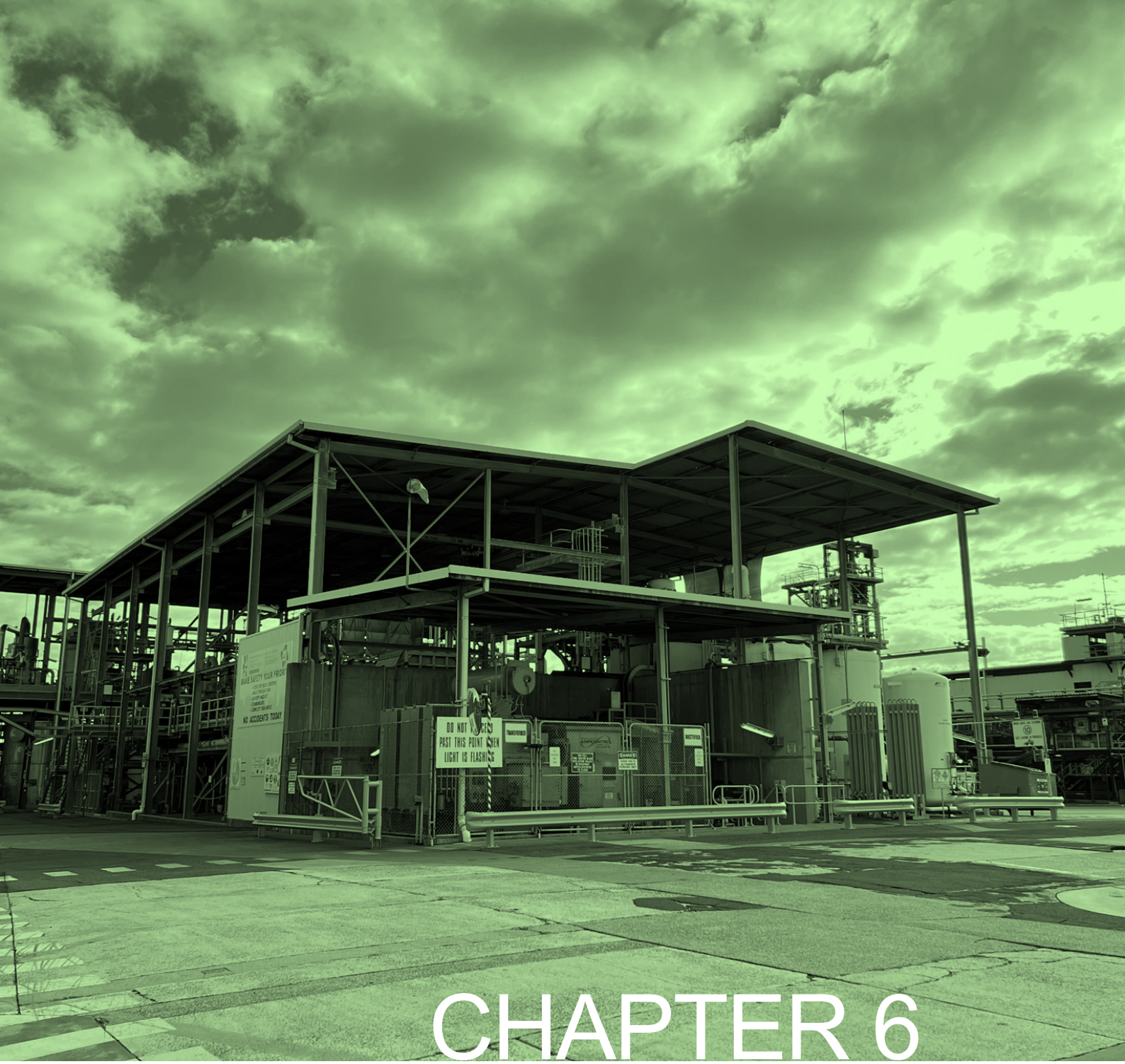
In addition, the Botany site represents the most appropriate and lowest-risk location for the proposed chlorine liquefaction plant, particularly given its co-location with essential materials and safety infrastructure, including immediate access to caustic soda required for effective chlorine scrubbing, as well as existing utilities, containment systems, operational expertise and integration with established safety systems.

Accordingly, the modification provides an appropriate mechanism to assess the proposal against modern safety and environmental standards within the existing consent framework, and ensures that any relevant risks associated with the proposed works are properly identified, quantified and managed in accordance with current regulatory expectations.

Item 139: Botany, Pagewood and Eastgardens residents should not be exposed to toxic chlorine risks simply because of outdated and incomplete approvals made more than 25 years ago.

The Government has a responsibility to act in the interests of community safety. Refusing the proposed modification and working towards relocation of the plant is the only safe and sensible course of action.

As outlined in the responses above, the modification is supported by comprehensive quantitative risk and transport risk assessments. These assessments address existing land uses, current traffic conditions and emergency response arrangements, and demonstrate that the modification does not result in a material change to the existing risk profile or exceed the relevant HIPAP risk criteria. On this basis, refusal of the modification or relocation of the facility is not warranted on safety grounds, and the modification represents an appropriate, risk-based assessment.



CHAPTER 6

UPDATED PROJECT JUSTIFICATION

6 UPDATED PROJECT JUSTIFICATION

6.1 Stakeholder Support Letters

Submissions below from water utilities and service providers highlighted the critical role of the Botany facility in supporting essential services, including drinking water disinfection and wastewater treatment across New South Wales and other states. The proposed chlorine liquefaction plant would provide additional resilience and contingency capacity, reducing reliance on a single liquefaction source and improving supply security in the event of a major operational disruption. In this context, there would be an overall negative outcome if consent was not granted, as the proposal addresses an identified vulnerability in Australia's chlorine supply chain with potential implications for public health, environmental protection and essential service infrastructure operations.

6.1.1 Water Utilities and Corporations

Sydney Water

Sydney Water strongly supports the modification, stating that chlorine supply security is critical for Greater Sydney's drinking water and that the Botany plant will provide a second, domestic source capable of meeting Australian demand if Laverton fails.

Melbourne Water

Melbourne Water provided support for the modification as an additional national manufacturing source of liquefied chlorine, reducing risk from reliance on a single producer and safeguarding potable water disinfection.

Gippsland Water

Gippsland Water supports the modification as it will increase supply security and minimise supply-chain risk for liquefied chlorine across the water sector.

TasWater

TasWater endorses and adopts the WSAA position, supporting the modification as a contingency source should Laverton be unavailable and to reduce dependence on overseas supply.

SA Water

SA Water strongly supports the modification, emphasising that an additional liquefaction and packaging plant will improve risk resilience for the water industry, align with national sovereign-manufacturing policy and deliver value for customers.

Water Corporation (WA)

The Water Corporation supports the modification as an important step to strengthen local supply chains and ensure continuity of chlorine supply for essential water services.

Power and Water Corporation (NT)

The Power and Water Corporation, responsible for water and sewerage services and electricity transmission and distribution across the Northern Territory, provided support for the modification as it would provide a second domestic source of liquefied chlorine, able to supply 100% of the

Australian market if Laverton fails, reducing reliance on imports and improving sovereign supply-chain resilience.

Seqwater

SeqWater supports the modification on the basis that it will strengthen national security and resilience of liquefied chlorine supply, reducing the need for emergency imports and supporting the safe operation of drinking-water services.

Suez Water Pty Ltd

Suez Water Pty Ltd (Suez), a primary operations contractor to both Sydney Water and SA Water, supplies drinking water to over 14 million Australians and is highly dependent on chlorine from Laverton. Suez provided support for the modification as it represents a critical contingent supply point to mitigate sovereign risk and avoid reliance on international imports.

Veolia (Veolia Water Operations and Veolia Water Technologies)

As a major national operator of water treatment plants, Veolia also offers support for the project to increase supply-chain resilience for a key disinfection chemical and reduces exposure to international shipping disruptions.

Water Services Association of Australia (WSAA)

The Water Services Association of Australia (WSAA), on behalf of the urban water sector, supports the project as a key measure to address sovereign risk created by reliance on a single domestic bottling plant and to reduce dependence on international supply in the event of major operational disruptions.

6.1.2 Government Departments / Agencies

Department of Industry, Science and Resources (DISR)

DISR recognises the importance of resilient supply chains and notes that a new chlorine facility in NSW has potential to diversify supply of a key drinking-water treatment chemical.

Department of Climate Change, Energy, the Environment and Water (DCCEEW)

DCCEEW acknowledges that disruptions to chlorine supply would have national public-health and economic consequences and commends IXOM's efforts to strengthen sovereign supply-chain resilience for this critical input.

6.1.3 Overall Sentiment

Across all letters, the common themes are that:

- Chlorine is a critical input, essential for safe drinking water disinfection nationwide.
- Reliance on a single chlorine liquefaction facility at Laverton, Victoria poses a sovereign risk and a single point of failure.
- The modification would:
  - provide a contingent domestic source of liquefied chlorine able to meet national demand; in the event that the Laverton plant fails; and
  - reduce or remove Australia's reliance on emergency imports and the risks associated with international shipping and production in the event of a major failure of the Laverton plant

Accordingly, it can be inferred that the agencies, utilities and companies listed above are in support of the approval of the modification.

6.2 Conclusion

The project is consistent with the principles of environmentally sustainable design (ESD) as follows:

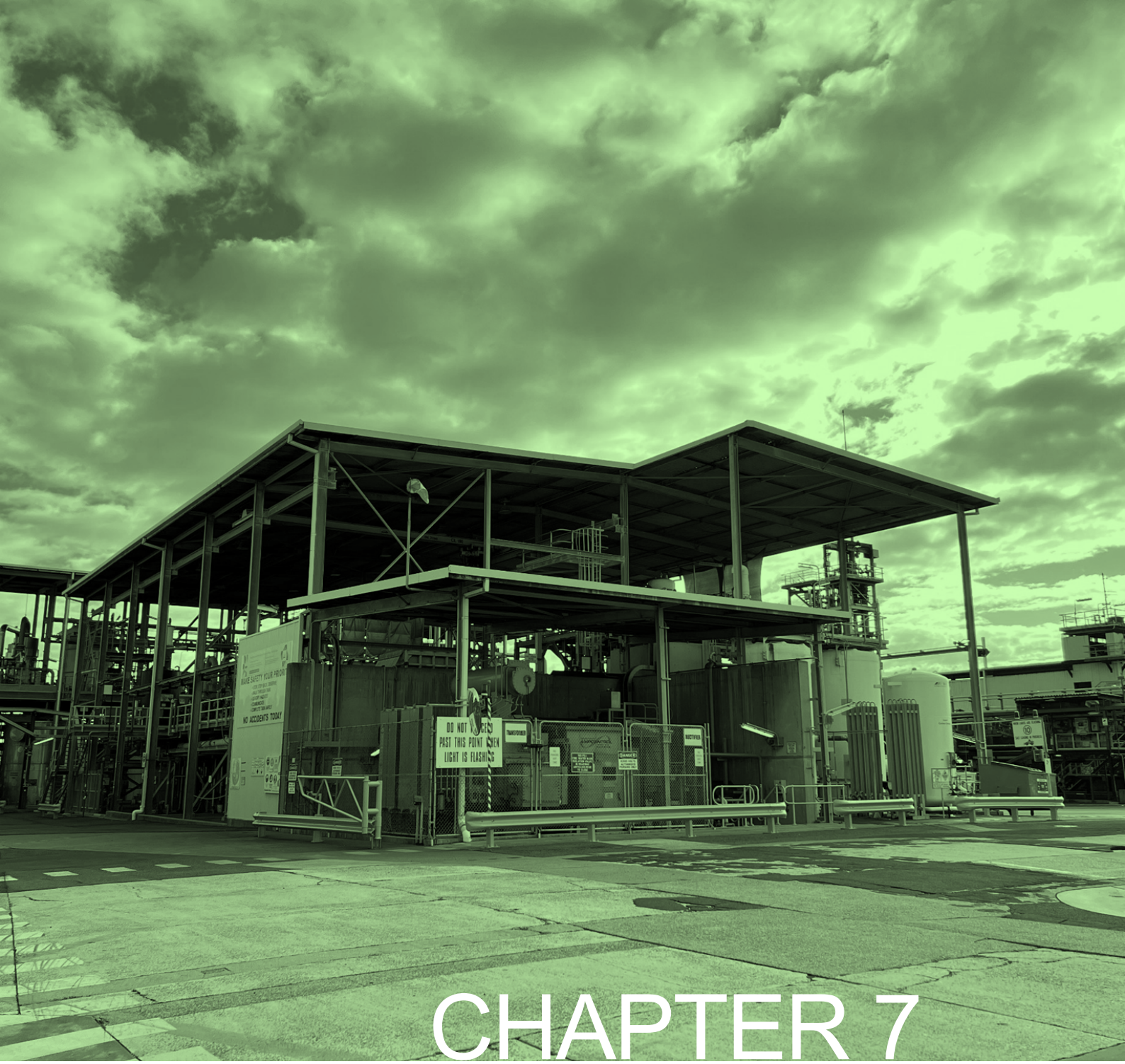
- Precautionary principle – the potential environmental impacts associated with the project are well understood and have been assessed to a level of detail proportional to each aspects environmental risk.
- Intergenerational equity –
    - Suitably qualified and experienced technical specialists have been engaged to ensure that the environmental assessment phase of the project is independent, thorough, technically robust and transparent.
    - IXOM has engaged extensively with neighbours and the local community to understand any concerns they had with the project.
    - Management strategies and mitigation measures have been identified to minimise any potential adverse impacts from the project.
- Conservation of biological diversity and ecological integrity – the project will not adversely impact threatened species or ecological communities.
- Improved valuation, pricing and incentive mechanisms.
    - EPL 20547 and the TWA 489 apply to the site. The EPL regulates the fee based activities and the TWA licenses the discharge of treated wastewater to the reticulated sewer system.

The modification report, this submissions report and associated technical investigations have concluded that with the implementation of the proposed design, environmental management and mitigation measures, the modification will not significantly impact the local biophysical and social environments.

Based upon the predicted environmental impacts of the modification and the ability to manage these impacts to minimise harm to the environment, the modification is unlikely to create any significant adverse environmental impacts on adjoining properties or prejudice the future use of land in the locality.

Since exhibition, IXOM has undertaken additional targeted technical work and stakeholder engagement to respond to issues raised in submissions and through DPHI's post-exhibition review. This has included clarification and updates to the Quantitative Risk Assessment (Appendix B), Dangerous Goods Transport Risk Assessment (Appendix C) and Greenhouse Gas assessment (Appendix E), progression of an independent site audit process to confirm suitability of the proposed remediation action plan and land suitability (Appendix F), and discussions with Bayside Council, Randwick City Council and relevant agencies. These actions have not resulted in any alterations to the scope, scale or nature of the modification.

Balancing the demonstrated strategic need for secure chlorine supply, alignment with state planning and infrastructure objectives, the absence of significant environmental impacts, and the broader social, economic and public health benefits, the modification is in the public interest.



CHAPTER 7
REFERENCES

7 REFERENCES

Department of Planning, Housing and Infrastructure (DPHI) (2024). *State Significant Development Guidelines*.

Department of Planning, Housing and Infrastructure (DPHI) (2025). *Request for Further Information – IXOM Chlorine Liquefaction Plant (DA35/98-MOD 6)*, dated 3 November 2025.

IXOM Operations Pty Ltd (2025). *Modification report – Chlorine Liquefaction Plant, Botany Industrial Park (DA35/98-MOD 6)*.

NSW Environment Protection Authority (EPA) (2017). *Guidelines for the NSW Site Auditor Scheme*.

NSW Environment Protection Authority (EPA) (2023). *Guide for Large Emitters*.

NSW Hazardous Industry Planning Advisory Paper No. 4 (HIPAP 4) (2011). *Risk Criteria for Land Use Safety Planning*.

Sherpa Consulting (2026). *Quantitative Risk Assessment – IXOM Chlorine Liquefaction Plant* (revision 5, dated 26 March 2026).

Sherpa Consulting (2026). *Dangerous Goods Transport Risk Assessment – IXOM Chlorine Liquefaction Plant* (revision 4, dated 26 March 2026).

Ramboll Australia Pty Ltd (2025). *Site Audit Proposal – IXOM Chlorine Liquefaction Plant, Botany Industrial Park*.

Ramboll Australia Pty Ltd (2026), *Interim Audit Advice Letter No. 1 – DA35/98-MOD-6* (dated 17 February 2026)

Todoroski Air Sciences Pty Ltd (TAS) (2026), *Air Quality Impact and Greenhouse Gas Assessment – Chlorine Liquefaction Plant – Modification to State Significant Development Consent.*



APPENDIX A

Submissions register

Group	Name (as per submission)	Section where issues addressed in submissions report
Government agencies	Department of Planning, Housing and Infrastructure (DPHI)	Chapter 3 (Sections 3.1–3.3); Chapter 4.10
	NSW Environment Protection Authority (EPA)	Chapter 4.7
	SafeWork NSW	Chapter 4.8
	Department of Climate Change, Energy, the Environment and Water (DCCEEW) – Conservation Programs, Heritage and Regulation (CPHR)	Chapter 4.6
	Transport for NSW (TfNSW)	Chapter 2 (noted; no issues raised)
	Sydney Trains	Chapter 4.1
	Airservices Australia	Chapter 4.2
	Fire and Rescue NSW	Chapter 4.3
	Department of Industry, Science and Resources	Chapter 4 (Justification and evaluation)
Local government	Bayside Council	Chapter 4.5
	Randwick City Council	Chapter 4.9
Service providers / utilities	Sydney Water	Chapter 6.1.1
	SA Water	Chapter 6.1.1
	Water Corporation	Chapter 6.1.1
	Melbourne Water	Chapter 6.1.1
	TasWater	Chapter 6.1.1
	Seqwater	Chapter 6.1.1
	Gippsland Water	Chapter 6.1.1
	Power and Water Corporation	Chapter 6.1.1
	Veolia (including Veolia Water Operations and Veolia Water Technologies)	Chapter 6.1.1
	SUEZ Water Pty Ltd	Chapter 6.1.1
Stakeholder groups	Water Services Association of Australia (WSAA)	Chapter 6.1.1
	Kogarah Bay Progress Association (KBPA)	Chapter 5.2
Individuals / community	Simon Berckelman (Hillsdale NSW)	Chapter 5.2
	Erin McBean (Hillsdale NSW)	Chapter 5.2
	Mohammad B. Ghasemian (Hillsdale NSW)	Chapter 5.2
	Lynne Salakas (Hillsdale NSW)	Chapter 5.2
	Aydar Shamsutdinov	Chapter 5.2
	Andrea Jackson	Chapter 5.2
	Yvonne Stelianidis	Chapter 5.3
	Stephen Haigh	Chapter 5.4
	Thomas Buxton	Chapter 5.5
	Danielle Phair	Chapter 5.6
	Robert Driscoll	Chapter 5.8
	Maria Poulos (NOPE residents' group, Maroubra NSW)	Chapter 5.9
	Name withheld (Beverly Park NSW)	Chapter 5.2
	Name withheld (Banksmeadow NSW)	Chapter 5.2

Group	Name (as per submission)	Section where issues addressed in submissions report
	Name withheld (Botany NSW)	Chapter 5.2
	Name withheld (Matraville NSW)	Chapter 5.7
	Local resident – Grace Campbell Crescent, Hillsdale NSW	Chapter 5.2



APPENDIX B

QUANTITATIVE RISK ASSESSMENT

QUANTITATIVE RISK ASSESSMENT REPORT

PROPOSED CHLORINE LIQUEFACTION PLANT

MODIFICATION TO CHLORALKALI FACILITY

BOTANY INDUSTRIAL PARK

IXOM

PREPARED FOR:	**Jamie van Rooyen** **Head of Projects and Technology, IXOM**
DOCUMENT NO:	**21838-RP-002**
REVISION:	**5**
DATE:	**26-Mar-2026**

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DOCUMENT REVISION RECORD

Rev	Date	Description	Prepared	Checked	Approved	Method of issue
A	05-Mar-2025	Issued to client for comments	M. Amouzegar	J. Polich	-	Email PDF
0	28-Mar-2025	Final issue	J. Polich	G. Peach	G. Peach (Sherpa) J. van Rooyen (IXOM)	Email PDF
1	30-Jun-2025	Issued for IXOM approval	J. Polich M. Amouzegar	G. Peach	G. Peach (Sherpa) J. van Rooyen (IXOM)	Email PDF
2	09-Jul-2025	Issued for submission with MOD report to DPHI	J. Polich M. Amouzegar	G. Peach	G. Peach (Sherpa) J. van Rooyen (IXOM)	Email PDF
3	29-Dec-2025	Updated to address response to submissions for IXOM review	M. Amouzegar	J. Polich	J. Polich (Sherpa)	Email PDF
4	26-Feb-2026	Updated for DPHI review for inclusion in Response to Submissions (RTS) report	J. Polich	G. Peach	G. Peach (Sherpa) J. van Rooyen (IXOM)	Email PDF
5	26-Mar-2026	Final included in RTS report	J. Polich	G. Peach	G. Peach (Sherpa) J. van Rooyen (IXOM)	Email PDF

RELIANCE NOTICE

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Title: **Quantitative Risk Assessment Report** **Proposed Chlorine Liquefaction Plant** **Modification to Chloralkali Facility** **Botany Industrial Park**	**QA verified:** K Shen **Date:** 26-Mar-2026

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
ADG	Australian Dangerous Goods (Code)
AEGL	Acute Emergency Guideline Level
ALARP	As Low As Reasonably Practicable
AS	Australian Standard
AWS	Automatic Weather Station
BIP	Botany Industrial Park
BoM	Bureau of Meteorology
CAP	Chloralkali Plant
Cl_2	Chlorine
CLP	Chlorine Liquefaction Plant
DA	Development Application
DCS	Distributed Control System
DG	Dangerous Good
DPHI	Department of Planning, Housing and Infrastructure[1]
ESD	Emergency Shutdown
FHA	Final Hazard Analysis
HAZID	Hazard Identification
HCl	Hydrogen Chloride
HIPAP	Hazardous Industry Planning Advisory Paper
HS	Hazard Studies
HSE	(UK) Health and Safety Executive
IFR	Individual Fatality Risk (offsite)
IRPA	(worker) Individual Fatality Risk per annum
LBS	Liquefaction Building Scrubber
LCP	Local Control Panel
LGA	Local Government Area
LOC	Loss of Containment
JRPP	Joint Regional Planning Panel
MHF	Major Hazard Facility
MI	Major Incident
NaOH	Sodium hydroxide (caustic soda)
NCl_3	Nitrogen chloride
NH_3	Ammonia
NSW	New South Wales
PFD	Process Flow Diagram
PFDavg	Probability of Failure on Demand
PID	Piping and Instrumentation Diagram
ppm	parts per million

[1] This acronym covers all previous forms of the same authority e.g. DPIE, DUAP, DPE, DoP.

PPE	Personal Protective Equipment
QRA	Quantitative Risk Assessment
R2P2	Reducing Risks, Protecting People
SA	Statistical Area
SEARs	Secretary's Environmental Assessment Requirements
SEE	Statement of Environmental Effects
SERM	State and Emergency Rescue Management (Act)
SFARP	So Far As Reasonably Practicable
SIL	Safety Integrity Level
SMS	Safety Management System
TfNSW	Transport for NSW
TRA	Transport Risk Assessment
TZ	Travel Zone

1. SUMMARY

1.1. Overview

IXOM is proposing to construct a Chlorine Liquefaction Plant (CLP) at the existing Chloralkali Plant (CAP) located on the Botany Industrial Park (BIP), New South Wales (NSW). The CAP is an existing Major Hazard Facility (MHF) which manufactures gaseous chlorine and caustic soda and then uses the chlorine to make hydrochloric acid, ferric chloride, and sodium hypochlorite in downstream product plants. Liquid chlorine (from IXOM's Laverton plant in Victoria) is also stored in drums, cylinders and a parked road tanker in an outdoor storage area at the CAP.

The CLP will be located within a containment building fitted with a Liquefaction Building Scrubber (LBS) to treat chlorine leaks. Bulk liquid chlorine will be stored in pressure vessels under refrigerated conditions and atmospheric pressure within the building. The existing outdoor chlorine drum, cylinder storage and parked tanker associated with the CAP will be relocated to within the containment building.

The NSW Department of Planning, Housing and Infrastructure (DPHI) has issued Secretary's Environmental Assessment Requirements (SEARs) for the project which require IXOM to assess the offsite, onsite and Dangerous Goods (DG) transport risk. IXOM retained Sherpa Consulting Pty Ltd (Sherpa) to carry out the risk study.

1.2. Objectives

The overall objective of this study is to undertake a Quantitative Risk Assessment (QRA) in accordance with the Hazardous Industry Planning Advisory Paper No. 6 *Hazard Analysis* (HIPAP 6) to determine if the cumulative risk from the existing CAP and proposed CLP complies with qualitative and quantitative HIPAP 4 *Risk Criteria for Land Use Safety Planning*. The criteria for individual fatality risk, toxic injury and irritation risk and societal risk have been included in the study.

All specific requirements of the SEARs in relation to hazard and risk and the location in the report where they are addressed are summarised in APPENDIX A.

Note that the QRA has been prepared in the context that the Qenos and Indorama operations on the BIP have been shut down, hazardous materials removed and these no longer present a source of risk. These areas have been assessed as potential additional industrial populations in the societal risk assessment.

1.3. Scope

The study covers the proposed CLP facility. The CLP will have two operational modes:

- Normal case: During normal operation, the CLP is operated at reduced liquefaction capacity. The produced chlorine is primarily used to fill the bulk tankers to supply the liquid chlorine demand in the NSW region.
- Contingent case: During contingent operation, when the chlorine liquefaction plant at Laverton is unavailable, the CLP will run at full capacity and facilitate bulk tanker loading as well as chlorine drum and cylinder filling for export via flatbed trucks.

Both operational cases for the CLP are covered in the QRA.

The existing CAP and associated downstream product plants are also included in the cumulative risk assessment.

Results for both offsite risk and onsite risk are included in this report. Transport risk is not covered in this report as it is addressed separately.

1.4. Revision

This QRA report was initially prepared for inclusion in the planning submission to the NSW DPHI. This revision of the report has been updated to include some additional information to respond to the submissions made to the application. There are no technical changes or changes to QRA results or conclusions in this updated version.

1.5. Methodology

The QRA included the following steps:

1. Consultation with DPHI and SafeWork to discuss key assumptions and reporting requirements.
2. Hazard Identification (HAZID) for the CLP was undertaken based on experience with chlorine plants, review of similar IXOM operations and the project hazard studies (HS) completed for the CLP. This included a review of the MHF Major Incidents (MIs) at the IXOM Laverton liquefaction plant in Victoria and was also generally informed by Chlorine Institute and Euro Chlor industry guidance.
3. Frequencies of potential hazardous incidents were estimated from industry statistical data bases together with event trees and operational input.
4. Quantitative consequence modelling and risk calculations were completed using commercially available software, Gexcon Effects and Riskcurves v12.5.1 to generate individual risk contours (fatality, toxic injury and irritation) and a societal risk (FN curve) for comparison against the HIPAP 4 risk criteria.
5. Onsite risk to IXOM operators was estimated quantitatively using the QRA model as a basis and compared to UK HSE worker risk criteria.

1.6. Results

1.6.1. Qualitative criteria

MI scenarios associated with the CLP are typically chlorine releases. The overall intent of the CLP design with respect to risk was to:

- ensure that the cumulative offsite individual risk for the overall modified CAP (i.e. including the CAP and the CLP) is not materially higher than from the current CAP operations, and
- ensure that the worst-case consequence is not larger than from the current CAP operations.

This approach is consistent with ensuring the risk from a major hazard is reduced where practicable, irrespective of the numerical value of the cumulative risk. The project design decisions have been progressed in accordance with inherent safety principles and best practices for chlorine liquefaction with key control measures relevant at the design stage summarised below. Note that the QRA does not form an overall demonstration that the overall risk is reduced So Far As Reasonably Practicable (SFARP). This demonstration is required to be made as part of an update to the MHF Safety Case prior to any operations commencing.

1.6.2. Quantitative assessment

Key findings of this study are provided below:

1. Maximum consequence: No scenarios associated with the CLP were identified to have a greater consequence impact to the 1% fatality level than the existing CAP scenarios. The scenario with the largest impact remains a release from a 13-tonne chlorine road tanker at ambient conditions.
2. Control measures: High level design choices that minimise risk include:
   - Selection of the 'Block L' site within the BIP maximises the distance to residential areas along Denison St and minimises the extension of the pressurised chlorine gas piping from the CAP to the CLP that cannot be located within the containment building. This also maximises the distance to onsite occupied areas such as the existing CAP control room and administration building.
   - Refrigerated storage conditions (i.e. atmospheric pressure and a temperature of approximately -34°C) limit the release rate and associated evaporation rate of chlorine allowing containment within a building and treatment by a scrubber at manageable rates.
   - Minimising the bund surface area for the storage tanks and other liquid chlorine handling areas significantly reduces spill evaporation rate. Hence, consequence impact of major release scenarios from refrigerated storage at atmospheric pressure such as storage tank failure.

- Containment building large enough to carry out all liquid storage and handling activities and sized to contain flash fraction of liquid chlorine scenarios including filled road tanker after warming up in combination with the highly reliable scrubber system (which includes redundant fans, pumps and power supplies) is an effective risk reduction measure for the CLP. The QRA has estimated a 5% 'unavailability' of the containment building and scrubbing system. This will be verified as achievable as part of detailed design as per the recommendations.

3. Offsite risk:

- All individual fatality risk criteria are met for the modified facility (i.e. cumulative case of CAP and CLP for both normal and contingent cases) as per Figure 1.1 and as summarised in Table 1.2. This is consistent with the existing CAP as per Table 1.2.
- Due to the effect of the containment building there is only a small difference in offsite risk between the normal and contingent cases as can be seen in the comparative risk contours in Figure 8.4.
- The toxic injury contour (see Figure 8.5) for the modified facility (i.e. cumulative case of CAP and CLP for both normal and contingent cases) does not reach the residential area hence meets the toxic injury criterion as per the current CAP case.
- The toxic irritation contour (see Figure 8.6) for the modified facility (i.e. cumulative case of CAP and CLP for both normal and contingent cases does not reach the residential area and hence, meets the toxic irritation criterion as per the current CAP case.
- Societal risk is in the negligible region for both the normal and contingent cases as per Figure 1.2. The assessment assumes a population of 40 people/hectare on the Qenos and Indorama areas of the BIP.
- Due to the containment building, the individual and societal risk profile does not materially increase compared to the existing CAP plant risk profile.
- The overall extent of the individual fatality risk contours offsite is slightly reduced for the normal case compared to the current CAP due to the opportunity to relocate the existing liquid chlorine storages (drums, cylinder, parked road tanker) from the outdoor location to inside the containment building. The contingent case is slightly increased primarily due to potential leaks from drum filling hoses, except to the north where it is decreased (refer to Figure 8.4 for a comparative risk contour).
- The toxic injury and irritation risk contours are reduced for the normal and contingent cases due to the opportunity to relocate the existing liquid chlorine storages (drums, cylinder, parked road tanker) from the outdoor location to inside the containment building (refer to Figure 8.5 and Figure 8.6 for comparative risk contours).

4. Onsite risk (exposure mitigation not included): The purpose of the planning stage onsite risk calculation is to show that the worker risk can meet tolerability criteria. These results are not intended to demonstrate that worker risk is reduced SFARP as this demonstration will be undertaken as part of the MHF safety assessment. Onsite risk was estimated for typical roles for both the normal and contingent cases including the CAP plus the future CLP operations using the QRA model. The risk estimate included adjustments for occupancy to calculate worker individual fatality risk per annum (IRPA). Mitigation factors relevant to reducing exposure of workers (e.g. self-escape, Personal Protective Equipment (PPE), localised ventilation) are not accounted for hence the calculations are conservative. As the IRPA without accounting for mitigation is below the UK Health and Safety Executive (HSE) 'intolerable' risk of 1 x 10^{-3} per year, the risk is tolerable for all worker roles including the effect of the CLP as summarised in Table 1.1.

Table 1.1: Onsite risk

Role	Day time IRPA – Modified facility CAP & CLP	
	Normal case	Contingent case
Day Plant Operator	3.65 x 10^{-5}	7.15 x 10^{-4}
Engineers/Planners	4.69 x 10^{-6}	1.17 x 10^{-5}
Technical/Quality	5.42 x 10^{-6}	1.43 x 10^{-5}
Operations	5.16 x 10^{-6}	1.24 x 10^{-5}
Admin staff	1.02 x 10^{-6}	2.65 x 10^{-6}

Risk contributors associated with operation of the modified facility are chlorine releases. There are small quantities of ammonia present in the CLP for the refrigeration system however ammonia risk contributions are not material due to the small inventory. The dominant risk contributors to the offsite individual fatality risk are liquid chlorine releases due to hose failures or piping failures in pumped liquid piping, i.e. for tanker loading for the normal case, and for drum and cylinder filling as well as tanker loading for the contingent case. These scenarios have been modelled conservatively for the QRA i.e. generic hose failure rates have been adopted, and the probability of failure of isolation and time to isolation has been selected conservatively for the planning stage QRA. These assumptions may be refined in detailed design stage further reducing the estimated risk.

1.7. Recommendations

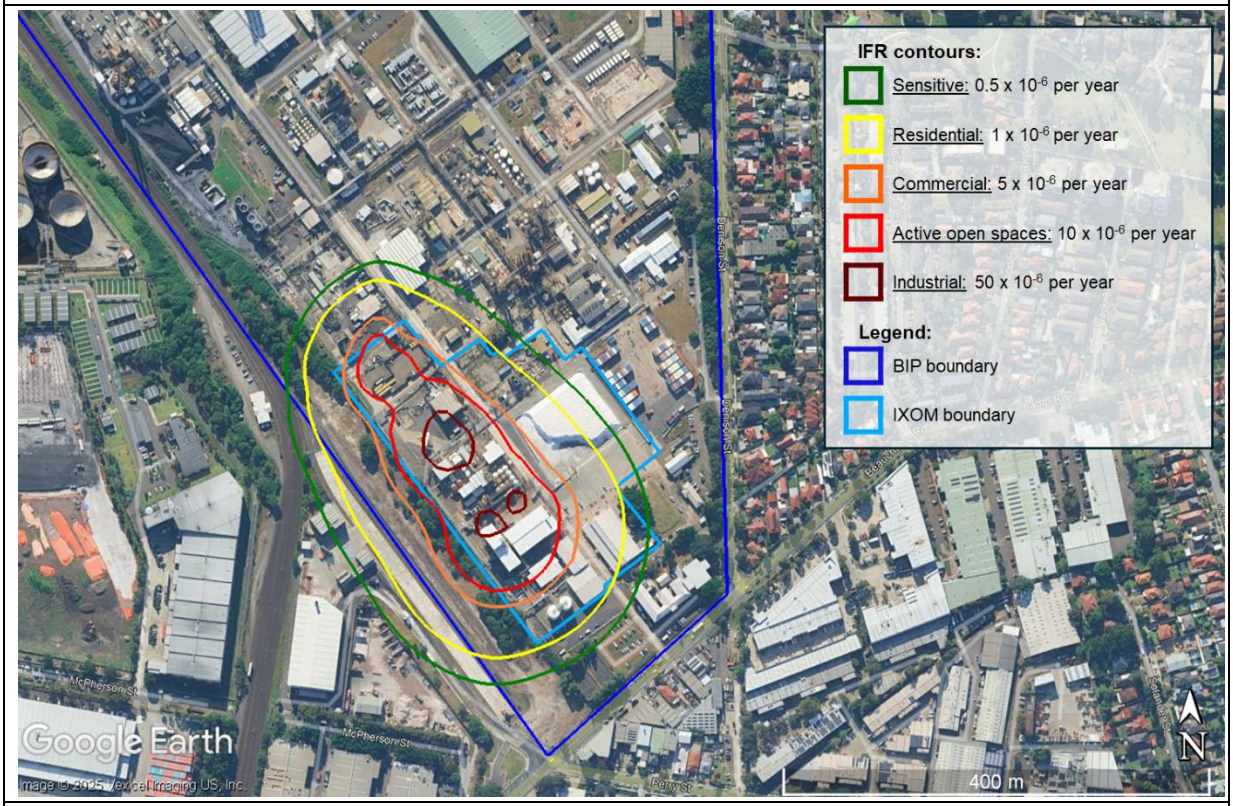
The QRA is based on the design stage of the CLP. The key control that ensures the risk does not materially increase compared to current levels is the CLP containment building and scrubber. The dominant residual risk contributors for both the normal and contingent cases are related to failures in equipment for transferring liquid chlorine between storages and tankers, drums or cylinders.

Recommendation 1: *It is recommended that as part of detailed design, the containment building and scrubber design should be verified to ensure that the estimated unavailability of no more than 5% is achieved. It is anticipated that this can be carried out as part of a Final Hazard Analysis (FHA) if project consent is received.*

Recommendation 2: *The QRA has conservatively assessed the probability of failure on demand (PFDavg) of automatic detection and isolation (PFDavg = 0.1) and time to isolation (up to 3 minutes) for isolatable chlorine leak scenarios. It is recommended that as part of detailed design, automatic detection and isolation time and probability of failure on demand for detection and isolation of chlorine leaks from hoses and pumped liquid systems be more accurately assessed to confirm whether greater risk reduction is achievable for the residual risk contributors.*

Figure 1.1: Individual Fatality Risk results

Modified facility CAP & CLP – Normal case (Case SC1C)



Modified facility CAP & CLP – Contingent case (Case SC2C)

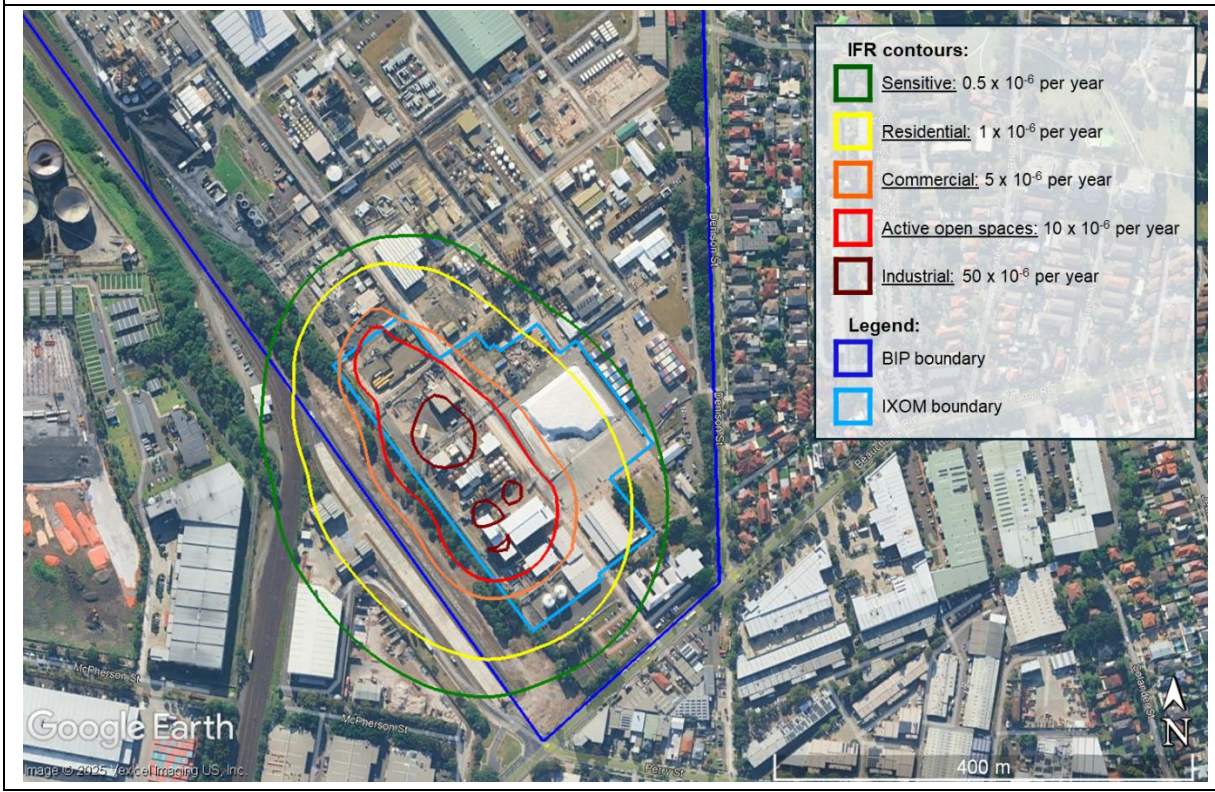
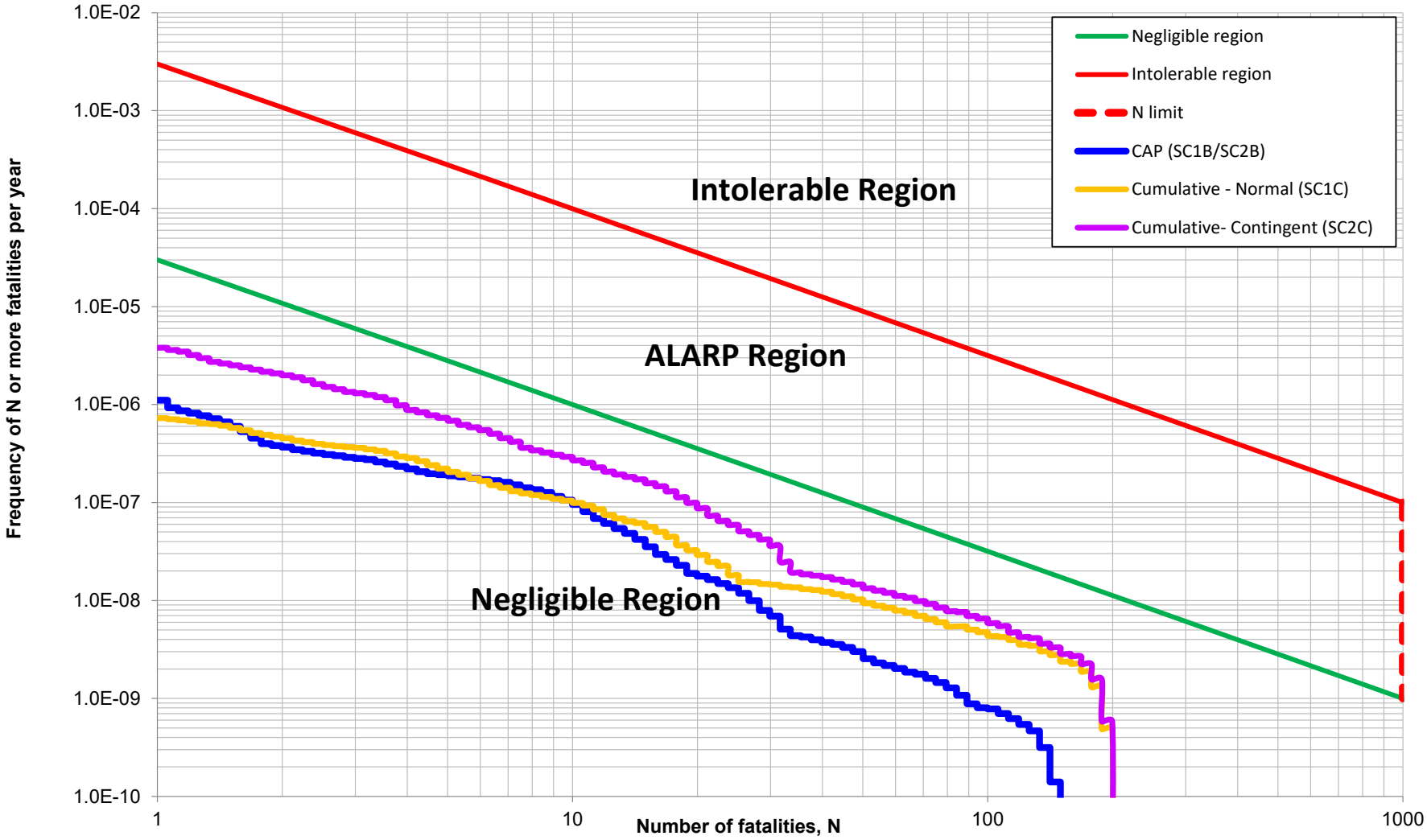


Table 1.2: Compliance with HIPAP 4 risk criteria

Description	Risk criterion (per year)	Risk criteria met?		Comments
		Existing CAP only	Modified facility CAP & CLP – normal and contingent cases (SC1C/SC2C)	
Individual Fatality Risk				
Sensitive land uses, including hospitals, schools, aged care	0.5×10^{-6}	Yes	Yes	Contour extends past IXOM boundary but does not extend to any sensitive land uses Matraville Botany Public School (Beauchamp Rd). Complies with criteria.
Residential areas and hotels	1×10^{-6}	Yes.	Yes.	Contour extends past IXOM boundary but does not extend to any residential land uses (Denison St). Complies with criteria.
Commercial areas, including offices, retail centres, warehouses	5×10^{-6}	Yes	Yes	Does not reach any commercial land uses. Complies with criteria.
Sporting complexes and active open spaces	10×10^{-6}	Yes	Yes	Does not reach any open space land uses. Complies with criteria.
Contained within the boundary of an industrial site	50×10^{-6}	Yes	Yes	Contour remains within IXOM boundary Complies with criteria.
Injury/Irritation Risk				
Injury (residential and sensitive areas only)	10×10^{-6}	Yes	Yes	Contour extends past IXOM boundary to the south and west but does not extend to any residential or sensitive land uses, e.g. Matraville Botany Public School (Beauchamp Rd) to the east. Complies with criteria.

Description	Risk criterion (per year)	Risk criteria met?		Comments
		Existing CAP only	Modified facility CAP & CLP – normal and contingent cases (SC1C/SC2C)	
Irritation (residential and sensitive areas only)	50 x 10^{-6}	Yes	Yes	Contour extends past IXOM boundary to the south and west but does not extend to any residential or sensitive land uses such as Matraville Botany Public School (Beauchamp Rd) to the east. Complies with criteria.
Societal Risk				
Populations external to IXOM site	HIPAP 4 (2011) criteria ALARP or negligible region	Yes (Negligible)	Yes (Negligible)	Max N < 1000. Results FN curve within negligible area for all cases.

Figure 1.2: Societal risk – Population includes additional 40/hectare former BIP operations



2. INTRODUCTION

2.1. Background

IXOM operates a Chloralkali Facility located at the Botany Industrial Park (BIP). Chlorine and caustic soda are currently manufactured in the Chloralkali Plant (CAP) and all chlorine is used in downstream product plants. These plants plus various storages comprise the Chloralkali Facility. The Chloralkali Facility is a Major Hazard Facility (MHF) under New South Wales (NSW) regulations.

IXOM is proposing to construct a Chlorine Liquefaction Plant (CLP) at the existing Chloralkali Facility which will liquefy a portion of the overall chlorine produced by the CAP for filling into road tankers, drums or cylinders.

The NSW Department of Planning, Housing and Infrastructure (DPHI) has issued Secretary's Environmental Assessment Requirements (SEARs) for the project which require IXOM to assess the offsite, onsite and transport risk associated with the CLP project. IXOM retained Sherpa Consulting Pty Ltd (Sherpa) to carry out the risk analysis study.

This report documents the Quantitative Risk Analysis (QRA) inputs and results.

2.2. Objectives

A requirement of the SEARs is to perform a QRA in accordance with Hazardous Industry Planning Advisory Paper No. 6 (HIPAP 6) *Hazard Analysis*, Ref [1], to determine if the cumulative risk from the existing CAP and proposed CLP complies with qualitative and quantitative HIPAP 4 *Risk Criteria for Land Use Safety Planning*, Ref [2], risk criteria as follows.

> *'Include a Quantitative Risk Analysis (QRA) in accordance with the Department's Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis' demonstrating that the existing chloralkali plant (CAP) with the proposed chlorine liquefaction plant (CLP) ('the modified facility' up to* [Development Application (DA)] *35/98-Mod-6) complies with both the qualitative criteria, in particular the consideration of site location and technology, and the quantitative criteria in the Department's Hazardous Industry Planning Advisory Paper No. 4, 'Risk Criteria for Land Use Safety Planning'.*

This QRA report aims to address the 'Hazards and Risks' component of the SEARs. Additional details of specific SEARs requirements in relation to hazard and risk and the location in this report where they are addressed is provided in APPENDIX A.

2.3. Scope

The study covers the proposed CLP operations and new equipment associated with the CLP including:

- new compressed chlorine gas piping from CAP to CLP

- CLP process equipment including:
  - chlorine liquefier and liquid chlorine separator,
  - two chlorine storage tanks (one is a standby tank kept empty for use in an emergency),
  - chlorine treatment facility including degas reactor and chlorine scrubber, and
  - loading operations (chlorine tanker loading, cylinder and drum filling).

The existing CAP and downstream product plants are included in the cumulative risk assessment.

Results for both offsite risk and onsite risk are included in this report.

2.4. Study approach

The QRA has been conducted and reported in accordance with the NSW DPHI HIPAP 6 *Hazard Analysis*. The key stages of the study are as follows:

- Potential hazardous incidents were identified based on proposed facility and operations.
- Quantitative consequence modelling for toxic releases was carried out.
- Frequencies of potential hazardous incidents were estimated from industry statistical data bases supplemented by event tree analysis as required.
- Quantitative risk calculations were completed, using the identified hazardous incident scenarios and recent meteorological and population data as inputs.
- Individual risk contours (fatality, toxic injury and irritation) and a societal risk (FN curve) were generated from the risk model and compared against the risk criteria in HIPAP 4 *Risk Criteria for Land Use Safety Planning*.
- Onsite risk to the IXOM operators was estimated quantitatively using the QRA model as a basis and compared to UK Health and Safety Executive (HSE) worker risk tolerability criteria suggested in *Reducing Risks, Protecting People – HSE's Decision-Making Process* (R2P2), Ref [3].
- Other SEARs requirements related to hazards and risks were addressed.
- A QRA report was prepared for submission to the NSW DPHI as part of the overall planning application.

2.5. Links to MHF regulatory requirements

As an MHF, IXOM submits a periodic Safety Case report for the CAP to SafeWork NSW with the latest MHF licence renewal application occurring in 2024.

The objective of the MHF Safety Case is to demonstrate that the risks associated with an MHF have been eliminated, or if this is not achievable, adequate controls must be implemented to reduce the risk 'So Far As Reasonably Practicable' (SFARP). A Safety

Management System (SMS) must be in place that ensures the effectiveness and reliability of the controls that reduce the risk SFARP.

The QRA report is not intended to meet the full requirements of an update to the MHF safety assessment and is not intended as a demonstration the risk have been reduced SFARP. However, the QRA has been developed taking into account the hazard studies carried out as part of the project as applicable to the stage of the project to develop the QRA scenarios for modelling and account for control measures applicable at the design stage.

An update to safety assessment included in the MHF Safety Case will be required prior to the commissioning phase of the CLP. Aspects of the QRA (for example consequence modelling, cumulative risk assessment) will also be used to inform updates to the MHF safety assessment included in the MHF Safety Case at the relevant time in the project schedule.

2.6. Exclusions and limitations

The exclusions and limitations that apply to this report are summarised in Table 2.1.

Table 2.1: Exclusions and limitations

Item	Scope area	Exclusion/limitation
1	Offsite risk – boundary	The risk from the facility has been assessed against the IXOM boundary (not the BIP boundary).
2	Onsite risk	The study only assesses the risk to IXOM operators. Populations on the other areas of the BIP are treated as 'offsite' and hence are part of societal risk assessment.
3	Transport risk	The Denison St Dangerous Goods (DG) transport risk results are not included in this report. Transport risk associated with the CLP project is provided in a separate report, Ref [4].
4	Consultation outcomes	This report does not include the detail of consultation with relevant bodies in relation to the QRA or other aspects relating to hazard and risk. A consultation summary is reported as part of the overall planning application. Note that the outcomes of consultation process where relevant to QRA scope and methodology are included in this report.
5	Escalation	No potential events in the existing plants on the BIP were identified as affecting the CAP or CLP. Qenos and Indorama, which previously posed explosion hazards, have now been shut down and hazardous inventories removed.
6	External events	External events include earthquakes, plane crashes, floods etc. Even allowing for the airport a few kilometres away, these are very low frequency events in the Botany area. These are not quantified in the QRA.

Item	Scope area	Exclusion/limitation
7	IXOM existing CAP facility	The scenarios associated with the existing plants within the Chloralkali Facility were initially based on the most recent QRA prepared to comply with the CAP conditions of consent (Condition 11 DA 35/98 consolidated consent Mods 1 to 4). Various updates have been made to the modelling inputs or risk assessment methodology for the CAP in consultation with DPHI up to June 2025, Ref [5] and an updated CAP QRA report was submitted and approved by DPHI (July 2025) Ref [6]. Note that the CAP QRA report itself is not in the public domain as it is not part of a planning application as CAP is an approved existing facility.
8	Environmental risk	The main concern relating to environmental risk from accident events is generally with effects on whole systems or populations. Whereas any adverse effect on the environment is obviously undesirable, there are no materials handled at the chlorine and product plants or proposed CLP with persistent toxicity or bioaccumulation issues. Environmental risk is excluded from the scope of the QRA.
9	MHF considerations (including: SFARP demonstration, control measure adequacy)	A description of relevant project design decisions and engineering control measures included in the design to date is included in the QRA report as per Table 3.2 and APPENDIX G. However, the QRA does not include detailed adequacy assessments of control measures or details of assurance of their integrity via the relevant facility operator's SMS. This will be covered as part of the overall update to the MHF Safety Assessment at the relevant time in the project schedule.
10	SMS	IXOM operates under an SMS that covers the elements of HIPAP 9 *Safety Management Systems* and has been reviewed as part of the MHF Safety Case and by various internal and external audits. The QRA does not attempt to quantitatively account for the quality of the SMS. This is because data used to estimate event frequencies in a QRA is based on historical information from a variety of plants and processes with different standards and designs. It is assumed that these generic failure frequencies apply to installations which have safety management systems corresponding to 'industry practice'. This assumption is believed to be conservative in that it will overstate the risk from modern, well-managed installations.
11	Emergency planning	The QRA does not provide details of emergency response to a chlorine release. A detailed emergency plan will be required to meet regulatory obligations prior to commissioning.

Item	Scope area	Exclusion/limitation
12	Cessation of Indorama and Qenos operations 2024	In 2024, Qenos and Indorama shut down operations at the BIP and have confirmed that hazardous materials have been removed with demolition commencing (see https://botanyindustrialpark.com.au/updatesalerts/) This means: • The overall BIP QRA risk contours last submitted to DPHI in Nov 2024 under BIP DA 30/98 are no longer relevant and are not used as a basis of comparison in this QRA report. • Escalation effects due to potential explosions at these facilities are no longer relevant to IXOM facilities and have not been assessed. Note that future potential land uses (i.e. non-hazardous industrial warehousing) have been assessed in the QRA as a societal risk sensitivity case as per Section 8.4 of this report.

3. FACILITY DESCRIPTION

3.1. Location

The location of the CLP building is in the 'Block L' within the IXOM boundary, in the western area of the BIP, and to the north of the existing CAP as shown in Figure 3.2 and APPENDIX C. This location was selected as:

- separation distance to the residential area to the east along Denison St is maximised
- separation distance to the IXOM Main Admin building and existing CAP control room is maximised
- the additional extension of compressed chlorine gas piping from the existing CAP to the CLP is minimised
- the plot provides adequate space for the CLP within IXOM's existing leased land
- the location provides for current and future traffic flow through the overall BIP site.

3.2. Surrounding land use

The BIP site is bounded to the north by Corish Circle, the east by Denison St, the south by Beauchamp Rd and to the west by the Botany Goods railway line easement. The land around most of the BIP site perimeter is zoned commercial and industrial. The rail easement is adjacent to the CAP process area, with the BIP/rail easement fence line approximately 15 m away from the edge of the nearest process area.

The exception is land adjacent to part of the eastern boundary of the BIP, which is zoned residential, with significant residential areas along Denison Street. The nearest residential site along Denison St is approximately 200 m to the east from the main CAP chlorine process areas (lower hazard areas such as the salt heap, bulk Class 8 chemical storage tanks and some utilities are closer). On the western side, there are residential areas extending west from Stephen Rd. Banksmeadow Public School is located near Stephen Rd, about 650 m southwest of the nearest BIP boundary.

The nearest known sensitive land use is Matraville Public School, approximately 400 m to the east of the Denison St BIP boundary.

The area around Corish Circle at the northeast corner of the BIP is zoned recreational (Hensley Athletic Field), and beyond this to the north is the large commercial Eastgardens shopping complex.

The BIP land is industrial. There is no change to the BIP zoning proposed as part of the Qenos/Indorama shutdown, i.e. for the purposes of the QRA the BIP remains industrial.

3.3. CLP capacity and operating modes

The CLP will have a maximum production capacity of 50 tonnes per day but will typically operate at a reduced rate to supply liquefied chlorine in 13-tonne tankers to the NSW region.

There are two operating modes:

- Normal operations case: During normal operation, the CLP is operated at rates between 10% capacity to full capacity). The produced chlorine is primarily used to fill road tanker to supply the liquid chlorine demand in the NSW region.
- Contingent operations case: During contingent operation, when the chlorine liquefaction plant at the Laverton, Victoria is unavailable, the Botany CLP will run at full capacity and facilitate tanker loading as well as chlorine drum and cylinder filling.

The CLP will not have a significant impact on chlorine derivative product volumes produced under normal operation as shown in Table 3.1.

Table 3.1: Chlorine usage and production rate of the Botany plant

Chlorine usage/ production rate	CAP*	HCL*	HYPO*	FERRIC*	LIQUEFACTION
Maximum, t/d	97	50	34	18	50
Minimum, t/d	40	15	6	5	5

During normal operation, the CLP will be continually monitored from the remote control room. It will be unattended except when:

- a tanker is being moved to or from the building,
- a tanker is being connected or disconnected,
- during routine inspection, or
- during maintenance or for handling of chlorine drums and cylinders.

Neither the operator nor the driver is expected to be in attendance for the duration of the filling of a tanker.

The plant will operate up to full capacity only in the unlikely event that the Laverton CLP became non-operational for an extended period to supply the national liquefied chlorine demand. Chlorine gas for derivative product requirements would be less available through this period. In this contingent operation mode, the Botany CLP will be used to degas and fill 920 kg chlorine drums and 70 kg, and 33 kg chlorine cylinders in addition to 13-tonne chlorine tankers.

In normal operation, the space required for drum and cylinder filling functions will be used to store drums and cylinders that are currently stored in an outdoor storage area. In the contingent operation mode, internal storage of drums and cylinders will be restricted and IXOM will use its supply chain capacity and existing licensed chlorine container storage locations across Australia to continue to handle and store containers.

3.4. Plant layout

A plant layout diagram for normal operation is provided in Figure 3.4. Layout diagrams for both modes are provided in APPENDIX C.

3.5. Chlorine liquefaction plant details

The CLP will be designed from proven equivalent IXOM processes consistent with industry good practices guidance for chlorine liquefaction. It will comprise:

- liquefaction unit comprising a shell and tube heat exchanger to liquefy chlorine
- ammonia refrigeration system with intermediate refrigerant (most of this system will be located outside of the containment building as it will not contain chlorine)
- chlorine separator to separate liquefied chlorine from any uncondensed chlorine gas and other incondensable gasses
- two 50-tonne chlorine stock tanks to store up to 50-tonne of liquefied chlorine at -34°C and atmospheric pressure. One tank will be kept in service and the other kept empty on standby
- two chlorine storage pumps to distribute chlorine for tanker and container filling
- vacuum chlorine catch pot to ensure any liquefied chlorine from filling functions will pass the absorption system as gas
- chlorine tanker loading station
- two chlorine drum filling stations
- two chlorine cylinder filling stations
- eight chlorine drum degassing stations
- twelve chlorine cylinder degassing stations
- degas reactor to absorb any uncondensed chlorine gas and other non-condensable gases from the separator and intermittent liquefied chlorine and chlorine gas from chlorine container filling and degassing functions. The degas reactor will be located outside of the containment building as it will contain minimal chlorine. The vent from the degas reactor will be directed to the containment building scrubbing system.
- containment building scrubbing system to absorb any fugitive emissions of chlorine in the building and to provide secondary absorption of any chlorine gas from storage and container degassing and filling functions.

3.6. Process description

A block diagram is shown in Figure 3.3. Process Flow Diagrams (PFDs) are provided in APPENDIX C.

The process is summarised below:

- The liquefaction unit is responsible for receiving chlorine gas from the CAP compressor and liquefying it. It also separates the liquid chlorine from non-condensable gas components, which mainly consist of carbon dioxide, nitrogen, hydrogen and oxygen.
- Two 50-tonne chlorine storage tanks (designed as pressure vessels) will operate in a duty/standby arrangement with one always kept empty. These tanks are insulated and self-cooled via chlorine evaporation. The tanks will be fitted with:
  - vents to allow transfer of gaseous chlorine to the degas reactor, and
  - two liquid chlorine transfer pumps (duty/standby) to provide recirculation flow and transfer liquid chlorine to tanker loading bays as well as drum and cylinder filing units. Pumps will be configured to allow remotely operable transfer to the standby tank in the case of failure of the online tank
- The tanker filling and production units will supply liquid chlorine to tankers, drums, and cylinders, as well as degassing of returned drums and cylinders.
- The degas reactor system absorbs chlorine gas from several sources by contact with sodium hypochlorite solution. Vent gas from the liquefier and chlorine storage tank are absorbed in the degas reactor scrubber. Sodium hydroxide solution is used as the motive fluid for an ejector in the system to remove chlorine from the piping systems used to fill and degas chlorine containers and to remove chlorine in cylinders that need to be degassed. The degas reactor system also efficiently removes liquid chlorine from drums before residual chlorine is degassed The absorption of the chlorine into the caustic makes sodium hypochlorite product which is sent to existing CAP storages and the degas reactor is replenished with 'fresh' caustic.

The liquefaction building scrubber is continuously running. The scrubbing system prepares dilute caustic for the degas reactor system. It scrubs vent gas from the degas reactor to ensure chlorine concentration is below 1 part per million (ppm) during normal operation. In case of a chlorine gas leak in the building, it's capacity will extend to scrub chlorine from the air in the building to below 25 ppm at the elevated vent exit before discharging the air to atmosphere.

3.7. Chlorine liquefaction plant building

3.7.1. Overview

All handling, storage and packaging of liquid chlorine will be managed within a containment building. An isometric view of the CLP building is shown in Figure 3.1.

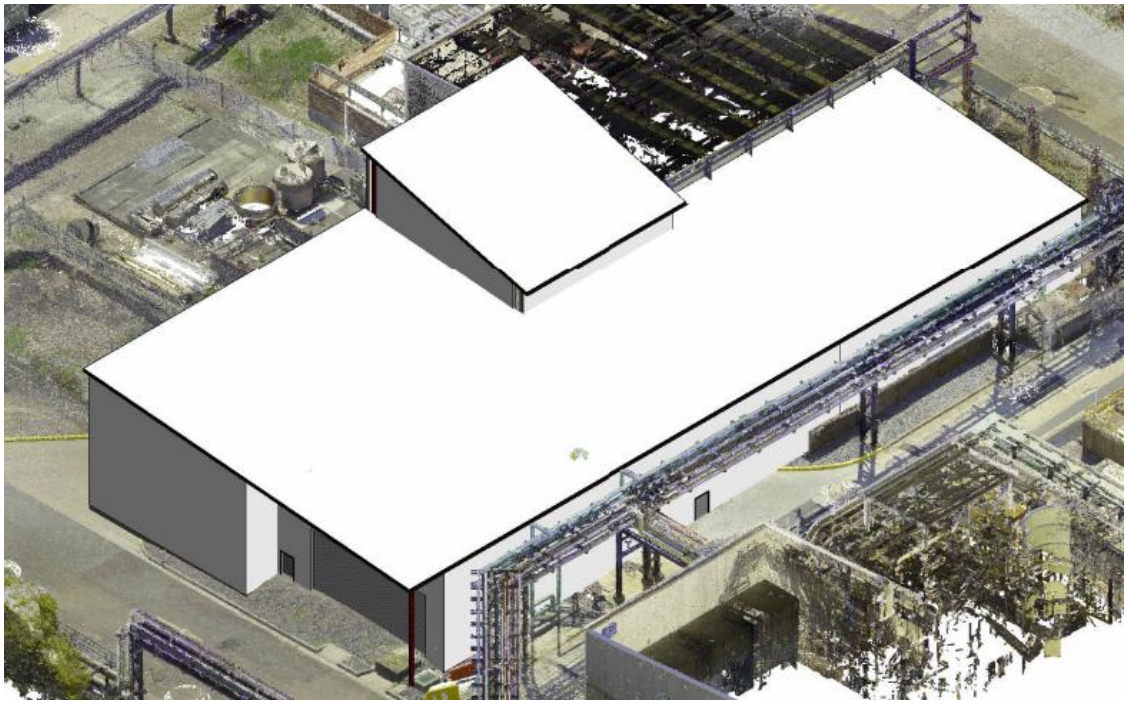
The CLP building has two roller doors on the west and east sides for vehicles entering/exiting the building, and four self-closing pedestrian doors located at each side of the building for operator access. Doors are designed to minimise air leakage. The

roller doors only open to allow for vehicle entry and exit and remain closed at all other times.

The CLP building has a footprint of 1,258 m^2. The building wall is approximately 7 m high on the southeast side and ranges from 10 m to 15 m high on the other sides of the building. The total volume of the building is 11,402 m^3.

Liquefaction plant equipment and chlorine storage tanks are located on the northwest side of the CLP Building. On the southeast side of the building, there is a double-line driveway to facilitate chlorine drum and cylinder (container) loading/unloading operations from the transport vehicle. The building space on the west side of the building is used for either container storage or chlorine container degas, filling and storage depending on the plant operation mode. For normal operation, either full or empty containers, are stored at the west side of the building. For contingent operation, the west side of the building shall have the container packing equipment installed. Refer to APPENDIX C.

Figure 3.1: Isometric view of the Chlorine Liquefaction Plant building



3.7.2. Building ventilation system

The building ventilation system has been designed to comply with Australian Standard (AS) 1668.1-2015, AS 1668.2-2012 and AS 2927-2019. It will provide 39,960 m^3/hr to meet the most onerous standard requirement. The system consists of motorised inlet air louvres, dedicated exhaust ducting, a centrifugal exhaust fan, a motorised damper at the fan intake and an outlet stack. The fan draws air from outside the building, through the motorised inlet air louvres and discharges the air through the outlet stack.

The fan will normally be running to provide ventilation of the building except when it is manually stopped or when chlorine is detected in the building. A motorised air damper is provided at the fan intake. The damper will close when chlorine is detected in the building. Orange flashing beacons will be mounted inside and outside the building at each access point to indicate when the ventilation system is not in service and to initiate an evacuation of the building.

Inlet air louvres are located in the upper section of the south-east building wall. The louvres will provide weatherproofing of the building and be fitted with vermin proof mesh. The inlet air louvres are normally in the open position but will close if chlorine is detected in the building and if the scrubbing system is not in operation.

The exhaust ducting will extend inside the building and extract air from the building close to ground level in the northern side of the building. The exhaust air extraction points will be regulated to provide even flow through each point. This arrangement will promote even air changeover across the building.

Control of the exhaust fan, the damper at the fan inlet and the motorised inlet louvres and all associated monitoring of the ventilation systems including chlorine gas detection is conducted at a Local Control Panel (LCP) outside of the building and is interfaced with the site Distributed Control System (DCS) system.

The benefits of such a design are:

- the damper on the fan suction will shut off immediately if chlorine gas is detected within the building retaining chlorine in the building
- lower risk of chlorine release through the inlet air louvres as the louvres are located away from potential chlorine leak points.

The makeup air louvres fail close. A chlorine gas leak would be contained in the unlikely event that the scrubbing system is not available.

3.7.3. Liquefaction Building Scrubber (LBS) System

The LBS system is provided to scrub chlorine gas from the building if required.

The LBS system has capacity to treat all chlorine release scenarios including the very unlikely events of a storage tank or road tanker catastrophic failure. The system uses the motorised air inlet louvres and also consists of dedicated exhaust ducting with dampers, a packed column served by redundant fans and pumps and an outlet stack. If the system must operate to attend to a chlorine gas leak in the building, a fan draws air from outside the building, through the motorised air inlet louvres, into the exhaust ducting through dampers, across the packed column, where any chlorine in the gas is absorbed, and then discharges the air through the outlet stack.

The LBS uses dilute sodium hydroxide solution in a packed column to absorb chlorine. The system has redundant analysers to continually monitor the capacity of the sodium

hydroxide solution to absorb chlorine and to allow for the solution to be replaced as required.

The LBS is served with redundant pumps and fans in a duty/standby arrangement. The pumps provide recirculation of sodium hydroxide solution across the column. The fans induce a draft of gas through the column. Power to scrubber pumps and fans are supplied from separate supplies and those supplies are backed up by emergency generator.

The LBS has exhaust ducting that is independent of the building ventilation ducting. The ducting is made from PVC and is connected to the inlet of the LBS. The LBS ducting extends to potential chlorine leak points in the building and will be installed close to grade. At each extension, a damper is installed. The dampers are normally closed and will fail open. The dampers open automatically when chlorine is detected by sensors located near the dampers. The exhaust ducting also contains a damper in the common section of duct upstream of the LBS outside of the CLP Building. This damper will also open automatically when chlorine is detected by sensors located near the dampers. This damper is normally closed and will fail closed to contain a chlorine leak in the building if the LBS is not available. The state of the damper will be able to be manipulated from the field as required. Red flashing beacons will be mounted inside and outside the building at each access point and a siren will call attention to when chlorine is detected in the building to initiate immediate evacuation. The dampers can also be opened from the DCS or from hand switches on a control panel outside the building. When a damper opens, air is drawn into the through the building, through the associated extension point, and into the LBS.

The LBS is always in operation. The primary function of the LBS system is to always be available to scrub a potential chlorine gas leak in the CLP building. The LBS also receives scrubbed vent gas from the degas reactor when any processes upstream of the degas reactor are in operation.

The LBS system supplies sodium hydroxide solution to the degas reactor and both the inventory and quality of sodium hydroxide solution is maintained in the LBS system through the addition of sodium hydroxide solution from CAP caustic storage.

Some benefits associated with the LBS system include:

- full redundancy for LBS fans and pumps under a power failure or a switch room failure event
- the LBS is always available to immediately attend to a chlorine gas leak as it will always be in operation
- air flow through the LBS system is restricted in normal operation to minimise the formation of carbonate in the scrubber solution and ensure scrubber performance.

The scrubber solution is continuously replenished in normal operation when the degas reactor is in service to ensure ‘fresh’ caustic for maximum efficiency/absorption.

3.8. CLP interface with CAP

The CAP is an existing MHF which manufactures gaseous chlorine and caustic soda and then uses the chlorine to make hydrochloric acid, ferric chloride, and sodium hypochlorite in downstream product plants. Liquid chlorine (from IXOM's Laverton plant) is also stored in drums, cylinders and a road tanker at the CAP.

3.8.1. Location and layout changes

The only change to the existing CAP layout is that the existing sodium hypochlorite tanker loading facility (located on Block L) will be moved north of the existing outdoor chlorine drum and cylinder area adjacent to the existing caustic loading bay. Drums and cylinders and also the parked tanker will be relocated to inside the CLP containment building.

3.8.2. Production and process changes

There will be no changes to the overall production rate from the CAP, up to 50% of the production rate that is currently used by existing products plant will be able to be diverted to the CLP if chlorine is required to be liquefied.

The CLP sources two DGs from the CAP and supplies one DG back to the CAP as per the following interfaces:

- Chlorine gas is sourced from the main supplying the hypo plant which runs in the pipe bridge alongside the new building.
- Sodium hydroxide (50% /w sodium hydroxide (NaOH) solution) is sourced from one of two 1,800 tonne storage tanks on site through redundant pumps and dedicated piping.
- Sodium hypochlorite (13.5% /w av. chlorine (Cl_2) solution) is transferred from the liquefaction plant back to the Sodium Hypochlorite Storage Tanks in the CAP.

The plant will also source various utilities from the site including electricity, nitrogen, compressed air, towns water and cooling water. Trade effluent and stormwater will be discharged into existing systems.

The proposed development will not affect the maximum production rate of the CAP, and no modification is required to the existing CAP process equipment i.e. the only changes are the pipework interfaces as mentioned above.

Figure 3.2: Site location

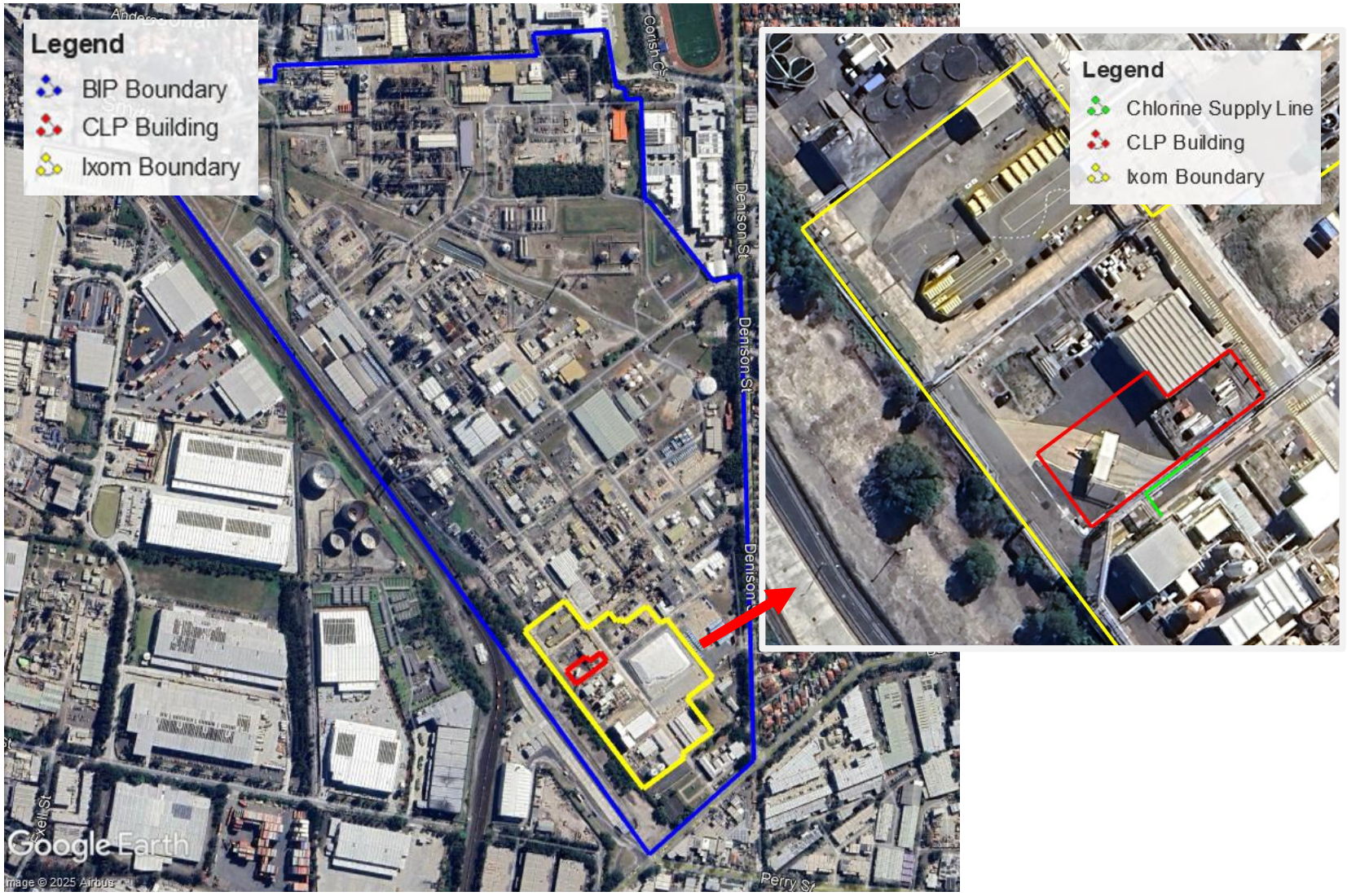


Figure 3.3: CLP block diagram

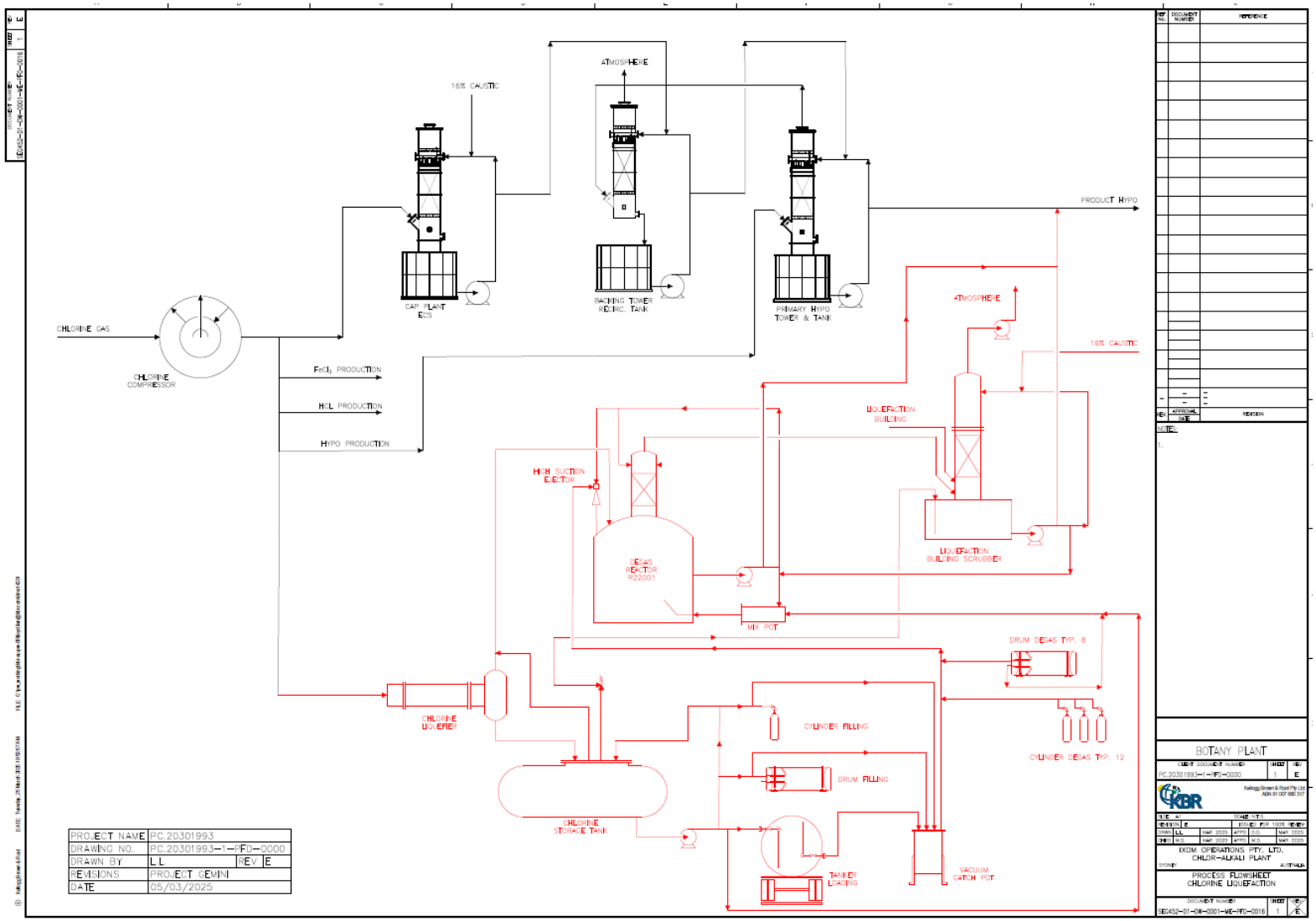
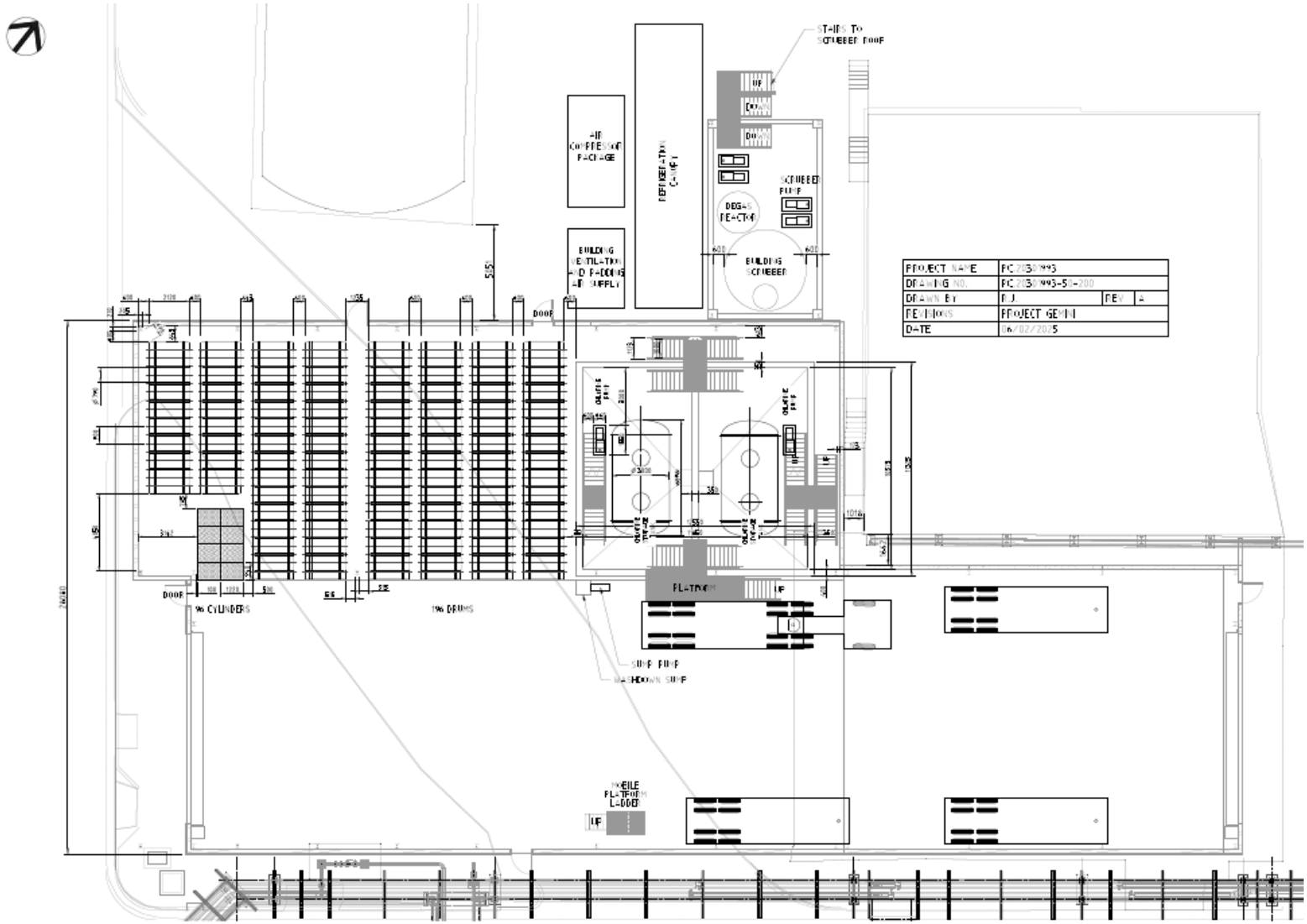


Figure 3.4: CLP building layout



3.9. Risk minimisation

Major Incidents (MI) scenarios associated with the CLP are typically chlorine releases. A summary of overall high level design choices that minimise risk of such events is provided in Table 3.2.

The overall intent of the design with respect to risk is to:

- ensure that the cumulative offsite individual risk (i.e. including the CLP) is not materially higher than from the current CAP operations, and
- ensure that the worst-case consequence is not larger than from the current CAP operations.

The following approach is also generally consistent with the HIPAP 4 qualitative risk criteria as follows with further detail provided in Table 9.2:

- the risk from a major hazard should be reduced wherever practicable, even where the likelihood of exposure is low,
- the effects of significant events should, wherever possible be contained within the site boundary, and
- where the risk from an existing installation is already high, further development should not pose any incremental risk.

Note that there are also numerous engineering controls including Safety Integrity Level (SIL) rated instrumentation which will be further defined as part of the detailed design.

The approach is consistent with the intent to minimise risk SFARP as required under the MHF legislation and the design choices summarised in Table 3.2 will provide input to the demonstration required as part of the MHF Safety Case.

Table 3.2: Design choices to minimise risk

Design	Risk reduction hierarchy	Description
Development area – Block L within BIP selected	Substitute	Selection of site within BIP to ensure: • separation distance to the residential area along Denison St is maximised (other options were closer to Denison St) • separation distance to the IXOM Main Admin building and CAP control room is maximised. • extension of compressed chlorine piping from the existing CAP to CLP is minimised
Refrigerated storage condition for liquid chlorine	Eliminate/ Substitute	Replaces pressurised ambient temperature storage conditions with low temperature atmospheric pressure conditions. Note that storage tanks are still designed as pressure vessels eliminating loss of refrigeration as a cause of loss of containment. This minimises the flash fraction and hence scale and severity from a loss of containment of liquid chlorine.
Minimisation of bund surface area	Engineering control (passive)	Individual bunds are designed for each chlorine storage tank to contain leaked chlorine. The bund area is minimised to operationally practical size to reduce the evaporation rate from a loss of containment of liquid chlorine allowing building scrubber to be designed to practical scale. Refer to Section 6.3 for assessment of surface area on evaporation rate and associated effect distances. Bund coating will be selected at detailed design phase to minimise heat inleak/evaporation rate.
Minimisation of bulk Chlorine inventory and provision of spare empty bulk tank	Engineering control (passive)	Bulk inventory storage minimised to operationally practical level of nominally 1 day production. Minimises the scale of the loss of containment that needs to be contained by building. Spare tank provides redundancy to transfer material and contain a leak in the event of vessel or tanker failure in the building. Pumps will be configured to allow remotely operated transfer between tanks. One tank is always kept empty.
Containment building large enough to carry out all liquid storage and handling activities and sized to contain flash fraction of liquid chlorine scenarios including filled road tanker after warming up	Engineering control	The chlorine storage tanks, pumps and associated facilities will be located inside a large containment building. The design intent is that leaks can be fully contained (i.e. no significant openings in building that cannot be closed, designed to withstand both pressure and vacuum effects for worst release of chlorine) and then directed to a high reliability scrubber at a manageable rate to treat chlorine to a safe level before release via the scrubber stack. There is also an opportunity to re-locate the existing chlorine drums from outdoor storage area and the parked road tankers will remain inside the containment building with the intent of reducing the risk to below the current CAP risk level. The risk reduction effect of the containment building has been quantified in the risk model with an allowance for 5% 'unavailability' as per Section F2.

Design	Risk reduction hierarchy	Description
Building scrubber	Engineering control	Highly reliable continuous scrubber provided: • continuously running on low speed, ramp up fans on Chlorine detection (NOTE: if fans are already operating and do not ramp up then this affects the rate of contaminated air treated and does not affect the outlet concentration) • 3 x 100% fan/circulation pump sets (independent power supplies including back-up generator) • continuous supply of caustic (without top more than 1 hour of containment capacity) • continuous removal of chlorinated caustic (capacity provided at Hypo Storage Tanks). Note that the option of a batch scrubber was not selected to eliminate the risk of the scrubber not being able to start on demand. The advantage to locating the CLP at the existing CAP is that there is a readily available caustic supply available, and the hypo generated by the scrubber can be directed to the Hypo Plant storage tanks meaning that a continuously running scrubber is technical feasible.
Chlorine detection and automatic isolation	Engineering control	Multiple chlorine detectors will be installed onsite at various locations. In the case of detection of chlorine, the automatic control system will be activated to isolate the facility, and the operations will be immediately stopped. This will minimise the quantity of chlorine released into the building that will require treatment by the scrubber. The scrubber fans will also ramp up automatically to scrub chlorine from the gas released into the building. Note the building is under negative pressure so there is no release outside the building.
Intermediate non-hazardous refrigerant for refrigeration package	Substitute	To eliminate cross contamination and nitrogen trichloride formation. Prevents any interaction between ammonia (refrigerant) and chlorine in liquefaction building and avoid generation of nitrogen trichloride, an intermediate refrigerant (carbon dioxide) will be used in the refrigeration unit. The ammonia refrigeration unit, which contains limited inventory, is located outside the CAP building with no direct contact with chlorine. This approach also minimises the inventory of ammonia required

3.10. Abnormal event control philosophy

While all equipment in the CLP is equipped with control and monitoring systems to prevent Loss of Containment (LOC) events, the CLP design also includes safeguards to mitigate the potential consequences. The controls are summarised in APPENDIX G (Hazard Identification table). The controls implemented in the design are based on good industry practices published by chlorine industry associations (e.g. The Chlorine Institute, Euro Chlor).

In the event of a chlorine release within the CLP, the key control to mitigate offsite impacts is the containment building and scrubber system.

- The building is a physical barrier which confines any chlorine in air to within the building and obstructs and contains toxic gas dispersion. The building has no significant openings that cannot be closed both locally and remotely from the CAP control room.
- The scrubber system maintains a negative pressure within the building. A fan draws air from outside the building, through the motorised air inlet louvres, into the exhaust ducting through dampers, across the packed column, where any chlorine in the gas is absorbed, and then discharges the air, with a chlorine content less than 25 ppm, through an elevated outlet stack.

The containment building in combination with a reliable scrubber system ensures that the toxicity level of a chlorine leak from process equipment primary containment is reduced to below injurious levels.

The design basis of the scrubber is provided in Table 3.3.

Table 3.3: Scrubber design summary

Parameter	Value
Column dimension (L x W x H)	1.3 m x 1.3 m x 5 m
Stack height	18.7 m
Venting gas flowrate (emergency condition)	10,000 m^3/hr
Design case chlorine in inlet gas	4,200 kg/hr[(a)]
Target chlorine concentration in discharge[(b)]	Less than 1 ppm (normal operation) Less than 25 ppm (chlorine leak event)

Notes:

(a) The scrubber design accommodates both the rupture of a chlorine tanker and the rupture of a stock tank. The scrubbing system has capacity to scrub the maximum liquid chlorine inventory (i.e. 50 t).

(b) Consequence modelling for release of equivalent flowrate Cl_2 under design conditions when treating a leak (i.e. 25 ppm in 10000 m^3/h air is 0.0002 kg/s Cl_2) shows concentrations > Acute Emergency Guideline Level (AEGL) 2 are limited to less than 10 m from the stack and remain elevated 17 m above ground level. These scenarios are not included in the QRA as they have no effect on fatality, injury or irritation risk at receptor heights of 1.5 m.

4. STUDY BASIS AND ASSUMPTIONS

4.1. Overview

The risk assessment requires multiple inputs and assumptions. The key inputs to the study are provided in the following sections. An overall assumptions register is provided in APPENDIX B which summarises the approach to key assumptions, together with commentary on the sensitivity and level of conservative in the assumptions.

Broadly the QRA assumptions are conservative in that inventories and throughputs are assumed to be at the upper limit all the time. A best estimate approach which reflects known conditions, data or operations is typically adopted for assumptions where data is available, e.g. meteorological conditions, population data, frequency estimates.

4.2. Inventory and throughputs

The liquid chlorine inventory for the current operations as well as the proposed CLP is summarised in Table 4.1. Throughputs are summarised in Table 4.2.

Table 4.1: Chlorine inventory QRA basis

Product	Basis – current CAP[a,b,c]	Basis – CAP including CLP[d]
Stored Cylinders (70 kg) (ambient conditions)	100 cylinders Outdoor storage area Assumed present 100% of time.	100 cylinders Inside liquefaction building Assumed present 100% of time.
Stored Drums (920 kg per drum) (ambient conditions)	200 drums Outdoor storage area Assumed present 100% of time.	200 drums Inside liquefaction building Assumed present 100% of time.
Bulk chlorine tanker (13 t) (ambient conditions)	1 parked tanker Outdoor area 50% of time as per conditions of consent	1 tanker being filled (refrigerated) 1 tanker warming up (to above 0°C) prior to going on road Inside liquefaction building
Bulk storage (refrigerated conditions)	-	2 x 50 tonne storage tank (duty/standby arrangement) Inside liquefaction building 1 tank assumed full 100% of time. The other tank is kept empty and on-standby.

Notes:

(a) CAP in-process inventory estimated at 150 kg unchanged by CLP.

(b) Minor extension to compressor Chlorine header (from CAP plant compressor discharge) in QRA model.

(c) No change to CAP max production rate – CLP is simply another user as per existing products plants.

(d) Storage is assumed to be the same, i.e. upper limit for normal and contingent cases. For the contingent case it is likely that the number of stored drums/cylinders at any one time will be lower as they will be filled to order then immediately dispatched to customers. This has not been accounted for in the QRA

Table 4.2: CLP chlorine throughputs QRA basis

Botany CLP Facility	Unit	Normal	Contingent	Comment
CLP maximum production rate	kg/s	0.58	0.58	Note normal case will typically be a production rate of 0.06 kg/s (10% of max capacity). Conservatively, the normal case also assumes full production rate.
Number of cylinders stored		100	100	All inside containment building.
Number of drums stored		200	200	All inside containment building.
Number of drum trucks through site	per year	484	520	
No of drums filled per year	per year	0	13520	Based on max 26 drums loaded on every truck and consistent with Laverton annual throughput. Assumes contingent mode activity occurs over full year. Conservative.
No of drums handled	per year	12584	13520	Note 2024 CAP QRA has 5650 full drums per year as actual site throughput so conservative.
No of road tankers through site	per year	156	187	
No of road tankers filled	per year	156	187	All 13 tonne tankers.
No of road tankers parked	per year	1 (50% of time)	1 (50% of time)	Road tanker is assumed to be parked inside containment building up to 50% of time as this is consistent with existing CAP conditions of consent. This is in addition to the time road tankers are present while being filled. Conservative.

4.3. Meteorological data

The meteorological data up to 2024 from Sydney Airport has been used as per Table 4.3. The detailed analysis of the data and the wind rose are provided APPENDIX D.

The following environmental conditions were used for consequence modelling:

- Ambient air temperature: 19°C
- Relative humidity: 67%.

Table 4.3: Meteorological data summary

Pasquill stability class	Wind speed (m/s)	Description
B	2.8	Daytime, moderate wind speed
D	1.7	Low wind speed, split between day and night
D	4.3	Moderate wind speed, split between day and night
D	8.4	High wind speed, split between day and night
E	3.1	Nighttime and moderate wind
F	1.4	Nighttime/early morning, low wind speed

4.4. Population data

The day and night population data used for the societal risk calculations reflects the recent changes to the BIP operations and surrounding areas as discussed in APPENDIX E. Population data for surrounding land use is largely from the 2021 Census from the Australian Bureau of Statistics (ABS). As per previous QRAs for the BIP site, the following assumptions have been applied to populations:

- 10% of the population during the day outdoors (with daytime being between the hours of 6 am to 6 pm).
- 5% of the population outdoors at night (with nighttime being between the hours of 6 pm to 6 am).

Population on the BIP site (except for the IXOM facility) is included assuming future land use populations for the Qenos and Indorama areas of the BIP as per Section 8.4.

4.5. Toxicity effects

Fatality and injury effects due to toxic exposure depends on the nature of the material, the concentration, the duration and mode of exposure. Table 4.4 summarises the toxic injury and irritation Acute Emergency Guideline Levels (AEGLs) and probit equations of the form $Pr = A + b \ln(c^n t)$ used to estimate the probability of fatality based on concentration and duration of exposure for chlorine and ammonia. This approach is consistent with previous QRAs for the BIP site, additional details for chlorine toxicity are provided in APPENDIX H, Section H6.

Table 4.4: Toxic fatality, injury and irritation criteria

Material	Probit equation (ppm^n min)	Threshold Concentrations (ppm)		
		Fatality (outdoor dose) Probit prediction – example[(a)]	Injury threshold AEGL 3 (10 mins)	Irritation threshold AEGL 2 (10 mins)
Chlorine (Cl_2)	$-4.86 + 0.5\ln(c^{2.75}t)$	103 ppm (1% fatality 10 mins)	50 ppm	2.8 ppm
		1% fatality equivalent dose: 3.47E6 $ppm^{2.75}$min	equivalent toxic injury dose: 4.7E5 $ppm^{2.75}$min	equivalent toxic irritation dose: 1.69E2 $ppm^{2.75}$min

Material	Probit equation (ppm^n min)	Threshold Concentrations (ppm)		
		Fatality (outdoor dose) Probit prediction – example[(a)]	Injury threshold AEGL 3 (10 mins)	Irritation threshold AEGL 2 (10 mins)
Ammonia (NH_3)	-16.286 + ln(c^2t)	1794 ppm (1% fatality at 10 mins)	2,700 ppm	220 ppm
		1% fatality equivalent dose: 3.32E7 ppm^2.min	equivalent toxic injury dose: 7.29E7 ppm^2.min	equivalent toxic irritation dose: 4.84E5 ppm^2.min

Notes:
(a) This is an example only. QRA fatality, injury and irritation risk estimates use calculated cumulative dose based on variable concentration and variable exposure duration calculated within Riskcurves.

4.6. Offsite risk criteria

For offsite risk Individual Fatality Risk (IFR), toxic injury and irritation risk and societal risk have been assessed against risk criteria in NSW DPHI HIPAP 4 (2011), *Risk Criteria for Land Use Safety Planning*, Ref [2].

4.6.1. Individual risk

Individual risk represents the probability of some specified level of harm (usually fatality or injury) to a theoretical individual located permanently at a particular location, assuming no mitigating action such as escape can be taken, hence is considered to cover sensitive or vulnerable individuals such as the very young, sick or elderly. NSW DPHI quantitative individual risk criteria are summarised in Table 4.5. The criteria are expressed in terms of IFR or likelihood of exposure to threshold values of heat radiation, explosion overpressure or toxicity. For this study, the relevant hazard is toxicity.

Table 4.5: NSW HIPAP 4 risk criteria

Description	Risk criteria (per year)	Applicable
Individual Fatality Risk (IFR)		
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6}	Yes
Fatality risk to residential and hotels	1×10^{-6}	Yes
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6}	Yes
Fatality risk to sporting complexes and active open spaces	10×10^{-6}	Yes
Fatality risk to contained within the boundary of an industrial site	50×10^{-6}	Yes
Injury/Irritation		
Fire/Explosion 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}	No. (No significant flammable inventories)

Description	Risk criteria (per year)	Applicable
Toxic Injury – Toxic concentrations in residential areas 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	10×10^{-6}	Yes
Toxic Irritation – Toxic concentrations in residential areas 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.	50×10^{-6}	Yes
Escalation		
Incident heat flux radiation at neighbouring potentially hazardous installations or at land zoned to accommodate such installations should not exceed a risk of 50 in a million per year for the 23 kW/m^2 heat flux level.	50×10^{-6}	No. (No significant flammable inventories)
Incident explosion overpressure at neighbouring potentially hazardous installations, at land zoned to accommodate such installations or at nearest public buildings should not exceed a risk of 50 in a million per year for the 14 kPa explosion overpressure level	50×10^{-6}	No. (No significant explosive/ flammable inventories)

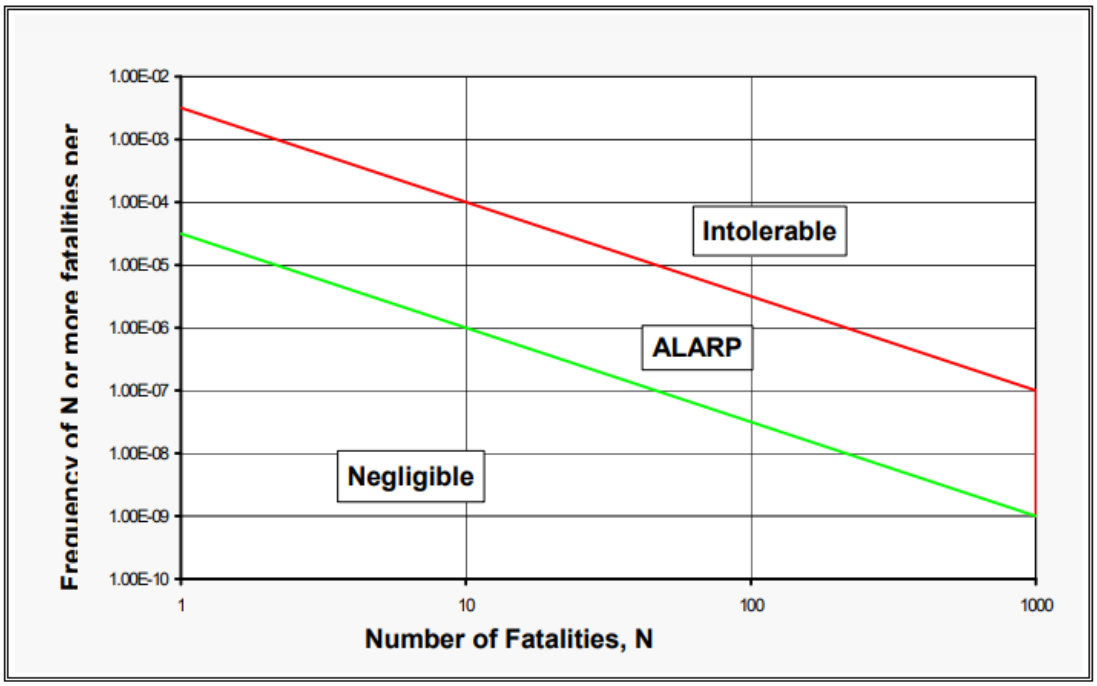
4.6.2. Societal risk

Societal risk is a measure of the probability of incidents affecting an actual population (rather than a theoretical individual as in individual risk). It is usually presented in the form of an 'FN' curve which is a graph of the cumulative frequency of fatality (F) of a number (N) or more people. Societal risk is considered in three regions, Ref [2]:

- 'Intolerable region' represented by an upper criterion line above which an activity is considered undesirable, even if individual risk criteria are met.
- 'Negligible' represented by a lower criterion line below which, provided other individual criteria are met, societal risk is not considered significant.
- 'As Low As Reasonably Practicable (ALARP)' region in between the 'negligible' and 'intolerable' where the emphasis is on reducing risks as far as possible towards the negligible line. Provided other quantitative and qualitative criteria of HIPAP 4 are met, the risks from the activity would be considered tolerable in the ALARP region.

HIPAP 4 provides indicative societal risk criteria as shown in Figure 4.1.

Figure 4.1: Indicative societal risk criteria from Figure 3, HIPAP 4 (2011)



4.7. Software

Consequence calculation was carried out for toxic releases using commercially available risk and consequence assessment software, GEXCON Riskcurves v12.5.1 and Effects v12.5.1. The consequence models used for assessing toxic dispersion within Effects and Riskcurves are documented in the TNO Yellow Book, Ref [7], and supplementary technical manuals for the software.

5. HAZARD IDENTIFICATION

5.1. Overview

Hazard identification is the process of identifying hazardous material properties as well as hazardous incidents that could result in an adverse impact, together with their causes, consequences and existing safeguards. The main hazards associated with the proposed facility are from the storage and transfer of liquid chlorine.

5.2. Hazardous material

The hazardous materials that have the potential to contribute to risk levels are:

- chlorine (Cl_2)
- ammonia (NH_3)
- nitrogen trichloride (NCl_3).

5.2.1. Chlorine

Chlorine is a greenish-yellow highly reactive halogen gas with a pungent odour. It is heavier than air (specific gravity is 2.4 relative to air). It is a highly irritating and corrosive gas that reacts directly with moist surfaces in the eyes and respiratory tract producing hydrochloric and hypochlorous acids. It is easily detected by odour by most people at low levels (around 0.3 ppm).

Chlorine reacts violently with most classes of chemicals, including organics, acids, alkalis and combustibles. It is non-flammable and classified under the Australian Dangerous Goods (ADG) Code as a Class 2.3. Toxicity information is provided in APPENDIX H.

5.2.2. Ammonia

Ammonia is toxic, colourless gas at room temperature. Ammonia toxicity occurs when susceptible individuals suffer exposure to external sources of ammonia via ingestion, inhalation, direct contact with skin, or contact with the eye.

Ammonia is also flammable but is very difficult to ignite with a narrow flammable range. Based on the properties and the small quantities in use, toxic properties are the focus of the hazard study.

5.2.3. Nitrogen trichloride

Nitrogen trichloride (NCl_3) is a highly explosive compound that can form from the reaction of nitrogen-containing compounds (which may be present in the raw materials) with chlorine. It may be present in non-hazardous trace quantities in produced liquid chlorine. If the chlorine is vapourised accumulation of nitrogen trichloride in the liquid chlorine inventory con increase concentration to dangerous level and increases the risk of explosion events that rupture process equipment.

5.3. Hazard identification

Hazard Identification (HAZID) for the CLP was undertaken as a desktop activity based on experience with chlorine plants, review of similar operations and input from the site operators including the project hazard studies completed for the CLP. This included review of the MHF MIs at the IXOM Laverton liquefaction plant in Victoria and was also generally informed by Chlorine Institute and Euro Chlor guidance.

For the existing CAP the most recent 2024 Chloralkali Facility QRA Report, Ref [6], prepared under Development Application DA 35/98 together with updates agreed with DPHI in June 2025 Ref [5], was referenced.

The HAZID table for the CLP is provided in APPENDIX G. The hazardous incident scenarios can be broadly grouped as follows:

- Mechanical failures resulting in liquid or gaseous chlorine leaks from piping and process equipment.
- Liquid or gaseous chlorine leaks due to mechanical failure in storage tanks, drum, cylinder or parked tanker.
- Liquid or gaseous chlorine leaks due to damage during cylinder and drum handling.
- Liquid chlorine leaks from transfer pump or transfer hoses.
- Overfilling of cylinders, drums or road tankers (human error).
- Release of ammonia from ammonia circulation in refrigeration unit.
- Nitrogen chloride accumulation in liquid inventories (explosion hazards).

QRA LOC scenarios have been developed around these scenario groupings as noted in APPENDIX G. Detail of any scenarios screened from quantitative assessment are also provided in the HAZID table in APPENDIX G.

6. CONSEQUENCE ANALYSIS

6.1. Consequence results

Consequence analysis involves quantitative review of the identified hazardous incidents to estimate the potential to cause injury or fatalities.

The consequence results are summarised in APPENDIX H. The consequence modelling results for the CLP scenarios presented do not account for the impact of the containment building and scrubber system (i.e. releases were assumed to occur in an open area with no mitigation) to determine the maximum impact distances.

6.2. Worst-case consequences

The consequence results were reviewed to identify scenarios with the maximum consequence distances to 1% fatality. Among all modelled scenarios for the CLP, the liquid chlorine releases have the biggest consequence impact. The results indicates that the addition of the CLP to the existing IXOM facility does not affect the maximum consequence impact as the existing parked road tanker release scenario has the greatest consequence effect for both the current CAP operational case (parked road tanker at ambient condition) and liquefaction plant (road tanker within the CLP building). Therefore, the CLP does not result in an increase in the maximum consequence effect distance.

Note that the chlorine storage tank has a greater inventory than the tanker, however, as chlorine is stored at atmospheric pressure under refrigerated conditions, and the bund limits the surface area for evaporation this reduced the impact of the storage tank LOC scenarios compared to the parked road tanker impacts.

6.3. Storage tank bund impact

Two 50-tonne tanks in a duty/standby arrangement will store chlorine. Each tank is located in a separate bund. To evaluate the impact of the bund surface area on consequence distance, the storage tank rupture scenario was modelled for nominal bund sizes and the toxic consequence results were compared as per APPENDIX H Section H2. The results indicate that the bund can significantly reduce the impact distance of a major LOC such as tank rupture from 6 km to about 1 km.

A bund area of 57 m^2 for each tank was adopted in the design as an operationally practical minimum and is used in the QRA to limit the spreading area of pools where relevant.

6.4. Effect of building scrubber

As per the design of the building scrubber, a chlorine release within the building will be treated to reduce Cl_2 discharge concentration at the elevated vent (19 m height) to

25 ppm or less. Dispersion modelling of this scenario for all meteorological conditions shows that there is no ground level injury or irritation effects.

Refer to APPENDIX H Section H7.

7. FREQUENCY ANALYSIS

The frequency of an event is defined as the number of occurrences of the event over a specified time period, with the period in risk analysis generally taken as one year. The overall approach and specific frequencies used in the QRA are given in APPENDIX I.

7.1. Release frequencies

To estimate the frequencies of hazardous events, events were estimated based on:

- statistical data for the frequency of failure from equipment items such as drums, vessels and piping,
- an estimated count of equipment items ('parts count') based on Piping and Instrument Diagrams (PIDs),
- operational failures (e.g. road tanker filling) based on the human error probability and number of operations,
- online time probability or proportion of time the equipment is in use.

7.2. Control measures

The risk reduction effect of safeguards in place to prevent LOCs or mitigate the consequences has been accounted for as per APPENDIX I.

At this stage of design the key control accounted for is the building containment/scrubber system for the CLP. An event tree has been developed to estimate the potential unavailability of the building containment/scrubber system. This covers failure modes as follows:

- Proportion of time doors are open (3% for contingent case, 1.3% for normal case) and also fail to close on chlorine detection or when manually activated.
- Failure of scrubber system to maintain extraction from containment building and treat chlorine.
- As per the event tree in APPENDIX F, for the purposes of the planning stage QRA the estimated overall containment 'unavailability' is 5% 'unavailable' for both short duration events where manual response is effective (4%) and completely unmitigated (1%) events. Conservatively the QRA assumes a 5% probability that all events are completely unmitigated, i.e. the LBS has no effect and does not model the short duration events separately.

Note that releases outside the building are not mitigated by the containment building and the event tree does not apply. The equipment outside is the extension of chlorine piping from the CAP, degas reactor, scrubber breakthrough and ammonia refrigeration. Specific scenarios where the building containment/scrubber system applies and does not apply are identified in APPENDIX I.

8. RISK ASSESSMENT

8.1. Modelled cases

A number of cases were defined to compare the cumulative and standalone risk profiles. The modelled cases, which are based on the scenarios defined by the SEARs, are described in Table 8.1.

Table 8.1: Sensitivity cases

SEARs proposed case	QRA case	Description
Cases 1 - 3	n/a	These cases all cover operational cases associated with Qenos and Indorama. Case 1, Case 2 and Case 3 were not modelled, as by early 2025 Indorama and Qenos have shut down and hazardous materials removed (see https://botanyindustrialpark.com.au/updatesalerts/). They are no longer a source of risk and the overall risk contours last submitted to DPHI under DA 30/98 are not relevant.
Sensitivity Case 1	SC1A (CLP - normal case)	CLP only – normal case • No cylinder or drum filling operation • Road tanker filling operation inside CLP building • Storage of cylinders/drums as well as road tanker parking area inside building
	SC1B (existing CAP)	CAP only – current operation • No cylinder, drum or road tanker filling operation • Storage of cylinders/drums as well as road tanker parking area in open space This case was defined to determine the impact of the CLP on the current risk profile. The 2024 CAP QRA risk results were used including updates agreed in 2025 with DPHI, Ref [5, 6].
	SC1C (modified facility CAP & CLP - normal case)	Cumulative risk – normal case • No cylinder or drum filling operation • Road tanker filling operation inside CLP building • Storage of cylinders/drums as well as road tanker parking area inside building
Sensitivity Case 2	SC2A (CLP - contingent case)	CLP only – contingent case • Cylinder, drum and road tanker filling operation inside CLP building • Storage of cylinders/drums as well as road tanker parking area inside CLP building
	SC2B (existing CAP)	CAP only – current operation Not modelled explicitly, same as SC1B
	SC2C (modified facility CAP & CLP - contingent case)	Cumulative risk – contingent case • Cylinder, drum and road tanker filling operation inside CLP building • Storage of cylinders/drums as well as road tanker parking area inside CLP building

8.2. Individual fatality risk results

8.2.1. CLP risk

SC1A (CLP – normal case) represents the normal operational case for the CLP, and SC2A (CLP – contingent case) shows the effect of cylinder and drum filling on the standalone liquefaction plant offsite risk assuming that this activity occurs over one year. The IFR contours for SC1A and SC2A are shown in Figure 8.1.

The cylinder and drum filling operation slightly increases the CLP risk as can be seen by the effect on contours. However, all IFR criteria in HIPAP 4 are met for CLP alone for both the normal and contingent cases.

8.2.2. Cumulative risk results (CAP and CLP)

The cumulative impact of the CLP on the existing CAP risk was assessed and the IFR contours for normal and contingent cases are shown in Figure 8.2 and Figure 8.3 respectively.

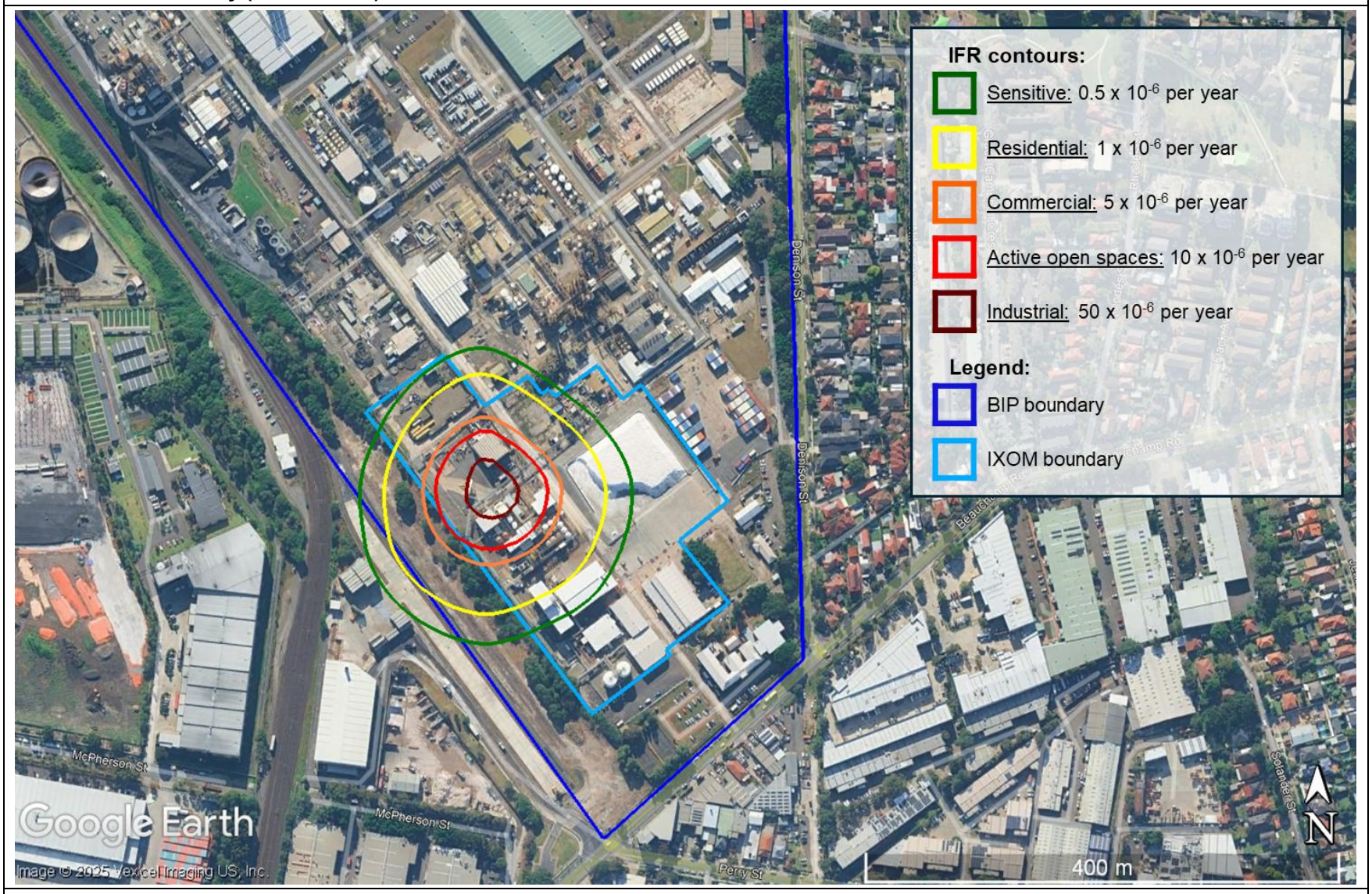
All fatality risk criteria are met for the cumulative (CAP plus CLP) risk case for both normal and contingent CLP operations as the 50 x 10^{-6} per year contour remains within the IXOM boundary and other contours do not extend to non-industrial land uses. (Note that it is assumed that the current Qenos and Indorama area remains industrial land use only as there is no current proposal for rezoning any part of the BIP).

A comparison between the most recent CAP risk contour (i.e. SC1B/SC2B) and the cumulative cases (i.e. SC1C and SC2C) indicates that the new risks posed by the CLP operations are managed by the proposed control measures and the CLP operation does not materially affect the existing risk level.

- Figure 8.4 compares the 1 x 10^{-6} per year contours for the cumulative cases (SC1A and SC2A) as well as the most recent CAP risk contour (SC1C/SC2C) for reference.
- Normal case: Comparing the cumulative risk against the current CAP risk indicates that the addition of the containment building would result in a reduction in the overall extent of the risk contour at the 1 x 10^{-6} per year level for the normal CLP cumulative case. This is because the drum storage and road tanker parking area (which are the current dominant risk contributor in the far field for the CAP) have been relocated inside the containment building.
- Contingent case: The 1 x 10^{-6} contours for the cumulative contingent case extend slightly further to the west, east and south than the current CAP case and have reduced to the north. However, there is no impact on non-industrial land and the 50 x 10^{-6} per year contour remains within the IXOM site boundary.

Figure 8.1: IFR contours – CLP only

Case SC1A – CLP only (normal case)



Case SC2A – CLP only (contingent case)

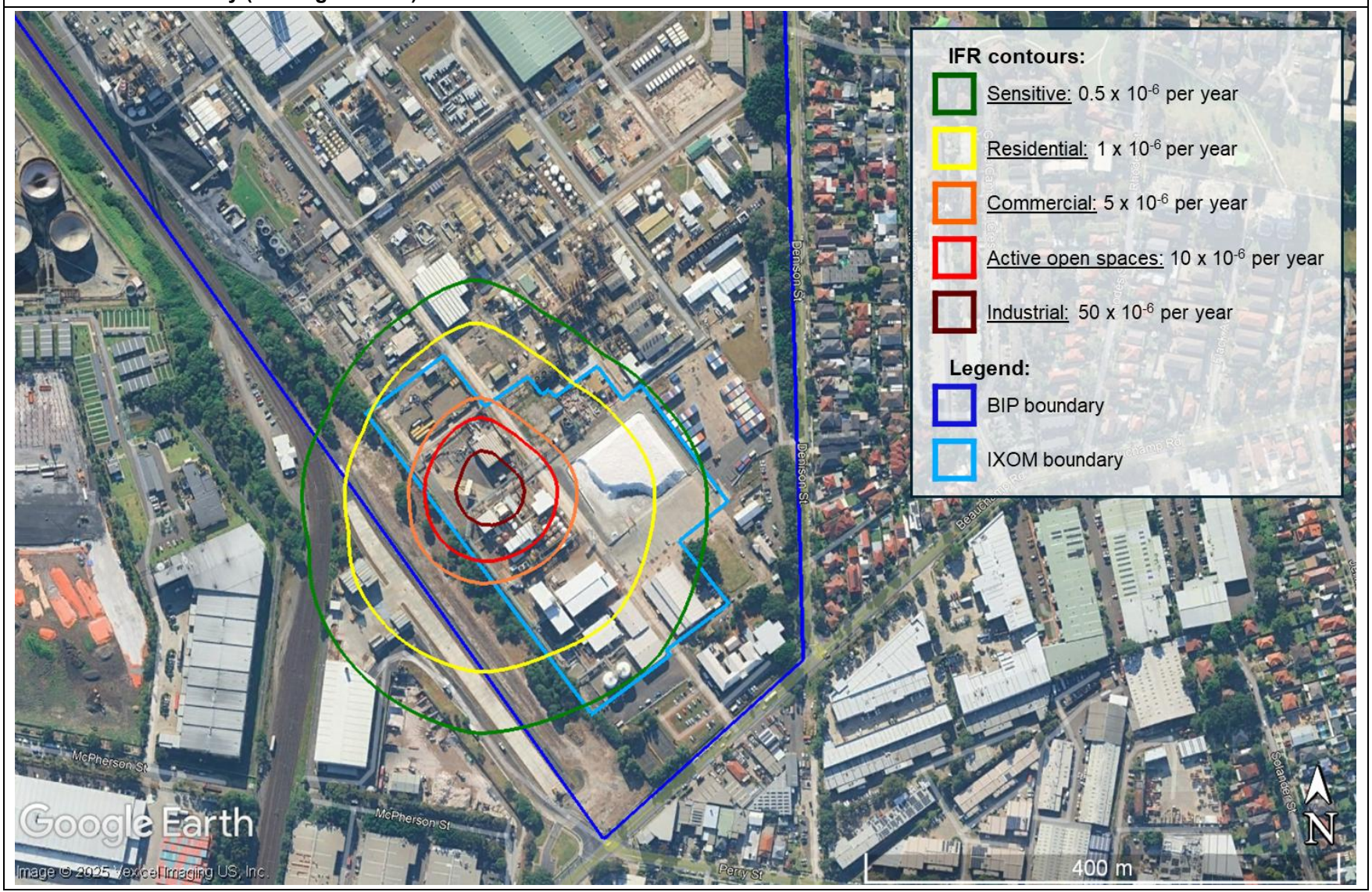
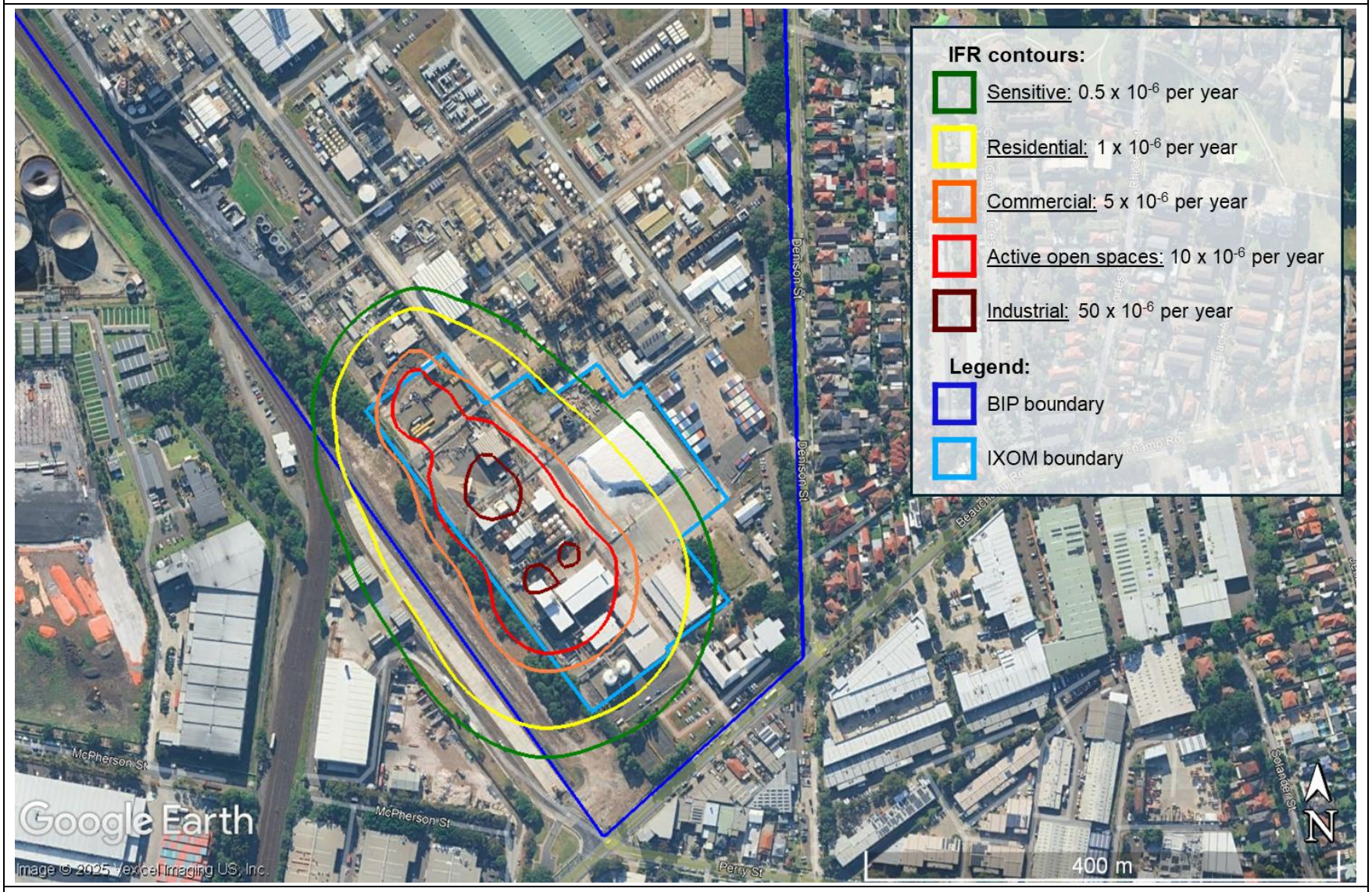


Figure 8.2: IFR contours – cumulative risk (normal case)

Case SC1C – modified facility (cumulative CAP & CLP normal case)



Case SC1B – existing CAP for reference

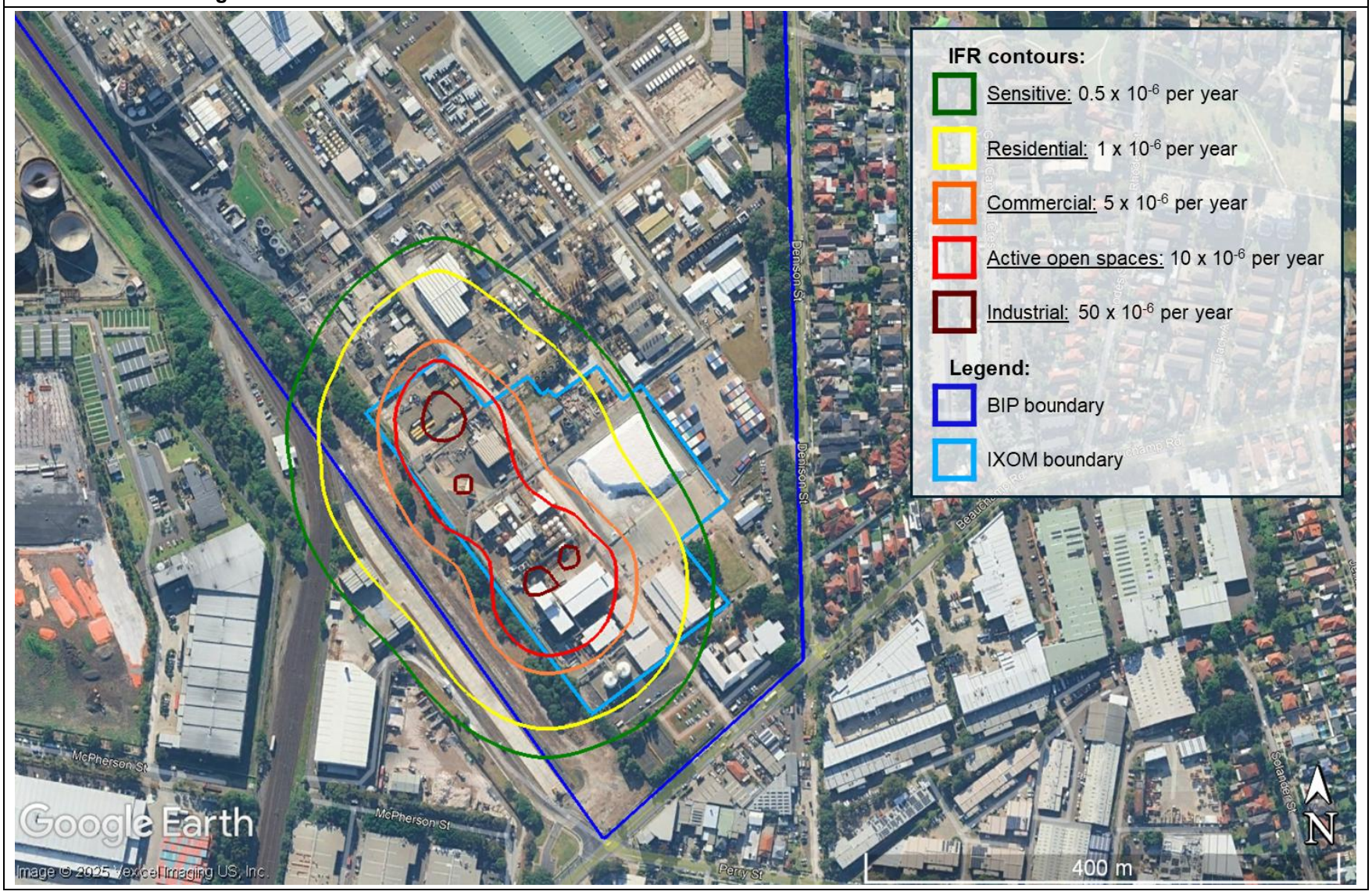
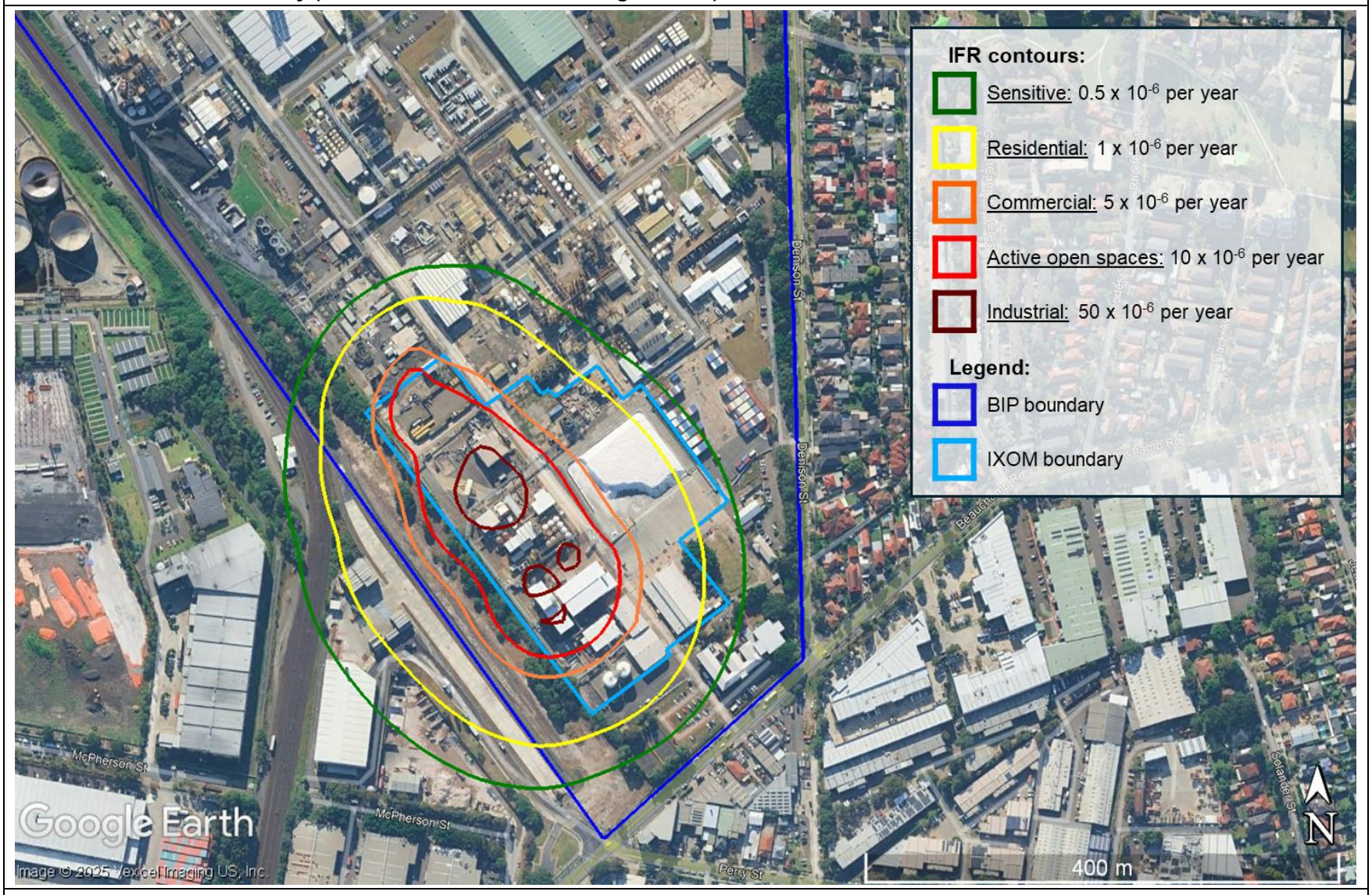


Figure 8.3: IFR contours – cumulative risk (contingent case)

Case SC2C – modified facility (cumulative CAP & CLP contingent case)



Case SC2B – existing CAP for reference

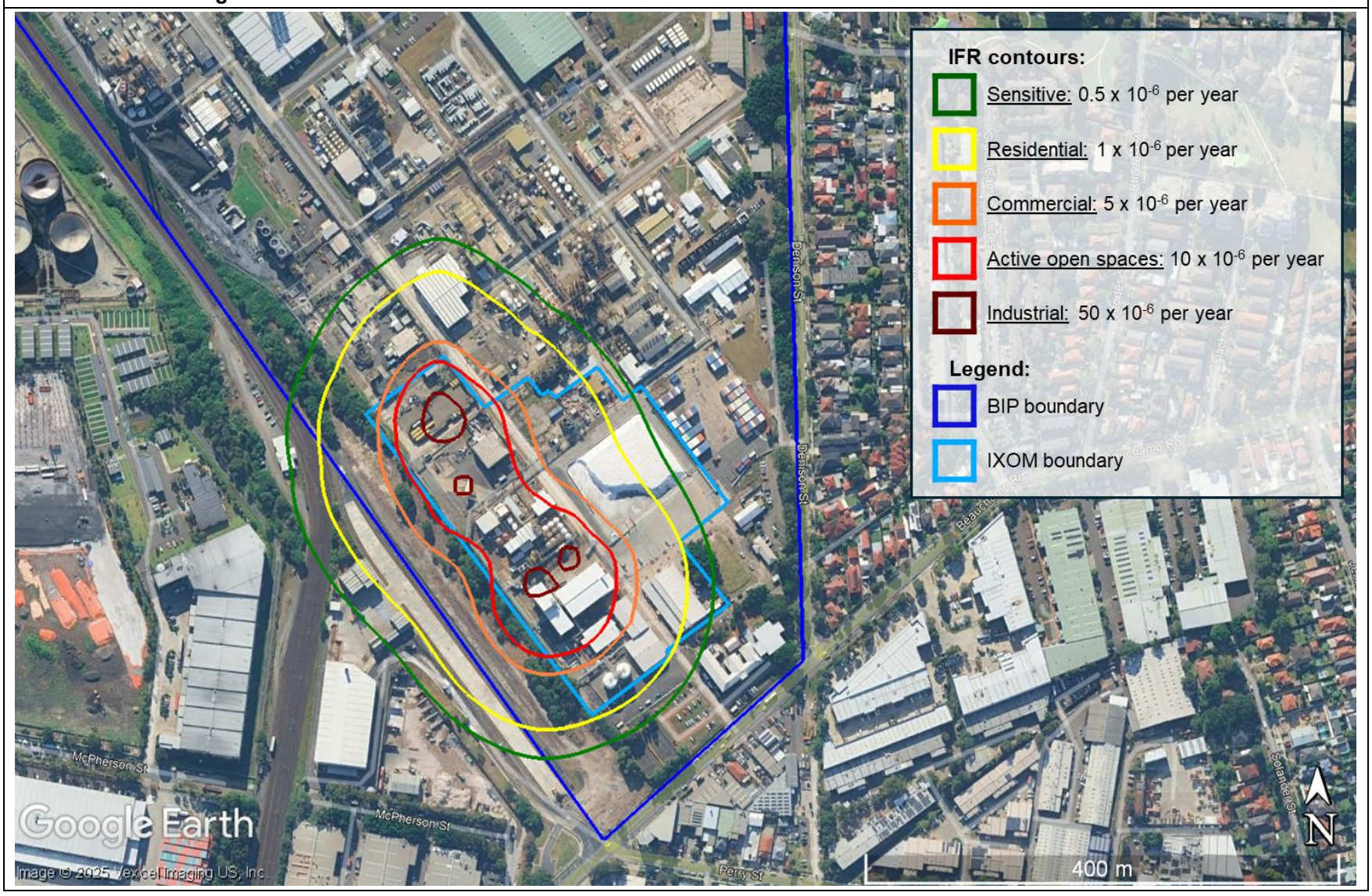
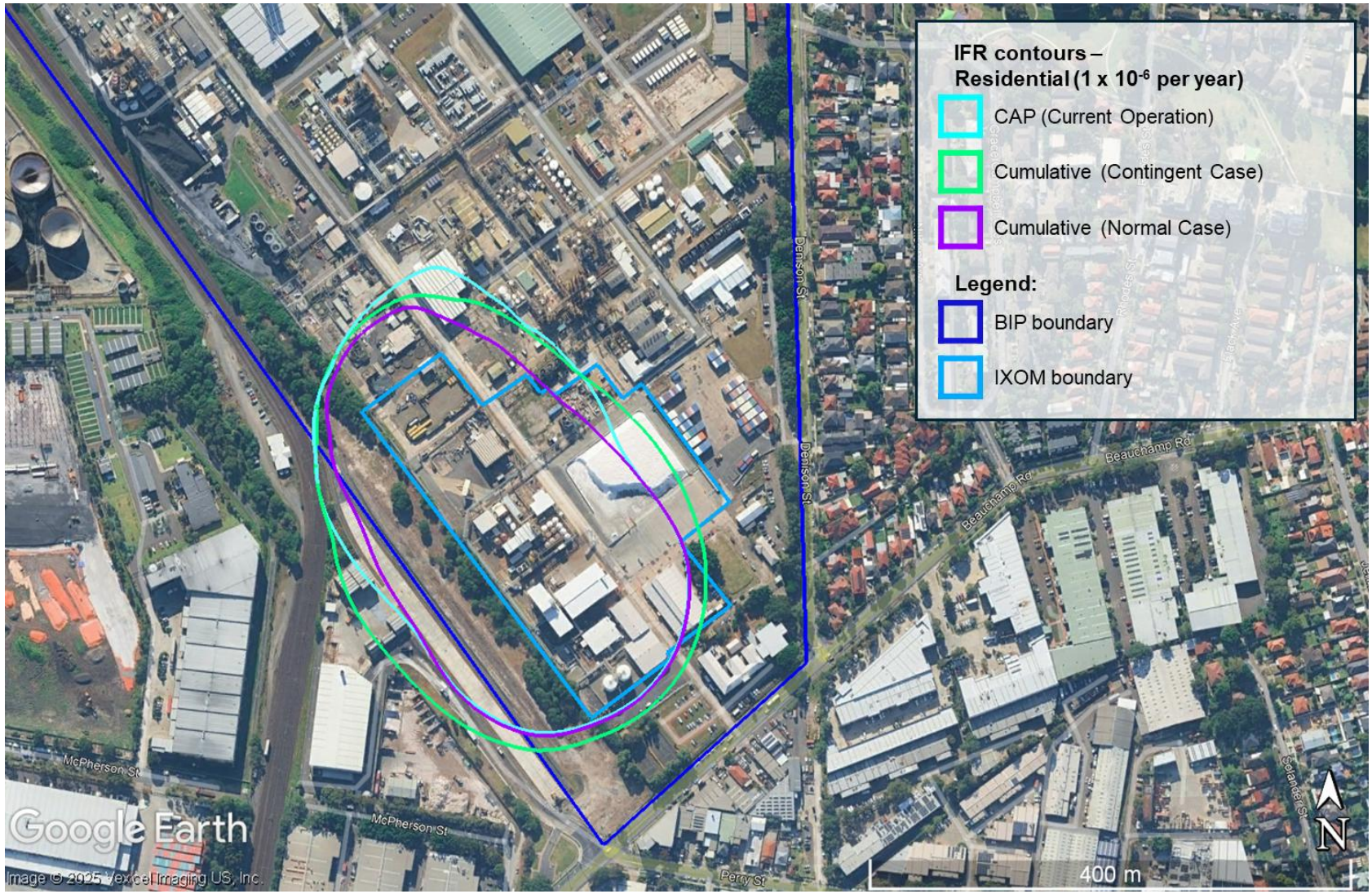


Figure 8.4: CLP impact on future risk comparison of 1x10^{-6} per year individual fatality contour



8.3. Injury and irritation risk

The injury and irritation contours indicate the likelihood of a threshold toxic dose being exceeded at a particular location.

Figure 8.5 shows the 10 x 10^{-6} per year toxic injury risk contours for the cumulative normal and contingent cases (SC1C/SC2C) and the CAP only, which represent frequency of exceedance of a toxic dose corresponding to the AEGL 3 (10 mins). For all cases, the contour extends beyond the IXOM and BIP boundaries. However, they do not reach the nearest residential areas to the east or any sensitive land uses, so the HIPAP 4 toxic injury criterion is met.

Figure 8.6 indicates the 50 x 10^{-6} per year toxic irritation risk contours for the cumulative normal and contingent cases (SC1C/SC2C) and the CAP only, which represent frequency of exceedance of a toxic dose corresponding to the AEGL 2 (10 mins). For all cases, the contour extends beyond the IXOM and BIP boundaries. However, they do not reach the nearest residential areas to the east or any sensitive land uses, so the HIPAP 4 toxic irritation criterion is met.

Figure 8.5: Toxic injury contour (AEGL 3 equivalent toxic dose, 10 x 10^{-6} per year contour)

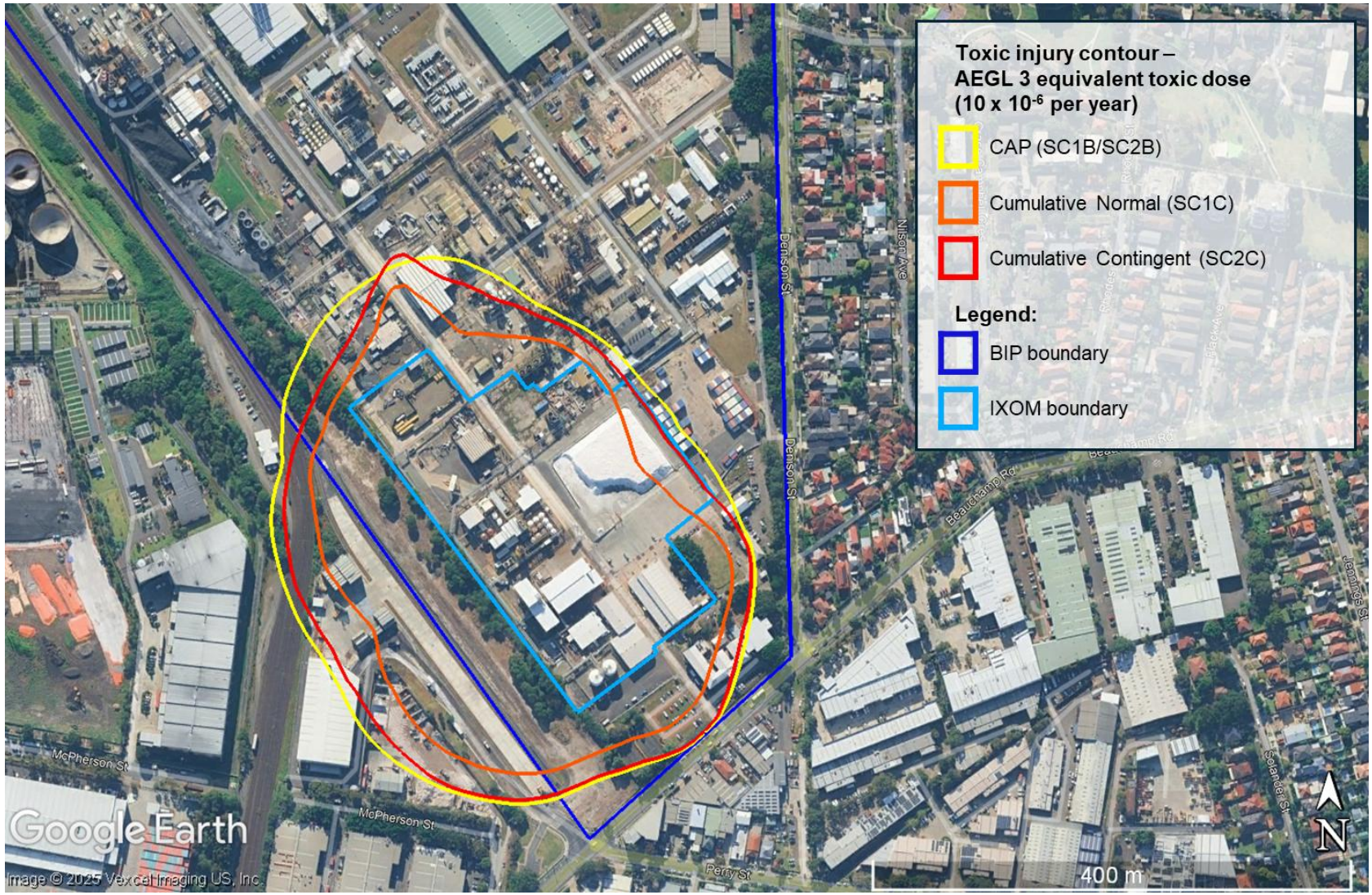
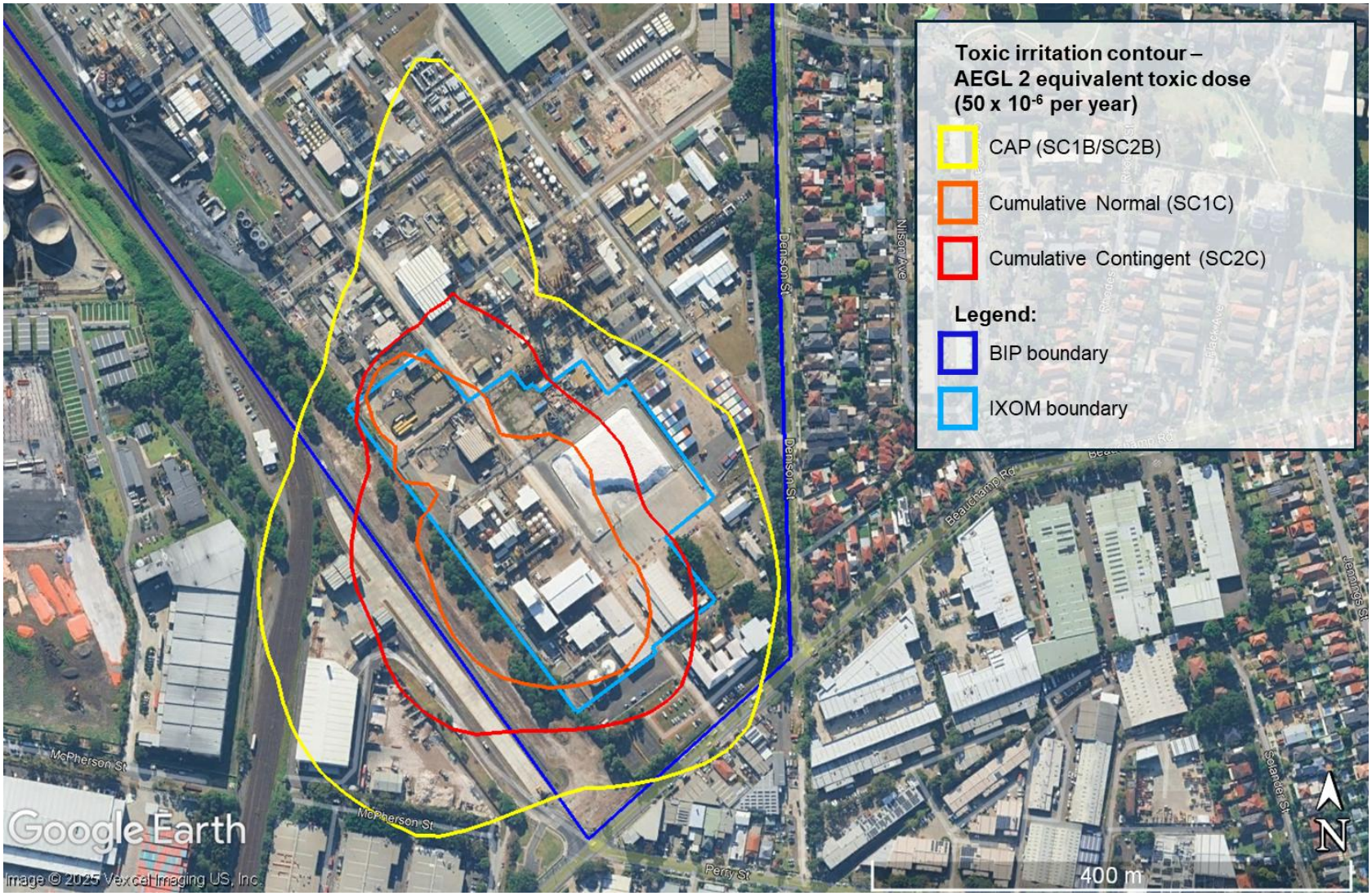


Figure 8.6: Toxic irritation contour (AEGL 2 equivalent toxic dose, 50 x 10^{-6} per year contour)



8.4. Societal risk

8.4.1. Current population

The societal risk calculations were conducted using the most recently available population data from the 2021 Census as summarised in APPENDIX E for populations around the BIP. Note this is consistent with the most recent CAP QRA and also the most recent overall BIP QRA (as submitted to DPHI in 2024).

Note that by convention for societal risk calculations, the population on the site under consideration is not included in the total population, so the population on the IXOM site is not included in societal risk calculations.

8.4.2. Future population

The future population on Qenos/Indorama sites is not clear yet. However, ESR the buyer of the site intends to develop industrial warehousing and advises 40 people per hectare is a conservative basis for these sites. The following case was therefore defined for societal risk assessment:

- 40 people per hectare for daytime, and
- 4 people per hectare for nighttime.

8.4.3. Mitigation taken into account

The concentration of gas inside a building engulfed by a gas cloud will rise gradually until the release has stopped and the cloud diluted to non-hazardous levels. The indoor concentration then falls gradually towards zero. The peak concentration will be less than outside, (unless the duration of the release is very long, or the building has very high ventilation rates). Hence, a person inside will normally be exposed to significantly lower gas concentrations than someone outside and the risk of fatality from a toxic gas will be significantly less for a person located indoors than the risk in the open at the same location.

The toxic dose to indoor populations is calculated within the risk software based on building ventilation rates. For this QRA, natural ventilation (1 air change per hour) was assumed.

8.4.4. Societal risk results

The societal risk associated with the CAP current operation as well as the cumulative normal case and contingent case are presented in Figure 8.7, including the effect of the future population on the former Qenos and Indorama areas on the BIP site.

The results indicate that the societal risk level for the cumulative case does not reach the ALARP or intolerable regions. There is some increase in the societal risk which still remains fully within the negligible region. This is due to increased event frequencies from extra equipment and time in use of equipment primarily tanker loading for the normal

case, and additionally drum filling hoses for the contingent case with the leak coinciding with failure of containment building and scrubber (i.e. accounting for the 5% 'unavailability'). However, as the societal risk remains fully within the negligible region for all cases it fully meets the HIPAP 4 societal criteria which states that

> *'Below the negligible line, provided other individual criteria are met, societal risk is not considered significant.'*

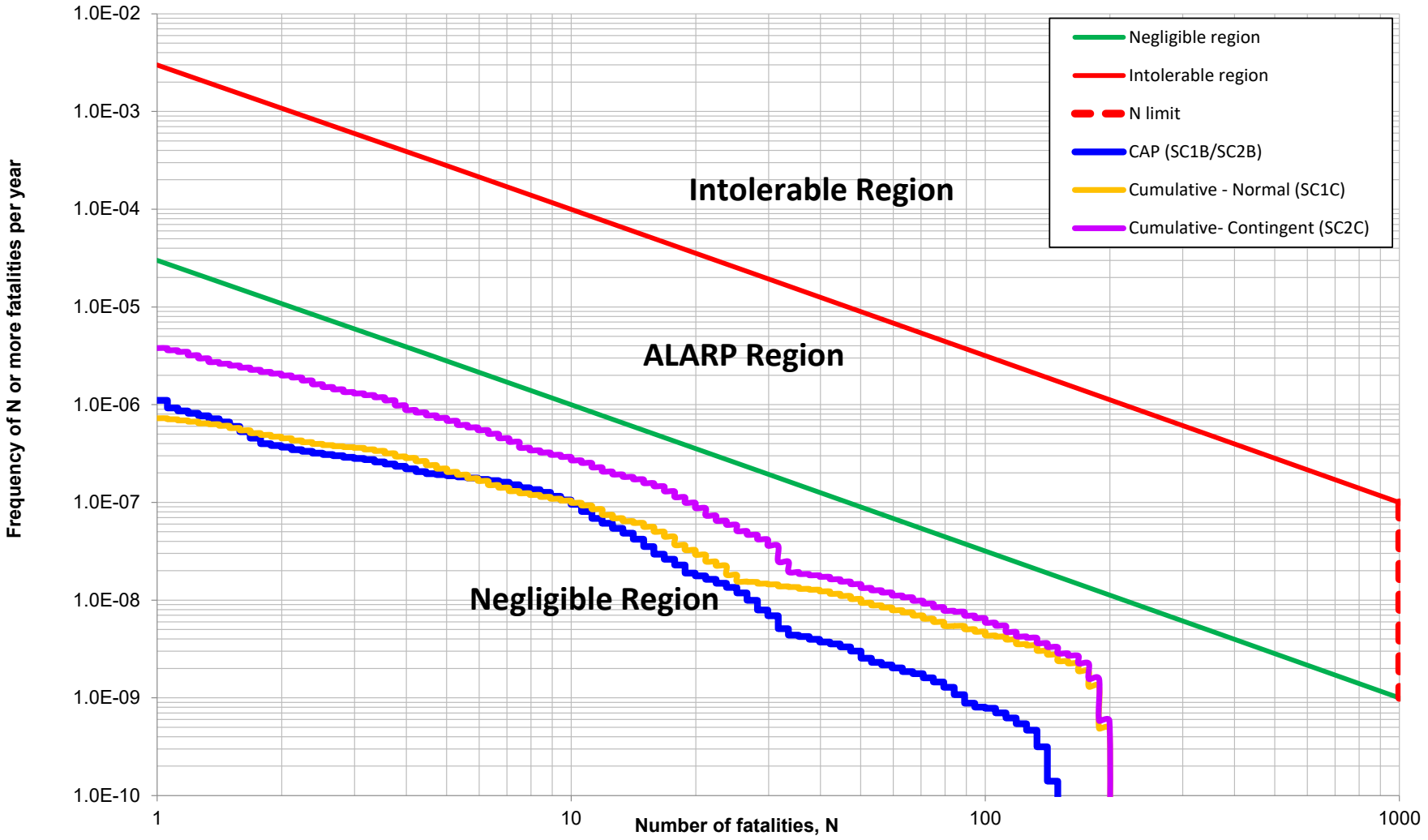
8.5. Risk contributors

APPENDIX J summarises the significant risk contributors (i.e. scenario contributing around 80-90% of the risk as a specific location) at the IXOM site boundaries and at various distances from the IXOM facility (albeit at low absolute risk levels below the HIPAP 4 criteria) for both the normal and contingent cases.

The major contributors to the offsite individual fatality risk are un-isolated liquid chlorine releases due to hose failures or piping failures in pumped liquid piping, i.e. for tanker loading for the normal case, and for drum and cylinder filling as well as tanker loading for the contingent case. It should be noted that these scenarios have been modelled conservatively i.e. the probability of failure of automatic isolation (0.1) and time to isolation (up to 3 minutes) has been selected conservatively for the planning stage QRA and may be refined in detailed design stage (refer to Recommendations in Section 9.2).

The slightly larger individual fatality, injury and irritation risk contours for the contingent case compared to the normal case are due to the increased leak frequency due to higher time in use of equipment (primarily drum filling hoses) in the contingent case which are not applicable to the normal case.

Figure 8.7: Societal risk – Population 1 (additional 40 people/hectare on former BIP operations)



8.6. Onsite risk

The purpose of the planning stage onsite risk calculation is to show that the worker risk will meet the tolerability criteria. The results are not intended to demonstrate that worker risk is reduced SFARP as this demonstration will be undertaken as part of the MHF safety assessment. Risk estimates to onsite employees will be further refined to account for all relevant controls and ensure the risk is reduced SFARP as part of the MHF safety assessment process.

Onsite risk has been estimated for typical roles for both the normal and contingent cases including risk from the CAP plus the future CLP operations using the QRA model as per results in APPENDIX K. Additional factors that are not part of offsite risk calculations are included in the onsite risk estimate as follows:

- Probability of presence (assumptions as per APPENDIX K).
- Exposure controls. In this case for the proportion of time a role is located inside the Control Room or the Main Admin building the toxic dose is reduced by accounting for ventilation rate and shutdown of air conditioning.
- For activities occurring inside the liquefaction building (tanker filling, etc.) the mitigation effect of the containment building is removed from the risk calculation.
- No mitigation factors or conditional modifiers relating to exposure (e.g. self-escape, PPE, local ventilation) for scenarios involving drum or tanker filling operations inside the containment building are accounted for hence the calculations are conservative.

There is no specific on site risk criteria in Australia. Therefore, the risk to a worker assuming a 40-hour work week was assessed against the UK HSE risk tolerability targets (from UK HSE R2P2, Ref [3]) for representative worker roles:

- Maximum tolerable criterion: 1×10^{-3} per year
- Broadly acceptable criterion: $< 1 \times 10^{-6}$ per year.

The resulting individual risk of fatality per annum (IRPA) for all roles is below the UK HSE 'intolerable' criterion of 1×10^{-3} per year and hence will be tolerable for all worker roles including the effect of the CLP as per the summary in Table 8.2.

Table 8.2: Onsite risk as daytime individual fatality risk per annum (IRPA)

Role	Modified facility CAP & CLP – normal case	Modified facility CAP & CLP – contingent case
Day Plant Operator	3.65×10^{-5}	7.15×10^{-4}
Engineers/Planners	4.69×10^{-6}	1.17×10^{-5}
Technical/Quality	5.42×10^{-6}	1.43×10^{-5}
Operations	5.16×10^{-6}	1.24×10^{-5}
Admin staff	1.02×10^{-6}	2.65×10^{-6}

9. CONCLUSION

9.1. Main findings

The proposed development was assessed against the HIPAP 4 quantitative and qualitative risk criteria, as summarised in Table 9.1 and Table 9.2.

Key findings of this study are provided below:

1. Maximum consequence: No scenarios associated with the CLP were identified to have a greater consequence impact to the 1% fatality level than the existing CAP scenarios. The scenario with the largest impact remains a release from a 13-tonne chlorine road tanker at ambient conditions.
2. Control measures: High level design choices that minimise risk include:
   - Selection of the 'Block L' site within the BIP maximises the distance to residential areas along Denison St and also minimises the extension of the pressurised chlorine vapour piping from the CAP to the CLP that cannot be located within the containment building. This also maximises the distance to onsite occupied areas such as the existing CAP control room and administration building.
   - Refrigerated storage conditions (i.e. atmospheric pressure and a temperature of approximately -34°C) limit the release rate and associated evaporation rate of chlorine allowing containment within a building and treatment by a scrubber at manageable rates.
   - Minimising the bund surface area for the storage tanks and other liquid chlorine handling areas significantly reduces spill evaporation rate hence consequence impact of major release scenarios from refrigerated storage at atmospheric pressure such as storage tank failure.
   - Containment building large enough to carry out all liquid storage and handling activities and sized to contain flash fraction of liquid chlorine scenarios including filled road tanker after warming up in combination with the highly reliable scrubber system (which includes redundant fans, recirculation pumps and power supplies) is an effective risk reduction measure for the CLP. The QRA has estimated a 5% 'unavailability' of the containment building and scrubbing system. This will be verified as achievable as part of detailed design as per the recommendations.
3. Offsite risk:
   - All individual fatality risk criteria are met for the modified facility (i.e. cumulative case of CAP and CLP for both normal and contingent cases) as per Figure 8.2 and Figure 8.3 and as summarised in Table 9.1. This is consistent with the existing CAP.

- Due to the effect of the containment building there is only a small difference in offsite risk between the normal and contingent cases as can be seen in the comparative risk contours in Figure 8.4.
- The toxic injury contour (see Figure 8.5) for the modified facility (i.e. cumulative case of CAP and CLP for both normal and contingent cases) does not reach the residential area hence it meets the toxic injury criterion as per the current CAP case.
- The toxic irritation contour (see Figure 8.6) for the modified facility (i.e. cumulative case of CAP and CLP for both the normal and contingent cases does not reach the residential area hence meets the toxic irritation criterion as per the current CAP case.
- Societal risk is in the negligible region for both the normal and contingent cases as per Figure 8.7. The assessment assumes a population of 40 people/hectare on the Qenos and Indorama areas of the BIP.
- Due to the containment building, the individual and societal risk profile does not materially increase compared to the existing CAP plant risk profile.
- The overall extent of the individual fatality risk contours offsite is slightly reduced for the normal case compared to the current CAP due to the opportunity to relocate the existing liquid chlorine storages (drums, cylinder, parked road tanker) from the outdoor location to inside the containment building. The contingent case is slightly increased primarily due to potential leaks from drum filling hoses, except to the north where it is decreased (refer to Figure 8.4 for a comparative risk contour).
- The toxic injury and irritation risk contours are slightly reduced for the normal and contingent cases compared to the current CAP due to the opportunity to relocate the existing liquid chlorine storages (drums, cylinder, parked road tanker) from the outdoor location to inside the containment building (refer to Figure 8.5 and Figure 8.6 for comparative risk contours).

4. Onsite risk: Onsite risk was estimated for typical roles for cumulative case including future CLP operations for the normal and contingent cases using the QRA model and also including adjustments for occupancy to calculate worker IRPA. The IRPA is below the UK HSE 'intolerable' risk of 1 x 10^{-3} per year and hence is tolerable for all worker roles including the effect of the CLP as per Table 8.2.

Risk contributors associated with operation of the modified facility are chlorine releases. There are small quantities of ammonia present in the CLP for the refrigeration system. However, ammonia risk contributions are very low due to the small inventory.

The dominant risk contributors to the offsite individual fatality risk are liquid chlorine releases due to hose failures or piping failures in pumped liquid piping, i.e. for tanker loading for the normal case, and for drum and cylinder filling as well as tanker loading for the contingent case. These scenarios have been modelled conservatively for the

QRA, i.e. generic hose failure rates have been adopted, and the probability of failure of isolation and time to isolation has been selected conservatively for the planning stage QRA. These assumptions may be refined in detailed design stage further reducing the estimated risk.

9.2. Recommendations

The QRA is based on the design stage of the CLP. The key control that ensures the risk does not materially increase compared to current levels is the CLP containment building and scrubber. The dominant residual risk contributors for both the normal and contingent cases are related to failures in equipment for transferring liquid chlorine between storages and tankers, drums or cylinders.

Recommendation 1: *It is recommended that as part of detailed design, the containment building and scrubber design should be verified to ensure that the estimated unavailability of no more than 5% is achieved. It is anticipated that this can be carried out as part of a Final Hazard Analysis (FHA) if project consent is received.*

Recommendation 2: *The QRA has conservatively assessed the probability of failure on demand (PFDavg) of automatic detection and isolation (PFDavg = 0.1) and time to isolation (up to 3 minutes) for isolatable chlorine leak scenarios. It is recommended that as part of detailed design, automatic detection and isolation time and probability of failure on demand for detection and isolation of chlorine leaks from hoses and pumped liquid systems be more accurately assessed to confirm whether greater risk reduction is achievable for the residual risk contributors.*

Table 9.1: Comparison against HIPAP 4 quantitative risk criteria

Description	Risk criterion (per year)	Risk criteria met?		Comments
		Existing CAP only	Modified facility CAP & CLP – normal and contingent cases (SC1C/SC2C)	
Individual Fatality Risk				
Sensitive uses, including hospitals, schools, aged care	0.5×10^{-6}	Yes	Yes	Contour extends past IXOM boundary but does not extend to any sensitive land uses Matraville Botany Public School (Beauchamp Rd). Complies with criteria.
Residential areas and hotels	1×10^{-6}	Yes.	Yes.	Contour extends past IXOM boundary but does not extend to any residential land uses (Denison St). Complies with criteria.
Commercial areas, including offices, retail centres, warehouses	5×10^{-6}	Yes	Yes	Does not reach any commercial land uses. Complies with criteria.
Sporting complexes and active open spaces	10×10^{-6}	Yes	Yes	Does not reach any open space land uses. Complies with criteria.
Contained within the boundary of an industrial site	50×10^{-6}	Yes	Yes	Contour remains within IXOM boundary Complies with criteria.
Injury/Irritation Risk				
Injury (residential and sensitive areas only)	10×10^{-6}	Yes	Yes	Contour extends past IXOM boundary to the south and west but does not extend to any residential or sensitive land uses, e.g. Matraville Botany Public School (Beauchamp Rd) to the east. Complies with criteria.

Description	Risk criterion (per year)	Risk criteria met?		Comments
		Existing CAP only	Modified facility CAP & CLP – normal and contingent cases (SC1C/SC2C)	
Irritation (residential and sensitive areas only)	50 x 10^{-6}	Yes	Yes	Contour extends past IXOM boundary to the south and west but does not extend to any residential or sensitive land uses, e.g. Matraville Botany Public School (Beauchamp Rd) to the east. Complies with criteria.
Societal Risk				
Populations external to BIP	HIPAP 4 (2011) criteria ALARP or negligible	Yes (negligible)	Yes (negligible)	Max N < 1000 Results FN curve within negligible area for all cases.

Table 9.2: Comparison against HIPAP 4 qualitative risk criteria

Criteria	Comments	Consistent?
a) All 'avoidable' risks should be avoided. This necessitates the investigation of alternative locations and alternative technologies, wherever applicable, to ensure that risks are not introduced in an area where feasible alternatives are possible and justified.	As part of the project feasibility studies a variety of alternative locations were reviewed. Location of the plant at the existing CAP which provides appropriate infrastructure to contain and treat chlorine releases was selected as the most practicable option. Refer to additional information in planning application for alternatives considered.	Yes
b) The risk from a major hazard should be reduced wherever practicable, irrespective of the numerical value of the cumulative risk level from the whole installation. In all cases, if the consequences (effects) of an identified hazardous incident are significant to people and the environment, then all feasible measures (including alternative locations) should be adopted so that the likelihood of such an incident occurring is made very low. This necessitates the identification of all contributors to the resultant risk and the consequences of each potentially hazardous incident. The assessment process should address the adequacy and relevancy of safeguards (both technical and locational) as they relate to each risk contributor.	The plant is designed in accordance with inherent safety principles and best practices. The high-level risk reduction measures are discussed in Section 3.9 and include design choices from concept and site selection to engineering controls to reduce the risk SFARP. The CAP is an MHF with a documented SFARP demonstration.	Yes
c) The consequences (effects) of the more likely hazardous events (i.e. those of high probability of occurrence) should, wherever possible, be contained within the boundaries of the installation.	The chlorine releases will be contained within the building. The containment building in combination with the scrubber system would prevent significant impacts outside the CLP boundary. The design intent is to contain a chlorine release in a building and scrub the vent to below hazardous ppm. The containment building in combination with the scrubber system would prevent significant impacts outside the CLP boundary.	Yes
d) Where there is an existing high risk from a hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.	The QRA results demonstrate that the addition of the CLP has minimal impact on individual and societal risk results and does not alter the assessment against risk HIPAP 4 criteria. The overall risk is reduced compared to the current risk due to the opportunity to relocate the liquid chlorine storages (drums, cylinder, parked road tanker) from the outdoor location to inside the containment building.	Yes

APPENDIX A. SEARS CROSS REFERENCES

A1. SEARs (Hazard and risk only)

SEARs – Key issues – Hazard and Risks	
SEARs requirements	**Study approach**
Include a Quantitative Risk Analysis (QRA) in accordance with the Department's Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis' demonstrating that the existing chloralkali plant (CAP) with the proposed chlorine liquefaction plant (CLP) ('the modified facility' up to DA 35/98-Mod-6) complies with both the qualitative criteria, in particular the consideration of site location and technology, and the quantitative criteria in the Department's Hazardous Industry Planning Advisory Paper No. 4, 'Risk Criteria for Land Use Safety Planning'. The QRA must also include:	QRA was prepared as per HIPAP 6 guidance. Assessment against the HIPAP 4 quantitative and qualitative risk criteria is covered in Section 8.
• a site layout diagram showing the location of all buildings enclosing the CLP and dangerous goods (DG) storage, and the location of all DG piping to and from these buildings.	Overall locations and CLP site layout are shown in Section 3.1. Additional site layout diagrams provided in APPENDIX C. The location of all DG piping to and from the new facility is described in Section 3.8.
• a description of all buildings enclosing the CLP and DG storage including: – structural design specifications to enable full containment of major DG release incidents, – building capacities and ventilation rates, – scrubber design specifications including inlet and outlet conditions (flow rates, concentrations, etc.), – building layout diagrams showing the location of the CLP, DG piping to and from these buildings, DG storage, and staging and parking areas for vehicles associated with DG transport for all operating modes of the modified facility.	A description of the building and details such as volume, ventilation and scrubbing provisions and its functionality is provided in Section 3.7. The building structural design specification and layout is provided in APPENDIX C. Staging and parking areas provided in APPENDIX C. The location of all DG piping to and from the new facility is described in Section 3.8.

SEARs – Key issues – Hazard and Risks	
SEARs requirements	**Study approach**
• a detailed process description of the CLP including: – process flow diagrams, – operating conditions (flow rates, temperature, pressure, state of matter, etc.), – maximum DG quantities for all operating modes of the modified facility, and – overview of mass balance between the CAP and the CLP for all operating modes.	A process description is provided in Section 3.6. A control philosophy (PC.20301993-06-100_B) is being reviewed and can be provided on request. Refer to PFDs in APPENDIX C. Some operating conditions are available in the process description. All operating conditions are provided in the master PFD's (PC.20301993-PFD-0010 to 0037) and can be provided on request. Maximum DG are provided in Section 4.2. An overview of mass balance between CAP and CLP available in Section 3.3.
• a description of all necessary modifications at the CAP to accommodate the design and operation of the CLP.	CAP operation is virtually unchanged. With the CLP up to 50% of the output can be diverted to the CLP so total chlorine production does not increase. The project is a change in storage and handling of chlorine. Refer to Section 3.8.
• major incident hazard identification and details of all safeguards to address these hazards with reference to all relevant engineering standards, codes of practice and best practice especially for chlorine and ammonia.	Section 3.9 discusses the safeguards implemented to minimise the risk of major incidents. APPENDIX G provides more details on controls in place for identified hazardous incidents.
• a QRA assumptions register with justification on the appropriateness of all assumptions.	Refer to APPENDIX B. Key assumptions and approach are also described in relevant sections as pre cross reference details.
• a list of all potential major incident hazards which may affect both on-site or off-site and the associated consequence distances with corresponding release conditions including and not limited to the total isolatable quantity, flow rate, temperature, pressure and state of matter.	Refer to APPENDIX H.
• a description of the major incidents control philosophy of the CLP including identification of all preventative and mitigative safety critical engineering safeguards against all major incidents with required reliability for these safeguards where appropriate.	Key approaches are described in Section 3.10 and Section 3.9. APPENDIX I summaries the required reliability of the containment building/scrubber.

SEARs – Key issues – Hazard and Risks	
SEARs requirements	**Study approach**
• justification for all safeguards to minimise the risk from major incidents 'so far as is reasonably practicable' consistent with the intent under the Work Health Safety Regulation 2017 (WHS Regulation).	Key approaches are described in Section 3.10 and Section 3.9.
• all population assumptions with justification adopted in the QRA.	Refer to APPENDIX E.
• risk analysis for both on-site and off-site consequences from the modified facility for all major incident hazards.	Onsite risk is covered in Section 8.4. For offsite risk, refer to Section 8.2 to Section 8.4.
• the individual and societal risk results for the CLP and the modified facility for the following cases, and compare these results against the most recent Botany Industrial Park (BIP) QRA submitted under DA 30/98 and the most recent CAP QRA submitted under DA 35/98 up to MOD 5: – Case 1: Currently approved operations in the vicinity of the modified facility including the Genos and Indorama facilities operating at its consent limits and the CLP operating at its expected utilisation intent across both normal operating mode or contingent operating mode, – Case 2: Currently approved operations in the vicinity of the modified facility including the Qenos and Indorama facilities operating at its consent limits and the CLP is only operating at the normal operating mode at all times, – Case 3: Currently approved operations in the vicinity of the modified facility including the Qenos and Indorama facilities operating at its consent limits and the CLP is only operating at the contingent operating mode at all times,	Case 1, Case 2 and Case 3 were not modelled, as Indorama and Qenos have shut down and de-inventoried (see https://botanyindustrialpark.com.au/updatesalerts/). Therefore, they are no longer a source of risk and the overall risk contours last submitted to DPHI under DA 30/98 are no longer relevant. The future estimated population for future land use, however, were considered for societal risk assessment.
– Sensitivity Case 1: Potential future operations replacing the Qenos and Indorama facilities following permanent shut-down of these facilities and the CLP is operating at its expected utilization intent across both normal operating mode or contingent operating mode, and – Sensitivity Case 2: Potential future operations replacing the Qenos and Indorama facilities following permanent shut-down of these facilities and the worst-case scenario (higher risk profile) between the normal operating mode or the contingent operating mode.	Sensitivity Case 1 and Sensitivity Case 2 were modelled in the risk analysis. The modelled scenarios are detailed in Section 8.1 and results presented in APPENDIX H.

SEARs – Key issues – Hazard and Risks	
SEARs requirements	**Study approach**
• demonstration that risks from the modified facility will not have any effect on future developments in the vicinity of the modified facility;	Results indicate that the risk profile is suitable for industrial land uses. Societal risk has accounted for potential future populations on the BIP. The proposed development will not significantly affect the existing risk level. Any future developments on the BIP will need to go through the DA process in any case.
• address all recommendations from the 2001 Botany/Randwick Industrial Area Land Use Safety Study Overview Report which are relevant to the modified facility;	Refer to APPENDIX L. The CLP and CAP cumulative risk is less than what was previously estimated in 2001. This is because of the inherent safer design and new controls now introduced (e.g. containment building).
• include a Transport Risk Assessment (TRA) to evaluate the potential impacts from DG transport to and from the modified facility with comparison to the TRA findings from Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility);	Transport risk results are presented in a separate document. Refer to Transport Risk Assessment Report, Ref [4].
• Report on the consultation outcomes with: – SafeWork NSW in regard to compliance with the requirements for major hazard facilities under the WHS Regulation, – the Local Emergency Management Committees as per the State and Emergency Rescue Management Act 1989 (SERM Act) for the Bayside LGA and Randwick LGA in regard to emergency planning in the vicinity of BIP, – the Regional Emergency Management Officer as per the SERM Act for the Central Metropolitan Region in regard to emergency planning for the credible worst-case scenarios and identify any issues in addressing such scenarios, – BIP in relation to the potential future land uses within BIP, and – the public in the vicinity of BIP in regard to the perception of risks from the modified facility.	The consultation outcomes are not included in this report and are provided in the overall DA submission.

APPENDIX B. ASSUMPTION REGISTER

The assumptions register below summarises the high-level approach for key inputs to each step of the QRA. Additional details specific to the project is provided in the link in the 'Report Reference' column.

Assumptions are either 'conservative' in that risk may be overstated compared to actual operations, or 'best estimate' where assumptions reflect likely operations or conditions or available data specific to the item. As this is a planning stage QRA for sensitive assumptions a conservative approach is typically applied, which may be refined at the detailed design stage.

Study area	Item	Approach for CLP	Report reference	Comments	Sensitivity of overall modelling	Level of conservatism
QRA basis	Inventories	Maximum isolatable inventory	Section 4.2	Maximum fill level for storage inventories Inventory in isolatable sections at process conditions for process equipment Data developed as available at design stage of project from PFDs/preliminary PIDs	Minor unless there are significant periods of time with low or no inventory	Conservative
	Throughputs	Maximum annual throughputs	Section 4.2	Maximum production rates assumed for both normal and contingent case, i.e. the QRA does not account for the normal case CLP operational production rate typically at 10% of maximum CLP production rate. Maximum annual throughputs for drum/tanker filling assumed	Minor unless there are significant periods of time with operations at low rates	Conservative
	Connecting pipelines	Not applicable	-	There are no pipelines containing hazardous materials connecting the IXOM facilities with any other facilities. Piping connecting the existing CAP and proposed CLP is process piping located within the IXOM site boundary	-	-
	DG Transport	Outside scope	-	Transport of hazardous materials outside the facility boundary is outside the scope of the QRA.	-	-
	Facility boundary	IXOM boundary	-	Boundary for the purposes of assessing risk against criteria is the overall IXOM site boundary (i.e. the IXOM boundary which is within the BIP boundary).	-	-
	Escalation (neighbours)	-	-	No potential events in the remaining plants on the BIP were identified as affecting the chlorine plant. Indorama and Qenos which posed explosion hazards, has now been shut down.	-	-
Hazard Identification	Hazardous materials	Cl_2, NH_3	Section 5.2	The hazardous materials for the CLP are chlorine and ammonia. Other materials are present in the existing CAP refer to CAP QRA report for additional details, Ref [6].	-	-
	Mechanical integrity failures	Quantitively accounted for using parts count and industry statistical leak frequency data	Section 5.3 APPENDIX I.	Statistical data for the frequency of failure from equipment items such as drums, vessels and piping, together with an estimated count of equipment items ('parts count') based on PIDs is used to estimate leak frequencies. The data used to estimate event frequencies in a QRA is based on historical information from a variety of plants and processes with different standards and designs with many contributing causes of failure. It is assumed that these generic failure frequencies apply to installations which have safety management systems corresponding to 'industry practice'. This assumption is believed to be conservative in that it will overstate the risk from modern, well-managed installations such as the IXOM facility which is regulated under the MHF licensing regime.	Sensitive. QRA is primarily depending on the number of equipment items and leak sources included in the model	Conservative
	Operational errors	Identified in HAZID Quantified if significant relative to mechanical integrity failure frequencies	Section 5.3 APPENDIX G APPENDIX I.	Statistical data includes all causes and will therefore include some proportion of human error/operational failures, hence if these are separately quantified there will be an element of double counting. Where relevant operational failures or human error frequency for events that could cause LOC may be estimated based on the human error probability guidance and number of operations where relevant e.g. misalignment of coupling during tanker/drum filling, driveaway. Specific scenarios included/excluded are noted in the HAZID and scenario frequency tables.	Sensitive r May materially affect the risk results if human error frequencies resulting in LOC are high compared to statistical leak frequencies	Conservative
	Process upsets	Identified in HAZID Quantified if significant relative to mechanical integrity failure frequencies	Section 5.3 APPENDIX G APPENDIX I.	Statistical data includes all causes and will therefore include some proportion of process upsets hence if these are separately quantified there will be an element of double counting. Examples of process upset events are high pressure resulting in a vessel failure, overfill resulting in LOC to atmosphere. Typically, these scenarios have multiple hardware control measures and provided standard techniques such as LOPA are used to demonstrate that controls reduce frequency of process upset events resulting in LOC to s a frequency similar to statistical LOC frequencies these are not quantified in the QRA. Specific scenarios included/excluded are noted in the HAZID and scenario frequency tables.	Sensitive r May materially affect the risk results if human error frequencies resulting in LOC are high compared to statistical leak frequencies	Best estimate
	Mixing of incompatible materials (e.g. in road tankers)	Not credible	-	Not credible for CLP tanker filling. The road tankers are specific for chlorine and owned by IXOM. No connection to any other materials. NOTE: Existing CAP QRA includes scenarios for mixing incompatible materials, e.g. sodium hypochlorite and acid	-	-
	External factors/natural hazards	Not quantified	-	No natural hazards (e.g. earthquake, flood) identified as high risks Not under direct flight path. Not quantified	-	-

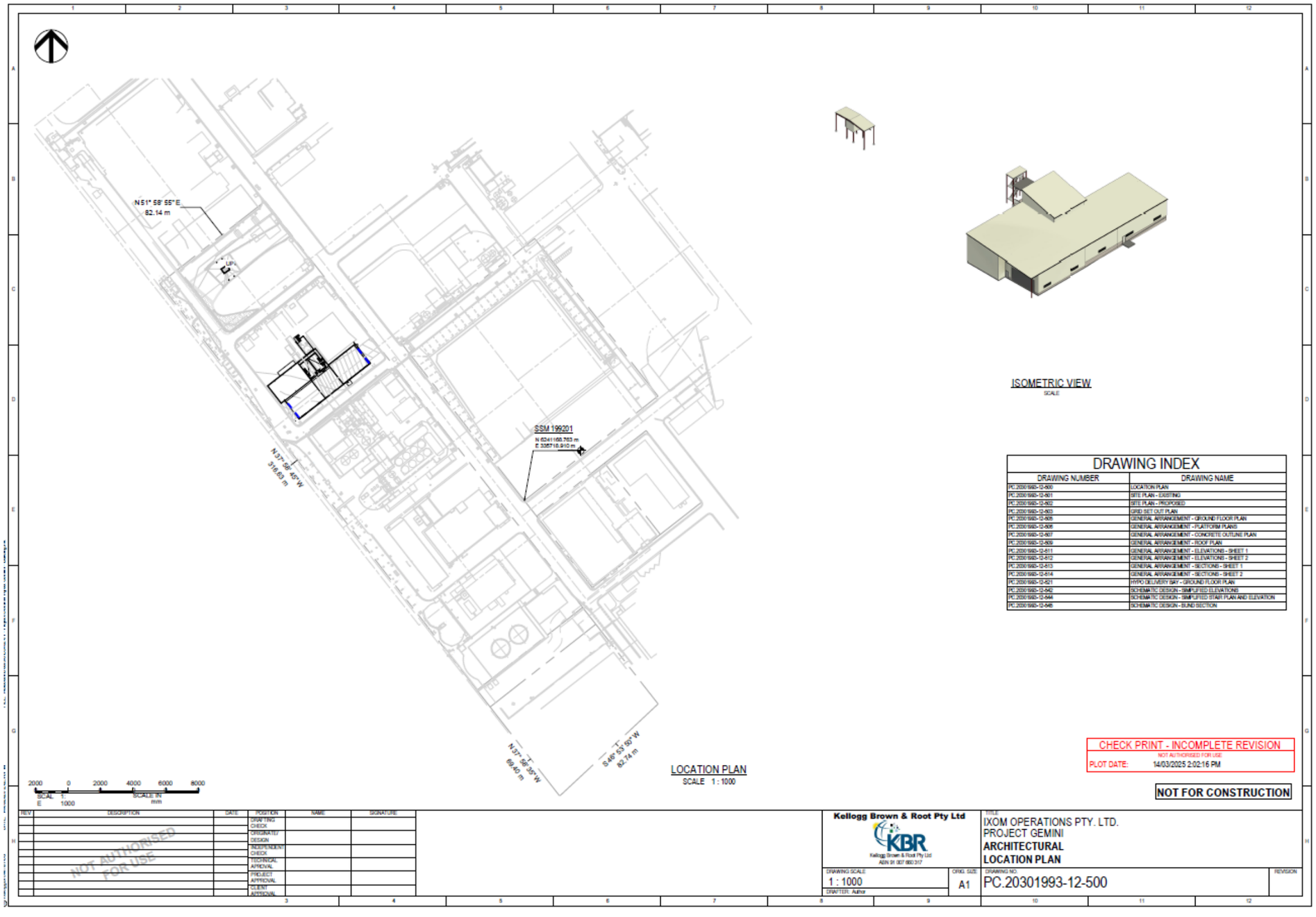
Study area	Item	Approach for CLP	Report reference	Comments	Sensitivity of overall modelling	Level of conservatism
Environmental factors	Meteorological data	Nearest BOM station Sydney Airport (AWS 66037)	APPENDIX D.	Nearest available meteorological station with hourly measurements of wind speed and direction. 10 years of data obtained and consolidated to format required for Riskcurves data entry.	Minor	Best estimate
	Environmental conditions	Nearest BOM station Sydney Airport (AWS 66037)	Section H5	The environmental data including ambient temperature, relative humidity used for the study is the average annual day and average annual night values from the nearest available meteorological station data	Minor	Best estimate
	Surface roughness factor	Estimated based on surrounding obstacle height	Section H5	Ground roughness affects turbulent flow properties of wind, hence the toxic dispersion behaviour. Surroundings fit the descriptor 'area with densely located low buildings or an industrial area with low structures' such as the BIP. This surface roughness factor is also appropriate for suburban areas adjacent to the BIP.	Sensitive Can have a significant impact on dispersion results. Higher surface roughness lengths result in smaller dispersion distances.	Best estimate
Consequence analysis	Process condition	Normal process conditions as per mass and energy balance	Section H6.	Data developed as available at design stage of project from PFDs	Minor	Best estimate
	Limiting flowrate	Physical limits downstream of pumps, control valves applied	Section H6.	Where relevant maximum release rate was limited to the maximum production or feed rates, or design flowrate for pumps or control valves. This avoids unrealistically high calculated leak rates that are not physically possible	Minor	Conservative
	Release inventory	Maximum isolatable inventory	Section H6.	Maximum inventory in the vessel or isolatable section.	Minor unless there are significant periods of time with low or no inventory	Conservative
	Bunds	Liquid spills constrained to surface area as per layout	Section H6.	Each storage tank has a separate bund (57.4 m^2 each). The releases from the liquefier, pumps and associated piping are contained by the bund.	Minor (unless unconstrained)	Best estimate
	Modelled hole sizes	Typically 3mm to rupture	Section H6.	The hole sizes are based on the corresponding leak sizes provided in the frequency data used. These cover a range of leak sizes from small (3 mm), medium (25 mm) to rupture i.e. full pipe diameter.	Minor	Best estimate
	Maximum release duration	1 hour	Section H6.	By convention in QRAs (which cover only abnormal accident events, not longer duration/chronic exposures in the workplace), the maximum event duration is set to a maximum of 1 hr as it is not reasonable to assume static conditions for the release, environmental conditions or exposure for longer periods. Also note that for dispersion modelling typically a release duration longer than 15-30 minutes is effectively a continuous source term, i.e. the maximum effect footprints are reached	Sensitive	Conservative
	Isolation time	3 mins to 1 hour	Section H6.	Durations of 3 to 60 minutes to manually isolate and control a leak from the plant or remotely from control room have been assumed. Isolation times only apply to transfer activities such as production rate and pumping to fill drums or a tanker. Isolation times are not applicable to inventories such as storage tanks. These durations judged to apply as noted in scenario tables are based on process alarms that would alert the operator to a problem, and also a large number of chlorine detectors distributed throughout the plant area. Accounting for automatic detection and isolation would be anticipated to reduce this and can be verified at detailed design stage.	Sensitive	Conservative
	Toxicity criteria	Probit for fatality AEGL for injury/irritation toxicity thresholds	Table 4.4. Section H6	Toxic dose based on probit was used to assess fatality effects Equivalent toxic dose based on AEGL 10 minutes was used to assess injury/irritation effects as use of concentration values only does not account for exposure duration.	Sensitive	Best estimate

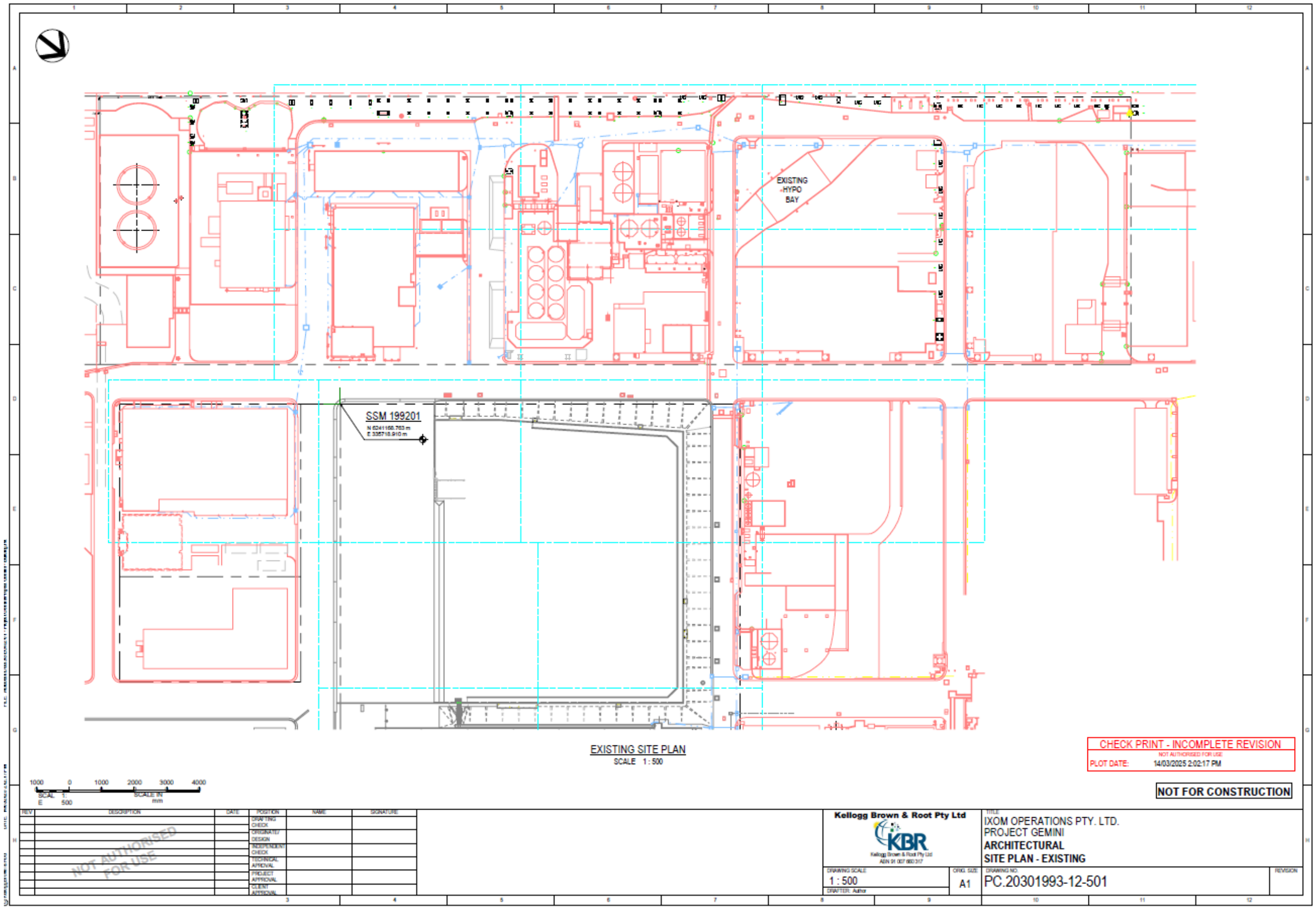
Study area	Item	Approach for CLP	Report reference	Comments	Sensitivity of overall modelling	Level of conservatism
	Receptor height	1.5 m	Section H5	Around upper body/face height.	Minor as majority of releases at ground level (Can have a significant impact on dispersion results if receptor is at different elevation to release point).	Best estimate
Frequency analysis	Base frequencies	Statistical leak frequency data	Section I2	Statistical data for the frequency of failure from equipment items such as drums, vessels and piping, together with an estimated count of equipment items ('parts count') based on PIDs is used to estimate leak frequencies. The data used to estimate event frequencies in a QRA is based on historical information from a variety of plants and processes with different standards and designs with many contributing causes of failure. It is assumed that these generic failure frequencies apply to installations which have safety management systems corresponding to 'industry practice'. This assumption is believed to be conservative in that it will overstate the risk from modern, well-managed installations such as the IXOM facility which is regulated under the MHF licensing regime.	Sensitive. QRA is primarily depending on the number of equipment items and leak sources included in the model	Conservative
	Online probability	Applied only for periodic activities such as tanker loading	Section I3	Continuous plants assumed to be on line 100% of time with maximum inventory 100% of time. This is conservative as there will be periods where plants have no or lower inventories (e.g. planned shutdowns).	Minor	Conservative
	Effect of control measures	Estimated using databases or event trees	APPENDIX F containment building/ scrubber) Section I4 (other control measures)	The main safeguards accounted for in the CLP are the containment building/scrubber and chlorine detection and automatic shutdown. An event tree has been developed to estimate containment building/scrubber failure probability of the using conservative data. For the purposes of the planning stage QRA the estimated overall containment unavailability is 5% 'unavailable' for both short duration (4%) and completely unmitigated (1%) events. Conservatively the QRA assumes that 5% of all events are completely unmitigated, i.e. the LBS has no effect and does not model the short duration events separately. At the detailed design stage, the QRA may be refined to differentiate between short duration and unmitigated releases but at the planning stage the approach taken is regarded as appropriately conservative.	Sensitive	Conservative
Societal risk	Population data	2021 Census supplemented as relevant	APPENDIX E	Census 2021 supplemented by estimates from developer for Qenos and Indorama sites on BIP. Sensitivity study doubling likely expected population on BIP land.	Minor	Best estimate
Onsite risk	IXOM occupancy	Shift patterns for normal and contingent case	APPENDIX K	The number of operators for the normal and contingent case was estimated by IXOM and used for onsite risk modelling to adjust probability of exposure.	Minor	Best estimate
Risk assessment	Risk criteria	HIPAP 4	Section 4.6	The risk results assessed against the HIPAP 4 quantitative and qualitative risk criteria. By convention, and as a conservative measure, risk contours are usually plotted on the basis that the individual is exposed for the full duration of the hazardous incident and no account is taken of evasive action or protection by clothing, buildings etc. HIPAP 4 contour levels have been set by the authority such that risk is very low compared to risk routinely accepted Societal risk criteria are indicative as per HIPAP 4.	Not applicable – risk criteria are set by DPHI	Conservative
	Societal risk	Population data from Census for probability of presence and numbers Mitigation factors allowed for indoor protection based on ventilation rate	APPENDIX E Section H6	Accounts for • the number of people in the affected area, the nature and scale of incidents which contribute to particular risk levels at particular points • proportion of indoor/outdoor population • outcomes of these incidents including any mitigation effects e.g. from being indoors resulting in a reduced toxic dose.	Sensitive	Best estimate

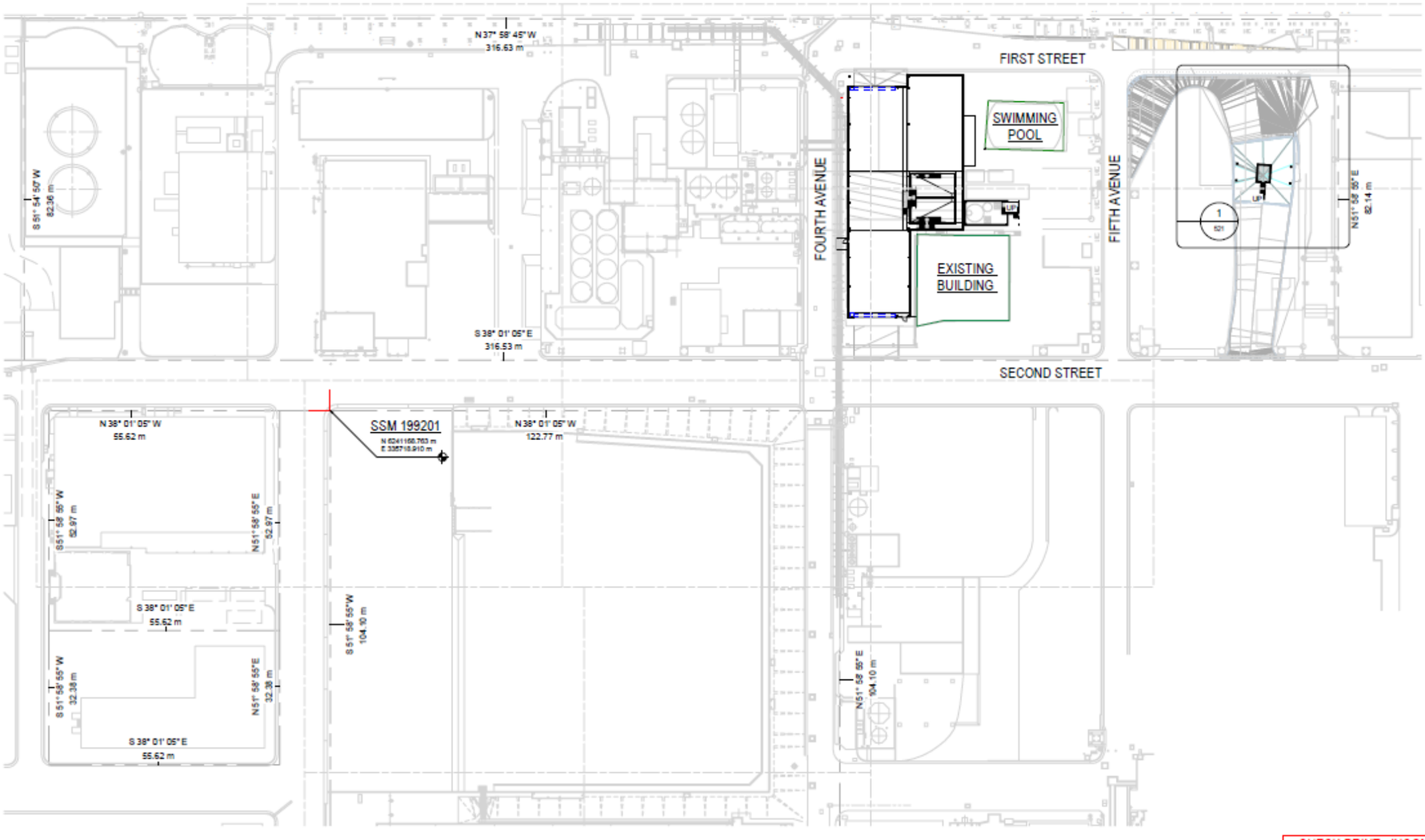
APPENDIX C. DRAWINGS

C1. Layouts

This includes various views of the CLP building layout for both normal and contingent cases




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PROJECT GEMINI
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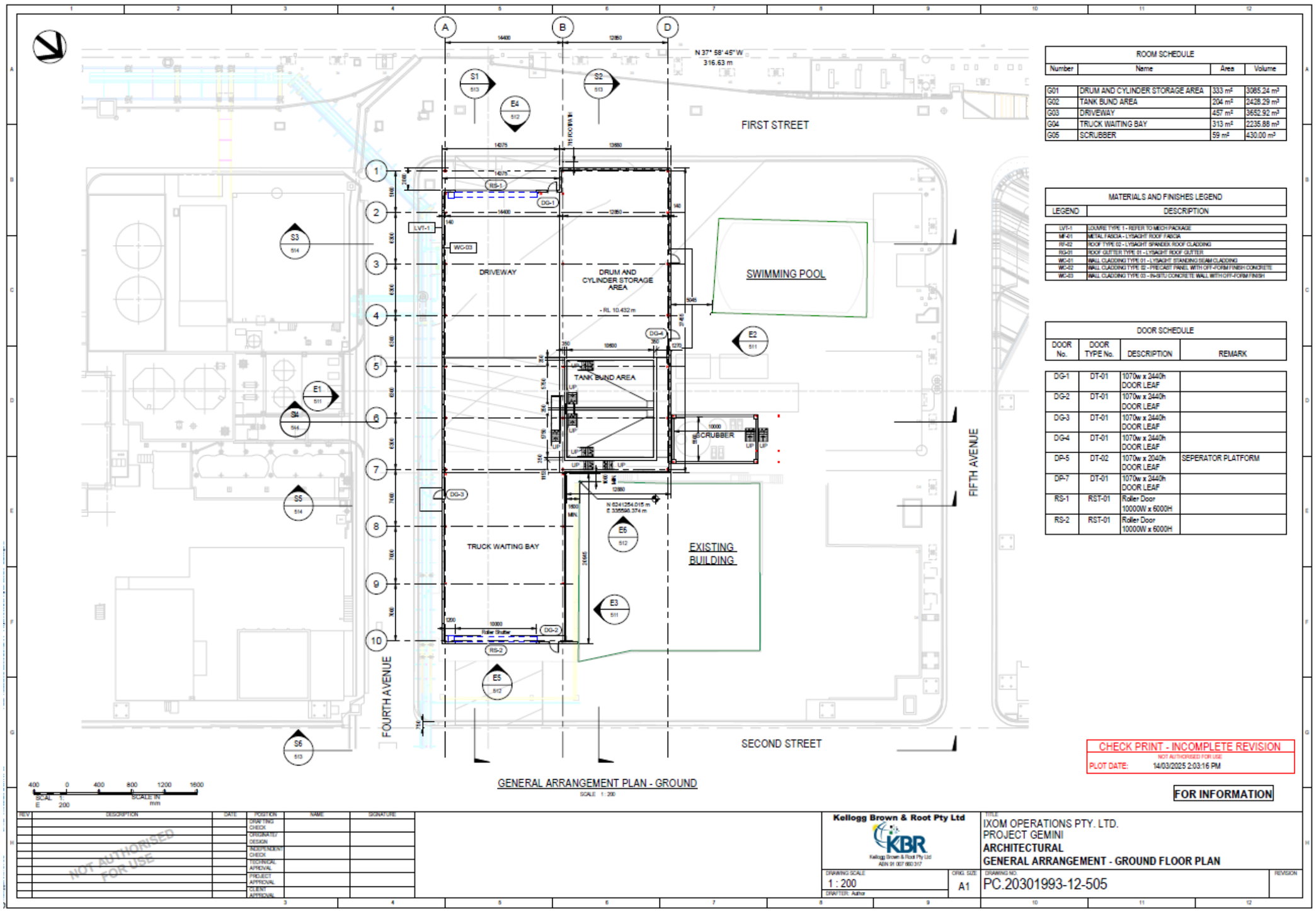
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ARCHITECTURAL
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Document number: 21838-RP-002
Revision: 5
Revision date: 26-Mar-2026
File name: 21838-RP-002 Rev5



GENERAL ARRANGEMENT PLAN - GROUND
SCALE 1 : 200

ROOM SCHEDULE			
Number	Name	Area	Volume
G01	DRUM AND CYLINDER STORAGE AREA	333 m²	3085.24 m³
G02	TANK BUND AREA	204 m²	2428.29 m³
G03	DRIVEWAY	457 m²	3652.92 m³
G04	TRUCK WAITING BAY	313 m²	2235.88 m³
G05	SCRUBBER	59 m²	430.00 m³

MATERIALS AND FINISHES LEGEND	
LEGEND	DESCRIPTION
LVT-1	LOUVRE TYPE 1 - REFER TO MECH PACKAGE
MF-01	METAL FASCIA - LYSAGHT ROOF FASCIA
RF-02	ROOF TYPE 02 - LYSAGHT SPANDEK ROOF CLADDING
RG-01	ROOF GUTTER TYPE 01 - LYSAGHT ROOF GUTTER
WC-01	WALL CLADDING TYPE 01 - LYSAGHT STANDING SEAM CLADDING
WC-02	WALL CLADDING TYPE 02 - PRECAST PANEL WITH OFF-FORM FINISH CONCRETE
WC-03	WALL CLADDING TYPE 03 - IN-SITU CONCRETE WALL WITH OFF-FORM FINISH

DOOR SCHEDULE			
DOOR No.	DOOR TYPE No.	DESCRIPTION	REMARK
DG-1	DT-01	1070w x 2440h DOOR LEAF	
DG-2	DT-01	1070w x 2440h DOOR LEAF	
DG-3	DT-01	1070w x 2440h DOOR LEAF	
DG-4	DT-01	1070w x 2440h DOOR LEAF	
DP-5	DT-02	1070w x 2040h DOOR LEAF	SEPERATOR PLATFORM
DP-7	DT-01	1070w x 2440h DOOR LEAF	
RS-1	RST-01	Roller Door 10000W x 6000H	
RS-2	RST-01	Roller Door 10000W x 6000H	

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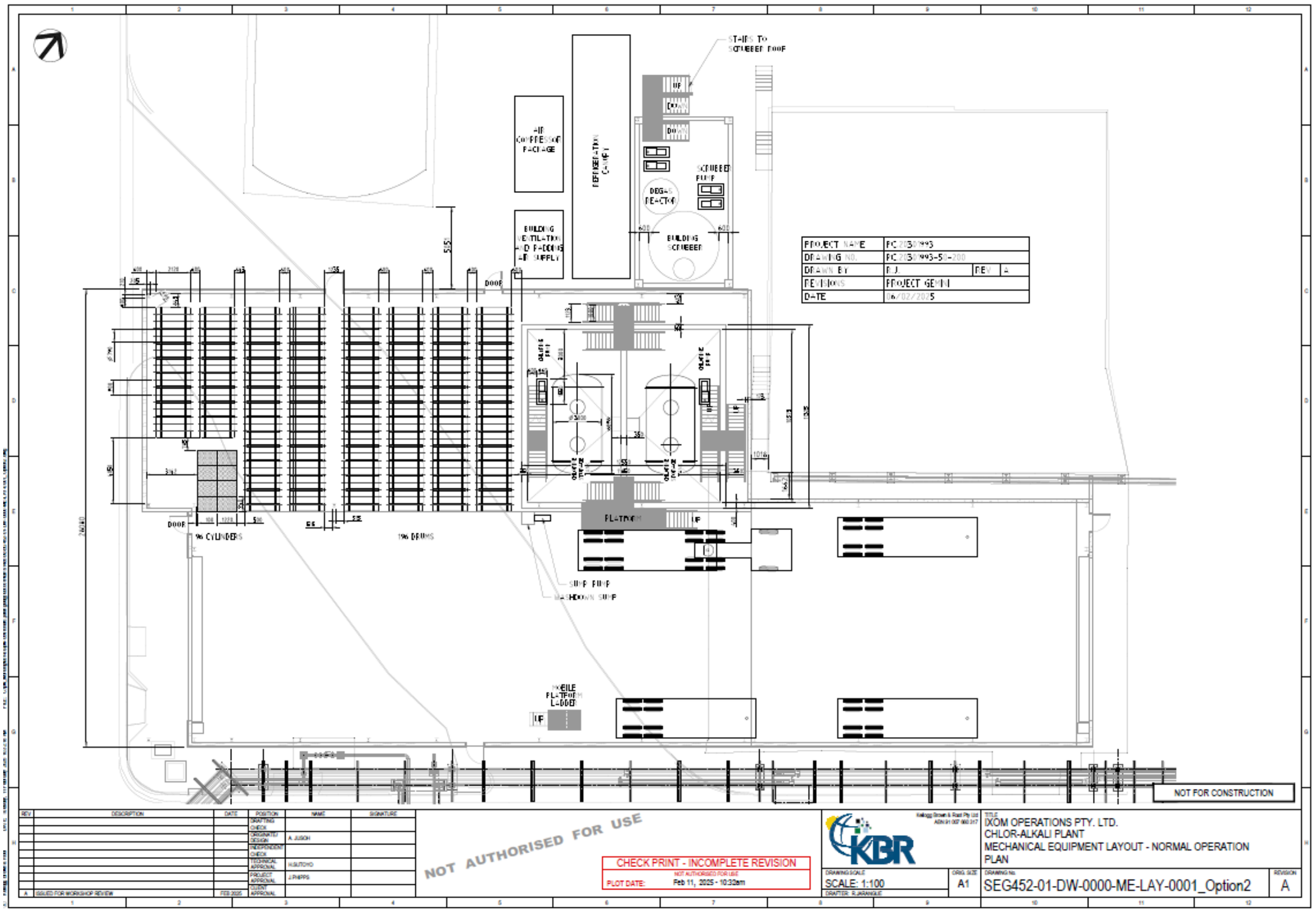
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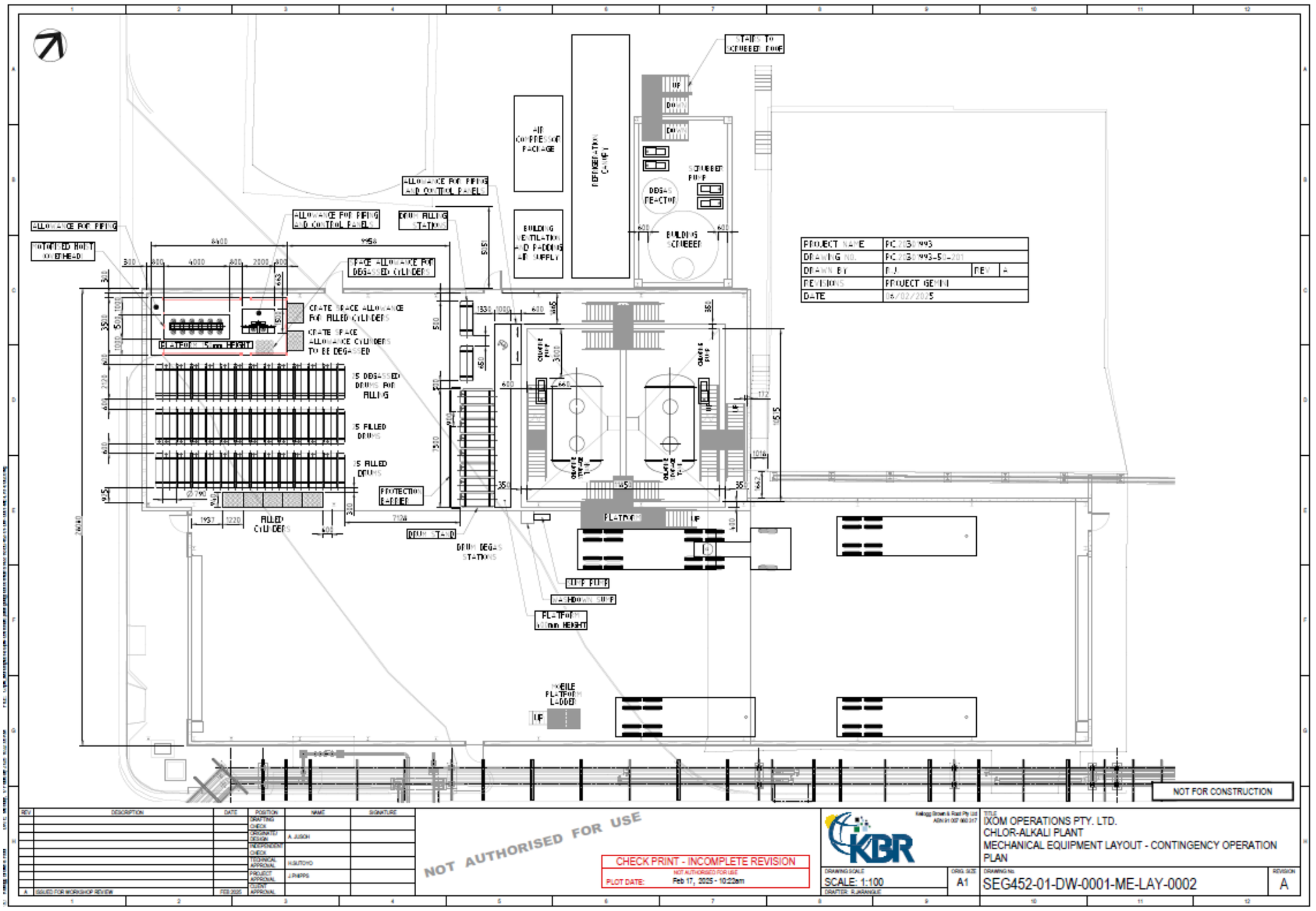
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GENERAL ARRANGEMENT - GROUND FLOOR PLAN

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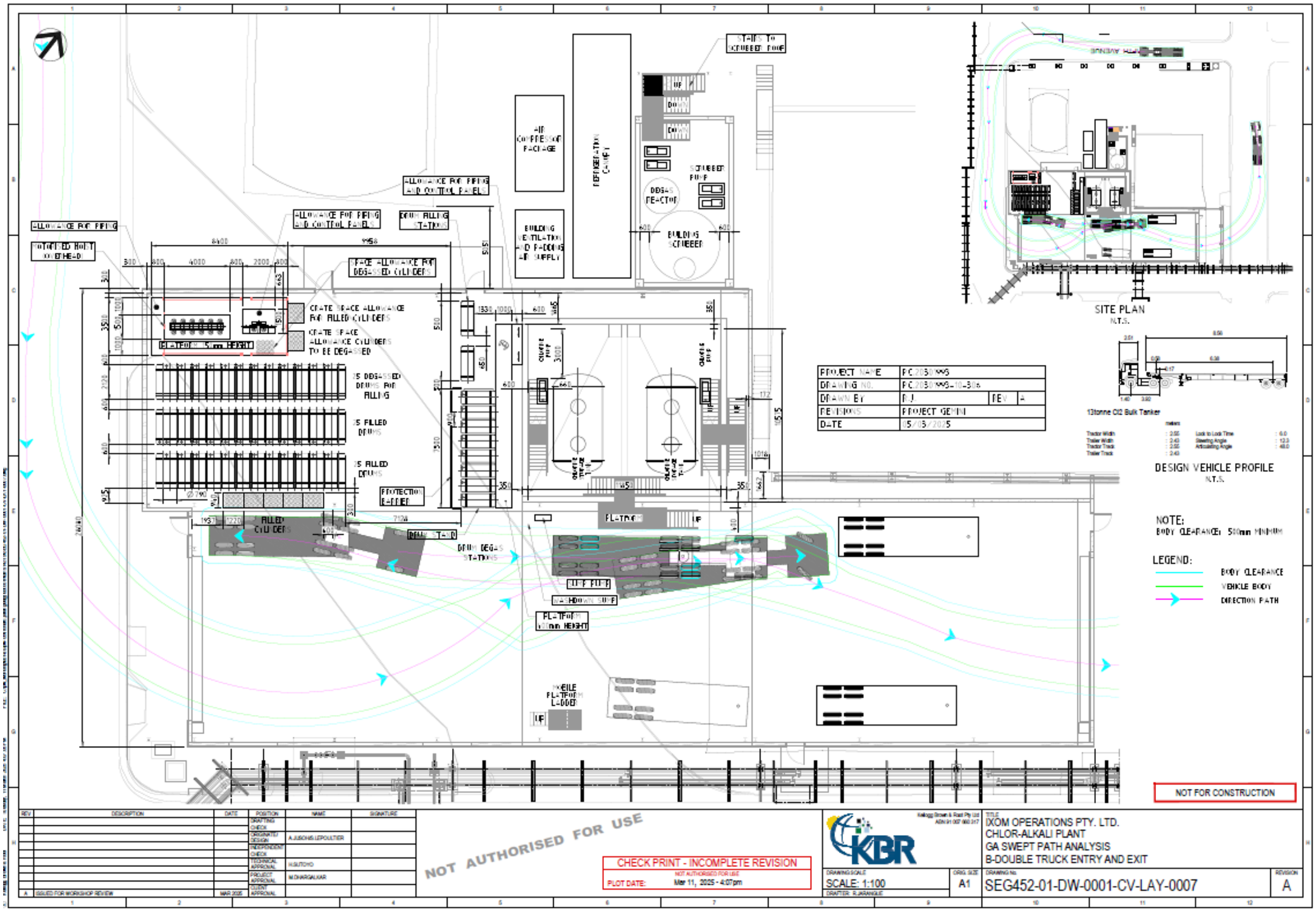
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AIR COMPRESSOR PACKAGE
REFRIGERATION UNIT
STAIRS TO SCRUBBER ROOF
UP
DOWN
DOWN
SCRUBBER PUMP
DEGAS REACTOR
BUILDING SCRUBBER
BUILDING VENTILATION AND PADDING AIR SUPPLY
5.5m
DOOR
CELLS
CELLS
DOOR
96 CYLINDERS
196 DRUMS
PLATFORM
UP
SUMP PUMP
WASHDOWN SUMP
MOBILE PLATFORM LADDER
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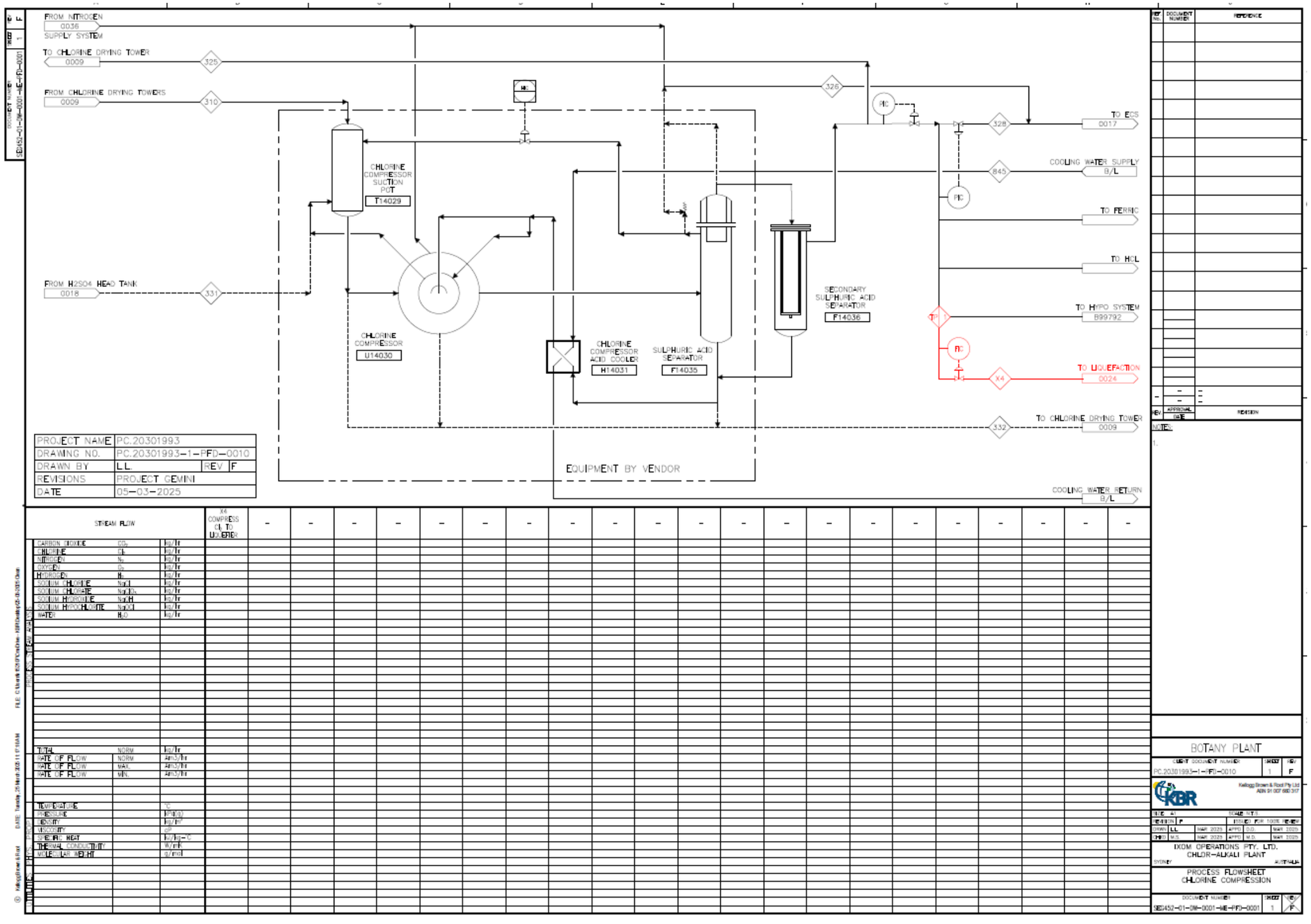
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GA SWEPT PATH ANALYSIS
B-DOUBLE TRUCK ENTRY AND EXIT

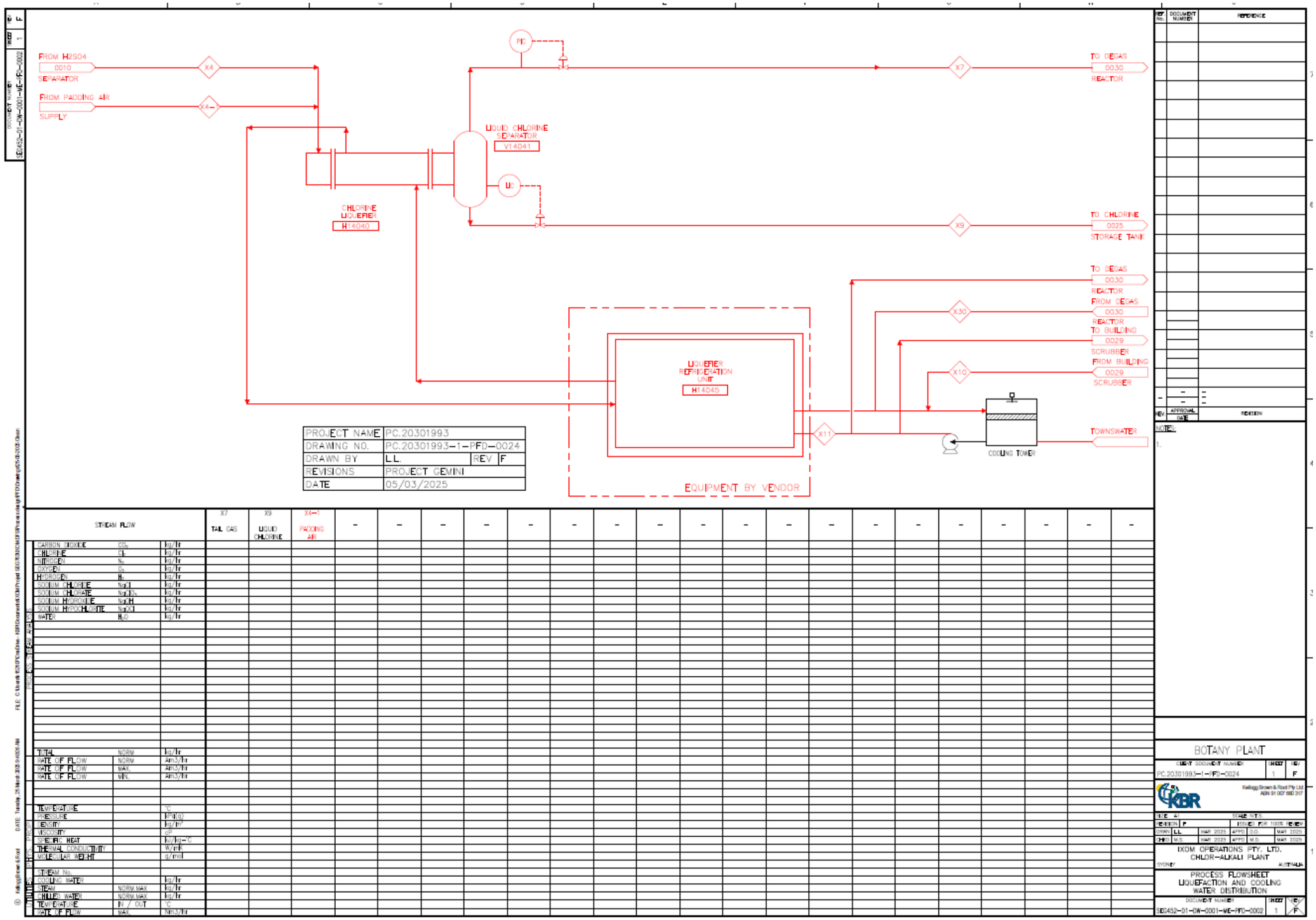
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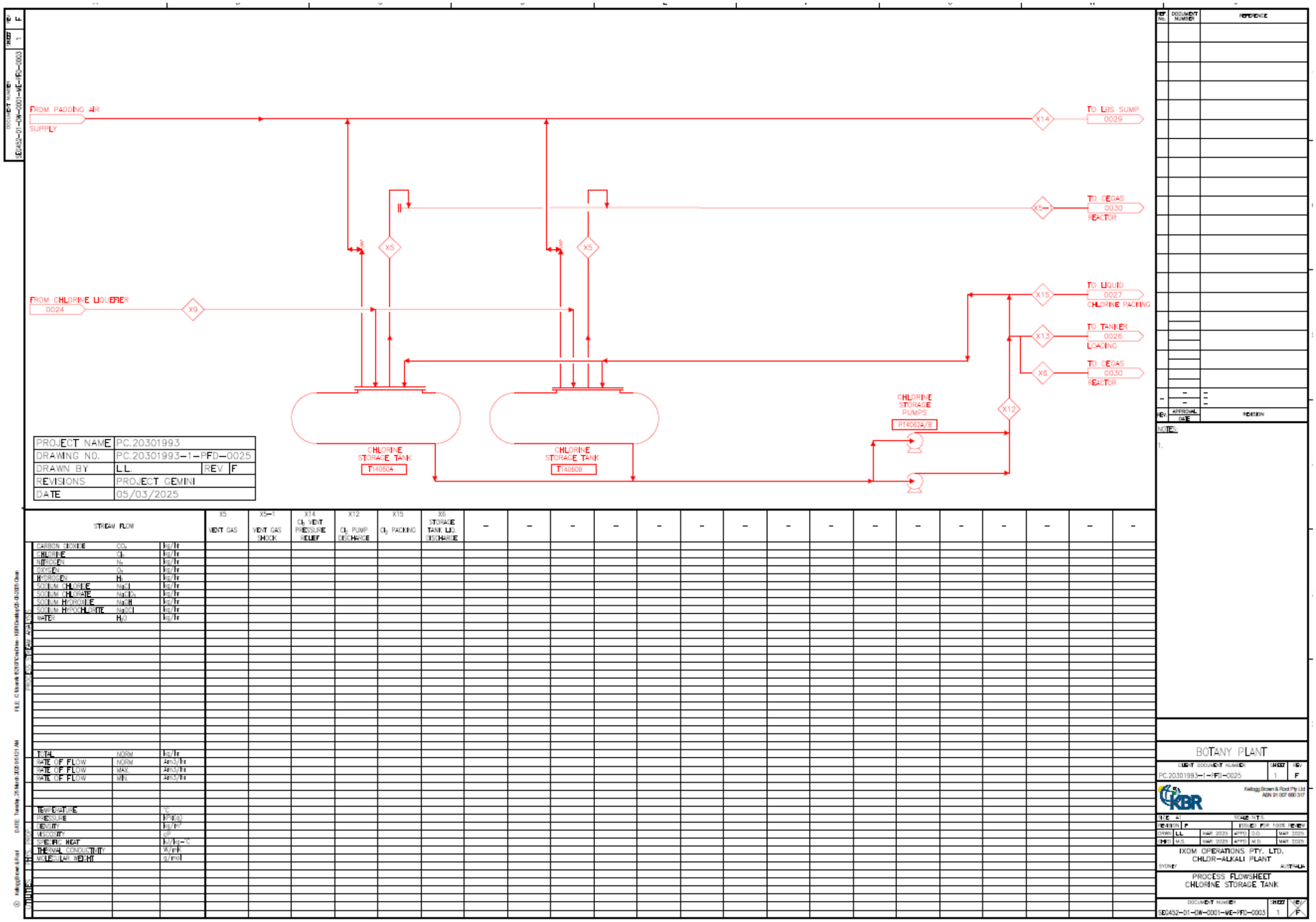
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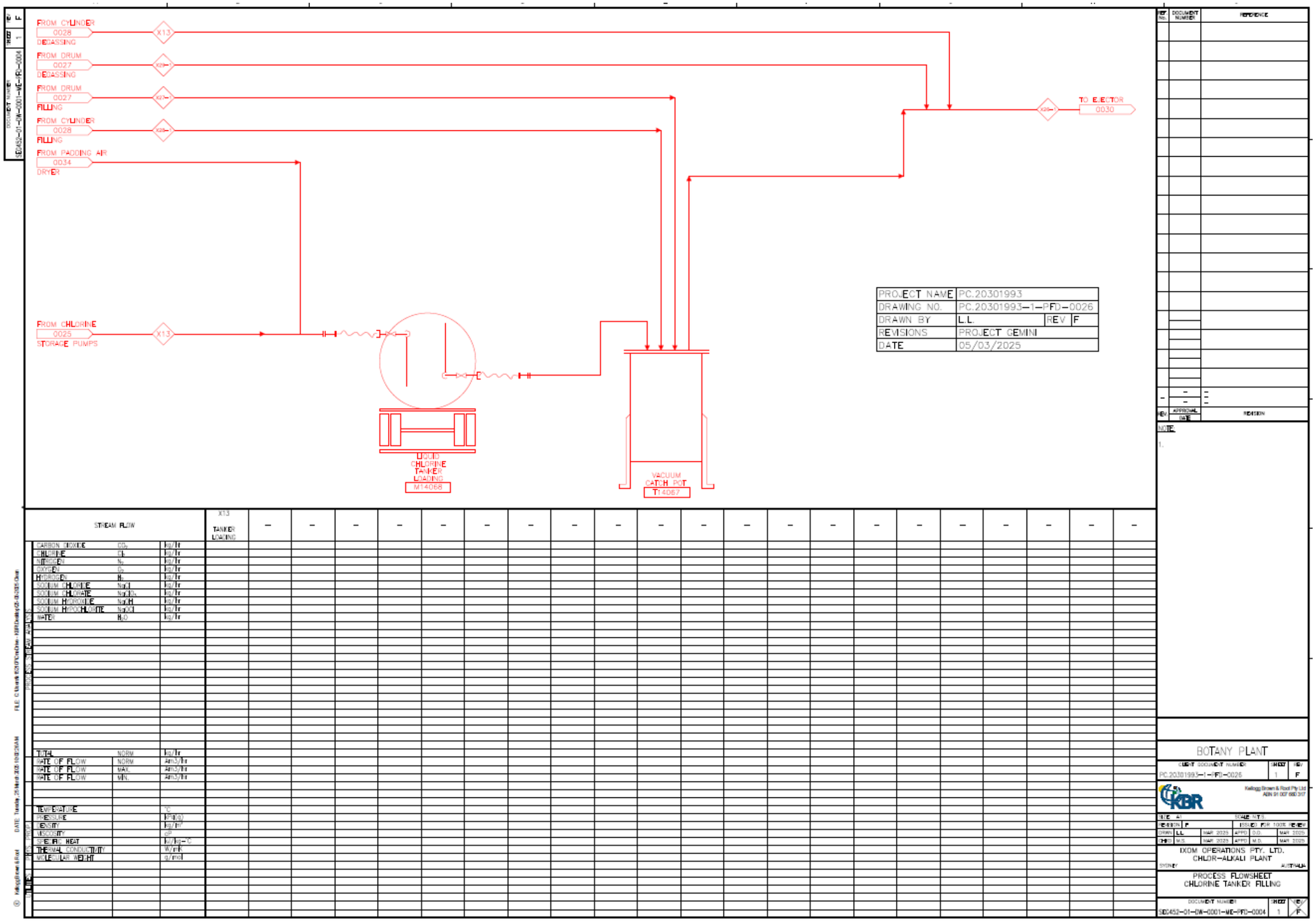
C2. Process Flow Diagrams (PFDs)

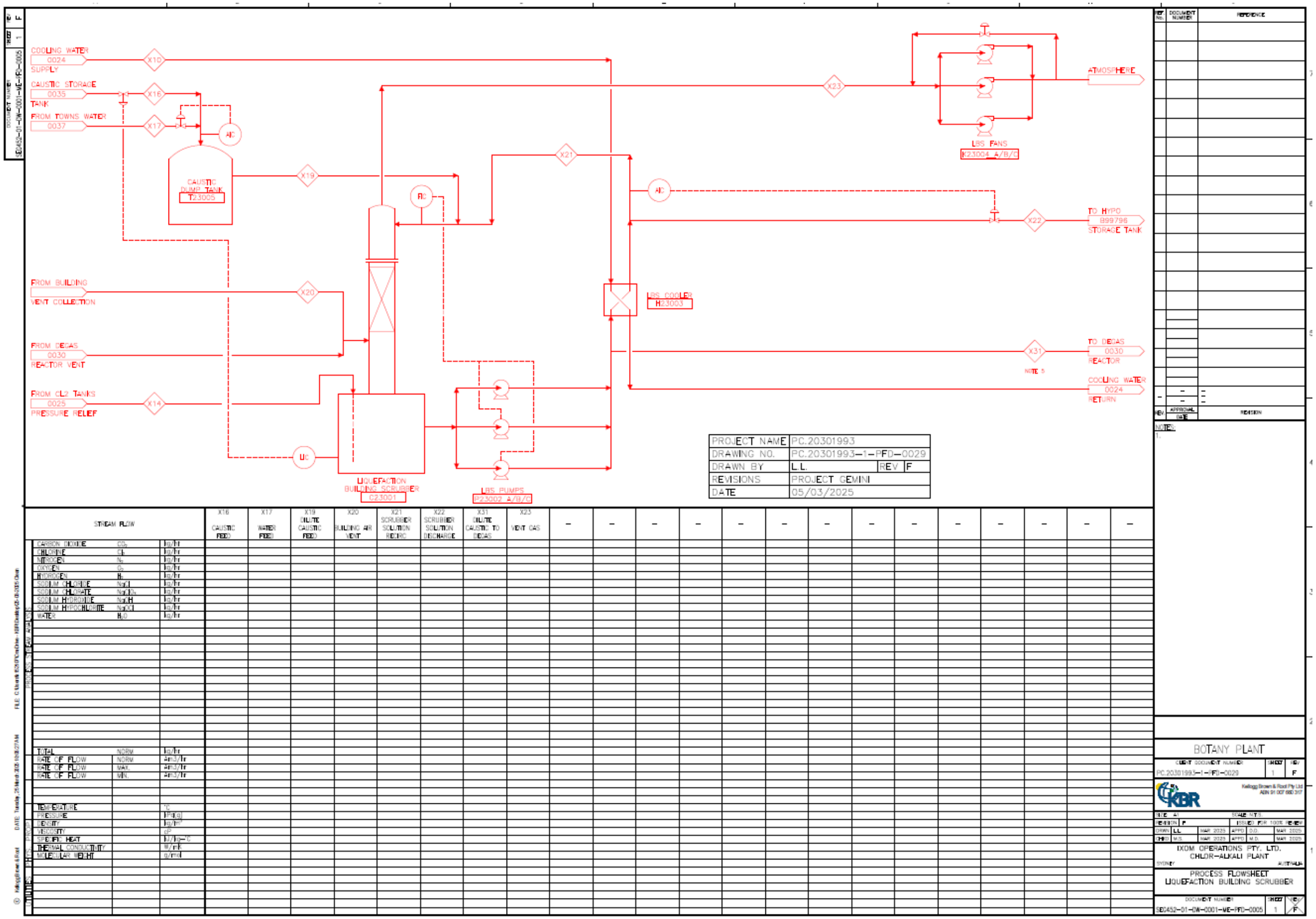
PFDs excluding commercially sensitive design information are provided in this section.

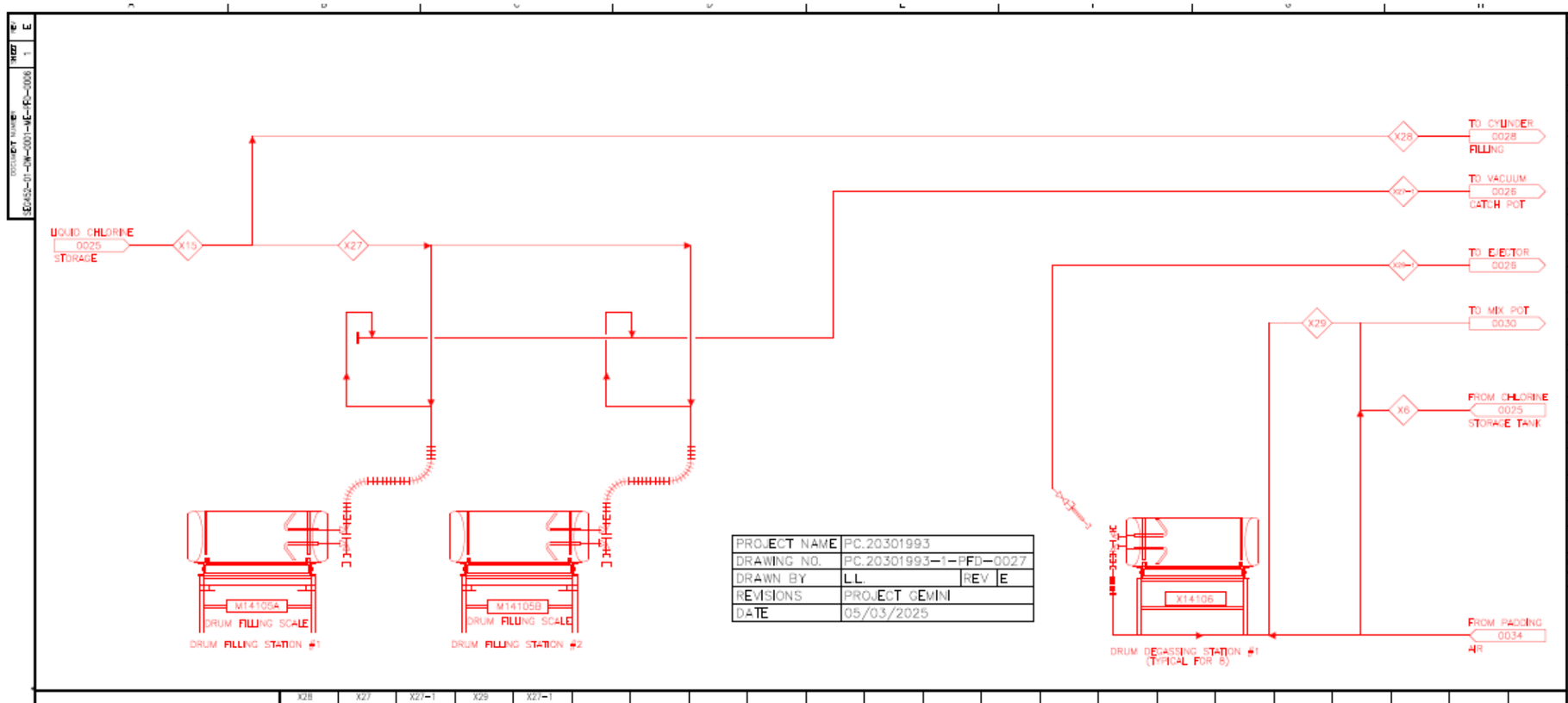



FROM H2SO4
0010
SEPARATOR
FROM PADDING AIR
SUPPLY
X4
X4-1
PIC
LIQUID CHLORINE SEPARATOR
V14041
LIC
CHLORINE LIQUEFIER
H14040
X7
TO BEGAS
0030
REACTOR
X9
TO CHLORINE
0025
STORAGE TANK
TO BEGAS
0030
REACTOR
X30
FROM BEGAS
0030
REACTOR
TO BUILDING
0029
SCRUBBER
X10
FROM BUILDING
0029
SCRUBBER
LIQUEFIER REFRIGERATION UNIT
H14045
X11
TOWNSWATER
COOLING TOWER
EQUIPMENT BY VENDOR
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993-1-PFD-0024
DRAWN BY L.L. REV F
REVISIONS PROJECT GEMINI
DATE 05/03/2025
REV
DOCUMENT NUMBER
REFERENCE
APPROVAL DATE
REVISION
NOTES:
1.
STREAM FLOW
X7 TAIL GAS
X9 LIQUID CHLORINE
X4-1 PADDING AIR
CARBON DIOXIDE CO2 kg/hr
CHLORINE Cl2 kg/hr
NITROGEN N2 kg/hr
OXYGEN O2 kg/hr
HYDROGEN H2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE NaClO3 kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM Am3/hr
RATE OF FLOW MAX. Am3/hr
RATE OF FLOW MIN. Am3/hr
TEMPERATURE °C
PRESSURE kPa(g)
DENSITY kg/m3
VISCOSITY cP
SPECIFIC HEAT kJ/kg-°C
THERMAL CONDUCTIVITY W/mK
MOLECULAR WEIGHT g/mol
STREAM No.
COOLING WATER
STEAM NORM/MAX kg/hr
CHILLED WATER NORM/MAX kg/hr
TEMPERATURE IN / OUT °C
RATE OF FLOW MAX. Nm3/hr
BOTANY PLANT
CLIENT DOCUMENT NUMBER PC.20301993-1-PFD-0024
SHEET 1
REV F
Kellogg Brown & Root Pty Ltd ABN 91 007 660 317
SIZE A1 SCALE N.T.S.
REVISION F ISSUED FOR TOOTE REVIEW
DRWN L.L. MAR 2025 APPD D.D. MAR 2025
CHKD M.S. MAR 2025 APPD M.D. MAR 2025
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
LIQUEFACTION AND COOLING WATER DISTRIBUTION
DOCUMENT NUMBER SD452-01-GN-0001-ME-PFD-0002
SHEET 1
REV F


FROM PADDING AIR SUPPLY
TO LBS SUMP 0029
TO DEGAS 0030 REACTOR
FROM CHLORINE LIQUEFIER 0024
TO LIQUID 0027 CHLORINE PACKING
TO TANKER 0026 LOADING
TO DEGAS 0030 REACTOR
CHLORINE STORAGE TANK T14060A
CHLORINE STORAGE TANK T14060B
CHLORINE STORAGE PUMPS P14062A/B
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993-1-PFD-0025
DRAWN BY L.L. REV F
REVISIONS PROJECT GEMINI
DATE 05/03/2025
STREAM FLOW
CARBON DIOXIDE CO_2 kg/hr
CHLORINE Cl_2 kg/hr
NITROGEN N_2 kg/hr
OXYGEN O_2 kg/hr
HYDROGEN H_2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE $NaClO_3$ kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H_2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM Am3/hr
RATE OF FLOW MAX Am3/hr
RATE OF FLOW MIN Am3/hr
TEMPERATURE °C
PRESSURE kPa(g)
DENSITY kg/m³
VISCOSITY cP
SPECIFIC HEAT kJ/kg-°C
THERMAL CONDUCTIVITY W/mK
MOLECULAR WEIGHT g/mol
X5 VENT GAS
X5-1 VENT GAS SHOCK
X14 Cl_2 VENT PRESSURE RELIEF
X12 Cl_2 PUMP DISCHARGE
X15 Cl_2 PACKING
X6 STORAGE TANK LIQ. DISCHARGE
BOTANY PLANT
CLIENT DOCUMENT NUMBER PC.20301993-1-PFD-0025
SHEET 1
REV F
Kellogg Brown & Root Pty Ltd ABN 91 007 660 317
SIZE A1
REVISION F
ISSUED FOR 100% REVIEW
DRN L.L. MAR 2025
CHD M.S. MAR 2025
APPD D.D. MAY 2025
APPD M.D. MAY 2025
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
CHLORINE STORAGE TANK
DOCUMENT NUMBER SE0452-01-DW-0001-ME-PFD-0003
SHEET 1
REV F


FROM CYLINDER
0028
DEGASSING
X13
FROM DRUM
0027
DEGASSING
X29
FROM DRUM
0027
FILLING
X27
FROM CYLINDER
0028
FILLING
X25
FROM PADDING AIR
0034
DRYER
FROM CHLORINE
0025
STORAGE PUMPS
X13
TO EJECTOR
0030
X99
LIQUID CHLORINE TANKER LOADING
M14068
VACUUM CATCH POT
T14067
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993-1-PFD-0026
DRAWN BY L.L. REV F
REVISIONS PROJECT GEMINI
DATE 05/03/2025
REV DOCUMENT NUMBER REFERENCE
NOTE
1.
REV APPROVAL DATE REVISION
STREAM FLOW
X13
TANKER LOADING
CARBON DIOXIDE CO2 kg/hr
CHLORINE Cl2 kg/hr
NITROGEN N2 kg/hr
OXYGEN O2 kg/hr
HYDROGEN H2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE NaClO3 kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM Am3/hr
RATE OF FLOW MAX. Am3/hr
RATE OF FLOW MIN. Am3/hr
TEMPERATURE °C
PRESSURE kPa(g)
DENSITY kg/m3
VISCOSITY cP
SPECIFIC HEAT kJ/kg-°C
THERMAL CONDUCTIVITY W/mK
MOLECULAR WEIGHT g/mol
BOTANY PLANT
CLIENT DOCUMENT NUMBER PC.20301993-1-PFD-0026
SHEET 1
REV F
Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317
ISSUED FOR TOOTE REVIEW
DRWN LL MAR 2025 APPD D.D. MAR 2025
CHKD M.S MAR 2025 APPD M.D. MAR 2025
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
CHLORINE TANKER FILLING
DOCUMENT NUMBER SB0452-01-DW-0001-ME-PFD-0004
SHEET 1
REV F


COOLING WATER
0024
SUPPLY
CAUSTIC STORAGE
0035
TANK
FROM TOWNS WATER
0037
X10
X16
X17
X19
X20
X21
X22
X23
X31
X14
AIC
RC
UC
CAUSTIC DUMP TANK T23005
FROM BUILDING
VENT COLLECTION
FROM DEGAS
0030
REACTOR VENT
FROM CL2 TANKS
0025
PRESSURE RELIEF
LIQUEFACTION BUILDING SCRUBBER C23001
LBS PUMPS P23002 A/B/C
LBS COOLER H23003
LBS FANS K23004 A/B/C
ATMOSPHERE
TO HYPO B99796 STORAGE TANK
TO DEGAS
0030
REACTOR
COOLING WATER
0024
RETURN
NOTE 5
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993-1-PFD-0029
DRAWN BY L.L. REV F
REVISIONS PROJECT GEMINI
DATE 05/03/2025
STREAM FLOW
CARBON DIOXIDE CO2 kg/hr
CHLORINE Cl2 kg/hr
NITROGEN N2 kg/hr
OXYGEN O2 kg/hr
HYDROGEN H2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE NaClO3 kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM m3/hr
RATE OF FLOW MAX. m3/hr
RATE OF FLOW MIN. m3/hr
TEMPERATURE °C
PRESSURE kPa(g)
DENSITY kg/m3
VISCOSITY cP
SPECIFIC HEAT kJ/kg-°C
THERMAL CONDUCTIVITY W/m°K
MOLECULAR WEIGHT g/gmol
PROCESS STREAM ANALYSIS
PROPERTIES
PROCESS DESIGN
CONDITIONS
BOTANY PLANT
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
LIQUEFACTION BUILDING SCRUBBER
DOCUMENT NUMBER SD452-01-0W-0001-ME-PFD-0005
SHEET 1
REV F
KBR
Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317
ISSUED FOR TOOTE REVIEW
DRWN L.L. MAR 2025 APPD D.D. MAY 2025
CHKD M.S. MAR 2025 APPD M.D. MAY 2025
NOTES:



STREAM FLOW			X28 Cl_2 CYLINDER FILLING	X27 DRUM FILLING	X27-1 DRUM LINE FLUSH	X29 Cl_2 LIQUID DISCHARGE	X27-1 DRUM DEGAS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CARBON DIOXIDE	CO_2	kg/hr																					
CHLORINE	Cl_2	kg/hr																					
NITROGEN	N_2	kg/hr																					
OXYGEN	O_2	kg/hr																					
HYDROGEN	H_2	kg/hr																					
SODIUM CHLORIDE	NaCl	kg/hr																					
SODIUM CHLORATE	$NaClO_3$	kg/hr																					
SODIUM HYDROXIDE	NaOH	kg/hr																					
SODIUM HYPOCHLORITE	NaOCl	kg/hr																					
WATER	H_2O	kg/hr																					
TOTAL	NORM	kg/hr																					
RATE OF FLOW	NORM	Am3/hr																					
RATE OF FLOW	MAX.	Am3/hr																					
RATE OF FLOW	MIN.	Am3/hr																					
TEMPERATURE		°C																					
PRESSURE		kPa(g)																					
DENSITY		kg/m³																					
VISCOSITY		cP																					
SPECIFIC HEAT		kJ/kg-°C																					
THERMAL CONDUCTIVITY		W/mK																					
MOLECULAR WEIGHT		g/mol																					

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BOTANY PLANT

CLIENT DOCUMENT NUMBER: PC.20301993-1-PFD-0027 | SHEET 1 | REV E

Kellogg Brown & Root Pty Ltd ABN 91 007 660 317

SIZE A1 | SCALE N.T.S.

REVISION E | ISSUED FOR TIDIE REVIEW

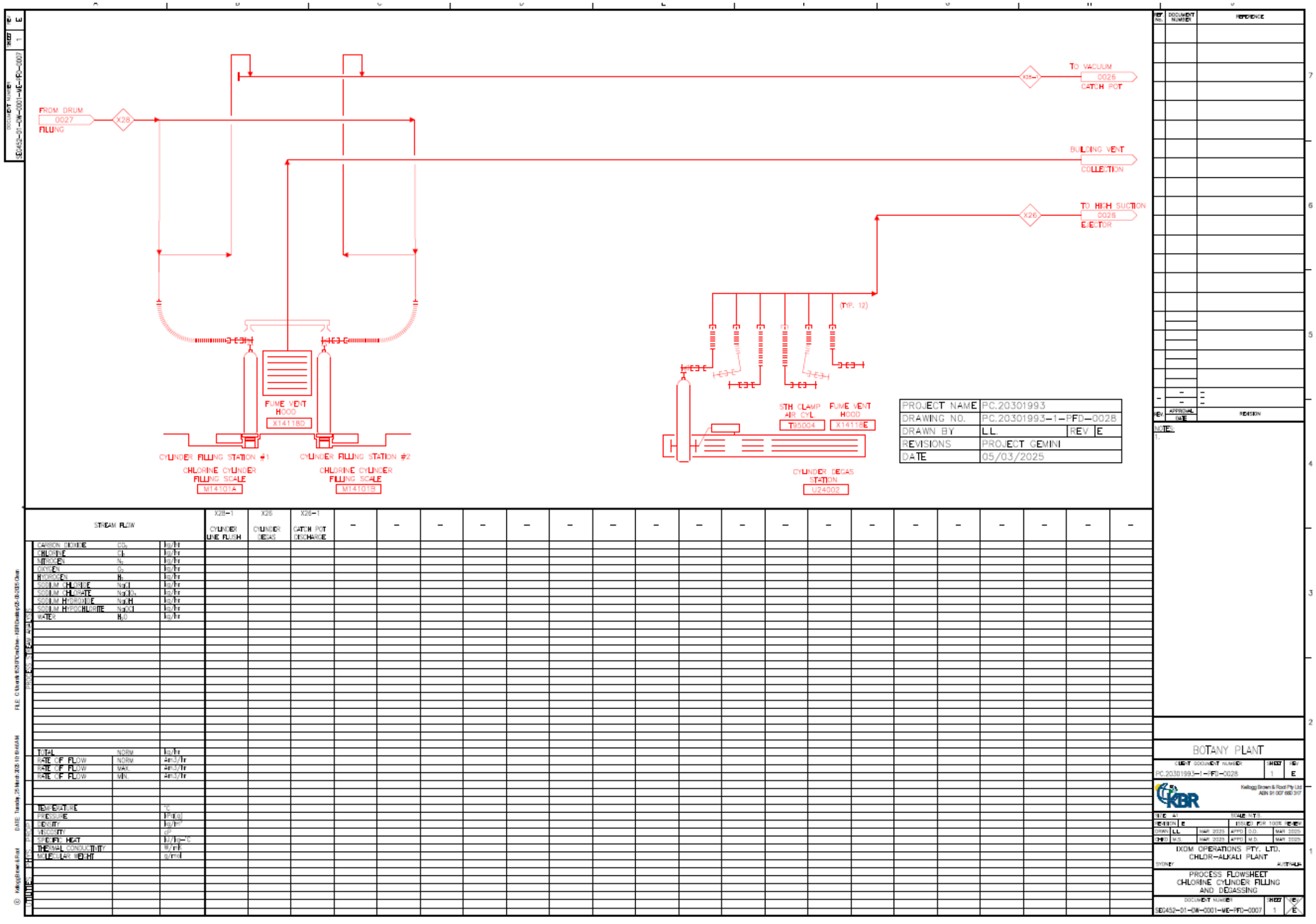
DRWN L.L. MAR 2025 | APPD D.D. MAR 2025

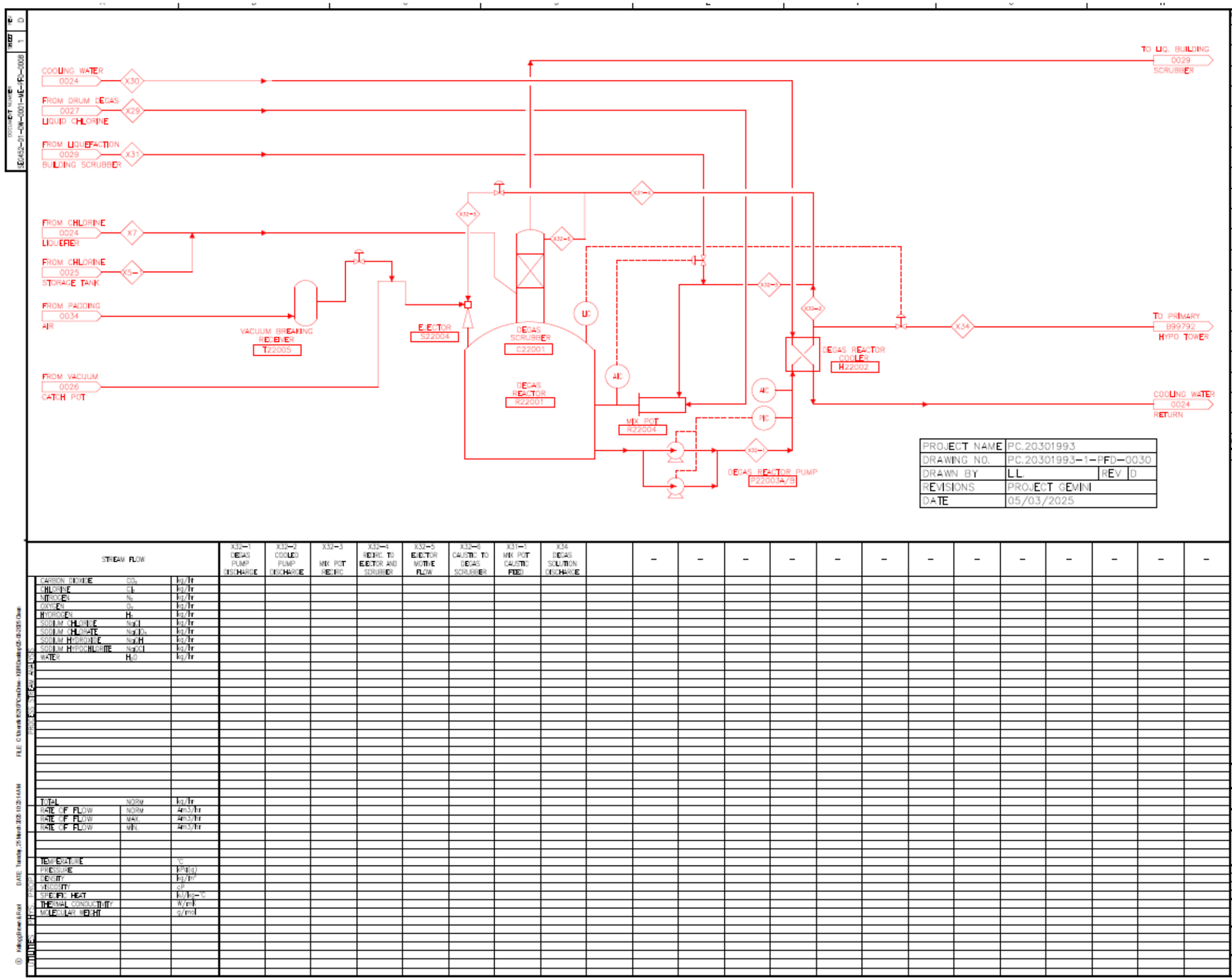
CHKD M.S. MAR 2025 | APPD M.D. MAR 2025

IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA

PROCESS FLOWSHEET
CHLORINE DRUM FILLING AND DEGASSING

DOCUMENT NUMBER: SED452-01-0W-0001-ME-PFD-0006 | SHEET 1 | REV E


FROM DRUM
0027
FILLING
X28
TO VACUUM
0026
CATCH POT
X25
BUILDING VENT
COLLECTION
TO HIGH SUCTION
0026
EJECTOR
X26
(TYP. 12)
FUME VENT HOOD
X14118D
CYLINDER FILLING STATION #1
CHLORINE CYLINDER FILLING SCALE
M14101A
CYLINDER FILLING STATION #2
CHLORINE CYLINDER FILLING SCALE
M14101B
STH CLAMP AIR CYL
T95004
FUME VENT HOOD
X14118E
CYLINDER DEGAS STATION
U24002
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993-1-PFD-0028
DRAWN BY L.L. REV E
REVISIONS PROJECT GEMINI
DATE 05/03/2025
REF. NO. DOCUMENT NUMBER REFERENCE
REV APPROVAL DATE REVISION
NOTES:
STREAM FLOW
X28-1 CYLINDER LINE FLUSH
X26 CYLINDER DEGAS
X28-1 CATCH POT DISCHARGE
CARBON DIOXIDE CO2 kg/hr
CHLORINE Cl2 kg/hr
NITROGEN N2 kg/hr
OXYGEN O2 kg/hr
HYDROGEN H2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE NaClO3 kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM Am3/hr
RATE OF FLOW MAX. Am3/hr
RATE OF FLOW MIN. Am3/hr
TEMPERATURE °C
PRESSURE kPa(g)
DENSITY kg/m3
VISCOSITY cP
SPECIFIC HEAT kJ/kg-°C
THERMAL CONDUCTIVITY W/m-K
MOLECULAR WEIGHT g/mol
BOTANY PLANT
CLIENT DOCUMENT NUMBER PC.20301993-1-PFD-0028
SHEET 1 REV E
Kellogg Brown & Root Pty Ltd ABN 91 007 660 317
SIZE A1 SCALE N.T.S.
REVISION E ISSUED FOR TOOTE REVIEW
DRAWN L.L. MAR 2025 APPD D.O. MAR 2025
CHKD M.S. MAR 2025 APPD M.D. MAR 2025
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
CHLORINE CYLINDER FILLING AND DEGASSING
DOCUMENT NUMBER SE0452-01-0W-0001-WE-PFD-0007
SHEET 1 REV E



STREAM FLOW			X32-1 DEGAS PUMP DISCHARGE	X32-2 COOLED PUMP DISCHARGE	X32-3 MIX POT RETURN	X32-4 RETURN TO EJECTOR AND SCRUBBER	X32-5 EJECTOR MOTIVE FLOW	X32-6 CAUSTIC TO DEGAS SCRUBBER	X31-1 MIX POT CAUSTIC FEED	X34 DEGAS SOLUTION DISCHARGE		–	–	–	–	–	–	–	–	–	–	–	–
CARBON DIOXIDE	CO_2	kg/hr																					
CHLORINE	Cl_2	kg/hr																					
NITROGEN	N_2	kg/hr																					
OXYGEN	O_2	kg/hr																					
HYDROGEN	H_2	kg/hr																					
SODIUM CHLORIDE	NaCl	kg/hr																					
SODIUM CHLORATE	$NaClO_3$	kg/hr																					
SODIUM HYDROXIDE	NaOH	kg/hr																					
SODIUM HYPOCHLORITE	NaOCl	kg/hr																					
WATER	H_2O	kg/hr																					
TOTAL	NORM	kg/hr																					
RATE OF FLOW	NORM	Am3/hr																					
RATE OF FLOW	MAX.	Am3/hr																					
RATE OF FLOW	MIN.	Am3/hr																					
TEMPERATURE		°C																					
PRESSURE		kPa(g)																					
DENSITY		kg/m³																					
VISCOSITY		cP																					
SPECIFIC HEAT		kJ/kg-°C																					
THERMAL CONDUCTIVITY		W/mK																					
MOLECULAR WEIGHT		g/mol																					

NOTES:
1.

REF No.	DOCUMENT NUMBER	REFERENCE

REV	APPROVAL DATE	REVISION
–	–	–

BOTANY PLANT

CLIENT DOCUMENT NUMBER: PC.20301993-1-PFD-0030 | SHEET 1 | REV D

Kellogg Brown & Root Pty Ltd ABN 91 007 660 317

TITLE AT | SCALE N.T.S.

REVISION: 0 — ISSUED FOR TOXE REVIEW

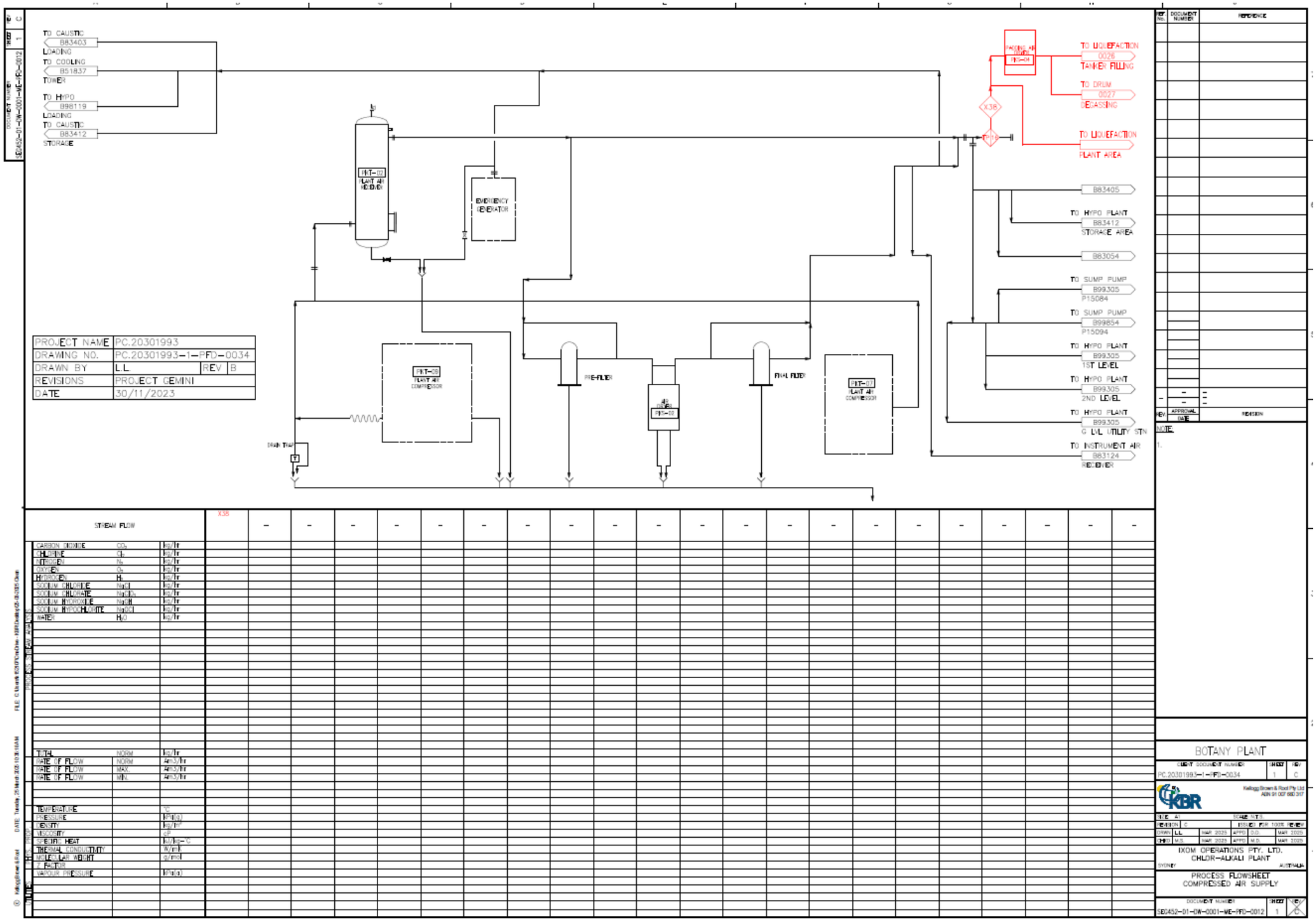
DRAWN LL MAR 2025 | APPD D.D. MAR 2025

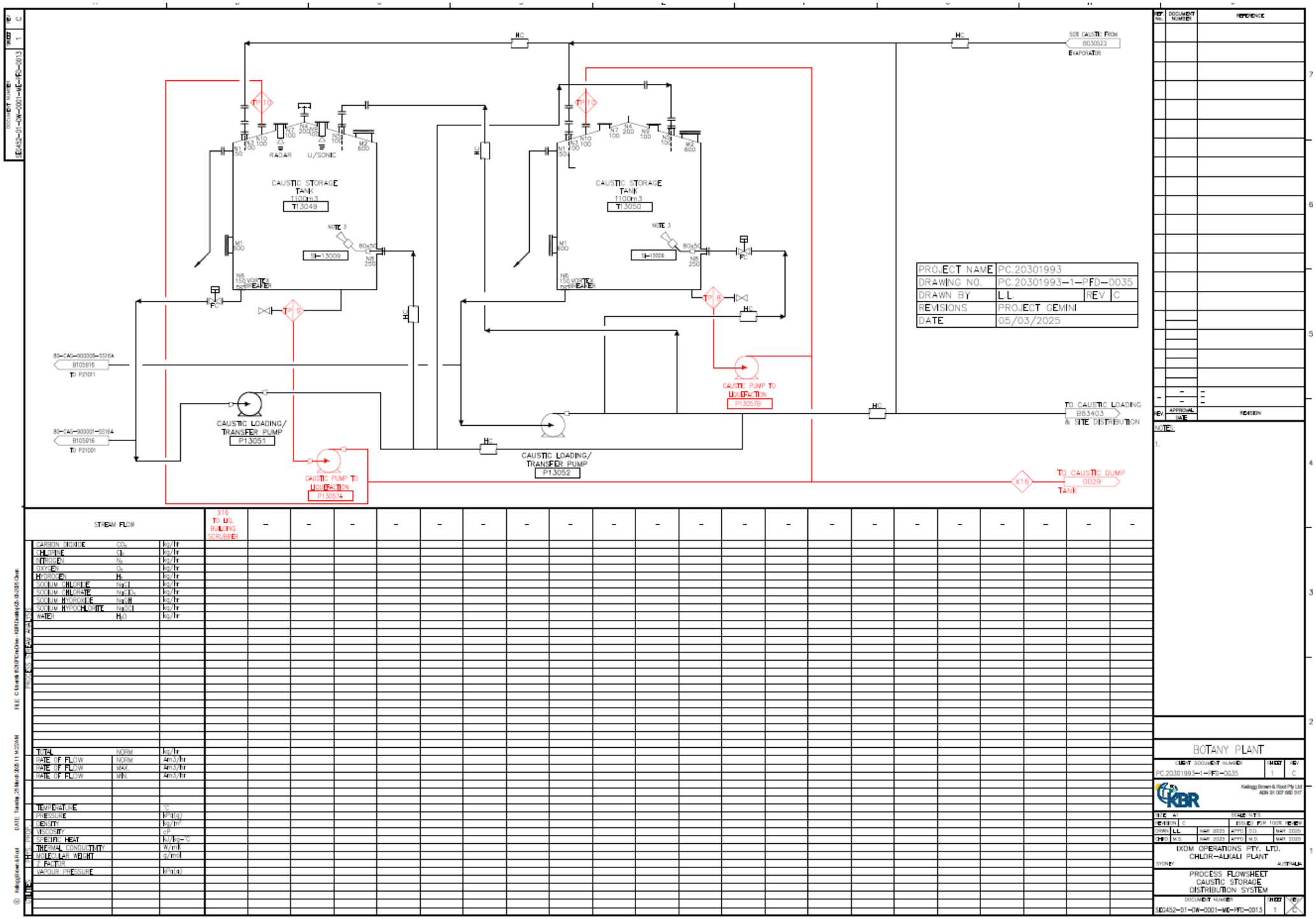
CHKD M.S. MAR 2025 | APPD M.S. MAR 2025

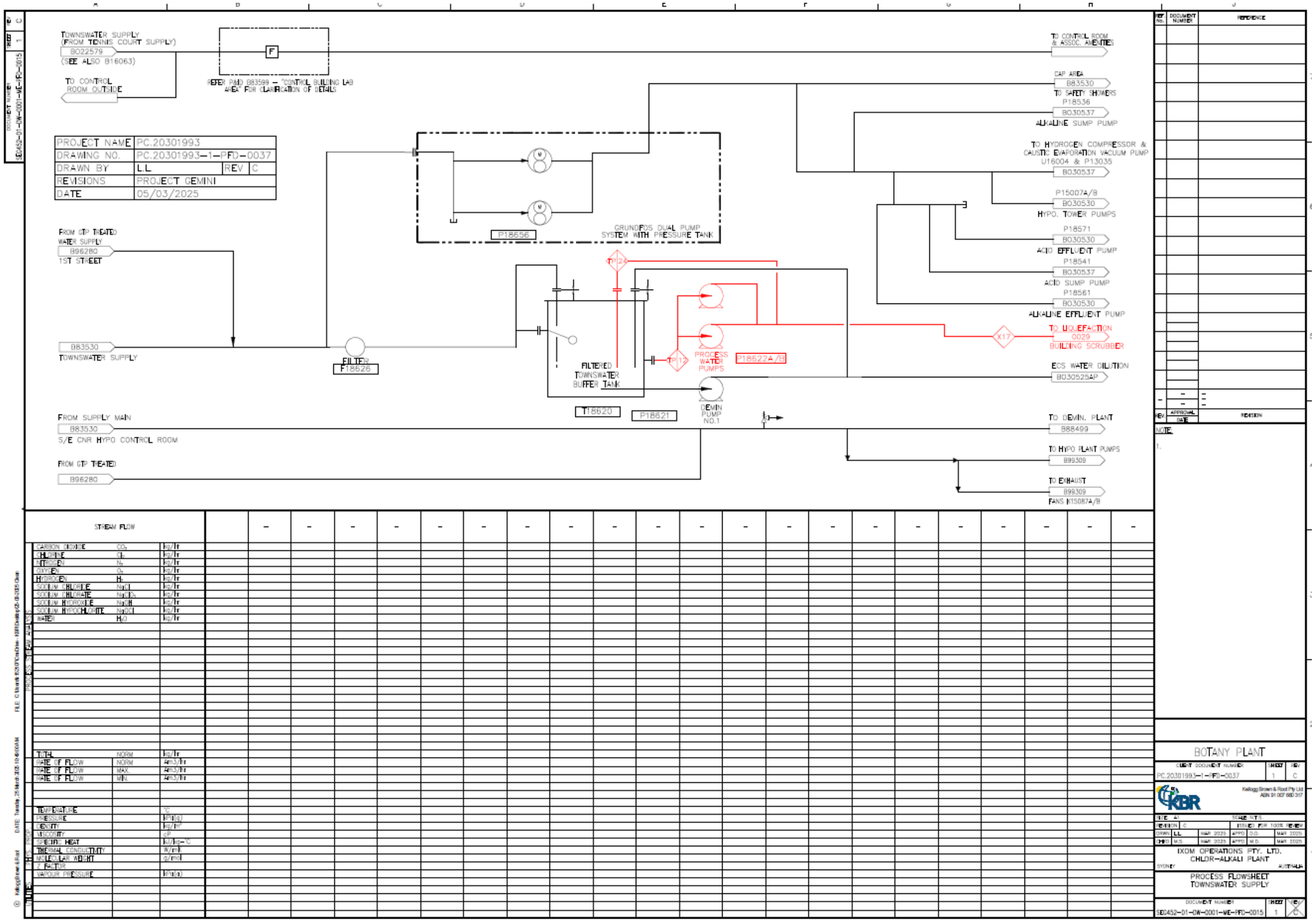
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA

PROCESS FLOWSHEET
DEGAS REACTOR

DOCUMENT NUMBER: SD452-01-DW-0001-ME-PFD-0008 | SHEET 1 | REV D


TO CAUSTIC
B83403
LOADING
TO COOLING
B51837
TOWER
TO HYPO
B98119
LOADING
TO CAUSTIC
B83412
STORAGE
INT-02
PLANT AIR RECEIVER
EMERGENCY GENERATOR
INT-03
PLANT AIR COMPRESSOR
PRE-FILTER
FINAL FILTER
INT-07
PLANT AIR COMPRESSOR
DRAIN TRAP
PACKING HR
INT-04
X38
TP1
TO LIQUEFACTION
0026
TANKER FILLING
TO DRUM
0027
DEGASSING
TO LIQUEFACTION
PLANT AREA
B83405
TO HYPO PLANT
B83412
STORAGE AREA
B83054
TO SUMP PUMP
B99305
P15084
TO SUMP PUMP
B99854
P15094
TO HYPO PLANT
B99305
1ST LEVEL
TO HYPO PLANT
B99305
2ND LEVEL
TO HYPO PLANT
B99305
G LVL UTILITY STN
TO INSTRUMENT AIR
B83124
RECEIVER
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993-1-PFD-0034
DRAWN BY L.L REV B
REVISIONS PROJECT GEMINI
DATE 30/11/2023
STREAM FLOW
CARBON DIOXIDE CO2 kg/hr
CHLORINE Cl2 kg/hr
NITROGEN N2 kg/hr
OXYGEN O2 kg/hr
HYDROGEN H2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE NaClO3 kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM Am3/hr
RATE OF FLOW MAX Am3/hr
RATE OF FLOW MIN Am3/hr
TEMPERATURE °C
PRESSURE (Pa(g))
DENSITY kg/m3
VISCOSITY cP
SPECIFIC HEAT kJ/kg-°C
THERMAL CONDUCTIVITY W/m/K
MOLECULAR WEIGHT g/mol
Z FACTOR
VAPOUR PRESSURE (Pa(a))
NOTE
1.
REV
DOCUMENT NUMBER
REFERENCE
APPROVAL DATE
REVISION
BOTANY PLANT
CLIENT DOCUMENT NUMBER
PC.20301993-1-PFD-0034
SHEET 1
REV C
Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317
SIZE A1
SCALE N.T.S.
ISSUED FOR 100% REVIEW
DRWN L.L MAR 2025
APPD D.D. MAR 2025
CHKD M.S. MAR 2025
APPD M.D. MAR 2025
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
COMPRESSED AIR SUPPLY
DOCUMENT NUMBER
SD452-01-CW-0001-ME-PFD-0012
SHEET 1
REV C


HC
50% CAUSTIC FROM
B030523
EVAPORATOR
CAUSTIC STORAGE TANK
110Cm.3
T13049
CAUSTIC STORAGE TANK
110Cm.3
T13050
RADAR
U/SONIC
NOTE 3
SH-13009
TP 10
TP 9
TP 8
FC
CAUSTIC LOADING/ TRANSFER PUMP
P13051
CAUSTIC LOADING/ TRANSFER PUMP
P13052
CAUSTIC PUMP TO LIQUEFACTION
P13057A
CAUSTIC PUMP TO LIQUEFACTION
P13057B
TO CAUSTIC LOADING & SITE DISTRIBUTION
B85403
TO CAUSTIC DUMP TANK
0029
X16
TO LIQ. BUILDING SCRUBBER
B105916
TO P21011
B105916
TO P21001
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993-1-PFD-0035
DRAWN BY L.L. REV C
REVISIONS PROJECT GEMINI
DATE 05/03/2025
STREAM FLOW
CARBON DIOXIDE CO2 kg/hr
CHLORINE Cl2 kg/hr
NITROGEN N2 kg/hr
OXYGEN O2 kg/hr
HYDROGEN H2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE NaClO3 kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM Am3/hr
RATE OF FLOW MAX Am3/hr
RATE OF FLOW MIN Am3/hr
TEMPERATURE °C
PRESSURE kPa(g)
DENSITY kg/m3
VISCOSITY cP
SPECIFIC HEAT kJ/kg-°C
THERMAL CONDUCTIVITY W/mK
MOLECULAR WEIGHT g/mol
Z FACTOR
VAPOUR PRESSURE kPa(a)
REV NO. DOCUMENT NUMBER REFERENCE
REV APPROVAL DATE REVISION
NOTES:
1.
BOTANY PLANT
CLIENT DOCUMENT NUMBER PC.20301993-1-PFD-0035 SHEET 1 REV C
Kellogg Brown & Root Pty Ltd ABN 91 007 660 317
IXOM OPERATIONS PTY. LTD.
CHLOR-ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
CAUSTIC STORAGE
DISTRIBUTION SYSTEM
DOCUMENT NUMBER SE0452-01-CW-0001-ME-PFD-0013 SHEET 1 REV C


TOWNSWATER SUPPLY
(FROM TENNIS COURT SUPPLY)
B022579
(SEE ALSO B16063)
TO CONTROL ROOM OUTSIDE
REFER P&ID B83599 – "CONTROL BUILDING LAB AREA" FOR CLARIFICATION OF DETAILS
PROJECT NAME PC.20301993
DRAWING NO. PC.20301993–1–PFD–0037
DRAWN BY L.L. REV C
REVISIONS PROJECT GEMINI
DATE 05/03/2025
P18656
GRUNDFOS DUAL PUMP SYSTEM WITH PRESSURE TANK
FROM GTP TREATED WATER SUPPLY
B96280
1ST STREET
B83530
TOWNSWATER SUPPLY
FILTER P18628
TP23
TP12
PROCESS WATER PUMPS
P18622A/B
FILTERED TOWNSWATER BUFFER TANK
T18620
P18621
DEMIN PUMP NO.1
FROM SUPPLY MAIN
B83530
S/E CNR HYPO CONTROL ROOM
FROM GTP TREATED
B96280
TO CONTROL ROOM & ASSOC. AMENITIES
CAP AREA
B83530
TO SAFETY SHOWERS
P18536
B030537
ALKALINE SUMP PUMP
TO HYDROGEN COMPRESSOR & CAUSTIC EVAPORATION VACUUM PUMP U16004 & P13035
B030537
P15007A/B
B030530
HYPO. TOWER PUMPS
P18571
B030530
ACID EFFLUENT PUMP
P18541
B030537
ACID SUMP PUMP
P18561
B030530
ALKALINE EFFLUENT PUMP
X17
TO LIQUEFACTION 0029 BUILDING SCRUBBER
ECS WATER DILUTION
B030525AP
TO DEMIN. PLANT
B88499
TO HYPO PLANT PUMPS
B99309
TO EXHAUST
B99309
FANS K15087A/B
STREAM FLOW
CARBON DIOXIDE CO2 kg/hr
CHLORINE Cl2 kg/hr
NITROGEN N2 kg/hr
OXYGEN O2 kg/hr
HYDROGEN H2 kg/hr
SODIUM CHLORIDE NaCl kg/hr
SODIUM CHLORATE NaClO3 kg/hr
SODIUM HYDROXIDE NaOH kg/hr
SODIUM HYPOCHLORITE NaOCl kg/hr
WATER H2O kg/hr
TOTAL NORM kg/hr
RATE OF FLOW NORM Am3/hr
RATE OF FLOW MAX. Am3/hr
RATE OF FLOW MIN. Am3/hr
TEMPERATURE °C
PRESSURE kPa(g)
DENSITY kg/m3
VISCOSITY cP
SPECIFIC HEAT kJ/kg–°C
THERMAL CONDUCTIVITY W/m°K
MOLECULAR WEIGHT g/mol
Z FACTOR
VAPOUR PRESSURE kPa(g)
REF. NO.
DOCUMENT NUMBER
REFERENCE
REV
APPROVAL DATE
REVISION
NOTE
1.
BOTANY PLANT
CLIENT DOCUMENT NUMBER
PC.20301993–1–PFD–0037
SHEET 1
REV C
Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317
SIZE A1
SCALE N.T.S.
REVISION C
ISSUED FOR TOWN REVIEW
DRAWN L.L. MAR 2025
APPD D.D. MAR 2025
CHKD M.S. MAR 2025
APPD M.D. MAR 2025
IXOM OPERATIONS PTY. LTD.
CHLOR–ALKALI PLANT
SYDNEY AUSTRALIA
PROCESS FLOWSHEET
TOWNSWATER SUPPLY
DOCUMENT NUMBER
SE0452–01–CW–0001–ME–PFD–0015
SHEET 1
REV C

APPENDIX D. METEOROLOGICAL DATA

D1. Data source

Historical meteorological weather data for the terminal was obtained from the Bureau of Meteorology (BoM). The acquired data sets were based on readings from the Automatic Weather Station (AWS) at Sydney Airport (AWS 66037) over the period of June 2014 to June 2024. The station is located approximately 2 km away.

The following data were sourced from the BoM for AWS 66037:

- Wind speed
- Wind direction
- Temperature
- Humidity
- Ceilometer cloud data
- Solar elevation angle data.

D2. Pasquill stability class

The actual Pasquill stability classes were determined using the Gifford, Ref [8], definition of the conditions for different stability classes as summarised below. The ceilometer cloud and solar elevation data were used to accurately classify the data into stability classes defined by Gifford.

Table D.1: Stability class allocation

Surface wind speed, m/s	Daytime insolation			Nighttime conditions		Anytime
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	≥ 3/8 cloudiness	Heavy overcast
< 2	A	A-B	B	F	F	D
2-3	A-B	B	C	E	F	D
3-4	B	B-C	C	D	E	D
4-6	C	C-D	D	D	D	D
> 6	C	C	D	D	D	D

D3. Representative stability class and wind speed

The TNO Purple Book approach uses a correlation between the actual Pasquill stability class and wind speed to determine the representative Pasquill stability classes, as presented in Table D.2.

Suitable analysis of the obtained raw data from the BoM was performed using the approach detailed in the TNO Purple Book, and the data were consolidated into six different representative weather conditions, as per table above, which are:

- Pasquill stability class: B (medium); wind speed 2.8 m/s (B2.8)

- Pasquill stability class: D (low); wind speed 4.5 m/s (D1.7)
- Pasquill stability class: D (medium); wind speed 4.3 m/s (D4.3)
- Pasquill stability class: D (high); wind speed 8.4 m/s (D8.4)
- Pasquill stability class: E (medium); wind speed 3.1 m/s (E3.1)
- Pasquill stability class: F (low); wind speed 1.4 m/s (F1.4).

Table D.2: Allocation of observations into six representative weather classes

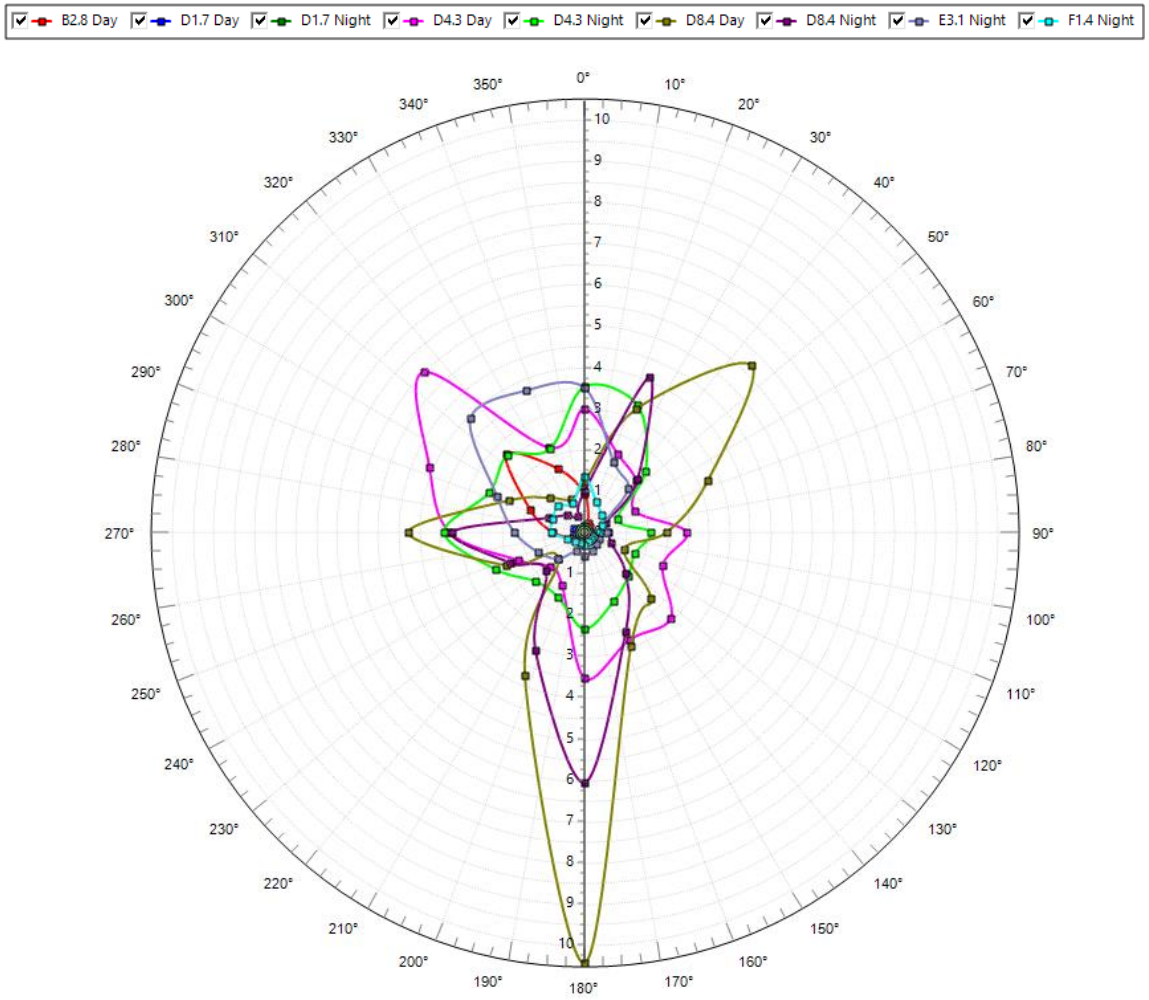
Surface wind speed, m/s	Actual Pasquill stability class							
	A	B	B/C	C	C/D	D	E	F
< 2.5	B Medium			D Low			F Low	
2.5-6				D Medium			E Medium	
> 6				D High				

The meteorological data sets used for the QRA are presented in Table D.3. Additionally, the wind rose map is also provided in Figure D.1.

Table D.3: Meteorological data sets used for QRA

Direction wind from	Probability of occurrence of windspeed ranges (m/s), within stabilities classes in the day and at night												Total day	Total night
	B2.8	B2.8	D1.7	D1.7	D4.3	D4.3	D8.4	D8.4	E3.1	E3.1	F1.4	F1.4		
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night		
N	0.94	0.00	0.15	0.16	3.00	3.54	1.22	1.00	0.00	3.50	0.00	1.35	5.30	9.54
NNE	0.26	0.00	0.07	0.12	2.07	3.33	3.24	4.08	0.00	1.85	0.00	0.79	5.64	10.18
NE	0.16	0.00	0.06	0.11	1.78	2.07	5.72	1.80	0.00	1.48	0.00	0.60	7.72	6.06
ENE	0.11	0.00	0.08	0.08	1.32	0.87	3.24	0.56	0.00	0.49	0.00	0.44	4.75	2.43
E	0.14	0.00	0.12	0.09	2.48	1.61	1.98	0.58	0.00	0.54	0.00	0.35	4.72	3.16
ESE	0.08	0.00	0.09	0.07	2.06	1.32	1.06	0.70	0.00	0.40	0.00	0.25	3.29	2.74
SE	0.07	0.00	0.07	0.05	2.95	1.52	2.29	1.40	0.00	0.39	0.00	0.21	5.38	3.58
SSE	0.11	0.00	0.10	0.08	2.82	1.81	2.98	2.62	0.00	0.50	0.00	0.26	6.01	5.26
S	0.18	0.00	0.12	0.10	3.54	2.35	10.45	6.09	0.00	0.58	0.00	0.33	14.28	9.45
SSW	0.16	0.00	0.11	0.08	1.40	1.71	3.77	3.09	0.00	0.48	0.00	0.28	5.43	5.65
SW	0.19	0.00	0.12	0.08	1.19	1.68	0.90	1.34	0.00	0.89	0.00	0.33	2.40	4.31
WSW	0.33	0.00	0.18	0.09	1.75	2.33	2.07	1.94	0.00	1.23	0.00	0.45	4.34	6.04
W	0.78	0.00	0.25	0.16	3.28	3.42	4.29	3.23	0.00	1.71	0.00	0.79	8.60	9.32
WNW	1.41	0.00	0.29	0.15	4.08	2.49	1.98	0.95	0.00	2.31	0.00	0.83	7.76	6.73
NW	2.68	0.00	0.14	0.13	5.50	2.66	1.18	0.61	0.00	3.92	0.00	0.91	9.50	8.22
NNW	1.68	0.00	0.10	0.12	2.24	2.19	0.86	0.42	0.00	3.72	0.00	0.78	4.88	7.23
Total	**9.27**	**0.00**	**2.06**	**1.68**	**41.45**	**34.89**	**47.22**	**30.41**	**0.00**	**23.99**	**0.00**	**8.96**	**100.00**	**100.00**

Figure D.1: Wind rose distribution



APPENDIX E. POPULATION DATA

E1. Source data

Residential population data from the 2021 Census was obtained from the ABS. Employment population (i.e. industrial/commercial) was obtained from Transport for NSW (TfNSW). The Travel Zone (TZ) Projection 2025 developed from the 2016 Census was used.

The data was initially obtained for areas within approximately a 3km radius of the centre of the BIP site. This is greater than the largest estimated impact area to the 1% fatality consequence for any scenario in the QRA, so is sufficient to account for all potentially affected populations.

This data was then supplemented by specific data for particular locations such as Eastgardens and Bunnings.

Table E.1 summarises the various data sources used to compile the population data input to the QRA.

Table E.1: Data sources

Data	Source	Comments
Data for general area		
Residential population	Aust Bureau of Stats (www.abs.gov.au)	Latest available ABS Census data is 2021. This data represents the maximum residential population (i.e. nighttime). Data was supplied by ABS as a centroid for each Census Statistical Area (SA) Level 1 (X, Y, no of people).
Employed population (i.e. commercial/ industrial)	TfNSW	Data was supplied by TfNSW for each Travel Zone around the BIP site as a centroid (X, Y, no of people). This data represents the number of people who travel into the area close to the BIP for work, i.e. the commercial/industrial population. The data is produced from information collected in the 2016 Census a sit has not been made available using the 2021 Census. The values projected for 2025 were used.
BIP site (current data)		
Population on BIP site (i.e. BIP, Nant St)	Refer to future BIP population	The population of the BIP (505 during day, 51 at night) has been removed from the employment data for the TZ that covers the BIP and the populations on the BIP site and Nant St set to 0. The remaining population from the employment data (TZ400) has been reallocated over the remaining area of the travel zone that the BIP is within. Qenos/Indorama areas have population assigned as per Section E2

Data	Source	Comments
Additional point sources		
Schools	-	No specific data was entered for schools as the pupils are assumed to be largely local and covered by the Census data. The nearest school is Matraville Public around 400 m to the east of Denison St.
Eastgardens shopping centre	Joint Regional Planning Panel report (JRPP Number 2014SYDE076) for DA 2017/1107 by Bayside Planning Panel states car spaces as 3,089 (though 418 are for staff)	Eastgardens Shopping Centre population is assumed as 3,089 shoppers (in addition to the staff who are identified in travel zone data TZ423) for daytime only. Note: that this is regarded as a best estimate and could be an over or underestimate for shoppers as there would be multiple people in some cars and public transport usage, but people are not present all day.
Bunnings development, Denison St east side	Dangerous Goods Transport QRA, Denison St, Hillsdale (Systra Scott Lister Issued: 12th February 2015)	200 people (daytime only).
BIP subdivision, Denison St west side	Statement of Environmental Effects (SEE) Botany Industrial Park Staged 20-Lot Subdivision 20 Dec 2010	DA 10/486 approved by Land and Environment Court on 13/09/2012 for 20 lot subdivision. Number of people over whole area (including former Masters site on Corish Circle) estimated at 40 based as this is a concrete batching works (reduced compared to 265 for previous QRA which was based on warehousing). 200 day time only on the southern part of the subdivided area along Denison St as advised by the DPE. Zero population on lots with covenant (i.e. R1 and R2 restrictions as per Deposited Plan 1204999).
Meriton development Former BATA Site, Banks Avenue, Heffron Road & Bunnerong Road, Eastgardens	-	Not included. Sensitivity case in previous BIP QRAs – too far away to affect FN results.

E2. Future BIP population

For the areas within the BIP boundary, the density population of 40 people per hectare (daytime 100% and nighttime 10%) was assumed based on the future operations likely to be industrial warehousing and included in the societal risk calculation.

E3. Day and night population

Weighting factors (Table E.2) have been applied to the raw data to distribute population between day and night and inside and outside populations. The factors used are summarised in the following table. Note that these factors have been agreed with DPIE in previous studies and have not changed since the previous QRA.

The day and night factors have been applied to raw data from 2021 Census (residential) and TfNSW (employment), which are provided in Table E.3 and Table E.4. The population data were reviewed and adjusted in some cases as described in Table E.1

Table E.2: Population factors

Factor	Value	Comments
Day and nighttime weighting factor	0.5	Assumed that day is 6am to 6pm
Nighttime population	Census	Residential only. Census data values used for residential population. The population of schools and industrial or commercial areas are assumed 0
Fraction of population outside at night	0.05	No particular basis. Has been used before in previous studies approved by DPIE.
Day time population	Census adjusted as per comments	No particular basis. Has been used before in previous studies approved by DPIE. Residential – use 1/3 of Census value. (Remaining 2/3 assumed at work out of area) Other industrial/commercial - use values in Travel Zone data and additional sources (e.g. Eastgardens shoppers) in Table A8.2.
Fraction of population outside during day	0.10	No particular basis. Has been used before in previous studies approved by DPIE.

Table E.3: Residential populations (Reference: 2021 Census Data)

SA1 2022	Estimated Nighttime Population	Estimated Daytime Population
11701132001	4	2
11701132002	487	163
11701132003	0	0
11701132108	444	148
11701132113	521	174
11701132121	0	0
11701132124	356	119
11701132125	79	27
11701132126	314	105
11701132133	341	114
11701132135	383	128
11701132136	88	30

SA1 2022	Estimated Nighttime Population	Estimated Daytime Population
11701132137	397	133
11701132138	281	94
11701132139	755	252
11701132128	305	102
11701132129	367	123
11701132130	266	89
11701132302	295	99
11701132332	347	116
11701132334	386	129
11701132333	351	117
11701132335	555	185
11701132311	335	112
11701132312	299	100
11701132313	336	112
11701132314	412	138
11701132318	256	86
11701132319	389	130
11701132320	506	169
11701132331	364	122
11701132336	1212	404
11701132330	1492	498
11701132322	376	126
11701132323	478	160
11701132324	7	3
11701132325	377	126
11701132326	321	107
11701132327	431	144
11701132328	502	168
11701132329	252	84
11701132401	6	2
11802165318	393	131
11802165322	504	168
11802165303	495	165
11802165329	551	184
11802165310	678	226
11802165313	622	208
11802165308	503	168
11802165312	353	118
11802165323	336	112
11802165324	298	100

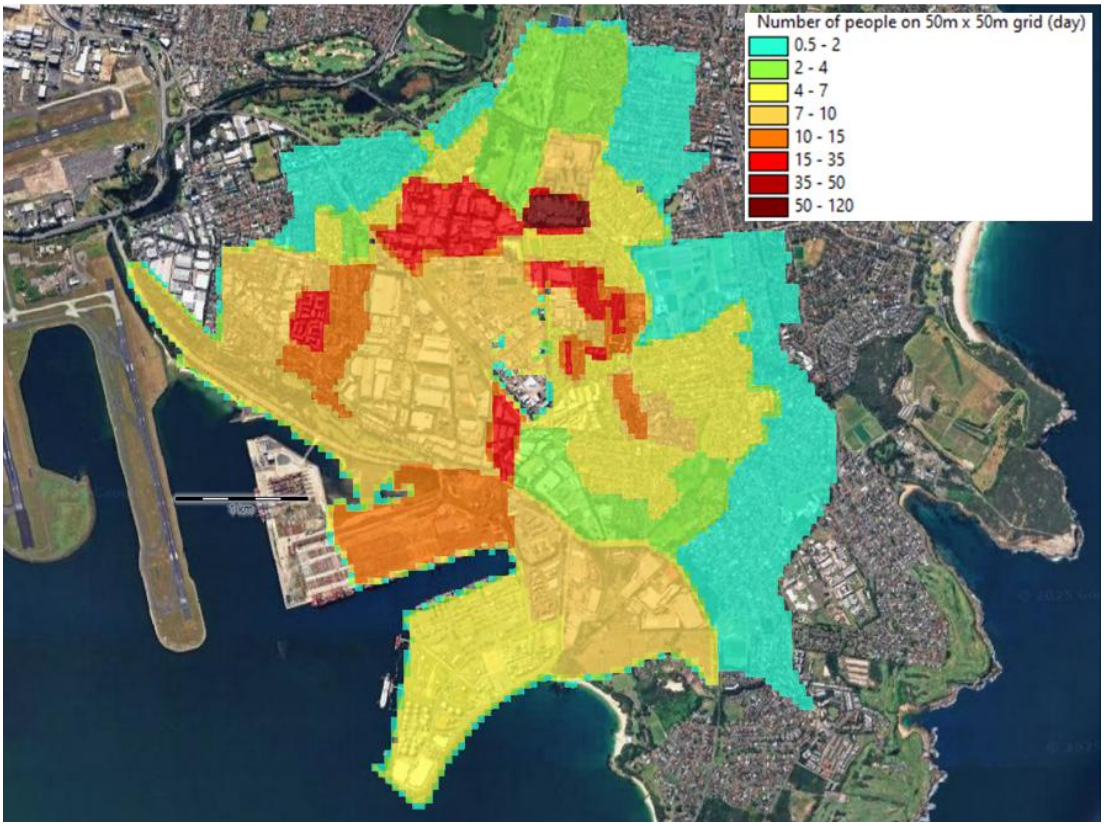
SA1 2022	Estimated Nighttime Population	Estimated Daytime Population
11802165328	510	170
11802165311	262	88
11802165309	538	180
11802165305	387	129
11802165319	321	107
11802165316	392	131
11802165321	375	125
11802156805	437	146
11802156815	591	197
11802156821	0	0

Table E.4: Transport populations (Reference: TfNSW)

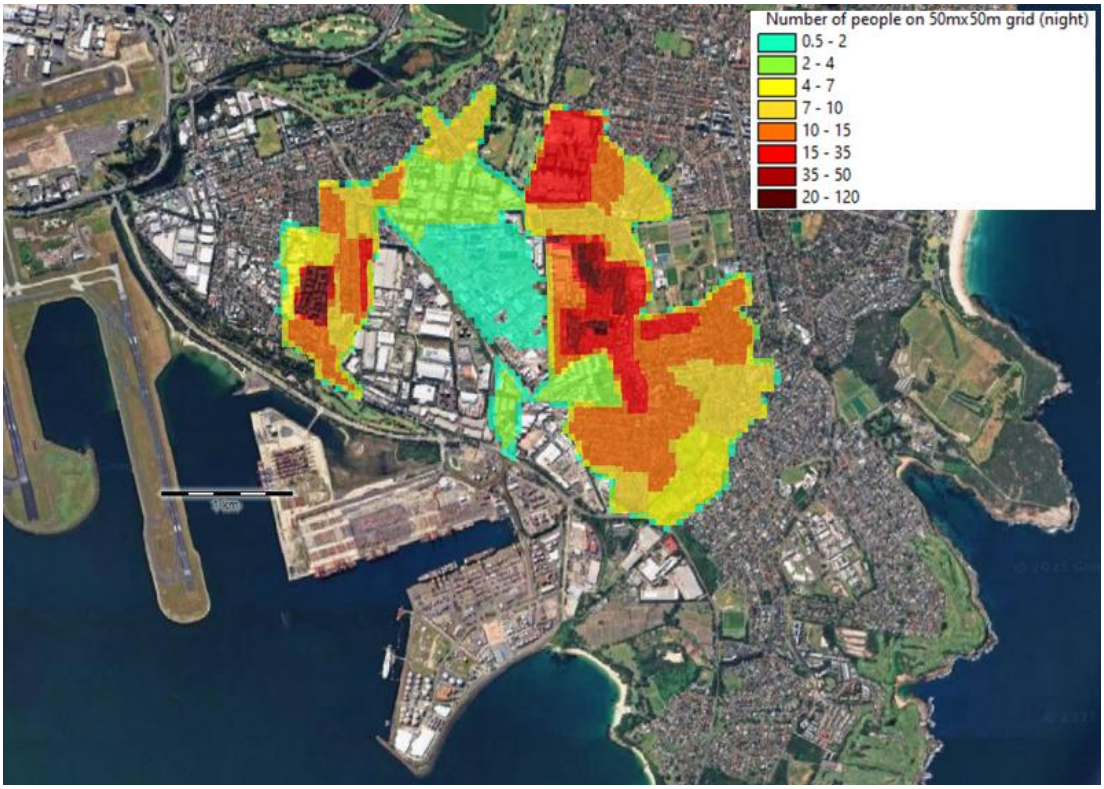
Transport Zone	Description	Estimated Daytime Population	Estimated Nighttime Population
400	Orica Australia	4897	0
401	Discovery Cove Industrial Park	3870	0
402	Caltex Sydney Terminal	3828	0
406	Botany William St	138	0
408	Botany Industrial Area	5242	0
421	Bonnie Doon Golf Club	1089	0
422	Pagewood Wentworth Av and Page St	341	0
423	Eastgardens Shopping Centre	341	0
424	South Point Shopping Centre	599	0
425	Matraville Public School	63	0
428	Port Botany Business Park West	371	0
429	Military Rd	3713	0
430	Port Botany Southern Container Terminal	2460	0
624	Matraville Eastern Rd and Beauchamp Rd	135	0
625	Matraville	667	0
627	Matraville Menin Av and Flinders St	528	0
628	Port Botany Business Park East	114	0
629	Matraville High School	744	0
640	South Sydney High School	524	0
645	Heffron Park	156	0

E4. Day and night population maps

Day time population (number of people per 50 m x 50 m grid)



Night time population (number of people per 50 m x 50 m grid)



APPENDIX F. LIQUEFACTION BUILDING AND SCRUBBER DESIGN

F1. Containment building

The majority of the liquefaction facility equipment except for the refrigeration unit and the building ventilation and scrubbing system will be located inside a large containment building. The refrigeration unit is directly adjacent to the building wall around the chlorine liquefier to minimise pipe runs. The liquefaction building scrubber is located at the northeast side of the building adjacent to the degas reactor. The design intent is that any leaks can be fully contained and then directed to a scrubber at a manageable rate. The building site layout, showing the location of equipment and storage areas, are provided in Figure 3.4.

The building design incorporates the design of the liquid chlorine production and the packing/filling building at Laverton. The building wall is 15.7 meters high at the southeast side of the building to accommodate the chlorine liquefier. The building roof then slides down at 6° towards the northwest direction to 8-meter high.

The building ventilation system is used during normal and contingent operation to maintain a negative pressure in the building and provide adequate air recirculation. The ventilation fan is used to extract air from the building. The capacity of the building ventilation fan is 11.1 m^3/s. When the ventilation fan is operating, the air velocity through the air inlet is estimated at around 0.7 m/s, and the building pressure will be maintained at a slight vacuum of around -15 Pa. Weatherproof louvres will be maintained manually open for any additional make up air.

When a chlorine release is detected in the building, ventilation fan and the motorised air damper will be closed. Various chlorine vent scrubbing isolation valves near the chlorine release point will open and the scrubber fan will ramp up to suck building air through the scrubber. The weatherproof louvre will be maintained manually open to provide make up air to the building scrubber.

The building materials (concrete and steel) are compatible with chlorine and will be confirmed in detailed design. As per existing similar facilities there is no anticipated requirement for special coatings or unusual materials of construction. Should a major release occur all structures and equipment would require detailed inspection prior to re-commencing any operations.

F2. Containment building availability

The potential failure modes of the LBS have been identified, and an associated event tree has been developed to estimate the probability that a chlorine release will not be contained. There are two different event tree nodes considering different starting states. Note that:

- ‘Building state closed’ is the starting state of the building which is the case 97% of the time. In this case, as per the event tree, there is no action required in relation to

closing the vehicle roller doors on chlorine detection as they are already in the closed state.

- For the starting state of 'Building open' (i.e. for the portion of time vehicles are entering or leaving) the roller doors would close as soon as the vehicle fully enters or exits the building. If this does not occur, an alarm will be generated, and the operator will have the ability to close the doors via a push button located on the outside of the building or remotely from the control room using CCTV surveillance. Roller doors will be fitted with position switches and will be monitored remotely from the control room via CCTV therefore negating the need for manual inspection.
- In the event of a detected chlorine release in the building, an audible and visual alarm would be initiated at both the CLP Building and the control room, and the roller doors will automatically close if not already in the closed state. If an operator were in the building, they would be trained to immediately leave the building via the nearest exit to the site safe haven
- Percentages open has been determined by calculating the time a roller door needs to be open to allow for a truck to enter or exit the building for both the Normal Case and Contingent Case. Door opening and closing times are based on IXOM's Laverton North VIC Chlorine Liquefaction Plant. Only one roller door will be open at a time. That is, the entry roller door will open to allow a truck to enter the building then immediately close. The exit roller door will open when the vehicle is ready to leave then immediately close. An alarm will be raised if either door does not close after a truck has passed through it. There is no room in the building for truck queuing with open doors and there is no requirement for this based on throughputs.
- Pedestrian doors will be self-closing wind proof doors as per the Laverton Plant and will always be in the closed position except for when an Operator enters or exits the building. This is not quantified as the open time will be very short.
- Chlorine gas detectors wiring network will be designed with redundancy in the wiring such that the failure of a single chlorine detector will not lead to a loss of detection of a potential leak. Common cause failure of all chlorine gas detectors is not credible. Common cause failure of wiring may be possible however detailed design will ensure that there is sufficient redundancy of the wiring such that this failure is detected (i.e. fault detection/loss of communications detection is provided) and interlocked with the CLP operation which will lead to a failsafe state such that if chlorine detection is unavailable then liquefaction operations shall be shutdown and/or prevented from occurring. Failure of chlorine detection is not quantified in the event tree.

For the purposes of the planning stage QRA the estimated overall containment unavailability is 5% 'unavailable' for both short duration (4%) and completely unmitigated (1%) events. Conservatively the QRA assumes that 5% of all events are completely unmitigated, i.e. the LBS has no effect and does not model the short duration events separately. At the detailed design stage, the QRA may be refined to differentiate

between short duration and unmitigated releases but at the planning stage the approach taken is regarded as appropriately conservative.

NOTE: Chlorine releases outside the building are not mitigated by the Containment Building and the event tree does not apply.

F3. Performance verification

F3.1. Commissioning verification activities

Key equipment/items associated with the scrubber and building such as scrubber pumps, fans have been identified during the design phase/hazard studies and redundancy built into the design, i.e. 2 x pumps, 3 x fans, redundant power supplies, etc. Detailed design will include technical safety studies to identify the required SIL of instrumented trips.

To then ensure the scrubber and containment building function as designed the following typical activities will be completed as part of commissioning. Note that these would be detailed in the formal commissioning plan for the project.

- Control and trip loop testing to confirm loop correct electrical connections and output logic functions as designed
- Function testing and closure timing for building doors and other openings
- Building ventilation and scrubber fan capacity testing (flow and pressure differential measurements) to confirm design velocities/volumes achieved for all conditions including abnormal operations for building openings remaining opening and failure to automatically shutdown building ventilation.
- Smoke testing within building to confirm placement of gas detectors and ducting intakes/louvres.

F3.2. Maintenance tasks to ensure scrubber and containment building availability

Periodic maintenance tasks and functional checks to ensure reliable operation of key controls at the CLP will be defined and completion tracked. Note that these are anticipated to be similar to the IXOM Laverton MHF facility and will be tracked in a similar way to existing control measures at the Botany CAP. A high-level summary is provided in Table F.1.

Note that details of these tasks will be refined based on equipment supplier advice and operating experience. Also note that the MHF safety case requires that major incident controls such as the scrubber and building have defined performance standards and supporting activities to ensure these standards are met. Confirming that these are in place and tasks are being completed to plan and any detected failures investigated is typically a significant focus of regulatory SafeWork MHF audits which occur periodically for an operating MHF such as the CAP/CLP.

Table F.1: Typical maintenance tasks

Item	Typical task (periodic as per inspection plans)
Cl_2 gas detection - alarm and trip functions	Calibration (to ensure correct setpoint) Function check trip and alarms (to ensure gas detection initiates correct final elements e.g. closes valves, opens scrubber ducts etc.)
Containment building	Physical inspection of doors, louvres Structural inspection (to detect any failures in building walls, degradation of structure) Function check trip and alarms (to ensure manual door close buttons, gas detection initiates correct final elements e.g. closes doors, louvres etc.)
Load cells	Calibration (to ensure correct measurement of chlorine bulk tank contents) Function check trip and alarms (to ensure detection initiates correct final elements e.g. closes valves to prevent overfill etc)
Scrubber fans	Mechanical tasks (e.g. greasing, motor checks) to ensure these remain electrically and mechanically available Function check trip and alarms (to ensure detection initiates correct final elements e.g. starts second fan) Power failure function check to ensure switchover to backup supplies (x2) if main power fails
Scrubber pumps	Mechanical tasks (e.g. greasing, motor checks) to ensure these remain electrically and mechanically available. Power failure function check to ensure switchover to backup supplies (x2) if main power fails
Scrubber	Cleanout to prevent any buildup
Emergency shutdown (ESD)	Function check of manually initiated ESD buttons (to ensure ESD initiates correct final elements e.g. closes valves, opens scrubber ducts etc.)

Table F.2: Event tree analysis

Event tree failure mode	Critical controls	Potential consequence	Justification	Included in event tree
Building ventilation - failed to stop on chlorine release - LBS starts	• Motorized damper • Operator detection – can shut down building ventilation remotely and locally	Release chlorine through building exhaust	If building fans fails to stop, the motorised damper stops air flow to the building ventilation fans. For a release to occur to atmosphere the building ventilation fan would need to remain running AND the damper would need to stay open Operators can also stop building ventilation fans and close damper remotely or locally. NOTE: If all other controls fail, the LBS once will still suck in most of chlorine as the ventilation building ventilation duct inlets are elevated and the LBS inlet ducts at lower at the level of the process equipment.	Yes Frequency included in the overall building unavailability event tree. Modelled as release in open area (i.e. building/scrubber assumed ineffective)
Building ventilation stops AND LBS inlet dampers fails to open	• Operator detection – can manually close air inlet dampers remotely and locally • Multiple motorized LBS inlet dampers, fail open	Discharge chlorine through building air inlet intakes	If building fans stop and there is no flow path to LBS scrubber fan or LBS fans all simultaneously failed there is a potential leak path from the building air intake inlets. These can be closed remotely by operator NOTE: if there is a chlorine release, significant cooling inside will occur, and air would tend to be drawn into building even in the absence of fans running rather than let out.	Yes Frequency included in the overall building unavailability event tree. Modelled as release in open area (i.e. building/scrubber assumed ineffective)
Failure of chlorine detection	• Multiple Cl2 sensors and alarm/shutdown	Discharge chlorine through building exhaust	This scenario only occurs if the chlorine release inside the building is not detected. Given that multiple detectors with redundant wiring and fault detection will be installed within the building, complete failure of Cl2 detection is not credible.	No Extremely unlikely-not included.
LBS - failed to open inlet dampers on chlorine release	• Motorized LBS inlet dampers, fail open • Operator detection – can manually open dampers remotely and locally	Discharge chlorine through ventilation inlet air intakes		Yes Frequency included in the overall building unavailability event tree. Modelled as release in open area (i.e. building/scrubber assumed ineffective)
LBS – scrubber fan failed to ramp up	• Fan configuration (3x 100%) • Damper design (motorised, fail open)	None	3 x 100% fans are available. Simultaneous failure of all fans is extremely unlikely. Even if a fan fails to ramp up the rate of air drawn through the scrubber is lower, but the scrubber still works – rate of treatment is slower.	No Not included – no chlorine release
LBS - failed to scrub (loss of caustic circulation)	• -LBS pump configuration (3 x 100%)	Release of chlorine from LBS stack	The caustic circulation is always working at the design rate (i.e. no need to ramp up in case of chlorine release). • Two standby pumps are available in case of pump failure. • LBS damper design is 'fail open'. Even if one fails to open, there are multiple air inlets to LBS. Operator can open dampers remotely.	Yes Modelled as scrubber breakthrough
LBS - failed to scrub (caustic solution exhausted)	• Continuous mode of scrubber – always a small makeup/removal flow	Release of chlorine from LBS stack	Continuous mode of scrubber operation minuses likelihood of problem with the caustic solution – always a small makeup/removal flow. Minimum volume available in Hypo Storage Tanks to dump scrubber volume if needed and significant quantity of bulk caustic available to top up. The caustic buffer volume in the scrubber sump has more than 1 hour capacity for scrubbing (i.e. can act as batch scrubber) without top up of caustic or removal of hypo solution. Ie no immediate effect of deviation in caustic availability. Only other cause is catastrophic mechanical failure of scrubber. Very unlikely..	No Not included – no immediate effect
Chlorine release while building vehicle doors open	• Doors normally closed, wind rated with minimal leak paths • Remote control of doors • Doors automatically close on Cl2 detection	Release chlorine through vehicle doors	Doors will be immediately closed after the road tanker goes in/out. If the roller door is left open, the scrubber fan will be unable to maintain the negative pressure within the building and chlorine can escape from the openings (e.g. door, louvers, etc.).	Yes Frequency included in the overall building unavailability. Modelled as release in open area (i.e. building/scrubber assumed ineffective)

Event tree failure mode	Critical controls	Potential consequence	Justification	Included in event tree
Chlorine release while building pedestrian doors open	• Self-closing pedestrian doors, wind rated with minimal leak paths	Release chlorine through pedestrian doors	Doors are self-closing. The scrubber fan will be able to maintain the negative pressure within the building and chlorine cannot escape from this opening even if open.	No Extremely unlikely-not included.
Common mode – power failure	• Redundancy of power supply to scrubber equipment • Fail safe position of dampers: • Air intakes open • Building ventilation damper – closed • LBS intakes – open	Scrubber unavailable for treating chlorine	3 x100% scrubber fan/pump banks each with a different power supply, one of which is emergency generator. Manually box up building – all building openings can be remotely closed NOTE: no chlorine manufacturing or transfer can occur in a power failure case, static process equipment inventories only.	No Extremely unlikely-not included.

F4. Event tree

		Building state - vehicle doors closed	Building ventilation shut down	LBS Scrubber inlet dampers open	Operator action (remote within a few minutes)	Scrubber pump / fan running	Outcome
						Yes	Scrubber will still suck - design case (no release)
						0.99	9.8E-03
				Yes		No	Chlorine escaping from building
			No (failed to stop ventilation fan AND fail to close louvre)	0.99		0.01	9.9E-05
			0.01	No (failed to open LBS dampers)	Yes (opens LBS dampers	Yes	Chlorine escaping from building - short duration
				0.01	0.9	0.99	8.91E-05
						No	Chlorine escaping from building - unmitigated
						0.01	9E-07
					No		Chlorine escaping from building - unmitigated
					0.1		1.0E-05
		Yes (doors in closed state)					
		0.97					
				Yes		Yes	Scrubber design case (no release)
				0.99		0.99	0.97
						No	Chlorine escaping from building - unmitigated
			Yes			0.01	9.8E-03
			0.99	No (failed to open LBS dampers)	Yes (opens LBS dampers	Yes	Chlorine escaping from building - short duration
Chlorine release				0.01	0.9	0.99	8.8E-03
(QRA freq for scenario)						No	Chlorine escaping from building - unmitigated
						0.01	8.91E-05
					No		Chlorine escaping from building - unmitigated
					0.1		9.9E-04
			Building doors close automatically			**Operator action (closes doors within a few minutes)**	
		No (doors in open state)	Yes				Chlorine escaping from building - short duration
		0.03	0.99				0.030
		(contingent case)					
			No			Yes (closes doors	Chlorine escaping from building - short duration
			0.01			0.9	2.7E-04
						No	Chlorine escaping from building - unmitigated
						0.1	3.0E-05
						Chlorine escaping from building - unmitigated	0.011
						Chlorine escaping from building - short duration	0.039
						Total unavailability	**0.050**

APPENDIX G. HAZARD IDENTIFICATION

Rev	Date	Description	Prepared	Checked									
A	21/02/2025	Draft for comment	M Amouzegar	J Polich									
1	30/05/2025	Minor updates for Rev 1 QRA report	M Amouzegar	J Polich									
Notes													
	Added / changed for liquefaction project												
	As per CAP HAZID												

HAZID No	Area	Activity / Operation	Material	Hazardous Event	Causes	Consequence	Comments re Frequency (site experience - takes into account control measures) see Note 1	Control Measures / Safeguards (try to formulate these in terms of barriers)			Carried forward for analysis (quantitative) in QRA?	Operating node Liquefaction Project (Normal/ Contingent / both)	Comments
								Prevention	Detection	Protection / Mitigation			
1	CAP	Brine treatment and brine circuit	Chlorine	Release of chlorine	Failure of the dichlorination system	Evolution of chlorine from the spent brine	Unlikely	Brine at high pH. Acidic (i.e.. low pH) conditions required for Cl2 release	Online analysers and alarm.	Very low rate of chlorine formation (<0.01kg/s)	No	Both	Localised effect
2	CAP	Brine treatment and brine circuit	Chlorine	Large spill of spent brine onto the ground.	Overfilling of tanks.	Evolution of chlorine vapours from spent brine.	Very unlikely	Brine at high pH. Acidic conditions required for Cl2 release	Level detection of tanks	Escape respirators for plant personnel & visitors	Yes	Both	Very large spill only included in QRA consequence calcs
					Operator error (e.g. failure to close valve, or erroneous opening of valves, maintenance activities etc).			Overfill protection of tanks.		Bund limits surface area for evaporation			
					Failure or rupture of piping.			Regular maintenance and periodic inspection of pipelines, instruments and tanks.					
3	CAP	Cells - electrolysis / catholyte system	Chlorine	Failure of piping or associated equipment	Impact or other mechanical damage.	Chlorine leak	Unlikely	System operates under slight vacuum (up to -10 kPag), i.e. air will leak in for small leaks	Cl2 detectors in the cell area.	Shut down and chlorine air purge of piping to the ECS .	Yes	Both	Large leaks included in QRA with generic failure frequency. Small leaks assumed to suck air in, ie fans are include as mitigation .
					Corrosion, wear and tear.			suitable materials of construction					
					Wrong gasket material or faulty flanges.			Periodic Non Destructive Testing (NDT).					
					Valve left open.			Minimum of 2 valves between Cl2 and atmosphere. NRV designed to let air into system rather than chlorine out					
4	CAP	Cells - electrolysis / catholyte system	Chlorine	Pressure seal relieves	High pressure blows the seal.	Cl2 ex seal to the ECS (i.e.. no loss of containment unless scrubber fails).	Unlikely	Operating procedures ensure level maintained in the seal.	High pressure trips cell power supply Double redundancy pressure trip is first line of defence	The pressure seal is relieved to the ECS which is sized for 10 minutes absorption of the full production.	Yes	Both	Included as a demand on ECS
					Operational error during maintenance of the seal.								
5	CAP	Cells - electrolysis / catholyte system	Hydrogen	Process explosion involving hydrogen	High pressure in cells causes membrane failure.	Hydrogen breaks through membrane Hydrogen/chlorine explosion in cells, electrolyser or in downstream equipment Explosion causes equipment damage, subsequent H2 leak and fire	Very unlikely	Membrane configured to minimise pressure fluctuation and exposure to gas phase, therefore maximising membrane life.	Continuous monitoring of differential pressure across the membranes, and the concentration of hydrogen in chlorine.	Plant trips (stopping H2 production) on cell membrane differential pressure upset, high H2 pressure, low brine flow or low caustic flow.	No	Both	Asset damage. Cl2 could be released but very similar to other scenarios considered. Frequency not assessed separately. MHF frequency estimate is< 1e-7 per year
					Maintenance issue (wear and tear) of membrane.			Maintenance of membranes.		Electrolysers trip on high voltage (stopping H2 production).			
					Loss of brine or caustic flow with power still on causes membrane to fail.					Bund limits surface area for evaporation			
6	CAP	Cells - electrolysis / catholyte system	Hydrogen	Hydrogen leak	Leak from pipework, flange, e.g due to corrosion, mechanical impact	Local torch fire, radiation impact on adjacent equipment / plant.	Very unlikely	Continuously welded pipeline to limit potential leak sites, minimum number of flanges around equipment items.	Low pressure trips of H2 supply system, initiated both upstream and downstream of hydrogen compressor discharge pressure control valve	Located in open-sided structure or in open, providing good natural ventilation and reducing likelihood of explosion.	No	Both	Localised effect Hydrogen is used at low flowrates (maximum production rate is 0.03 kg/s). Hydrogen is “leaky” due to its very low molecular weight, and also has a very low ignition energy, hence is very easy to ignite. Plant inventory is low, the maximum operating pressure is low (less than 100 kPag), and the effect area would be limited. Torch fire consequence model results show flame lengths of less than 1m and heat radiation levels above 4.7 kW/m2 confined to within 1m of the flame. In addition the number of joints in the hydrogen system has been minimised (i.e. piping is generally welded) to reduce the likelihood of leaks. Hydrogen is much lighter than air, hence is very buoyant and disperses very easily unless confined. All areas handling hydrogen are well ventilated (there is no hydrogen handled within buildings) so confinement of a leak and subsequent explosion is also very unlikely. As per conclusions in the previous issue of the QRA, hydrogen fires and explosions are not considered further as they would have no impact outside the immediate leak area. Escalation potential is also minimal as hydrogen inventories are very small and there are no external flammable or combustible inventories in the vicinity of the hydrogen piping and compressor.
						Build up of hydrogen, delayed ignition and explosion.		Low hydrogen pressure in plant (approx 2 kPag in cells and 50kPag downstream of compressor) minimises leak rate, likelihood of ignition and subsequent fire damage					

HAZID No	Area	Activity / Operation	Material	Hazardous Event	Causes	Consequence	Comments re Frequency (site experience - takes into account control measures) see Note 1	Control Measures / Safeguards (try to formulate these in terms of barriers)			Carried forward for analysis (quantitative) in QRA?	Operating node Liquefaction Project (Normal/ Contingent / both)	Comments
								Prevention	**Detection**	**Protection / Mitigation**			
								Appropriate electrical hazardous area classification and equipment provided suitable for area classification.					
7	CAP	Cells - electrolysis / catholyte system	Chlorine	Chlorine Dioxide decomposition / explosion during chlorate destruction	Procedure not followed	Gaseous chlorine release	Very unlikely	Procedures			No	Both	Small , turbulent release - no offsite effects.
8	CAP	Chlorine cooling, drying and compression	Chlorine	Failure of piping or associated equipment	Corrosion (eg dryer failure) , wear and tear.	Chlorine leak	Very unlikely	Periodic Non Destructive Testing (NDT).	Cl2 detectors in the cell area.	Shut down and chlorine air purge of piping to the ECS .	Yes	Both	Included at generic pipe / equipment leak frequencies
					Wrong gasket material or faulty flanges.			Suitable materials of construction					
					Valve left open.			Minimum of 2 valves between Cl2 and atmosphere. NRV designed to let air into system rather than chlorine out					
					Impact or other mechanical damage.								
9	CAP	Chlorine cooling, drying and compression	Chlorine	Main plant trip trips the compressor but fails to trip the rectifier	Fault in electrical circuit, interference.	Chlorine production maintained at full rate without the compressor evacuating the chlorine from the piping. High pressure in header and relief of pressure seal	Cl2 ex seal to the ECS i.e.. no loss of containment unless scrubber fails and operator fails to trip power.	Periodic testing of plant trips.	Chlorine alarms to control room.	Emergency scrubber (ECS) designed to absorb at least 10 minutes of full production chlorine stream.	Yes	Both	Included as a demand on ECS
										Manual shut down of plant.			
10	CAP	Chlorine cooling, drying and compression	Chlorine	Failure of chlorine compression.	Power failure causes failure of the compressor.	Chlorine gas not compressed.	Very unlikely	Preventative maintenance	Any compressor trip causes power supply to rectifiers to trip	Plant depressurises to ECS i.e.. the chlorine contained in process equipment can safely be evacuated through the system to the scrubber. Scrubber sized for 10 min full production rate.	No	Both	No release - plant shutdown only.
					Failure of compressor coolant					Automatic shut-down of plant in case of power failure.			
										Power to safety critical equipment supplied from the emergency diesel generator.			
11	CAP	Chlorine cooling, drying and compression	Chlorine	Large spill of chlorinated H2SO4 (from drying) onto the ground.	Overfilling of tanks.	Evolution of chlorine vapours from chlorinated H2SO4	Very unlikely	Overfill protection of tanks.	Level detection of tanks	Escape respirators for plant personnel & visitors	Yes	Both	Same type of scenario as HAZID 2
					Operator error (e.g. failure to close valve, or erroneous opening of valves).			Regular maintenance and periodic inspection of pipelines, instruments and tanks.					
					Failure or rupture of piping.								
12	CAP	Chlorine cooling, drying and compression	Chlorine	Process fire (i.e not hydrogen related)	Dry chlorine reaches titanium cooler	Chlorine / titanium fire in cooler - chlorine release via failed equipment	Very unlikely	Titanium used in wet chlorine area of plant only (directly ex cells). Water spray into candle filter to ensure dry chlorine does not reverse flow.			No	Both	Asset damage. Cl2 could be released but very similar to other scenarios considered. Frequency not assessed separately. MHF frequency estimate is < 1e-7 per year
					Chlorine / iron fire if temperature above 150oC, equipment damage	Metal fire in chlorine compressor - chlorine release via failed equipment		Water cooling of chlorine gas in compressor system.	Monitoring of chlorine exit gas temperature of sealing liquid. Alarm and trips on high temperature.				
					Cl2 and hydrocarbon - leaking oil - accelerates corrosion			Centrifugal liquid ring compressor. Unlikely to cause significant temperature rise in process fluid					
13	CAP	Emergency Caustic Scrubber (ECS)	Chlorine	Loss of ECS suction through CAP	Failure to open/close the correct valves (e.g. after shut down)	Chlorine release in event of simultaneous plant upset	Very unlikely	Procedures	Position detection (DCS) on valves.		Yes	Both	ECS failure probability estimated via fault tree
					Loss of power			Critical equipment, such as the standby fan will start up automatically if the duty-fan fails.	Chlorine detector in ECS stack	Back-up diesel generator for all critical equipment in case of power failure.			
					Blocked absorption tower due to salting out (due to high caustic strength)			Caustic concentration to ECS dump tank limited to 18% to avoid scrubber salting up.		Nitrogen ejector provides some suction - no power supply required			
14	CAP	Emergency Caustic Scrubber (ECS)	Chlorine	Failure of the caustic soda absorption circulation in ECS.	Pump failure.	Chlorine release in event of simultaneous plant upset.	Very unlikely		Alarm on failure of the circulation flow.	Chlorine detector in ECS stack	Yes	Both	ECS failure probability estimated via fault tree

HAZID No	Area	Activity / Operation	Material	Hazardous Event	Causes	Consequence	Comments re Frequency (site experience - takes into account control measures) see Note 1	Control Measures / Safeguards (try to formulate these in terms of barriers)			Carried forward for analysis (quantitative) in QRA?	Operating node Liquefaction Project (Normal/ Contingent / both)	Comments
								Prevention	Detection	Protection / Mitigation			
					Power failure.			Critical equipment, such as the standby pump, will start up automatically if the duty pump fails Pumps designed to ride through voltage dip		Pumps on diesel generator emergency power back-up			
					Loss of caustic soda supply.			Caustic supplied from bulk caustic storage – large inventory		Emergency caustic dump tank contains some backup caustic supply.			
					Wrong strength caustic.				ORP measurement used to ensure caustic strength is in correct range				
15	Hypo Plant	Hypo destruction	Hypo	Reaction between hydrochloric acid (or other acids, e.g. sulphuric acid) and sodium hypochlorite.	Mixture in drains.	Formation of chlorine - toxic release.	Drain design prevented any mixing of acids (HCl, H2SO4) and Hypo.				Yes	Both	This has now been include for consistency with Safety Case. Release at EP6
					Contact in process piping.		Strict procedures for activities such as hypo destruction at hypo decomp tank						
16	Hypo Plant	Hypo production	Chlorine	Hypo caustic strength circulation or suction failure	Pump failure. Fan failure Wrong strength caustic causes plugging of make towers	Chlorine passes through make tower into back tower, Cl2 breakthrough if backing tower fails If suction fails emission from hypo circ tank (not backing tower)	Very unlikely	Critical equipment, such as the standby fan will start up automatically if the duty-fan fails.	Low flow alarm on circulation flow Caustic concentration controlled, deviations detected as per ECS High pressure trip if fans fail - isolate Cl2 feed	Backup tower exists at the Hypo plant	Yes	Both	Release frequency estimated by Fault Tree Split conseq into two locations with separate frequencies - 1. emission from backing tower and 2. emission from hypo circ tank (suction failure only)
17	Hypo Plant	Hypo production	Chlorine	Failure of feed chlorine piping	Corrosion, wear and tear.	Chlorine release.	Very unlikely	Periodic Non Destructive Testing (NDT).	Cl2 detectors in hypo	Shut down and chlorine air purge of piping to the ECS .	Yes	Both	Included at generic pipe / equipment leak frequencies
					Wrong gasket material, or faulty flanges.			Suitable materials of construction					
					Valve left open.			Minimum of 2 valves between Cl2 and atmosphere. NRV designed to let air into system rather than chlorine out					
					Impact or other mechanical damage.								
18	Ferric Plant	Chlorine feed	Chlorine	Failure of feed chlorine piping	Corrosion, wear and tear.	Chlorine release.	Very unlikely	Periodic Non Destructive Testing (NDT).		Shut down and chlorine air purge of piping to the ECS .	Yes	Both	Included at generic pipe / equipment leak frequencies
					Wrong gasket material, or faulty flanges.			Suitable materials of construction	Cl2 detectors				
					Valve left open.			Minimum of 2 valves between Cl2 and atmosphere. NRV designed to let air into system rather than chlorine out					
					Impact or other mechanical damage.								
19	Ferric Plant	Reaction	Chlorine	Chlorine unreacted and breaks through stack	Ineffective absorption in make towers Loss of suction in backing towers	Chlorine breakthrough, release to atmosphere	Very unlikely			Goes through Hypo backing tower	Yes	Both	Unlikely - same sort of scenario as hypo make tower failure but less likely. Included as demand on Hypo backing tower failure fault tree
20	HCl Plant	Chlorine feed	Chlorine	Failure of feed chlorine piping	Corrosion, wear and tear.	Chlorine release.	Very unlikely	Periodic Non Destructive Testing (NDT).	Cl2 detectors	Shut down and chlorine air purge of piping to the ECS .	Yes	Both	Included at generic pipe / equipment leak frequencies
					Wrong gasket material, or faulty flanges.			Suitable materials of construction					
					Valve left open.			Minimum of 2 valves between Cl2 and atmosphere. NRV designed to let air into system rather than chlorine out					
					Bellows failure			Bellows use minimised - only at burner to cater for temperature differential					
					Impact or other mechanical damage.								
21	HCl Plant	HCl synthesis	Chlorine	Release of toxic gases from the stack of the HCl plant.	Cl2 or H2 feed valve stuck open or opens prematurely during start up.	Chlorine release from top of stack.	Very unlikely	Trips on flame failure, instrument air failure, chlorine low pressure, hydrogen low pressure, flame failure.	Limit switches on valves (DCS controlled)	Automatic nitrogen purge on startup and shutdown.	Yes	Both	Release frequency estimated by Fault Tree

HAZID No	Area	Activity / Operation	Material	Hazardous Event	Causes	Consequence	Comments re Frequency (site experience - takes into account control measures) see Note 1	Control Measures / Safeguards (try to formulate these in terms of barriers)			Carried forward for analysis (quantitative) in QRA?	Operating node Liquefaction Project (Normal/ Contingent / both)	Comments
								Prevention	Detection	Protection / Mitigation			
					Cl2 or H2 feed valve fails to close during shut down.				Chlorine detector in the vent stack from the scrubber.				
					Ratio control failure.				Monitoring of synthesis unit bursting disc with trip on failure detection				
					N2 ingress to H2 feed - Cl2 not within H2 / Cl2 flammability range								
22	HCl Plant	HCl synthesis	Hydrogen Chloride	Release of toxic gases the stack of the HCl plant.	Failure of absorption water or major, prolonged failure of cooling water.	HCl release from top of stack.	Very unlikely		Low absorption water flow trip HCl detector in stack	Burner shutdown	Yes	Both	Release frequency estimated by Fault Tree
23	HCl Plant	HCl synthesis	Chlorine Hydrogen	Explosion in burner unit	Attempt to ignite with flammable atmosphere in unit.	Confined explosion in burner chamber. Internal damage to synthesis unit.	Very unlikely	Automatic nitrogen purging after shutdown and prior to start-up.	Flame detection to warn of flame failure.	Burst disc may rupture with small release of HCl or chlorine.	No	Both	Localised effect
					Flame failure and no or inadequate nitrogen purging.	Burn back into hydrogen or chlorine supply lines.		Automatic shutdown of plant after flame failure.		Flame arresters in hydrogen and chlorine supply lines.			
24	HCl Plant	Hydrogen compression and supply	Hydrogen	Hydrogen fire	Leak of hydrogen gas from supply line Compressor failure	Local torch type fire with radiation impact on adjacent equipment / plant.	Very unlikely	Low hydrogen pressure in plant (approx 2 kPag in cells and 50kPag downstream of compressor) minimises leak rate, likelihood of ignition and subsequent fire damage	Low pressure trips of H2 supply system, initiated both upstream and downstream of hydrogen compressor discharge pressure control valve	Automatic isolation valves (number and location) to stem hydrogen flow and extinguish fire by stopping fuel supply	No	Both	Localised effect Hydrogen is used at low flowrates (maximum production rate is 0.03 kg/s). Hydrogen is “leaky” due to its very low molecular weight, and also has a very low ignition energy, hence is very easy to ignite. Plant inventory is low, the maximum operating pressure is low (less than 100 kPag), and the effect area would be limited. Torch fire consequence model results show flame lengths of less than 1m and heat radiation levels above 4.7 kW/m2 confined to within 1m of the flame. In addition the number of joints in the hydrogen system has been minimised (i.e. piping is generally welded) to reduce the likelihood of leaks. Hydrogen is much lighter than air, hence is very buoyant and disperses very easily unless confined. All areas handling hydrogen are well ventilated (there is no hydrogen handled within buildings) so confinement of a leak and subsequent explosion is also very unlikely. As per conclusions in the previous issue of the QRA, hydrogen fires and explosions are not considered further as they would have no impact outside the immediate leak area. Escalation potential is also minimal as hydrogen inventories are very small and there are no external flammable or combustible inventories in the vicinity of the hydrogen piping and compressor.
									Low pressure trip of supply to burner local to burner				
25	HCl Plant	Hydrogen compression and supply	Hydrogen	Explosion in hydrogen compression area	Leak of hydrogen along cable ducting.	Explosion in switch gear	Very unlikely	Appropriate seal at end of cable ducting.		small hydrogen inventory and leak areas minimised as far as possible.	No	Both	Localised effect
					Leak of hydrogen into compressor crank case.	Explosion in crank case, equipment damage							
26	HCl Plant	HCl synthesis	Hydrogen	Hydrogen fire at vent	Ignition of plant vent stack by lightning or static	Local torch type fire with radiation impact on adjacent equipment / plant.	Very unlikely	Lightning protection for stack and piping electrical continuity,	burn through tubing and alarm.	provision of nitrogen to snuff flame	No	Both	Localised effect
										Stack exit at least 20m from other equipment items.			
27	HCl Plant	Hydrochloric acid bulk storage and handling	Hydrochloric acid	Overfill of HCl stock tank or major spill of HCl into bund due to failure of tank.	Overfill protection fails.	Aqueous hydrochloric acid spill into bund. Release of toxic HCl fumes.	Very unlikely	Maintenance of equipment and instruments		Manual intervention for HCl spill - foam available to apply to spill surface to minimise evaporation.	Yes	Both	
					Mechanical failure of tank.					Bunded area			
					Impact								
28	HCl Plant	Hydrochloric acid bulk storage and handling	Hydrochloric acid	Spill during HCl tanker loading	Failure of loading arm at tanker loading bay or overfill of tanker.	Aqueous hydrochloric acid spill into bunded unloading bay. Release of toxic HCl fumes.	Possible	Maintenance of equipment and instruments		Manual intervention for HCl spill - foam available to apply to spill surface to minimise evaporation.	Yes	Both	Release frequency estimated by Fault Tree
								Loading arm rather than hoses used		Bunded area			
					Tanker overfill protection fails.								
29	Chlorine drum and cylinder storage (inside liquefaction building - post liquefaction project)	Storage and handling	Chlorine	Dropping of drum / cylinder during handling	Wrong method used to move containers. Failure of the equipment (lifting jib on forklift) used to move containers. Operator error.	Damage to drum (eg, catastrophic rupture, leak from valve or plug) with subsequent release of chlorine to atmosphere.	Very unlikely	Procedures for moving drums. Drums handled using load rated, recommended lifting jib equipment. Drums designed to withstand dropping from height. Valves on drums capped.	Cl2 detectors. (Attended operation in any case)	Emergency procedures / capping equipment to disperse vapours escaping from damaged drum. Personnel with detailed knowledge and understanding of how to handle a chlorine emergency Containment building (offsite mitigation)	Yes	Both	Frequency estimated from IXOM drum failure data Drum handling occurs in similar manner using forklift jib pre and post liquefaction. Post liquefaction drums will be loaded / unloaded onto trucks inside containment building
30	Chlorine drum and cylinder storage (inside liquefaction building - post liquefaction project)	Storage and handling	Chlorine	Leak from static drum / cylinder	Mechanical impact Catastrophic failure Corrosion	Release of chlorine to atmosphere.	Very unlikely	Drums stored away from road way i.e. not exposed to impact. Drums designed and maintained to relevant codes and standards.	Cl2 detectors	Emergency procedures / capping equipment to disperse vapours escaping from damaged drum Personnel with detailed knowledge and understanding of how to handle a chlorine emergency Containment building (offsite mitigation)	Yes	Both	Frequency estimated from IXOM drum failure data

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								Prevention	Detection	Protection / Mitigation			
31	Chlorine drum and cylinder storage	Sampling from drums	Chlorine	Release from sampling apparatus	Technician error Overpressure of apparatus, eg blockage in tubing	Release of << 1 kg Cl2.	Activity has been carried out over many years. (while drum filling was done at Botany) Release has occurred once (March 2005)	Activity discontinued	-	-	No	Contingent	This activity discontinued at Botany and transferred to Laverton. Wil be reinstated for contingent mode post liquefaction. Small scale release not included in QRA, operator in PPE
32	Chlorine drum and cylinder storage	Sampling from drums	Chlorine	Release from drum while withdrawing sample	Technician error	Release of liquid chlorine from drum valve	Release from drum side has never occurred.	Activity discontinued	-	-	No	Contingent	This activity discontinued at Botany and transferred to Laverton. Wil be reinstated for contingent mode post liquefaction. Small scale release not included in QRA, operator in PPE
33	Bulk tanker parking area (inside liquefaction building - post liquefaction project)	Static tanker	Chlorine	Leak from parked full tanker	Valve leak Flange leak Mechanical impact	Release of chlorine to atmosphere	Very unlikely	Tankers designed and maintained to relevant codes and standards Tanker parked in dedicated area away from impact by vehicles etc	Cl2 detectors Plant log each shift to check tanker	Personnel with detailed knowledge and understanding of how to handle a chlorine emergency Containment building (offsite mitigation)	Yes	Both	Frequency estimated from pressure vessel data Post liquefaction tankers will be loaded and warm up to above 0degC inside containment building Impact not quantified - assumed to be included in statistical data as no specifc causes identified
34	Other Storages	Bulk Hypo storage	Sodium Hypochlorite	Leak from storage	Overfill	Spill of hypo, localised fumes	Possible	Fill enable and pumps interlocked with high level.	High and high high level alarms in tanks. high level interlock implemented in 2011	Bund	No	Both	
					Catastrophic failure of tank (construction defect, impact etc)	Large spill of hypo, fumes	Very unlikely	Appropriate materials of construction Located to minimise likelihood of impact Maintenance and inspection					Limited effect - local odours around hypo. No offsite effect
35	Other Storages	Bulk Hypo storage	Sodium Hypochlorite	Mixing of leaks with acidic medium in drains, chlorine formation	Leak in hypo system, drain system is acidic	Chlorine evolution from effluent system	Very unlikely	Drain systems designed so there are no interconnections between acid and hypo sources.	Bund high level alarms		Yes	Both	Included for consistency with Safety Case
			Sodium Hypochlorite	Dunk tank failure in hypo bunded area	Acidic content reacts with hypo in bund	Chlorine evolution from spill reaction	Very unlikely	Bunds are kept empty, strict procedures	Cl2 detectors		No	Both	Not included in MHF Safety Case hence removed from QRA scenarios
36	Other Storages	Hypo tanker loading	Sodium Hypochlorite	Leak during unloading	Driveaway Hose failure	Spill of hypo, localised fumes	Unlikely	Maintenance of equipment (hoses) Driver training and loading procedures	Loading bay sump high level alarm	Bund	No	Both	Hypo spill - OHS issue only
37	Other Storages	Hypo tanker loading	Sodium Hypochlorite	Mixing of hypo with incompatible material in road tanker, chlorine formation	Residual chemicals in tanker (i.e wrong / undedicated tanker used) Tanker parked in wrong loading bay	Evolution of Cl2.	Very unlikely that a large quantity of acid and hypo would mix without a stop being activated . More likely that a small residual reacts, however Cl2 quantity is limited by residual amount.	Dedicated loading bays for acid and hypo in separate locations. Dedicated tankers including contractual cleaning requirements. Tankers generally empty before refilling. Permissives (control room) before loading can occur	CCTV monitoring of loading bay Driver attendance	E stop (locally and in control room)	Yes	Both	Included for consistency with Safety Case
38	Other Storages	Other Storages - Bulk Ferric Chloride	Ferric chloride	Leak from storage	Overfill	Spill of ferric localised fumes (acidic)	Possible	Fill enable and pumps interlocked with high level.	High and high high level alarms in tanks	Bund	No	Both	Corrosive chemical - limited onsite effect area
					Catastrophic failure of tank (construction defect, impact etc)	Large spill of ferric, acidic fumes	Very unlikely	Appropriate materials of construction Located to minimise likelihood of impact Maintenance and inspection					
39	BIP transport	Vehicle incident on BIP roads involving Cl2 drums	Chlorine	Mixing of hypo with incompatible material in road tanker, chlorine formation	Vehicle collision	Release of Cl2.	No incidents involving trucks carrying Cl2 drums within BIP	Speed limit 25km/hr Drums have very robust design		Emergency response	Yes	Both	Included for consistency with Safety Case. Assumed maximum of 2 drums inventory lost
40	Repack plant	Drum and IBC filling	Chlorine	Release of chlorine due to mixing of acid and hypo when filling packages	Returned package with material remaining	Evolution of chlorine gas from mixture	Unlikely	Wash out procedures and washout station for returned containers Segregation of clean / returned containers	Attended operation and shutdown by operator (Cl2 highly odourous)	Emergency response	No	Both	Top filling of IBCs does not occur onsite.
		Drainage system	Chlorine	Release of chlorine due to mixing of acid and hypo in drainage system, sumps or bunds	Spill not cleaned up	Evolution of chlorine gas from mixture	Very Unlikely	Spill clean up procedures Dedicated drainage systems for acid that are separated from hypo	pH and conductivity probes in truck sump High level switches and alarm in truck loading area sump and IBC storage area sumps Cl2 detector and alarm in drainage pits Cl2 detectors around plant area	Emergency response	No	Both	Similar but smaller scale than scenario above.
41	Liquefaction plant	Chlorine feed (CAP to liquefaction)	Chlorine	Failure of chlorine piping and fittings	Corrosion, wear and tear. Wrong gasket material, or faulty flanges. Bellows failure Impact or other mechanical damage.	Chlorine release	Very unlikely	Periodic Non Destructive Testing (NDT) Suitable materials of construction - Ixom piping specs consistent with CI and Eurochlor guidance	Cl2 detectors Low flow alarm (flow transmitter upstream of liquefier)	Automatic shut down	Yes	Both	Included as generic pipe leak frequencies No history of leaks in pressurised Cl2 piping at Botany or Laverton

HAZID No	Area	Activity / Operation	Material	Hazardous Event	Causes	Consequence	Comments re Frequency (site experience - takes into account control measures) see Note 1	Control Measures / Safeguards (try to formulate these in terms of barriers)			Carried forward for analysis (quantitative) in QRA?	Operating node Liquefaction Project (Normal/ Contingent / both)	Comments
								Prevention	Detection	Protection / Mitigation			
42	Liquefaction plant	Liquefaction unit, storage and pumps	Chlorine	Failure of equipment or associated piping and fittings	Corrosion , wear and tear Wrong gasket material or faulty flanges Impact or other mechanical damage	Chlorine release	Very unlikely	Periodic Non Destructive Testing (NDT) Suitable materials of construction - specs consistent with CI and Eurochlor guidance	Cl2 detectors	Automatic shut down Bund limits surface area for evaporation Containment building (offsite mitigation) Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm.	Yes	Both	Included as generic pipe / equipment leak frequencies
43	Liquefaction plant	Chlorine liquefaction	Chlorine	Loss of liquefaction Exceed liquefier capacity	Liquefier refrigeration unit failure High flow rate to liquefaction	Chlorine gas flows to the storage tanks or degas reactor and scrubber Potential exceedance of liquefaction capacity, high pressure in storage	Very unlikely Not credible - Designed out	Refrigeration unit control system Liquid level control in liquefier separator Physical restriction (RO or similar) preventing flow exceeding design feed rate (~50% of CPA capacity) to liquefaction	Low weight alarm on storage tank	Automatic shut down Chlorine vapour will continue to boil off under pressure control maintaining low temperature	No	Both	Loss of refrigeration does not lead to chlorine release. The maxium chlorine flow rate to the scrubber does not exceed the design capacity of scrubber. Chlorine vessels are designed as pressure vessels suited to ambient temperature / full pressure storage conditions .No loss of containment even if tanks fully warm up, PSVs discharge to scrubber
44	Liquefaction plant	Chlorine storage	Chlorine	Storage tank failure	Overfilling of storage tanks (overpressure, overflow)	Storage tank rupture and chlorine release	Very unlikely	Flow control valve on chlorine gas line, maximum flow limited by valve orifice Filled by weight (continuous weight measurement), Spare storage tank available that can be used to transfer content in case of emergency	Cl2 detectors High weight trip alarm	High high weight trip and automatic shut down PSV on storage tank relieves to scrubber Bund limits surface area for evaporation Containment building (offsite mitigation) Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm.	No	Both	PSV is discharged to the scrubber. Multiple safeguards need to be failed to result in a tank rupture. Likelihood is covered by statistical vessel rupture frequency .
45	Liquefaction plant	Cylinder and drum filling	Chlorine	Release of chlorine from transfer hose and associated piping	Corrosion , wear and tear. Hose mechanical failure Coupling failure (operator error)	Chlorine release	Unlikely	Preventative maintenance and hose testing Operator checks the transfer hose before loading operation	Operator detection (attended operation) Cl2 detectors	Automatic shut down Containment building (offsite mitigation) Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm.	Yes	Contingent	
				Cylinder/ drum failure	Overfilling of cylinder/ drum (human error)	Thermal expansion and high pressure in drum, chlorine release eg valve passing	Very unlikely	Filled by weight Drum design (dish end - reverse on overpressure) Cylinder high design pressure Training and procedures	High weight alarm Operator detection (attended operation Cl2 detectors	Automatic shut down Containment building (offsite mitigation) Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm. Operators wear PPE	No	Contingent	Not explicitly modelled due to the drum and cylinder design features - overfill will result in thermal expansion, potential overpressure and reversal of drum dished ends
				Release of chlorine when disconnecting filled cylinder/drum	Human error (e.g. cylinder valve left open, wrong isolation sequence)	Chlorine release	Very unlikely	Training and procedures	Operator detection (attended operation Cl2 detectors	Containment building (offsite mitigation) Operators wear PPE Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm.	Yes	Contingent	Short duration release- operators in PPE can immediately isolate the leak
46	Liquefaction plant	Road tanker filling	Chlorine	Release of chlorine from transfer hose and associated piping	Corrosion , wear and tear. Hose mechanical failure Coupling failure (human error)	Chlorine release	Unlikely	Preventative maintenance and hose testing Operator checks the transfer hose before loading operation	Operator detection (attended operation Cl2 detectors	Automatic shut down Containment building (offsite mitigation) Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm.	Yes	Both	
				Release of chlorine from transfer hose	Road tanker driveaway whilst still connected (human error)	Chlorine release	Very unlikely		Operator detection (attended operation Cl2 detectors	Automatic shut down Containment building (offsite mitigation) Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm.	No	Both	Physically impossible to have the loading arms connected when the prime mover connected to the road tanker (Ixom to confirm)
				Road tanker overpressure	Overfilling of road tanker	road tanker failure	Very unlikely	Filled by weight (continuous weight measurement) Flow totalizer Training and procedures Tanker relief valve	Operator detection (attended operation Cl2 detectors	Automatic cut-off once max weight is reached Automatic shut down by chlorine detectors Containment building (offsite mitigation) Scrubber designed to absorb chlorine and reduce the chlorine concentration to below 25 ppm.	No	Both	Not credible to pump liquid through tanker PSV -the pumps do not have the sufficient head to lift the relief valve - reduces to thermal expansion scenario
47	Liquefaction plant	Chlorine refrigeration	Ammonia	Release of ammonia from ammonia circulation in refrigeration unit	Failure of equipment or associated piping and fittings	Release of ammonia, toxic exposure	Very unlikely	Refrigeration unit control system	Ammonia sensors at exhaust point	Shutdown	Yes	Both	Ammonia

HAZID No	Area	Activity / Operation	Material	Hazardous Event	Causes	Consequence	Comments re Frequency (site experience - takes into account control measures) see Note 1	Control Measures / Safeguards (try to formulate these in terms of barriers)			Carried forward for analysis (quantitative) in QRA?	Operating node Liquefaction Project (Normal/ Contingent / both)	Comments
								Prevention	Detection	Protection / Mitigation			
						Reaction with chlorine (NCl3 generation)	Eliminated by design				No		Ammonia inventory is located outside containment building, intermediate CO2 refrigerant inside building liquefaction equipment, no contact between NH3 and Cl2 in process equipment
48	Liquefaction plant	Liquid chlorine - vapouristaion activities	Nitrogen trichloride	Accumulation of NCl3 to hazardous levels in liquid chlorine and decomposition if liquid chlorine vapourised,	NCl3 forms from N impurities in feed: eg salt contaminated with ammonium compounds	Decomposition and vessel rupture if NCl3 is accumulated to hazardous level.	Very unlikely	Raw material quality management (e.g. periodic sampling)	Ammonia analyser for brine solution	Shutdown	No	Both	The accumulation of NCl3 occurs over time and can be prevented through raw material quality assurance, regular measuring the nitrogen content in the product and limiting the degassing of the liquid chlorine. There is no history of NCl3 accumulation detection above safe levels at the CAP at Botany or Laverton.
					Sulphuric acid\ sodium sulphite\ coagulant and filter aid contaminated with ammonium compounds			Restriction orifices in vent lines from liquid chlorine inventories restrict rate of vaporisation	Regular testing of product NCl3 level as per Cl guidelines. Safe level is NCl3 below 20ppm				No environmental factors that would result in significant ammonia contamination (ie no source of nitrogen in surrounding sites)
								Degas reactor (very small inventory) is the only inventory where routine vapourisation is occurring					Continuous removal of liquid chlorine to tanker filling prevents accumulation of trace NCl3 in storage. .
								Limited degassing of liquid chlorine from liquefier, storage tanks and road tankers.					Decomposition frequency is not quantified. Covered by statistical failure frequencies for pressure vessels.
					Chlorine contamination with ammonia in refrigeration unit	Generation of explosive gas (NCl3)	Designed out	Ammonia circuit located outside the building	Ammonia sensors at exhaust point	Shutdown	No	Both	The event is eliminated by having intermediate refrigerant (CO2), ammonia is physically separated and located outside the building.

APPENDIX H. CONSEQUENCE RESULTS

H1. Release sources

Releases from equipment mechanical leaks was generally modelled for the following hole sizes:

- 3 mm
- 13 mm
- 50 mm
- Rupture.

Release rates were calculated by Riskcurves from standard flow rate correlations based on the hole size, material state, the operating temperature and pressure defined. For scenarios where the calculated release rate exceeds a limiting process flow rate, the consequences were modelled using the limiting flow rate (e.g. maximum production rate, maximum pump flowrate, etc.).

A release from a drum or cylinder could be either gaseous or liquid depending on its orientation. If a leak develops as a result of a maloperation (e.g. by dropping the container and damaging a valve or a plug), the operator could orient the damaged end of the container resulting in a gaseous rather than liquid release. In this assessment, such emergency actions have been disregarded, and it has been assumed that 50% of all leaks involving drums result in a gaseous release, and 50% result in a liquid release.

H2. Flash and evaporation rate

In the case of a spill of liquid chlorine (e.g. from storage tanks or road tanker), part of the chlorine will initially flash off and evaporate, with any remaining liquid evaporating at a lower rate due to the cooling down of the liquid spill.

Flash and evaporation rate calculations were performed by Riskcurves with a normal concrete surface. Conservatively, no special concrete (e.g. insulating concrete) was accounted for at this stage of design. The maximum pool spreading area was defined based on the bund area or plant layout if the release occurs outside the bund.

Note that to evaluate the impact of the bund surface area on consequence distance, the storage tank rupture scenario was modelled for nominal bund sizes and the toxic consequence results were compared as per Table H.1. The modelling also includes the unconstrained scenario where the chlorine releases are not confined by the bund.

The distance to AEGL 3 concentration and 1% lethality for these cases are reported in the following table. The results indicate that the bund can significantly reduce the impact distance of a major LOC such as tank rupture from 6 km to about 1 km under F1.7 weather condition. A bund area of 57 m^2 for each tank was adopted in the design as an

operationally practical minimum and is used in the QRA to constrain the spreading area of pools where relevant.

Table H.1: Effect of surface area on evaporation rate

Scenario	Bund area (m^2)	Distance to (m) – D9.2		Distance to (m) – F1.7	
		1% lethality	AEGL-3 [600s]	1% lethality	AEGL-3 [600s]
1	30	189	228	551	811
2	45	224	269	680	1,029
3	**57**	**254**	**305**	**765**	**1,189**
4	80	290	347	900	1,444
5	120	336	405	1,096	1,814
6	Unconstrained	623	759	2,274	6,060

H3. Release inventory

The maximum release in the CAP was limited to the contents of the process equipment (approximately 150 kg) plus the amount lost before shutdown occurs (assumed to be up to approximately 3 minutes of production), i.e. set equal to 300 kg of chlorine if a catastrophic failure occurs.

For the CLP and chlorine storage (i.e. storage tank, drums, cylinders, road tanker) and associated piping, the inventory was limited to the maximum inventory in the vessel.

H4. Release duration

Durations of up to 60 minutes to manually isolate and control a gaseous leak from the plant have been assumed. The maximum duration of any scenario is set to one hour.

The release duration considered for each scenario is provided in the scenario tables in Section H6.

H5. Environmental data

The environmental conditions used for consequence modelling is summarised in Table H.2.

Table H.2: Environmental input data

Item	Value	Basis
Ambient temperature day	20.0	Weather data, average annual day temperature
Soil temperature day	20.0	Assumed equal to ambient day temperature.
Ambient temperature night	17.5	Weather data, average annual night temperature.
Soil temperature night	17.5	Assumed equal to ambient night temperature.
Relative humidity day	61.8	Weather data, average annual day relative humidity

Item	Value	Basis
Relative humidity night	72.9	Weather data, average annual night relative humidity
Roughness length	1 m	Ground roughness affects turbulent flow properties of wind, hence dispersion of a released material. Terrain effects are taken into account to some degree in dispersion modelling by use of a parameter known as surface roughness length. A surface roughness factor of 1 m was used, corresponding to an area with densely located low buildings or an industrial area with low structures such as the BIP. This surface roughness factor is also appropriate for suburban areas adjacent to the BIP.
Surface type	Concrete	Typical terminal surface parameters appropriate to concrete in plant area assumed for pool spreading calculation in EFFECTS. No special properties (e.g. insulating concrete) accounted for in QRA
Receptor height	1.5m	Typical face height

H6. Vulnerability due to chlorine toxicity

This section summarises the approach for assessing chlorine toxicity effects in the QRA. It is consistent with previous QRAs for the BIP site and the most recent CAP QRA.

H6.1. Toxicity to humans

Toxicity effects of chlorine on humans are summarised below.

Table H.3: Toxicity effects on humans

Exposure Level (ppm)	Duration (mins)	Effects
Chlorine		
0.2 - 3.5	Not stated in reference	**Threshold of odour perception** in those individuals without chronic exposure to low doses of chlorine
3 - 5	30 - 60	Tolerated without undue ill effect
5 - 8	Not stated in reference	**Slight irritation** of the mucous membranes of the upper respiratory tract and of the eyes
15	Immediate	**Irritation** of the nose, throat and eyes with cough and tearing
30	Immediate	Cough with choking sensation, chest pain and a sense of constriction in the chest. Wheezing may occur. Possibility of nausea and vomiting.
40 - 60	Not stated in reference	Development of chemical tracheo-bronchitis and pulmonary oedema.
100	1	Intolerable concentration

H6.2. Toxicity risk criteria summary

Table H.4 summarises the toxic fatality, injury and irritation effects and corresponding probability criteria used for chlorine in the QRA.

Table H.4: Toxic fatality, injury and irritation criteria

		Risk Criteria (set by HIPAP 4)		
		1 x 10^{-6}/yr	10 x 10^{-6}/yr	50 x 10^{-6} /yr
Material	**Probit (Ref [9]) (ppm^n min)**	**Threshold Concentrations (ppm)**		
		Fatality (outdoor dose) Probit prediction – example [(a)]	**Injury threshold AEGL 3 (10 mins)**	**Irritation threshold AEGL 2 (10 mins)**
Chlorine (Cl_2)	-4.86 + 0.5ln($c^{2.75}$t)	103 ppm (1% fatality at 10 mins)	50 ppm (as equivalent dose below)	2.8 ppm (as equivalent dose below)
		1% fatality equivalent dose: 3.47e6 $ppm^{2.75}$min	equivalent toxic injury dose: 4.7e5 $ppm^{2.75}$min	equivalent toxic irritation dose: 1.69e2 $ppm^{2.75}$min

Notes:
(a) This is an example only. QRA fatality risk estimate uses calculated cumulative dose based on variable concentration and variable exposure duration as calculated within Riskcurves.

H6.3. Fatality prediction

To quantify the risk from toxic releases, probit equations of the form Pr = A + b ln(c^nt) are used to estimate the probability of fatality based on concentration and duration of exposure. These have generally been developed on limited human exposure data and extrapolation of animal experimental data. The relationship between probit and probability of fatality is determined from the standard probit curve or table as follows:

$$\text{Probability of fatality} = 0.5\left(1 + \text{erf}\left(\frac{\text{Pr} - 5}{\sqrt{2}}\right)\right)$$

For this analysis, the probit equations used to predict fatality risk from chlorine and hydrogen chloride are taken from the TNO Purple Book, Ref [9].

These have not changed since the previous QRA.

H6.4. Toxic injury/irritation risk

Injury due to toxic exposure depends on the nature of the material, the concentration, the duration and mode of exposure and on the sensitivity of the person exposed. It therefore follows that toxic criteria applicable to one chemical will not necessarily be appropriate for another chemical.

The approach required by HIPAP 4 is to assess each case on its merits based on known dose-effect relationships for a particular chemical, ('*Toxic criteria applicable to one chemical may not necessarily be appropriate to others. The department's experience*

conclusively shows that the formulation of a uniform criteria to cover all toxic effects is not appropriate or valid. Instead, each case should be justified on its merits....', pg. 5*).*

The definitions are as follows:

Injury

'Toxic concentrations in residential areas 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.'

Irritation

'Toxic concentrations in residential areas should not cause irritation to eyes or throat, coughing or other acute physiological response in sensitive members of the community over a maximum frequency of 50 in a million per year.'

Establishing the appropriate criteria for a particular chemical necessitates determination of the terms 'seriously injurious', 'sensitive', 'relatively short' and 'irritation'.

Given that a relationship between toxic effect and concentration/exposure time (i.e. dose) exists, it can be inferred that for shorter exposure durations higher concentrations would apply to obtain an equivalent effect and vice versa.

The US AEGLs are set for various exposure durations from 10 minutes to 8 hours. AEGL 'levels' are dictated by the severity of the toxic effects caused by the exposure, with Level 1 being the least and Level 3 being the most severe. All levels are 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 could experience, including susceptible individuals:

AEGL 1

Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL 2

Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL 3

Life-threatening health effects or death

The duration of the releases considered in the risk assessment of the facility ranges from a few minutes up to sixty minutes. The AEGL 10 minutes values (as shown in Table H.5) match most closely the 'relatively short' exposure duration in the HIPAP 4 criteria definition.

However, when comparing the threshold values against the exposure effects in Table H.3, it can be seen that the AEGLs are set conservatively, e.g. the Cl_2 AEGL1 for irritation is 0.5 ppm compared to irritation in Table H.3 at above 5 ppm, AEGL 2 for serious injury is 2.8 ppm with Table H.3 suggesting 30 ppm for serious injury.

Therefore, for the QRA, AEGL 2 (10 minutes) and AEGL 3(10 minutes) have been used as representative of irritation and serious injury respectively as per the HIPAP 4 definitions.

Table H.5: AEGL values

Interpretation	AEGL (10-minute)		
	AEGL 1	**AEGL 2**	**AEGL 3**
Intended usage by AEGL definition – onset threshold of effect for susceptible people	Irritation	Injury	Fatality
Usage in QRA study	**-**	**Irritation threshold**	**Injury threshold**
Chlorine	0.5 ppm	2.8 ppm	50 ppm

H6.5. Reduced dose experienced by indoor population

The concentration of gas inside a building engulfed by a gas cloud will rise gradually until the release has stopped and the cloud passed. The indoor concentration then falls gradually towards zero. The peak concentration inside will be much less than that outside, (unless the duration of the release is very long, or the building has very high ventilation rates).

Hence, a person inside will normally be exposed to significantly lower gas concentrations than someone outside and the risk of fatality from a toxic gas will be significantly less for a person located indoors than the risk in the open at the same location.

This effect is accounted for in the QRA within the risk model using the ventilation rate. Natural ventilation rate was assumed which is 1 air change per hour.

H7. Discharges from building scrubber stack

The design target scrubber discharge scenario (when treating a leak) is up to 25 ppm in 10000 m^3/hr of air discharged from stack at elevation of 19 m. A material mixture at this very low contaminant concentration cannot be set up in EFFECTS modelling software. Modelling at the equivalent flowrate of a pure component (Cl_2) shows concentrations greater than the irritation threshold level of AEGL 2 are limited to less than 50 m from the stack and remain elevated (i.e. at least 16 m above ground level) under all modelled meteorological conditions. The modelling inputs and results are shown in Table H.6 with representative side views showing that the plume remains elevated are shown in Figure H.1.

The dispersion modelling results demonstrate that there are no impacts to surrounding land uses when the scrubber works as per design. Note that these results are also

conservative (i.e. overpredict impact distance) as predilution to 25 ppm by scrubber air flow at release point is not accounted as per the model limitation noted above. Note that these scenarios (i.e. leak occurs inside building and the scrubber works as per the design intent) are not included in the QRA as they have no effect on fatality, injury or irritation risk at receptor heights of 1.5 m.

Table H.6: Scrubber discharge dispersion inputs and results

Model Inputs

Parameter	Value	Unit	Notes
Chlorine concentration	25	ppm(v)	
Venting gas flowrate	10000	m3/hr	scrubber fan rate
Cl2 vol flowrate	0.25	m3/hr	
Cl2 mass density	3	kg/m3	
Cl2 mass flowrate	0.75	kg/hr	
Cl2 mass flowrate	0.00021	kg/s	dispersion source term
Temperature	20	deg C	
Stack height	19	m	
Discharge orinetation	Horizontal	worst case	would be vertical

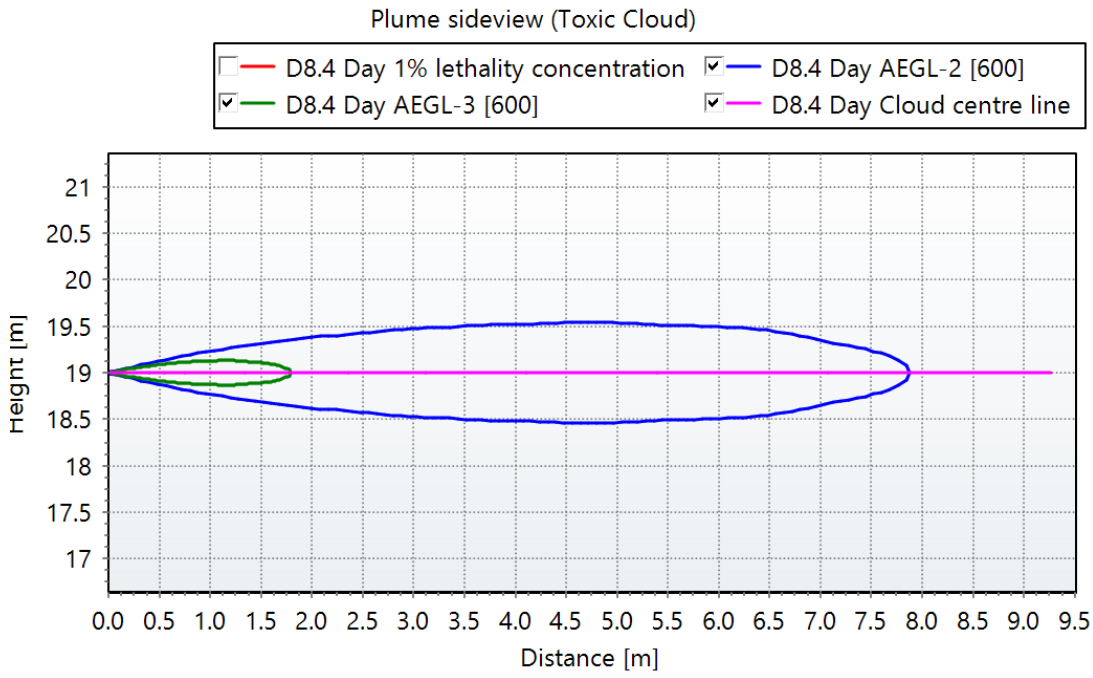
Meteorological case	Effect distance (m)			
	Comments	AEGL 3 (injury)[(a)]	AEGL 2 (irritation)	Minimum height above ground (AEGL 2)
B2.8	-	2.5	7.5	18
D1.7	-	4.5	18	17.5
D4.3	-	2.5	11	18
D8.4	Most common conditions (typical day)	2	8	18.5
E3.1	-	5	18	18
F1.4	Furthest effect distance (typical night)	14.5	55	18

Notes:

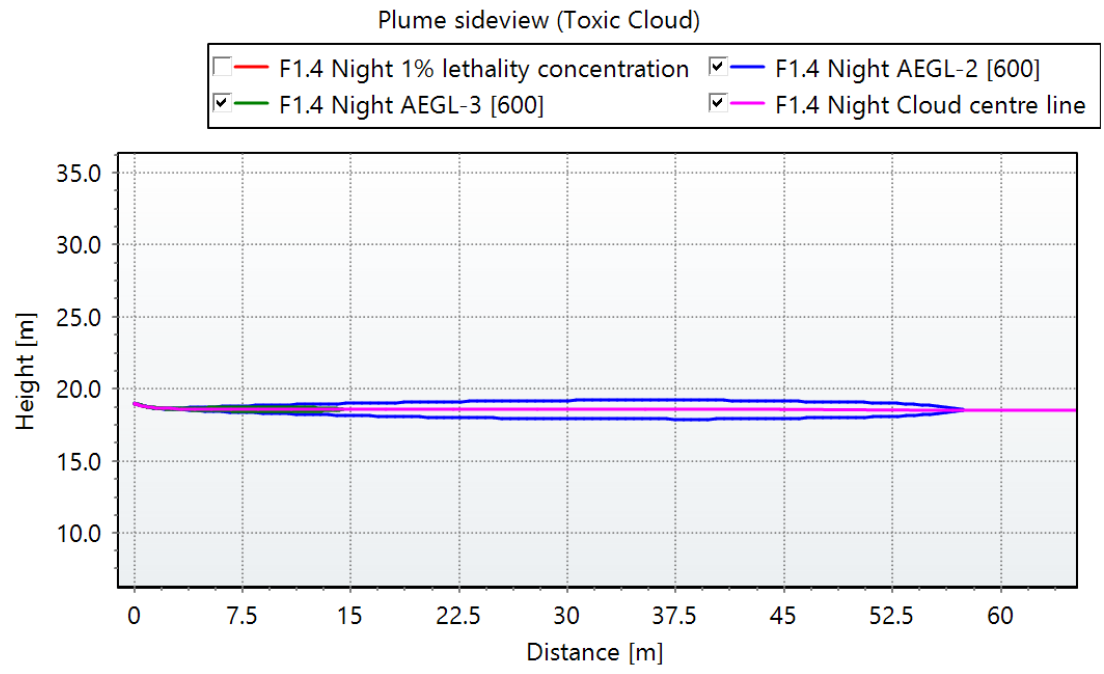
(a) AEGL 3 is 50 ppm and the scrubber vent outlet concentration is in reality less than 25 ppm. The AEGL 3 result is generated by the model and is not physically possible as the modelling has been carried out using a pure component and does not account for the dilution by scrubber air flow.

Figure H.1: Side plumes dispersion scrubber discharge (at 25 ppm)

D8.4 conditions



F1.4 conditions



H8. Scenario inputs and consequence modelling results summary

The distances to AEGL 2 (irritation), AEGL 3 (injury), 1% lethality concentration (i.e. equivalent concentration assuming maximum exposure duration) and the 1% lethality toxic dose which accounts for variable concentration and exposure duration were calculated by Riskcurves for the identified hazardous scenarios as per the input assumptions for each isolatable section summarised in following Table H.7.

The results showing the distance to relevant concentrations for most common day condition (i.e. D8.4) and most conservative night weather condition (i.e. F1.4) are summarised in the following Table H.8 together with input assumptions for each modelled scenario for the CLP.

Note that the toxic dose results that account for variable concentration and variable exposure duration at specific locations are used in the risk model. Toxic dose accounts for the actual exposure duration as the cloud passes a particular location (variable depending on inventory, wind speed, location etc) at specific locations which is typically shorter than the maximum duration used in the 1% lethality concentration output reported in Table H.8. An example of the effect of accounting for variable concentration and exposure duration in estimation of toxic dose fatality effect distance compared to using concentration threshold only is shown in Table H.9 for two liquid chlorine release scenarios.

Table H.9: Effect of accounting for variable exposure / concentration to estimate toxic dose effect distance

Modelset: Chlorine Tanker - 13 mm Leak (QRA scenario ID 13.03a)		**Modelset: Release from Filled Drums - 6mm valve leak (QRA scenario ID 14.03)**	
Model: Liquefied Gas LOC Scenario Continuous Leak		**Model: Liquefied Gas LOC Scenario Continuous Leak**	
Inputs	**F1.4 Night**	**Inputs**	**F1.4 Night**
Process Conditions		**Process Conditions**	
Chemical name	CHLORINE (DIPPR)	**Chemical name**	CHLORINE (DIPPR)
Hole diameter (mm)	13	**Hole diameter (mm)**	6
Jet source: Initial mass in vessel (kg)	12729	**Jet source: Initial mass in vessel (kg)**	916.88
Jet source: Representative release rate (kg/s)	3.2791	**Jet source: Representative release rate (kg/s)**	0.68542
Concentration contours distance [m]	**F1.4 Night**	**Concentration contours distance [m]**	**F1.4 Night**
1% lethality concentration at 1.5m (Toxic Cloud)	**1728**	1% lethality concentration at 1.5m (Toxic Cloud)	**604**
Lethality dose contours distance [m]	**F1.4 Night**	**Lethality dose contours distance [m]**	**F1.4 Night**
1 % lethality dose (Toxic Cloud)	**1240**	1 % lethality dose (Toxic Cloud)	**518**

Project: 21838: Ixom Botany Chlorine Liquefaction Plant QRA

Table H.7 QRA Basis - Isolatable Sections

ID	Description	Material released	Phase	Limiting Inventory		Operating Time	Release conditions					Comments	Hazardous Properties		Typical causes
				(kg)	(m3)	(hours/year)	Limiting flowrate (kg/s)	Temp (°C)	Pressure (kPag)	Density (kg/m3)	Conc. (wt%)		Flammable?	Toxic?	
CLP-00	Release of HP chlorine from import line from compressor (outside)	Chlorine	Vapour	4200	523	8760	0.58	40	185	8.0	100	- Compressed chlorine header outside the building- assumed always online - Limiting inventory assumed 4.2 tonnes as it is the maximum total CAP chlorine production per hour - Max production rate to CLP 0.58 kg/s, based on PFD	N	Y	Generic mechanical failures
CLP-01	Release of HP chlorine from import line from compressor (inside)	Chlorine	Vapour	4200	523	8760	0.58	40	185	8.0	100	- Compressed chlorine header outside the building- assumed always online - Limiting inventory assumed 4.2 tonnes as it is the maximum total CAP chlorine production per hour - Max production rate to CLP 0.58 kg/s, based on PFD	N	Y	Generic mechanical failures
CLP-02	Release of chlorine from liquefier and separator	Chlorine	Liquid	2493	1.60	8760	-	-34	185	1558	100	Total volume 1 .6 m3 ~ 1 hour production. - Liquefier (3.5m x 0.254m x 0.254m): 0.18 - Separator (0.91m diam x 2.25m height): 1.46	N	Y	Generic mechanical failures
CLP-03	Release of chlorine from LIQUID CHLORINE RUNDOWN	Chlorine	Liquid	2493	1.6	8760	-	-34	10	1558	100	- Limiting inventory assumed 2493 kg, same as liquifier	N	Y	Generic mechanical failures
CLP-04	Release of chlorine from TAIL GAS TO DEGAS REACTOR	Chlorine	Vapour	2493	712	8760	0.014	-20	1	3.5	100	- Limiting inventory assumed 2493 kg, same as liquifier -Design tail gas flowrate 0.014 kg/s	N	Y	Generic mechanical failures
CLP-05	Release of chlorine from liquid storage tanks	Chlorine	Liquid	50000	32	8760	-	-34	10	1558	100	- 2 tanks provided, 1 kept empty - Tanks (40 m3, 3.05m diam x 6.14m length), filling degree assumed 80% -Design pressure 1550 kPag	N	Y	Generic mechanical failures
CLP-06	Release of chlorine from relief line	Chlorine	Vapour	50000	15152	8760	0.8	-5	1	3.3	100	-Max flow through relief valve 0.8 kg/s (RV vented to scrubber so pipe failure during relief vent only scenario)	N	Y	Generic mechanical failures
CLP-07	Release of chlorine from pump suction	Chlorine	Liquid	50000	32	8760	-	-34	60.6	1558	100		N	Y	Generic mechanical failures
CLP-08	Release of chlorine from liquid storage pumps	Chlorine	Liquid	50000	32	8760	12.5	-34	750.0	1558.0	100	-Assumed always online. - Inventory limited to storage tanks volume - Max pump flowrate from pump curve when pumping against zero head is 12.5 kg/s	N	Y	Generic mechanical failures
CLP-09	Release of chlorine from tanker loading	Chlorine	Liquid	50000	32	8760	12.50	-34	700.0	1558.0	100		N	Y	Generic mechanical failures, connection errors.
CLP-10	Release of drum/cylinder filling supply line (CONTINGENT ONLY)	Chlorine	Liquid	50000	32	4380	12.50	-34	700.0	1558.0	100	Assumes annual filling of 13520 drums, 20 mins per drum . Some portion will actually be cylinders. Total time in use 0.5, split between cylinder and drum filing equipment for frequencies	N	Y	Generic mechanical failures
CLP-11	Release of chlorine from drum filling (CONTINGENT ONLY)	Chlorine	Liquid	50000	32	2253	12.50	-34	700.0	1558.0	100	Assumes annual filling of 13520 drums, 20 mins per drum . Some portion will actually be cylinders. Total time in use 0.5, split between cylinder and drum filing equipment for frequencies	N	Y	Generic mechanical failures, connection errors.
CLP-12	Release of chlorine from cylinder filling (CONTINGENT ONLY)	Chlorine	Liquid	50000	32	2253	12.50	-34	700.0	1558.0	100	Assumes annual filling of 13520 drums, 20 mins per drum . Some portion will actually be cylinders. Total time in use 0.5, split between cylinder and drum filing equipment for frequencies	N	Y	Generic mechanical failures, connection errors.
CLP-13	Release of chlorine from parked road tanker	Chlorine	Liquid	13000	9.21	8760	-	19	564.7	1412.0	100	Inventory limited to storage tanks volume	N	Y	Generic mechanical failures
CLP-14	Release of chlorine from stored cylinders and drums	Chlorine	Liquid	920	0.65	8760	-	19	564.7	1412.0	100	Inventory limited to drum volume	N	Y	Generic mechanical failures Handling errors
CLP-15	Release of chlorine from scrubber	Chlorine	Vapour	120	40.00	8760	0.58	20	0.0	3.0	100	-Venting flowrate assumed 0.58 kg/hr equal to max Cl2 flowrate to scrubber -Stack height 19m - Volume assumed 40 m3	N	Y	Generic mechanical failures Process upset scrubber breakthrough
NH3-01	Release of ammonia from ammonia fridge	Ammonia	Liquid	200	0.33	8760	-	20	VP	609	100	Client advised to assume 200 kg of ammonia stored	Y	Y	Generic mechanical failures NH3 Flammability effects excluded - toxic effects larger

TABLE H.8 QRA Scenario Consequence Results

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	OP PRESS	TEMP	RELEASE HEIGHT	Release Rate	EFFECT DISTANCE to (m)						HOLE DIAM	LIMITING INVENTORY	LIMIT TO LEAK RATE	MAX LEAK DURATION	COMMENTS	BUND SIZE	ASSUMPTIONS
									D8.4 (day time)			F1.4 (night time)									
					kPa (g)	(deg C)	(m)	(kg/s)	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	(mm)	(kg)	(kg/s)	(sec)		(m2)	
CLP-00: Chlorine Supply (Extension from CAP-Outside Liquefaction Building)																					
00.01	SUPPLY PIPELINE (OUTSIDE)	80 mm RUPTURE	Cl2	V	185	40	1	0.58	646	145	122	2828	528	422	80	4200.0	0.58	300	Approx. 30m of piping outside the building.	-	N/A Gas release
00.02	SUPPLY PIPELINE (OUTSIDE)	50 mm HOLE	Cl2	V	185	40	1	0.58	641	143	121	2804	515	411	50	4200.0	0.58	300	Approx. 30m of piping outside the building.	-	N/A Gas release
00.03	SUPPLY PIPELINE (OUTSIDE)	13 mm HOLE	Cl2	V	185	40	1	0.08	222	50	42	1512	219	171	13	4200.0	0.58	900	Approx. 30m of piping outside the building.	-	N/A Gas release
00.04	SUPPLY PIPELINE (OUTSIDE)	3 mm HOLE	Cl2	V	185	40	1	0.01	48	9	7	287	41	32	3	4200.0	0.58	900	Approx. 30m of piping outside the building.	-	N/A Gas release
00.05	SUPPLY PIPELINE (OUTSIDE)	GASKET	Cl2	V	185	40	1	0.08	222	50	42	1512	219	171	13	4200.0	0.58	900	Welded piping, assumed 1 flange at connection point	-	N/A Gas release
CLP-01: Chlorine Supply (Inside Liquefaction Building)																					
01.01	SUPPLY PIPELINE (INSIDE)	80 mm RUPTURE	Cl2	V	185	40	1	0.58	646	145	122	2828	528	422	80	4200.0	0.58	300	Assume 25m of piping inside.	-	N/A Gas release
01.02	SUPPLY PIPELINE (INSIDE)	50 mm HOLE	Cl2	V	185	40	1	0.58	641	143	121	2804	515	411	50	4200.0	0.58	300	Assume 25m of piping inside.	-	N/A Gas release
01.03	SUPPLY PIPELINE (INSIDE)	13 mm HOLE	Cl2	V	185	40	1	0.08	222	50	42	1512	219	171	13	4200.0	0.58	900	Assume 25m of piping inside.	-	N/A Gas release
01.04	SUPPLY PIPELINE (INSIDE)	3 mm HOLE	Cl2	V	185	40	1	0.01	48	9	7	287	41	32	3	4200.0	0.58	900	Assume 25m of piping inside.	-	N/A Gas release
01.05	SUPPLY PIPELINE (INSIDE)	GASKET	Cl2	V	185	40	1	0.08	222	50	42	1512	219	171	13	4200.0	0.58	900	1 flange as per P&ID	-	N/A Gas release
CLP-02: Chlorine Liquefier																					
02.01	SEPARATOR	RUPTURE	Cl2	L	185	-34	1	-	766	158	130	4564	710	539	RUP	2492.8	N/A	n/a instantaneous	-	57.4	Assumed chlorine overfills from liquefier bund to storage tank bund
02.02	SEPARATOR	50 mm HOLE	Cl2	L	185	-34	1	10.60	827	171	142	4567	737	565	50	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
02.03	SEPARATOR	25 mm HOLE	Cl2	L	185	-34	1	2.65	757	156	129	4234	567	433	25	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
02.04	SEPARATOR	13 mm HOLE	Cl2	L	185	-34	1	0.77	627	129	106	3465	438	334	13	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
02.05	SEPARATOR	6 mm HOLE	Cl2	L	185	-34	1	0.18	296	61	50	1763	217	166	6	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
CLP-03:LIQUID CHLORINE RUNDOWN																					
03.01	PIPING DOWNSTREAM OF LIQUEFIER	RUPTURE	Cl2	L	10	-34	1	31.90	827	171	142	4677	776	613	80	2492.8	N/A	n/a instantaneous		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
03.02	PIPING DOWNSTREAM OF LIQUEFIER	50 mm	Cl2	L	10	-34	1	12.50	822	170	141	4587	745	575	50	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
03.03	PIPING DOWNSTREAM OF LIQUEFIER	13 mm HOLE	Cl2	L	10	-34	1	0.77	627	129	106	3465	438	334	13	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
03.04	PIPING DOWNSTREAM OF LIQUEFIER	3 mm HOLE	Cl2	L	10	-34	1	0.04	148	30	25	767	95	72	3	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
03.05	PIPING DOWNSTREAM OF LIQUEFIER	GASKET	Cl2	L	10	-34	1	0.77	627	129	106	3465	438	334	13	2492.8	N/A	3600		57.4	Assumed chlorine overfill from liquefier bund to storage tank bund
CLP-04:TAIL GAS TO DEGAS REACTOR																					
04.01	TAIL GAS TO DEGAS REACTOR	50 mm HOLE	Cl2	V	1	-20	1	0.01	89	18	15	564	72	55	50	2492.8	0.014	n/a instantaneous	Flowrate limited to design tail gas flowrate	-	N/A Gas release
04.02	TAIL GAS TO DEGAS REACTOR	13 mm HOLE	Cl2	V	1	-20	1	0.01	47	8	6	283	37	29	13	2492.8	0.014	900	Flowrate limited to design tail gas flowrate	-	N/A Gas release
04.03	TAIL GAS TO DEGAS REACTOR	3 mm HOLE	Cl2	V	1	-20	1	0.01	8	-	-	55	6	4	3	2492.8	0.014	900	Flowrate limited to design tail gas flowrate	-	N/A Gas release
04.04	TAIL GAS TO DEGAS REACTOR	GASKET	Cl2	V	1	-20	1	0.01	47	8	6	283	37	29	13	2492.8	0.014	900	Flowrate limited to design tail gas flowrate	-	N/A Gas release
CLP-05: Storage Tanks																					
05.01	STORAGE TANK	RUPTURE	Cl2	L	10	-34	1	-	1425	339	290	8443	965	735	RUP	50000	N/A	n/a instantaneous		57.4	Bund size as per site layout (~5.7 x 10.6 m)
05.02	STORAGE TANK	50 mm HOLE	Cl2	L	10	-34	1	11.45	952	199	165	7139	796	608	50	50000	N/A	3600		57.4	Bund size as per site layout (~5.7 x 10.6 m)
05.03	STORAGE TANK	25 mm HOLE	Cl2	L	10	-34	1	3.00	745	155	128	5300	581	442	25	50000	N/A	3600		57.4	Bund size as per site layout (~5.7 x 10.6 m)

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	OP PRESS	TEMP	RELEASE HEIGHT	Release Rate	EFFECT DISTANCE to (m)						HOLE DIAM	LIMITING INVENTORY	LIMIT TO LEAK RATE	MAX LEAK DURATION	COMMENTS	BUND SIZE	ASSUMPTIONS
									D8.4 (day time)			F1.4 (night time)									
					kPa (g)	(deg C)	(m)	(kg/s)	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	(mm)	(kg)	(kg/s)	(sec)		(m2)	
05.04	STORAGE TANK	13 mm HOLE	Cl2	L	10	-34	1	0.89	674	138	114	4137	457	349	13	50000	N/A	3600		57.4	Bund size as per site layout (~5.7 x 10.6 m)
05.05	STORAGE TANK	6 mm HOLE	Cl2	L	10	-34	1	0.20	316	65	54	1989	233	180	6	50000	N/A	3600		57.4	Bund size as per site layout (~5.7 x 10.6 m)
CLP-06: STORAGE RELIEF																					
06.01	STORAGE TANK RELIEF	50 mm HOLE	Cl2	V	1	-5	1	0.07	195	43	36	1330	186	145	50	50000.0	0.8	n/a instantaneous	Max flow ex relief valve	-	N/A Gas release
06.02	STORAGE TANK RELIEF	13 mm HOLE	Cl2	V	1	-5	1	0.01	48	8	6	289	38	29	13	50000.0	0.8	900	Max flow ex relief valve	-	N/A Gas release
06.03	STORAGE TANK RELIEF	3 mm HOLE	Cl2	V	1	-5	1	0.01	8	-	-	55	6	4	3	50000.0	0.8	900	Max flow ex relief valve	-	N/A Gas release
06.04	STORAGE TANK RELIEF	GASKET	Cl2	V	1	-5	1	0.01	48	8	6	289	38	29	13	50000.0	0.8	900	Max flow ex relief valve	-	N/A Gas release
CLP-07 Pump Suction																					
07.01	PUMP SUCTION	100 mm RUPTURE	Cl2	L	61	-34	1	42.00	1242	258	214	8769	1017	776	100	50000	N/A	n/a instantaneous		57.4	Pump located within tank bund
07.02	PUMP SUCTION	50 mm HOLE	Cl2	L	61	-34	1	11.66	956	200	165	7168	800	611	50	50000	N/A	3600		57.4	Pump located within tank bund
07.03	PUMP SUCTION	13 mm HOLE	Cl2	L	61	-34	1	1.31	658	141	117	4470	497	383	13	50000	N/A	3600		57.4	Pump located within tank bund
07.04	PUMP SUCTION	3 mm HOLE	Cl2	L	61	-34	1	0.07	187	38	32	1058	129	99	3	50000	N/A	3600		57.4	Pump located within tank bund
07.05	PUMP SUCTION	GASKET	Cl2	L	61	-34	1	1.31	658	141	117	4470	497	383	13	50000	N/A	3600		57.4	Pump located within tank bund
CLP-08: Storage Pumps																					
08.01	PUMP FAILURE	RUPTURE	Cl2	L	750	-34	1	12.50	992	206	171	5932	789	604	80	50000	12.5	n/a instantaneous	Limited to pump maximum rate	57.4	Pump located within tank bund
08.02	PUMP FAILURE	3 mm HOLE	Cl2	L	750	-34	1	0.21	360	81	68	3221	385	298	3	50000	12.5	3600	Limited to pump maximum rate	57.4	Pump located within tank bund
08.03	PUMP DISCHARGE	80 mm RUPTURE	Cl2	L	750	-34	1	12.50	992	206	171	5932	789	604	RUP	50000	12.5	3600	Limited to pump maximum rate	57.4	Pump located within tank bund
08.04	PUMP DISCHARGE	50 mm HOLE	Cl3	L	750	-34	1	12.50	1002	208	172	6095	815	622	50	50000	12.5	3600	Limited to pump maximum rate	57.4	Pump located within tank bund
08.05	PUMP DISCHARGE	13 mm HOLE	Cl2	L	750	-34	1	3.67	1600	336	281	15403	2458	1899	13	50000	12.5	3600	Limited to pump maximum rate	57.4	Pump located within tank bund
08.06	PUMP DISCHARGE	3 mm HOLE	Cl2	L	750	-34	1	0.21	360	81	68	3221	385	298	3	50000	12.5	3600	Limited to pump maximum rate	57.4	Pump located within tank bund
08.07	PUMP DISCHARGE	GASKET	Cl2	L	750	-34	1	3.70	1600	336	281	15403	2458	1899	13	50000	12.5	3600	Limited to pump maximum rate	57.4	Pump located within tank bund
CLP-09: Road Tanker Filling (NORMAL)																					
09.01	TANKER FAILURE	RUPTURE	Cl2	L	VP	-34	1	-	2199	425	349	15494	2464	1905	RUP	13000	N/A	n/a instantaneous		490	Assume limited to 25m diameter (building width)
09.02a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	700	-34	1	12.50	3188	632	526	17888	4808	3820	25	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.02b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	700	-34	1	-	1668	463	386	2885	537	438	25	108	12.5	9	Inventory estimated based on a shutdown time of 60s and flowrate of 1.8 kg/s (normal filling rate)	490	Assume limited to 25m diameter (building width)
09.03a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	700	-34	1	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.03b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	700	-34	1	-	357	81	68	2029	326	264	3	108	12.5	540	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.04	HOSE FAILURE (TANKER OVERFILL TO (	RUPTURE	Cl2	V	50	-34	1	0.01	80	17	13	499	65	51	12.5	13000		3600	Restricted by 12.5mm XFV in tanker	N/A	
09.05	HOSE FAILURE (TANKER OVERFILL LINE TO CATCH POT)	3 mm HOLE	Cl2	V	50	-34	1	0.01	36	6	5	211	30	23	3	13000		3600		490	Assume limited to 25m diameter (building width)
09.06	TANKER FILLING LINE	50 mm HOLE	Cl2	L	700	-34	1	12.50	2143	415	341	12211	1941	1487	50	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.07	TANKER FILLING LINE	13 mm HOLE	Cl2	L	700	-34	1	3.56	1574	330	276	15232	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.08	TANKER FILLING LINE	3 mm HOLE	Cl2	L	700	-34	1	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.09	TANKER FILLING LINE	GASKET	Cl2	L	700	-34	1	3.56	1574	330	276	15232	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
	ROADTANKER OVERFILL (RELIEF VALVE	25 mm HOLE	Cl2	V	50	-34	1	3.50	1368	271	223	8544	1383	1064	25	13000	1.3		Relief valve characteristic - average flowrate over 0.5 hours taking into account pressure decrease as cooling occurs.	490	Assume limited to 25m diameter (building width)
9.10a	HOSE COUPLING ERROR_no isolation	50 mm HOLE	Cl2	L	700	-34	1	12.50	3188	632	526	17888	4808	3820	25	0	12.5	0		490	Assume limited to 25m diameter (building width)
9.10b	HOSE COUPLING ERROR_isolation	50 mm HOLE	Cl2	L	700	-34	1	-	1668	463	386	2885	537	438	25	0	12.5	9		490	Assume limited to 25m diameter (building width)
9.11	VACUUM CATCH POT FAILURE	RUPTURE	Cl2	L	101	20	1	-	779	224	193	1226	229	185	25	15		n/a instantaneous		N/A	
CLP-09: Road Tanker Filling (CONTINGENT)																					
09.01	TANKER FAILURE	RUPTURE	Cl2	V	564.7	-34	1	-	2199	425	349	15494	2464	1905	RUP	13000	N/A	n/a instantaneous		490	Assume limited to 25m diameter (building width)
09.02a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	700	-34	1	12.50	3188	632	526	17888	4808	3820	25	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.02b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	700	-34	1	-	1668	463	386	2885	537	438	25	65	12.5	5	Inventory estimated based on a shutdown time of 60s and flowrate of 1.08 kg/s (normal filling rate)	490	Assume limited to 25m diameter (building width)
09.03a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	700	-34	1	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.03b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	700	-34	1	-	357	81	68	2029	326	264	3	65	12.5	324	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	OP PRESS	TEMP	RELEASE HEIGHT	Release Rate	EFFECT DISTANCE to (m)						HOLE DIAM	LIMITING INVENTORY	LIMIT TO LEAK RATE	MAX LEAK DURATION	COMMENTS	BUND SIZE	ASSUMPTIONS
									D8.4 (day time)			F1.4 (night time)									
					kPa (g)	(deg C)	(m)	(kg/s)	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	(mm)	(kg)	(kg/s)	(sec)		(m2)	
09.04	HOSE FAILURE (TANKER OVERFILL TO (	RUPTURE	Cl2	V	50	-34	1	0.01	80	17	13	499	65	51	12.5	13000		3600	Restricted by 12.5mm XFV in tanker	N/A	
09.05	HOSE FAILURE (TANKER OVERFILL TO (	3 mm HOLE	Cl2	V	50	-34	1	0.01	36	6	5	211	30	23	3	13000		3600		490	Assume limited to 25m diameter (building width)
09.06	TANKER FILLING LINE	50 mm HOLE	Cl2	L	700	-34	1	12.50	2143	415	341	12211	1941	1487	50	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.07	TANKER FILLING LINE	13 mm HOLE	Cl2	L	700	-34	1	3.56	1574	330	276	15232	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.08	TANKER FILLING LINE	3 mm HOLE	Cl2	L	700	-34	1	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
09.09	TANKER FILLING LINE	GASKET	Cl2	L	700	-34	1	3.56	1574	330	276	15232	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
9.10a	HOSE COUPLING ERROR_no isolation	50 mm HOLE	Cl2	L	700	-34	1	12.50	3188	632	526	17888	4808	3820	25	50000	12.5	3600		490	Assume limited to 25m diameter (building width)
9.10b	HOSE COUPLING ERROR_isolation	50 mm HOLE	Cl2	L	700	-34	1	-	1668	463	386	2885	537	438	25	108	12.5	5		490	Assume limited to 25m diameter (building width)
9.11	VACUUM CATCH POT FAILURE	RUPTURE	Cl2	L	101	20	1	-	779	224	193	1226	229	185	25	15		n/a instantaneous			
CLP-10: Drum/Cylinder Filling Supply Line																					
10.01	SUPLLY LINE	50 mm HOLE	Cl2	L	700	-34	1	12.50	2143	415	341	12211	1941	1487	50	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
10.02	SUPLLY LINE	13 mm HOLE	Cl2	L	700	-34	1	3.56	1574	330	276	15323	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
10.03	SUPLLY LINE	3 mm HOLE	Cl2	L	700	-34	1	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
10.04	SUPLLY LINE	GASKET	Cl2	L	700	-34	1	3.56	1574	330	276	15323	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
CLP-11:Drum Filling																					
11.01a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	700	-34	0	4.60	1818	376	313	16200	2748	2145	15	50000	12.5	3600	Limited to pump maximum rate Inventory (60s x 1.5 kg/s)	490	Assume limited to 25m diameter (building width)
11.01b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	700	-34	0	-	1517	399	330	2780	525	426	15	90	12.5	21	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.02a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	700	-34	0	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.02b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	700	-34	0	-	364	82	68	1927	316	251	3	90	12.5	450	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.03a	HOSE CONNECTION FAILURE_no isolatio	RUPTURE	Cl2	L	700	-34	0	4.61	1818	376	313	16200	2748	2145	15	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.03b	HOSE CONNECTION FAILURE_isolation	RUPTURE	Cl2	L	700	-34	0	-	1517	399	330	2780	525	426	15	90	12.5	21	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.04	PIPING	RUPTURE	Cl2	L	700	-34	0	11.17	2913	578	483	16642	3817	3009	25	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.05	PIPING	13 mm HOLE	Cl2	L	700	-34	0	3.56	1574	330	276	15323	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.06	PIPING	3 mm HOLE	Cl2	L	700	-34	0	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
11.07	PIPING	GASKET	Cl2	L	700	-34	0	3.56	1574	330	276	15323	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
CLP-12:Cylinder Filling																					
12.01a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	700	-34	0	4.60	1818	376	313	16200	2748	2145	15	50000	12.5	3600	Inventory (60s x 0.64)	490	Assume limited to 25m diameter (building width)
12.01b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	564.7	19	0	-	1517	399	330	2780	525	426	15	38	-	8	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.02a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	700	-34	0	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.02b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	564.7	19	0	-	364	82	68	1927	316	251	3	38.4	-	192	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.03a	HOSE CONNECTION FAILURE_no isolatio	RUPTURE	Cl2	L	564.7	19	0	4.61	1818	376	313	16200	2748	2145	15	50000	-	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.03b	HOSE CONNECTION FAILURE_isolation	RUPTURE	Cl2	L	700	-34	0	-	1517	399	330	2780	525	426	15	38.4	12.5	8	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.04	PIPING	RUPTURE	Cl2	L	700	-34	0	11.17	2913	578	483	16642	3817	3009	25	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.05	PIPING	13 mm HOLE	Cl2	L	700	-34	0	3.56	1574	330	276	15323	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.06	PIPING	3 mm HOLE	Cl2	L	700	-34	0	0.21	354	80	67	3161	379	293	3	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
12.07	PIPING	GASKET	Cl2	L	700	-34	0	3.56	1574	330	276	15323	2386	1836	13	50000	12.5	3600	Limited to pump maximum rate	490	Assume limited to 25m diameter (building width)
CLP-13: Parked Road Tanker																					

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	OP PRESS	TEMP	RELEASE HEIGHT	Release Rate	EFFECT DISTANCE to (m)						HOLE DIAM	LIMITING INVENTORY	LIMIT TO LEAK RATE	MAX LEAK DURATION	COMMENTS	BUND SIZE	ASSUMPTIONS
									D8.4 (day time)			F1.4 (night time)									
					kPa (g)	(deg C)	(m)	(kg/s)	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	AEGL2 concentration	AEGL3 concentration	1% lethality Concentration	(mm)	(kg)	(kg/s)	(sec)		(m2)	
13.01	ROAD TANKER	RUPTURE	Cl2	L	578	19	1	-	9103	2349	2004	18886	3108	2512	RUP	13000	N/A	n/a instantaneous		490	Assume limited to 25m diameter (building width)
13.02a	ROAD TANKER	50 mm HOLE	Cl2	L	578	19	1	47.76	6686	1405	1162	23042	3977	3209	50	13000	N/A	3600		490	Assume limited to 25m diameter (building width)
13.02b	ROAD TANKER	50 mm HOLE	Cl2	V	578	19	1	2.00	1183	259	217	6165	1118	895	50	13000	N/A	3600		490	Assume limited to 25m diameter (building width)
13.03a	ROAD TANKER	13 mm HOLE	Cl2	L	578	19	1	3.27	1513	321	270	14746	2237	1728	13	13000	N/A	3600		490	Assume limited to 25m diameter (building width)
13.03b	ROAD TANKER	13 mm HOLE	Cl2	V	578	19	1	0.19	342	77	65	3059	372	290	13	13000	N/A	3600		490	Assume limited to 25m diameter (building width)
CLP-14: Storage and Handling of Filled Drums (NORMAL)																					
14.01	DRUM FAILURE	RUPTURE	Cl2	L	564.7	20	1	-	2903	808	692	5447	975	788	RUP	920	N/A	n/a instantaneous		490	Assume limited to 25m diameter (building width)
14.02	DRUM FAILURE	20 mm PLUG	Cl2	L	564.7	20	1	7.61	2422	568	474	6610	1197	956	20	920	N/A	3600		490	Assume limited to 25m diameter (building width)
14.03	DRUM FAILURE	6 mm VALVE	Cl2	L	564.7	20	1	0.69	657	146	124	5480	799	604	6	920	N/A	3600		490	Assume limited to 25m diameter (building width)
14.04	DRUM FAILURE	3 mm HOLE	Cl2	L	564.7	20	1	0.17	323	73	62	2811	332	254	3	920	N/A	3600		490	Assume limited to 25m diameter (building width)
14.05	CYLINDER FAILURE	RUPTURE	Cl3	L	564.7	20	1	-	1018	292	250	1672	314	254	RUP	70	N/A	n/a instantaneous		491	Assume limited to 25m diameter (building width)
CLP-14: Storage and Handling of Filled Drums (CONTINGENT)																					
14.01	DRUM FAILURE	RUPTURE	Cl2	L	564.7	20	1	-	2903	808	692	5447	975	788	RUP	920	N/A	n/a instantaneous		490	Assume limited to 25m diameter (building width)
14.02	DRUM FAILURE	20 mm PLUG	Cl2	L	564.7	20	1	7.61	2422	568	474	6610	1197	956	20	920	N/A	3600		490	Assume limited to 25m diameter (building width)
14.03	DRUM FAILURE	6 mm VALVE	Cl2	L	564.7	20	1	0.69	657	146	124	5480	799	604	6	920	N/A	3600		490	Assume limited to 25m diameter (building width)
14.04	DRUM FAILURE	3 mm HOLE	Cl2	L	564.7	20	1	0.17	323	73	62	2811	332	254	3	920	N/A	3600		490	Assume limited to 25m diameter (building width)
14.05	CYLINDER FAILURE	RUPTURE	Cl3	L	564.7	20	1	-	1018	292	250	1672	314	254	RUP	70	N/A	n/a instantaneous		491	Assume limited to 25m diameter (building width)
CLP-15: Chlorine Vapour to Scrubber System																					
15.01	VAPOUR PIPELINE TO SCRUBBER	Scrubber breakthrough	Cl2	V	0	20	19	0.58	582	-	-	6848	629	462	500	50000.00	0.58	300	Assumed the scrubber is failed and chlorine goes out of the stack.	-	N/A Gas release
15.02	VAPOUR PIPELINE TO SCRUBBER	500 mm RUPTURE	Cl2	V	0	20	1	5.50	174	47	41	246	50	41	500	120.00	-	300	Limited to scrubber design flowrate Assumed 10 m piping and 5 flanges	-	N/A Gas release
15.03	VAPOUR PIPELINE TO SCRUBBER	50 mm HOLE	Cl2	V	0	20	1	0.06	165	39	31	237	43	36	50	120.00	-	300	Limited to scrubber design flowrate Assumed 10 m piping and 5 flanges	-	N/A Gas release
15.04	VAPOUR PIPELINE TO SCRUBBER	13 mm HOLE	Cl2	V	0	20	1	0.01	49	7	6	189	29	24	13	120.00	-	900	Limited to scrubber design flowrate Assumed 10 m piping and 5 flanges	-	N/A Gas release
15.05	VAPOUR PIPELINE TO SCRUBBER	3 mm HOLE	Cl2	V	0	20	1	0.01	7	-	-	49	5	-	3	120.00	-	900	Limited to scrubber design flowrate Assumed 10 m piping and 5 flanges	-	N/A Gas release
15.06	VAPOUR PIPELINE TO SCRUBBER	GASKET	Cl2	V	0	20	1	0.01	49	7	6	189	29	24	13	120.00	-	900	Limited to scrubber design flowrate Assumed 10 m piping and 5 flanges	-	N/A Gas release
NH3-01: Ammonia (Refrigeration Unit)																					
16.01	DRUM FAILURE	RUPTURE	NH3	L	VP	20	1	-	450	135	143	748	158	172	RUP	180	N/A	n/a instantaneous	inventory - nominal	20	Assumed limited by Refrigeration Canopy area
16.02	DRUM FAILURE	3 mm HOLE	NH3	L	VP	20	1	0.13	82	19	21	317	31	36	3	180	N/A	3600	inventory - nominal	20	Assumed limited by Refrigeration Canopy area

APPENDIX I. FREQUENCY ANALYSIS

I1. Overview

The focus of this Appendix is on the CLP scenarios. The same methodology and base frequencies as the most recent CAP QRA study, Ref [5, 6], were used for this study where applicable.

I2. Base frequencies

I2.1. Generic equipment failure

The base frequencies are usually expressed on a per m of pipe or per equipment item basis per year or per million operating hours.

Piping and equipment mechanical failures frequencies were mainly sourced from data compiled for internal use by ICI, Ref [10], from frequency estimates published by the Institution of Chemical Engineers, Ref [11], or the CCPS and compared with more recently published data (UK HSE, Ref [12]). Data adopted for this study is summarised in Table I.1.

The preliminary PIDs were used to estimate the number of flanges and equipment, and pipe lengths were estimated from layout and information provided by IXOM.

Table I.1: Generic equipment failure frequencies

Type of Failure	Failure Rate (x 10^6 per year)	Reference	Comments
Piping			
3 mm hole	9/m	ICI Mond	-
13 mm hole	3/m		
50 mm hole	0.3/m		
Gasket (13 mm hole equivalent)	5/joint		
Guillotine fracture (full bore): < 50 mm > 50 mm but < 200 mm > 200 mm	 0.6/m 0.3/m 0.1/m		
Bellows			
Fracture (full bore)	4000/bellow		Used for hydrogen chloride (HCl) plant only
Pressure Vessels			
6 mm hole	24	ICI Mond	Used for liquid chlorine storage tanks and liquefier separator
13 mm hole	6		
25 mm hole	3		
50 mm hole	3		
Catastrophic failure	1		

Type of Failure	Failure Rate (x 10^6 per year)	Reference	Comments
Atmospheric Tanks			
Catastrophic failure – Non-metallic atmospheric tanks	0.021	CCPS	Lower end used. HCl tanks well maintained, inspected protected from impact. Appropriate mats of construction (fibreglass).
Canned Pump			
3 mm hole	50	TNO Purple Book	-
Catastrophic failure	10		
Compressor			
3 mm hole	12000	UK HSE	-
13 mm hole	270		
50 mm hole	2.9		
Catastrophic failure	2.9		
Road Tanker (pressurised)			
13 mm hole	5.7	UK HSE	Frequency split between liquid and vapour release (50%/50%) for non-rupture scenarios.
50 mm hole	0.5	TNO Purple Book	
Catastrophic failure	0.5		

I2.2. Cylinder, drum and road tanker filling

The frequencies of incidents due to hose failure during cylinder, drum or road tanker filling were obtained from TNO Purple Book, Ref [13], as below:

- Hose minor leak (3 mm): 4 x 10^{-5} per hour
- Hose rupture: 4 x 10^{-6} per hour.

I2.3. Drum and cylinder failure storage and handling

Drum failure rates are based on a study conducted by ICI UK into failures associated with chlorine drum storage and handling operations, Ref [14, 15].

Table I.2: Drum and cylinder failure frequencies

Type of failure	Failure rate
Static Drum Failures	
Catastrophic failure – drum	0.1 x 10^{-6} per year/drum
3mm hole – drum	5 x 10^{-6} per year/drum
Catastrophic failure – cylinder	0.1 x 10^{-6} per year/cylinder
Drum Handling Failures	
Probability of dropping drum during transfer	1 x 10^{-6}/transfer
Probability of valve damage per drop	0.001/drop
Probability of plug damage per drop	0.002/drop

I3. Online probability

The online time factor reduces the leak frequency based on the proportion of time that the equipment is used. It is assumed that all process equipment is always un-isolated and pressurised, and hence the online probability of 1 is applied to all sections except for the following:

- Cylinder filling: online probability of 0.01, equivalent to 2 hours per week (Contingent Case only, assumed to occur all year).
- Drum filling: online probability of 0.01, equivalent to 2 hours per week Contingent Case only, assumed to occur all year).
- Road tanker filling: online probability of 0.07, equivalent to 12 hours per week.
- Parked road tanker: online probability of 0.5, equivalent to half the time.

I4. Effect of safeguards

The effect of control measures factored into the QRA are summarised in Table I.3.

Table I.3: Control measures failure on demand

Description	PFDavg	Comments
Detection and isolation (ESD) – automatic	0.1	Cl_2 detection and shutdown (transfer equipment in buildings such as feed to storage tank, pumps for tanker/drum filling) - automatic by chlorine detection
Detection and isolation (ESD) – operator	0.1	Cl_2 detection and shutdown (transfer equipment in buildings such as feed to storage tank, pumps for tanker/drum filling) - by operator
Containment building and scrubber	0.05	Building/scrubber 'unavailability' has been estimated from the time that the building will be open for vehicles moving in and out (1.3% of time normal case, 3% of time contingent case) and an allowance for ventilation and scrubber failing. The overall design target for the building and scrubber containment system 'unavailability' is 5% and this will be verified in detailed design. The event tree developed to cover potential failure modes of this system indicates that this is achievable Refer to APPENDIX F for event tree. This is accounted for in the QRA as a frequency modification factor, i.e. for 5% of the time the building has no containment effect on any scenario in the liquefaction building, which is equivalent to all releases from the CLP occur inside a containment building and do not result in significant release outside the building 95% of time.
Emergency response	1	The QRA does not factor in emergency response actions such as sheltering in place or evacuation. These are highly dependent on human response and by convention are not accounted for in land use safety planning risk calculations.

I5. CLP incident frequencies

The frequencies for scenarios included in the QRA model for the CLP are summarised in the following Table I.4.

TABLE I.4 QRA Scenario Frequencies

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	LINE DIAM (mm)	LIMITING INVENTORY (kg)	LIMIT TO LEAK RATE (kg/s)	MAX LEAK DURATION (sec)	FAIL FREQ. (x 10e6)	PROB ONLINE	FAILURE PROB OF MITIG. (probab.)	RELEASE FREQUENCY (x 10e6)	Frequency Stationary equipment (per year)	Inside Containment Building?	Riskcurves Frequency (per year)	Normal/ Contingent Case?	Comments
														Unavailable factor:	0.05		
CLP-00: Chlorine Supply (Extension from CAP-Outside Liquefaction Building)																	
00.01	SUPPLY PIPELINE (OUTSIDE)	80 mm RUPTURE	Cl2	V	80	4200.0	0.58	300	9.0	1.00	1.00	9.0	9.00E-06	No	9.00E-06	Both	pipeline outside the building
00.02	SUPPLY PIPELINE (OUTSIDE)	50 mm HOLE	Cl2	V	80	4200.0	0.58	300	9.0	1.00	1.00	9.0	9.00E-06	No	9.00E-06	Both	pipeline outside the building
00.03	SUPPLY PIPELINE (OUTSIDE)	13 mm HOLE	Cl2	V	80	4200.0	0.58	900	90.0	1.00	1.00	90.0	9.00E-05	No	9.00E-05	Both	pipeline outside the building
00.04	SUPPLY PIPELINE (OUTSIDE)	3 mm HOLE	Cl2	V	80	4200.0	0.58	900	270.0	1.00	1.00	270.0	2.70E-04	No	2.70E-04	Both	pipeline outside the building
00.05	SUPPLY PIPELINE (OUTSIDE)	GASKET	Cl2	V	80	4200.0	0.58	900	5.0	1.00	1.00	5.0	5.00E-06	No	5.00E-06	Both	pipeline outside the building
CLP-01: Chlorine Supply (Inside Liquefaction Building)																	
01.01	SUPPLY PIPELINE (INSIDE)	80 mm RUPTURE	Cl2	V	80	4200.0	0.58	300	7.5	1.00	1.00	7.5	7.50E-06	Yes	3.75E-07	Both	
01.02	SUPPLY PIPELINE (INSIDE)	50 mm HOLE	Cl2	V	80	4200.0	0.58	300	7.5	1.00	1.00	7.5	7.50E-06	Yes	3.75E-07	Both	
01.03	SUPPLY PIPELINE (INSIDE)	13 mm HOLE	Cl2	V	80	4200.0	0.58	900	75.0	1.00	1.00	75.0	7.50E-05	Yes	3.75E-06	Both	
01.04	SUPPLY PIPELINE (INSIDE)	3 mm HOLE	Cl2	V	80	4200.0	0.58	900	225.0	1.00	1.00	225.0	2.25E-04	Yes	1.13E-05	Both	
01.05	SUPPLY PIPELINE (INSIDE)	GASKET	Cl2	V	80	4200.0	0.58	900	5.0	1.00	1.00	5.0	5.00E-06	Yes	2.50E-07	Both	
CLP-02: Chlorine Liquefier																	
02.01	SEPARATOR	RUPTURE	Cl2	L	-	2492.8	N/A	n/a instantaneous	1.0	1.00	1.00	1.0	1.00E-06	Yes	5.00E-08	Both	
02.02	SEPARATOR	50 mm HOLE	Cl2	L	-	2492.8	N/A	3600	3.0	1.00	1.00	3.0	3.00E-06	Yes	1.50E-07	Both	
02.03	SEPARATOR	25 mm HOLE	Cl2	L	-	2492.8	N/A	3600	3.0	1.00	1.00	3.0	3.00E-06	Yes	1.50E-07	Both	
02.04	SEPARATOR	13 mm HOLE	Cl2	L	-	2492.8	N/A	3600	6.0	1.00	1.00	6.0	6.00E-06	Yes	3.00E-07	Both	
02.05	SEPARATOR	6 mm HOLE	Cl2	L	-	2492.8	N/A	3600	24.0	1.00	1.00	24.0	2.40E-05	Yes	1.20E-06	Both	
CLP-03:LIQUID CHLORINE RUNDOWN																	
03.01	PIPING DOWNSTREAM OF LIQUEFIER	RUPTURE	Cl2	L	80	2492.8	N/A	n/a instantaneous	6.0	1.00	1.00	6.0	6.00E-06	Yes	3.00E-07	Both	
03.02	PIPING DOWNSTREAM OF LIQUEFIER	50 mm	Cl2	L	80	2492.8	N/A	3600	6.0	1.00	1.00	6.0	6.00E-06	Yes	3.00E-07	Both	
03.03	PIPING DOWNSTREAM OF LIQUEFIER	13 mm HOLE	Cl2	L	80	2492.8	N/A	3600	60.0	1.00	1.00	60.0	6.00E-05	Yes	3.00E-06	Both	
03.04	PIPING DOWNSTREAM OF LIQUEFIER	3 mm HOLE	Cl2	L	80	2492.8	N/A	3600	180.0	1.00	1.00	180.0	1.80E-04	Yes	9.00E-06	Both	
03.05	PIPING DOWNSTREAM OF LIQUEFIER	GASKET	Cl2	L	80	2492.8	N/A	3600	30.0	1.00	1.00	30.0	3.00E-05	Yes	1.50E-06	Both	
CLP-04:TAIL GAS TO DEGAS REACTOR																	
04.01	TAIL GAS TO DEGAS REACTOR	50 mm HOLE	Cl2	V	50	2492.8	0.014	n/a instantaneous	6.0	1.00	1.00	6.0	6.00E-06	Yes	3.00E-07	Both	
04.02	TAIL GAS TO DEGAS REACTOR	13 mm HOLE	Cl2	V	50	2492.8	0.014	900	30.0	1.00	1.00	30.0	3.00E-05	Yes	1.50E-06	Both	
04.03	TAIL GAS TO DEGAS REACTOR	3 mm HOLE	Cl2	V	50	2492.8	0.014	900	90.0	1.00	1.00	90.0	9.00E-05	Yes	4.50E-06	Both	
04.04	TAIL GAS TO DEGAS REACTOR	GASKET	Cl2	V	50	2492.8	0.014	900	10.0	1.00	1.00	10.0	1.00E-05	Yes	5.00E-07	Both	

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	LINE DIAM	LIMITING INVENTORY	LIMIT TO LEAK RATE	MAX LEAK DURATION	FAIL FREQ.	PROB ONLINE	FAILURE PROB OF MITIG.	RELEASE FREQUENCY	Frequency Stationary equipment	Inside Containment Building?	Riskcurves Frequency	Normal/ Contingent Case?	Comments
CLP-05: Storage Tanks																	
05.01	STORAGE TANK	RUPTURE	Cl2	L	-	50000	N/A	n/a instantaneous	1.0	1.00	1.00	1.0	1.00E-06	Yes	5.00E-08	Both	
05.02	STORAGE TANK	50 mm HOLE	Cl2	L	-	50000	N/A	3600	3.0	1.00	1.00	3.0	3.00E-06	Yes	1.50E-07	Both	
05.03	STORAGE TANK	25 mm HOLE	Cl2	L	-	50000	N/A	3600	3.0	1.00	1.00	3.0	3.00E-06	Yes	1.50E-07	Both	
05.04	STORAGE TANK	13 mm HOLE	Cl2	L	-	50000	N/A	3600	6.0	1.00	1.00	6.0	6.00E-06	Yes	3.00E-07	Both	
05.05	STORAGE TANK	6 mm HOLE	Cl2	L	-	50000	N/A	3600	24.0	1.00	1.00	24.0	2.40E-05	Yes	1.20E-06	Both	
CLP-06: STORAGE RELIEF																	
06.01	STORAGE TANK RELIEF	50 mm HOLE	Cl2	V	50	50000.0	0.8	n/a instantaneous	6.0	0.01	1.00	0.1	6.00E-08	Yes	3.00E-09	Both	
06.02	STORAGE TANK RELIEF	13 mm HOLE	Cl2	V	50	50000.0	0.8	900	30.0	0.01	1.00	0.3	3.00E-07	Yes	1.50E-08	Both	
06.03	STORAGE TANK RELIEF	3 mm HOLE	Cl2	V	50	50000.0	0.8	900	90.0	0.01	1.00	0.9	9.00E-07	Yes	4.50E-08	Both	
06.04	STORAGE TANK RELIEF	GASKET	Cl2	V	50	50000.0	0.8	900	10.0	0.01	1.00	0.1	1.00E-07	Yes	5.00E-09	Both	
CLP-07 Pump Suction																	
07.01	PUMP SUCTION	100 mm RUPTURE	Cl2	L	100	50000	N/A	n/a instantaneous	1.5	1.00	1.00	1.5	1.50E-06	Yes	7.50E-08	Both	
07.02	PUMP SUCTION	50 mm HOLE	Cl2	L	100	50000	N/A	3600	1.5	1.00	1.00	1.5	1.50E-06	Yes	7.50E-08	Both	
07.03	PUMP SUCTION	13 mm HOLE	Cl2	L	100	50000	N/A	3600	15.0	1.00	1.00	15.0	1.50E-05	Yes	7.50E-07	Both	
07.04	PUMP SUCTION	3 mm HOLE	Cl2	L	100	50000	N/A	3600	45.0	1.00	1.00	45.0	4.50E-05	Yes	2.25E-06	Both	
07.05	PUMP SUCTION	GASKET	Cl2	L	100	50000	N/A	3600	40.0	1.00	1.00	40.0	4.00E-05	Yes	2.00E-06		
CLP-08: Storage Pumps																	
08.01	PUMP FAILURE	RUPTURE	Cl2	L	80	50000	12.5	n/a instantaneous	10.0	1.00	1.00	10.0	1.00E-05	Yes	5.00E-07	Both	
08.02	PUMP FAILURE	3 mm HOLE	Cl2	L	80	50000	12.5	3600	50.0	1.00	1.00	50.0	5.00E-05	Yes	2.50E-06	Both	
08.03	PUMP DISCHARGE	80 mm RUPTURE	Cl2	L	80	50000	12.5	3600	3.0	1.00	1.00	3.0	3.00E-06	Yes	1.50E-07	Both	
08.04	PUMP DISCHARGE	50 mm HOLE	Cl3	L	80	50000	12.5	3600	3.0	1.00	1.00	3.0	3.00E-06	Yes	1.50E-07	Both	
08.05	PUMP DISCHARGE	13 mm HOLE	Cl2	L	80	50000	12.5	3600	30.0	1.00	1.00	30.0	3.00E-05	Yes	1.50E-06	Both	
08.06	PUMP DISCHARGE	3 mm HOLE	Cl2	L	80	50000	12.5	3600	90.0	1.00	1.00	90.0	9.00E-05	Yes	4.50E-06	Both	
08.07	PUMP DISCHARGE	GASKET	Cl2	L	80	50000	12.5	3600	20.0	1.00	1.00	20.0	2.00E-05	Yes	1.00E-06	Both	
CLP-09: Road Tanker Filling (NORMAL)																	
09.01	TANKER FAILURE	RUPTURE	Cl2	L	-	13000	N/A	n/a instantaneous	0.5	0.04	1.00	0.02	1.78E-08	Yes	8.90E-10	Normal	
09.02a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	50	50000	12.5	3600	35040.0	0.04	0.01	12.5	1.25E-05	Yes	6.24E-07	Normal	
09.02b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	50	108	12.5	9	35040.0	0.04	0.99	1235.5	1.24E-03	Yes	6.18E-05	Normal	
09.03a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	50	50000	12.5	3600	350400.0	0.04	0.01	124.8	1.25E-04	Yes	6.24E-06	Normal	
09.03b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	50	108	12.5	540	350400.0	0.04	0.99	12355.2	1.24E-02	Yes	6.18E-04	Normal	
09.04	HOSE FAILURE (TANKER OVERFILL TO CATCH	RUPTURE	Cl2	V	50	13000		3600	35040.0	0.04	1.00	1248.0	1.25E-03	Yes	6.24E-05	Normal	
09.05	HOSE FAILURE (TANKER OVERFILL LINE TO CATCH POT)	3 mm HOLE	Cl2	V	50	13000		3600	350400.0	0.04	1.00	12480.0	1.25E-02	Yes	6.24E-04	Normal	
09.06	TANKER FILLING LINE	50 mm HOLE	Cl2	L	50	50000	12.5	3600	6.0	0.04	1.00	0.2	2.14E-07	Yes	1.07E-08	Normal	
09.07	TANKER FILLING LINE	13 mm HOLE	Cl2	L	50	50000	12.5	3600	30.0	0.04	1.00	1.1	1.07E-06	Yes	5.34E-08	Normal	
09.08	TANKER FILLING LINE	3 mm HOLE	Cl2	L	50	50000	12.5	3600	90.0	0.04	1.00	3.2	3.21E-06	Yes	1.60E-07	Normal	
09.09	TANKER FILLING LINE	GASKET	Cl2	L	50	50000	12.5	3600	30.0	0.04	1.00	1.1	1.07E-06	Yes	5.34E-08	Normal	
	ROADTANKER OVERFILL (RELIEF VALVE)	25 mm HOLE	Cl2	V	50	13000	1.3		6.0	0.04	1.00	0.2	2.14E-07	Yes	1.07E-08	Normal	
9.10a	HOSE COUPLING ERROR_no isolation	50 mm HOLE	Cl2	L	50	0	12.5	0	18.7	1.00	0.01	0.2	1.87E-07	Yes	9.36E-09	Normal	
9.10b	HOSE COUPLING ERROR_isolation	50 mm HOLE	Cl2	L	50	0	12.5	9	18.7	1.00	0.99	18.5	1.85E-05	Yes	9.27E-07	Normal	

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	LINE DIAM	LIMITING INVENTORY	LIMIT TO LEAK RATE	MAX LEAK DURATION	FAIL FREQ.	PROB ONLINE	FAILURE PROB OF MITIG.	RELEASE FREQUENCY	Frequency Stationary equipment	Inside Containment Building?	Riskcurves Frequency	Normal/ Contingent Case?	Comments
9.11	VACUUM CATCH POT FAILURE	RUPTURE	Cl2	L	50	15		n/a instantaneous	1.0	1.00	1.00	1.0	1.00E-06	Yes	5.00E-08	Contingent	
CLP-09: Road Tanker Filling (CONTINGENT)																	
09.01	TANKER FAILURE	RUPTURE	Cl2	V	-	13000	N/A	n/a instantaneous	0.5	0.04	1.00	0.02	2.13E-08	Yes	1.07E-09	Contingent	
09.02a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	50	50000	12.5	3600	35040.0	0.04	0.01	15.0	1.50E-05	Yes	7.48E-07	Contingent	
09.02b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	50	65	12.5	5	35040.0	0.04	0.99	1481.0	1.48E-03	Yes	7.41E-05	Contingent	
09.03a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	50	50000	12.5	3600	350400.0	0.04	0.01	149.6	1.50E-04	Yes	7.48E-06	Contingent	
09.03b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	50	65	12.5	324	350400.0	0.04	0.99	14810.4	1.48E-02	Yes	7.41E-04	Contingent	
09.04	HOSE FAILURE (TANKER OVERFILL TO CATCH	RUPTURE	Cl2	V	50	13000		3600	35040.0	0.04	1.00	1496.0	1.50E-03	Yes	7.48E-05	Contingent	
09.05	HOSE FAILURE (TANKER OVERFILL TO CATCH	3 mm HOLE	Cl2	V	50	13000		3600	350400.0	0.04	1.00	14960.0	1.50E-02	Yes	7.48E-04	Contingent	
09.06	TANKER FILLING LINE	50 mm HOLE	Cl2	L	50	50000	12.5	3600	6.0	0.04	1.00	0.3	2.56E-07	Yes	1.28E-08	Contingent	
09.07	TANKER FILLING LINE	13 mm HOLE	Cl2	L	50	50000	12.5	3600	30.0	0.04	1.00	1.3	1.28E-06	Yes	6.40E-08	Contingent	
09.08	TANKER FILLING LINE	3 mm HOLE	Cl2	L	50	50000	12.5	3600	90.0	0.04	1.00	3.8	3.84E-06	Yes	1.92E-07	Contingent	
09.09	TANKER FILLING LINE	GASKET	Cl2	L	50	50000	12.5	3600	30.0	0.04	1.00	1.3	1.28E-06	Yes	6.40E-08	Contingent	
9.10a	HOSE COUPLING ERROR_no isolation	50 mm HOLE	Cl2	L	50	50000	12.5	3600	22.4	1.00	0.01	0.2	2.24E-07	Yes	1.12E-08	Contingent	
9.10b	HOSE COUPLING ERROR_isolation	50 mm HOLE	Cl2	L	50	108	12.5	5	22.4	1.00	0.99	22.2	2.22E-05	Yes	1.11E-06	Contingent	
9.11	VACUUM CATCH POT FAILURE	RUPTURE	Cl2	L	50	15		n/a instantaneous	1.0	1.00	1.00	1.0	1.00E-06	Yes	5.00E-08	Contingent	
CLP-10: Drum/Cylinder Filling Supply Line																	
10.01	SUPLLY LINE	50 mm HOLE	Cl2	L	50	50000	12.5	3600	12.0	1.00	1.00	12.0	1.20E-05	Yes	6.00E-07	Contingent	
10.02	SUPLLY LINE	13 mm HOLE	Cl2	L	50	50000	12.5	3600	60.0	1.00	1.00	60.0	6.00E-05	Yes	3.00E-06	Contingent	
10.03	SUPLLY LINE	3 mm HOLE	Cl2	L	50	50000	12.5	3600	180.0	1.00	1.00	180.0	1.80E-04	Yes	9.00E-06	Contingent	
10.04	SUPLLY LINE	GASKET	Cl2	L	50	50000	12.5	3600	10.0	1.00	1.00	10.0	1.00E-05	Yes	5.00E-07	Contingent	
CLP-11:Drum Filling																	
11.01a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	25	50000	12.5	3600	35040.0	0.26	0.01	90.1	9.01E-05	Yes	4.51E-06	Contingent	
11.01b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	25	90	12.5	21	35040.0	0.26	0.99	8923.2	8.92E-03	Yes	4.46E-04	Contingent	
11.02a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	25	50000	12.5	3600	350400.0	0.26	0.01	901.3	9.01E-04	Yes	4.51E-05	Contingent	
11.02b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	25	90	12.5	450	350400.0	0.26	0.99	89232.0	8.92E-02	Yes	4.46E-03	Contingent	
11.03a	HOSE CONNECTION FAILURE_no isolation	RUPTURE	Cl2	L	25	50000	12.5	3600	1622.4	0.26	0.01	4.2	4.17E-06	Yes	2.09E-07	Contingent	
11.03b	HOSE CONNECTION FAILURE_isolation	RUPTURE	Cl2	L	25	90	12.5	21	1622.4	0.26	0.99	413.2	4.13E-04	Yes	2.07E-05	Contingent	
11.04	PIPING	RUPTURE	Cl2	L	25	50000	12.5	3600	12.0	0.26	1.00	3.1	3.09E-06	Yes	1.54E-07	Contingent	
11.05	PIPING	13 mm HOLE	Cl2	L	25	50000	12.5	3600	60.0	0.26	1.00	15.4	1.54E-05	Yes	7.72E-07	Contingent	
11.06	PIPING	3 mm HOLE	Cl2	L	25	50000	12.5	3600	180.0	0.26	1.00	46.3	4.63E-05	Yes	2.32E-06	Contingent	
11.07	PIPING	GASKET	Cl2	L	25	50000	12.5	3600	50.0	0.26	1.00	12.9	1.29E-05	Yes	6.43E-07	Contingent	
CLP-12:Cylinder Filling																	
12.01a	HOSE FAILURE_no isolation	RUPTURE	Cl2	L	25	50000	12.5	3600	35040.0	0.26	0.01	90.1	9.01E-05	Yes	4.51E-06	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.01b	HOSE FAILURE_isolation	RUPTURE	Cl2	L	25	38	-	8	35040.0	0.26	0.99	8923.2	8.92E-03	Yes	4.46E-04	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.02a	HOSE FAILURE_no isolation	3 mm HOLE	Cl2	L	25	50000	12.5	3600	350400.0	0.26	0.01	901.3	9.01E-04	Yes	4.51E-05	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.02b	HOSE FAILURE_isolation	3 mm HOLE	Cl2	L	25	38.4	-	192	350400.0	0.26	0.99	89232.0	8.92E-02	Yes	4.46E-03	Contingent	Assumed to be the same as drums for time in use, probably a lot less

RC Scenario No	Description	Incident Type	MAT'L.	PHASE (L/V)	LINE DIAM	LIMITING INVENTORY	LIMIT TO LEAK RATE	MAX LEAK DURATION	FAIL FREQ.	PROB ONLINE	FAILURE PROB OF MITIG.	RELEASE FREQUENCY	Frequency Stationary equipment	Inside Containment Building?	Riskcurves Frequency	Normal/ Contingent Case?	Comments
12.03a	HOSE CONNECTION FAILURE_no isolation	RUPTURE	Cl2	L	25	50000	-	3600	1622.4	0.26	0.01	4.2	4.17E-06	Yes	2.09E-07	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.03b	HOSE CONNECTION FAILURE_isolation	RUPTURE	Cl2	L	25	38.4	12.5	8	1622.4	0.26	0.99	413.2	4.13E-04	Yes	2.07E-05	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.04	PIPING	RUPTURE	Cl2	L	25	50000	12.5	3600	12.0	0.26	1.00	3.1	3.09E-06	Yes	1.54E-07	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.05	PIPING	13 mm HOLE	Cl2	L	25	50000	12.5	3600	60.0	0.26	1.00	15.4	1.54E-05	Yes	7.72E-07	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.06	PIPING	3 mm HOLE	Cl2	L	25	50000	12.5	3600	180.0	0.26	1.00	46.3	4.63E-05	Yes	2.32E-06	Contingent	Assumed to be the same as drums for time in use, probably a lot less
12.07	PIPING	GASKET	Cl2	L	25	50000	12.5	3600	50.0	0.26	1.00	12.9	1.29E-05	Yes	6.43E-07	Contingent	Assumed to be the same as drums for time in use, probably a lot less
CLP-13: Parked Road Tanker																	
13.01	ROAD TANKER	RUPTURE	Cl2	L	-	13000	N/A	n/a instantaneous	0.5	0.50	1.00	0.3	2.50E-07	Yes	1.25E-08	Both	Parked tanker at Ambient temp has been included for consistency with CAP DA - probably conservative as tankers will be filled, warm up in building then leave to customer - no substantial parking time
13.02a	ROAD TANKER	50 mm HOLE	Cl2	L	-	13000	N/A	3600	0.3	0.50	1.00	0.1	1.25E-07	Yes	6.25E-09	Both	
13.02b	ROAD TANKER	50 mm HOLE	Cl2	V	-	13000	N/A	3600	0.3	0.50	1.00	0.1	1.25E-07	Yes	6.25E-09	Both	
13.03a	ROAD TANKER	13 mm HOLE	Cl2	L	-	13000	N/A	3600	2.9	0.50	1.00	1.4	1.43E-06	Yes	7.13E-08	Both	
13.03b	ROAD TANKER	13 mm HOLE	Cl2	V	-	13000	N/A	3600	2.9	0.50	1.00	1.4	1.43E-06	Yes	7.13E-08	Both	
CLP-14: Storage and Handling of Filled Drums (NORMAL)																	
14.01	DRUM FAILURE	RUPTURE	Cl2	L	-	920	N/A	n/a instantaneous	20.0	1.00	1.00	20.0	2.00E-05	Yes	1.00E-06	Normal	
14.02	DRUM FAILURE	20 mm PLUG	Cl2	L	-	920	N/A	3600	50.3	1.00	1.00	50.3	5.03E-05	Yes	2.52E-06	Normal	
14.03	DRUM FAILURE	6 mm VALVE	Cl2	L	-	920	N/A	3600	25.2	1.00	1.00	25.2	2.52E-05	Yes	1.26E-06	Normal	
14.04	DRUM FAILURE	3 mm HOLE	Cl2	L	-	920	N/A	3600	1000.0	1.00	1.00	1000.0	1.00E-03	Yes	5.00E-05	Normal	
14.05	CYLINDER FAILURE	RUPTURE	Cl3	L	-	70	N/A	n/a instantaneous	10.0	1.00	1.00	10.0	1.00E-05	Yes	5.00E-07	Normal	
CLP-14: Storage and Handling of Filled Drums (CONTINGENT)																	
14.01	DRUM FAILURE	RUPTURE	Cl2	L	-	920	N/A	n/a instantaneous	20.0	1.00	1.00	20.0	2.00E-05	Yes	1.00E-06	Contingent	
14.02	DRUM FAILURE	20 mm PLUG	Cl2	L	-	920	N/A	3600	54.1	1.00	1.00	54.1	5.41E-05	Yes	2.70E-06	Contingent	
14.03	DRUM FAILURE	6 mm VALVE	Cl2	L	-	920	N/A	3600	27.0	1.00	1.00	27.0	2.70E-05	Yes	1.35E-06	Contingent	
14.04	DRUM FAILURE	3 mm HOLE	Cl2	L	-	920	N/A	3600	1000.0	1.00	1.00	1000.0	1.00E-03	Yes	5.00E-05	Contingent	
14.05	CYLINDER FAILURE	RUPTURE	Cl3	L	-	70	N/A	n/a instantaneous	10.0	1.00	1.00	10.0	1.00E-05	Yes	5.00E-07	Contingent	
CLP-15: Chlorine Vapour to Scrubber System																	
15.01	VAPOUR PIPELINE TO SCRUBBER	Scrubber breakthrough	Cl2	V	500	50000.00	0.58	300	1.0	1.00	1.00	1.0	1.00E-06	No	1.00E-06	Both	
15.02	VAPOUR PIPELINE TO SCRUBBER	500 mm RUPTURE	Cl2	V	500	120.00	-	300	1.0	1.00	1.00	1.0	1.00E-06	No	1.00E-06	Both	
15.03	VAPOUR PIPELINE TO SCRUBBER	50 mm HOLE	Cl2	V	500	120.00	-	300	3.0	1.00	1.00	3.0	3.00E-06	No	3.00E-06	Both	
15.04	VAPOUR PIPELINE TO SCRUBBER	13 mm HOLE	Cl2	V	500	120.00	-	900	30.0	1.00	1.00	30.0	3.00E-05	No	3.00E-05	Both	
15.05	VAPOUR PIPELINE TO SCRUBBER	3 mm HOLE	Cl2	V	500	120.00	-	900	90.0	1.00	1.00	90.0	9.00E-05	No	9.00E-05	Both	
15.06	VAPOUR PIPELINE TO SCRUBBER	GASKET	Cl2	V	500	120.00	-	900	25.0	1.00	1.00	25.0	2.50E-05	No	2.50E-05	Both	
NH3-01: Ammonia (Refrigeration Unit)																	
16.01	DRUM FAILURE	RUPTURE	NH3	L	-	180	N/A	n/a instantaneous	1.0	1.00	1.00	1.0	1.00E-06	No	1.00E-06	Both	
16.02	DRUM FAILURE	3 mm HOLE	NH3	L	-	180	N/A	3600	5.0	1.00	1.00	5.0	5.00E-06	No	5.00E-06	Both	

APPENDIX J. RISK CONTRIBUTORS

J1. Analysis point locations

Analysis points have been selected at IXOM boundaries and at points in the Denison St residential area as shown below.



J2. Cumulative CAP and CLP Normal case risk contributors

Analysis point: 1. Denison st south

Total Individual risk at analysis point (X=335882,Y= 6.24118E6) is: 6.58E-08/yr

Individual risk Risk ranking

	Scenario	Contribution	Value
1	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [N] Chlorine Road Tanker Filling)	31.4	2.06E-08
2	Scenario 139 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-016: 17 Chemical loadout 1)	17.2	1.13E-08
3	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	14.2	9.36E-09
4	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	9.49	6.24E-09
5	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	8.43	5.55E-09
6	Scenario 026-350 Chlorine to Cooler Gas RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	2.92	1.92E-09
7	Scenario 011-1500 Weak Brine Tank Gas RUP (Toxic) (Location IXM-002: 02 CAP brine)	1.3	8.56E-10
8	14.02a Drum Failure Plug - 20mm leak (liquid) (14. [N] Storage and Handling of Filled Drums)	1.19	7.85E-10
9	13.01 Chlorine Parked Road Tanker - Rupture (13. [N/C] Parked Road Tanker)	1.05	6.88E-10
10	Scenario 071-300 Dryed Chlorine Gas RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	0.813	5.35E-10
		87.993	5.7834E-08

Analysis point: 2. High density nearest

Total Individual risk at analysis point (X=335981,Y= 6.24135E6) is: 1.32E-08/yr

Individual risk Risk ranking

	Scenario	Contribution	Value
1	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [N] Chlorine Road Tanker Filling)	56.6	7.47E-09
2	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	21.4	2.83E-09
3	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	14.3	1.88E-09
4	13.01 Chlorine Parked Road Tanker - Rupture (13. [N/C] Parked Road Tanker)	1.59	2.10E-10
5	13.02a Chlorine Parked Road Tanker -50 mm (liquid) (13. [N/C] Parked Road Tanker)	1.27	1.67E-10
6	09.10a Chlorine Road Tanker Coupling Error - Rupture (no isolation) (09. [N] Chlorine Road Tanker Filling)	0.847	1.12E-10
7	13.03a Chlorine Parked Road Tanker -13 mm (liquid) (13. [N/C] Parked Road Tanker)	0.833	1.10E-10
8	14.02a Drum Failure Plug - 20mm leak (liquid) (14. [N] Storage and Handling of Filled Drums)	0.728	9.60E-11
9	09.07 Chlorine Road Tanker Filling Line - 13mm Leak (09. [N] Chlorine Road Tanker Filling)	0.722	9.53E-11
10	09.09 Chlorine Road Tanker Filling Line - 13mm Leak (Gasket) (09. [N] Chlorine Road Tanker Filling)	0.722	9.53E-11
		99.012	1.30656E-08

Analysis point: 3. Ixom boundary (east)

Total Individual risk at analysis point (X=335756,Y= 6.24129E6) is: 2.48E-0

Individual risk Risk ranking

	Scenario	Contribution	Value
1	Scenario 139 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-016: 17 Chemical loadout 1)	22.5	5.57E-08
2	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [N] Chlorine Road Tanker Filling)	17.2	4.26E-08
3	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	11.9	2.94E-08
4	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	7.92	1.96E-08
5	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	7.7	1.91E-08
6	09.03b Chlorine Road Tanker Hose Failure - 3mm leak (isolation) (09. [N] Chlorine Road Tanker Filling)	6.91	1.71E-08
7	Scenario 141 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) ([CUMULATIVE] Location IXM-018: 19 Chemical loadout 3)	4.28	1.06E-08
8	09.02b Chlorine Road Tanker Hose Failure - Rupture (isolation) (09. [N] Chlorine Road Tanker Filling)	3.17	7.86E-09
9	14.02a Drum Failure Plug - 20mm leak (liquid) (14. [N] Storage and Handling of Filled Drums)	3.02	7.47E-09
10	Scenario 026-350 Chlorine to Cooler Gas RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	1.32	3.28E-09
		85.92	2.1271E-07

Analysis point: 4. Ixom boundary (north)

Total Individual risk at analysis point (X=335531,Y= 6.24133E6) is: 1.22E-05/yr

Individual risk Risk ranking

	Scenario	Contribution	Value
1	Scenario 141 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) ([CUMULATIVE] Location IXM-018: 19 Chemical loadout 3)	96.6	1.18E-05
2	09.02b Chlorine Road Tanker Hose Failure - Rupture (isolation) (09. [N] Chlorine Road Tanker Filling)	0.659	8.07E-08
3	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	0.459	5.62E-08
4	09.03b Chlorine Road Tanker Hose Failure - 3mm leak (isolation) (09. [N] Chlorine Road Tanker Filling)	0.456	5.58E-08
5	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [N] Chlorine Road Tanker Filling)	0.414	5.07E-08
6	14.02a Drum Failure Plug - 20mm leak (liquid) (14. [N] Storage and Handling of Filled Drums)	0.356	4.36E-08
7	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	0.306	3.74E-08
8	14.01 Drum failure - Rupture (14. [N] Storage and Handling of Filled Drums)	0.185	2.26E-08
9	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	0.0464	5.68E-09
10	14.04a Drum Failure - 3 mm leak (vapour) (14. [N] Storage and Handling of Filled Drums)	0.0455	5.58E-09
		99.5269	1.21583E-05

Analysis point: 5. Ixom boundary (west)

Total Individual risk at analysis point (X=335569,Y= 6.24121E6) is: 1.44E-05/yr

Individual risk Risk ranking

	Scenario	Contribution	Value
1	09.03b Chlorine Road Tanker Hose Failure - 3mm leak (isolation) (09. [N] Chlorine Road Tanker Filling)	29.2	4.19E-06
2	09.02b Chlorine Road Tanker Hose Failure - Rupture (isolation) (09. [N] Chlorine Road Tanker Filling)	26.2	3.76E-06
3	14.04a Drum Failure - 3 mm leak (vapour) (14. [N] Storage and Handling of Filled Drums)	8.25	1.19E-06
4	00.02 Vapour Supply Pipeline - 50mm Leak (00. [N/C] Chlorine Supply (Extension from CAP-Outside Liquefaction Building))	4.57	6.57E-07
5	00.03 Vapour Supply Pipeline - 13mm Leak (00. [N/C] Chlorine Supply (Extension from CAP-Outside Liquefaction Building))	3.59	5.16E-07
6	Scenario 141 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) ([CUMULATIVE] Location IXM-018: 19 Chemical loadout 3)	3.34	4.79E-07
7	14.01 Drum failure - Rupture (14. [N] Storage and Handling of Filled Drums)	2.57	3.69E-07
8	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	2.35	3.38E-07
9	00.01 Vapour Supply Pipeline - 80mm Leak (00. [N/C] Chlorine Supply (Extension from CAP-Outside Liquefaction Building))	2.33	3.35E-07
10	14.02a Drum Failure Plug - 20mm leak (liquid) (14. [N] Storage and Handling of Filled Drums)	1.94	2.79E-07
		84.34	1.2113E-05

Analysis point: 6. BIP boundary (south)

Total Individual risk at analysis point (X=335785,Y= 6.24102E6) is: 1.39E-07

Individual risk Risk ranking

	Scenario	Contribution	Value
1	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [N] Chlorine Road Tanker Filling)	17.3	2.41E-08
2	Scenario 139 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-016: 17 Chemical loadout 1)	15.7	2.18E-08
3	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	15.3	2.13E-08
4	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	7.83	1.09E-08
5	Scenario 026-350 Chlorine to Cooler Gas RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	7.47	1.04E-08
6	Scenario 011-1500 Weak Brine Tank Gas RUP (Toxic) (Location IXM-002: 02 CAP brine)	6.7	9.30E-09
7	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	5.22	7.25E-09
8	Scenario NEW1-Clorine Compressor Suction Pot RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	1.94	2.69E-09
9	Scenario 066-760 Secondary Drying Tower Gas RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	1.94	2.69E-09
10	Scenario 041-1800 Candle Filter Gas RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	1.93	2.69E-09
		81.33	1.1312E-07

J3. Cumulative CAP and CLP Contingent case risk contributors

Analysis point: 1. Denison st south

Total Individual risk at analysis point (X=335882,Y= 6.24118E6) is: 1.90E-0

Individual risk Risk ranking

	Scenario	Contribution	Value
1	11.01a Hose Failure - 15mm Leak (no isolation) (11. [C] Drum Filling)	19.5	3.70E-08
2	12.01a Hose Failure - 15mm Leak (no isolation) (12. [C] Cylinder Filling)	19	3.62E-08
3	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [C] Chlorine Road Tanker Filling)	13	2.48E-08
4	10.02 Drum/Cylinder Filling Supply Line - 13mm Leak (10. [C] Drum/Cylinder Filling Supply Line)	8.82	1.68E-08
5	Scenario 139 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-016: 17 Chemical loadout 1)	5.95	1.13E-08
6	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	4.92	9.36E-09
7	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	3.28	6.24E-09
8	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	2.92	5.55E-09
9	11.05 Piping Failure - 13mm Leak (11. [C] Drum Filling)	2.25	4.29E-09
10	12.05 Piping Failure - 13mm Leak (12. [C] Cylinder Filling)	2.2	4.19E-09
		81.84	1.5573E-07

Analysis point: 2. High density nearest

Total Individual risk at analysis point (X=335981,Y= 6.24135E6) is: 5.20E

Individual risk Risk ranking

	Scenario	Contribution	Value
1	12.01a Hose Failure - 15mm Leak (no isolation) (12. [C] Cylinder Filling)	22	1.14E-08
2	11.01a Hose Failure - 15mm Leak (no isolation) (11. [C] Drum Filling)	21.9	1.14E-08
3	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [C] Chlorine Road Tanker Filling)	17.2	8.96E-09
4	10.02 Drum/Cylinder Filling Supply Line - 13mm Leak (10. [C] Drum/Cylinder Filling Supply Line)	9.68	5.04E-09
5	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	5.44	2.83E-09
6	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	3.62	1.88E-09
7	12.05 Piping Failure - 13mm Leak (12. [C] Cylinder Filling)	2.46	1.28E-09
8	11.05 Piping Failure - 13mm Leak (11. [C] Drum Filling)	2.45	1.27E-09
9	12.04 Piping Failure - 25mm Leak (12. [C] Cylinder Filling)	2.07	1.08E-09
10	12.07 Piping Failure - 13mm Leak (Gasket) (12. [C] Cylinder Filling)	2.06	1.07E-09
		88.88	4.621E-08

Analysis point: 3. Ixom boundary (east)

Total Individual risk at analysis point (X=335756,Y= 6.24129E6) is: (

Individual risk Risk ranking

	Scenario	Contribution	Value
1	12.01a Hose Failure - 15mm Leak (no isolation) (12. [C] Cylinder Filling)	17.2	1.09E-07
2	11.01a Hose Failure - 15mm Leak (no isolation) (11. [C] Drum Filling)	17.1	1.08E-07
3	Scenario 139 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-016: 17 Chemical loadout 1)	8.81	5.57E-08
4	10.02 Drum/Cylinder Filling Supply Line - 13mm Leak (10. [C] Drum/Cylinder Filling Supply Line)	8.45	5.34E-08
5	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [C] Chlorine Road Tanker Filling)	8.09	5.11E-08
6	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	4.66	2.94E-08
7	09.03b Chlorine Road Tanker Hose Failure - 3mm leak (isolation) (09. [C] Chlorine Road Tanker Filling)	3.23	2.04E-08
8	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	3.11	1.96E-08
9	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	3.02	1.91E-08
10	12.05 Piping Failure - 13mm Leak (12. [C] Cylinder Filling)	2.12	1.34E-08
		75.79	4.791E-07

Analysis point: 4. Ixom boundary (north)

Total Individual risk at analysis point (X=335531,Y= 6.24133E6) is: 1.31E-05

Individual risk Risk ranking

	Scenario	Contribution	Value
1	Scenario 141 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) ([CUMULATIVE] Location IXM-018: 19 Chemical loadout 3)	90.3	1.18E-05
2	12.01a Hose Failure - 15mm Leak (no isolation) (12. [C] Cylinder Filling)	1.76	2.31E-07
3	11.01a Hose Failure - 15mm Leak (no isolation) (11. [C] Drum Filling)	1.62	2.13E-07
4	10.02 Drum/Cylinder Filling Supply Line - 13mm Leak (10. [C] Drum/Cylinder Filling Supply Line)	0.883	1.16E-07
5	09.02b Chlorine Road Tanker Hose Failure - Rupture (isolation) (09. [C] Chlorine Road Tanker Filling)	0.735	9.63E-08
6	09.03b Chlorine Road Tanker Hose Failure - 3mm leak (isolation) (09. [C] Chlorine Road Tanker Filling)	0.508	6.66E-08
7	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [C] Chlorine Road Tanker Filling)	0.464	6.08E-08
8	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	0.429	5.62E-08
9	14.02a Drum Failure Plug - 20mm leak (liquid) (14. [C] Storage and Handling of Filled Drums)	0.357	4.67E-08
10	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	0.286	3.74E-08
		97.342	0.000012724

Analysis point: 5. Ixom boundary (west)

Total Individual risk at analysis point (X=335569,Y= 6.24121E6) is: 2.39E-05/yr

Individual risk Risk ranking

	Scenario	Contribution	Value
1	09.03b Chlorine Road Tanker Hose Failure - 3mm leak (isolation) (09. [C] Chlorine Road Tanker Filling)	20.9	5.00E-06
2	09.02b Chlorine Road Tanker Hose Failure - Rupture (isolation) (09. [C] Chlorine Road Tanker Filling)	18.8	4.49E-06
3	11.03b Hose Connection Failure - 15mm Leak (isolation) (11. [C] Drum Filling)	8.31	1.99E-06
4	14.04a Drum Failure - 3 mm leak (liquid) (14. [C] Storage and Handling of Filled Drums)	4.95	1.19E-06
5	11.02a Hose Failure - 3mm Leak (no isolation) (11. [C] Drum Filling)	4.25	1.02E-06
6	11.01a Hose Failure - 15mm Leak (no isolation) (11. [C] Drum Filling)	3.91	9.37E-07
7	12.01a Hose Failure - 15mm Leak (no isolation) (12. [C] Cylinder Filling)	3.84	9.20E-07
8	12.02a Hose Failure - 3mm Leak (no isolation) (12. [C] Cylinder Filling)	3.74	8.96E-07
9	00.02 Vapour Supply Pipeline - 50mm Leak (00. [N/C] Chlorine Supply (Extension from CAP-Outside Liquefaction Building))	2.74	6.57E-07
10	10.02 Drum/Cylinder Filling Supply Line - 13mm Leak (10. [C] Drum/Cylinder Filling Supply Line)	2.28	5.47E-07
		73.72	0.000017647

Analysis point: 6. BIP boundary (south)

Total Individual risk at analysis point (X=335785,Y= 6.24102E6) is: 2.88E

Individual risk Risk ranking

	Scenario	Contribution	Value
1	11.01a Hose Failure - 15mm Leak (no isolation) (11. [C] Drum Filling)	15.7	4.52E-08
2	12.01a Hose Failure - 15mm Leak (no isolation) (12. [C] Cylinder Filling)	15	4.34E-08
3	09.02a Chlorine Road Tanker Hose Failure - Rupture (no isolation) (09. [C] Chlorine Road Tanker Filling)	10	2.89E-08
4	Scenario 139 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-016: 17 Chemical loadout 1)	7.55	2.18E-08
5	Scenario 140 Mixing hypo & acid loadout generating Cl2 Gas (Toxic) (Location IXM-017: 18 Chemical loadout 2)	7.39	2.13E-08
6	10.02 Drum/Cylinder Filling Supply Line - 13mm Leak (10. [C] Drum/Cylinder Filling Supply Line)	6.9	1.99E-08
7	08.05 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	3.77	1.09E-08
8	Scenario 026-350 Chlorine to Cooler Gas RUP (Toxic) (Location IXM-004: 04 CAP dry, cool, compress)	3.6	1.04E-08
9	Scenario 011-1500 Weak Brine Tank Gas RUP (Toxic) (Location IXM-002: 02 CAP brine)	3.22	9.30E-09
10	08.07 Pump Discharge - 13mm Leak (08. [N/C] Chlorine Storage Pumps)	2.51	7.25E-09
		75.64	2.1835E-07

APPENDIX K. ONSITE RISK BASIS

K1. Occupancy

Role: Day Plant Operator

Location	Probability of presence (Current)	Probability of presence (Future)
CAP control room	0.65	0.60
Main admin	0.02	0.02
Maintenance workshop	0.02	0.02
Repack plant	0.00	0.00
Drum storage area	0.02	0.00
CAP plant area	0.15	0.15
Products Area	0.15	0.15
Liquefaction building	0.00	0.06

Role: Night Plant Operator

Location	Probability of presence (Current)	Probability of presence (Future)
CAP control room	0.83	0.83
Main admin	0.00	0.00
Maintenance workshop	0.00	0.00
Repack plant	0.00	0.00
Drum storage area	0.00	0.00
CAP plant area	0.08	0.08
Products Area	0.08	0.08
Liquefaction building	0.00	0.00

Role: Maintenance Technicians

Location	Probability of presence (Current)	Probability of presence (Future)
CAP control room	0.09	0.09
Main admin	0.00	0.00
Maintenance workshop	0.28	0.28
Repack plant	0.02	0.02
Drum storage area	0.02	0.02
CAP plant area	0.30	0.22
Products Area	0.30	0.22
Liquefaction (excluding transfer)	0.00	0.16

Role: Engineers/Planners

Location	Probability of presence (Current)	Probability of presence (Future)
CAP control room	0.13	0.13
Main admin	0.13	0.13
Maintenance workshop	0.50	0.50
Repack plant	0.00	0.00
Drum storage area	0.00	0.00
CAP plant area	0.13	0.13
Products Area	0.13	0.13
Liquefaction building	0.00	0.00

Role: Technical/Quality

Location	Probability of presence (Current)	Probability of presence (Future)
CAP control room	0.25	0.25
Main admin	0.50	0.50
Maintenance workshop	0.00	0.00
Repack plant	0.00	0.00
Drum storage area	0.00	0.00
CAP plant area	0.13	0.13
Products Area	0.13	0.13
Liquefaction building	0.00	0.00

Role: Operations

Location	Probability of presence (Current)	Probability of presence (Future)
CAP control room	0.13	0.13
Main admin	0.50	0.50
Maintenance workshop	0.00	0.00
Repack plant	0.09	0.09
Drum storage area	0.03	0.03
CAP plant area	0.13	0.13
Products Area	0.13	0.13
Liquefaction building	0.00	0.00

Role: Admin staff

Location	Probability of presence (Current)	Probability of presence (Future)
CAP control room	0.04	0.04
Main admin	0.90	0.90
Maintenance workshop	0.01	0.01
Repack plant	0.00	0.00
Drum storage area	0.00	0.00
CAP plant area	0.03	0.03
Products Area	0.03	0.03
Liquefaction building	0.00	0.00

K2. IRPA results

Role: Day Plant Operator

Location	Probability of presence (Current)	Probability of presence (Future)	Day time			Night time		
			Current operation	Future operation (normal case)	Future operation (contingent case)	Current operation	Future operation (normal case)	Future operation (contingent case)
CAP control room	0.65	0.60	6.83E-07	3.46E-06	1.21E-05	n/a	n/a	n/a
Main admin	0.02	0.02	0.00E+00	3.19E-10	1.32E-09	n/a	n/a	n/a
Maintenance workshop	0.02	0.02	-	-	-	n/a	n/a	n/a
Repack plant	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Drum storage area	0.02	0.00	8.85E-07	0.00E+00	0.00E+00	n/a	n/a	n/a
CAP plant area	0.15	0.15	1.86E-06	1.87E-06	2.01E-06	n/a	n/a	n/a
Products Area	0.15	0.15	1.52E-06	2.77E-06	8.74E-06	n/a	n/a	n/a
Liquefaction building	0.00	0.06	0.00E+00	2.84E-05	6.92E-04	n/a	n/a	n/a
Cumulative risk			4.95E-06	3.65E-05	7.15E-04	0.00E+00	0.00E+00	0.00E+00

Role: Night Plant Operator

Location	Probability of presence (Current)	Probability of presence (Future)	Day time			Night time		
			Current operation	Future operation (normal case)	Future operation (contingent case)	Current operation	Future operation (normal case)	Future operation (contingent case)
CAP control room	0.83	0.83	n/a	n/a	n/a	2.43E-06	6.04E-06	1.80E-05
Main admin	0.00	0.00	n/a	n/a	n/a	0.00E+00	0.00E+00	0.00E+00
Maintenance workshop	0.00	0.00	n/a	n/a	n/a	-	-	-
Repack plant	0.00	0.00	n/a	n/a	n/a	0.00E+00	0.00E+00	0.00E+00
Drum storage area	0.00	0.00	n/a	n/a	n/a	0.00E+00	0.00E+00	0.00E+00
CAP plant area	0.08	0.08	n/a	n/a	n/a	1.06E-06	1.07E-06	1.15E-06
Products Area	0.08	0.08	n/a	n/a	n/a	8.71E-07	1.58E-06	4.99E-06
Liquefaction building	0.00	0.00	n/a	n/a	n/a	0.00E+00	0.00E+00	0.00E+00
Cumulative risk			0.00E+00	0.00E+00	0.00E+00	4.37E-06	8.69E-06	2.41E-05

Role: Maintenance Technicians

Location	Probability of presence (Current)	Probability of presence (Future)	Day time			Night time		
			Current operation	Future operation (normal case)	Future operation (contingent case)	Current operation	Future operation (normal case)	Future operation (contingent case)
CAP control room	0.09	0.09	9.92E-08	5.37E-07	1.88E-06	n/a	n/a	n/a
Main admin	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Maintenance workshop	0.28	0.28	-	-	-	n/a	n/a	n/a
Repack plant	0.02	0.02	3.99E-08	4.02E-08	4.07E-08	n/a	n/a	n/a
Drum storage area	0.02	0.02	6.64E-07	1.09E-07	2.14E-07	n/a	n/a	n/a
CAP plant area	0.30	0.22	3.78E-06	2.80E-06	3.02E-06	n/a	n/a	n/a
Products Area	0.30	0.22	3.10E-06	4.16E-06	1.31E-05	n/a	n/a	n/a
Liquefaction (excluding transfer)	0.00	0.16	0.00E+00	1.02E-05	1.02E-05	n/a	n/a	n/a
Cumulative risk			7.69E-06	1.78E-05	2.84E-05	0.00E+00	0.00E+00	0.00E+00

Role: Engineers/Planners

Location	Probability of presence (Current)	Probability of presence (Future)	Day time			Night time		
			Current operation	Future operation (normal case)	Future operation (contingent case)	Current operation	Future operation (normal case)	Future operation (contingent case)
CAP control room	0.13	0.13	1.32E-07	7.16E-07	2.51E-06	n/a	n/a	n/a
Main admin	0.13	0.13	0.00E+00	1.92E-09	7.94E-09	n/a	n/a	n/a
Maintenance workshop	0.50	0.50	-	-	-	n/a	n/a	n/a
Repack plant	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Drum storage area	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
CAP plant area	0.13	0.13	1.59E-06	1.60E-06	1.72E-06	n/a	n/a	n/a
Products Area	0.13	0.13	1.31E-06	2.38E-06	7.49E-06	n/a	n/a	n/a
Liquefaction building	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Cumulative risk			3.03E-06	4.69E-06	1.17E-05	0.00E+00	0.00E+00	0.00E+00

Role: Technical/Quality

Location	Probability of presence (Current)	Probability of presence (Future)	Day time			Night time		
			Current operation	Future operation (normal case)	Future operation (contingent case)	Current operation	Future operation (normal case)	Future operation (contingent case)
CAP control room	0.25	0.25	2.65E-07	1.43E-06	5.02E-06	n/a	n/a	n/a
Main admin	0.50	0.50	0.00E+00	7.66E-09	3.18E-08	n/a	n/a	n/a
Maintenance workshop	0.00	0.00	-	-	-	n/a	n/a	n/a
Repack plant	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Drum storage area	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
CAP plant area	0.13	0.13	1.59E-06	1.60E-06	1.72E-06	n/a	n/a	n/a
Products Area	0.13	0.13	1.31E-06	2.38E-06	7.49E-06	n/a	n/a	n/a
Liquefaction building	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Cumulative risk			3.16E-06	5.42E-06	1.43E-05	0.00E+00	0.00E+00	0.00E+00

Role: Operations

Location	Probability of presence (Current)	Probability of presence (Future)	Day time			Night time		
			Current operation	Future operation (normal case)	Future operation (contingent case)	Current operation	Future operation (normal case)	Future operation (contingent case)
CAP control room	0.13	0.13	1.32E-07	7.16E-07	2.51E-06	n/a	n/a	n/a
Main admin	0.50	0.50	0.00E+00	7.66E-09	3.18E-08	n/a	n/a	n/a
Maintenance workshop	0.00	0.00	-	-	-	n/a	n/a	n/a
Repack plant	0.09	0.09	2.40E-07	2.41E-07	2.44E-07	n/a	n/a	n/a
Drum storage area	0.03	0.03	1.33E-06	2.17E-07	4.27E-07	n/a	n/a	n/a
CAP plant area	0.13	0.13	1.59E-06	1.60E-06	1.72E-06	n/a	n/a	n/a
Products Area	0.13	0.13	1.31E-06	2.38E-06	7.49E-06	n/a	n/a	n/a
Liquefaction building	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Cumulative risk			4.60E-06	5.16E-06	1.24E-05	0.00E+00	0.00E+00	0.00E+00

Role: Admin staff			Day time			Night time		
Location	**Probability of presence (Current)**	**Probability of presence (Future)**	**Current operation**	**Future operation (normal case)**	**Future operation (contingent case)**	**Current operation**	**Future operation (normal case)**	**Future operation (contingent case)**
CAP control room	0.04	0.04	3.97E-08	2.15E-07	7.53E-07	n/a	n/a	n/a
Main admin	0.90	0.90	0.00E+00	1.38E-08	5.72E-08	n/a	n/a	n/a
Maintenance workshop	0.01	0.01	-	-	-	n/a	n/a	n/a
Repack plant	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Drum storage area	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
CAP plant area	0.03	0.03	3.18E-07	3.20E-07	3.45E-07	n/a	n/a	n/a
Products Area	0.03	0.03	2.61E-07	4.75E-07	1.50E-06	n/a	n/a	n/a
Liquefaction building	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	n/a	n/a	n/a
Cumulative risk			6.19E-07	1.02E-06	2.65E-06	0.00E+00	0.00E+00	0.00E+00

APPENDIX L. BOTANY/RANDWICK SAFETY STUDY RECOMMENDATIONS (2001)

Recommendation	Comment
Future developments within the Botany/Randwick industrial area should be subject to full risk assessment, following the seven-stage approval process. In addition, proposed developments should undergo comprehensive environmental impact assessment to conclusively demonstrate that the development will not produce off-site risks that are inappropriate for surrounding land uses.	As required by the SEARs the DA application includes a full QRA and evaluated the offsite individual and societal risk. i.e. the present QRA report fulfills the function of assessing offsite risk
Any future development in the vicinity of the Botany/Randwick industrial area should generally provide a buffer between the industrial area and surrounding residential zones. In assessing a proposed development, residential intensification should not be considered in the shaded region of Figure 1 until the new Orica chlorine plant is operational and bulk chlorine storage on the site has ceased. The Department should be consulted regarding proposed development within the 'consultation region' of Figure 1. It would also be prudent for the Department to be consulted regarding these regions after the replacement of the existing (pre-2001) Orica chlorine plant, at least during the early stages of plant operation.	Not applicable. The 'new chlorine plant' is the current CAP commissioned in 2001. As required by the SEARs the DA application includes a full QRA and evaluated the offsite individual and societal risk including in the shaded region
As this study has not included the impacts of dangerous goods traffic along Stephen Road and Denison Street, or the operations of Port Botany and Sydney Airport, it is strongly recommended that these activities be taken into account in the assessment of any development in the Botany/Randwick area.	The transport risk has been reviewed. Refer to doc no 21383-RP-003 Sherpa Consulting
It is recommended that all facilities be investigated as part of this study review and strengthen safety management systems. These systems should be monitored by periodic independent compliance audits at intervals of not less than two years. As part of the review of safety management systems, incident/near miss reporting and follow-up procedures should be updated to be consistent with best practice. Training arrangements should be reviewed to ensure that a safety management system is supported by an employee understanding of operational hazards and emergency procedures.	As an MHF, IXOM submits a periodic Safety Case report to SafeWork NSW. The Safety Case reviews the SMS as well as all other recommended items and IXOM including the SMS is periodically audited as part of eth MHF licensing requirements. The CLP will be operated under the same SMS
Emergency procedures for facilities within the industrial area should be reviewed and updated with the aim of establishing greater consistency between the procedures at different sites. There should also be a greater level of integration between facilities in terms of regional emergency planning. An integrated emergency plan for the area should be developed and mutual aid agreements established.	The recommendation has been addressed for the existing facilities within BIP. The existing emergency procedures will be updated to account for the new facility post DA approval.

Recommendation	Comment
The community should be adequately informed about activities, associated risks and safety management measures adopted within the Botany/Randwick industrial area. A formal mechanism needs to be established to implement a community right-to-know program. Community Consultative Committees should be established for developments, or groups of developments, in the industrial complex to act as an interface between the community and industry. particularly in regard to safety issues.	This function was fulfilled by setting up the Botany Industrial Park Community Consultative Committee (BIPCCC) which meets periodically. Refer to the consultation section of the DA submission for consultation activities relating to the liquefaction project.

APPENDIX M. REFERENCES

[1] NSW Department of Planning, Hazardous Industry Planning Advisory Paper No. 6 (HIPAP 6) - Hazard Analysis, 2011.

[2] NSW Department of Planning, “Hazardous Industry Planning Advisory Paper No.4 (HIPAP 4)- Risk Criteria for Land Use Safety Planning,” 2011.

[3] UK HSE, “Reducing Risks, Protecting People – HSE’s Decision-Making Process (R2P2),” 2001.

[4] Sherpa Consulting Pty Ltd, “Dangerous Goods Transport Risk Assessment - Denison St Chlorine Liquefaction Plant Chloralkali Facility,” 21838-RP-003 Rev 2, 2026.

[5] DPHI, “Email Nick Hon DPHI to Ben Smith IXOM, Re: IXOM RFI on 2024 CAP QRA,” 26 June 2025.

[6] Sherpa Consulting Pty Ltd, Quantitative Risk Assessment Report - Chloralkali Facility, 21972-RP-001 Rev 1, July 2025.

[7] TNO Institute of Environmental Sciences, Yellow Book: Methods for the calculation of physical effects due to releases of hazardous materials (liquids and gases), 2005.

[8] Gifford, Turbulent Diffusion-Typing Schemes: A Review, Nucl Saf, Vol.17, No. 1, Jan/Feb, 1961, pp.68-86, 1961.

[9] Committee for the Prevention of Disasters, TNO Purple Book, Guidelines for Quantitative Risk Assessment, CPR 18E, 1st edition, 1999.

[10] ICI Engineering Department, Process Safety Guide 14 - Reliability Data, ICI PLC (UK).

[11] A W Cox, F P Lees and M L Ang, Classification of Hazardous Locations, Institution of Chemical Engineers, 1990.

[12] UK Health & Safety Executives, Failure Rate and Event Data for use within Risk Assessments, 2012.

[13] TNO, Purple Book: Guidelines for quantitative risk assessment (CPR 18E), PGS3 ed., TNO, 2005.

[14] ICI Engineering UK, Chlorine Drum Hazard Analysis, Internal Orica (ICI Australia at that time) memo to DA Beattie, 1993.

[15] Ixom Operations Pty Ltd (formerly Orica), Drum Failure Frequency Data for Chlorine Risk Assessments. Rev C.



APPENDIX C

DANGEROUS GOODS TRANSPORT RISK ASSESSMENT

DANGEROUS GOODS TRANSPORT RISK ASSESSMENT
DENISON ST

CHLORINE LIQUEFACTION PLANT

CHLORALKALI FACILITY

BOTANY INDUSTRIAL PARK

IXOM OPERATIONS PTY LTD

PREPARED FOR:	**Jamie Van Rooyen** Head of Projects and Technology
DOCUMENT NO:	**21838-RP-003**
REVISION:	**4**
DATE:	**26-Mar-2026**

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DOCUMENT REVISION RECORD

Rev	Date	Description	Prepared	Checked	Approved	Method of issue
A	28-Feb-2025	Issued to Client for initial comments	N. Barty	J. Polich	-	Email PDF
B	12-Mar-2025	Updated with comments	N. Barty	J. Polich	-	Email PDF
0	21-Mar-2025	For final review	J. Polich	G. Peach	G. Peach	Email PDF
1	28-Mar-2025	Final Issue (included in MOD application)	J. Polich	G. Peach	G. Peach	Email PDF
2	30-Jan-2026	Updated to address exhibition period submissions for IXOM review	J. Polich N. Barty	G. Peach	G. Peach	Email PDF
3	26-Feb-2026	Final included in response to submissions (RTS) report for DPHI review	J. Polich	G. Peach	G. Peach (Sherpa)	Email PDF
4	26-Mar-2026	Minor updates Included with RTS report.	J. Polich	G. Peach	G. Peach (Sherpa)	Email PDF

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Title: **Dangerous Goods Transport Risk Assessment Denison St Chlorine Liquefaction Plant** **Chloralkali Facility** **Botany Industrial Park**	**QA verified:** M. Amouzegar **Date:** 26-Mar-2026

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ABBREVIATIONS

ADG	Australian Dangerous Goods (Code)
AMO	Automated Meteorological Observatory
BIP	Botany Industrial Park
BLEVE	Boiling Liquid Expanding Vapour Explosion
BOM	Bureau of Meteorology
CAP	Chloralkali Plant
Cl_2	Chlorine
CLP	Chlorine Liquefaction Plant
DG	Dangerous Goods
DOT	(US) Department of Transport
DPHI	Department of Planning, Housing and Infrastructure
EPA	Environment Protection Authority
FMCSA	(US) Federal Motor Carrier Safety Administration
IFR	Individual Fatality Risk
IOGP	International Association of Oil and Gas Producers
LOC	Loss of Containment
LPG	Liquefied Petroleum Gas
NSW	New South Wales
QRA	Quantitative Risk Assessment
RSS	Roll Stability System
RTS	Response To Submissions (report)
SEARS	Secretary's Environmental Assessment Requirements
TfNSW	Transport for New South Wales
TRA	Transport Risk Assessment
US	United States of America
VCE	Vapour Cloud Explosion

1. SUMMARY

1.1. Background

IXOM Operations Pty Ltd (IXOM) is proposing to construct a Chlorine Liquefaction Plant (CLP) at the existing Chloralkali Plant (CAP) located in the Botany Industrial Park (BIP), New South Wales (NSW). As a result, there will be an increase in chlorine (Cl_2) transport movements to and from the plant. Chlorine is a Class 2.3 (Toxic Gas) Dangerous Good (DG).

The Department of Planning, Housing and Infrastructure (DPHI) issued Secretary's Environmental Assessment Requirements (SEARS) for the project, which included the following requirement for assessing DG transport risk:

> *Include a Transport Risk Assessment (TRA) to evaluate the potential impacts from Dangerous Good (DG) transport to and from the modified facility with comparison to the TRA findings from Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility).*

The study that is referred to in the SEARS is the *Vopak Port Botany Expansion – Denison St Transport QRA – July 2016 Update. Rev 4* prepared by Scott Lister (issued August 2016 doc ref: MC20160715, Ref [1]) and covers Denison St only. The risk model used in the Scott Lister study is not publicly available and is not available via the consultant as they no longer practice in this field. The study does not directly report the number of vehicle movements transporting Cl_2 and there have been many updates in risk modelling software since 2016.

Therefore, as agreed with DPHI, the approach for the CLP TRA involved:

- Preparing a new TRA model in current commercially available software Gexcon RISKCURVES (v13.0.01) retaining Scott Lister risk modelling assumptions where possible and also still relevant, to produce an updated TRA model.
- Using the new TRA model to assess the risk from current and future (i.e. post CLP) Cl_2 transport only, and also the change in cumulative DG transport risk along Denison St resulting from Cl_2 transport movements associated with the CLP project.
- Comparing the results to the Individual Fatality Risk (IFR) criteria in Hazardous Industry Planning Advisory Paper No. 4 - *Risk Criteria for Land Use Safety Planning*, 2011 (HIPAP 4) Ref [2].

1.2. TRA basis

The CLP will have two operational modes with different transport volumes:

- **Normal case:** During normal operation, the CLP will typically be operated at a reduced rate. The produced Cl_2 will be used to fill bulk tankers to supply the liquid Cl_2 demand in the NSW region. This will result in a total of 156 loaded road tankers per year and 484 loaded drum trucks per year.

- **Contingent case (basis for the TRA):** During contingent operation, when the Ixom chlorine liquefaction plant at Laverton, Victoria is unavailable, the CLP will run at full capacity and facilitate Cl_2 tanker loading as well as Cl_2 drum and cylinder filling for export via flatbed trucks. This will result in a total of 187 loaded road tankers per year and 520 loaded drum trucks per year.

The contingent case is used for the TRA as this has the higher volume of Cl_2 transport movements.

The current CAP case is 4 road tankers per year and 484 drum trucks per year. There is no change to the existing route along Denison St.

1.3. Scope

The scope of the new TRA covers the change in Cl_2 transport risk for the following movements along Denison St resulting from the proposed CLP project:

- Drum route: Flatbed trucks transport 920 kg Cl_2 drums and 70 kg cylinders in and out of the BIP site via the northern part of Denison St between BIP Gate 3 and Wentworth Ave.
- Tanker route: Bulk Cl_2 tankers (13 tonne) travel out of the BIP site via the southern part of Denison St between BIP Gate 3 and Beauchamp Rd.

The new TRA includes assessment of DG transport risk along Denison St for three cases:

- Current Cl_2 transport risk (CAP only IFR).
- Future Cl_2 transport risk (i.e. CAP plus CLP contingent case IFR).
- Cumulative DG transport risk including the future Cl_2 transport risk (CLP contingent case IFR).

As per the Scott Lister report, the cumulative DG transport risk along Denison St accounts for:

- Class 2.1 transport (e.g. Liquefied Petroleum Gas LPG). These numbers have been reduced compared to the basis in the Scott Lister report to account for the closure of the Qenos and Indorama facilities at the BIP. LPG tanker movements from Port Botany are assumed to still occur along Denison St.
- Class 3 transport (flammable liquids such as gasoline) is the Vopak Port Botany expansion case and is unchanged from the Scott Lister report.

1.4. Updates to TRA

As part of the DA35/98-Mod-6 exhibition period, agency and community submissions were received relating to the DG transport risk on Denison St. Following consultation with DPHI, an update to the TRA has been prepared for inclusion with the Response to Submissions (RTS) report. The update in this revision (Rev 4) includes:

- Additional information provided regarding ADG Code and regulatory context for DG transport in Section 3.2.
- Extension of risk results to the northern end of Denison St / Wentworth Ave intersection as per figures in Section 7.
- Consolidation of discussion of how the TRA assumptions and risk criteria in the Scott Lister DG Transport studies referred to in the SEARS have been used or modified to prepare the new TRA model as per APPENDIX A.
- The main technical change compared to the TRA submitted as part of the MOD application relates to application of statistical generic DG transport leak frequency data in the TRA risk model locationally along Denison St. The statistical DG transport total incident frequency data was previously spread evenly along Denison St as the assumptions regarding intersections made in the previous Scott Lister report did not match the physical number of intersections along Denison St. In the updated TRA, the DG transport incident frequency has been apportioned to locations along Denison St based on locational Transport NSW crash data which shows that 90% of all Denison St accidents are at intersections and the majority of all accidents (>60% of the total) are at the Wentworth Ave / Denison St intersection at northern end of Denison St. Note that Cl_2 road tankers do not go through this intersection as they head south only from Gate 3 along Denison St.

Additional details of changes are provided in APPENDIX A.

1.5. Results

The key findings of the updated TRA are as follows:

- Figure 1.1 shows a comparison of IFR contours between the current Cl_2 transport case and the contingent case accounting for the CLP. This shows that for cases considering Cl_2 transport only:
    - For the current case, a small contour at the 0.5 x10 $^{-6}$ per year level is generated around the Wentworth Ave intersection only. This does not extend to any sensitive land uses. Risk levels are below this for the remainder of Denison St.
    - For the future case, a very small contour at the 1 x10 $^{-6}$ per year level is also generated (which remains within the road verge on the east side of Denison St) as well as the 0.5 x10 $^{-6}$ per year contour. These do not extend to residential or sensitive land uses. The commercial risk contour (relevant to Eastgardens) is not generated.
    - There are no contours for either case shown at HIPAP 4 levels at other locations along Denison St as the frequency is below all criteria due to the relatively higher accident frequency at the Wentworth Ave intersection.

- Therefore, all relevant HIPAP 4 IFR criteria are met for all land uses for both the current and future chlorine only cases.

- Figure 1.2 shows the cumulative DG transport risk case accounting for the Cl_2 future contingent case and compares this against the risk results from the 2016 Scott Lister TRA. This contour is significantly smaller than the 2016 Scott Lister contour in all areas except the Wentworth Rd intersection where it is slightly smaller.

1.6. Conclusion

Overall, the TRA results accounting for cumulative DG transport risk along Denison St including the increased chlorine transport associated with the CLP show:

- The CLP contingent case Cl_2 only transport risk along Denison St meets all HIPAP4 IFR criteria for all land uses. Note this would be the remaining risk if the CLP project proceeds and all other DG transport on Denison St ceased.
- Cumulative risk shows:
  - Reduced cumulative IFR contours along Denison St particularly in the southern part when compared to the previously assessed cumulative risk presented in the Scott Lister TRA from Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility).
  - 1 $x10^{-6}$ per year cumulative IFR contour around Wentworth Ave intersection extends into residential land use hence does not meet HIPAP 4 criteria. Criteria are met for other land uses and at other locations along Denison St.
- Whilst there is some change in cumulative risk contours due to changes in modelling approach, the risk reduction compared to previous Scott Lister 2016 results is due primarily to the reduction in Class 2.1 tankers due to the closure of Qenos and Indorama on the BIP and the adjustment of frequencies to reflect the relative frequency of crash data at intersections along Denison St.

Overall, it can be concluded that the cumulative DG transport risk along Denison St is not materially affected by current CAP or post CLP project Cl_2 transport and the DG transport risk remains dominated by Class 2.1 tankers as previously shown in the Scott Lister report.

Figure 1.1: IFR risk results for Cl_2 only transport

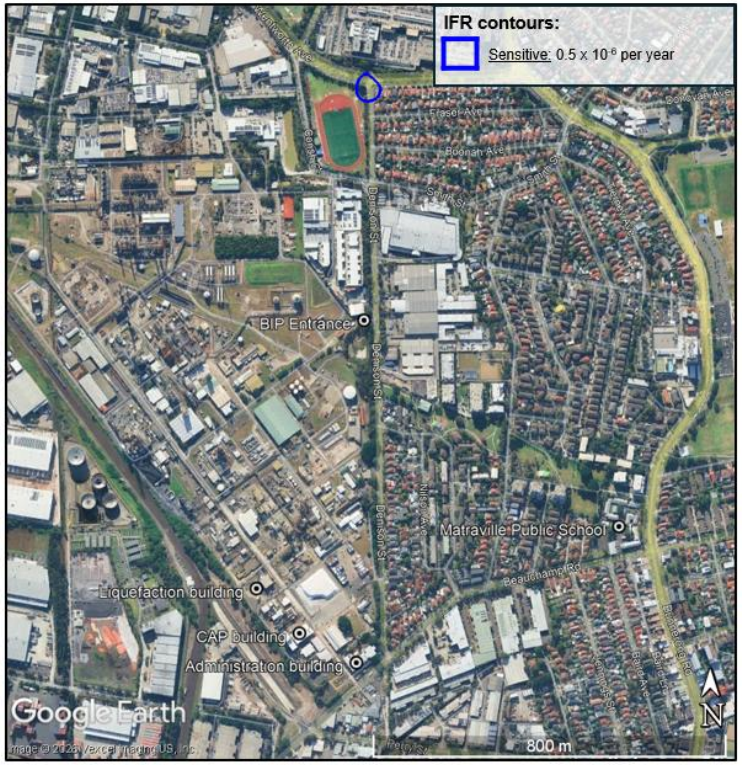
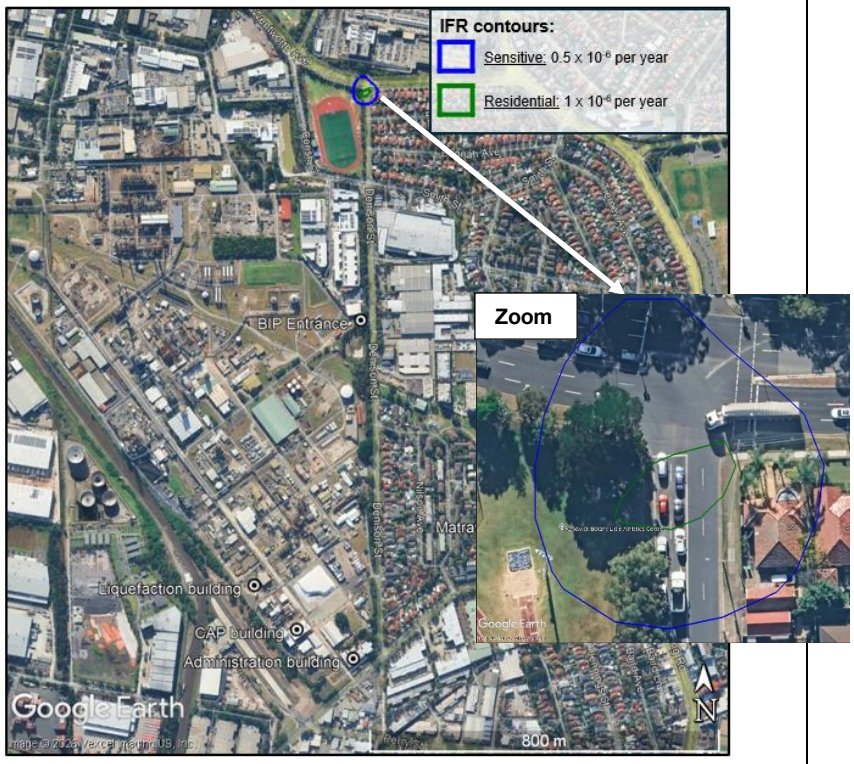
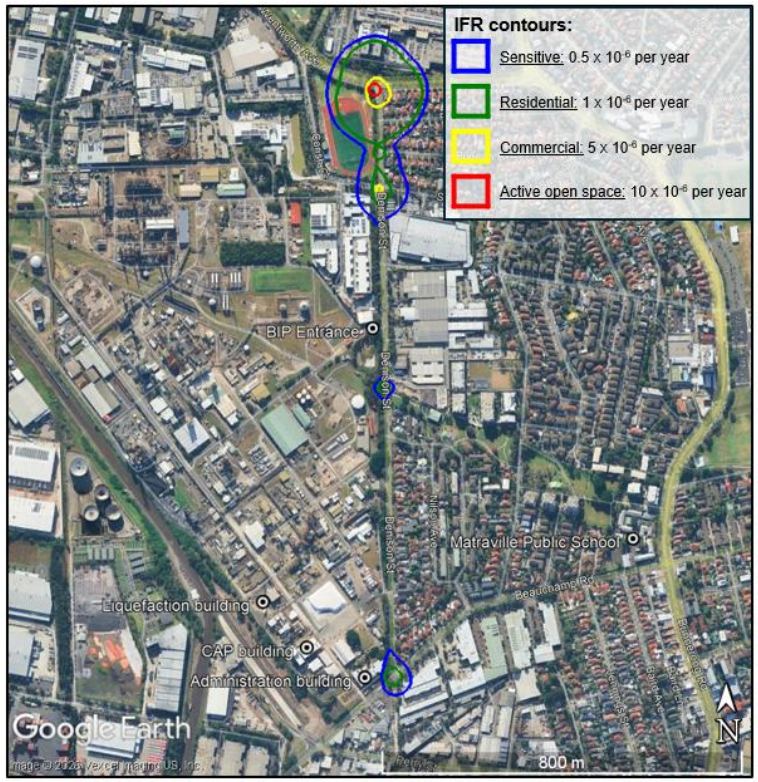
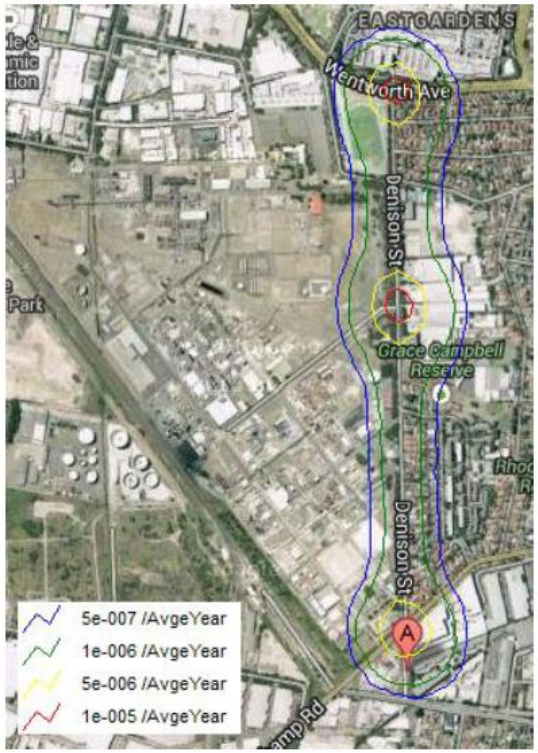
Current Cl_2 transport (CAP only)	Future Cl_2 transport risk (i.e. CAP plus CLP contingent case)
	
Key assumptions: 4 tankers per year, 484 loaded drum trucks per year Drum trucks turn left at Gate 3 and go north on Denison St Road tankers turn right at Gate 3 and go south on Denison St **Result:** 0.5 x10^{-6} per year only at Wentworth Ave intersection (does not reach sensitive land uses)	Key assumptions: 187 tankers per year, 520 loaded drum trucks per year Drum trucks turn left at Gate 3 and go north on Denison St Road tankers turn right at Gate 3 and go south on Denison St **Result:** Very small 1 x10^{-6} contour and 0.5 x10^{-6} per year only at Wentworth Ave intersection (does not reach residential or sensitive land uses respectively – see zoom in)

Figure 1.2: IFR risk results cumulative risk (CLP contingent case) comparison with Scott Lister TRA

Cumulative Risk CLP contingent case (TRA Rev 2 Feb 2026)	Cumulative risk results from Scott Lister TRA 2016
	
Key assumptions: Cl_2 as per Figure 1.1 1500 Class 2.1 (LPG) road tankers per year 7712 Class 3 (flammable liquid) road tankers per year **Result:** 10, 5 , 1 and 0.5 x10^{-6} per year contours. Reach residential land use around Wentworth Ave intersection 1 and 0.5 x10^{-6} per year contours at Beauchamp Rd (does not reach residential or sensitive land uses in this location)	Key assumptions: Cl_2 unknown 4521 Class 2.1 (LPG) road tankers per year 7712 Class 3 (flammable liquid) road tankers per year **Result:** 1 and 0.5 x10^{-6} per year contours along the whole of Denison St that extend into residential areas along the whole street, 5x10^{-6} per year contour extends into commercial land uses at Eastgardens near Wentworth Ave and north part of Denison St i.e. does not meet all HIPAP 4 criteria.

2. INTRODUCTION

2.1. Project description

IXOM Operations Pty Ltd (IXOM) is proposing to construct a Chlorine Liquefaction Plant (CLP) at the existing Chloralkali Plant (CAP) located in the Botany Industrial Park (BIP), New South Wales (NSW). The project will increase chlorine transport movements to and from the plant. Chlorine is a Class 2.3 (toxic gas) Dangerous Goods (DG).

2.2. Background

The Department of Planning Housing, and Infrastructure (DPHI) issued Secretary's Environmental Assessment Requirements (SEARS) for the project, requiring Ixom to assess the onsite, offsite and transport risk.

The SEARS requirement for assessing DG transport risk is:

> *Include a Transport Risk Assessment (TRA) to evaluate the potential impacts from Dangerous Good (DG) transport to and from the modified facility with comparison to the TRA findings from Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility).*

2.3. Report version

A TRA (Ref [3] doc ref Sherpa 21838-RP-003 Rev 1 dated March 2025) was prepared to address the SEARS and included in the modification application. This version of the report (Rev 3) has been updated and restructured to address agency and community submissions received during the exhibition period and will be attached to the Return to Submissions (RTS) report. The main changes compared to the previous version are summarised in APPENDIX A.

2.4. Study objectives

The overall objective of the TRA is to address the specific SEARs requirement for the evaluation of potential impacts from DG transport along Denison St.

This is addressed by:

- Assessment of the impact on the current cumulative DG transport risk along Denison St as a result of increased Cl_2 DG transport
- Assessment of the transport Individual Fatality Risk (IFR) against the risk criteria defined in the NSW DPHI Hazardous Industry Planning Advisory Paper No. 4 – *Risk Criteria for Land Use Planning Safety Planning* (HIPAP 4), Ref [2].
- Comparison of these findings against previous TRA studies for Denison St from Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility).

2.5. Scope

The scope of this study covers the change in chlorine transport risk for the following movements along Denison St resulting from the proposed CLP project only:

- Flatbed trucks transport 920 kg chlorine drums and 70 kg cylinders in and out of the BIP site via the northern portion of Denison St between Gate 3 and Wentworth Ave.
- Bulk tankers (13-tonne) travel in and out of the BIP site via the southern portion of Denison St between Gate 3 and Beauchamp Rd.

2.6. Exclusions and limitations

The exclusions, assumptions and limitations that apply to this study are summarised below:

- There is no available traffic count data for current DG transport movements along Denison St. Traffic counts have not been undertaken for this study.
- Risk metrics other than individual risk criteria were not assessed (i.e. societal risk) as there are no defined societal risk criteria for transport. Note that this was included in the previous Scott Lister study. Refer to APPENDIX A Table A1.1 for further commentary.
- DGs associated with the CAP apart from chlorine are not assessed. Other DGs associated with the CAP are Class 8 (corrosives) and these have not been assessed quantitatively in previous transport risk assessments as a Loss of Containment (LOC) during transport has localised environmental effects.
- The only other potentially hazardous DG apart from chlorine associated with the CLP is a small quantity of ammonia (< 200 kg) contained in the refrigeration system. Whilst there may be an occasional need for re-gassing of the refrigerant, there are no routine transport activities planned with this, so ammonia is not included in the TRA.
- As per the scope of previous studies including for Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility), any sections of the overall transport route apart from the Denison St section are outside the scope of the study.
- Alternative routes apart from the existing route Gate 3 from the BIP onto Denison St are not within scope of this study. It is noted that IXOM has evaluated alternatives involving exit from other Gates on the BIP and more use of internal roads within the BIP to reduce the use of Denison St. Other Gates are located in close proximity to existing road intersections or exit onto narrow roads that are not safe or designed for large trucks to be turning into. Roads within BIP are owned by other land holders and not available to IXOM and are not designed for heavy vehicles. None of the options were found to be reasonably practicable.

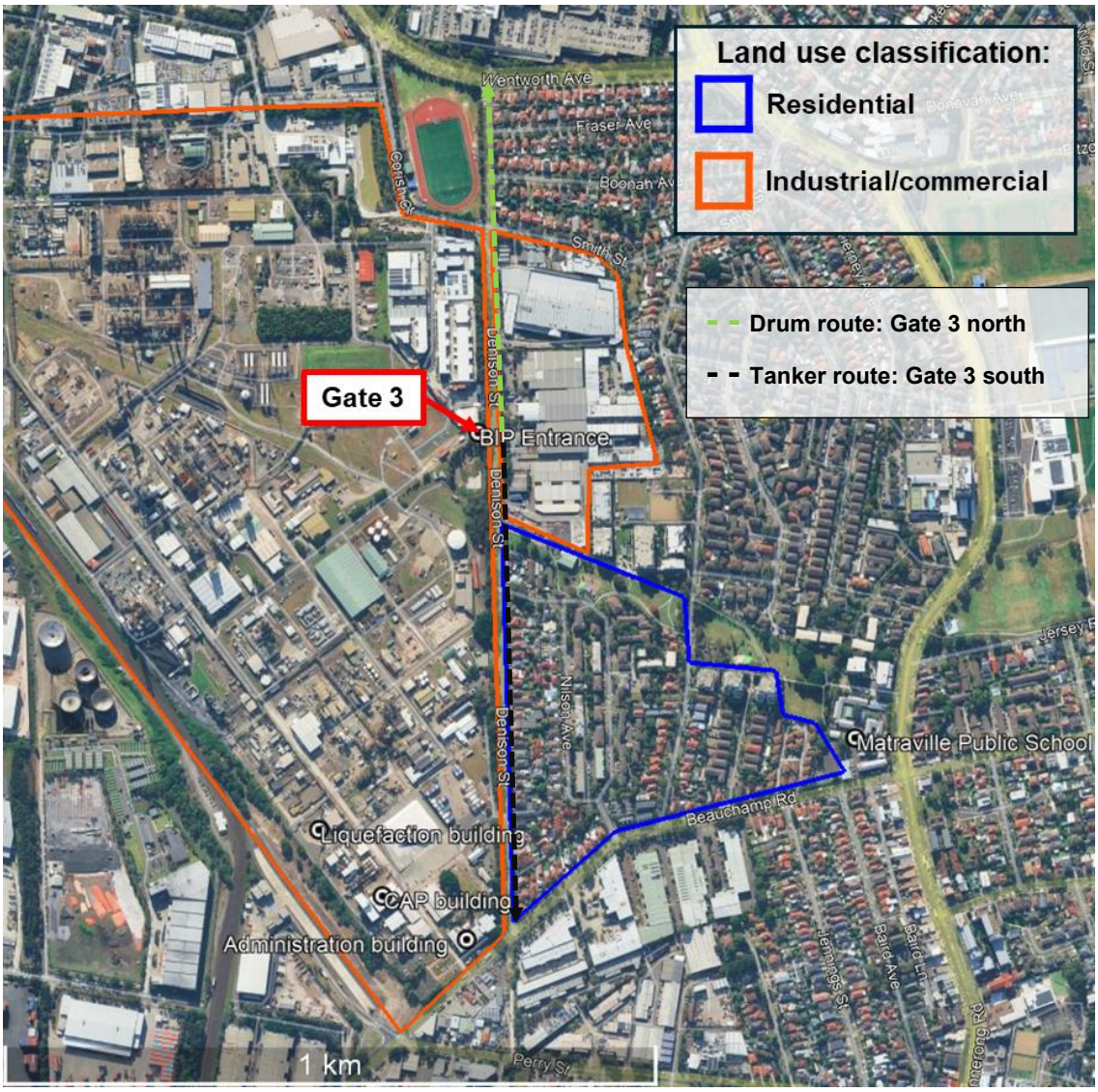
- Transport within the BIP boundary is also outside scope of the study.

3. CONTEXT AND CRITERIA

3.1. Location and surrounding land uses

The location of the proposed CLP and surrounding land uses are shown in Figure 3.1, with the nearest sensitive land use (Matraville Public School) also shown. The operation of the CLP will increase chlorine traffic volume along Denison St.

Figure 3.1: Site location and surrounding land uses



3.2. DG transport regulatory context

3.2.1. Overview

In NSW, DG transport is administered under the:

- Dangerous Goods (Road and Rail Transport) Act 2008.
- Dangerous Goods (Road and Rail Transport) Regulation 2022.

NSW legislation implements international and national frameworks covering transport of DGs including the Australian Dangerous Good (ADG) Code. The Environment Protection Authority (EPA) and SafeWork NSW are jointly appointed as competent authorities for land transport of DG in NSW. The EPA regulates the road and rail transport of dangerous goods under this Act while SafeWork NSW regulates activities prior to transport, including correct classification, packaging and labelling. The EPA carry out regular audits of DG transport to ensure compliance with the legislation. Key requirements of the legislation are:

- **Compliance with ADG Code:** All transportation must adhere to the current edition of the ADG Code for classification, packaging, and marking.
- **Licensing:** Drivers must hold a DG driver licence, and vehicles carrying placard loads require a DG vehicle licence.
- **Documentation:** A transport document containing consignor details, UN number, proper shipping name, class, packing group, and aggregate quantity must be in the vehicle.
- **Safety Equipment & Marking:** Vehicles must be correctly placarded and equipped with safety gear, including fire extinguishers and safety equipment required by the ADG Code.
- **Prohibited Areas & Tunnels:** Strict restrictions apply to carrying dangerous goods through specific NSW roads and tunnels, particularly in the Sydney network (e.g., prohibited areas under Rule 300-2). (NOTE: there are no prohibitions for DG transport on Denison St)
- **Incident Reporting:** Prime contractors must notify the EPA within one hour of a dangerous situation or accident.
- **Vehicle Standards:** Heavy tank trailers must have an operational electronic Roll Stability System (RSS).

Note there are no new or changed DG transport regulations that apply to the Cl_2 transport associated with the CLP project, the trucks, tankers, drivers, transport emergency response or routes taken. These are all existing approvals for CAP operations and transport frequency only will change.

3.2.2. Cl_2 tanker design

IXOM Cl_2 tankers are designed and maintained as follows:

- All Cl_2 tankers are owned by IXOM and built to IXOM specification.
- Cl_2 tanker design approval from NSW and Victorian authorities as per details following:

- NSW: Dangerous goods tank design approval (NSWDGT2158). Approved through NSW EPA. Section 48, NSW Dangerous Goods (Road and Rail Transport) Regulation 2022 & Australian Code for the Transport of Dangerous Goods by Road and Rail 7.7.
- Vic: WorkSafe design registration (WSV-0150567255_0). Registration through WorkSafe VIC. OHS Safety Act 2004, OHS Regs 2017, Equipment (Public Safety) Act 1994 & Equipment (Public Safety) Regs 2017

- Tankers and trailers are designed to the following codes:

  1. AS1210 – 2010 - Pressure Vessels with supporting tanker pressure vessel design calculations.
  2. AMSE VIII – Div 1 and 2 - Boiler and Pressure Vessel Code, as applicable.
  3. AS2809.1 – 2020 - General requirements for all road tank vehicles, AS2809.3 – 2022 - Road tank vehicles for compressed liquefied gases.

- All tankers including barrel, relief devices, valves and fittings are periodically inspected externally and internally to ensure asset integrity is maintained
- As part of driver DG licencing compliance, a vehicle pre-start inspection is required prior to use.

3.2.3. Route risk assessment by transporter

Under the ADG Code, a route risk assessment and emergency plan must be prepared for DG transport prior to any transport occurring with a focus on ensuring any higher risk locations are avoided, for example right turns with no lights, narrow roads, steep slopes, low bridges etc. Existing route risk assessments cover Cl_2 transport along Denison St.

- Drums: The route risk assessment specifies that the drum trucks turn left out of Gate 3 as there are no lights. Also, the drum trucks travel during busy periods and there are several trucks per day.
- Tankers: The route risk assessment specifies that the tankers can turn right out of Gate 3 as they travel during quiet periods and this route minimises the overall exposure of residential areas (i.e. eliminates travel along Wentworth Ave and Bunnerong Rd) as they go straight south to Foreshore Rd rather than having to go a longer way round.

3.3. Previous Denison St traffic risk assessments

There is minimal information available regarding the overall volume of DG traffic in the Port Botany precinct and surrounding industrial areas.

Discussions between Sherpa and DPHI were held, and it was agreed that the methodology adopted in previous DG transport risk studies completed by Scott Lister for

Denison St could be broadly adopted and used as a baseline for risk assessment[1]. The previous DG transport Quantitative Risk Assessments (QRA) were commissioned by a Joint Regional Planning Panel (which included the DPHI and City of Botany Bay Council) to assess the risk to a proposed Bunnings development in Denison St.

The relevant studies are:

- Scott Lister, *Dangerous Goods Transport QRA, Denison St, Hillsdale* Rev 3 Issued: 12 February, 2015, Ref [4].
- Scott Lister, *Addendum to Dangerous Goods transport QRA, Denison St, Hillsdale*. An update to the Dangerous Goods Transport QRA in the form of an Addendum was released in July 2015, Ref [5].
- Scott Lister, *Vopak Port Botany Expansion – Denison St Transport QRA – July 2016 Update. Rev 4*, issued August 2016 (doc ref: MC20160715), Ref [1]. Note: This study formed the basis for the TRA for the Major Project approval MP 06_0089 MOD 2, referred to in the SEARs. The results in this study are the basis for comparison for IFR contours for Denison St transport risk.

Review of these studies found there were a number of assumptions that needed to be modified as they were no longer applicable or there was missing data in the Scott Lister reports that had to be estimated. APPENDIX A provides commentary on the Scott Lister TRA assumptions and whether they were retained or modified for the new TRA.

3.4. Criteria

As per the Scott Lister TRA, individual fatality risk criteria used in the TRA are from NSW HIPAP 4, Ref [2], as shown in Table 3.1.

Table 3.1: NSW HIPAP 4 individual fatality risk criteria

Limit (per year)	Land use
0.5×10^{-6}	Hospitals, child-care facilities and old age housing developments
1×10^{-6}	Residential developments and places of continuous occupancy such as hotels and tourist resorts
5×10^{-6}	Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres
10×10^{-6}	Sporting complexes and active open space areas
50×10^{-6}	Industrial – as a target must not be exceeded any boundary adjacent to another industrial facility

[1] Email, D Yau (DPHI) to J Polich (Sherpa), 20 Feb 2025.

4. TRANSPORT RISK ASSESSMENT BASIS

4.1. Risk assessment approach

The CLP TRA involved preparing a new risk model in Gexcon RISKCURVES (v13.0.1) retaining previous risk modelling assumptions as far as possible to produce an updated current case TRA as per APPENDIX A. The new TRA model was then used to assess the change in cumulative transport risk resulting from the increase in Cl_2 transport movements associated with the CLP project.

The remainder of this report documents the assumptions and results for the new TRA. Refer to APPENDIX A for any comparisons to the Scott Lister TRAs.

4.2. Meteorological data

The meteorological data from the CLP QRA was used in the TRA. This was obtained from the Bureau of Meteorology's (BOM's) Automated Meteorological Observatory (AMO) located at Sydney Airport (BOM station No. 066037), as per the QRA study for the CLP, Ref [3]. The acquired data was based on hourly data readings over the period of January 2014 to June 2024. The average ambient conditions at this station are summarised in Table 4.1 and uses as input to the modelling. The wind rose map and consolidated data used in the risk model are presented in APPENDIX C.

Table 4.1: Average ambient conditions at Sydney Airport AMO (2014 – 2024)

Average ambient condition	Value
Air temperature	19°C
Relative humidity	67%

4.3. Release scenarios

Table 4.2 summarises the release scenarios used for the modelling with the base leak frequencies shown in Section 6. Scenarios for chlorine transport are consistent with the CAP and CLP QRA LOC scenarios for chlorine drums and tankers.

Table 4.2: DG transport release scenarios

Scenario ID	Vehicle	Inventory	Release scenario
Class 2.1 flammable liquefied gases			
1.1	Liquefied Petroleum Gas (LPG) bulk tanker	10-tonnes, Ref [1]	Vapour space leak (50 mm), Ref [1]
1.2			Liquid space leak (50 mm), Ref [1]
1.3			Cold rupture (instantaneous release), Ref [1]
1.4			Boiling Liquid Expanding Vapour Explosion (BLEVE), Ref [1]
Class 2.3 toxic gases			
2.1	Chlorine bulk tanker	13-tonnes	Mechanical failure and leak liquid (13 mm), Ref [6]

Scenario ID	Vehicle	Inventory	Release scenario
2.2			Cold rupture (instantaneous release), Ref [6]
3.1	Chlorine flatbed truck	920 kg per drum	Drum rupture (instantaneous release), Ref [7]
3.2			Mechanical failure equivalent to drum valve leak (6 mm), Ref [7]
Class 3 flammable liquids			
4.1	Gasoline bulk tanker	20-tonnes, Ref [1]	Cold rupture (instantaneous release), Ref [1]

4.4. DG transport release frequencies

Typically, LOC during transport is due to:

- LOC as a result of damage due to vehicle accidents. These are typically the most severe incidents and result from serious impact due to accidents such as rollover or high speed collisions.
- LOC as a result of a mechanical failure on-route. These typically are smaller leaks from valves or passing relief devices.

There is very little information available regarding LOC during DG transport, and it is not clear in some cases whether the data is 'all causes' or due to accidents only. The data adopted for this study is from International Association of Oil and Gas Producers (IOGP) *Report No. 434-9: Land transport accident statistics*, and covers both external (eg accidents, impacts) and internal (eg mechanical failures) causes, Ref [8]. These are summarised in Section 6, see Table 6.1.

4.5. Denison St accident rate

A review of vehicle accident data, published by Transport for New South Wales (TfNSW), for Denison St over the period from 2020 – 2024, Ref [9], found that 30 accidents had occurred on Denison St. Over 90% of accidents occurred at intersections and the majority (> 60%) of accidents occurred at the intersection between Denison St. and Wentworth Ave. Note that the Cl_2 road tankers do not go through this intersection as they go south along Denison St to Beauchamp Rd.

A summary of the identified accidents is provided in APPENDIX B.

The data indicates that few accidents involve heavy vehicles (2 only) and less than 5 accidents resulted in injury/fatality. Therefore, the data shows there is no history of accidents of sufficient severity (e.g. high-speed impact, rollover) that are likely to result in a DG release. Therefore, no attempt was made to directly correlate accident rates with DG vehicle LOCs.

However, the data shows that intersections are the major accident risk. Therefore, it was assumed that the base LOC rates for serious incidents involving DG vehicles would correlate proportionally with the probability of all accidents at intersection locations. The

LOC frequencies were apportioned to the intersections with the remaining 10% of accidents allocated along the overall length of Denison St as shown in APPENDIX B.

4.6. Vehicle movements

All data refers to loaded vehicles. Empty vehicles are not included in the DG TRA.

4.6.1. Chlorine

The CLP will have two operational modes:

- **Normal case:** During normal operation, the liquefaction plant is operated at turndown. The produced chlorine is primarily used to fill the bulk tankers to supply the liquid chlorine demand in the NSW region.
- **Contingent case:** During contingent operation, when the chlorine liquefaction plant at Laverton, Victoria is down, the CLP will run at full capacity and facilitate tanker loading as well as chlorine drum and cylinder filling for export via flatbed trucks.

The chlorine transport movements associated with these operational cases are summarised in Table 4.4.

4.6.2. Other hazardous materials

There is minimal information publicly available regarding the overall volume of DG traffic in the Port Botany precinct and surrounding industrial areas. Therefore, for consistency, vehicle movement numbers have been sourced from previous Scott Lister studies and adjusted based on operational information made available to Sherpa by IXOM and the BIP companies.

The previous Scott Lister study, Ref [1], demonstrated that transport risk was dominated by Class 2.1 LPG tankers. With the closure of the Qenos BIP facility, there will be a reduction in the number of LPG tankers moving to and from the BIP. The base value of 4,521 Class 2.1 tankers per year was sourced from the previous Scott Lister study, Ref [1], and the BIP Class 2.1 tanker traffic removed. The reduced number of 1,500 vehicles per year represents an estimate of Class 2.1 traffic from Port Botany that is not associated with the Qenos or Indorama BIP facilities and hence will not be affected by the facility's closure.

The Class 3 movements remain as per the Vopak Site B expansion case.

4.6.3. Summary of DG vehicle movements

The values used in risk calculations for the total number of vehicles (current and future cases) transporting DGs entering and exiting the BIP site are summarised in Table 4.3. The chlorine transport movements associated with the BIP for current and future cases are summarised in Table 4.4. Note that for chlorine transport, the contingent mode is adopted which has the highest number of chlorine transport movements. Current/future

cases were only applicable for chlorine transport, accounting for the additional traffic volume generated by operation of the CLP.

Table 4.3: DG vehicle movements

Vehicle	Inventory	Total number of loaded vehicle movements (to/from BIP) per year		Reference
		Current	Future	
Class 2.1 flammable liquefied gases				
LPG bulk tanker	10 tonnes	1,500 (i.e. BIP Class 2.1 traffic removed)	1,500	[10]
Class 2.3 Toxic gases				
Chlorine bulk tanker	13 tonnes	4[(a)]	187	IXOM operational information for normal and contingent mode
Chlorine flatbed truck	920 kg per drum	484	520[(b)]	
Class 3 Flammable liquids				
Gasoline bulk tanker	20 tonnes	7,712 (no change – Vopak Site B expansion)	7,712	[10]

Notes:

(a) This value is nominal for parked tankers only to and from the site only, with no filling occurring.

(b) This value allows for the contingent mode of operation when drum filling is occurrent at the site, as this results in the highest chlorine transport throughput.

Table 4.4: Chlorine vehicle movements

Vehicle	Inventory	Scenario – transport LOC	Current case (loaded vehicles per year)			Comments	Gemini - post liquefaction (loaded vehicles per year)						Comments
							Normal			Contingent			
			to BIP	from BIP	Total		to BIP	from BIP	Total	to BIP	from BIP	Total	
Chlorine (Cl_2) bulk tanker	13 tonnes	LOC of complete tanker contents	0	0	**4**	There are no routine trips to/from Botany by bulk Cl2 tanker. Conditions of consent allow parking 1 full tanker 50% of time but this is very rarely on site - allow for a few trips in QRA – 4 times per year	0	156	156	0	187	**187**	Normal: Bulk tankers servicing NSW clients up to 3 per week in total Contingent: Would also need to take on Laverton filling, Botany would need to cover Melbourne Water (31 per year) in the contingent case
Cl_2 flatbed truck	70 kg cylinder 920 kg drum	LOC of complete drum contents	104	380	**484**	2 flatbeds per week from Laverton to Botany, each carrying up to 26 drums and 48 cylinders (4 crates of 12) From BIP - Approximately 380 truck movements from Botany for container deliveries to NSW customers, consisting of approximately 280 metro deliveries and 100 regional deliveries.	104	380	484	0	520	**520**	Normal: No drum /cylinder filling all delivered from Laverton Contingent: Botany would continue servicing NSW customers (380 trucks) Would also need to take on Laverton filling = additional 105 to 140 trucks per year + (2-3 per week)

5. CONSEQUENCE ANALYSIS

5.1. Overview

Consequence analysis was undertaken for the release scenarios summarised in Section 4.2 using Gexcon RISKCURVES (v13.0.1).

The inputs and basis for each release are summarised in Section 4.2.

5.2. Input assumptions

The key model input assumptions are summarised in Table 5.1. For scenarios involving pools, it was assumed that the pool diameter would be constrained by the road gutters, i.e. equivalent to the road diameter which was estimated to be approximately 15 m.

Table 5.1: Consequence modelling input assumptions

Scenario ID	Material	Inventory (m^3)	Temperature (ºC)	Leak size (mm)	Consequence modelled
Class 2.1 flammable liquefied gases					
1.1	Propane	25	25	50	Jet fire, flash fire (with Vapour cloud explosion [VCE])
1.2				50	Jet fire, flash fire (with VCE)
1.3				Rupture	Flash fire (with VCE)
1.4				BLEVE	BLEVE
Class 2.3 toxic gases					
2.1	Chlorine	9.2	25	13	Toxic cloud
2.2				Rupture	Toxic cloud
3.2	Chlorine	0.65	25	Rupture	Toxic cloud
3.3				6	Toxic cloud
Class 3 flammable liquids					
4.1	Gasoline	25	25	50	Pool fire, flash fire (with VCE)

5.3. Results

Consequence results for the distance to 1% fatality for all release scenarios in the model have been included in APPENDIX D.

The largest potential effect distance is from a rupture of a Cl_2 road tanker.

6. FREQUENCY ANALYSIS

6.1. Ignition probability

For consistency, ignition probabilities for this study were based on the values used in the previous Scott Lister report, Ref [1]. For immediate ignition, a probability of 30% was used and for delayed ignition a value of 20% was used.

6.2. LOC base frequencies

The base LOC frequencies used in the assessment of DG transport risk are from IOGP *Report No. 434-9: Land transport accident statistics* (Ref [8]) and are summarised in Table 6.1.

Table 6.1: Summary of DG transport LOC base frequencies

DG class	Load	Scenario	LOC per km	Comments
Class 2.1 (i.e. LPG)	Tanker	Rupture	2.60×10^{-9}	All classes adopt IOGP (Ref [8])
		Leak liquid 50mm	1.80×10^{-8}	
		Leak vapour 50mm	2.10×10^{-9}	
		BLEVE	2.70×10^{-12}	
Class 3	Tanker	Rupture	2.10×10^{-8}	
Class 2.3 (i.e. chlorine)	Tanker	Rupture	2.60×10^{-9}	
		Leak liquid 13mm	1.80×10^{-8}	
	Drum	Rupture	2.60×10^{-9}	
		Leak liquid 6mm	1.80×10^{-8}	

6.3. DG transport release frequencies

The base LOC frequencies were apportioned to the intersections as per accident location data as described in Section 4.5 with the remaining 10% of accidents allocated along the overall length of Denison St as shown in APPENDIX B. These were then adjusted to account for the annual number of DG loaded vehicles.

The frequencies for LOC used in the risk model for the identified scenarios and accident locations are summarised in APPENDIX D.

7. RISK ANALYSIS AND EVALUATION

7.1. Transport risk assessment case definition

Risk analysis was performed using Gexcon RISKCURVES (v13.0.1), which combines the consequences and frequencies of the identified release scenarios. Assessment of the risk results against relevant risk criteria was then conducted to determine the impact that the additional DG transport movements due to the operation of the CLP will have on the existing risk profile.

A range of transport risk assessment cases were developed to allow for comparison against the HIPAP 4 risk criteria, these cases are summarised in Table 7.1.

7.2. Results

IFR results were reported as contours which are overlaid on a map of Denison St. and the surrounding area.

Table 7.2 provides a comparison of the IFR assessed for all transport risk assessment cases against the individual fatality risk criteria specified by Table 3.1, as well as a discussion on the effect that the increase in volume of Cl_2 DG transport will have on the current cumulative transport risk along Denison St.

The conclusions from the evaluation of IFR for all specified transport risk assessment cases were as follows:

- A new TRA model using equivalent assumptions where possible to the 2016 Scott Lister study was developed. The main changes to input assumptions are the reduction in Class 2.1 (LPG) tankers and apportioning incident frequency using the crash locational data for Denison St.
- Figure 7.2 compares the new TRA cumulative DG transport risk model including the modified facility CLP contingent operation case against the 2016 Scott Lister model. The new TRA contour is significantly smaller than the 2016 Scotter Lister contours in all areas except the Wentworth Rd intersection (where it is still smaller).

As per Figure 7.1, both the CAP current case and the CLP contingent case for chlorine (Class 2.3 DG) transport traffic volume only comply with all relevant HIPAP 4 risk criteria.

Table 7.1: CLP TRA case definitions

Case ID	Case definition	Class 2.1	Class 2.3 (Cl_2)		Class 3	Objective
			Current	Future		
1	Current chlorine transport (CAP)	×	✓	×	×	Assess current risk due to the transport of liquefied chlorine only to and from the CAP.
2	Future chlorine transport (CLP contingent case)	×	×	✓	×	Assess any additional risk generated due to the increased volume of liquefied chlorine transport to and from the CAP as a result of the operation of the CLP.
3	Cumulative QRA risk model – reduced Class 2.1 tanker numbers, current chlorine transport (CAP) **(New cumulative baseline)**	✓ **(reduced)**	✓	×	✓	Assess the current cumulative DG transport risk (allowing for closure of Indorama and Qenos).
4	Cumulative QRA risk model – reduced Class 2.1 tanker numbers and future chlorine transport (CLP contingent case)	✓ **(reduced)**	×	✓	✓	Assess the contribution the increase in chlorine transport will make to the current cumulative DG transport risk profile (allowing for closure of Indorama and Qenos).

Table 7.2: Comparison of transport risk assessment cases against HIPAP 4 risk criteria

Case ID	Case definition	Met criteria? (Yes/No)[(a)]				Comments
		10 x 10^{-6} per year	**5 x 10^{-6} per year**	**1 x 10^{-6} per year**	**0.5 x 10^{-6} per year**	
1	Current chlorine transport only	Yes	Yes	Yes	Yes	• From Figure 7.1 the current risk due to the transport of chlorine to and from the CAP along Denison St. meets all relevant HIPAP 4 risk criteria, as the 0.5 x 10^{-6} and 1 x 10^{-6} per year IFR contours do not reach sensitive (i.e. Matraville Public School) or residential land uses, respectively.
2	Future chlorine transport only (CLP contingent case)	Yes	Yes	Yes	Yes	• From Figure 7.1 the increase in chlorine transport due to the operation of the CLP will increase the risk at some intersections along Denison St however; the risk still meets all relevant HIPAP 4 risk criteria, as the 0.5 x 10^{-6} and 1 x 10^{-6} per year IFR contours do not reach sensitive (i.e. Matraville Public School) or residential land uses, respectively.
3	Cumulative QRA risk model – reduced Class 2.1 tanker numbers, current chlorine transport (CAP) **(New cumulative risk baseline)**	Yes	Yes	No	Yes	• From Figure 7.2, it can be seen that the cumulative risk meets the HIPAP 4 risk criteria for sensitive land uses as the cumulative 0.5 x 10^{-6} per year IFR contour does not reach any sensitive land uses (i.e. Matraville Public School). • The cumulative 1 x 10^{-6} per year IFR contour reaches the residential zones along the north of Denison St (near Wentworth Ave.).
4	Cumulative QRA risk model – reduced Class 2.1 tanker numbers and future chlorine transport (CLP contingent case)	Yes	Yes	No	Yes	• From Figure 7.2, it can be seen that the cumulative risk including increased chlorine transport from the operation of the CLP is very similar to the cumulative risk accounting for current case chlorine transport. • The overall assessment against HIPAP 4 criteria remains consistent with the results presented in the 2016 Scott Lister study (see Figure 7.3), i.e. 1 x 10^{-6} per year IFR contour reaches the residential zones. However, the commercial 5 x 10^{-6} per year contour at Wentworth Ave intersection in the new TRA does not reach Eastgardens which it did in Scott Lister study.

Note:
(a) The HIPAP 4 criteria for industrial sites (50 x 10^{-6} per year) was met as the IFR generated was not high enough to produce these contours.

Figure 7.1: IFR risk results current chlorine transport only (left) and future chlorine transport only (right)



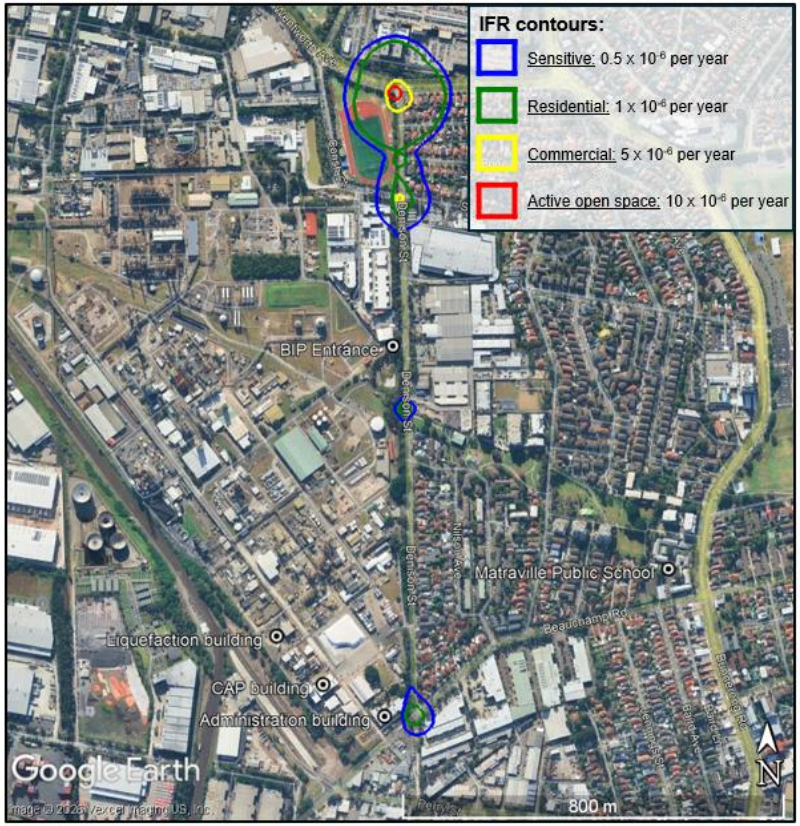
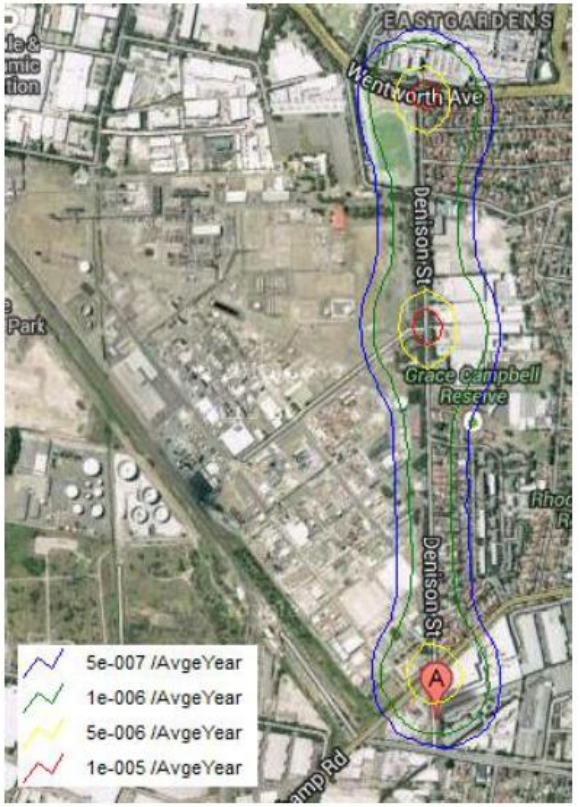
Comparison: this shows that there is a small increase in risk associated with the increased future chlorine traffic movements along Denison St., however this meets all relevant individual fatality risk criteria. 1 x10^{-6} per year contour remains on verge and does not extend past residential lot boundary.

Figure 7.2: Cumulative IFR including current chlorine transport (left) and future chlorine transport (right)



Comparison: this shows the minimal increase in cumulative risk resulting from the inclusion of increased chlorine transport compared to the current risk. This is because the risk is dominated by Class 2.1 tankers not chlorine transport.

Figure 7.3: Cumulative IFR including future chlorine transport contingent case compared with Scott Lister 2016

Cumulative Risk CLP contingent case (TRA Rev 2 Feb 2026)	Cumulative risk results from Scott Lister TRA 2016
	

Comparison: this shows the new TRA cumulative risk model has a smaller risk footprint than the Scott Lister 2016 study even when accounting for increased chlorine transport due to CLP. The smaller risk footprint is due to reduced Class 2.1 LPG tanker numbers.

7.3. Conclusion

A TRA has been completed to evaluate the potential impacts from DG transport to and from the modified facility (i.e. the CAP and CLP cumulative operations) with comparison to the TRA findings from *Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility)*.

Overall, the TRA results accounting for cumulative DG transport risk along Denison St including the increased chlorine transport associated with the CLP show:

- The CLP contingent case Cl_2 only transport risk along Denison St meets HIPAP 4 IFR criteria for all land uses. Note this would be the remaining risk if the CLP project proceeds and all other DG transport on Denison St ceased.
- Cumulative risk shows:
  - Reduced cumulative IFR contours along Denison St particularly in the southern part when compared to the previously assessed cumulative risk presented in the Scott Lister TRA from Major Project approval MP 06_0089 MOD 2 (Vopak Bulk Liquids Storage Facility).
  - 1 x10^{-6} per year cumulative risk contour around Wentworth Ave intersection extends into residential land use hence does not meet HIPAP 4 criteria. Criteria are met for other land uses and at other locations along Denison St.
- Whilst there is some change in cumulative risk contours due to changes in modelling approach, the risk reduction compared to previous Scott Lister 2016 results is due primarily to the reduction in Class 2.1 tankers due to the closure of Qenos and Indorama on the BIP, and the adjustment of frequencies to reflect the relative frequency of crash data at intersections along Denison St.

Overall, it can be concluded that the cumulative DG transport risk along Denison St is not materially affected by current or post CLP Cl_2 transport, the risk remains dominated by Class 2.1 tankers as previously shown in the Scott Lister report.

APPENDIX A. APPROACH TO RISK ASSESSMENT AND COMPARISON TO SCOTT LISTER STUDY

A1. Changes made to overall TRA report

The TRA study report has been substantially restructured compared to the original submission to address agency and community submissions received during the exhibition period, including:

- Additional information provided re ADG and regulatory context for DG transport in Section 3.2.
- Extension of all risk results to the northern end of Denison St / Wentworth Ave intersection as per figures in Section 7.
- Consolidation of the discussion of how the Scott Lister DG Transport studies referred to in the SEARS have been used, and explicitly stating which assumptions are different and why in the new TRA model, into this new appendix, APPENDIX A.
- The body of the report now only includes results for 3 cases from the new TRA model: a) current Cl_2 only transport, b) the new model contingent case (i.e. CAP plus CLP) Cl_2 only transport, c) cumulative case that accounts for both reduced Class 2.1 tankers due to Qenos / Indorama closure, the Vopak Site B expansion and the contingent case (i.e. CAP plus CLP) Cl_2 transport. All sensitivities and comparison to Scott Lister study are now in APPENDIX A
- The main technical change is that after discussion with DPHI 28 Jan 2026, and also noting the absence of any traffic accidents at BIP Gate 3 intersection and DPHI's request to extend results to Wentworth Ave intersection, the approach taken to the accident frequency data in the TRA risk model has been changed. The statistical DG transport total LOC incident rate data (which was from a source OGP 434-09 Land Transport Accident statistics as per the Scott Lister study) has now been apportioned to the accident locations along Denison St as per the locational crash data 2020 – 2024 provided in APPENDIX B. This shows that 90% of the accidents are at intersections. This approach (together with some other minor adjustments to respond to comments in submissions) shows that the risk is a lot lower along most of Denison St than the previous approach of evenly spreading the accident rate data down Denison St as the majority of accidents in the crash data (>60% of the total) are around Wentworth Ave / Denison St intersection at northern end. Cl_2 road tankers do not go through this intersection as they head south only from Gate 3 along Denison St.

A2. Scott Lister assumption review

Table A1.1 summarises the assumption review and notes what was retained and what was modified. Changes with largest effect are highlighted in grey.

Table A1.1 Assumptions adopted in TRA and comparison to Scott Lister TRA

Item	Scott Lister TRA 2016	Status	CLP TRA Approach 2026	Comments
Number of loaded Cl_2 vehicles per year	Number of Class 2.3 trucks per year was included as part of total pressurised liquefied gas transport	Modified	Current case: 4 tankers per year, 484 loaded drum trucks per year Future case: 187 tankers per year, 520 loaded drum trucks per year	As Class 2.3 transport numbers which include Cl_2 could not be separated from the total including 2.1s or otherwise obtained from the SL TRA it was assumed that the current CAP transport numbers were applicable for drums and tankers for the current case cumulative risk
Number of loaded 2.1 vehicles per year	4421 per year	Modified	1500 per year	Reduced to remove Class 2.1 associated with BIP Qenos and Indorama shutdown. Class 2.1 still occurs from Elgas Port Botany
Number of loaded Class 3 vehicles per year	7712 per year	Retained	7712 per year	Vopak Site B expansion
Cl_2 inventory during transport	1 tonne (Table Ref [4])	Modified	Drum 920 kg Tanker 13 tonnes	Cl_2 tankers do not appear to be accounted for in Scott Lister study
Cl2 transport route	Along the whole length of Denison St for all DG classes	Modified	Cl_2 drum trucks turn left at Gate 3 and go north on Denison St Cl_2 road tankers turn right at Gate 3 and go south on Denison	For CLP TRA route has been split for Cl_2 transport as advised by IXOM and is consistent with ADG existing transport route risk assessments. Other materials over the whole length of Denison St

Item	Scott Lister TRA 2016	Status	CLP TRA Approach 2026	Comments
LOC frequency during transport - Class 2.1	Class 2.1 (LPG) - OGP data (Ref [8])	Retained	Class 2.1 (LPG) - OGP data (Ref [8])	IOGP data for LPG Failure case: Frequency per km BLEVE: 2.70×10^{-12} Cold rupture (instant release): 2.60×10^{-9} Large liquid space leak 50 mm: 1.80×10^{-8} Large vapour space leak 50 mm: 2.10×10^{-9} Total LOC rate[(a)]: 2.27×10^{-8} Notes: (a) Total LOC rate calculated as the sum of all release types excluding BLEVE (flammable effects) as this is not credible for liquefied chlorine.
LOC frequency during transport - Cl_2	Chlorine - OGP data (Ref [8]),	Modified	OGP data (Ref [8]), assumed to apply to both drums and tankers Excluded BLEVE (flammable effects) as this is not credible for chlorine which is not flammable	Unclear if BLEVE was used for chlorine in Scott Lister report (very low frequency so minimal impact) Failure case: Frequency per km BLEVE: 2.70×10^{-12} Cold rupture (instant release): 2.60×10^{-9} Large liquid space leak 50 mm: 1.80×10^{-8} Large vapour space leak 50 mm: 2.10×10^{-9} Total LOC rate[(a)]: 2.27×10^{-8} Notes: (a) Total LOC rate calculated as the sum of all release types excluding BLEVE (flammable effects) as this is not credible for liquefied chlorine. OGP data has been compared against data collected by the United States of America's (US) Department of Transportation (DOT) Federal Motor Carrier Safety Administration (FMCSA) Ref [11]. The OGP frequency for LPG tanker LOC is broadly similar to the US DoT LOC frequency for Class 2.3 tankers therefore the OGP frequency was retained for Class 2.3 chlorine transport Source: OGP Report 434-09 LPG bulk tankers; Frequency per km: 2.27×10^{-8}; Reference: Ref [8] Report conducted for FMCSA by Abkowtiz et al., Class 2.3 bulk tankers.; Frequency per km: 2.47×10^{-8}; Reference: Ref [11]

Item	Scott Lister TRA 2016	Status	CLP TRA Approach 2026	Comments
LOC frequency during transport - Class 3	Class 3 – all scenarios IOGP data (Ref [8])	Modified	Include > 1500 kg only - OGP data (Ref [8])	Results show the that small spills (< 1500kg) had no influence on risk results. These were excluded from TRA model Spill size: Frequency per km 5 – 5 kg: 6.00 x 10-9 15 – 150 kg: 2.60 x 10-8 150 – 1,500 kg: 7.00 x 10-9 > 1,500 kg: 2.10 x 10-8 **Total: 6.00 x 10-8**
LOC frequency during transport apportioned to route	66% evenly apportioned over main intersections (Beauchamp Rd, Wentworth Ave, Gate 3) Remaining release frequency was spread evenly along Denison St (Section 2.2.2 Ref [4])	Modified	Apportioned as per locational crash rate data for Denison St	The Scott Lister studies apportioned 60% of LOC frequency to some intersections along Denison St and some to the overall road length. This approach excluded the intersections at the Bunnings hardware and at Smith St and the rationale for the inclusion of some intersections only was not clear. Initial Sherpa TRA (March 2025) LOC frequencies were distributed evenly along the relevant route. Updated to reflect the locational crash rate data for Denison St as per APPENDIX B.
Ignition probability	Immediate ignition probability of 30% Delayed ignition probability 20% (Appendix A Ref [4])	Retained	Immediate ignition probability of 30% Delayed ignition probability 20%)	No change
Meteorological data	Sydney Airport BOM data 1999-2004 (Appendix A Ref [4])	Modified	Sydney Airport BOM data 2014-2024	Updated TRA wind rose, average temperature etc to match CLP QRA. (Relatively minor effect as same location for data, minor differences only)

Item	Scott Lister TRA 2016	Status	CLP TRA Approach 2026	Comments
Software	DNV SAFETI v6.7	Modified	GEXCON Riskcurves v13.0.1	Most recent software version used. Note that there have been numerous refinements to dispersion modelling in both DNV and GEXCON software since 2016, generally resulting in smaller effect distances for dispersion for otherwise equivalent scenarios compared to previous software versions
Risk criteria	Individual fatality risk HIPAP4 Societal risk HIPAP4	Modified	Individual fatality risk HIPAP4	As agreed with DPHI there are no agreed criteria for societal risk for transport applications. Therefore the present study does not include an assessment of societal risk. Qualitatively it can be inferred from the reduction in cumulative individual fatality risk due to reduction in Class 2.1 tankers (see Figure 7.3) compared to previous results, the overall societal risk will also be lower than previously presented as there are less populations affected by the risk contours even when the CLP contingent case is accounted for.

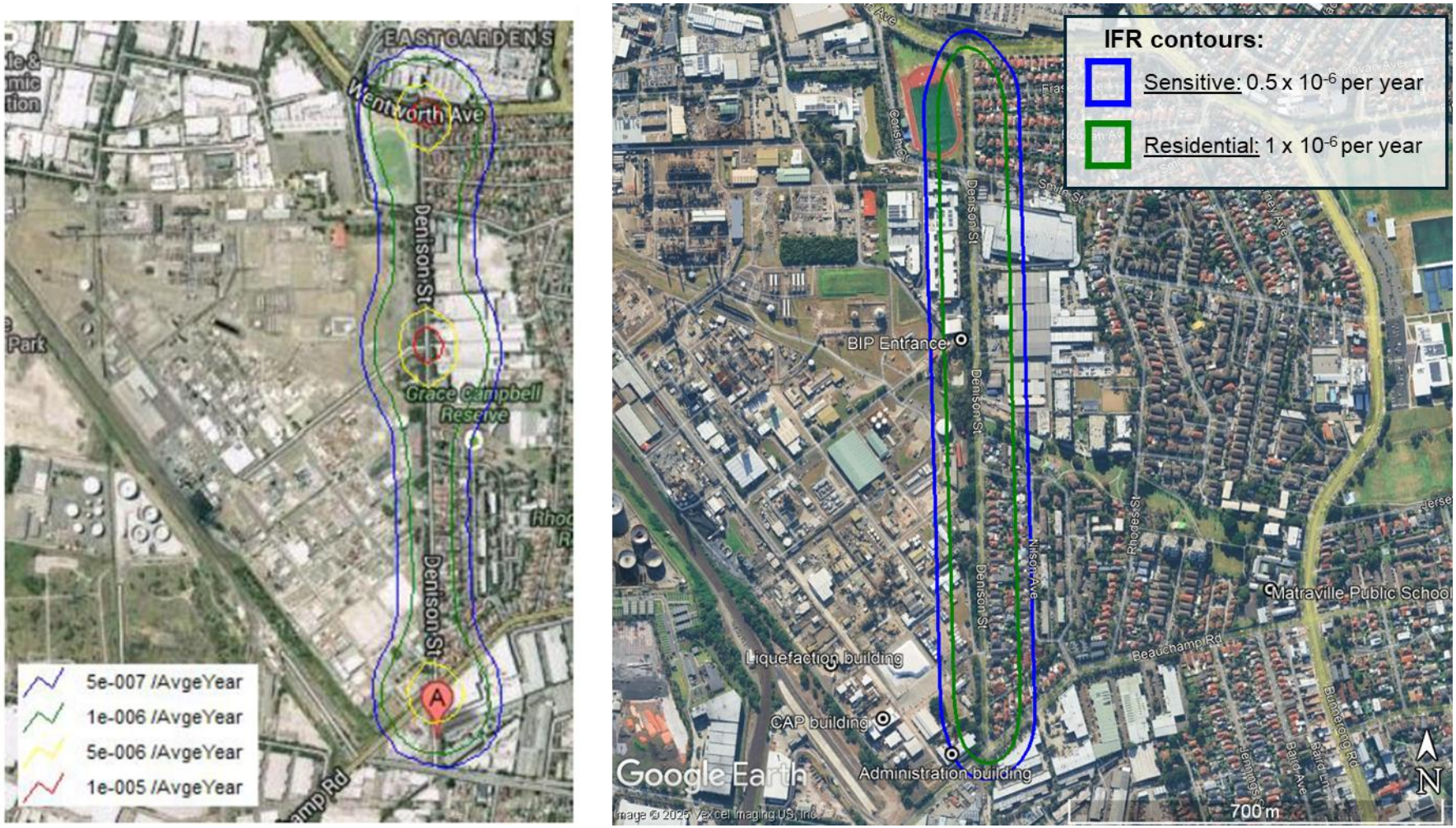
A3. Comparative results and sensitivity studies

As a cross check an initial 'equivalent QRA' model was set up in Riskcurves using assumptions similar to the Scott Lister 2016 TRA, i.e. LPG tanker numbers 4421, previous met data. Frequencies were spread evenly along the route and intersections not accounted for. A comparison is shown in Figure A1.1.

The results are broadly comparable as follows which indicates that the change of software is not dominating, the effect on TRA results is due to the updated assumptions.

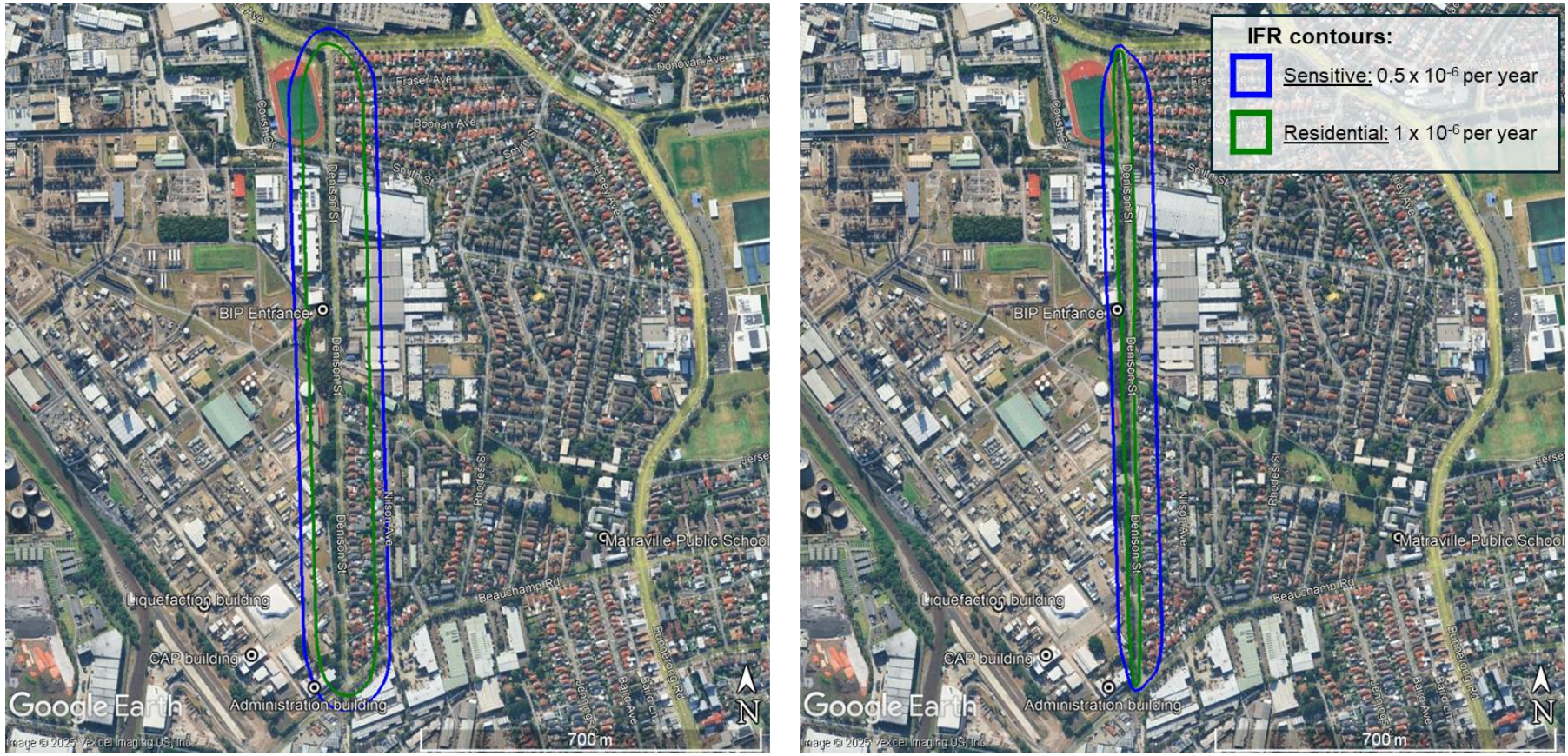
- In both cases the (non-intersection) 1 x 10^{-6} per year IFR contour extends approximately 60 – 70 m from Denison St.
- The 'equivalent QRA' model does not generate a 5 or 10x10^{-6} per year contour.
- The effect of reducing LPG tanker numbers is shown in Figure A1.2.

Figure A.1: IFR risk results for the 2016 Scott Lister study, Ref [1], (left) and 'equivalent QRA' risk model with similar parameters



Comparison: this shows that the new TRA risk model is similar to the 2016 Scott Lister model. Note that the map scale is not the same however in both cases the (non-intersection) 1 x 10^{-6} per year IFR contour extends approximately 60 – 70 m from Denison St.

Figure A.2: IFR for case 3 & 5 – Equivalent QRA risk model (left) and equivalent QRA risk model (reduced 2.1 tanker numbers) (right)



Comparison: this shows the effect of reducing Class 2.1 tankers which is the dominant DG transport risk contributor. The 1 x 10^{-6} per year contour still extends into residential areas in the southern part of Denison St.

APPENDIX B. DENISON ST ACCIDENT SUMMARY

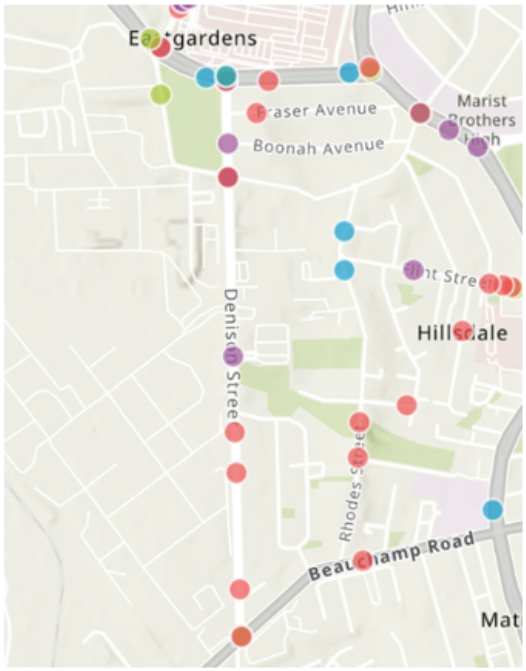
Table B.1: Summary of accidents on Denison St. over the period from 2020 – 2024, Ref [9]

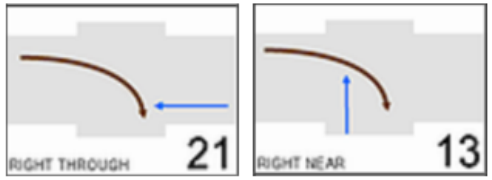
General Comments

LGA view - crashes map | Transport for NSW

Heavy vehicle crash profile | Transport for NSW

Crashes Map - Bayside





Denison and Boonah
2023 Left Rear

Denison and Smith
2023 Right Through
2023 Right Through
2024 Rear End

Denison and Res Driveway
2024 Emerging from Drive

Denison St
2021 Head on

Denison and Ind Driveway
2021 Left turn side swipe

Denison St
2023 Off Road Right

Denison and Beauchamp Rd
2022 – Other Manoeuvring
2024 – Right Near

Dennison and Wentworth

2020 Right Near
2020 Right Through
2023 Left Near
2023 Right Through
2023 Right Through
2023 Right Near
2023 Right Near
2023 Right Through
2024 Right Through

2020Right Near
2020 Right Through
2022 Lane change Right
2023 Left Near
2023 Right Through
2023 Right through
2023 Ped nearside
2023 Right near
2023 Right through
2024 Right Though
2024 Right Though

Traffic Incident on Denison St Assessment

Intersections v Straight Road

30 Traffic incidents from 2020 to 2024
- 28 Occurred at intersections
  - 20 at Wentworth intersection *
- 2 occurred on strait sections of road.
- 0 occurred at Gate 3 of the BIP

Truck Incidents

2 Incidents involved Heavy Vehicles (Trucks)
- Denison and Smith St – Minor
- Denison and Wentworth - Minor

* Denison and Wentworth has significantly more points of conflict than other intersections aligning with the analysis in Austroads 2019.

Table B.2: Probability of accident per location along Denison St

Denison St intersection street	No. of crashes (2020-2024)	Percentage of total crashes across Denison St.	North/South of Gate 3?	Comments
Beauchamp Rd	2	6.7%	South	Traffic lights
Industrial driveway	1	3.3%	South	
Gate 3 BIP	0	0.0%	-	No crashes at Gate 3. NOTE: no traffic lights here. Currently and for future CLP case Cl2 drum trucks turn left as per route risk assessment to avoid right turn during busy period with no lights. Cl2 tankers (~3 per week) turn right as these are usually not during busy traffic periods
Bunnings intersection	0	0.0%	North	No crashes at Bunnings traffic lights
Boonah Ave.	1	3.3%	North	
Smith St.	3	10.0%	North	Traffic lights
Wentworth Ave.	20	66.7%	North	Traffic lights
Denison St - non intersection / straight road	3	10.0%	n/a	Includes Denison St and residential driveways
Total	30	100.0%		

Table B.3: DG transport LOC frequency apportioned per accident location along Denison St

Scenarios	Base frequency (per vehicle)		Adjusted frequency (for percentage of crashes at location) (per vehicle)							Adjust by vehicle movements (no. /year)		
	(/km.year)	(/year)	(/year)					(/km.year)	(/year)	Current	Future	Reduced
			Beauchamp Rd	Ind. driveway	Boonah Ave.	Smith St.	Wentworth Ave.	Straight				
1.1 - LPG 50mm Vapour	2.1E-09	2.7E-09	1.8E-10	9.1E-11	9.1E-11	2.7E-10	1.8E-09	2.1E-10	2.7E-10	~~4521~~	-	1500
1.2 - LPG 50mm Liquid	1.8E-08	2.3E-08	1.6E-09	7.8E-10	7.8E-10	2.3E-09	1.6E-08	1.8E-09	2.3E-09	~~4521~~	-	1500
1.3 - LPG Catastrophic Rupture	2.6E-09	3.4E-09	2.2E-10	1.1E-10	1.1E-10	3.4E-10	2.2E-09	2.6E-10	3.4E-10	~~4521~~	-	1500
1.4 - LPG Tanker BLEVE	2.7E-12	3.5E-12	2.3E-13	1.2E-13	1.2E-13	3.5E-13	2.3E-12	2.7E-13	3.5E-13	~~4521~~	-	1500
2.1 - Chlorine Road tanker- Mechanical Leak (13 mm)	1.8E-08	1.4E-08	9.3E-10	4.6E-10	-	-	-	1.8E-09	1.4E-09	4	187	-
2.2 - Chlorine Road tanker - Rupture	2.6E-09	2.0E-09	1.3E-10	6.7E-11	-	-	-	2.6E-10	2.0E-10	4	187	-
3.1 - Release from Filled Drums - Rupture	2.6E-09	1.4E-09	-	-	4.5E-11	1.4E-10	9.0E-10	2.6E-10	1.4E-10	484	520	-
3.2 - Release from Filled Drums - 6mm valve	2.0E-08	1.0E-08	-	-	3.5E-10	1.0E-09	7.0E-09	2.0E-09	1.0E-09	484	520	-
4.1 - Class 3 Rupture	2.1E-08	2.7E-08	1.8E-09	9.1E-10	9.1E-10	2.7E-09	1.8E-08	2.1E-09	2.7E-09	7712	-	-

Route	Route Length	Units	Comments
Beauchamp -> Wentworth (Total)	1.30	km	Used to adjust base frequency for scenarios 1.1-1.4, 3.2 & 4.1
Gate 3 -> Wentworth (North)	0.52	km	Used to adjust base frequency for scenarios 3.1 & 3.2
Gate 3 -> Beauchamp (South)	0.77	km	Used to adjust base frequency for scenarios 2.1 & 2.2

APPENDIX C. METEOROLOGICAL CONDITIONS

C1. Data source

For consistency the meteorological data used for the TRA is the same as that used for the QRA submitted for the CLP planning application.

Historical meteorological weather data was obtained from the BOM. The acquired data sets were based on readings from the AMO at Sydney Airport (BOM No. 066037) over the period of June 2014 to June 2024. The station is located approximately 2 km away.

The following data was sourced from the BOM for AMO No. 066037:

- wind speed
- wind direction
- temperature
- humidity
- ceilometer cloud data
- solar elevation angle data.

C2. Pasquill stability class

The actual Pasquill stability classes were determined using the Gifford, Ref [12], definition of the conditions for different stability classes as summarised below. The ceilometer cloud and solar elevation data were used to accurately classify the data into stability classes defined by Gifford.

Table C.1: Stability class allocation

Surface wind speed, m/s	Daytime insolation			Nighttime conditions		Anytime
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	≥ 3/8 cloudiness	Heavy overcast
< 2	A	A-B	B	F	F	D
2-3	A-B	B	C	E	F	D
3-4	B	B-C	C	D	E	D
4-6	C	C-D	D	D	D	D
> 6	C	C	D	D	D	D

C3. Representative stability class and wind speed

The TNO Purple Book, Ref [13], approach uses a correlation between the actual Pasquill stability class and wind speed to determine the representative Pasquill stability classes, as presented in Table C.2.

Suitable analysis of the obtained raw data from the BOM was performed using the approach detailed in the TNO Purple Book, and the data were consolidated into six different representative weather conditions, as per table above, which are:

- Pasquill stability class: B (medium); wind speed 2.8 m/s (B2.8)
- Pasquill stability class: D (low); wind speed 4.5 m/s (D1.7)
- Pasquill stability class: D (medium); wind speed 4.3 m/s (D4.3)
- Pasquill stability class: D (high); wind speed 8.4 m/s (D8.4)
- Pasquill stability class: E (medium); wind speed 3.1 m/s (E3.1)
- Pasquill stability class: F (low); wind speed 1.4 m/s (F1.4).

Table C.2: Allocation of observations into six representative weather classes

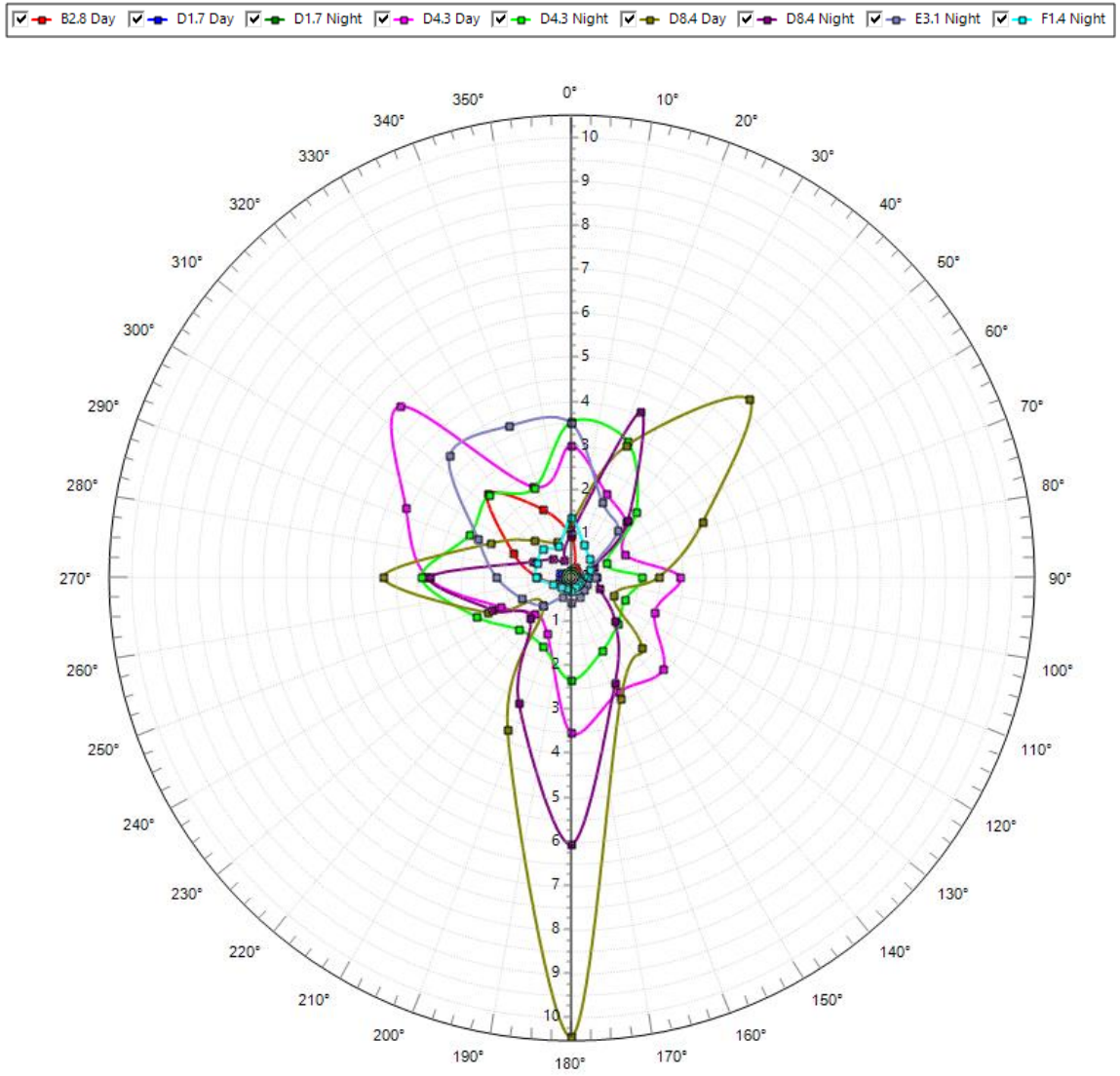
Surface wind speed, m/s	Actual Pasquill stability class							
	A	**B**	**B/C**	**C**	**C/D**	**D**	**E**	**F**
< 2.5	B Medium			D Low			F Low	
2.5-6				D Medium			E Medium	
> 6				D High				

The meteorological data sets used for the QRA are presented in Table C.3. Additionally, the wind rose map is also provided in Figure C.1.

Table C.3: Meteorological data set used for QRA and TRA

Direction wind from	Probability of occurrence of windspeed ranges (m/s), within stabilities classes in the day and at night												Total day	Total night
	B2.8	B2.8	D1.7	D1.7	D4.3	D4.3	D8.4	D8.4	E3.1	E3.1	F1.4	F1.4		
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night		
N	0.94	0.00	0.15	0.16	3.00	3.54	1.22	1.00	0.00	3.50	0.00	1.35	5.30	9.54
NNE	0.26	0.00	0.07	0.12	2.07	3.33	3.24	4.08	0.00	1.85	0.00	0.79	5.64	10.18
NE	0.16	0.00	0.06	0.11	1.78	2.07	5.72	1.80	0.00	1.48	0.00	0.60	7.72	6.06
ENE	0.11	0.00	0.08	0.08	1.32	0.87	3.24	0.56	0.00	0.49	0.00	0.44	4.75	2.43
E	0.14	0.00	0.12	0.09	2.48	1.61	1.98	0.58	0.00	0.54	0.00	0.35	4.72	3.16
ESE	0.08	0.00	0.09	0.07	2.06	1.32	1.06	0.70	0.00	0.40	0.00	0.25	3.29	2.74
SE	0.07	0.00	0.07	0.05	2.95	1.52	2.29	1.40	0.00	0.39	0.00	0.21	5.38	3.58
SSE	0.11	0.00	0.10	0.08	2.82	1.81	2.98	2.62	0.00	0.50	0.00	0.26	6.01	5.26
S	0.18	0.00	0.12	0.10	3.54	2.35	10.45	6.09	0.00	0.58	0.00	0.33	14.28	9.45
SSW	0.16	0.00	0.11	0.08	1.40	1.71	3.77	3.09	0.00	0.48	0.00	0.28	5.43	5.65
SW	0.19	0.00	0.12	0.08	1.19	1.68	0.90	1.34	0.00	0.89	0.00	0.33	2.40	4.31
WSW	0.33	0.00	0.18	0.09	1.75	2.33	2.07	1.94	0.00	1.23	0.00	0.45	4.34	6.04
W	0.78	0.00	0.25	0.16	3.28	3.42	4.29	3.23	0.00	1.71	0.00	0.79	8.60	9.32
WNW	1.41	0.00	0.29	0.15	4.08	2.49	1.98	0.95	0.00	2.31	0.00	0.83	7.76	6.73
NW	2.68	0.00	0.14	0.13	5.50	2.66	1.18	0.61	0.00	3.92	0.00	0.91	9.50	8.22
NNW	1.68	0.00	0.10	0.12	2.24	2.19	0.86	0.42	0.00	3.72	0.00	0.78	4.88	7.23
Total	**9.27**	**0.00**	**2.06**	**1.68**	**41.45**	**34.89**	**47.22**	**30.41**	**0.00**	**23.99**	**0.00**	**8.96**	**100.00**	**100.00**

Figure C.1: Wind rose distribution



APPENDIX D. CONSEQUENCE AND FREQUENCY ANALYSIS

D1. Riskcurves scenario summary

Table D.1 summarises the maximum distances to 1% fatality for each as well as the frequencies for each scenario included in the TRA. .

Table D.1: Maximum distance to 1% fatality for modelling scenarios

Scenarios	Frequency	Max. distance to 1% fatality dose
	[/year]	[m]
1.1. Wentworth Ave.		
1.1 - 50mm Vapour	2.72E-06	41
1.2 - 50mm Liquid	2.34E-05	171
1.3 - Catastrophic Rupture	3.38E-06	223
1.4 LPG Tanker BLEVE	3.50E-09	163
3.1 Release from Filled Drums - Rupture	4.38E-07	476
3.1 Release from Filled Drums - Rupture – F	4.70E-07	446
3.2 Release from Filled Drums - 6mm valve	3.38E-06	536
3.2 Release from Filled Drums - 6mm valve – F	3.63E-06	536
4.1 - Rupture	1.40E-04	21
1.2. Boonah Ave.		
1.1 - 50mm Vapour	1.36E-07	41
1.2 - 50mm Liquid	1.17E-06	171
1.3 - Catastrophic Rupture	1.68E-07	223
1.4 LPG Tanker BLEVE	1.76E-10	163
3.1 Release from Filled Drums - Rupture	2.19E-08	476
3.1 Release from Filled Drums - Rupture - F	2.35E-08	446
3.2 Release from Filled Drums - 6mm valve	1.69E-07	536
3.2 Release from Filled Drums - 6mm valve - F	1.81E-07	536
4.1 - Rupture	6.99E-06	21
1.3. Smith St.		
1.1 - 50mm Vapour	4.08E-07	41
1.2 - 50mm Liquid	3.50E-06	171
1.3 - Catastrophic Rupture	5.05E-07	223
1.4 LPG Tanker BLEVE	5.25E-10	163
3.1 Release from Filled Drums - Rupture	6.58E-08	476
3.1 Release from Filled Drums - Rupture - F	7.07E-08	446

Scenarios	Frequency	Max. distance to 1% fatality dose
	[/year]	[m]
3.2 Release from Filled Drums - 6mm valve	5.08E-07	536
3.2 Release from Filled Drums - 6mm valve - F	5.46E-07	536
4.1 - Rupture	2.10E-05	21
2.1. Ind. Driveway		
1.1 - 50mm Vapour	1.36E-07	41
1.2 - 50mm Liquid	1.17E-06	171
1.3 - Catastrophic Rupture	1.68E-07	223
1.4 LPG Tanker BLEVE	1.76E-10	163
2.1 Chlorine Storage Tanker - Mechanical Leak (13 mm)	1.86E-09	1296
2.1 Chlorine Storage Tanker - Mechanical Leak (13 mm) - F	8.70E-08	1296
2.2 Chlorine Storage Tanker - Rupture	2.69E-10	1914
2.2 Chlorine Storage Tanker - Rupture - F	1.26E-08	1914
4.1 – Rupture	6.99E-06	21
2.2. Beauchamp Rd.		
1.1 - 50mm Vapour	2.72E-07	41
1.2 - 50mm Liquid	2.34E-06	171
1.3 - Catastrophic Rupture	3.38E-07	223
1.4 LPG Tanker BLEVE	3.50E-10	163
2.1 Chlorine Storage Tanker - Mechanical Leak (13 mm)	3.72E-09	1296
2.1 Chlorine Storage Tanker - Mechanical Leak (13 mm) - F	1.74E-07	1296
2.2 Chlorine Storage Tanker - Rupture	5.36E-10	1914
2.2 Chlorine Storage Tanker - Rupture - F	2.51E-08	1914
4.1 – Rupture	1.40E-05	21
Class 2.1 Traffic Vopak Expansion Case (reduced) [1.30 km]		
1.1 - 50mm Vapour	3.15E-07	41
1.2 - 50mm Liquid	2.70E-06	171
1.3 - Catastrophic Rupture	3.90E-07	223
1.4 - T1.1 LPG Tanker BLEVE	4.05E-10	163
Class 3 Traffic Vopak Expansion Case [1.30 km]		
4.1 – Rupture	1.62E-05	21
CURRENT Denison St North [0.52 km]		

Scenarios	Frequency	Max. distance to 1% fatality dose
	[/year]	[m]
3.1 Release from Filled Drums - Rupture	1.26E-07	476
3.2 Release from Filled Drums - 6mm valve	9.73E-07	536
CURRENT Denison St South [0.77 km]		
2.1 Chlorine Storage Tanker - Mechanical Leak (13 mm)	7.20E-09	1296
2.2 Chlorine Storage Tanker - Rupture	1.04E-09	1914
FUTURE Denison St North [0.52 km]		
3.1 Release from Filled Drums - Rupture	1.35E-07	446
3.2 Release from Filled Drums - 6mm valve	1.05E-06	536
FUTURE Denison St South [0.77 km]		
2.1 Chlorine Storage Tanker - Mechanical Leak (13 mm)	3.37E-07	1296
2.2 Chlorine Storage Tanker - Rupture	4.86E-08	1914
Notes: '-F' is future case including CLP for locations specific scenarios		

D2. Comparison to QRA

Note that the consequence impact distance in the TRA to the maximum extent of the 1% fatality toxic dose under any meteorological conditions as reported in Table D.1 is similar to the scenarios with equivalent hole size and release conditions for Cl_2 drum and road tanker release scenarios modelled in the QRA. However results are not identical due to minor changes in dispersion modelling from Riskcurves V12.4 (QRA) to v13 (TRA) and some differences in maximum pool spreading areas and surface type for the TRA compared to the parameters within the CLP containment building used in the QRA.

A comparison of the main inputs that are different between the TRA and QRA (Ref [3]) and the resulting effect on the maximum distance to the 1% fatality dose used in the risk model is provided for the following scenarios in Table D.2:

- 2.1 Chlorine Storage Tanker - Mechanical Leak (13 mm)
- 3.2 Release from Filled Drums - 6mm valve

It can be seen that the difference in effect distance is minor and this conclusion is applicable to all chlorine scenarios relevant to both the QRA and TRA.

Table D.2: Example scenario comparison between TRA and QRA consequences

	Main reason for difference in dispersion results					
	Very minor effect					
	Result comparison as used in QRA model					
Modelset: Chlorine Tanker - 13 mm Leak	**TRA - 13mm tanker leak**	**QRA - parked tanker 13mm lea**	**Modelset: Release from Filled Drums**	**TRA - 6mm valve leak**	**QRA - 6mm valve leak**	
Model: Liquefied Gas LOC Scenario Continuous Leak			**Model: Liquefied Gas LOC Scenario Continuous Leak**			
Inputs	**F1.4 Night**	**F1.4 Night**	**Inputs**	**F1.4 Night**	**F1.4 Night**	**Comments**
Process Conditions			**Process Conditions**			
Chemical name	CHLORINE (DIPPR)	CHLORINE (DIPPR)	**Chemical name**	CHLORINE (DIPPR)	CHLORINE (DIPPR)	
Initial temperature in vessel (°C)	25	19	**Initial temperature in vessel (°C)**	25	19	TRA temp is higher than average ambient - assumed to have warmed up a bit - consistent with Scott Lister approach
Pressure inside vessel determination	Use vapour pressure	Use vapour pressure	**Pressure inside vessel determination**	Use vapour pressure	Use vapour pressure	
Process Dimensions			**Process Dimensions**			
Vessel volume (m3)	9.2	10	**Vessel volume (m3)**	0.65	0.65	
Filling degree (%)	100	90	**Filling degree (%)**	100	100	
Hole diameter (mm)	13	13	**Hole diameter (mm)**	6	6	
Hole rounding	Sharp edges	Sharp edges	**Hole rounding**	Sharp edges	Sharp edges	
Max. pool surface area (m2)	314	490	**Max. pool surface area (m2)**	314	490	TRA limited to road width (~20m) , QRA building fillling area footprint
Environment			**Environment**			
Solar radiation flux	User defined	User defined	**Solar radiation flux**	User defined	User defined	
Type of subsoil (evaporation)	Average subsoil	Isolation concrete	**Type of subsoil (evaporation)**	Average subsoil	Light concrete	Assumed lower heat capacity concrete in builiding in QRA (affects initial evap rate only) where tankers are parked. TRA assumed soil
Results	**F1.4 Night**	**F1.4 Night**	**Results**	**F1.4 Night**	**F1.4 Night**	
Process Conditions			**Process Conditions**			
Jet source: Initial (vapour) pressure in vessel (bar)	7.8056	6.6073	**Jet source: Initial (vapour) pressure in vessel (bar)**	7.8056	6.6073	Results in lower leak flowrate due to lower temp and lower associated vap pressure
Source Definition			**Source Definition**			
Jet source: Initial mass in vessel (kg)	12811	12729	**Jet source: Initial mass in vessel (kg)**	905.12	916.88	Minor effect on inventory - model input is fixed volume hence inventory for pressurised liquefied gas varies with temperature conditions in model
Jet source: Hole diameter used (mm)	13	13	**Jet source: Hole diameter used (mm)**	6	6	
Jet source: Representative release rate (kg/s)	3.5776	3.2791	**Jet source: Representative release rate (kg/s)**	0.74809	0.68542	Results in lower leak flowrate due to lower temp and lower associated vap pressure
Density after mixing with air (kg/m3)	15.624	17.477	**Density after mixing with air (kg/m3)**	15.897	17.786	Denser as colder in QRA
Lethality contours distance [m]	**F1.4 Night**	**F1.4 Night**	**Lethality contours distance [m]**	**F1.4 Night**	**F1.4 Night**	
1 % lethality dose (Toxic Cloud)	**1295**	**1240**	1 % lethality dose (Toxic Cloud)	**536**	**518**	
Main program	RISKCURVES 13.0.1.	RISKCURVES 12.5.1.25009	Main program	RISKCURVES 13.0.1.4	RISKCURVES 12.5.1.25009	

APPENDIX E. REFERENCES

[1] Systra, Scott Lister, “Vopak Port Botany Expansion - Denison St Transport QRA - July 2016 Update. Rev 4,” 2016.

[2] NSW Department of Planning, “Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning,” 2011.

[3] Sherpa Consulting Pty Ltd, “Quantitative Risk Assessment Report: Proposed Chlorine Liquefaction Plant - Modification to Chloralkali Facility,” 21838-RP-002, Rev 5, March 2026.

[4] Scott Lister, “Dangerous Goods transport QRA, Denison St, Hillsdale Rev 3,” 2015.

[5] Scott Lister, “Addendum to Dangerous Goods transport QRA, Denison St, Hillsdale,” 2015.

[6] Imperial Chemical Industries (ICI) PLC (UK), “ICI Engineering Department, Process Safety Guide 14 - Reliability Data,” 1992.

[7] Ixom Operations Pty Ltd (formerly Orica), “Drum failure frequency data for chlorine risk assessment, Rev C”.

[8] International Association of Oil & Gas Producers, “Report No. 434-9: Land transport accident statistics,” OGP, 2010.

[9] TfNSW, “NSW Road Crash Data - 2020-2024,” 2024. [Online]. Available: https://opendata.transport.nsw.gov.au/data/dataset/nsw-crash-data.

[10] Sherpa Consulting Pty Ltd, “Vopak Terminals Australia: Site B proposed throughput increase - Dangerous Goods road transport risk assessment,” 2016.

[11] M. Abkowitz, J. Delorenzo, R. Duych and A. Greenberg, “Comparative risk assessment of hazmat and non-hazmat truck shipments,” *Transportation Research Record,* pp. 1-15, 2000.

[12] Gifford, Turbulent Diffusion-Typing Schemes: A Review, Nucl Saf, Vol.17, No. 1, Jan/Feb, 1961, pp.68-86, 1961.

[13] TNO, Purple Book: Guidelines for quantitative risk assessment, 1st ed., 2005.

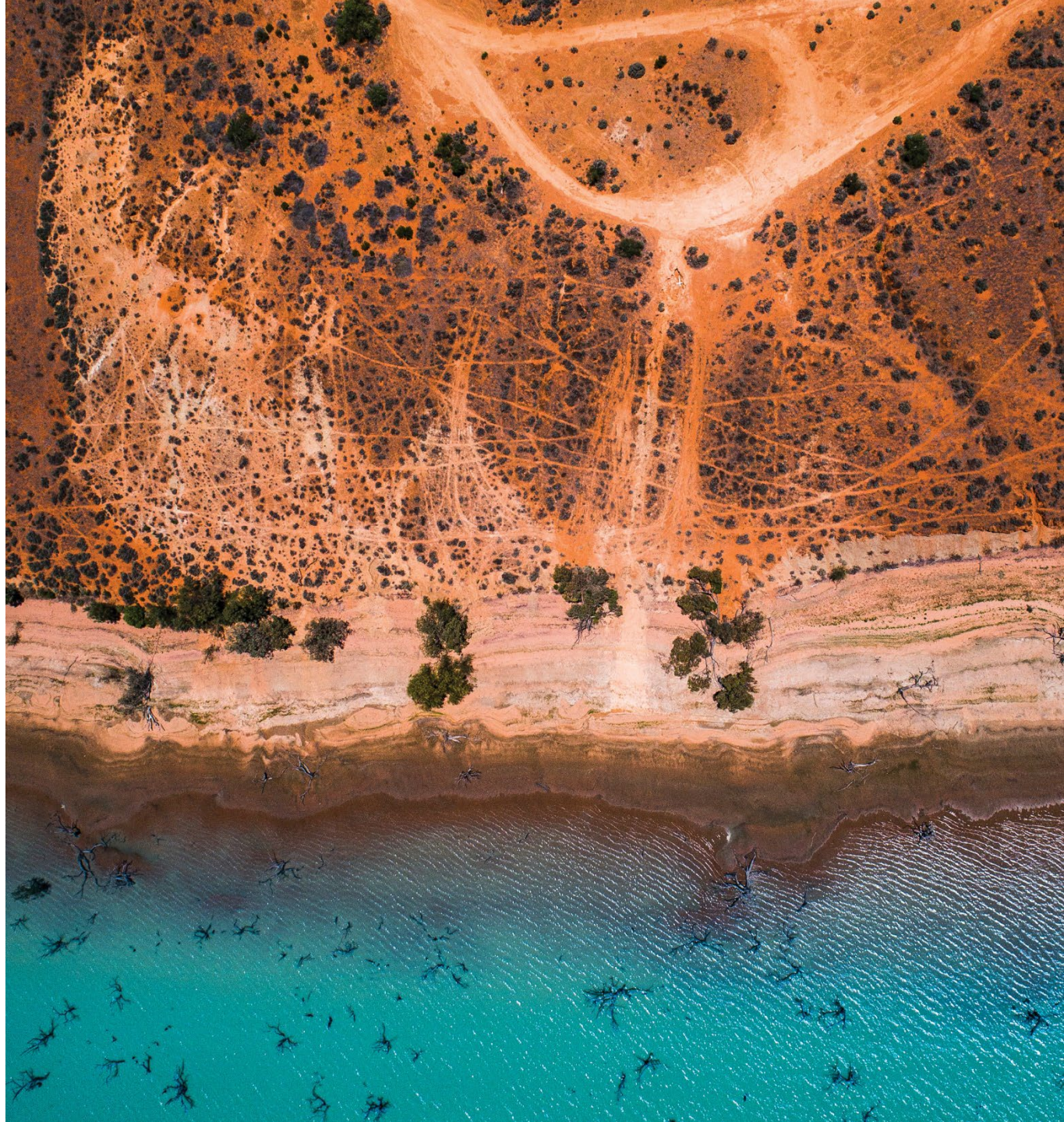


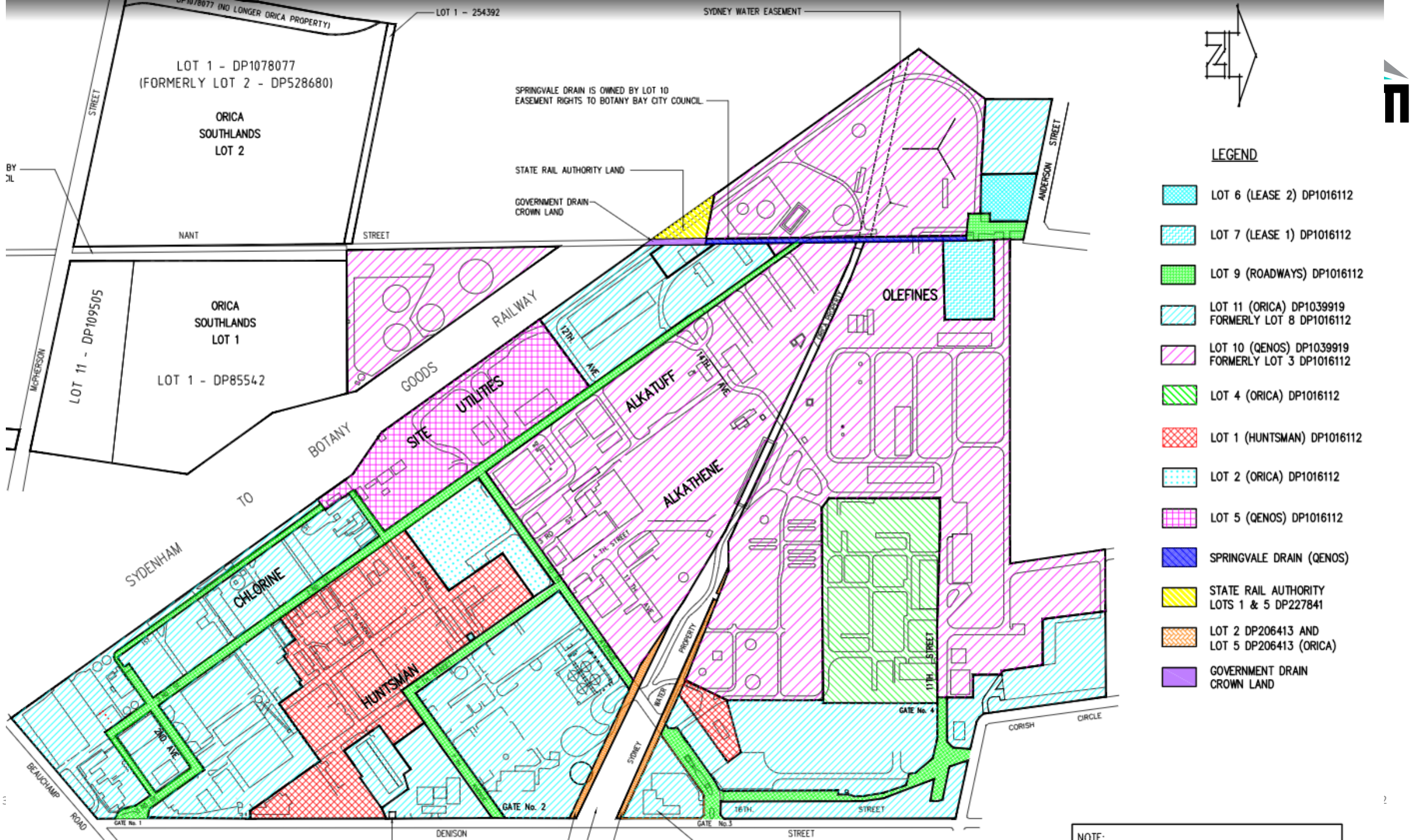
APPENDIX D

ALTERNATIVE BIP ROUTE AND GATE ANALYSIS

Alternate BIP Route and gate analysis.

Chlorine Liquification Plant




LOT 1 - 254392
SYDNEY WATER EASEMENT
LOT 1 - DP1078077
(FORMERLY LOT 2 - DP528680)
ORICA
SOUTHLANDS
LOT 2
SPRINGVALE DRAIN IS OWNED BY LOT 10
EASEMENT RIGHTS TO BOTANY BAY CITY COUNCIL
STATE RAIL AUTHORITY LAND
GOVERNMENT DRAIN
CROWN LAND
ANDERSON STREET
NANT STREET
LOT 11 - DP109505
ORICA
SOUTHLANDS
LOT 1
LOT 1 - DP85542
McPHERSON
RAILWAY
GOODS
BOTANY
TO
SYDENHAM
OLEFINES
ALKATUFF
ALKATHENE
SITE UTILITIES
CHLORINE
HUNTSMAN
12TH AVE
14TH AVE
2ND AVE
11TH STREET
16TH STREET
GATE No. 1
GATE No. 2
GATE No. 3
GATE No. 4
BEAUCHAMP ROAD
DENISON STREET
CORISH CIRCLE
SYDNEY WATER PROPERTY
LEGEND
LOT 6 (LEASE 2) DP1016112
LOT 7 (LEASE 1) DP1016112
LOT 9 (ROADWAYS) DP1016112
LOT 11 (ORICA) DP1039919
FORMERLY LOT 8 DP1016112
LOT 10 (QENOS) DP1039919
FORMERLY LOT 3 DP1016112
LOT 4 (ORICA) DP1016112
LOT 1 (HUNTSMAN) DP1016112
LOT 2 (ORICA) DP1016112
LOT 5 (QENOS) DP1016112
SPRINGVALE DRAIN (QENOS)
STATE RAIL AUTHORITY
LOTS 1 & 5 DP227841
LOT 2 DP206413 AND
LOT 5 DP206413 (ORICA)
GOVERNMENT DRAIN
CROWN LAND

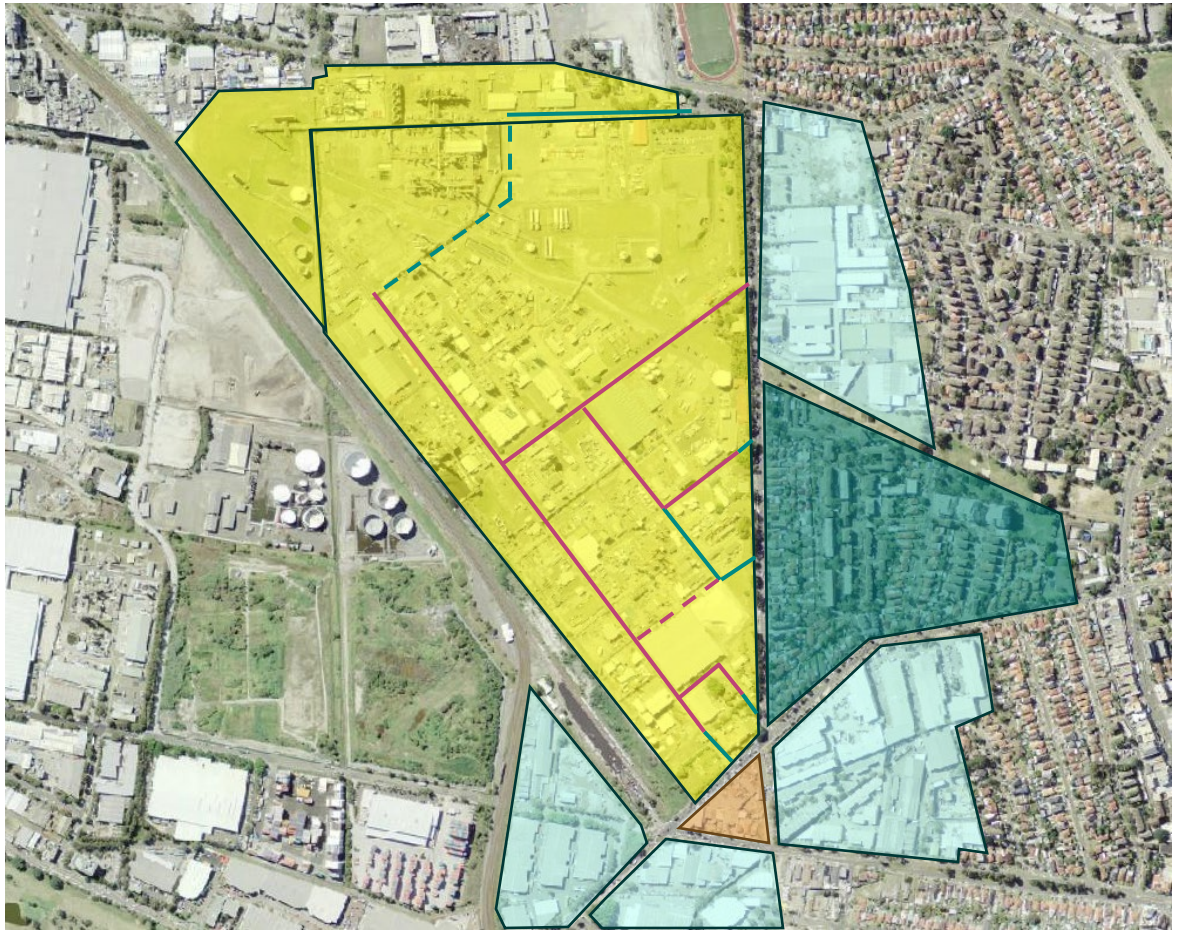
BIP Roads and surrounding area

BIP Access Roads

IXOM Lease road
Single lane only

Owned by others

Owned by others
Not load rated



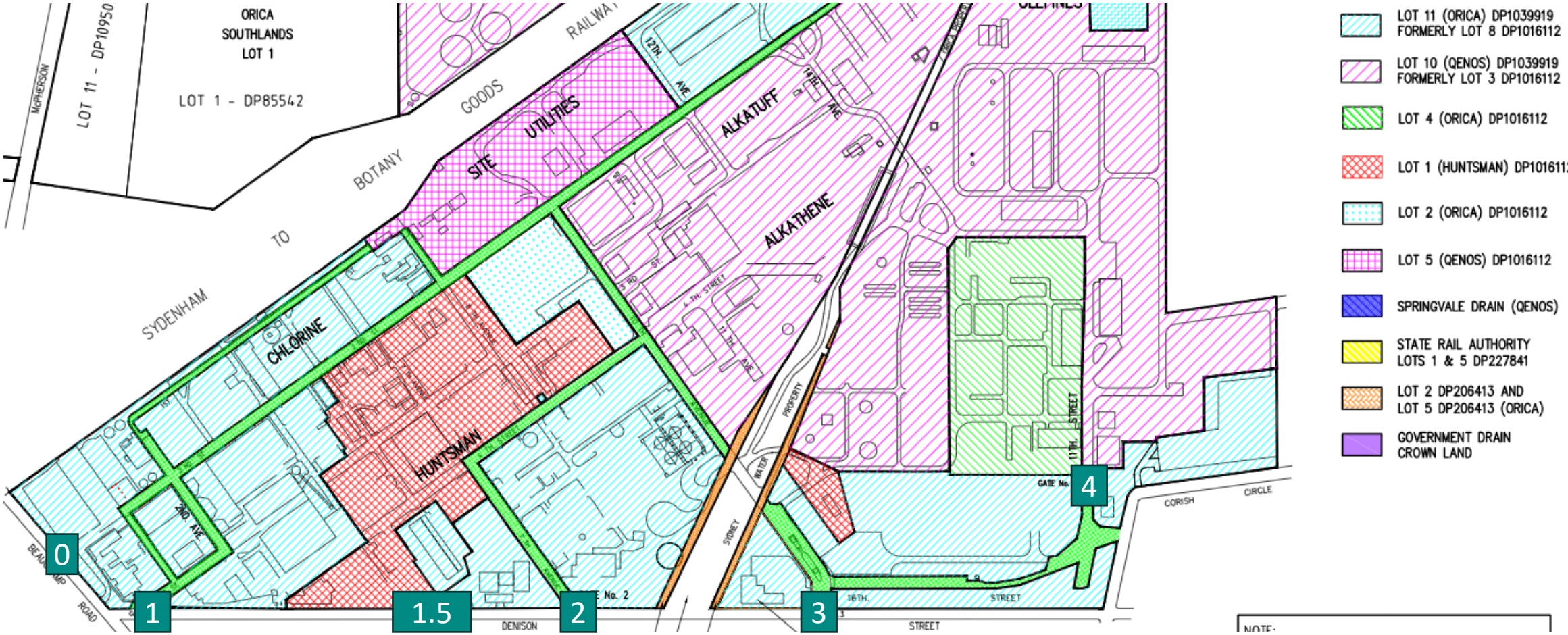
BIP

Industrial / Commercial

Residential

Mixed
Commercial / Residential

BIP Gate Locations



General Comments

(Ref. Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings) Austroads 2019

1.2 Safety Objectives

In terms of crash likelihood and severity, intersection safety performance, is predominantly influenced by approach speed, impact angle and opportunity for conflict (Austroads 2015c; Candappa et al. 2015). The influence that impact angles and travel speed have on transferable kinetic energy (and therefore the impact forces experienced during a collision) is illustrated in Figure 1.2 (Next Slide)

1.3 Traffic Management Objectives

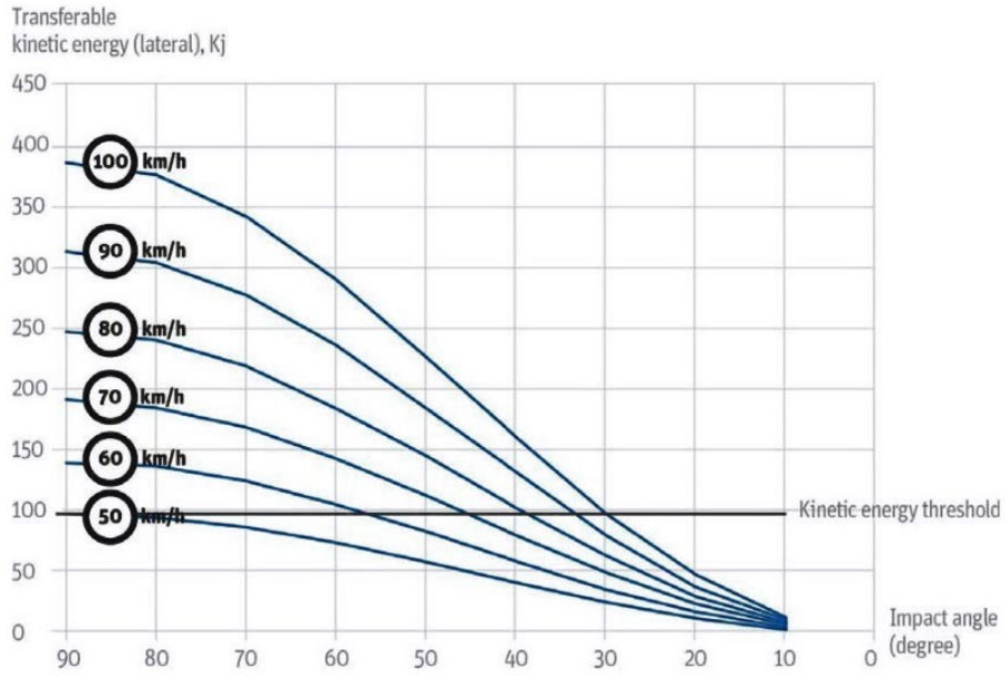
The objectives of traffic management are discussed in Part 1 of the Guide to Traffic Management. ‘An overall aim of traffic management is to facilitate the operation of traffic on the roads with safety and efficiency, taking into account’ needs of all relevant road users (Austroads 2019a). This aim is particularly relevant to intersections and crossings because:

- a large proportion of road crashes occur at intersections
- the capacity of road systems is often determined by the capacity of its intersections
- conflict between different types of road or rail users often occurs at intersections/crossing

General Comments

(Ref. Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings) Austroads 2019

Figure 1.2 Influence of impact angle and travel speed on transferable kinetic energy



Source: ITF (2016), based on Candappa et al. (2015).

Severity of potential incidents

Vehicle incidents at 50 km/hour regardless of the impact angle do not reach the Kinetic Energy level for severe injury

Likelihood of potential incidents.

Vehicle incidents at 50 km/hour regardless of the impact angle do not reach the Kinetic Energy level for severe injury.

Safe intersection performance is based on the following principles:

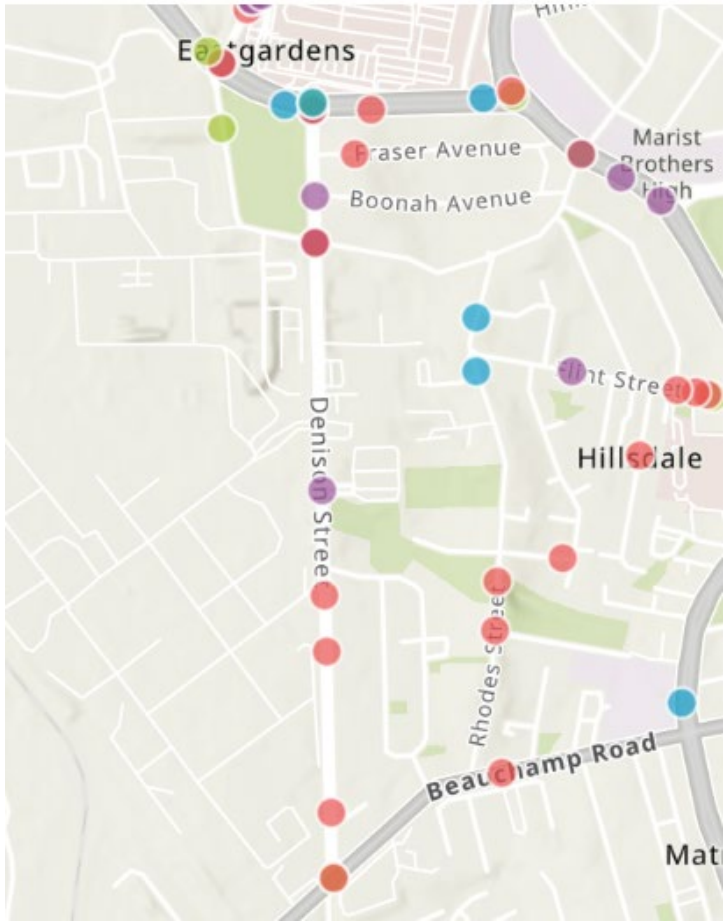
- ensuring adequate visibility
- minimising potential for conflict
- managing priority movements
- managing speeds
- clear and easy to understand design and layout

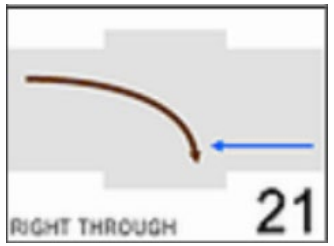
General Comments

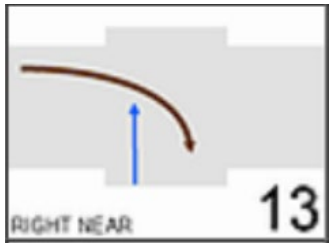
[LGA view - crashes map | Transport for NSW]

[Heavy vehicle crash profile | Transport for NSW]

Crashes Map - Bayside







Denison and Boonah
2023 Left Rear

Denison and Smith
2023 Right Through
2023 Right Through
2024 Rear End

Denison and Res Driveway
2024 Emerging from Drive

Denison St
2021 Head on

Denison and Ind Driveway
2021 Left turn side swipe

Denison St
2023 Off Road Right

Denison and Beauchamp Rd
2022 – Other Manoeuvring
2024 – Right Near

Dennison and Wentworth

2020 Right Near
2020 Right Through
2023 Left Near
2023 Right Through
2023 Right Through
2023 Right Near
2023 Right Near
2023 Right Through
2024 Right Through

2020Right Near
2020 Right Through
2022 Lane change Right
2023 Left Near
2023 Right Through
2023 Right through
2023 Ped nearside
2023 Right near
2023 Right through
2024 Right Though
2024 Right Though

Traffic Incident on Denison St Assessment

Intersections v Strait Road

30 Traffic incidents from 2020 to 2024
- 28 Occurred at intersections
  - 20 at Wentworth intersection *
- 2 occurred on strait sections of road.
- 0 occurred at Gate 3 of the BIP

Truck Incidents

2 Incidents involved Heavy Vehicles (Trucks)
- Denison and Smith St – Minor
- Denison and Wentworth - Minor

* Denison and Wentworth has significantly more points of conflict than other intersections aligning with the analysis in Austroads 2019.

Gate 0

- Currently used for;
  - Admin office parking access
  - Access to Orica owned area leased to Empire (Film company)
  - Access to IXOM for over height vehicles (that cannot fit under the pipe bridges on site)
- BIP / Ownership
  - Internal roadway between IXOM and Beauchamp Rd traverses Orica land
    - Not included in IXOM Lease
    - Yellow leased to Empire
    - Blue Orica parking area
- Road access
  - Gate driveway is 70m from Denison st Lights and 140m from Perry St Lights
  - Road is Single lane with parking on either side of the road
  - Road is very heavily used,
  - To turn left Trucks would need to cross onto the incorrect side of the road
- What would be needed
  - Lease / purchase of Orica Land (est. $5m),
  - Compensation for loss of income on Orica lease (?) + Devalue admin sale value significantly
  - Roadworks and traffic lights (est. $5m)
  - Weigh bridge
  - Secure access gates
  - Removal or parking on Beauchamp Rd
- **Conclusion**
  - **Not Recommended due to traffic impact on Beauchamp Rd and impact to commercial operations to local businesses**
  - **Not Practicable due to cost of Land for access to roadway**



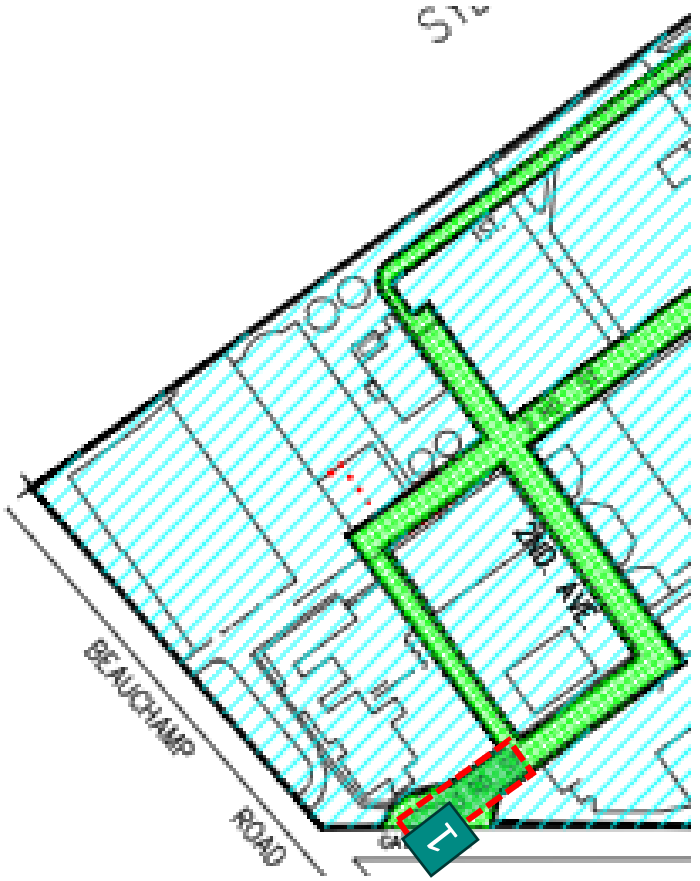
Gate 1

- Currently used for;
  - Second Emergency entry point for Emergency services

- BIP / Ownership
  - Internal roadway between IXOM and Beauchamp Rd traverses Orica land
    - Not included in IXOM Lease

- Road access
  - Gate driveway is 20m from Denison and Beauchamp st Lights
  - If Beauchamp to foreshore Road is blocked or closed there is no alternate safe route
    - Turning left onto Denison is not possible
    - Turning left onto Beauchamp Rd would block / need to cross 2 lanes.
  - Intersection is opposite residential properties
- What would be needed
  - Lease / purchase of Orica Land (est. $?m),
  - Roadworks and traffic light changes ? (est. $5m)
  - Weigh bridge
  - Maintenance of alternate route ?

- **Conclusion**
  - **Not feasible due to lack of a second Route**
  - **Increased risk due to high number of points of conflict at this intersection**



Gate 1.5

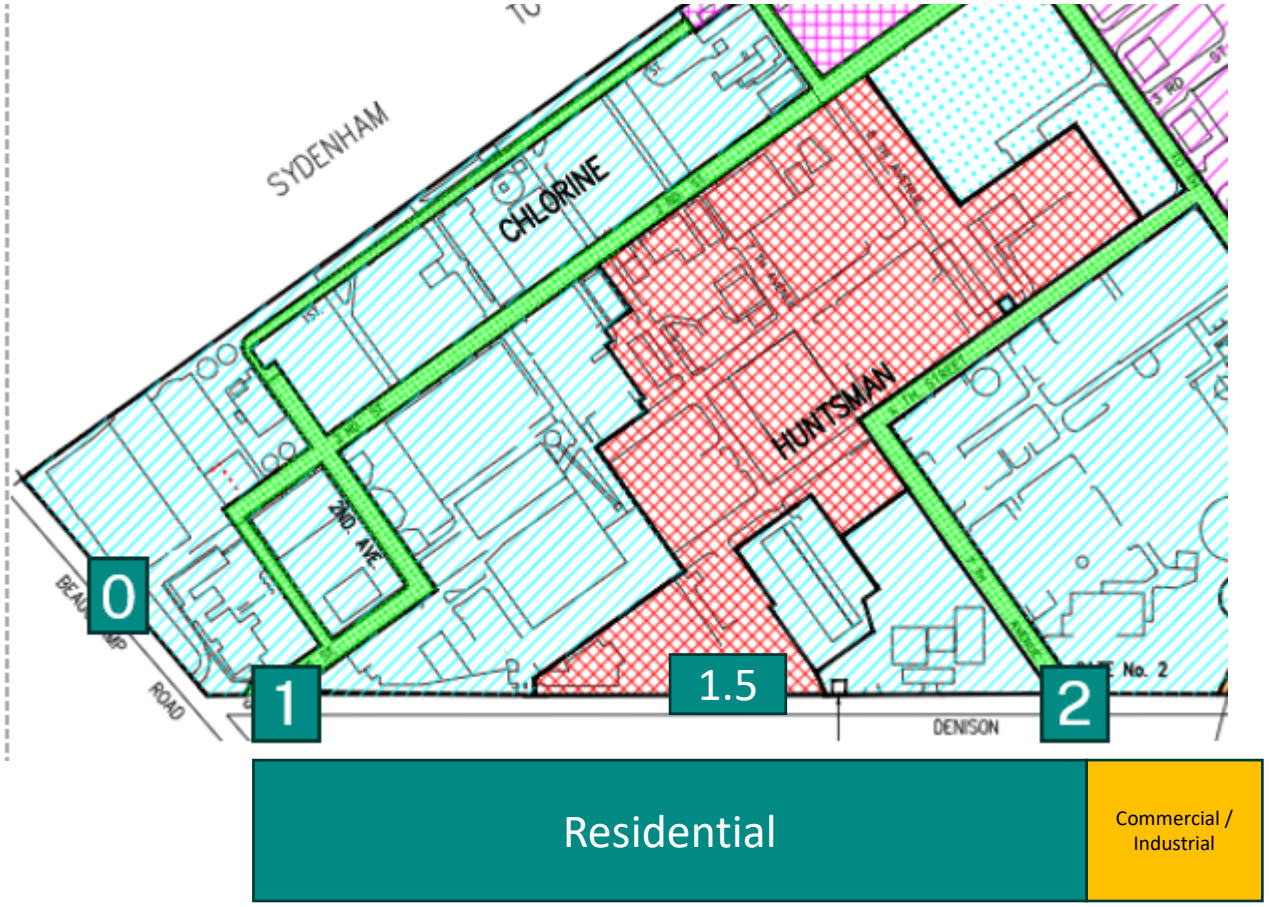
- Currently used for;
  - Indorama administration building car parking

- BIP / Ownership
  - Gate 1.5 is only accessible by crossing Orica and Indorama owned land
  - Access from Second St down to the end of the IXOM leased land is not wide enough to allow two way traffic.

- Road access
  - There is no existing heavy vehicle street access from this gate.
  - The exit driveway is opposite residential properties.

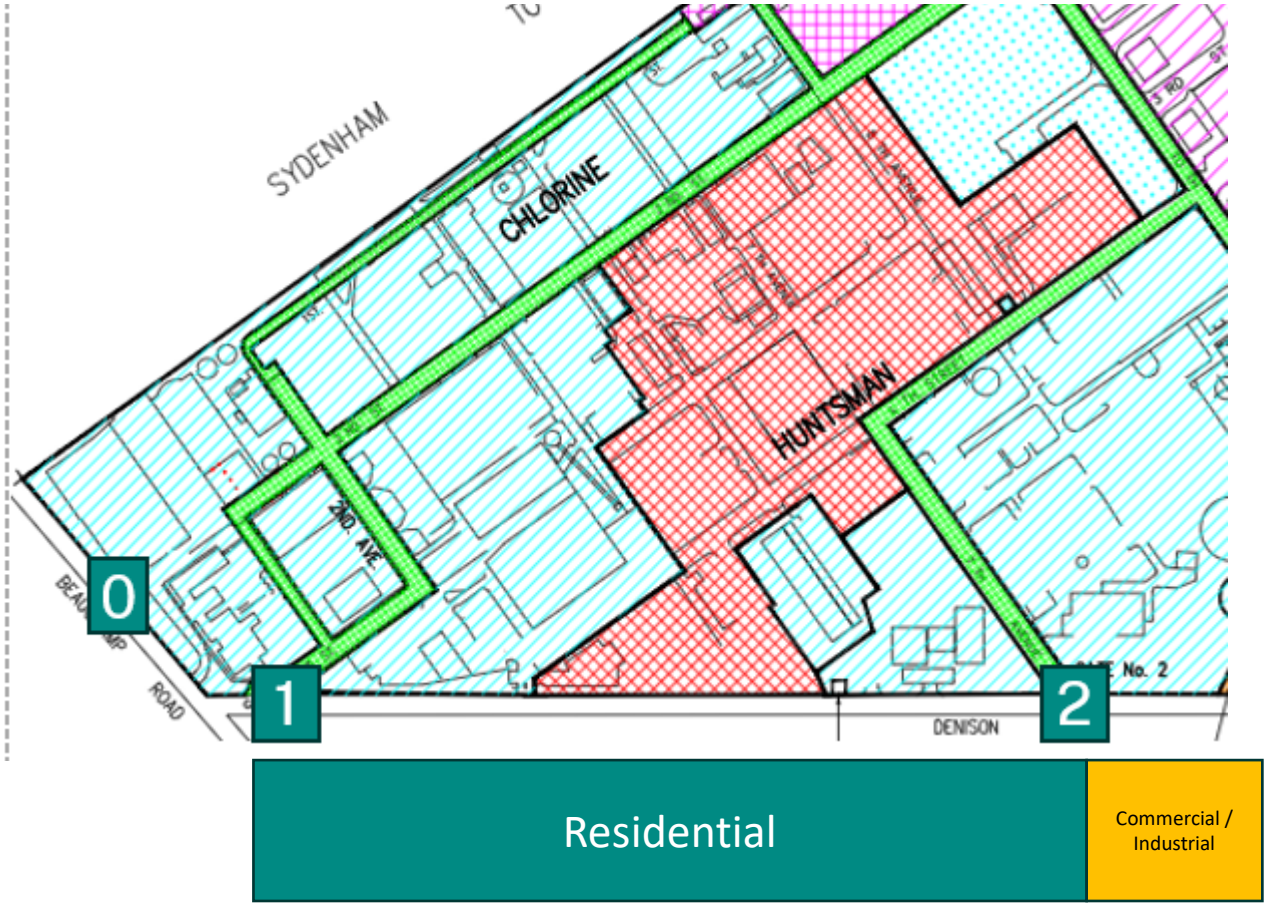
- What would be needed
  - Roadworks and traffic light changes ? (est. $5m)
  - Weigh bridge
  - Removal of parking outside residential properties near the intersection.
  - Approval as a heavy Vehicle driveway

- **Conclusion**
  - **Not recommended due to increased risk to residents by introducing and intersection in a residential section of the road**
  - **Note practicable due to cost of land between IXOM and the road**



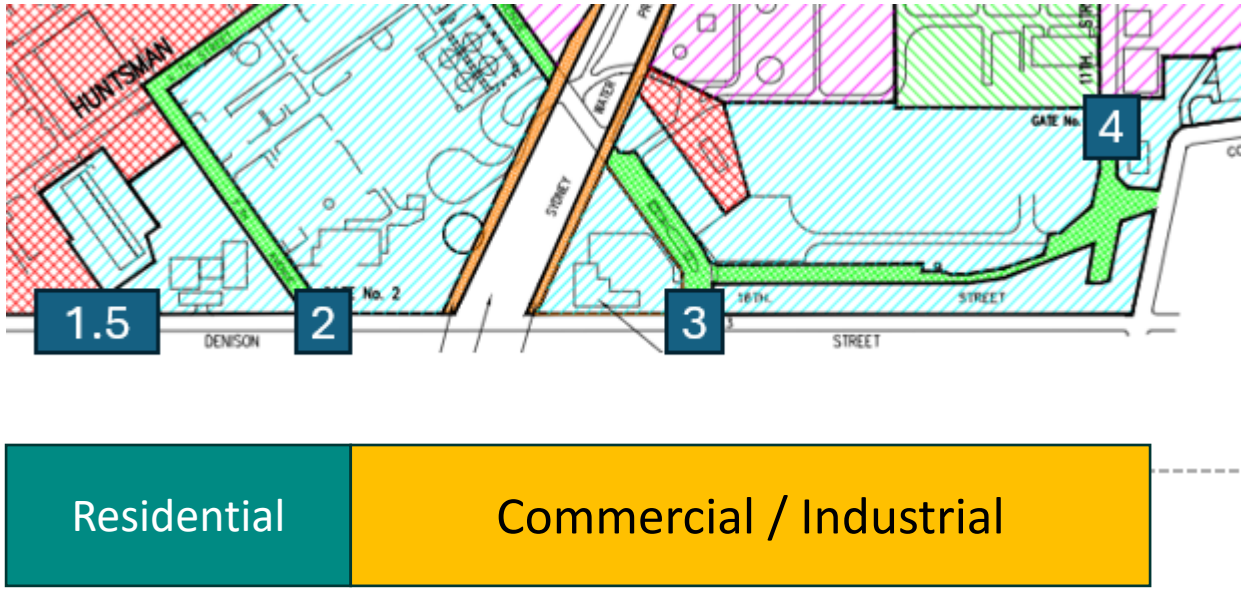
Gate 2

- Currently used for;
  - Light vehicle access
- BIP / Ownership
  - Gate 2 is accessible using existing BIP Roadways
  - Access via 3rd ave and 4th St is not practical as 3rd Ave is not wide enough for 2 way traffic
- Road access
  - Gate driveway is 240m Gate 3 Driveway
  - The area between gates 2 and 3 is industrial
  - Gate 2 puts the intersection (which is a higher risk) closer to residents.
- What would be needed
  - Roadworks to upgrade to heavy vehicle access
  - Approval from Orica to alter the driveway and street access
  - Weigh bridge
  - Removal of parking outside residential properties near the intersection.
- **Conclusion**
  - **Not recommended due to increased risk to residents by introducing and intersection in a residential section of the road**
  - **Not recommended due to additional cost of relocation of weighbridge and other works.**



Gate 3

- Currently used for;
  - Main Exit for all Trucks entering the BIP
- BIP / Ownership
  - Gate 3 is accessible using existing BIP Roadways
  - This gate has security and a weigh bridge on exit
    - In addition to the regulatory need to weigh trucks as they exit site this also reduces the entry speed of trucks approaching the intersection with Denison St.
- Road access
  - Driveway is purpose designed for heavy and large vehicle entering and exiting the site
  - The area Opposite gate 3 is Industrial / commercial
- What would be needed
  - Nil



Conclusion

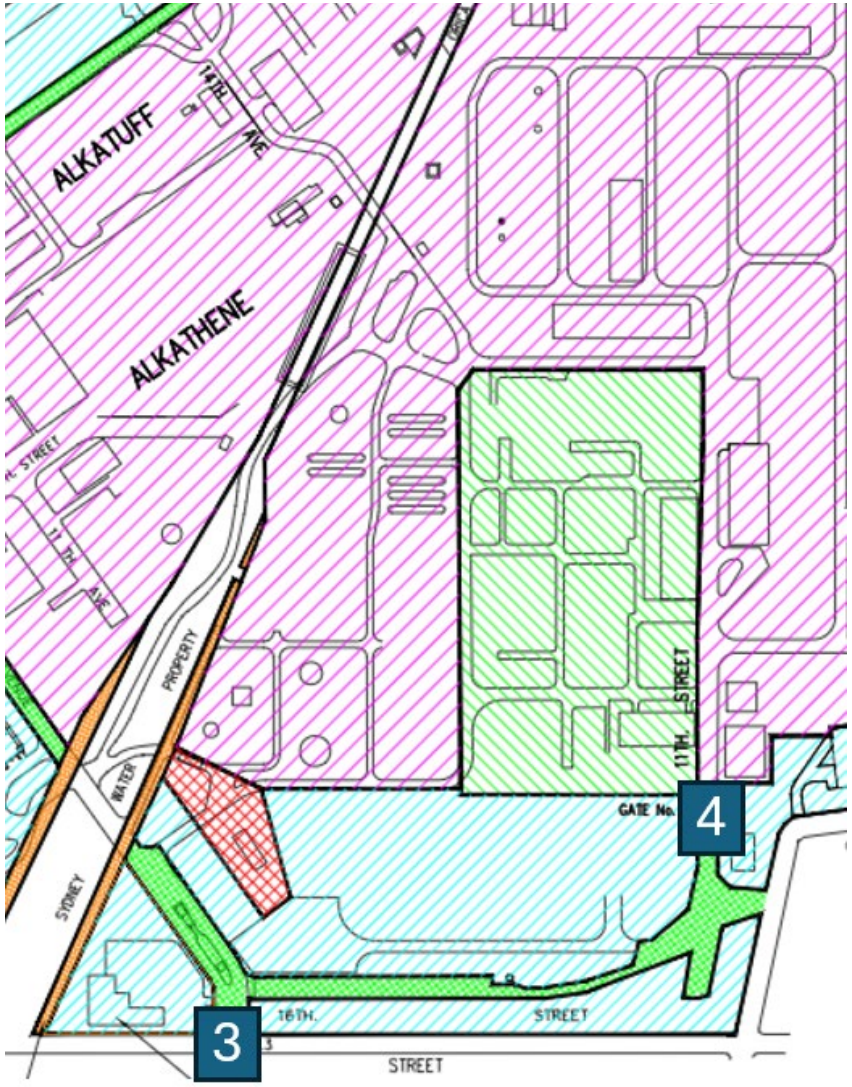
- **Recommended as this is the lowest risk option in terms of having low points of conflict as well as being furthest from residential homes.**

Gate 4

- Currently used for;
  - Access to Orica and Qenos operations North of the Sydney water easment
- BIP / Ownership
  - Gate 4 is accessible using BIP Roads
  - Internal BIP Roads between IXOM and Gate 4 are not rated for heavy vehicles
- Road access
  - Trucks leaving the site would significantly increase traffic at the Smith st intersection
- What would be needed
  - To access this gate the BIP would need to construct heavy vehicle roads spanning across Sydney water land

Conclusion

- **Not recommended due to high cost of construction.**
- **Not recommended due to increased risk due to increased traffic at Smith St intersection with Denison.**



Conclusion

- **In determining the lowest risk option for the location of a Gate for IXOM operations the following were considered**
  - The number of points of conflict
  - Speed entering the intersection
  - The distance to the nearest residential houses
  - Historical accident rates

- **Gate 3 represents the lowest risk to residents due to**
  - Low points of conflict compared to Gates 0, 1 and 4
  - Reduced entry speed into the intersection due to weigh bridge and security
  - Gate places the intersection with Denison opposite Industrial / Commercial land
  - There have been 0 Incidents at this intersection (2020 – 2024)

- **All other gates also have significant cost as well as legal / property access implications requiring**
  - Access across other companies owned land
  - Construction of Weigh Bridge, Security controls and street access
  - Removal of on street parking
  - Construction of internal roads rated to support heavy vehicles.


IXOM



APPENDIX E

UPDATED GREENHOUSE GAS ASSESSMENT

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3 February 2026

Jacob Vickers
Senior Environmental Consultant
Element Environment
Via email: jacob@elementsenvironment.com.au

RE: Chlorine Liquefaction Plant Modification – Greenhouse Gas Calculations Explanation

Dear Jacob,
Todoroski Air Sciences prepared the *Air Quality Impact and Greenhouse Gas Assessment Chlorine Liquefaction Plant – Modification to State Significant Development Consent* (**Todoroski Air Sciences, 2025**), which quantified greenhouse gas (GHG) emissions associated with the operation of the IXOM CAP and the proposed chlorine liquefaction plant (the Project).

Information provided by the Proponent was used to estimate potential future GHG emissions and was presented for both a typical operating scenario and a maximum operating scenario based on the Project's maximum production rate. Subsequent review identified that the GHG estimates for the maximum production scenario overstated the likely emissions.

The overestimation arose from the assumption that the electricity demand provided for the Project represented a unit-based intensity (i.e. kWh per tonne of chlorine), which was then extrapolated to a maximum production rate of 18,250tpa. This assumption resulted in a significant overestimation of electricity consumption. It was subsequently confirmed that the electricity demand provided represents the maximum operating load of the Project, rather than a production-scaled value.

The GHG assumptions have therefore been revised to reflect the actual operating characteristics of the Project, and the assumptions for the existing approved operations have also been updated using contemporary data. Updated GHG emissions have been recalculated and are presented in the revised version of the report.

Please feel free to contact us if you would like to clarify any aspect of this letter.

Yours faithfully,
Todoroski Air Sciences



Philip Henschke

References

Todoroski Air Sciences (2025)

"Air Quality Impact and Greenhouse Gas Assessment Chlorine Liquefaction Plant – Modification to State Significant Development Consent", prepared by Todoroski Air Sciences, March 2025.

TODOROSKI AIR SCIENCES

AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT

CHLORINE LIQUEFACTION PLANT - Modification to State Significant Development Consent

3 February 2026

Job Number 24021689

Prepared by

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Air Quality Impact and Greenhouse Gas Assessment

Chlorine Liquefaction Plant - Modification to State Significant Development Consent

DOCUMENT CONTROL

Report Version	Prepared by	Reviewed by
FINAL - 005	RW & PH	PH

Doc No. P20301993-PM-028_B

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1 INTRODUCTION

Todoroski Air Sciences has prepared this air quality impact assessment to support an application to modify the State Significant Development (SSD) consent for the IXOM Operations Pty Ltd (IXOM) Chlor-alkali Plant (CAP) at Banksmeadow, New South Wales (NSW) (hereafter referred to as the Project).

The IXOM-operated CAP has approval to produce 35,000 tonnes per annum (tpa) of gaseous chlorine. However, the site does not have a chlorine liquefaction plant, and all liquefied chlorine is manufactured at IXOM's chlorine liquefaction plant at Laverton, Victoria. This Project seeks to modify the current development consent to allow for the construction and operation of a new chlorine liquefaction and packaging plant at Banksmeadow, which will be integrated into the existing site operations. All chlorine produced at the liquefaction plant will be sourced from existing CAP processes.

The report presents an assessment of potential air quality impacts associated with the Project. This air quality impact assessment has been prepared in general accordance with the New South Wales (NSW) Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**). The greenhouse gas assessment for the Project generally follows guidance in the *Interim climate change assessment requirements for large emitters* (**NSW EPA, 2024**).

To assess the potential air quality impacts and greenhouse gas emissions associated with the Project, this report comprises:

- A background to the Project and description of the proposed site and operations;
- A review of the existing meteorological and air quality environment surrounding the site;
- A description of the dispersion modelling approach and emission estimations used to assess potential air quality impacts;
- Presentation of the predicted results and discussion of the potential air quality impacts, and associated mitigation and management measures; and,
- Estimates of greenhouse gas emissions generated due to the operation of the Project and potential mitigation and abatement measures.

2 PROJECT SETTING AND DESCRIPTION

2.1 Project setting

The Project is located in the Botany Industrial Park (BIP), at 16-20A Beauchamp Road, Banksmeadow, approximately 4.5 kilometres (km) southeast of Sydney Kingsford Smith Airport and approximately 1km south of Pagewood. Land use surrounding the Project is comprised of various industrial and commercial operations as well as residential areas. The nearest residential area is located approximately 50 metres (m) to the east of the site in the suburb of Hillsdale.

Figure 2-1 presents the location of the Project with reference to the assessment locations which are identified in **Table 2-1** and considered in this assessment. The stacks in **Figure 2-1** are described in **Section 7.4.2**.

Table 2-1: Assessment locations

Assessment location ID	X coordinate (m)	Y coordinate (m)	Address	Type
IND1	335356	6241222	28 McPherson St	Industrial
IND2	335562	6241404	Botany Industrial Park	Industrial
IND3	335727	6241372	Botany Industrial Park	Industrial
IND4	335809	6241095	16 Beauchamp Rd	Industrial
R1	335893	6241140	34 Denison St	Residential
R2	335888	6241183	30 Denison St	Residential
R3	335837	6240945	18 Perry St	Residential

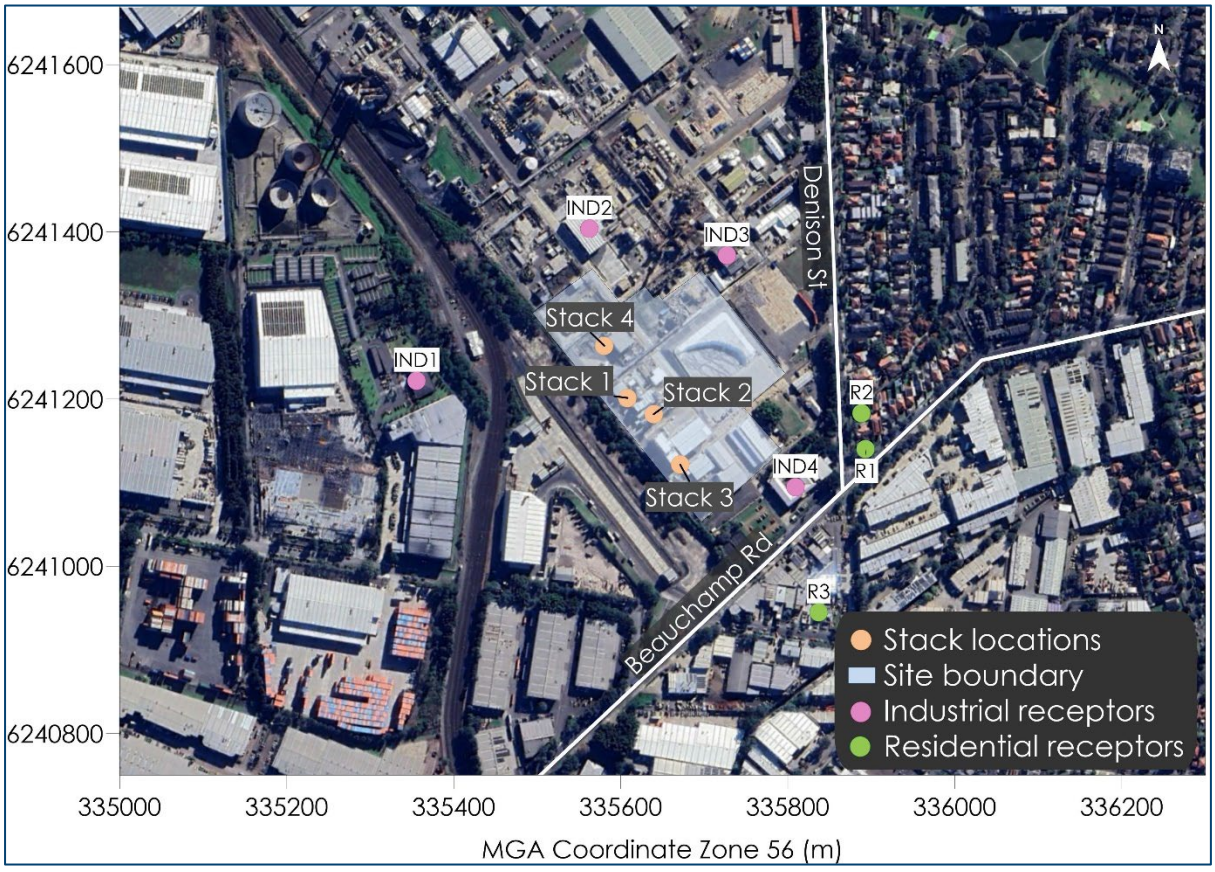


Figure 2-1: Project location

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project. The local topography features gentle undulations gradually increasing to the west and with steep elevation changes along the coastline to the east.

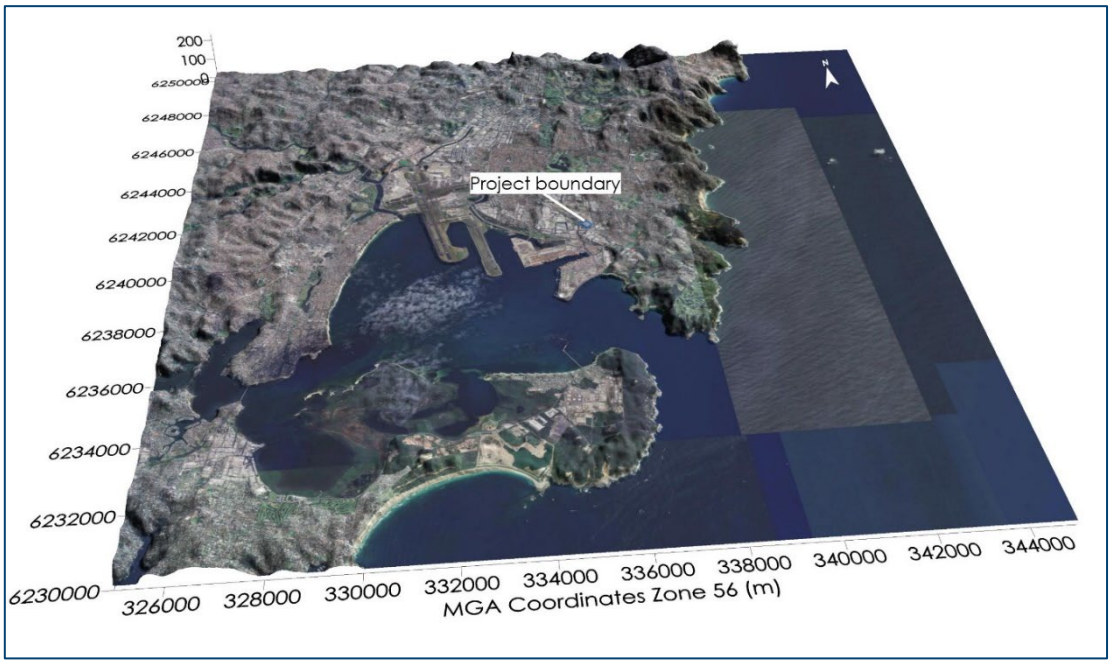


Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Project description

The Project involves the construction and operation of a new chlorine liquefaction and packaging plant on site which will be integrated into existing site operations. All chlorine will be sourced from existing CAP processes.

The chlorine liquefaction plant will have a maximum production capacity of 50 tonnes per day (tpd) but will operate at a reduced rate to supply liquefied chlorine in 13 tonne (t) tankers to the NSW region. The chlorine liquefaction plant will provide redundancy in the event that the existing chlorine liquefaction plant at Laverton becomes non-operational.

During normal operation, the chlorine liquefaction plant will be monitored from the control room. It will be unattended except when:

- a tanker is being moved to or from the building;
- a tanker is being connected or disconnected;
- during routine inspection; or,
- during maintenance or for handling of chlorine drums and cylinders.

Neither the operator nor the driver is expected to be in attendance for the duration of the filling of a tanker.

Most of the chlorine liquefaction plant will be in a containment building to minimise risk associated with fugitive chlorine gas emissions. The containment building shall be under slight negative pressure and

will be fitted with a scrubbing system to ensure any potential chlorine emissions are captured and treated. The stack of the scrubbing system will extend above the roofline and any chlorine gas emissions from the stack will be well below the existing site stack limits even in the event of the highest loading case. There will be sufficient internal and external space for heavy vehicles to drive through the building to access the loading point. There will be roller doors on the vehicle entry and exit points.

The chlorine liquefaction plant will be designed from proven equivalent IXOM processes. It will comprise:

- Shell and tube heat exchanger to liquefy chlorine.
- Ammonia/ CO_2 refrigeration system (most of this system will be located outside of the Containment Building as it will not contain chlorine).
- Chlorine Separator to separate liquefied chlorine from incondensable gasses. Two chlorine stock tanks to store up to 50t of liquefied chlorine at -34°C and atmospheric pressure. One will be kept in service and the other kept empty to receive chlorine.
- Two chlorine storage pumps to distribute chlorine for tanker and container filling.
- Vacuum chlorine catch pot to ensure any liquefied chlorine from filling functions will pass the absorption system as gas.
- Chlorine tanker loading station.
- Two chlorine drum filling stations.
- Two chlorine cylinder filling stations.
- Eight chlorine drum degassing stations.
- 12 chlorine cylinder degassing stations.
- Degas reactor to absorb incondensable gasses from the separator and intermittent liquefied chlorine and chlorine gas from chlorine container filling and degassing functions (most of this system will be located outside of the containment building as it will contain minimal chlorine). The vent from the degas reactor will be directed to the containment building scrubbing system.
- Containment building scrubbing system to absorb any fugitive emissions of chlorine in the building and to provide tertiary absorption of any chlorine gas from storage and container degassing and filling functions.

Figure 2-3 shows the site layout with the proposed location of the chlorine liquefaction plant in orange. **Figure 2-4** presents the indicative chlorine liquefaction plant layout, and **Figure 2-5** presents a building cross section.

Three 13t bulk liquid tankers will arrive for loading and be dispatched with liquefied chlorine per week under normal operations. If the chlorine liquefaction plant at Laverton becomes non-operational, then up to a maximum production capacity of 50tpd could be generated, if required.

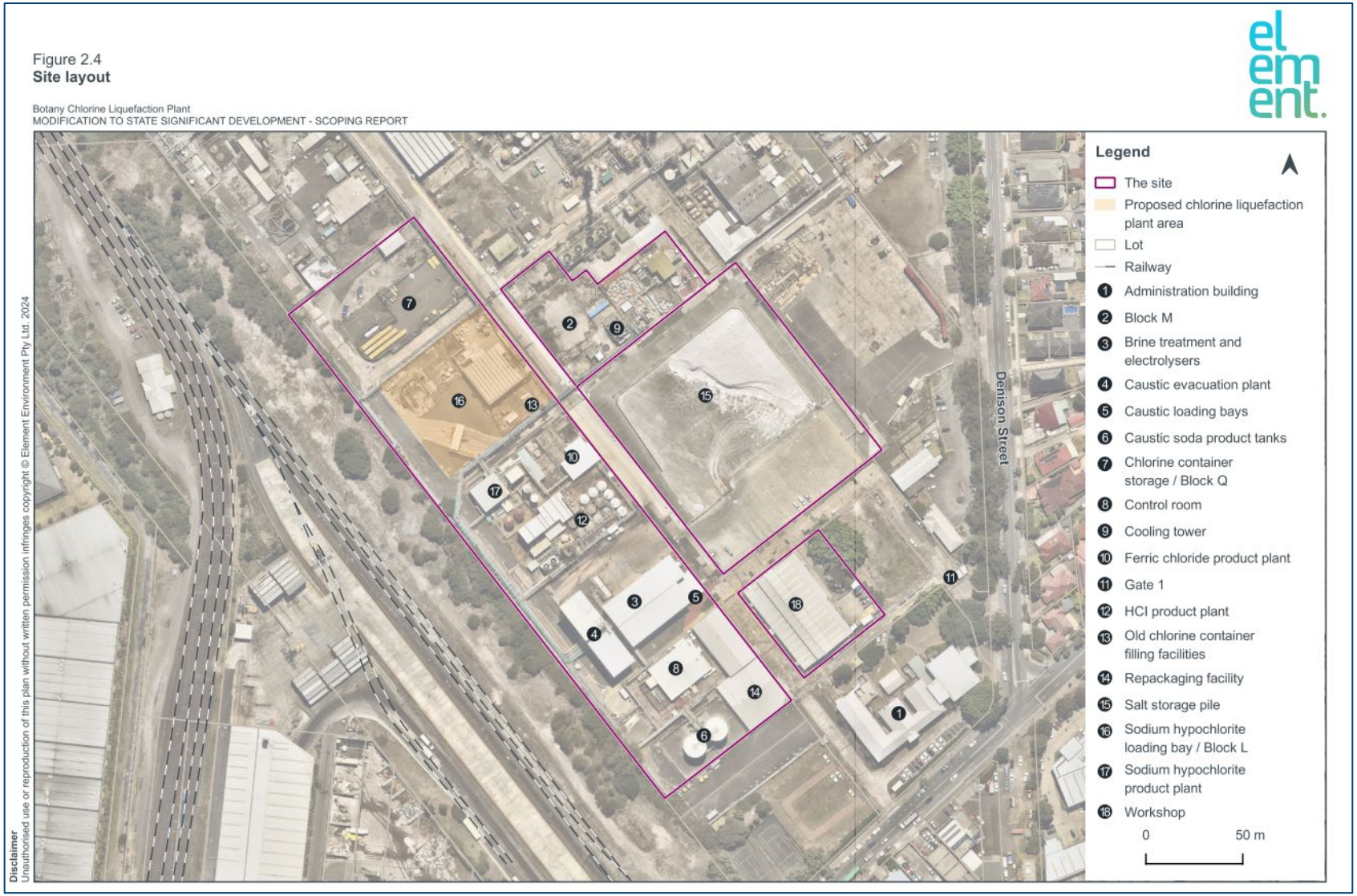
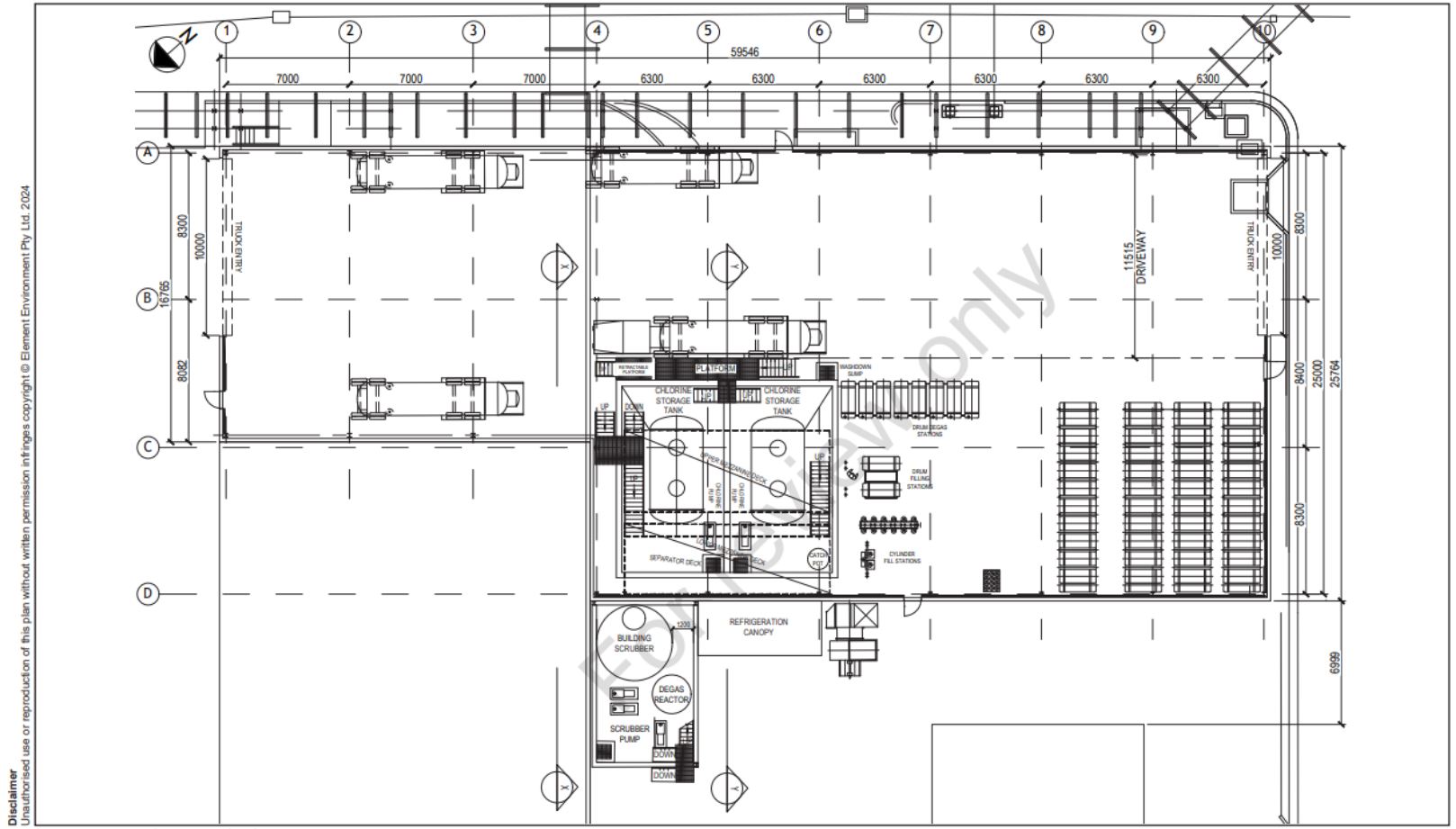


Figure 2-3: Site layout

Figure 2.9
Conceptual chlorine liquefaction plant layout

Botany Chlorine Liquefaction Plant
MODIFICATION TO STATE SIGNIFICANT DEVELOPMENT - SCOPING REPORT



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Source: Kellogg Brown & Root Pty Ltd (KBR), 2024

Figure 2-4: Indicative chlorine liquefaction plant layout

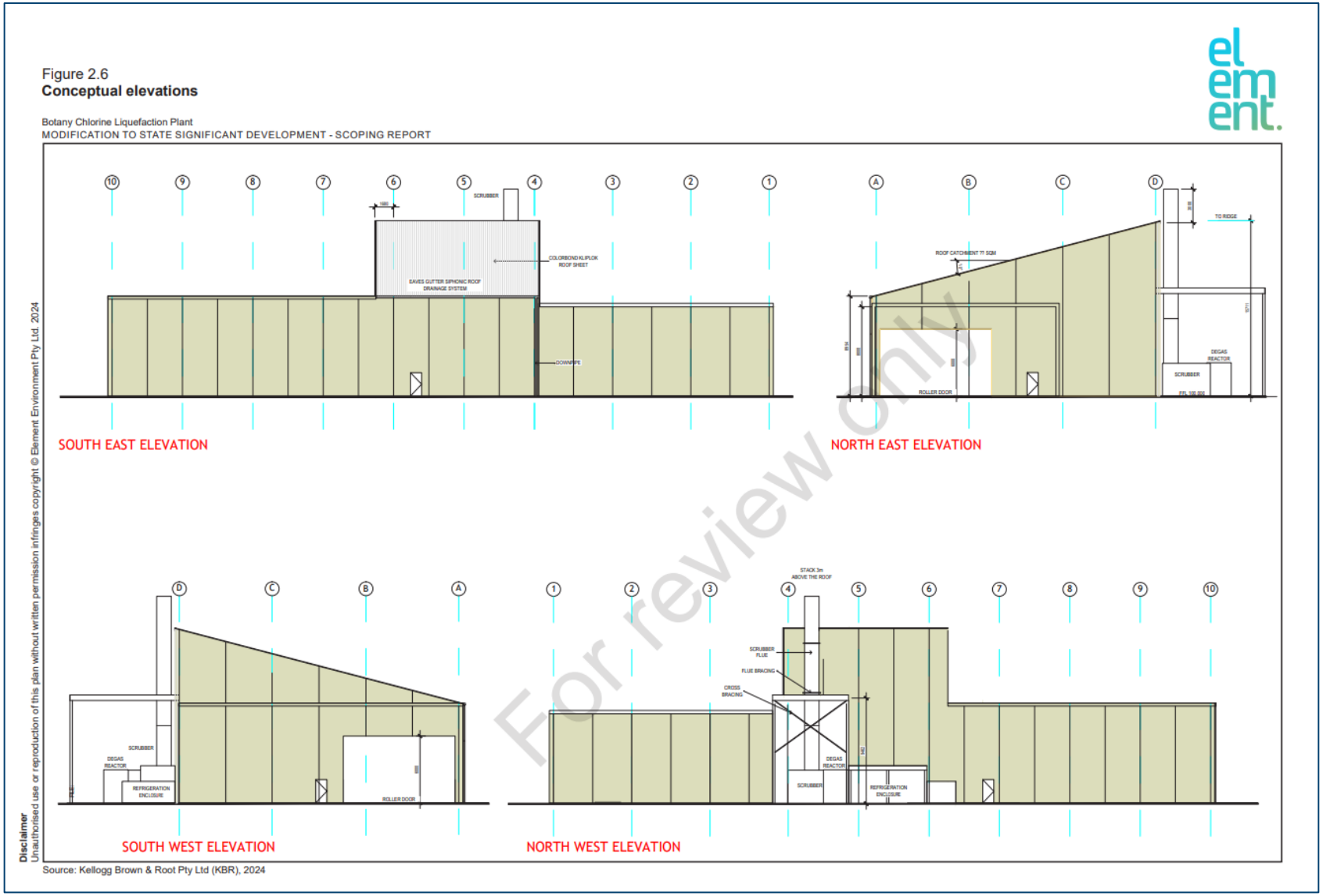


Figure 2-5: Indicative cross sections of chlorine liquefaction plant

3 AIR QUALITY CRITERIA

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the Project and the applicable air quality criteria.

3.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

3.2 Chlorine

Chlorine is a highly reactive, greenish-yellow gas at room temperature with a characteristic odour. It is commonly used as a disinfectant, in water treatment to kill harmful bacteria, and as a key component in the production of various industrial chemicals. While it is essential in many chemical processes, chlorine is also toxic and corrosive, requiring careful handling and storage.

3.3 NSW EPA impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**).

The air quality goals for key pollutants relate to the total pollutant burden in the air and not just the contribution from the Project. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Criterion	Percentile	Assessment location
TSP	Annual	90 µg/m^3	100	Receptor
PM_{10}	Annual	25 µg/m^3	100	Receptor
	24 hour	50 µg/m^3	100	Receptor
$PM_{2.5}$	Annual	8 µg/m^3	100	Receptor
	24 hour	25 µg/m^3	100	Receptor
Deposited dust	Annual	2 g/m^2/month	100	Receptor
		4 g/m^2/month	100	Receptor
Chlorine	1-hour	50 µg/m^3	99.9	Boundary

Source: **NSW EPA, 2022**

µg/m^3 = micrograms per cubic metre

g/m^2/month = grams per square metre per month

4 STUDY REQUIREMENTS

The purpose of this report is to provide an assessment of the likely Project-related effects on air quality. In recognition that the Project would interact with the existing/approved operations at the site, the assessment also considers the impacts of the Project with the existing/approved operations. The assessment presented in this report addresses planning and regulatory agency requirements, as set out below.

4.1 Environmental Assessment Requirements

In preparing this Air Quality Impact Assessment, the Department of Planning, Housing and Infrastructure (DPHI) Secretary's Environmental Assessment Requirements (SEARs), which were issued for the Project (DA35/98-Mod-6), have been addressed and the key matters raised for consideration in the Air Quality Impact Assessment are outlined in **Table 4-1** along with a reference to where the requirements are addressed in the report.

Table 4-1: SEARs - DA35/98-Mod-6

Specific issue	General requirements	Section
Air Quality	An assessment of potential air quality, dust and odour impacts from construction and operation on surrounding landowners, businesses and sensitive receptors, in accordance with relevant Environment Protection Authority guidelines, including details of proposed mitigation, management and monitoring measures.	This report

4.2 NSW EPA Requirements

This Air Quality Impact Assessment has been prepared in general accordance with the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**) and the specific requirements outlined therein as well as the SEARs requested by the NSW EPA as outlined in **Table 4-2**.

Table 4-2: NSW EPA SEARs input

Specific issue	Input	Section
Air Quality	Identify all sources or potential sources of air emissions from the development.	Section 7.4
	Provide details of the project that are essential for predicting and assessing air impacts include: a) the quantities and physio-chemical parameters (e.g. concentration, moisture content, bulk density, particle sizes etc) of materials to be used, transported, produced, stored or evaporated b) an outline of procedures for handling, transport, production, storage and evaporation c) the management of solid, liquid and gaseous waste streams with potential to generate emissions to air.	Section 2.2 & 7.4
	Describe the topography and surrounding land uses. Provide details of the exact locations of dwellings, schools and hospitals. Where appropriate provide a perspective view of the study area such as the terrain file used in dispersion models.	Section 2.1
	Describe the surrounding buildings that may effect plume dispersion.	Section 2.2 & 7.4.2
	Provide and analyse site representative data on following meteorological parameters: a) temperature and humidity b) rainfall, evaporation and cloud cover c) wind speed and direction d) atmospheric stability class e) mixing height (the height that emissions will be ultimately mixed in the atmosphere)	Section 5

Specific issue	Input	Section
	f) katabatic air drainage g) air re-circulation.	
	Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data.	Section 5
	Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point.	Section 3 & 7.4
	Estimate the resulting ground level concentrations of all pollutants. Where necessary (e.g. potentially significant impacts and complex terrain effects), use an appropriate dispersion model to estimate ambient pollutant concentrations. Discuss choice of model and parameters with the EPA	Section 8
	Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals.	Section 8
	Describe the contribution that the development will make to regional and global pollution, particularly in sensitive locations.	Section 8 & 10
	For potentially odorous emissions provide the emission rates in terms of odour units (determined by techniques compatible with EPA procedures). Use sampling and analysis techniques for individual or complex odours and for point or diffuse sources, as appropriate. Note: With dust and odour, it may be possible to use data from existing similar activities to generate emission rates.	Section 7.4
	Outline specifications of pollution control equipment (including manufacturer's performance guarantees where available) and management protocols for both point and fugitive emissions. Where possible, this should include cleaner production processes.	Section 2.2, 7.4.2 & 9
	EPA note that Section 2.4 of the Scoping Report states that the new building will be under "slight negative pressure". The air impact assessment must consider applying negative pressure under all operating conditions, including when roller doors are open for truck movements or other operations. The assessment must also include what measures will be put in place to ensure adequate negative pressure during all operating conditions.	Section 2.2 & 9

4.3 Bayside Council

Comments by Bayside Council as input to the EARs include:

• ***Amenity Impacts***

11. The proposed development has the potential to create adverse amenity impacts with regard to noise and vibration, light, and air quality. Council acknowledges the following measures being undertaken to assess potentially generated amenity impacts to nearby received as detailed in the Scoping Report:

ii. Section 6.2.4 Air – particulate matter and gases to conduct air quality impact assessment for potential pollutants and emissions as per the EPA requirements

This assessment provides a quantitative assessment of the potential air quality impacts associated with the operations at the Project.

5 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the site.

5.1 Local climatic conditions

Long-term climatic data from the Bureau of Meteorology (BoM) weather station at Sydney Airport Aeronautical Meteorological Office (AMO) (Site No. 066037) were analysed to characterise the local climate in the proximity of the site. The Sydney Airport AMO weather station is located approximately 4.7km northwest of the site.

Table 5-1 and **Figure 5-1** present a summary of data from the Sydney Airport AMO weather station collected over a 60 to 95 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 26.7 degrees Celsius (ºC) and July is the coldest month with a mean minimum temperature of 7.4ºC.

Rainfall peaks during the first half of the year declines during the latter, with an annual average rainfall of 1093.4 millimetres (mm) over 96.2 days. The data indicate that March is the wettest month with an average rainfall of 124.7mm over 9.7 days and September is the driest month with an average rainfall of 59.8mm over 6.8 days.

Relative humidity exhibits little variability across the year. Mean 9am relative humidity ranges from 61% in October to 74% in June. Mean 3pm relative humidity levels range from 49% in August to 63% in February.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the cooler months. Mean 9am wind speeds range from 12.6 kilometres per hour (km/h) in May to 16.3km/h in October. Mean 3pm wind speeds range from 17.1km/h in May to 25.3km/h in November.

Table 5-1: Monthly climate statistics summary – Sydney Airport AMO

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (ºC)	26.7	26.5	25.4	23.0	20.2	17.7	17.2	18.5	20.7	22.7	24.2	25.9	22.4
Mean min. temp. (ºC)	19.0	19.2	17.7	14.4	11.1	8.8	7.4	8.3	10.6	13.4	15.6	17.6	13.6
Rainfall													
Rainfall (mm)	94.4	118.0	124.7	106.6	96.4	123.3	71.8	75.5	59.8	72.1	79.7	72.6	1093.4
No. of rain days (≥1mm)	8.2	8.7	9.7	8.4	8.3	8.8	6.7	6.7	6.8	7.9	8.2	7.8	96.2
9am conditions													
Mean temp. (ºC)	22.4	22.3	21.1	18.2	14.6	11.9	10.8	12.5	15.7	18.4	19.9	21.6	17.4
Mean R.H. (%)	70	73	73	71	73	74	71	65	62	61	64	66	69
Mean W.S. (km/h)	14.4	13.8	12.9	12.9	12.6	13.4	13.3	14.4	15.5	16.3	16.0	14.8	14.2
3pm conditions													
Mean temp. (ºC)	24.8	24.8	23.9	21.7	19.0	16.6	16.1	17.2	19.0	20.7	22.1	23.9	20.8
Mean R.H. (%)	60	63	61	59	58	57	52	49	51	54	56	58	57
Mean W.S. (km/h)	24.1	23.0	21.0	19.3	17.1	17.8	18.2	20.8	23.1	24.6	25.3	25.2	21.6

Source: **Bureau of Meteorology, 2024**

R.H. – Relative Humidity, W.S. – wind speed

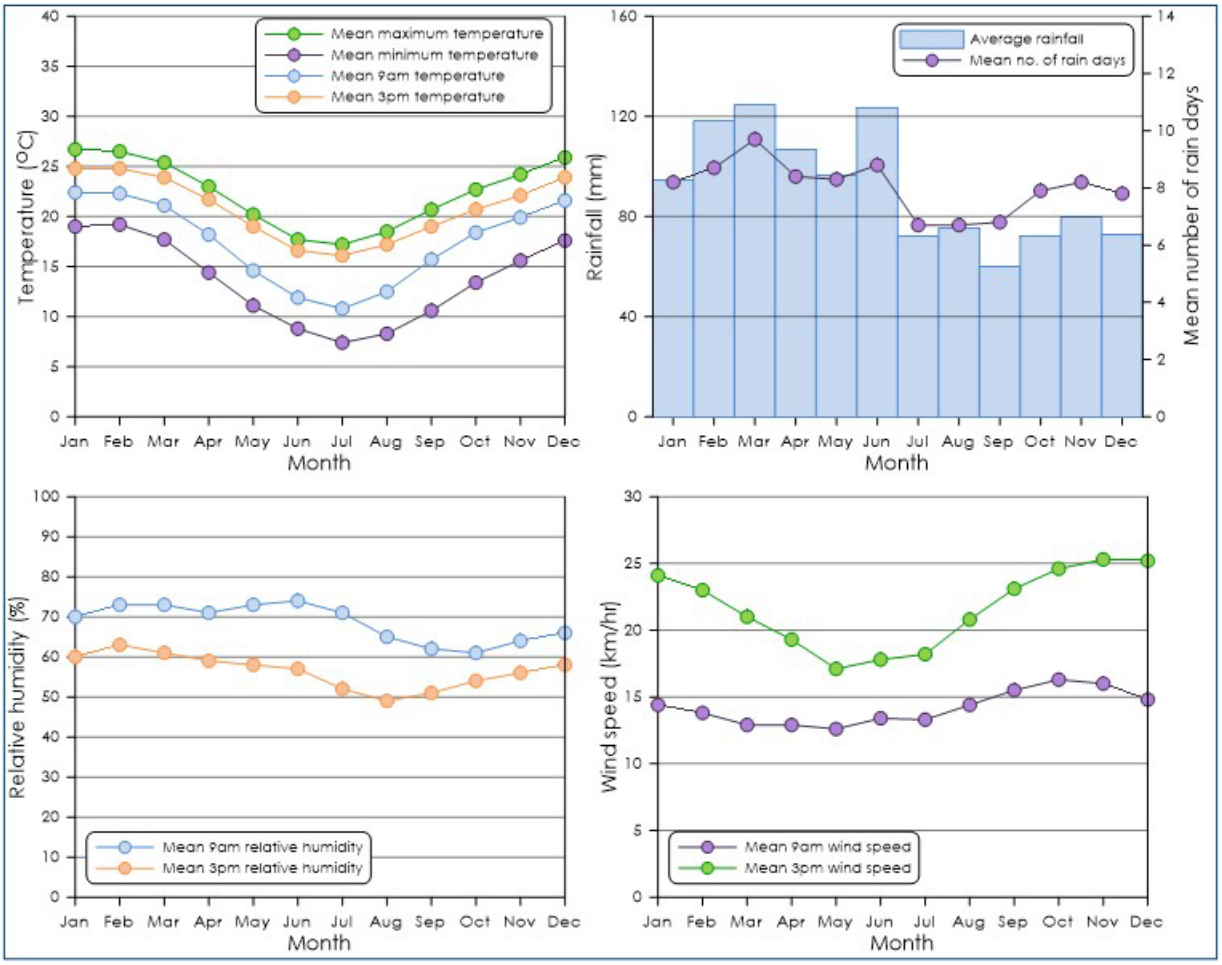


Figure 5-1: Monthly climate statistics summary – Sydney Airport AMO

5.2 Local meteorological conditions

Annual and seasonal windroses generated from data collected at the Sydney Airport AMO during 2020 are presented in **Figure 5-2**.

The 2020 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of data trends in meteorological data recorded and appropriate monitoring data for the area as outlined in **Appendix A**.

Strong winds are generally experienced in the area due to its proximity to the coast. Winds from the northwest quadrant are typically weaker than winds from other directions. On an annual basis, the winds are varied with the highest portion originating from the northwest and south.

In summer, winds are typically from the northeast and southeast quadrants, with dominant winds from the northeast and south. The autumn distribution is similar to the annual distribution with a high portion of winds from the northwest. During winter, winds typically range from the southwest and northwest quadrants, with winds from the northwest most frequent. Spring has similar distribution to the annual distribution, however, indicates a slightly higher portion of north-northeast winds. As described in **Section 2**, the topography features gentle slopes to the west and steep coastal elevation changes to

the east. Although the steep slopes may allow for some katabatic winds, their development is unlikely overall.

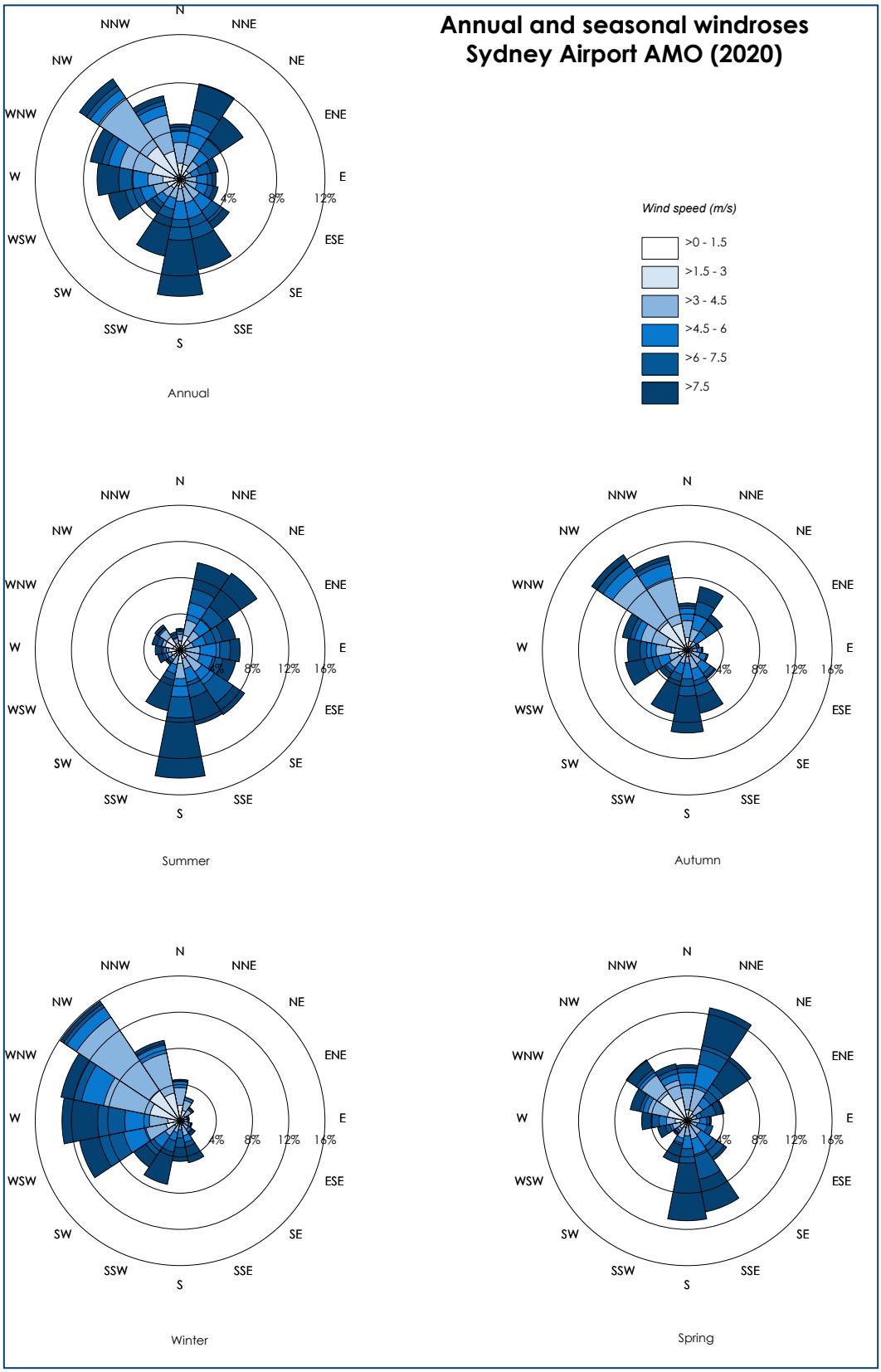


Figure 5-2: Annual and seasonal windroses for Sydney Airport AMO (2020)

5.3 Local air quality

The main sources of air pollutants in the area surrounding the Project include emissions from other industries within the local industrial area, local anthropogenic activities (such as motor vehicle exhaust and domestic wood heaters) and nearby commercial activities.

Available data from the nearest air quality monitor operated by the NSW Department of Climate Change, the Environment, Energy and Water (DCCEEW) were used to quantify the existing background level for PM_{10} and $PM_{2.5}$. The monitor is located at Randwick, approximately 3.1km northeast of the Project.

5.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data from 2019 to 2023 is presented in **Table 5-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 5-3**. A seasonal trend can be seen in the PM_{10} monitoring data at all monitoring stations with elevated levels occurring in the warmer months.

A review of **Table 5-2** indicates that the annual average PM_{10} concentrations recorded at Randwick were below the criterion of 25µg/m^3 for the review period. The maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m^3 during 2019, 2020 and 2023. Anomalously high PM_{10} concentrations recorded in December 2019 and January 2020 are attributed to wildfires and the drought period affecting NSW.

Table 5-2: Summary of PM_{10} levels from monitoring station (µg/m^3)

Year	Annual average	Criterion
2019	24.1	**25**
2020	19.5	**25**
2021	16.3	**25**
2022	14.6	**25**
2023	16.6	**25**
Year	**Maximum 24-hour average**	**Criterion**
2019	**127.7**	**50**
2020	**137.3**	**50**
2021	37.6	**50**
2022	37.4	**50**
2023	**89.0**	**50**

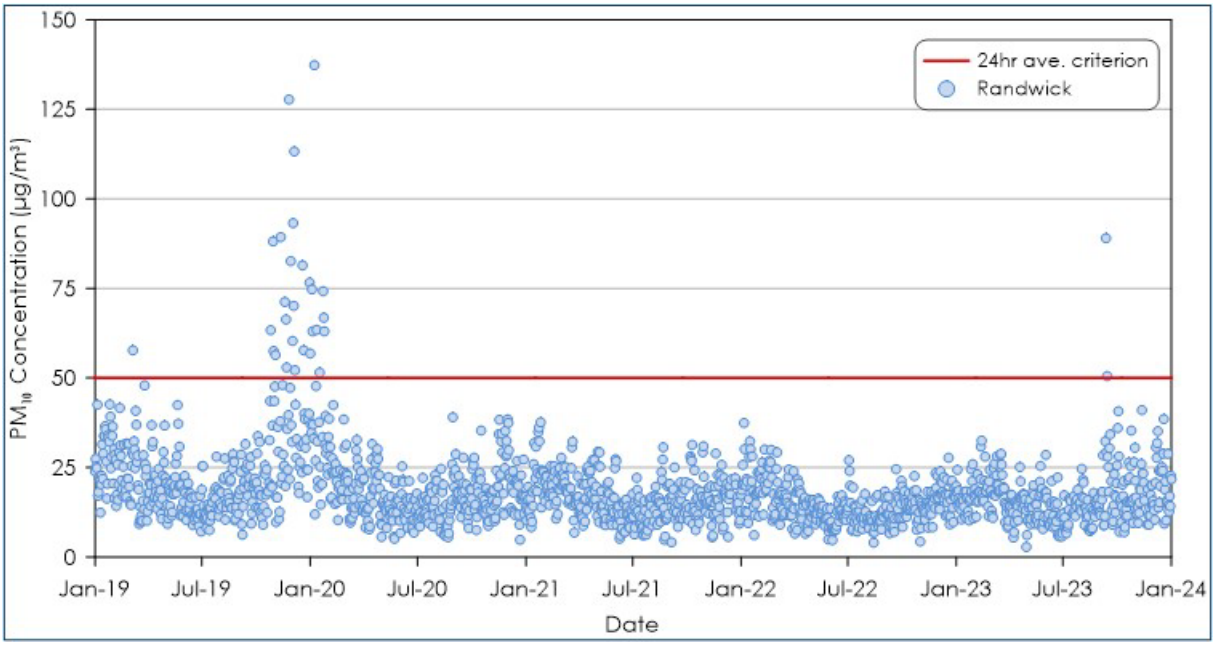


Figure 5-3: 24-hour average PM_{10} concentrations

5.3.2 $PM_{2.5}$ monitoring

A summary of the available $PM_{2.5}$ monitoring data for the 2019 to 2023 is presented in **Table 5-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 5-4**.

Table 5-3 indicates that the annual average $PM_{2.5}$ concentrations were above the relevant criterion of 8µg/m³ in 2019. The maximum 24-hour concentrations were above the criterion of 25µg/m³ during 2019 and 2020, similar to PM_{10} monitoring data, and on occasion in 2021 and 2023.

Table 5-3: Summary of $PM_{2.5}$ levels from monitoring stations (µg/m³)

Year	Annual average	Criterion
2019	**10.8**	**8**
2020	7.6	**8**
2021	6.4	**8**
2022	4.9	**8**
2023	6.2	**8**
Year	**Maximum 24-hour average**	**Criterion**
2019	**95.2**	**25**
2020	**114.8**	**25**
2021	**31.2**	**25**
2022	14.6	**25**
2023	**67.7**	**25**

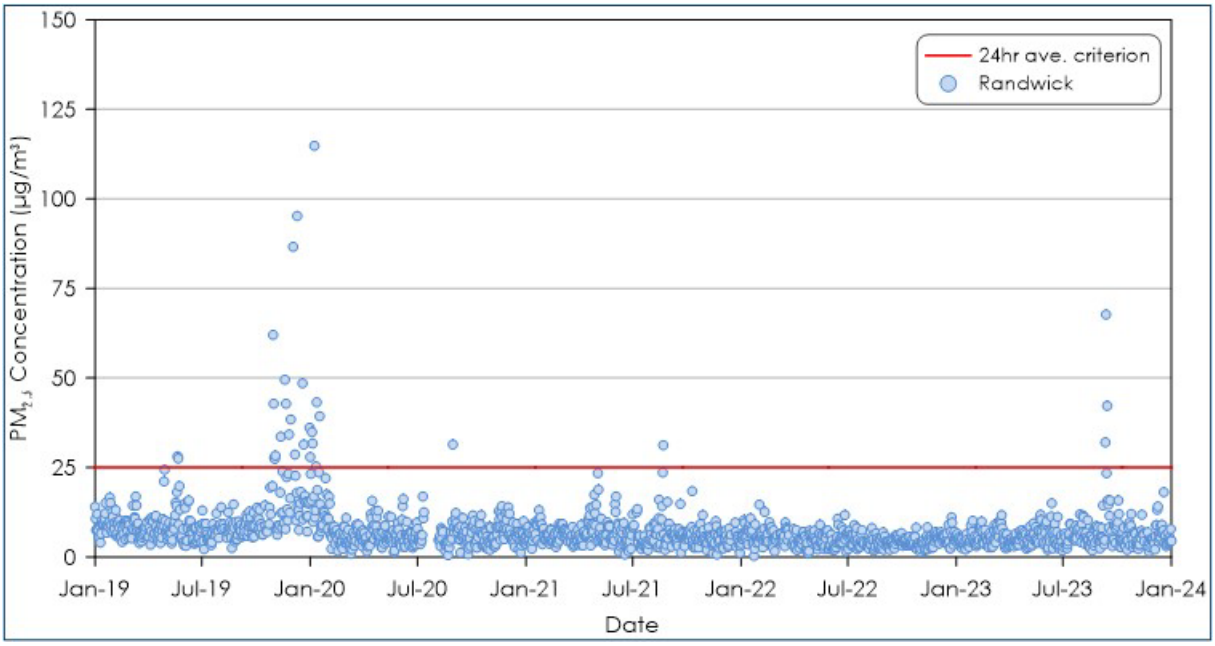


Figure 5-4: 24-hour average $PM_{2.5}$ concentrations

6 ASSESSMENT OF CONSTRUCTION IMPACTS

6.1 Introduction

The construction activities associated with the Project comprise:

- Block Q:
  - Works to prepare Block Q for relocation of the sodium hypochlorite loading bay, comprising removal of surface material and paving the access driveway and hardstand.
  - Dismantling the sodium hypochlorite loading bay on Block L and relocating to/assembly on Block Q.
- Block L:
  - Earthworks on Block L to remove existing surface material, level the block, excavate building footings and install services.
  - Paving external hardstand areas and pouring the reinforced concrete building floor.
  - Erection of the steel girt frame and portal frame roof.
  - Cladding of external walls and installation of roof sheeting.
  - Installation of internal componentry.
  - Commissioning and testing.

Estimated timing of the construction activities is approximately 12 months.

The construction activities associated with the Project have the potential to generate some dust emissions primarily generated from the handling of material, vehicle movements, exhaust emissions from diesel powered equipment and windblown dust generated from exposed areas.

The potential impact due to these activities is difficult to accurately quantify on any given day due to the temporary and sporadic nature of these activities and the short term and variable location of any one activity during the construction phase.

The potential dust emissions generated during the construction phase are expected to be minimal and controllable using standard methods, and as such have been assessed using a qualitative approach.

6.2 Qualitative assessment of the risk of construction dust impacts

The qualitative approach is on the basis of risk to determine the activities that pose the greatest risk of air quality impacts during the construction phase, which can be used to identify the key activities and to focus controls to manage the risk appropriately, and where required, reduce the impact through proactive management.

The methodology presented in the Institute of Air Quality Management (IAQM) document *Guidance on the assessment of dust from demolition and construction* (**IAQM, 2024**) has been used to assess the potential risks from construction impacts associated with the proposal.

The IAQM guidance methodology considers three separate dust air quality impacts during construction activities:

- Annoyance due to dust deposition;
- Harm to ecological receptors, referring to direct impacts on vegetation or aquatic ecosystems, from dust deposition; and
- The risk of health effects due to a significant increase in exposure to PM_{10}.

A risk-based assessment of the potential dust effects due to specific construction activities is determined by the scale and nature of the works, the proximity to receptors to identify the likelihood of an impact arising and the magnitude of specific mitigation required to ensure impacts are managed effectively.

The activities that have potential to generate dust impacts for the proposal considered in the risk assessment include demolition, earthworks, construction and track-out from unpaved roads onto public roads.

A site is allocated a risk category based on two factors, the scale and nature of works and the sensitivity of the area to dust impacts.

The potential dust emission magnitude associated with the construction activity for the Project is outlined in **Table 6-1**.

Table 6-1: Potential dust emission magnitude

Activity	Dust emission magnitude	Comment
Demolition	Small	Total building volume <12,000m³, construction material with low potential for dust release (e.g. metal cladding or timber).
Construction	Small	Total building volume <12,000m³, construction material with low potential for dust release (e.g. metal cladding or timber).
Track out	Small	<20 Heavy Duty Vehicles (HDV) movements in any one day, surface material with low potential for dust release, unpaved road length <50m.

The sensitivity of the area surrounding the construction activity is defined in **Table 6-2**.

Table 6-2: Outcome of defining the sensitivity of the area

Potential impact	Sensitivity of the surrounding area			Comment
	Demolition	Construction	Track out	
Dust soiling	Low	Low	Low	Low sensitivity area with 1-10 receptors located <250m from source
Human health	Low	Low	Low	Low sensitivity area with 1-10 receptors located <250m from source and annual mean PM_{10} <24µg/m³
Ecological	Low	Low	Low	Low sensitivity area

The dust emission magnitude is combined with the sensitivity of the area to determine the risk of impact with no mitigation applied. The risk of dust impact for the construction activity is summarised in **Table 6-3**. The IAQM method identifies a low risk based on the scale of dust emissions due to construction

activities, and the distance to sensitive receptors, thus dispersion modelling of the construction activities is not warranted.

Table 6-3: Summary of dust risk to define site-specific mitigation

Potential impact	Risk		
	Demolition	Construction	Trackout
Dust soiling	Negligible	Negligible	Negligible
Human health	Negligible	Negligible	Negligible
Ecological	Negligible	Negligible	Negligible

Based on the outcomes of the risk assessment, only standard construction dust mitigation measures are recommended to be implemented for the Project to minimise the risk of dust impacts occurring. Examples of these are outlined in **Table 6-4**.

Table 6-4: Examples of construction dust mitigation measures

Source	Mitigation measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of visible dust cannot be maintained)
	Engines of on-site vehicles and plant to be switched off when not in use
	Vehicles and plant are to be fitted with pollution reduction devices where practicable
	Vehicles are to be maintained and serviced according to manufacturer's specifications
	Visual monitoring of construction activities is to be undertaken to identify dust generation
Hauling material/ vehicle movements	Concrete hardstand on-site and entry / exit points to be swept/cleaned regularly as required etc..
	Construction vehicle traffic is to be restricted to designated routes (same routes as operational heavy vehicles)
	Construction speed limits are to be enforced
	Vehicle loads are to be covered when travelling off-site
Material handling	Drop heights from loading and handling equipment are to be reduced as much as practical
Exposed areas / stockpiles	The extent of exposed surfaces and stockpiles is to be kept to a minimum
	Exposed areas and stockpiles are either to be covered or are to be dampened with water as far as is practicable if dust emissions are visible
	Re-instate hardstand/concrete capping as soon as possible after completion of construction activities.

7 DISPERSION MODELLING APPROACH

7.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach applied for the assessment.

Modelling was undertaken using a combination of the CALPUFF Modelling System and the Weather Research and Forecasting model (WRF). The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets. WRF is a prognostic air model used to simulate meteorological data for input into CALMET.

The model was set up in general accordance with the NSW EPA's *Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation**, **2011**).

Sensitivity modelling using the Second-order Closure Integrated PUFF (SCIPUFF) with chemistry (SCICHEM) model has also been conducted, with results presented in **Appendix B**. The SCICHEM model incorporates complete gas phase, aqueous and aerosol phase chemistry within the SCIPUFF model. SCICHEM was chosen for sensitivity modelling due to its ability to account for dense gas effects, as chlorine is a dense gas.

7.2 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from WRF with surface observations.

The WRF model was applied to the available data to generate a three-dimensional upper air data file for use in CALMET. The centre of analysis for the WRF modelling used is 335713m East and 6241188m North. The simulation involved an outer grid of 435km with 15km grid spacing, with two nested grids with 3km and 1km grid spacing.

The CALMET domain was run on a domain of 10 x 10km with a 0.1km grid resolution. The available meteorological data the year 2020 from the Sydney Airport AMO (BoM) were included in the simulation. The 2020 calendar year was selected as the period for modelling the Project based on an analysis of data trends in meteorological data as outlined in **Appendix A**. The seven critical parameters used in the CALMET modelling are presented in **Table 7-1**.

Table 7-1: Seven critical parameters used in CALMET

Parameter	Value
TERRAD	15
IEXTRP	-4
BIAS (NZ)	-1.0, -0.5, -0.3, 0, 0, 0, 0, 0, 0, 0, 0, 0
R1 and R2	5, 5
RMAX1 and RMAX2	7, 7

7.3 Meteorological modelling evaluation

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extract data. **Figure 7-1** presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period (i.e. illustrative). The wind fields follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

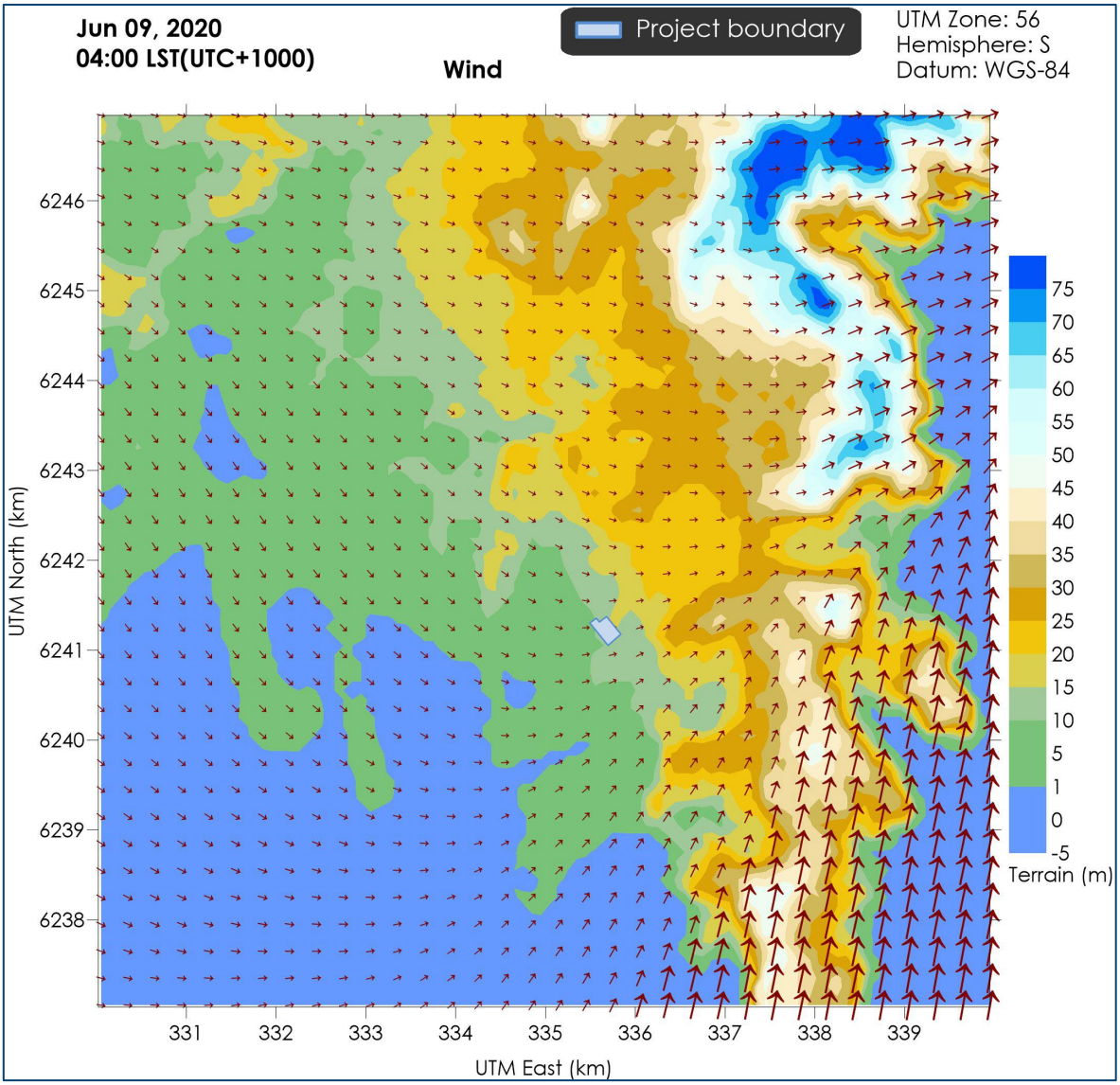


Figure 7-1: Representative 1-hour average snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 7-2** and **Figure 7-3**.

Figure 7-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. **Figure 7-3** includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

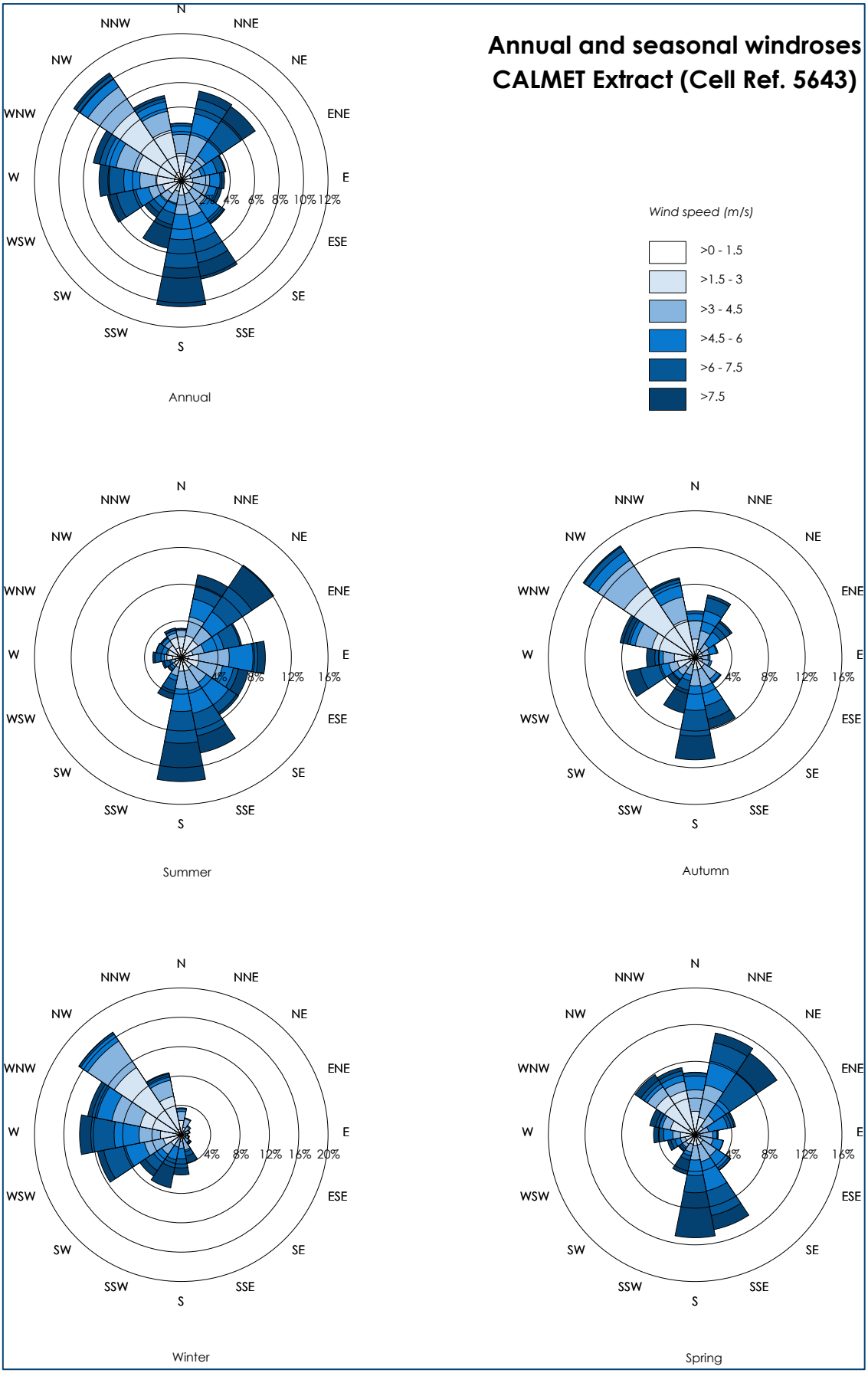


Figure 7-2: Annual and seasonal windroses from CALMET (Cell ref 5643)

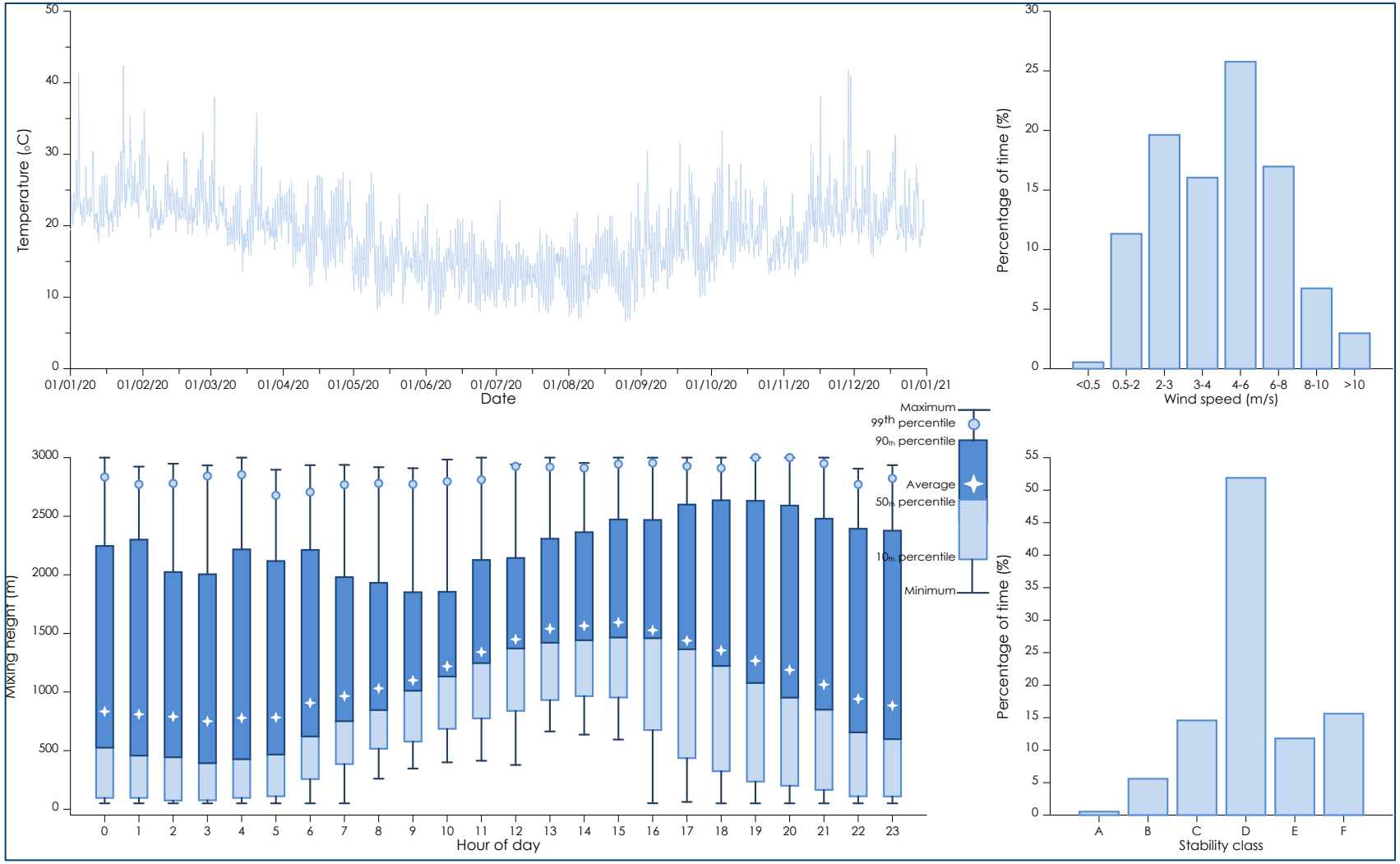


Figure 7-3: Meteorological analysis of CALMET (Cell REF 5643)

7.4 Estimated emissions

7.4.1 Particulate matter

The potential dust generating activities associated with the operation of the Project are identified as vehicles travelling on-site and from the diesel exhaust. Two scenarios are considered including under normal operations and at maximum production capacity.

Under normal operations, an additional three 13t bulk liquid tankers would arrive for loading and be dispatched with liquefied chlorine each week. In the situation where the chlorine liquefaction plant at Laverton becomes non-operational, then a maximum of 50tpd would be produced. The number of 13t bulk tankers and would remain at three as the majority of the exports of liquefied chlorine would be in drums and cylinders.

Importantly, in this scenario, the approved annual production of chlorine from the IXOM CAP would remain unchanged. The only change would be how the chlorine is dispatched, either as liquified chlorine or gaseous chlorine. It is assumed for this assessment that an additional 27 truck movements could be generated from the IXOM CAP beyond the existing traffic volumes.

Additionally, the exports of liquefied chlorine from the Project would be replacing those from the chlorine liquefaction plant at Laverton, and so the net number of trucks travelling to the customers would be the same.

Current traffic volumes for the IXOM CAP consist of:

- Twice a year there is an 8-day salt delivery campaign, totalling 1,000 truck movements;
- Employees, contractors and visitors generate approximately 100 light vehicle movements per day (700 per week);
- An average of 3 deliveries per week from the IXOM plant in Laverton to IXOM CAP; and,
- An average of 25 deliveries per week from IXOM CAP to its customers.

In comparison to traffic in the wider area and servicing the surrounding industrial area, the Transport for NSW (TfNSW) Traffic Volume Viewer (**TfNSW, 2024**) shows that at Counter Station 16150, on Wentworth Avenue (which Denison St feeds into), there was an average of 365,540 vehicles per week travelling along Wentworth Avenue.

Table 7-2 compares the additional vehicle movements associated with Project (whilst a salt campaign is active) and the existing vehicle movements servicing the surrounding industrial area.

Table 7-2: Vehicle movements summary (vehicle movements/week)

Vehicle Source	Average vehicle movements/week
Employees/contractors/visitors	700
Salt campaign	875
Deliveries from Laverton to Botany CAP	6
Deliveries from Botany CAP to customers	49
Wentworth avenue traffic	365,540
Total existing traffic	**367,170**
Additional due to normal operations	6

Vehicle Source	Average vehicle movements/week
Additional due to maximum production capacity	54
Change in vehicle movements under normal operations	+0.002%
Change in vehicle movements for maximum production capacity	+0.015%

Table 7-2 shows that the additional vehicle movements from the Project represent a negligible increase to the total vehicle movements for the wider area, less than a 1% increase in vehicle movements under normal operations and for the maximum production capacity scenario.

The proposed change in traffic volumes associated with the Project is considered to be negligible relative to the approved operations and other existing dust sources in the wider area. The change in dust levels associated with the Project is unlikely to be discernible from existing dust levels and thus, have not been assessed further.

7.4.2 Chlorine

The bulk storage tanks for liquid chlorine are located within the containment building. The containment building is kept under a slight negative pressure at all times and will remain closed except when access is required (e.g. three trucks per week). A caustic scrubber is used to treat any chlorine gas release in the containment building. Chlorine when treated with caustic soda will produce sodium hypochlorite which will be stored and sold as a product. In the event of an unlikely chlorine release, treated air from the caustic scrubber is released via a stack.

IXOM has provided design specifications for the caustic scrubber as presented in **Table 7-3**

Table 7-3: Caustic scrubber design specifications (new Stack 4)

Parameters	Operating conditions
Stack Height	18.7m
Stack Diameter	0.5m
Operating Temperature	80ºC
Operating Pressure	Atm
Venting Gas Flowrate (Worst case)	10,000 m^3/h
Chlorine Concentration in Discharge Gas	Normal 1ppm

Notes: m = metres, ºC = degrees Celsius, Atm = atmosphere, m^3/h = cubic metres per hour, ppm = parts per million

Other existing approved chlorine sources at the IXOM CAP include a Hypo Backing Tower (Stack 1), an Absorption Tail Tower (Stack 2), and an Emergency Chlorine Scrubber (Stack 3). The new caustic scrubber is listed below as Stack 4.

The modelled stack parameters are summarised in **Table 7-4**.

Table 7-4: Modelled stack parameters

Stack	Easting (m)	Northing (m)	Stack height (m)	Stack diameter (m)	Temp. (ºC)	Exit velocity (m/sec)	Flow rate (Am^3/s)	Flow rate (Nm^3/s)
Stack 1	335608	6241201	12.5	0.3	25	7	0.56	0.51
Stack 2	335639	6241182	24.2	0.2	50	6	0.17	0.14
Stack 3	335671	6241122	22	0.25	25	8	0.42	0.38
Stack 4	335580	6241264	18.7	0.5	80	14.15	2.78	2.35

The modelled emission rate for each stack is based on the historical maximum measured level over the past approximately eight years. The new Stack 4 emission rate is calculated from the design specifications for the chlorine concentration under normal operations given in **Table 7-3**. These emissions are summarised in **Table 7-5** and are held constant for all hours over the year-long modelling period.

Table 7-5: Modelled stack concentrations and calculated emission rates

Source	Concentration (mg/m^3)	Emission rate (g/s)
Stack 1	10.5	0.00583
Stack 2	10	0.00167
Stack 3	149.1	0.0621
Stack 4	2.9	0.00805

In the situation where the chlorine liquefaction plant at Laverton becomes non-operational, and the Project is operating at the maximum production capacity, the total chlorine production at the IXOM CAP would remain unchanged. The only change would be the dispatch of liquified chlorine instead of gaseous chlorine. The modelled stack concentrations in **Table 7-5** are based on the historical maximum measured level and would reflect the maximum operation of IXOM CAP. The emissions associated with the Project, i.e. Stack 4, would be capable of servicing the maximum production capacity of the chlorine liquification plant. As such, the modelled emission rate in **Table 7-5** reflects the situation where the chlorine liquefaction plant at Laverton becomes non-operational, providing a conservative estimate for normal operations.

The modelled source locations for the Project are shown in **Figure 7-4**. The model includes consideration of potential "building" wake effects on air dispersion that arise due to the effect of winds passing over the buildings at the Project site, per the BPIP procedure. The wake effects from the containment building as well as surrounding buildings and selected tanks adjacent to the Hypo Backing Tower and Absorption Tail Tower were included in the model.



Figure 7-4: Modelled source locations

8 DISPERSION MODELLING RESULTS

The spatial distribution of the dispersion modelling predictions for the Project (i.e. caustic scrubber only) is presented as an isopleth diagram showing the 99.9th percentile 1-hour average ground level chlorine concentrations in **Figure 8-1.** The modelling predictions for all sources of chlorine at the site are presented in **Figure 8-2**.

Table 8-1 presents the discrete dispersion modelling results at each of the assessment locations. It accounts for contributions from both the Project (in isolation) and all other sources at the site.

The results indicate that chlorine levels due to the Project will be below the applicable criterion of 50µg/m^3 at and beyond the site boundary, including at all assessment locations.

Table 8-1: Predicted 99.9th percentile 1-hour average chlorine concentrations

Receiver ID	Concentration due to Project in isolation (µg/m^3)	Total concentration due to all sources (µg/m^3)	Criterion (µg/m^3)
Max at site boundary	1.4	10.0	**50**
IND1	0.6	2.8	**50**
IND2	0.7	3.6	**50**
IND3	0.9	3.9	**50**
IND4	0.5	6.8	**50**
R1	0.5	4.6	**50**
R2	0.5	4.2	**50**
R3	0.4	4.5	**50**

Figure 8-1 presents the 99.9th percentile of the chlorine concentration from the Project, with the maximum at the boundary being less than 2µg/m^3. Concentrations beyond the site boundary are lower than this maximum value.

A review of **Figure 8-2** indicates that the maximum 99.9th percentile of the chlorine concentration from all sources at or beyond the site boundary (where the criterion is applicable) is 10µg/m^3, which is 20% of the criterion, indicating that the concentrations are significantly below the allowable limit.

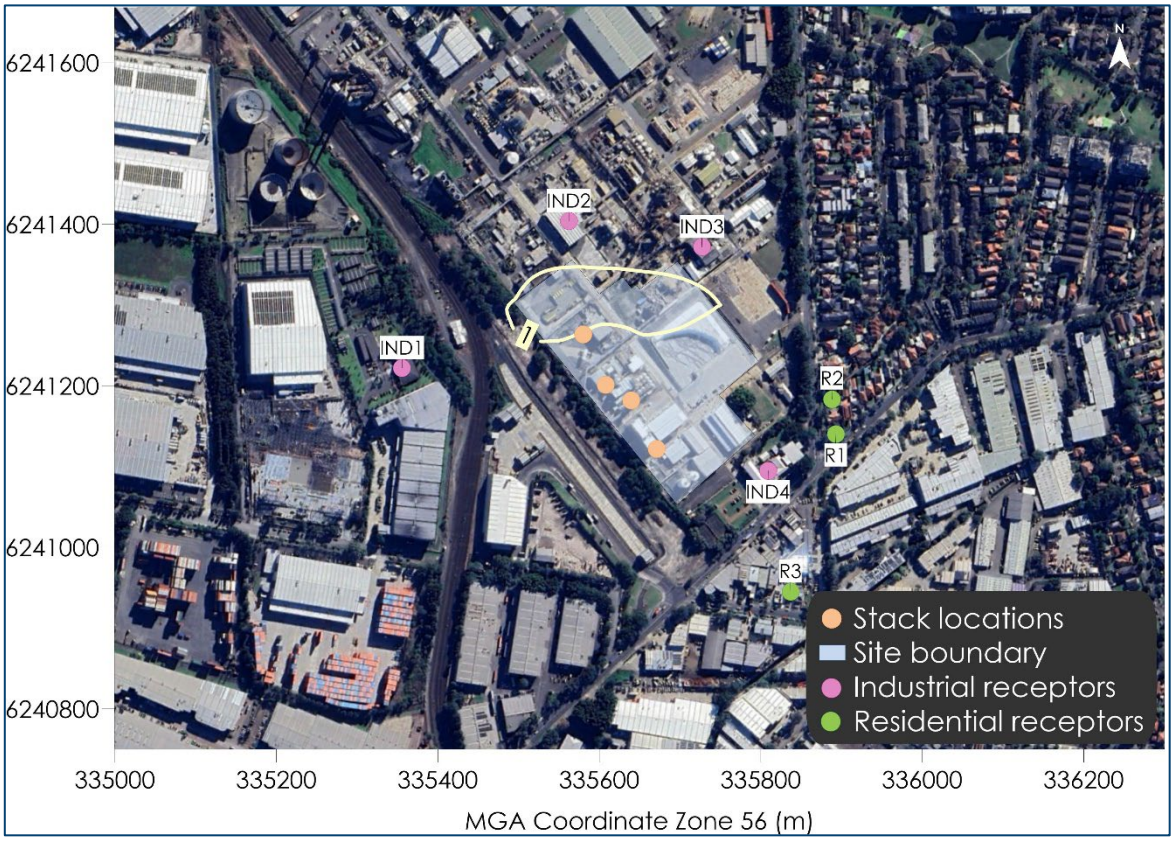


Figure 8-1: 99.9th percentile 1-hour average ground level chlorine concentrations from the Project (µg/m³)

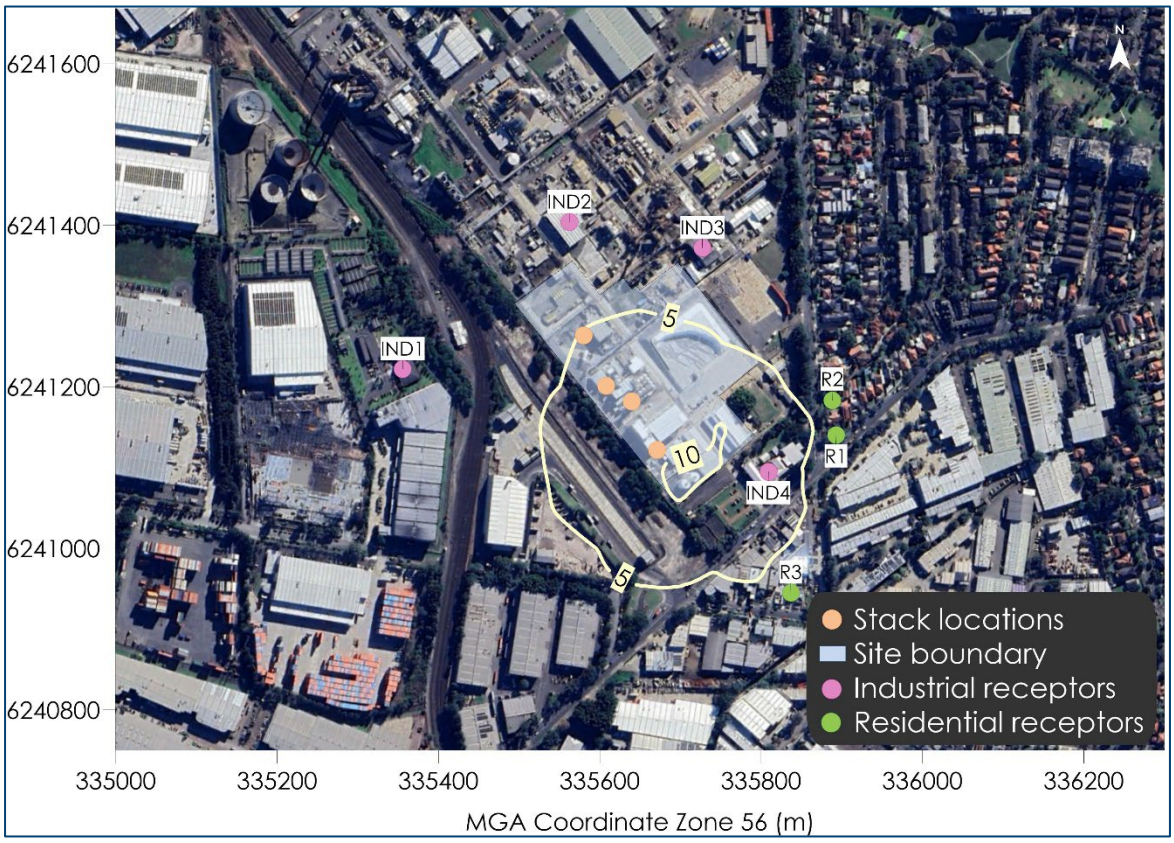


Figure 8-2: 99.9th percentile 1-hour average ground level chlorine concentrations from all sources at the site (µg/m³)

9 MITIGATION AND MANAGEMENT

A number of air quality control measures shall be incorporated into the Project which include:

- A containment building, containing the new significant sources of chlorine emissions, with the following features:
  - All doors of containment building to be closed at all times, unless required for access;
  - Chlorine scrubber, design specifications in (**Table 7-3**);
  - Slight negative pressure, maintained by the ventilation system and the caustic scrubbing system; and,
  - Gas detection system capable of identifying leaks at very low concentrations.

These air quality control measures will be used in conjunction with other air quality control measures as part of the existing operations.

10 QUANTIFICATION OF GREENHOUSE GAS EMISSIONS

The Australian National Greenhouse Accounts (NGA) Factors document published by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) defines three scopes (Scope 1, 2 and 3) for different emission categories based on whether the emissions are from "direct" or "indirect" sources.

Scope 1 emissions encompass the direct sources from the Project defined as:

> "*...produced from sources within the boundary of an organisation and as a result of that organisation's activities*" (**DCCEEW, 2025a**).

Scope 2 emissions are produced by the burning of fossil fuels to generate electricity and defined as:

> "*...indirect emissions which occur as a result of activities that generate electricity, heating, cooling or stream that is consumed by an organisation but which is generated outside that organisation's boundaries*" (**DCCEEW, 2025a**).

Scope 3 emissions are other indirect emissions which:

> "*...occur outside of the boundary of an organisation as a result of actions by the organisation*" (**DCCEEW, 2025a**).

For the purpose of this assessment, emissions generated in all three scopes defined above provide a suitable approximation of the total greenhouse gas (GHG) emissions generated from the Project.

10.1 Assessment boundary

The GHG assessment boundary for the Project encompasses key Scope 1, Scope2 and Scope 3 emissions sources from the operation of the IXOM CAP and the chlorine liquefaction plant.

Scope 1 emission sources are the combustion of diesel fuel and liquefied petroleum gas (LPG).

Scope 2 emission sources are associated with the on-site consumption of electricity.

Scope 3 emissions have been identified as resulting from the purchase of consumables for use on-site and the transport of the product material (i.e. liquefied chlorine).

Scope 3 emissions can be a significant component of the total emissions inventory; however, these emissions are often not directly controlled by the operation. These emissions are understood to be considered in the Scope 1 emissions from other various organisations related to the Project. Other Scope 3 emissions also arise from a number of other sources indirectly associated with the operation of the Project such as emissions generated by employees travelling to and from the site. These relatively minor individual contributions are difficult to accurately quantify due to the diversity and nature of the sources and have not been considered further in this assessment.

Three scenarios have been identified as follows:

- Business-as-usual scenario – operation of the IXOM CAP at the maximum approved production rate of 35,000tpa of gaseous chlorine;

- Project Only scenario – operation of the chlorine liquefaction plant (i.e. the Project) at maximum rate of 18,250tpa; and,
- Modified business scenario – concurrent operation of both the IXOM CAP and the chlorine liquefaction plant at their respective maximum production rates (i.e. Business-as-usual plus Project Only).

10.2 Emission sources

The Proponent has provided estimates of the quantities of materials consumed at the IXOM CAP for the FY25 period, together with the corresponding chlorine production. These values have been scaled linearly to represent a maximum chlorine production of 35,000 tpa under the business-as-usual scenario.

Historically, steam required for IXOM CAP operations was sourced from neighbouring facilities. This arrangement is expected to cease, with steam to be generated on-site in the future, resulting in increased LPG consumption. This increase has been accounted for in the material estimates for the business-as-usual scenario.

The estimated electricity consumption for the Project was also provided by the Proponent and is based on the actual power requirements of the equipment used for liquefied chlorine production. Annual electricity usage has been estimated assuming continuous operation at the maximum production rate over a full year.

The liquefied chlorine produced at the Project would be primarily delivered to customers in the Sydney region. The quantity of diesel fuel required to transport the liquefied chlorine to and from site has been estimated based on an approximate return travel distance to Prospect (111.6km return) and Warragamba (149.8km return) using 13t tanker trucks. To estimate the consumption of diesel fuel required, the average fuel consumption of 53.1L/100km for articulated trucks is applied (**ABS, 2024**) assuming 702 trips to each destination.

Table 10-1 presents a summary of the estimated quantities of materials.

Table 10-1: Summary of the estimated quantities of materials

Scenario	Business-as-usual	Project Only	Modified-business
Chlorine production (t)	35,000	18,250 as liquified	35,000 (including 18,250 as liquified)
LPG (kL)	2,711	-	2,711
Diesel (kL)	31	-	31
Electricity (kWh)	98,201,345	4,154,386	102,355,731
Diesel – Transport (kL)	-	97	97

10.3 Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the Project, emission factors were obtained from the NGA Factors (**DEECCW, 2025b**) and *Australia's emissions projections 2025* (**DCCEEW, 2025c**) documents. Emission factors for LPG, diesel and diesel - transport are summarised in **Table 10-2**.

Table 10-2: Summary of emission factors

Type	Energy content factor (GJ/kL)	Emission factor			Units	Scope
		CO_2	CH_4	N_2O		
LPG	25.7	60.2	0.2	0.2	kg CO_2-e/GJ	1
		20.2	-	-		3
Diesel	38.6	69.9	0.1	0.2	kg CO_2-e/GJ	1
		17.3	-	-		3
Diesel – Transport (Euro iv or higher)	38.6	69.9	0.07	0.4	kg CO_2-e/GJ	1
		17.3				3

Note: GJ = gigajoule, GJ/kL = gigajoule per kilolitre, kg CO_2-e = kilograms of carbon dioxide equivalent, CO_2 = Carbon Dioxide, CH_4 = Methane and N_2O = Nitrous Oxide

Emission factors for electricity usage are based on projections for the decarbonising of the NSW electricity grid overtime. The projected Scope 2 and 3 emissions factors for electricity usage for 2026 are presented in **Table 10-3**.

Table 10-3: Summary of emission factors for electricity usage (t of CO_2-e per MWh)

Period	Scope 2	Scope 2 and 3	Scope 3 *
2026	0.55	0.57	0.02

Source: **DCCEEW (2025c)**

* Calculated by subtracting the Scope 2 column from the Scope 2 and 3 column.

Note: The emission factors for electricity usage are based off calendar years but have been used to calculate emissions from electricity usage on a financial year basis.

10.4 Estimated greenhouse gas emissions

Table 10-4 presents a summary of the estimated annual CO_2-e emissions for the business-as-usual, Project Only and Modified business scenarios.

The estimated change in Scope 1 emissions for the Modified business scenario arises due to the additional diesel used to transport the liquefied chlorine. For Scope 2 emissions, there is an increase associated with the operation of the chlorine liquefaction plant.

The Project Only scenario indicates a maximum annual Scope 1 and Scope 2 emissions of 2,550 t CO_2-e, which is below the threshold of 25,000 t CO_2-e in accordance with the *NSW Guide for Large Emitters* (**NSW EPA, 2025**).

Table 10-4: Summary of estimated CO_2-e emissions for the Project (t CO_2-e)

Scenario	Business-as-usual	Project only	Modified business
Scope 1 emissions			
LPG	4,222	-	4,222
Diesel oil	84	-	84
Diesel - transport	-	265	265
Scope 2 emissions			
Electricity	54,011	2,285	56,296
Scope 3 emissions			
LPG	1,407	-	1,407
Diesel oil	21	-	21
Diesel - transport	-	65	65
Electricity	1,964	83	2,047
Summary			
Scope 1	4,306	265	4,571
Scope 2	54,011	2,285	56,296
Scope 3	3,392	148	3,540
Scope 1+2	58,317	2,550	60,867

10.5 Contribution of greenhouse gas emissions

The estimated annual GHG emissions for Australia for the year to June 2025 was 437.5 million tonnes of carbon dioxide equivalent (Mt CO_2-e) (**DCCEEW, 2025d**). In comparison, the estimated annual average GHG emission for the Project Only scenario is 0.003 Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of GHG emissions from the Project Only scenario in comparison to the Australian GHG emissions for the 2025 period is estimated to be approximately 0.0006%.

At a state level, the estimated GHG emissions for NSW in the FY23 period were 114.45 Mt CO_2-e (**DCCEEW, 2025a**). The annual contribution of GHG emissions from the Project Only scenario in comparison to the NSW GHG emissions for the FY23 period is estimated to be approximately 0.0022%.

10.6 Greenhouse gas abatement measures

It is recommended that IXOM considers a range of best-practice greenhouse gas abatement measures to apply to the Project which include:

- Service and maintain all machinery, as far as reasonably practical, in accordance with original equipment manufacturer recommendations for maintenance.
- Undertake periodic reviews of technologies and abatement measures to reduce GHG emissions from the Project, including whether these measures are reasonable and feasible to implement at the IXOM CAP.
- Continue to monitor, report and audit greenhouse gas emissions in accordance with the requirements of the Clean Energy Regulator (NGERS).

11 SUMMARY AND CONCLUSIONS

This report presents an assessment of the potential air quality impacts associated with the proposed operation of the chlorine liquefaction plant at IXOM CAP at Banksmeadow.

Air dispersion modelling using the CALPUFF model was applied to predict the potential chlorine impacts due to the operation of the Project. The modelling applies a conservative assumption of chlorine emission rates for the site operations to provide a reasonable worst-case assessment which covers normal operations and the scenario in which the chlorine liquefaction plant at Laverton becomes non-operational and customer supply for water treatment is required to continue.

It is predicted that all the assessed air pollutants generated by the operation of the Project would comply with the relevant assessment criteria at the applicable receptor locations and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area. The predicted concentrations of chlorine at sensitive residential receptors are less than 10% of the applicable criteria during normal operations, and would likely be far lower in reality, noting that the maximum measured concentrations are modelled at all times for all existing sources. This reflects the situation where the Project is operating at the maximum production capacity in the situation where the chlorine liquefaction plant at Laverton becomes non-operational.

An assessment of potential construction dust impacts indicates only a low risk of impact arising and standard construction dust mitigation measures are recommended to be implemented.

An estimate of the potential greenhouse gas emissions of the Project indicates the estimated annual GHG emission for the Project Only scenario is 0.003 Mt CO_2-e (Scope 1 and 2). In comparison to the Australian GHG emissions for the year to June 2025 period is estimated to be approximately 0.0006% and the NSW GHG emissions for the FY23 period is estimated to be approximately 0.0022%.

Overall, the assessment demonstrates that the Project can operate without causing any significant air quality impact at residential receptor locations in the surrounding environment. The site would apply the air quality management measures as set out in this report to minimise air emissions from the site and ensure no impacts arise.

12 REFERENCES

ABS (2024)

Survey of Motor Vehicle Use, Australia, Australian Bureau of Statistics website, accessed October 2024.
https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/latest-release

Bureau of Meteorology (2024)

Climate statistics for Australian locations, Bureau of Meteorology website, accessed June 2024.
http://www.bom.gov.au/climate/data/index.shtml

DCCEEW (2025a)

"State and Territory greenhouse gas inventories: 2023 emissions", prepared by the Department of Climate Change, Energy, the Environment and Water [DCCEEW], May 2025.

DCCEEW (2025b)

"Australian National Greenhouse Accounts Factors – For individuals and organisations estimating greenhouse gas emissions 2025", prepared by the Department of Climate Change, Energy, the Environment and Water [DCCEEW], August 2025.

DCCEEW (2025c)

"Australia's emissions projections 2025" prepared by the Department of Climate Change, Energy, the Environment and Water [DCCEEW], November 2023.

DCCEEW (2025d)

"National Greenhouse Gas Inventory Quarterly Update: June 2025", prepared by the Department of Climate Change, Energy, the Environment and Water [DCCEEW], December 2025.

IAQM (2024)

"Guidance on the assessment of dust from demolition and construction", Institute of Air Quality Management, January 2024

NSW EPA (2022)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, August 2022.

NSW EPA (2025)

"NSW Guide for Large Emitters", NSW Environmental Protection Authority, January 2025.

TfNSW (2024)

Traffic Volume Viewer, Transport for NSW website, accessed September 2024.
https://maps.transport.nsw.gov.au/egeomaps/traffic-volumes/index.html#/?z=6

TRC (2011)

"Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

Appendix A

Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest five contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Sydney Airport AMO is presented in **Table A-1**.

The standard deviation of the latest five years of meteorological data spanning 2019 to 2023 was analysed against the available measured wind speed, temperature and relative humidity. The analysis indicates that the 2023 dataset is closest to the mean for wind speed, the 2022 dataset is closest to the mean for temperature and the 2020 dataset is closest to the mean for relative humidity. On the basis of a score weighting analysis, 2020 was found to be most representative.

Table A-1: Statistical analysis results for Sydney Airport AMO

Year	Wind speed	Temperature	Relative humidity	Score
2019	0.9	1.1	4.1	6.1
2020	0.8	0.7	2.6	4.1
2021	0.8	0.5	3.4	4.7
2022	0.9	0.4	4.6	5.9
2023	0.7	0.9	4.3	5.9

Figure A-1 shows the frequency distributions for wind speed, wind direction, temperature and relative humidity for the 2020 year compared with the mean of the 2019 to 2023 data sets. The 2020 year data appear to be well aligned with the mean data.

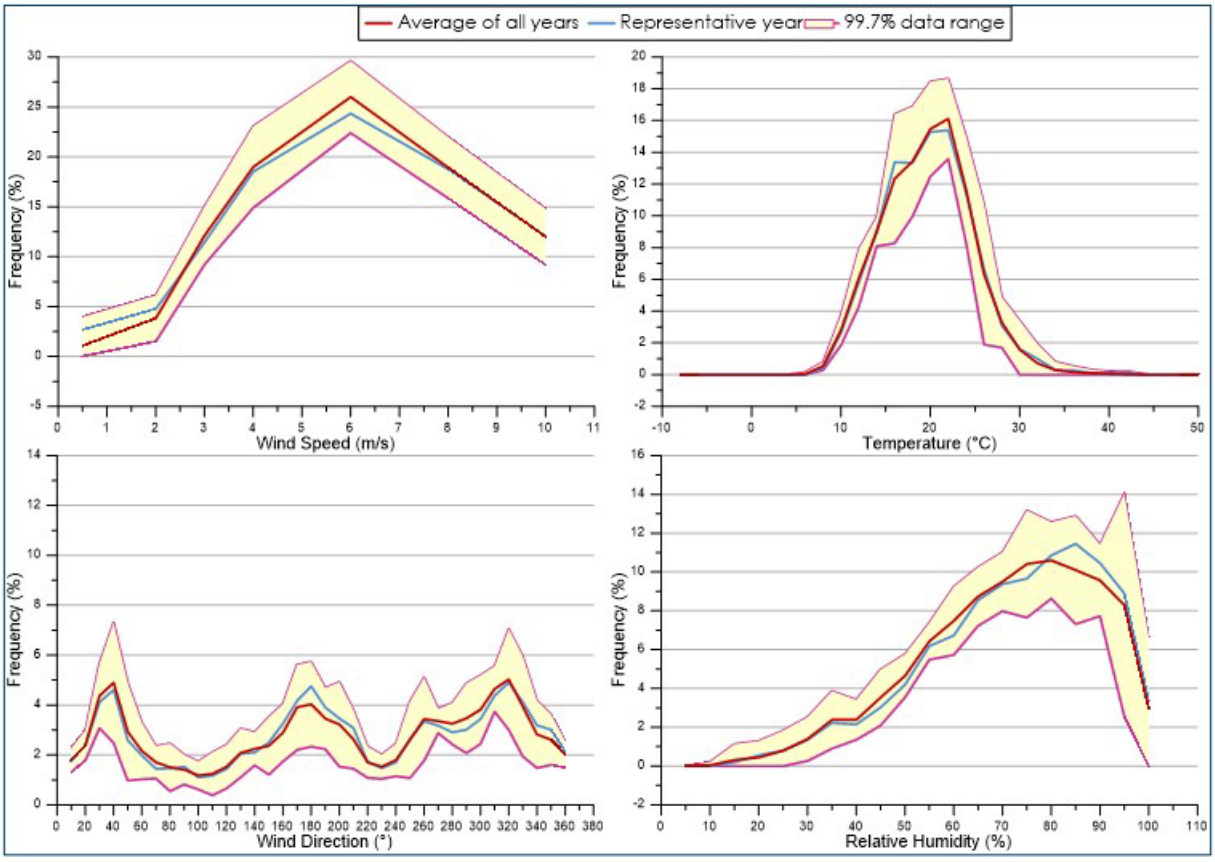


Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Sensitivity modelling - SCICHEM

Introduction

Sensitivity modelling using the SCICHEM model has been conducted to compare the CALPUFF modelling predictions.

The SCIPUFF with chemistry SCICHEM model, is an advanced air dispersion model capable of modelling gas phase, aqueous and aerosol phase chemistry within the model. Importantly it can account for dense gas effects, unlike the more standardly used CALPUFF modelling system.

It is a probabilistic model, so in addition to the expected concentration, it also provides a measure of the uncertainty in the modelling due to turbulent effects.

Modelling methodology

The same WRF meteorological data used for the CALPUFF/CALMET modelling was also applied to the SCICHEM model.

The SCICHEM was run with the following settings:

- Building downwash effects included, as they were in the CALPUFF model;
- Quasi-static calculations turned off;
- Dense gas effects included;
- No chemistry was modelled; and,
- No deposition modelled, for consistency with the CALPUFF modelling.

The same source parameters and constant emission rates that were used in the CALPUFF model were used in SCICHEM.

Dispersion Modelling Results

Given the SCICHEM model is probabilistic, for simplicity, the 99.9th percentile of the expected concentration is used in this report for comparison with the criterion, which is for the 99.9th percentile of the concentrations in the modelling period.

It is expected that, in general, there will be higher chlorine concentrations near the site in the SCICHEM modelling predictions due to dense gas effects being modelled, however given the low emission rates, it is not expected that certain features of dense gas dispersion, such as an increased horizontal spread, will be evident in the modelling due to the emissions not significantly changing the density of the air.

Figure B-1 presents a comparison of the predicted 99.9th percentile 1-hour average chlorine concentrations from all sources at the site for SCICHEM (blue isopleth) and CALPUFF (yellow isopleth). The maximum predicted 99.9th percentile chlorine concentration at the site boundary for the SCICHEM modelling is 11.5µg/m^3, which is below the 50µg/m^3 limit.

Due to the two models generating slightly different wind fields, there is some expected difference in the maximum predicted levels, nevertheless SCICHEM does indicate slightly higher concentrations as expected for the dispersion of a dense gas.

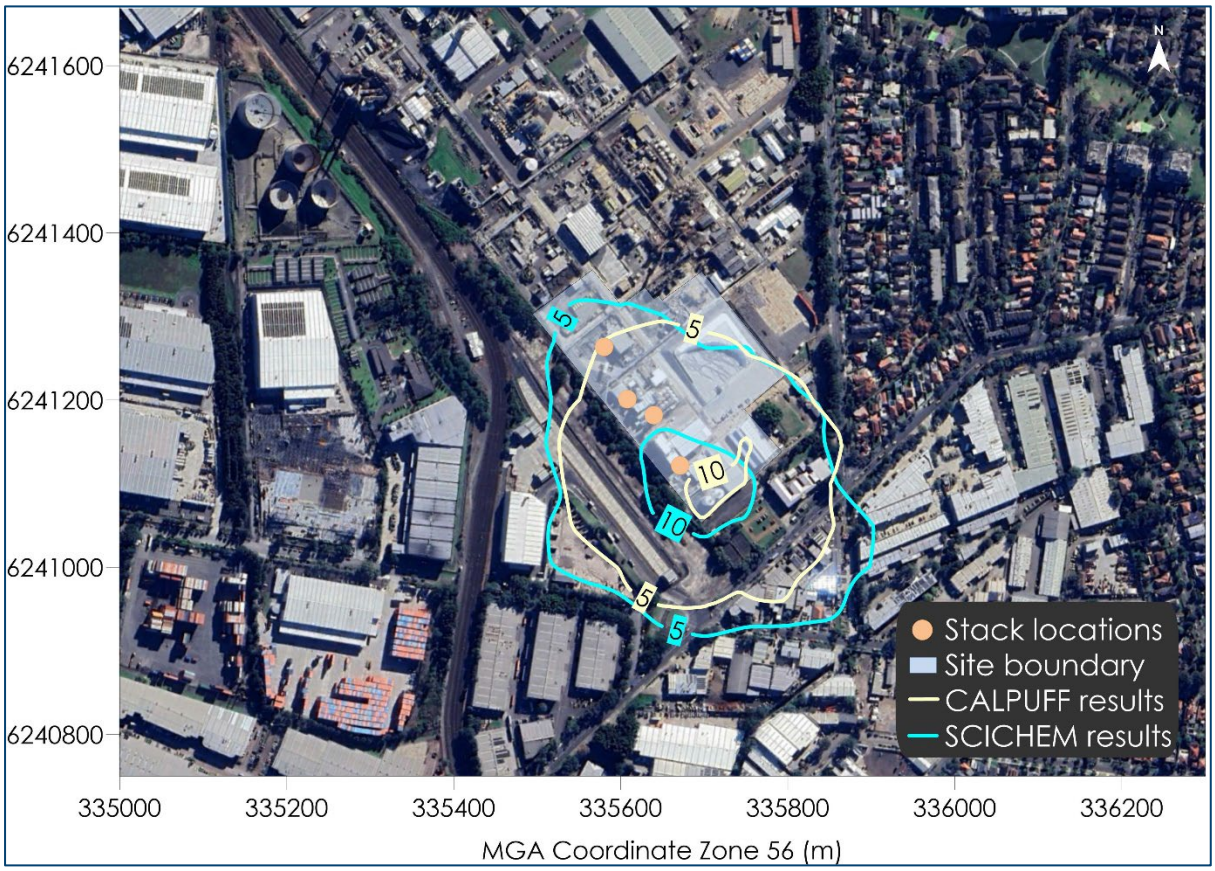


Figure B-1: SCICHEM 99.9th percentile chlorine concentrations from total site (µg/m³)

For further sensitivity testing, **Figure B-2** presents the precited annual average concentrations of chlorine for SCICHEM and CALPUFF.

We note that there are no applicable impact assessment criteria for annual average chlorine levels. Additionally, the predicted annual averages may not reflect actual conditions, as the modelling is based on every hour of the year using the highest recorded emission rates. The figure is presented for the sole purpose of comparing the SCICHEM and CALPUFF results.

The annual averages are not as sensitive to the slightly different wind fields between the models as the 99.9th percentiles are, and so, provide a more robust comparison. As expected from the dense gas effects, the comparison shows a slightly higher predicted level of impact for SCICHEM compared to CALPUFF.

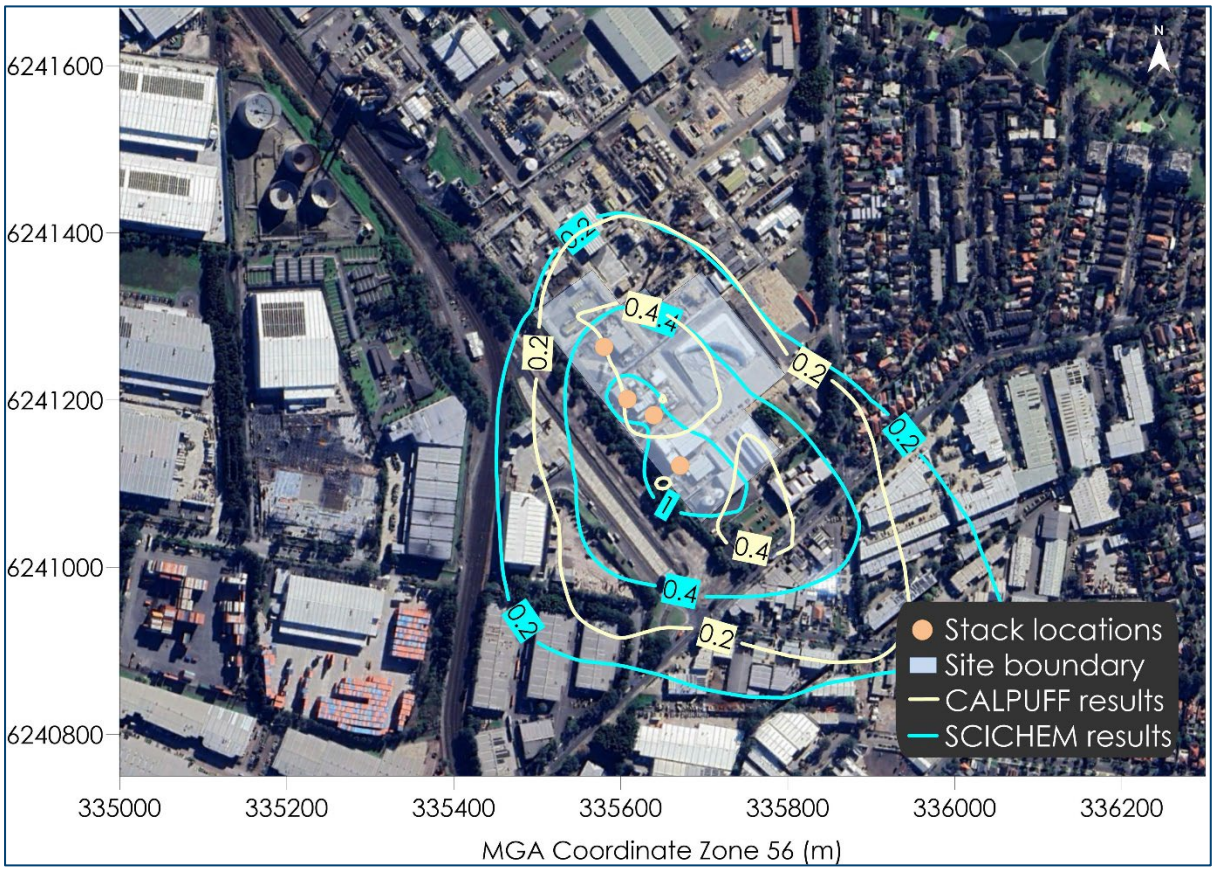


Figure B-2: SCICHEM annual average chlorine concentrations from total site (µg/m³)



APPENDIX F

INTERIM AUDIT ADVICE

RAMBOLL

ENVIRONMENT
& HEALTH

17 February 2026

IXOM Operations Pty Ltd
Attn: Giuliano Di Fabio
Level 8, 1 Nicholson Street
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By email: giuliano.di.fabio@ixom.com

Dear Giuliano,

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Level 3, 100 Pacific Highway
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Ref: 318002494

Audit Number: TO-163

RE: INTERIM AUDIT ADVICE LETTER NO. 1 - DA35/98-MOD-6, REMEDIATION ACTION PLAN, NEW CHLORINE LIQUEFACTION PLANT, DENISON STREET, BANKSMEADOW, NSW

1. INTRODUCTION

1.1. Background

As a NSW Environment Protection Authority (EPA) accredited Contaminated Sites Auditor, I am conducting an Audit (TO-163) under the NSW *Contaminated Land Management Act 1997* (CLM Act) in relation to the subject site.

IXOM Operations Pty Ltd (IXOM) proposes to construct and operate a new chlorine liquification plant at its Botany Chlor-Alkali Plant (CAP) located within the Botany Industrial Park (BIP) at Denison Street, Banksmeadow NSW, 2019. The subject site is the footprint of the proposed development which encompasses two separate areas (**Attachment 1**) within the CAP (**Attachment 2a**) and is located predominantly with an area referred to as Block L (**Attachment 4**)[1].

A modification application (MOD 6) for the State Significant Development (SSD) (DA35/98-Mod-6) for the project was referred to the NSW EPA and Randwick City Council (amongst others) for government authority advice.

The advice from the NSW EPA includes *"Where contamination is found and requires either a detailed site investigation, remediation or further human health or ecological risk assessments, a NSW EPA accredited Site Auditor must be engaged to carry out an independent audit of the work".*

Randwick City Council also recommended that *"…prior to determination of the modification, verification from a NSW EPA accredited site auditor via a site*

[1] While the land in this area is owned by Orica Australia Pty Ltd (Orica), the CAP has been owned and operated by Ixom Operations Pty Ltd since 2015.

Ramboll Australia Pty Ltd
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audit statement (SAS B) should be provided up front confirming that the proposed remediation is appropriate for the identified contamination and will not result in greater environmental or human health risks than leaving the site undisturbed. In addition, the proposed environmental management plan referred to in the proponents remediation assessment should be developed and reviewed by the NSW EPA accredited site auditor to confirm that the plan is reasonable and feasible in addressing the site-specific contamination and health risks".

JBS&G Australia Pty Ltd (JBS&G) has completed a detailed site investigation (DSI) and remediation action plan (RAP) in which the broad remedial scope includes site capping (to address asbestos) and application of a vapour membrane under the future building to address mercury and chlorinated hydrocarbon (CHC) vapours.

1.2. Objective of Site Audit

The overall objective of the Audit is anticipated to be an assessment of the suitability of the site for the proposed land use subject to the proposed ongoing management (i.e. a Section A2 Site Audit). The Audit is currently a recommendation of advice from EPA and Randwick Council and is therefore currently non-statutory. It is anticipated that the Audit will become statutory upon approval of MOD 6 by the Department of Planning, Housing and Infrastructure.

1.3. Objective of IAA #1

IXOM require this Interim Audit Advice No. 1 (IAA #1) to support the MOD 6 SSD submission and address the requests from NSW EPA and Randwick City Council by providing an independent review of the suitability and appropriateness of the RAP.

1.4. Scope of Audit

The scope of IAA #1 includes:

- Review of the following documents:
  - 'Detailed Site Investigation, New Chlorine Liquefaction Plant, Denison Street, Banksmeadow, NSW', dated 20 January 2026, JBS&G (**the DSI**).
  - 'Remedial Action Plan, New Chlorine Liquefaction Plant, Denison Street, Banksmeadow, NSW', dated 5 February 2026, JBS&G (**the RAP**).
- Reference to the following additional publicly available documents relating to nearby land and/or the BIP:
  - Site Audit Statement no. SA313/1 and 'Blocks A and M, Former ChlorAlkali Plant, Botany Industrial Park', C. M. Jewell & Associates Pty Ltd, 13 July 2012 (Section B SAS determining appropriateness of a RAP to address mercury contamination on land to the north and east of the site)
  - Site Audit Statement no. SA313/4 and 'Block G, Former ChlorAlkali Plant, Botany Industrial Park', C. M. Jewell & Associates Pty Ltd, 29 January 2014 (Section B SAS determining remediation of mercury contamination in shallow soils to the east of the site was adequately completed)
  - Site Audit Statement no. SA313/2 and 'Block G, Former ChlorAlkali Plant, Botany Industrial Park', C. M. Jewell & Associates Pty Ltd, 9 May 2017 (Section B SAS determining appropriateness of a concept RAP for capping and containment of mercury)
  - Site Audit Statement no. SA313/5 and 'Block G, Former ChlorAlkali Plant, Botany Industrial Park', C. M. Jewell & Associates Pty Ltd, 9 May 2017 (Section B SAS determining adequate installation of a cut off wall and capping system for mercury and appropriateness of the long-term environmental management plan for Block G)

- 'Former ChlorAlkali Plant, Human Health and Environmental Risk Assessment – 2013', Environmental Risk Sciences Pty Ltd, 20 June 2013 (**EnRiskS 2013**). This document was listed on SA313/4 and SA313/5 and was therefore reviewed by Chris Jewell as part of his Audit. This document was also the subject of a peer review referenced below. The DSI refers to risk-based assessment criteria for mercury from this document.
- 'Peer review: EnRiskS 2013 report on health & environmental risks associated with the former Chloralkali plant (FCAP)', 3 July 2013, Brian G. Priestly PhD, Monash University (**the Peer Review of EnRiskS (2013)**).
- Site Audit Statement no. SA313/3 and 'Site Audit, Blocks A and M, Former ChlorAlkali Plant, Botany Industrial Park', C. M. Jewell & Associates Pty Ltd, 19 December 2013 (**the 2013 Site Audit**).
- Site Audit Statement no. 313/4 and 'Site Audit, Excavation of Shallow Impacted Soils, Block G, Former ChlorAlkali Plant, Botany Industrial Park', C. M. Jewell & Associates Pty Ltd, 29 January 2014 (**the 2014 Site Audit**).
- 'Conceptual Site Model Orica Botany', 25 May 2022, Orica Australia Pty Ltd (**Orica CSM 2022**).
- 'Post-Remediation Biennial Groundwater Monitoring Event: December 2022, Former ChlorAlkali Plant, Botany Industrial Park', WSP Golder Associates Pty Ltd, 30 March 2023 (**WSP 2023**).
- 'Chlorine Liquification Plant, Modification to State Significant Development Consent, Modification Report', 13 August 2025, Element Environment Pty Ltd.

- Discussions with IXOM and JBS&G.
- A site inspection by the Auditor on 10 February 2026.
- JBS&G note that URS completed investigations within Block L (refer **Section 3**) in 2007 on behalf of Orica. These reports were not provided to JBS&G (or the Auditor).

I have reviewed the key documents against the requirements of guidelines made or approved under Section 105 of the CLM Act and other relevant documents, including the following:

- National Health and Medical Research Council (NHMRC) (2008) *'Guidelines for Managing Risks in Recreational Water'*
- NHMRC and Natural Resource Management Ministerial Council of Australia and New Zealand (2011) *'Australian Drinking Water Guidelines'*
- National Environment Protection Council (NEPC) *'National Environment Protection (Assessment of Site Contamination) Measure 1999'*, as Amended 2013
- NSW EPA (2015) *'Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997'*
- NSW EPA (2017) *'Guidelines for the NSW Site Auditor Scheme (3rd Edition)'*
- Australian and New Zealand Guidelines (ANZG) (2018) *'Guidelines for Fresh and Marine Water Quality'*
- NSW EPA (2020) *'Contaminated Land Guidelines, Consultants Reporting on Contaminated Land'*
- Chapter 4 Remediation of Land in the Resilience and Hazards State Environment Planning Policy (SEPP) (2021) (SEPP R&H, formerly known as SEPP 55) and NSW Department of Urban Affairs and Planning and NSW EPA (1998) *'Managing Land Contamination, Planning Guidelines SEPP 55 – Remediation of Land'*

- Western Australia Department of Health (2021) *'Guidelines for the assessment, remediation and management of asbestos contaminated sites'*
- NSW EPA (2022a) *'Contaminated Land Guidelines, Sampling design part 1 – application'* and *'Contaminated Land Guidelines, Sampling design part 2 – interpretation'*
- NSW EPA (2022b) *'Contaminated Land Consultant Certification Policy'*
- Australia and New Zealand Heads of EPAs (HEPA) (2025) *'PFAS National Environmental Management Plan, Version 3.0'*.

1.5. Regulation of BIP-related Contamination

The NSW EPA issued Orica with Notice of Clean Up Action (NCUA) No. 1030236 on 26 September 2003, under the *Protection of the Environment Operations Act 1997* (POEO Act) which applied to the BIP, inclusive of the site. The boundary of the BIP is shown on **Attachment 2b**. The NSW EPA also declared the land to be a remediation site under the CLM Act on 9 February 2005 (Notice No. 21074), with subsequent notices repealing the declaration on portions of land surrounding the BIP as they have been remediated and developed.

Following effective completion of the principal actions require by the NCUA, and consultation with the community and Orica, the NSW EPA determined that the project would be best managed by a Voluntary Management Proposal (VMP) under the CLM Act.

The current VMP was issued by the EPA on 24 September 2025 (No. 20251708). Orica are the Proponent under the VMP. The VMP is the current regulatory tool governing implementation of the 'Botany Groundwater Cleanup' (BGC) Project (**Section 1.6**).

The substances of concern named in the VMP are a range of volatile chlorinated hydrocarbons (VCH) inclusive of carbon tetrachloride (CTC), methylene chloride (DCM), chloroform (CFM), chloromethane, 1,1,1-trichloroethane (1,1,1-TCA), 1,1,2-trichloroethane (1,1,2-TCA), 1,1,1,2-tetrachloroethane (1,1,1,2-TeCA), 1,1,2,2-TeCA, 1,2-dichloroethane (1,2-DCA or EDC), chloroethane, cis-1,2-dichloroethene (cis-1,2-DCE), tetrachloroethene (PCE), trans-1,2-dichloroethene (trans-1,2-DCE), trichloroethene (TCE) and vinyl chloride (VC). It also applies to a range of semi-volatile chlorinated hydrocarbons inclusive of 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, 1,3,5-trichlorobenzene, 1,2,4,5-tetrachlorobenzene, pentachlorobenzene, hexachlorobenzene (HCB), hexachlorobutadiene (HCBD), hexachlorocyclopentadiene, hexachloroethane (HCE) and hexachloropropylene. These are referred to as the "BIP-related" contaminants.

The BGC Project addresses BIP-related contamination issues. The overall remediation strategy, as required by various regulatory mechanisms discussed briefly above, has been a risk-based approach to:

- Protect human health and environmental receptors via hydraulic containment of the CHC plumes and source areas and administrative measures.
- Monitor the nature and extent of contamination to identify potential exposure pathways that require management.
- Investigate potential technologies to remediate CHC source zones and plumes.

A revised Groundwater Remediation and Management Plan (GRAMP) (Orica, 2025) and the Groundwater Treatment Plant, Proposed Groundwater and Surface Water Monitoring Program, 2025-2029 support the VMP and outline management of the hydraulic containment and groundwater treatment plant (GTP) discussed below and associated surface water and groundwater monitoring requirements for the BIP.

1.6. Botany Groundwater Cleanup

BIP-related contamination is managed in accordance with the VMP. Orica is required to address risks associated with migration of their contamination from the BIP and is currently undertaking additional

investigations and assessments across the BIP to determine future remediation and ongoing monitoring requirements. We understand that this is likely to require access to the site.

Orica's approach for remediation of BIP-related contamination, as per the requirements of the NCUA and the subsequent VMP, has comprised:

- Containment of dissolved phase chlorinated hydrocarbon plumes on- and off-site to ensure risks to human health and the environment remain acceptable.
- Continual optimisation of operation of the hydraulic containment lines and GTP for protection of critical human health and environmental exposures and for gradual cleanup of contamination in selected areas.
- Improvements to the hydraulic containment system and GTP to further reduce impacts on Springvale Drain and Penrhyn Estuary/Botany Bay.
- Ongoing review of developments in remediation technologies and experience for dense non-aqueous phase liquid (DNAPL), soil and groundwater phase CHC, and their practical application to the BGC Project.

Containment of dissolved phase CHC plumes within the Declaration Area is achieved by:

- Groundwater extraction (with ex situ treatment) from the Botany Sands aquifer along the south-western boundary of the BIP (1st and 2nd Streets), the southern boundary of former Orica Southlands along McPherson Street and along Foreshore Road.
- Groundwater extracted is pumped to a purpose-built GTP located on the Orica-owned portion of the BIP.
- Performance monitoring at the GTP and monitoring of water levels and water quality within the aquifer is ongoing.

This system is often collectively referred to as the 'GTP system' or 'hydraulic containment system'. The boundary of the BIP, the principle inferred CHC source areas, plumes, and hydraulic containment lines extracted from the Orica CSM 2022 are presented as **Attachment 2b** and discussed further in **Section 1.5**.

The effectiveness of hydraulic containment is regularly reviewed (initially quarterly and then biannually since 2017) as part of compliance monitoring under the GTP monitoring program. A range of remedial options have been considered to address DNAPL impacted areas, however, none to date have been found to be effective or appropriate for full scale implementation. However, strategies and technologies continue to be reviewed by Orica as part of the commitments under the VMP.

1.7. Former Chlor-Alkali Plant (FCAP) Remediation and Regulation (Offsite in Blocks A, M and G)

The CAP was commissioned in 2001 to produce 35,000 tonnes per annum of gaseous chlorine and caustic soda through the electrolysis of salt using a mercury-free membrane technology. The CAP replaced the former CAP (FCAP) that was based on mercury cell technology. The FCAP site is comprised of Blocks G, L, M and A.

The 2013 and 2014 Site Audits by Chris Jewell (of C. M. Jewell & Associates Pty Ltd) as summarised by JBS&G in the DSI, indicate that investigations of the FCAP (2006–2009) revealed elemental and inorganic mercury in soil and groundwater beneath and downgradient of the FCAP. On 10 July 2009, the NSW EPA confirmed the contamination warranted regulation under the CLM Act. Orica committed to remediation through a VMP.

Orica submitted a VMP on 11 April 2011, focusing on remediation of Blocks M and G of the former CAP (**Attachment 4**).

Initial remediation efforts began in May 2011 with soil excavation and onsite soil washing being trialled on Block G. However, the process did not meet remediation objectives, leading Orica to suspend works in August 2011.

On 6 January 2012, the NSW EPA revoked the VMP and issued Management Order No. 20111406, requiring a new remediation framework. Golder Associates prepared a Remedial Options Appraisal Report (April 2012) recommending capping and containment of mercury impacted soils on Block G and excavation and offsite disposal for mercury "hotspots" in Blocks A and M (**Attachment 4**).

Excavation and offsite disposal of mercury-impacted soils to the extent practicable was completed on Blocks A and M.

A new Management Order (20131406) set objectives for implementing remediation on Block G, requiring excavation and offsite disposal of mercury impacts in shallow soils on Block G. These remedial works were completed to the extent practicable between September and November 2013. Residual mercury impacted soils on Block G were managed through a cap and contain system, that included the construction a slurry-wall extending to bedrock, around the whole of Block G.

At the completion of remediation works in accordance with the Management Order (20131406), the NSW EPA issued an Ongoing Maintenance Order (20172802) in accordance with Section 28 of the CLM Act. The order requires:

a) Maintain the ground surface of Blocks A and M in accordance with the Orica Former ChlorAlkali Plant Remediation Project, Blocks A & M Long Term Site Environmental Management Plan, 20 December 2013

b) Maintain the encapsulation cell on Block G of the Botany Industrial Park in accordance with the Orica Australia Pty Ltd, Block G Long-Term Site Environmental Management Plan, 31 January 2017

c) Monitor the mercury vapours within Block G in accordance with Orica Australia Pty Ltd, Block G Air Monitoring Plan, 31 January 2017

d) Monitor the groundwater levels and chemistry within and adjacent to Block G in accordance with the Golder Associates, Former ChlorAlkali Plant, Botany Industrial Park, Post-Remediation Groundwater Monitoring, 31 January 2017

e) Report to the EPA as soon as practicable any incident that may adversely affect the integrity of the encapsulation structure on Block G, the surface of Blocks A or M or cause migration of contaminants to the environment

f) Submit to the EPA annually, due by 31 March each year, a written report of compliance with this Notice detailing any instances of non-compliance, and potential changes to the long term management plans, including the monitoring programs and the results of any vapour and water quality monitoring.

The Auditor notes Blocks A, M and G are offsite with respect to the site. It is noted that no potential mercury contamination issues requiring regulation under the CLM Act were identified in relation to Block L. Further to this, the Auditor notes that EnRiskS (2013) (which had access to and referenced a broad list of investigation reports relevant to the FCAP and the associated regulation) states a review was undertaken of *"site history and soil concentrations reported"* and that *"No Hg^0 identified and all soil concentrations reported total mercury concentrations less than the industrial soil HIL (NEPC 1999 amended 2013d)"* in relation to Block L.

2. SITE DETAILS

2.1. Location

The boundary and layout of the CAP is shown as **Attachment 2a**. The site is the area of the footprint of the proposed development and comprises two distinct areas (shown in **Attachment 4**) as follows:

- The southern larger portion which is the current Sodium Hypochlorite (Hypo) Tanker Loading Bay proposed for the new plant.
- The northern small vacant parcel of land which is the proposed area for relocating the loading bay (within the area of a former solvents plant) and consists of the area of proposed ground disturbance.

The development layout is shown on **Attachment 3a**. The associated site boundary for the purpose of the Audit is shown on **Attachment 4**.

The site details are as follows:

Street address:	Denison Street, Banksmeadow NSW 2019
Identifier:	Part Lot 1101 in DP 1227173
Local Government:	Bayside City Council
Site Area:	Approximately 0.15 ha
Zoning:	IN1: General Industrial

The boundaries of the site are not well defined by streets or adjoining properties and comprise the footprint of the proposed development within the larger CAP. It is anticipated that the development site will be clearly defined as a construction site during remediation and development.

2.2. Adjacent Uses

The site is located within the BIP which has a long industrial history (since the early 1940s) and was formerly owned and operated by ICI Australia Ltd (ICI). Historical operations at the BIP have resulted in soil and groundwater contamination on and adjacent to the site, which have resulted in a range of environmental regulatory actions being applied to the site as described in **Section 1.5**.

Surrounding land uses (including those with potential to be a source of contamination and those that may be a sensitive receptor) identified by JBS&G in the DSI are summarised in **Table 2.1**.

Table 2.1: Surrounding Land Use

Identification	Location	Description
Orica	Surrounding site	Orica owns the land immediately surrounding the site within BIP. Facilities that are located nearby or adjacent to the site include: • CAP – located to the south of the site. While the land in this area is owned by Orica, the plant has been owned and operated by IXOM since 2015. • Groundwater Treatment Plant (GTP) - located 200 m to the north of the main portion of site. Used for the processing and treatment of contaminated groundwater recovered as part of large-scale groundwater extraction/remediation (BGC Project).
Indorama Ventures Oxides Australia Pty Ltd	North of site (approximately 100 m from larger portion)	This property has a long history of chemical manufacturing, which began in 1942 with the production of carbon bisulphide by ICI. Throughout the 1940s and 1950s, additional chemical plants were commissioned, including a rubber chemical plant, a herbicide plant, a formaldehyde plant, and an acetylene wet generation plant. These chemical manufacturing plants were decommissioned in the

Identification	Location	Description
		1960s, after which the property was used to manufacture surfactants. The property was acquired from Orica (formerly ICI) by Huntsman in 1998 and then by Indorama in 2019. Until recently, ethylene oxide (EtO) and its derivatives, including glycols, glycol ethers, and non-ionic surfactants, were manufactured at the site using primary raw materials supplied by the Olefines plant operated by Qenos, located to the north of the site within the BIP. It is understood that since Qenos has ceased operations, Indorama intends to shut down and decommission the manufacturing facility.
Former Qenos Facility	North and northwest of site	The former Qenos manufacturing facility is also located within BIP. Key features that are located nearby to the site include: • Alkathene - Until recently this area was used for the production of low density polyethylene (LDPE) products from ethylene (produced at Olefines II). The area contains the Alkathene plant (high and low pressure reactors, compressors, cooling towers, product extrusion machines, and a number of electrical substations), workshops, offices, bulk liquid (petroleum based) storage areas, product silos and warehouses • Alkatuff - Until recently this area was used for production of linear low density polyethylene (LLDPE) products from ethylene (Olefines II), hexene, nitrogen, hydrogen and TEAL (triethyl aluminium). The area also produced high density polyethylene (HDPE). The area comprises the Alkatuff plant, workshops, offices, additive store, catalyst store, hexene bulk storage tank, cooling towers, laboratory and two electrical substations • Site Utilities - The site utilities area includes steam generation, demineralisation of water, effluent treatment, cooling towers, and instrument air plant. Coal unloading and storage bay adjacent to the steam plant. By-product boiler ash hoppers and loading bay. Site utilities provides services to the broader BIP and as a result the majority of operations are ongoing.
Southlands	West	Southlands is located to the west of the site (beyond the extent shown on **Attachment 4**). The area has been remediated and divested by Orica. A range of contaminants were present inclusive of chlorinated hydrocarbons and asbestos.
Sydenham to Botany goods railway line	West	Operational freight rail line adjacent to the south-western boundary of BIP.
Residential Properties on Denison Street	East	To the east of the site (beyond the Orica owned land) is Denison Street. A variety of residential dwellings are located beyond.

2.3. Proposed Development

The proposed chlorine liquification plant will enable on site liquification and packaging of chlorine. Liquefied chlorine will be stored on site in a stock tank and distributed primarily by chlorine tankers with additional capability to fill and distribute chlorine in drums and cylinders if required. The plant will be housed in a containment building designed with safety measures including scrubbing system to manage potential emissions.

The project will also involve the relocation of the existing Hypo Tanker Loading Bay to an adjacent area to accommodate the new facility. No enclosed spaces are proposed to be constructed in this portion of the site.

The RAP states earthworks for the plant and loading bay will involve a total cut volume of approximately 1,035 m^3 and fill volume of 17.5 m^3. The maximum cut depth will be 1.5 m below ground level (mbgl), however, an average excavation depth will be more like approximately 0.5 mbgl.

Hardstand will be established across the extent of the site and no underground structures (excluding utilities such as power, etc.) are proposed.

The proposed development footprint including relocated loading bay is shown on **Attachment 3a**. The ground floor layout of the new plant is shown as **Attachment 3b**.

The proposed development is considered to fall within a 'commercial/industrial use' exposure scenario.

2.4. Site Condition

JBS&G undertook an inspection of the site on 23 October 2024 and reported the following in the DSI:

- *"The eastern portion of the existing Hypo Tanker Loading Bay reportedly comprises a raised concrete slab (approximately 1-1.5 m above surrounding ground levels) that formed the ground floor slab of a former warehouse structure. The area was primarily used for storage of disused equipment that included steel storage tanks, shipping containers, metal pipes, cylinders pumps, etc. Asbestos containing materials (ACM) in the form of bonded cement fragments were observed on exposed surface soils to the south of the raised slab.*
- *In the western portion of the existing Hypo Tanker Loading Bay, there was a 2-laned concrete driveway that serviced the loading bay. Associated infrastructure (pipes, bowsers etc) appeared to be aboveground and were fed from the new ChlorAlkali Plant located to the south of the site.*
- *The balance of the ground surface across the site comprised of road base gravels and igneous cobbles. There were no obvious signs of contamination (ACM, odours, staining of the ground surface) in these materials.*
- *To the north of the existing Hypo Tanker Loading Bay was a concrete lined pit. The pit was secured by chain link fencing and the base was sediment laden and covered with weeds.*

It is noted that the modern operations at the site are typically storing/handling products that are generally found to be non-hazardous (sodium hypochlorite) within the environment."

The Auditor undertook an inspection of the site on 10 February and noted site conditions consistent with JBS&G observations reported in the DSI. The Auditor observed multiple fragments of ACM on the ground surface in the east of the southern portion of the site. ACM fragments were not observed elsewhere on the site.

3. SITE HISTORY

A review of the history of the site and surrounds is presented in the DSI based on review of historical aerial photographs as well as information presented in available previous assessments completed for the site or for surrounding BIP land.

The Auditor has reproduced the site history for the site and surrounds summarised in the DSI in **Table 3.1 and Table 3.2**.

Table 3.1: Site History (Onsite)

Date	Activity
Prior to 1943	Site Wide Based on the review of aerial photographs, the site uses prior to 1943 may have included agricultural activities (market gardens) based on surrounding land-uses within BIP. Potential sand mining is also evident in surrounding land within the BIP. Sand mining was a common practice in the Botany area during this period, where optimal materials were extracted for glass making and potentially replaced with fill sourced from elsewhere.

Date	Activity
1948 to 1977	TCE and PCE Plant (Solvents Plant) Within Northern Portion of Site TCE and PCE were produced by chlorination of acetylene to produce PCE; yielding TCE on dehydrochlorination within the plant. The site of the proposed relocation of the loading bay is within the footprint of this plant where an above ground storage tank (AST) is visible in the 1961 aerial (**Attachment 5**) overlying the northern portion of the site.
1944 to 2002	Former CAP (FCAP) Within Southern Portion of Site The FCAP was commissioned in 1944. The southern portion of the site was located within Block L of the FCAP (**Attachment 5**). This was the Chlorine Liquefaction Area, where gaseous chlorine (Cl_2) was liquefied and placed into cylinders and drums. Elemental mercury (Hg^0) was not reported to be handled in this area; however, mercury may have been present as a trace impurity in the chlorine gas. Aerial photographs from 1961 (**Attachment 5**) indicate that there was a coal-fired boiler house present on Block L to the north of the site with associated cooling tower basin. A 200 tonne chlorine storage bullet (tank) was subsequently constructed over the location of the cooling tower basin and was present until 2001 when it was removed. When the chlorine bullet was removed in 2001 the pit was reportedly filled with mercury contaminated process wastes and demolition wastes from the FCAP (approximately 300 m^3) and was registered as a licensed waste storage area (labelled Depot 60). These wastes, which were subsequently removed from the pit early in 2007 (following assessment and disposal to a licenced landfill), reportedly included denuder balls, denuder pot steel, concrete and bricks.
2004-current	The warehouse structure was demolished and replaced with the current sodium hypochlorite loading bay.

Table 3.2: Site History (Surrounding Land)

Date	Activity
1944 to 2002	The FCAP extended into land surrounding the site as described below. Block G - consisted of three major cell rooms; H Cell Room (1944–1998); Mk1 Cell Room (1952– 1998); and B1 Cell Room (1965–2001) as well as the brine purification and chlorine drying sections. These cells primarily produced chlorine, hydrogen, and sodium hydroxide from brine using mercury as a liquid cathode. Historical records show the salt stockpile, initially stored near the Mk1 Cell Room, was relocated multiple times before settling east of the former B1 Cell Room. The cell rooms, particularly Block G, are identified as the main source of mercury contamination at the FCAP site due to the high volume of mercury used. Block M - The southern half of Block M was used by the FCAP operations and housed various processes. The southeast portion included stripped brine tanks on an unpaved surface, a mercury recovery retort operation (1972–1986), and a sludge filtration process (from 1990). This area also contained sulphuric acid loading bays and bulk storage, still in use today. The southwest portion supported hydrogen compression, purification (mercury removal via activated carbon), storage, and, since 1990, the FCAP cooling tower. Mercury contamination is linked to the hydrogen compression area (due to mercury vapour impurities), brine tank area (potential mercury and chloride sources), sludge filtration area (mercury precipitation in brine sludge), and mercury retort area, including nearby equipment storage. Block A - Part of Block A was used to remove mercury from caustic soda, with large storage tanks constructed between 1963 and 1966. Mercury was primarily present in unfiltered caustic soda as colloidal micro-droplets, potentially stabilized by oxide or hydroxide coatings, and possibly as dissolved oxy-hydroxide complexes. Filtration methods evolved from Stellar™ (carbon) filters in the 1960s to Memtec™ (microfiltration) filters in the 1990s. Mercury contamination in Block A is linked to its presence in caustic soda from the Chlor-Alkali process, with anecdotal reports suggesting possible losses of mercury-contaminated caustic soda.

Date	Activity
1945 to 1959	Carbon tetrachloride (CTC) was produced by reaction of carbon bisulphide and chlorine in the plant located to the east of the site. The byproduct sulphur chloride was decomposed with water.
1963 to 1996	The Solvents Plant produced CTC and PCE from propane and chloride. Propane was replaced by propylene and the plant also used byproducts from the Vinyl Chloride Monomer (VCM) plant.
1960s to current	All the above plants present within the footprint of the Indorama boundary (refer to **Attachment 5 and 6**) were decommissioned and replaced with the surfactants plant in the 1960s. The layout and manufacturing processes remained largely the same throughout this period until recently when operations ceased.

3.1. Auditor's Opinion

The historical reports note that, whilst there is considerable knowledge about BIP in the earlier years (including the site), particularly with regard to the basic manufacturing processes, raw materials and the location of plants, detailed information is not always available and is often anecdotal. The historical reports presented a broad overview of the chemicals that were used or produced in the major plants.

Overall, the site history is considered adequate to meet the project objectives.

4. CONTAMINANTS OF CONCERN

The DSI presents a summary of the known and potential sources of contamination identified at the site along with affected media as presented in **Table 4.1** and shown on **Attachment 7**.

Table 4.1: Known and Potential Sources of Contamination and Affected Media

Potential Source of Contamination (Areas of Environmental Concern)	Contaminants of Potential Concern	Potentially Affected Media
AEC1. Site Wide Imported and/or reworked fill materials used to create site levels (comprising material of unknown character and/or origin). Demolition of former site structures resulting in shallow soils impacted with hazardous materials (lead, asbestos).	Heavy metals (primarily Hg), polycyclic aromatic hydrocarbons (PAHs), total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylenes (BTEX), organochlorine pesticides (OCPs), chlorinated hydrocarbons (CHCs), polychlorinated biphenyls (PCBs), asbestos and pH	Soil Groundwater Soil Vapour
AEC2. Pit (Depot 60). This pit was reportedly filled with mercury contaminated process wastes and demolition wastes from the FCAP (approximately 300 m^3) which were reportedly removed in 2007. Owing to the proximity of the pit to the site, there is the potential that the waste materials caused impacts to surrounding soils / groundwater, that potentially extend into the site.	Heavy metals (primarily Hg), TRH, BTEX, PFAS, CHCs	Soil Groundwater Soil Vapour
AEC3. Former chemical manufacturing activities surrounding site. Refer to **Attachment 4** for chemical manufacturing activities conducted on surrounding land which may have caused impacts to the site.	Heavy metals (primarily Hg), TRH, BTEX, PFAS, CHCs	Soil Groundwater Soil Vapour

4.1. Auditor's Opinion

The COPC identified in the DSI investigations as summarised in **Table 4.1** are consistent with those identified by the site history and historical investigations. The analyte list used by JBS&G (**Table 6.1**) adequately considers the COPC.

EnRiskS (2013) discusses the various forms of mercury in relation to Blocks G, M and A and note elemental mercury (Hg^0) and total mercury impacts have been identified in soil. EnRiskS (2013) states the presence of mercury in soil at the FCAP site is considered to be an issue as there is the potential for direct contact (should impacts be near the surface, or excavated), inhalation of Hg^0 vapours (indoors and outdoors) and potentially providing an ongoing source to groundwater.

EnRiskS (2013) state that mercury in groundwater has been reported (present as dissolved inorganic species, sorbed mercury, Hg^0 and methylmercury) in shallow, intermediate and deep aquifers. Mercuric chloride ($HgCl_2$) has been identified in the reviewed reports as the dominant modelled mercury species in downgradient areas. EnRiskS (2013) state that some Hg^0 is also present, however, concentrations are less than in the source area.

5. GEOLOGY, HYDROGEOLOGY, TOPOGRAPHY AND HYDROLOGY

5.1. Geology

Previous soil investigations from surrounding BIP land reported that the geology of the area comprises Botany Sands, a sequence of predominantly unconsolidated to semi-consolidated permeable sands. These sands are interspersed with lenses and layers of peat, peaty sands, silts, and clay, which become more prevalent in the lower part of the sequence. The sand layer varies in thickness across BIP from less than 20 m to over 80 m and is underlain by the Hawkesbury Sandstone, a rock formation with significantly lower permeability compared to the overlying Botany Sands.

Borehole logs from previous soil investigations within the site or surrounding FCAP land were not available to JBS&G or the Auditor. However, EnRiskS (2013) provides a description of the soils encountered across Block L during previous investigations as follows:

- Fill ranged in depths from 0 to 1.0 m and comprised grey and brown sands that were medium to coarse grained with 20-50 mm gravels.
- Natural soils were reported to underly the fill materials (to 17 m as consistent with maximum depth of investigations in this area) and comprised grey/brown to white sands that are medium to coarse grained.

The site geology is largely consistent with that described across the broader BIP area in Orica (2022). Orica (2022) further reports that the fraction of organic carbon (foc) in soils across BIP ranges from low in sandy materials (<1%) to high in peat (4-20%) and occasionally in sands with a "brown" coloration (up to 22%), which influences contaminant mobility.

5.2. Hydrogeology

Historical groundwater levels in proximity of the site, within BIP land, confirmed that the regional groundwater flow direction in the vicinity of the site is south-westerly towards Botany Bay (Orica 2022). The presence of three hydraulic containment lines (**Attachment 2b**) at: the south-western boundary of BIP; adjacent to McPherson Street; and further south on Foreshore Road, immediately prior to Botany Bay, induces groundwater flow towards the three containment lines and results in the hydraulic containment of groundwater flowing from the BIP. Shallow groundwater within BIP is generally characterised as slightly acidic with low salinity (<1000 µS/cm).

In the area of the site, WSP (2023) reports that the inferred groundwater flow direction is to the southwest consistent with the above. Groundwater depths below the site are anticipated to be in the range of 2.5-4 mbgl based on the reported standing water levels within the nearest monitoring well (WG212S, shown on **Attachment 8**) ranging from 2.7-3.8 m below top of casing in the monitoring rounds completed in the years between 2018-2022 (WSP, 2023).

Orica CSM 2022 provides a detailed conceptual site model (CSM) for BIP and surrounding land (defined as the 'model area') as related to the BGC Project. The CSM includes a detailed overview of the hydrogeological conditions over the model area from investigations / monitoring completed since 1989.

Based on the results from historical investigations, a three-layer model was developed for the Botany Sands Aquifer and was described in Orica CSM 2022 as comprising:

- Layer 1 – Upper Sand Zone. This layer consists of Holocene aeolian sands and fill, typically loose to medium dense and fine to medium grained. It contains minor peat or silt layers and comprises an unconfined porous media aquifer that extends to nominal depths of up to 6 m. It is referred to as the 'shallow aquifer'.
- Layer 2 – Middle Sand Zone. Comprising Pleistocene dune and beach sands, this layer includes occasional thin, low-permeability layers of peat, clay, and organic-rich materials. It is generally denser than Layer 1 and can reach 10 to 20 m in thickness, particularly in the northern BIP area. Layer 2 is semi-confined as low-permeability layers/seams and is referred to as the 'deep' aquifer.
- Layer 3 – Basal Zone. This layer features interbedded fluvial and marine sands, clays, muds, and peats of Pleistocene age. Its composition varies with depth and location, often containing organic-rich clays. This layer is largely absent in areas east of Second Street within BIP.

The site is located within Prohibition Area 1 of the Botany Sands Groundwater Aquifer and is subject to *The Temporary Water Restriction (Botany Sands Groundwater Source) Order 2024.*

5.3. Topography and Hydrology

The site is characterised as being generally level over the site area, with a slight fall towards Springvale Drain. The south-western part of the site is located at a slightly lower level than the northern portions of the site as consistent with this fall. Noting that a significant portion of the site is not covered in hardstand (i.e. roadbase and cobbles), it is expected that the majority of rainfall will result in groundwater recharge.

5.4. Auditor's Opinion

The Auditor considers that the geology, hydrogeology, topography and hydrology have been adequately characterised for the purpose of remedial planning.

As described in **Section 1.6**, hydraulic containment lines result in the hydraulic containment of groundwater flowing from the BIP (including the site) to ensure the offsite risks to human health and the environment from groundwater remain acceptable.

Should hydraulic containment cease in the future (after clean-up of BIP contamination), Springvale Drain and Penrhyn Estuary/Botany Bay would become potential receptors to any site sourced (non-BIP-related) groundwater impacts.

6. EVALUATION OF QUALITY ASSURANCE AND QUALITY CONTROL

The Auditor has assessed the overall quality of the data by review of the information presented in the DSI. The data collected from the DSI is summarised in **Table 6.1**.

Table 6.1: Summary of Investigations (DSI)

Investigations	Field Investigations	Analytical Data Obtained
DSI *Field work: October 2024*	8 x boreholes (**Attachment 8**) converted to soil vapour probes (screened in fill) as follows: • BH2 (soil vapour probe – 1 m) • BH3 (soil vapour probe – 0.65 m) • BH4 (soil vapour probe – 1 m) • BH5 (soil vapour probe – 0.5 m) • HA1 (soil vapour probe – 1 m) • HA2 (soil vapour probe – 0.5 m) • HA3 (sub slab pin) • HA4 (sub slab pin)	Soil (excluding QA/QC samples): • Heavy metals – 18 samples • PAHs – 13 samples • TRH - 13 samples • BTEX – 25 samples • Asbestos – 8 samples • Volatile Organic Compounds (VOCs) – 25 samples • Semi-Volatile Organic Compounds (sVOCs) – 13 samples • OCPs – 13 samples • PCBs - 13 samples • PFAS/PFOS – 8 samples • TCLP for mercury – 6 samples • ASLP for mercury – 6 samples Soil vapour (excluding QA/QC samples): • VOC 8260 – 8 samples • Field screening of Hg with Draeger tubes – 8 samples • Hg Analysis with XAD – 2 samples (based on Draeger tube screening results)

The Auditor has assessed the overall quality of the data by review of the information presented in the referenced reports, supplemented by field observations. The Auditor's assessment follows in **Table 6.2 and Table 6.3**.

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor's Opinion
Data Quality Objectives (DQO) JBS&G defined specific DQOs in accordance with the seven-step process outlined in Schedule B2 of NEPM (2013) for the DSI. The 'Problem' was stated as: *"The site, as located within BIP and part of the former ICI operations, has a substantial history of heavy industrial use. Significant potential contamination sources have been identified through the review of site history that require assessment in order to confirm the suitability of the site for the proposed land-use."* The following 'Decisions' were identified in the DSI: • Are there any unacceptable risks to likely future onsite receptors from soils? • Are there any issues relating to local area background soil concentrations that exceed the appropriate soil criteria? • Are there any unacceptable human health or ecological risks resulting from impacted groundwater underlying the site? • Are there any potential vapours within unsaturated media that could present an unacceptable risk to future site receptors? • Are there any impacts of chemical mixtures? • Are there any aesthetic issues at the site? • Is there any evidence of, or potential for, migration of contaminants from the site? • Is a site management strategy required?	The identified DQOs were commensurate with the project objectives and reasonable for the investigations conducted.
Sampling pattern, locations, density and depth *Soil:* A systematic sampling program of shallow soils (up to 1.5 m) at 8 locations on a systematic basis. Of these, locations BH3 and HA2 are closest to AEC2 (Depot 60 pit) which is located offsite to the northwest (**Attachment 8**). At 4 of these locations, additional sampling was completed at depths up to 6 m from boreholes advanced via drill rig completed	The soil and soil vapour sampling density achieved an approximate 15 m grid which is equivalent to the minimum number of sampling points for a square grid recommended by NSW EPA (2022a) for a 0.15-hectare site and is therefore a

Sampling and Analysis Plan and Sampling Methodology	Auditor's Opinion
as part of combined environmental and geotechnical investigations – these locations are identified via the prefix "BH" on **Attachment 8**. Soil samples were analysed from shallow depths (between approximately 0.2 m and 0.5 m) and deeper depths (typically between 1 m to 1.5 at most locations). Deeper samples were analysed at 4 m and 6 m from boreholes in a limited number of locations. *Soil vapour:* sub slab pins (HA3 and HA4) and soil vapour probes (depths ranged from 0.5 m to 1 m) were installed on an approximate 15 m grid (equating to 8 locations) (**Attachment 8**).	reasonable screening density to inform the RAP. The Auditor agrees that soil and soil vapour sampling intervals were reasonable to assess the key exposure pathways under the proposed land use, which primarily consist of vapour intrusion and, to a lesser extent, direct contact should soil be disturbed, such as though intrusive maintenance works. The density is relatively low with respect to asbestos quantification as NSW EPA (2022a) states greater sampling densities and sample volumes should generally be used for asbestos. This is because asbestos can occur widely and unpredictably and, as a discrete contaminant, it can be hard to detect using conventional sampling regimes based on NEPM (2013). However, the achieved density is adequate given the remedial strategy proposed is capping and containing the whole site. Overall, the sampling pattern, locations, densities and depths for soil and soil vapour are adequate to inform the RAP. Groundwater investigations were not conducted as part of the DSI. JBS&G noted that future site users (excluding construction workers) can only be exposed to contaminants in groundwater through vapour intrusion of volatile compounds into buildings. The risks associated with this exposure pathway were directly assessed through the soil vapour assessment. Risks to offsite receptors through migration of impacted groundwater is currently being managed as part of the BGC program. Consequently, the assessment and potential remediation of groundwater would only be required in cases where there are significant impacts in soils that act as source materials contributing to ongoing groundwater impacts. These instances can be inferred from the results of the soil and soil vapour assessments with reference to the results of groundwater investigations completed historically within proximity of the site. Overall, the sampling pattern, locations, densities and depths for soil and soil vapour are adequate to inform the RAP.
Soil sample collection method Soil samples were collected via hand auger (up to depths of 1.5 m) or with Standard Penetration Testing (SPT) (at depths greater than 1.5 m) sampling apparatus using a track-mounted drilling rig. Soil samples (for chemical constituents) were collected directly underneath the hardstand (concrete), then generally at 0.5-1.0 m intervals to a maximum depth of 6 m or at least 0.5 m into natural materials (or prior refusal), whichever was shallower. During the collection of soil samples, features such as seepage, discolouration, staining, odours, and other indicators of contamination were noted by JBS&G. Approximate 10 L bulk soil samples were collected and inspected for the presence of asbestos via the excavation of boreholes (with 150 mm diameter) in one-metre increments until natural soils	Boreholes were acknowledged by JBS&G as not the preferred methodology for the assessment of asbestos in soils but, given the operational nature of the site, were considered the only practical means of collecting soil samples.

Sampling and Analysis Plan and Sampling Methodology	Auditor's Opinion
were identified at the sampling location to maximum depth of investigations. Generally, each 1 m increment was treated as a discrete sample. At each sampling location, material from each increment was collected on a separate plastic sheet and spread out for inspection for ACM. Any obvious ACM fragments were placed in a ziplock sample bag. For coarse-grained material (i.e., sand, gravel, etc.), the 10 L of material was passed through a 7 mm sieve in the field. The material captured on the sieve was then hand-sorted, and any further collected ACM fragments were placed in the sample bag. A representative 500 mL sample of material that passed through the 7 mm sieve was collected and placed in a separate ziplock sample bag for laboratory assessment of asbestos.	
Soil vapour probe construction Sub-slab vapour probes were installed on a grid across the site in hardstand areas via the following methodology: • A 16 mm diameter hole was drilled through the concrete slab at each location, with the encountered slab thickness typically being 100-200 mm • A VaporPin metallic probe was installed by hammering the probe with a silicone sleeve (to ensure an air-tight seal) into the drilled hole to the depth of the encountered slab thickness. Soil vapour probes were installed via the following methodology: • Installed to a depth of up to 1.0 m • Installed within a 150 mm diameter borehole advanced by hand auger • Constructed of 6 mm diameter LDPE tubing with a stainless steel gauze at the end of the tubing • Backfilled with washed 1-2 mm sand adjoining the end of the tubing, a shallow depth of bentonite granules, and completed with a bentonite-based grout • Allowed to stabilise for a period of 24 hours prior to sampling.	The soil vapour probe construction was adequate in the context of the project objectives.
Soil vapour sample collection method <u>Carbon tubes</u> • A GFM436 gas detector was used to purge each probe for approximately 30 seconds. Gas readings were monitored until oxygen and PID readings had stabilised • Following this, a leak detection evaluation was completed via placement of an isopropyl alcohol-soaked rag within an air-tight box containing the sample train located on top of the probe. Elevated PID readings (in excess of previously established and stable PID recordings) on the gas detector were assumed to indicate a leaking probe. Any leaking probes required re-installation and were re-checked prior to sampling using the same method • Following preliminary confirmation of the absence of any significant leaks, sub-slab vapour samples were collected onto SKC-anasorb carbon tubes. An isopropyl alcohol-saturated rag was maintained in an air-tight box (sealed container containing sample train) throughout purging and sampling for laboratory confirmation of potential leaks. At all sample locations, a 6.2 L volume was collected using a calibrated pump at a flow rate of 200 mL/min (31 min sample time) onto a carbon tube • A slight variation to this method was adopted in locations where additional sampling was undertaken to identify Hg (at two selected locations based on Draeger tube screening results). This comprised sampling onto an XAD tube, which allowed for specialised analysis for Hg. <u>Draeger tubes</u>:	JBS&G report no significant leaks were identified by the PID during soil vapour sampling. The soil vapour sample collection appears to have been adequate to provide representative samples to assess risks to the relevant receptors.

Sampling and Analysis Plan and Sampling Methodology	Auditor's Opinion
Soil vapour probes were also screened with Draeger tubes to quantify levels of Hg in vapour. The probes were purged using the above methodology prior to screening as per the following: • The appropriate tube for screening Hg (142s) was selected and tips at both ends of the glass tube broken prior to sampling • The tube was then inserted into the Kitagawa Gas Aspirating Pump • The sampling time (number of pump strokes) was conducted in accordance with manufacturer's recommendations (5 mins for Hg) • Following sampling, the tube was inspected for signs of colour change • Where there was a potential colour change, the corresponding concentration of the vapour was recorded in parts per million (ppm). It is noted that false positive results on Draeger tubes is common, resulting from other gases.	
Sample handling and containers Collected samples were immediately transferred to laboratory-supplied sample jars (additional 500 mL plastic bags were used where asbestos analysis was required). The sample jars/bags were then transferred to a chilled ice box for sample preservation prior to and during shipment to the testing laboratory. Carbon tubes were capped, and stored in a cool, dry, and dark container that excluded light, prior to laboratory analysis.	Adequate
Decontamination procedures *Soil:* Non-disposable sampling equipment, including augers, was cleaned between locations with a high-pressure water/detergent spray, rinsed with water, and then air-dried. The equipment was inspected to ensure that no soil, oil, debris, or other contaminants were apparent on the equipment prior to the commencement of works. New gloves were reportedly used for each new sample.	Adequate
Chain of Custody (COC) A chain-of-custody form was completed and forwarded with the samples to the testing laboratory. Completed chain of custody forms were provided in the DSI.	Adequate
Detailed description of field screening protocols *Soil:* Soil samples were screened on-site during the works using a PID to assess the presence of VOCs, including chlorinated hydrocarbons.	Adequate
Calibration of field equipment Daily field calibration records and decontamination records were provided for the PID. Supplier calibration records were provided for the PID.	Adequate
Sampling logs Bore logs were provided within the report for the soil bores and soil vapour probes. The logs indicate sample depth, PID readings and lithology. The logs provide comments regarding absence/presence of odour, asbestos and staining. Soil vapour field sampling records were provided, including purge time, PID and gas readings, leak detection, shroud PID readings and sample collection time.	Adequate

Table 6.3: QA/QC – Field and Lab Quality Assurance and Quality Control

Field and Lab QA/QC	Auditor's Opinion
Field quality control samples and results Field quality control samples included: • Preparation of blind and split duplicates in the field at a frequency of one duplicate per 20 primary samples respectively for each of the media and primary analytes assessed. Consistent with the guidance in HEPA (2025) adoption of an increased rate of duplicate sample collection and analysis for PFAS of one duplicate per 10 primary samples • Trip spike samples in sample batches containing sample analysis for VOCs • Trip blank samples in a representative number of analytical batches and analysis for relevant analytes as specific to the batch • Rinsate blanks where non-disposable / non laboratory supplied equipment/containers were used. The relative percent difference calculations (RPDs) for soil samples were largely within the preferred range except for a limited number of heavy metals, TRH fractions and individual organic compounds, which was considered by JBS&G to be a result of the relatively low concentrations of the compounds reported in the samples and/or the difficulty in obtaining homogenous soil samples in undisturbed sample types. As a conservative measure, the highest reported concentration of each constituent at each location was considered by JBS&G when interpreting the results. JBS&G state the analysis of blind and split duplicate carbon tube vapour samples met the required frequency. The RPDs for vapour samples were within the preferred range except for a limited number of samples where the results were relatively low. As a conservative measure, the highest reported concentration of each constituent at each location will be considered when interpreting the results of the investigation. Trip spike results were within the control limit of 70-130%, and trip blank and rinsate results were <LOR (i.e. within the respective JBS&G nominated control limits).	Based on the data reviewed, the Auditor agrees with the discussion and conclusions made by JBS&G summarised in column 1. Overall, the field quality control samples were adequate to demonstrate the respective aspects of data quality.
NATA registered laboratory and NATA endorsed methods JBS&G used project laboratories which are NATA registered (Eurofins MGT as the primary laboratory and Envirolab Services as the secondary laboratory) for the required analyses. In addition, JBS&G stated the laboratories meet JBS&G's internal Quality Assurance requirements.	Adequate
Analytical methods Analytical methods were included in the laboratory test certificates and where relevant in the text of the DSI and included VOC 8260 and VOC TO-15. Asbestos identification was conducted using polarised light microscopy with dispersion staining by method AS4964-2004 *Method for the Qualitative Identification of Asbestos Bulk Samples*.	The analytical methods are considered adequate for the purposes of the site audit. The NEPM (2013) methodology of assessing a 500 mL sample to achieve a lower detection limit was adopted and this is not NATA accredited. However, AS4964-2004 was the only available method in Australia for analysing asbestos. Also, the asbestos results were assessed by JBS&G within a weight of evidence framework rather than asbestos quantification. Therefore, the use of this method for the

Field and Lab QA/QC	Auditor's Opinion
	DSI is considered acceptable given the remedial strategy proposed is capping and containing the whole site.
Holding times The DSI states that the extraction and analysis of all soil and soil vapour samples were completed within the recommended holding times for all analytes.	Adequate
Laboratory Limits of Reporting (LORs) LORs for soil (except asbestos) were less than the assessment criteria for the contaminants of concern. The NATA approved limit of detection for asbestos in soil was 0.01% w/w although NEPM (2013) analysis were reported to 0.001% w/w for AF/FA. LORs for soil vapour were less than the assessment criteria for most key analytes. For some VOCs (e.g., chloroform and 1,1,2-trichloroethane) the LOR was higher than the assessment criteria.	Overall, the soil LORs are acceptable. In the absence of any other validated analytical method, the detection limit for asbestos is considered acceptable and was used within a weight of evidence framework rather than to quantify asbestos. For soil vapour where the LOR was higher than the assessment criteria, the data was also considered by JBS&G and the Auditor in a weight of evidence framework which considered the relative concentrations, co-located impacts, site history and observations, overall risks and the proposed remediation. Overall, the data was considered adequate for decision making.
Laboratory quality control samples and results Laboratory quality control samples including laboratory control samples, matrix spikes, surrogate spikes, blanks and duplicates were undertaken by the laboratory. The DSI states that the NATA certified laboratory results indicate that the project laboratory was generally achieving levels of performance within its recommended control limits during the period when the samples from this program were analysed.	The Auditor agrees the laboratory reports indicate that the laboratory was generally achieving levels of performance within its recommended control limits during the period when the samples from this program were analysed. Overall, adequate.
Data Quality Indicators (DQI) and Data Evaluation (completeness, comparability, representativeness, precision, accuracy) Predetermined data quality indicators (DQIs) were set for laboratory analysis including blanks, replicates, duplicates, laboratory control samples, matrix spikes and surrogate spikes. These were discussed with regard to the five category areas. The DSI concluded: *"The field sampling and handling procedures produced QA/QC results which indicate that the soil and soil vapour data are of an acceptable quality and suitable for use in site characterisation.* *The NATA certified laboratory results sheets indicate that the project laboratory was generally achieving levels of performance within its recommended control limits during the period when the samples from this program were analysed.* *On the basis of the results of the field and laboratory QA/QC program, the soil and soil vapour data are of an acceptable quality in order to achieve the objectives of the assessment."*	An assessment of the data quality with respect to the five category areas has been undertaken by the Auditor and is summarised in **Section 6.1** below.

6.1. Auditor's Opinion

Overall, the data is of adequate completeness, comparability, representativeness, precision, and accuracy to meet the project objectives and inform the RAP. The DSI and RAP acknowledge that the sampling program was not adequate to quantify asbestos in fill. However, this data gap is not material

as the remedial strategy proposed for asbestos is capping and containing the whole site. No other significant data gaps were identified within the proposed remedial framework.

7. ENVIRONMENTAL QUALITY CRITERIA

Assessment criteria are the concentrations of a contaminant above which further appropriate investigation and evaluation will be required and provide the basis of a Tier 1 risk assessment. As defined in NEPM (2013), a Tier 1 risk assessment is a risk-based analysis comparing site data against generic assessment criteria for various land uses to determine the need for further assessment or development of an appropriate management strategy.

Assessment criteria are developed for the protection of human health and ecological receptors, for a range of media including soil, sediment, groundwater, surface water and soil vapour. When selecting appropriate criteria for this Audit, a commercial/industrial exposure scenario has been adopted (NEPM Scenario D). Given the predominantly granular fill and sand (reworked natural and natural) material present, a sand/coarse soil type has been assumed when determining appropriate screening criteria.

Other key assumptions used by the Auditor when selecting appropriate criteria are related to the proposed development (**Section 2.3**) and include:

- Building slab or hard surfaces across the site with no or minimal landscaping areas.
- The proposed structure is for commercial/industrial purposes (new chlorine liquification plant and relocated tanker loading bay) and are constructed at grade (i.e., no basements or underground levels).
- Vapour intrusion is the primary relevant exposure pathway for contaminants in groundwater onsite. Vapour intrusion from groundwater offsite was also considered.
- Groundwater is anticipated to be at depths of approximately 2.5-4 mbgl based on **Section 5.2**.
- Groundwater may ingress to a potential future trench / excavation and therefore the potential exposure pathways for intrusive maintenance workers include direct contact pathways as well as the vapour inhalation pathway.
- Groundwater is not abstracted for beneficial reuse at the site or surrounds.
- Potential offsite surface water receptors include Springvale Drain and Penrhyn Estuary/Botany Bay. However, contamination in groundwater will remain managed by the hydraulic containment system until such time as BIP-related impacts have been remediated (by others) which ensure risks to human health and the environment remain acceptable.
- Non-BIP-related groundwater contamination could potentially pose a risk to offsite recreational and ecological receptors including Springvale Drain and Penrhyn Estuary/Botany Bay in the future should hydraulic containment cease.
- Mercury is not considered BIP-related groundwater contamination. The Auditor has considered the potential for mercury to act as a potential source to groundwater.

The adopted criteria for each media are presented in **Sections 7.1 to 7.2**.

7.1. Soil Assessment Criteria

Tier 1 (screening) soil criteria were adopted by the Auditor and JBS&G as follows:

- Human Health Assessment
  - NEPM (2013) HIL D for non-volatile compounds.

  - NEPM (2013) HSL D (sand, 0-<1 m) for TRH, BTEX and naphthalene compounds for the vapour intrusion pathway.
  - Friebel and Nadebaum (2011a) HSL D for direct contact.
  - HEPA (2025) Health Investigation Levels for 'Commercial/Industrial' land use for perfluorooctanesulfonic acid (PFOS)/perfluorohexane sulfonate (PFHxS) and perfluorooctanoic acid (PFOA). The PFOS+PFHxS criterion is compared to the sum of the PFOS and PFHxS concentrations.
  - The LOR was used as an initial screen within a weight of evidence framework for analytes for which no Australian guideline values are available.
  - For COPC that were detected above the LOR, reference was made to USEPA RSLs for composite workers. The Auditor also multiplied by a factor of 10 to adjust the target cancer risk level from 1:1,000,000 to 1:100,000 to be consistent with Australia's recommended target cancer risk level. For some chemicals, where a criterion has been derived using both non-cancer and cancer toxicity data, the lower criteria was adopted.
  - Asbestos was assessed based on presence/absence within a weight of evidence framework. JBS&G also considered NEPM (2013) HSLs (HSL D) for asbestos in soil. However, these results were interpreted within a weight of evidence framework and in consideration of the cap and contain strategy proposed for asbestos in the RAP.
- Terrestrial Ecological Assessment
  - NEPM (2013) Ecological Screening Levels (ESL) and Ecological Investigation Levels (EIL) generally apply to the top 2 m of soil. ESLs and EILs are not considered relevant to this assessment due to the proposed development covering the site in hardstand. Also, no significant terrestrial or other ecological receptors have been identified at the site which is in a highly industrialised setting.
- Management limits (ML) for coarse soil
- 'Aesthetic' contamination as outlined in *Section 3.6 Aesthetic Considerations* of NEPM (2013) Schedule B1 which requires a balanced consideration of the quantity, type and distribution of foreign material or odours in relation to the specific land use and its sensitivity.
- As well as reference to the HIL D for inorganic mercury of 730 mg/kg, the DSI refers to risk-based criteria (RBC) derived by EnRiskS (2013) for total mercury (inorganic and Hg^0) in soils for Blocks M and A that are protective of long-term exposures to workers on and off the site, as summarised as follows:

Table 6.3: RBC – Total Mercury in Soil (mg/kg)

Location	Outdoor / Open Space	Indoors
Block M	240	100
Block A	460	180

- JBS&G state that given that EnRiskS (2013) reported there were no risk issues (concentrations of inorganic mercury in soil that exceed the commercial/industrial HIL and no Hg^0 present) within Block L, it is likely that the application of the RBCs presented above to the site is conservative. Notwithstanding, they have been used as a screening tool for this investigation—noting that in the derivation of the RBCs, it was reported that inhalation exposure presents the greatest portion of the hazard index calculation—where the associated mercury levels in vapour have been assessed

empirically herein via the vapour assessment. As such, the application of the criteria to this assessment is simply as another line of evidence. The Auditor agrees.

- EnRiskS (2013) noted that remediation of Hg^0 to a level protective of inhalation (i.e., the RBC) exposures on the site (presented above) should also be protective of any limited potential for further contribution to surface water and groundwater given the low water solubility of Hg^0. EnRiskS (2013) determined a RBC for total mercury in soil that is protective of groundwater of 893 mg/kg. EnRiskS (2013) noted this value is greater than the RBC above and therefore the RBC are considered to be adequately protective of issues associated with an ongoing source to groundwater (for soil above water table).

The specific adopted soil assessment criteria and reference sources are presented in **Attachment 9** and discussed where relevant in **Section 8**.

7.2. Soil Vapour Assessment Criteria

Soil vapour human health criteria were adopted by the Auditor and JBS&G as follows:

- NEPM (2013) Health Screening Levels (HSL D) (sand, 0-<1 m).
- Interim soil vapour Health Based Investigation Levels (HIL D) for volatile organic chlorinated compounds (IHIL).
- The LOR was used as an initial screen within a weight of evidence framework for analytes for which no Australian guideline values are available.
- For COPC that were detected above the LOR, reference was made to USEPA Regional Screening Levels for Air (for composite workers) adopted from the online database of assessment criteria that are current as of November 2024 (USEPA RSLs). These were adjusted by an indoor air to soil vapour attenuation factor of 0.1 in accordance with NEPM (2013). The Auditor also multiplied USEPA RSLs by a factor of 10 to adjust the target cancer risk level from 1:1,000,000 to 1:100,000 to be consistent with Australia's recommended target cancer risk level. For some chemicals, where a criterion has been derived using both non-cancer and cancer toxicity data, the lower criteria was adopted.

The specific adopted soil assessment criteria and reference sources are presented in **Attachment 11** and discussed where relevant in **Section 9**.

7.3. Groundwater and Soil Leachate

Groundwater was not sampled as part of the DSI. However, mercury data from WSP (2023) and mercury data discussed in EnRiskS (2013) were considered by JBS&G as lines of support when assessing potential risks. JBS&G also conducted some ASLP and TCLP analyses on selected soil samples exhibiting the highest lead concentrations. The mercury WSP groundwater data and JBS&G leachate data was considered by JBS&G and the Auditor within the historical trends as well as being assessed against Tier 1 criteria sourced from:

- NHMRC (2008) *Guidelines for Managing Risks in Recreational Water* (GMRRW) as a conservative screen to assess potential recreational exposures down-gradient of the site and incidental contact/ingestion during intrusive maintenance works onsite. The GMRRW indicates that a qualitative assessment of recreational use can be undertaken using 10 times the concentrations of the NHMRC (2011) ADWG.
- ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia (www.waterquality.gov.au/anz-guidelines). The default guideline values (DGV) for fresh water at 95% level of species protection (LOSP) was adopted for the protection of ecosystems, aquatic foods, recreational uses and visual amenity as consistent with the water quality objectives

for the Botany Bay catchment (ANZG, August 2018) with reference to www.environment.nsw.gov.au/ieo/georgesriver/report-02.htm.

- EnRiskS (2013) also derived a target total mercury concentration to be protective of all offsite receptors based on the potential for groundwater to be extracted and used for industrial use. A target criterion of 0.5 mg/L was determined. This criterion was considered as a line of evidence by the Auditor when considering potential risks.

7.4. Auditor's Opinion

The assessment criteria adopted by JBS&G were commensurate with the project objectives and adequate to assess risks to the relevant receptors.

The RBC were considered acceptable criteria given that they were reviewed by a Site Auditor (Chris Jewell) for previous Site Audits listed in **Section 1.4** as well as being the subject of the Peer Review of EnRiskS (2013). Also, the RBC are conservative when compared to the HIL D of 740 mg/kg for inorganic mercury and consider total mercury (inorganic and Hg^0) and are protective of groundwater.

8. EVALUATION OF SOIL RESULTS

Soil and soil leachate results are presented as **Attachment 9** and **Attachment 10** extracted from the DSI. Soil and soil vapour investigation locations are shown on **Attachment 8**.

8.1. Field Results

The DSI states fill materials were encountered at all sampling locations at depths ranging from 0.6 to 1.5 mbgl. The fill comprised gravelly sands with varying levels of anthropogenic inclusions that included gravels, cobbles and building and demolition wastes (concrete, brick, etc.). There were no ACM fragments observed within soils sampled as part of investigation works. The fill materials were underlain by natural fine-grained sands (light yellow/brown and grey) to the maximum depth of the investigation (6 mbgl). Saturated soils were encountered at approximately 5 mbgl in deeper boreholes advanced as part of geotechnical investigations. There were no obvious signs of impact (odours, staining, oily materials) within the soils inspected during investigation works.

The Auditor notes PID readings documented on the borehole logs ranged from 0.7 to 3.1 ppm which is not indicative of significant volatile impacts in the soil.

8.2. Historical Investigations

The DSI states that review of data from historical investigations completed within the site is limited to summarised information presented in EnRiskS (2013). Wastes from the Depot 60 pit to the north of the site were reportedly removed in early 2007. Analytical results obtained from Orica (during assessment of the materials for disposal) indicate that the mercury concentrations in the wastes varied from 1.45 to 4,300 mg/kg. Following removal of the waste from Depot 60, the concrete surface was subject to high pressure washing and the concrete walls of the pit sampled for residual mercury.

The range of mercury reported in fill and waste materials (now removed) and residual concentrations in the concrete walls of Depot 60 ranged from 13 to 430 mg/kg - which were considered to be an insignificant source of Hg^0 vapours.

Soil investigations conducted in 2007 and 2009 within Block L reported mercury concentrations ranging from 0.2 to 272 mg/kg (sample locations unavailable for review), all below the commercial/industrial health investigation level (HIL) of 730 mg/kg for inorganic mercury. The soil is alkaline (pH 8.5–11.1), and no elemental mercury (Hg^0) was reportedly identified. Based on the data, it was considered that no further evaluation of inorganic mercury in this area was required.

No additional data as applicable to other contaminants within site soils was available for review by JBS&G or the Auditor.

The Auditor notes the historical concentrations are less than the RBC determined by EnRiskS (2013) as protective of groundwater of 893 mg/kg.

8.3. Metals

The DSI states:

> *"Heavy metal concentrations in all analysed samples were reported to be below the HIL-D criteria protective of human health. This included mercury, with levels predominantly ranging from 0.2 to 40 mg/kg, all below the HIL-D criterion of 730 mg/kg, which applies solely to inorganic mercury.*
>
> *It is noted however, that mercury vapour was detected at locations BH3 and HA2, indicating the likely presence of significant levels of mercury in the soils at these locations. These levels have been assessed on the basis of soil vapour data as discussed further in Section 9. Elevated total mercury concentrations were reported in shallow soils at these locations, with a maximum concentration of 520 mg/kg recorded at HA2 (0.4–0.5 m depth). This exceeds the RBC criteria derived by EnRisks (2013), suggesting that mercury levels in the soils at this part of the site pose a potentially unacceptable health risk…*
>
> *The elevated levels of mercury were further assessed to determine whether they present a potential ongoing risk of groundwater contamination. Additional leachability assessments (using ASLP and TCLP methods) were conducted on soils from these locations. The total mercury concentration in the leachate was reported at a maximum of 0.33 mg/L, substantially exceeding criteria protective of downgradient ecological receptors (ANZAST 2018 – 0.4 µg/L) and recreational exposures (0.01 mg/L).".*

8.4. Chlorinated Hydrocarbons

The DSI states:

> *"Chlorinated hydrocarbons were detected in soils as follows:*
>
> - *1,1-DCA in saturated soils (4.0-4.1 m bgs) at location BH5 at a concentration of 1.4 mg/kg;*
> - *PCE and TCE in soils throughout the assessed profile (i.e 0-6 m bgs) at location BH5 at concentrations up to 9.5 mg/kg and 0.9 mg/kg respectively; and*
> - *PCE and TCE in shallow soils at location HA3 0.2-0.3 m at concentrations of 1.9 mg/kg and 1.4 mg/kg respectively.*
>
> *Risks from these compounds are largely attributable to potential inhalation exposures. This has been discussed further in the soil vapour assessment..."*

The Auditor notes BH5 is located beneath the former solvent plant. The concentrations are well below the USEPA RSL x10 to adjust to a target risk of 1×10^{-5} for industrial soil as follows:

- 160 mg/kg for 1,1-DCA
- 1000 mg/kg for PCE
- 60 mg/kg for TCE.

8.5. Other Chemical Analytes

TRH, BTEX, PHAS, phenols, PFAS, OCPs and PCBs were detected below or close to the LOR and well below relevant assessment criteria.

8.6. Asbestos

Asbestos in the form of fragments of ACM were not reported to have been observed within material at any of the sampling locations. The laboratory analysis did not identify the presence of friable asbestos above the laboratory LOR (0.001% w/w) or within trace analysis in samples selected for analysis.

JBS&G note, however, that bonded ACM fragments were identified on the ground surface in the south-eastern portion which poses a potential aesthetic issue. Moreover, it indicates the potential for additional ACM to be encountered during future construction works following the removal of hardstand. Boreholes are not the preferred methodology for the assessment of asbestos given the relatively small volume of materials that can be inspected. On the basis of the ACM observed, and the soil characteristics across the site, ACM is considered by JBS&G to be potentially present in surface / near-surface soils across the extent of the site.

8.7. Auditor's Opinion

ACM is likely to be present in surface / near-surface soils across the extent of the site and the RAP proposes that this will be addressed through a physical barrier (cap).

The reported concentrations of all chemical contaminants in soil were below generic tier 1 health-based criteria applicable to commercial industrial land/use (HIL D) and associated risks appear to be low and acceptable.

However, total mercury concentrations were reported in shallow soils exceeding the RBC criteria derived by EnRiskS (2013) at one sample (from HA2). The Auditor notes the RBC are driven by vapour inhalation risks to site workers from Hg^0. The soil data is consistent with the soil vapour data discussed in **Section 9** which also identifies a potential vapour intrusion risk. The RAP proposes a vapour barrier to address potential inhalation risks. All concentrations were below the RBC of 893 mg/kg which was determined by EnRiskS (2013) to be protective of groundwater. Therefore, there would not appear to be an unacceptable risk to groundwater based on the data reviewed. This is consistent with the Auditor's understanding of the historical data for Block L as summarised by JBS&G in the DSI which was based on EnRiskS (2013).

JBS&G state there are no complete direct contact exposure pathways to impacted soils under the proposed land-use given the presence of hardstand that will extend across the site. Appropriate management actions will be required during future construction works to mitigate potential risks from direct contact/ingestion/inhalation exposure pathways associated with chlorinated hydrocarbon, mercury and asbestos impacts in soils. The Auditor agrees this is a reasonable conclusion.

The proposed capping would further reduce the potential for infiltration of surface water potentially causing leaching of mercury from soil to groundwater.

9. EVALUATION OF SOIL VAPOUR RESULTS

Soil vapour results are presented as **Attachment 11** extracted from the DSI. Soil and soil vapour investigation locations are shown on **Attachment 8**.

9.1. Field Results

The DSI states oxygen levels were generally elevated (i.e. in the range from 17-20%) and methane was not reported above the instrument detection limits at any location. Low levels of carbon dioxide (i.e. <3% v/v) were reported at most locations assessed. PID levels ranged from 0.1-9.6 ppm.

Each soil vapour probe was screened for the presence of mercury with Draeger tubes. In summary, the results were below detection limits with the exception of locations BH3 (0.8 mg/m^3) and HA2 (>2.0 mg/m^3). Resampling onto an XAD tube to allow laboratory analysis was undertaken at these locations to confirm the screening results.

9.2. Petroleum Hydrocarbons and Monocyclic Aromatic Hydrocarbons

The DSI states all BTEX and monocyclic aromatic hydrocarbon compounds were reported at concentrations below the laboratory detection limits, well below the adopted criteria.

9.3. Chlorinated Hydrocarbons

The DSI states:

> *"Significant detections of chlorinated alkenes inclusive of PCE and TCE at levels exceeding the adopted criteria were reported at all locations [**Attachment 8**]. The concentrations ranged from 1.3 to 33.9 mg/m^3 (PCE) and 0.2 to 29 mg/m^3 (TCE) respectively. The more elevated concentrations were reported in the [smaller] northern portion [of the site] (underlying the former solvents plant) and underlying the raised concrete slab in the [eastern portion of the southern larger portion of the site].*
>
> *A range of other constituents have been identified as co-occurring with the chlorinated alkenes that included chlorinated alkanes (1,1,2-TCA, 1,2-DCA, CTC and 1,2-dibromo-3-chloropropane) as well as CFM, HCBD at levels exceeding the adopted screening criteria (in lieu of Australian guideline values for these constituents). These constituents were similarly largely identified in the northern portion at location BH5, with the exception of CFM which was identified across the extent of the site (at concentrations ranging from 0.1 to 1.4 mg/m^3).*
>
> *It is noted that the NSW EPA screening levels for chlorinated hydrocarbons in soil vapour are based on a conservative soil to indoor attenuation factor of 10. No factor is applied to the US EPA criteria which are based on ambient air levels. The maximum factor that can typically be applied for a development like that proposed on the site is 1000. The use of this factor is noted as being required to be supported by a detailed health risk assessment (not completed for this site).*
>
> *The environmental dataset has been reconsidered by using the alternate attenuation factor of 1000. Significant exceedances will still be present for TCE, chloroform and HCBD present in soil vapour. The locations of these exceedances comprise most of the site extent."*

9.4. Mercury

The DSI states:

> *Confirmatory laboratory analysis was completed at the two locations which reported positive detections of mercury vapour on the Draeger tube samples. Vapour samples were collected onto XAD tubes, in which the corresponding laboratory results confirmed the presence of mercury in vapour at concentrations of 0.74 mg/m^3 (BH3) and 26 mg/m^3 (HA2) respectively…*
>
> *The maximum of these levels exceeds the US EPA Region 9 screening level based screening criterion by a factor exceeding 1000. This confirms that mercury vapour poses a potential unacceptable health risk via vapour intrusion / inhalation exposures within future buildings proposed on the site.*

The Auditor notes the USEPA RSL for industrial air adjusted by an attenuation factor of 0.1 is 0.013 mg/m^3 (as shown in **Attachment 11**).

9.5. Auditor's Opinion

Significant detections of CHCs and mercury have been reported in soil vapour at the site. JBS&G state the complete site extent is impacted with one or a mix of these compounds at levels which exceed a criteria that would likely be derived by a future health risk assessment (if undertaken). The maximum levels of constituents in soil vapour will pose a potential unacceptable health risk to future occupants of a building constructed on the site. The soil vapour impacts will require management / remediation to

address potential inhalation exposures via vapour intrusion into the future warehouse containing the proposed new chlorine liquefaction plant. The Auditor agrees with this conclusion.

10. EVALUATION OF CONCEPTUAL SITE MODEL

A conceptual site model (CSM) is a representation of the contaminant source, pathway and receptor (SPR) linkages at a site. JBS&G developed a preliminary CSM in the DSI to inform the investigation program and then refined this based on the investigation outcomes to inform remediation and management requirements. The CSM is presented as **Table 10.1** extracted from the DSI.

Table 10.1: Conceptual Site Model

Receptor	Location	Media	Potential Exposure Pathways	Commentary
On-site Receptors				
Future industrial users	Within Future Warehouse (i.e. the new Chlorine Liquefaction Plant)	Soils / Groundwater	Inhalation (vapours and gases) Inhalation (asbestos particulates)	This exposure pathway is potentially complete as a result of chlorinated hydrocarbon (including TCE, PCE, CTC, CFM and/or HCBD) and/or mercury impact in vapour which has been identified across the extent of the footprint in which the new Chlorine Liquefaction Plant is proposed (refer to Figure 5). Fragments of ACM have been noted in site soils, in which the future hardstand surface will mitigate any inhalation exposures. However, on-going management will be required to ensure an adequate capping arrangement is maintained.
	Outdoor Areas (limited to the new Hypo Loading Bay in the northern portion)	Soils	Inhalation (particulates or vapours) Oral ingestion Dermal contact	This exposure pathway is not complete given that the surface will be covered in hardstand (thereby precluding direct contact exposures). As per the above, fragments of ACM have been noted in site soils, in which the future hardstand surface will mitigate any inhalation exposures. However, on-going management will be required to ensure an adequate capping arrangement is maintained.
Construction worker or intrusive maintenance worker (short duration)	Construction areas/excavations	Soils	Inhalation (vapours, gases and particulates/fibres)	Potentially complete, as a result of chlorinated hydrocarbon and mercury impacts in site soils. Fragments of ACM were further identified on the ground surface in the south-eastern portion of the site – where it is noted that additional asbestos impacts may be encountered following removal of site hardstand during demolition and construction works.
		Groundwater	Inhalation (vapours and particulates/fibres) Oral (infiltrating seepage water) Dermal (infiltrating seepage water)	This exposure pathway has not been assessed directly herein. However, it should be assumed that the pathway is potentially complete as a result of chlorinated hydrocarbon and mercury impacts in groundwater underlying the site.
Off-site Receptors[10]				
Recreational users of Penrhyn Estuary and Botany Bay	Surface waters downgradient of the site	Surface Water as potentially affected by site groundwater	Inhalation (vapours) Oral, Dermal, Ingestion	This exposure pathway has not been directly assessed in this report. However, as of the time of reporting, it is considered incomplete due to the implementation of the BGC. Moreover, the reported contaminant levels of those compounds not currently regulated as part of the BGC (and Orica's responsibility) within site soils were not representative of gross impact that could cause groundwater contamination.
Off-site Commercial / Industrial users	Within buildings or outdoor areas.	Soils and/or groundwater	Inhalation (vapours, gases and particulates/fibres)	This exposure pathway is not complete based on current surrounding land-uses. Future land-uses which comprises construction of buildings in close proximity of the site may cause this exposure pathways to be complete in the future by potential lateral migration of vapours from the site.
Ecological Receptors within Penrhyn Estuary and Botany Bay	Surface waters downgradient of the site	Surface Water as potentially affected by site groundwater	Various	This exposure pathway has not been directly assessed in this report. However similarly for recreational uses of Penrhyn Estuary and Botany Bay is caused to be incomplete through the implementation of the BGC. Moreover, the reported contaminant levels of those compounds not currently regulated as part of the BGC (and Orica's responsibility) within site soils were not representative of gross impact that could cause groundwater contamination.

JBS&G Footnote 10: …the discharge of CHCs via groundwater from BIP is currently regulated and controlled as part of BGC. As such, the assessment of potential risks to off-site receptors from impacted groundwater potentially migrating from the site will largely be restricted to contaminants/impacts sourced from historical activities on site and not those sourced and currently managed as part of BGC.
Figure 5 refers to ***Attachment 8.***

10.1. Auditor's Opinion

The information obtained for the DSI provides a robust basis for the CSM. The CSM is consistent with the site history and the information reviewed.

The CSM identifies the following potentially complete pathways:

- CHCs and mercury vapour posing a potential risk to occupants of the proposed building structure via vapour intrusion.
- CHCs posing a potential risk to occupants of future commercial/industrial buildings offsite should buildings be established in the future on surrounding land in areas that are near to significant impacts in soil vapour onsite. The DSI states that contaminants in soil vapour on site do not pose a risk to current receptors surrounding the site. Future remediation works to address soil vapour impacts will need to consider the potential off-site migration risks, should surrounding land be redeveloped in close proximity to the identified impacts on site. Given the extent of soil vapour impacts that likely extend well beyond the site boundary within adjacent BIP land, any future on-site remedial works will likely comprise engineering controls (vapour membranes, etc.) rather than source removal works.
- Asbestos fibres (inhalation) posing a potential risk to intrusive maintenance workers onsite.
- Groundwater impacted by CHCs likely posing a potential risk to intrusive maintenance workers via oral and dermal routes in instances where excavations intercept groundwater.

The Auditor is of the opinion that the above provides a reasonable representation of the potential risks and provides an adequate basis to inform the RAP.

11. CONTAMINATION MIGRATION POTENTIAL

EnRiskS (2013) stated that mercury-impacted groundwater derived from the FCAP has not migrated to, nor has discharged to, any receiving body. Potential for further migration downgradient is considered likely by EnRiskS based on mobility of $HgCl^{3-}$ species that dominate the plume. Hence EnRiskS were of the opinion future migration and discharge to Springvale Drain (and subsequent discharge to Penrhyn Estuary) needed to be considered.

JBS&G note that there are no groundwater monitoring wells or previous groundwater data from directly underlying the site footprint. Notwithstanding, EnRiskS (2013) reports the following with respect to results from groundwater monitoring conducted underlying and downgradient of the FCAP:

- 2011: Dissolved mercury concentrations ranged from below detection (<0.0001 mg/L) to 9 mg/L, with the highest levels in shallow wells near the primary source of the FCAP (i.e. Blocks G, M and A). Concentrations declined sharply further downgradient. 44% of samples exceeded the ANZECC Trigger level, consistent with prior data.
- 2012: Dissolved mercury levels ranged from below detection limits to 1.32 mg/L, with 65% exceeding the ANZECC Trigger level. Methylmercury concentrations were detected (0.001–0.64 µg/L), consistent with historical data.

JBS&G note the most recent mercury monitoring data collected in accordance with the requirements of the Ongoing Maintenance Order (20172802) was reported in WSP (2023). Of note, there are two nested wells (WG212S/I/D and MWC04S/D) located approximately 25 m from the downgradient boundary of the site included in the ongoing monitoring. The total and dissolved mercury concentrations in these two wells (in the shallow aquifer) were reported to be stable and/or decreasing in the shallow aquifer during the period of monitoring from May 2006 till December 2022. Moreover, the most recent reported dissolved (D) and total (T) mercury concentrations at these locations (WG212S; D:<0.0001 mg/L,

T:0.0069 mg/L and MWC04S; D<0.0008 mg/L, T:0.38 mg/L) were substantially less than the reported results from monitoring locations upgradient of the site (within former Blocks M and G).

JBS&G note there is localised mercury impacts in soils (nearby Depot 60 in HA2) that exceed the RBC criteria derived by EnRiskS (2013) that is protective of groundwater. Mercury has been confirmed as leachable at elevated concentrations within unsaturated soils in this area. The most recent groundwater monitoring data in the downgradient monitoring well (WG212) in close proximity to Depot 60, indicates that the site is unlikely to be contributing to significant mercury impacts in groundwater at BIP. As such, during redevelopment of the site, it is recommended that the impacted soils are retained near the surface below hardstand (as proposed across the extent of the site) to mitigate the potential for leaching of materials to affect groundwater. It is considered that source removal works are not warranted on the basis of the potential to improve groundwater quality.

JBS&G also note there were no significant impacts in site soils that are potentially causing ongoing risks to groundwater that is currently not been managed as part of the BGC.

Contaminants in soil vapour on site do not pose a risk to current receptors surrounding the site. As the site will be completely covered in hardstand, there is low risk that impacts within site soils will migrate from the site through the generation of windblown dusts or surface water erosion. During future construction activities, standard asbestos/dust/odour suppression practices and sediment/erosion controls should be implemented to minimise the risk of contaminants in soils migrating from the site when additional soils are exposed.

11.1. Auditor's Opinion

Based on the mercury concentrations measured in soil by JBS&G (below the RBC of 893 mg/kg protective of groundwater) and the available historical information/data for Block L, and the WSP groundwater data, the Auditor agrees that site is unlikely to be contributing to significant mercury impacts in groundwater at BIP under the proposed land use. The Auditor agrees source removal works for mercury are not warranted. The capping of the site would further limit any leaching of metals from soil to groundwater via surface water infiltration.

Furthermore, the Auditor notes the ANZG (2018) DGV for mercury (freshwater, 95% LOSP) is 0.0006 mg/L. Dissolved concentrations reported in WG212S and MWC04S were below or close to this criterion, noting dissolved concentrations are more likely to be representative of risks to ecological receptors than total concentrations. The Auditor notes the GMRRW for mercury is 0.01 mg/L. The total concentrations were below this criterion in WG202S and exceeded in MWC04S (0.38 mg/L). However, the exceedance was less than two orders of magnitude. Therefore, overall, considering the distance to the nearest receptors (Springvale Drain and Penrhyn Estuary/Botany Bay approximately 1 km downgradient), the risks to offsite ecological and recreational receptors in the event hydraulic containment ceases are likely to be low and acceptable based on the reported information (and are currently managed by the BGC Project).

The maximum concentration of total mercury in groundwater (0.38 mg/L) was also less than the concentration determined by EnRiskS (2013) to be protective of all offsite receptors based on the potential for groundwater to be extracted and used for industrial use of 0.5 mg/L.

The Auditor notes concentrations of CHCs or other COPC in groundwater were not assessed. However, CHCs are BIP-related contamination and are the responsibility of Orica and are controlled by the BGC Project (**Section 1.6**) as regulated under the VMP (**Section 1.5**). Other COPC potentially requiring source removal works to address groundwater are unlikely to be of concern based on the site history and soil data reviewed herein. JBS&G state "*…the reported contaminant levels of those compounds not currently regulated as part of the BGC (and Orica's responsibility) within site soils were not representative of gross impact that could cause groundwater contamination."*

The Auditor agrees with the conclusions made by JBS&G discussed above.

12. EVALUATION OF PROPOSED REMEDIATION

12.1. Proposed Extent of Remediation

The RAP states the extent of contamination that will warrant remediation has been determined from a review of the DSI. The proposed extent of contamination is shown on **Attachment 12** and includes:

- Asbestos (bonded) impacts present in near surface/fill-based soils across the site; and
- Mercury and CHC impacts in soil vapour posing a potentially unacceptable health risk (via vapour intrusion) to future site users within the enclosed building of the new Chlorine Liquefaction Plant. The extent of potentially impacted vapour that will require management extends across the complete site extent and likely into adjoining BIP land.

The RAP proposes:

- Management of asbestos impacted soils with the redevelopment of the site by onsite containment
- Management of CHC and mercury impacted soils by inclusion of vapour barriers to buildings
- Retention of the mercury impacted materials in shallow, unsaturated media below future hardstand.

12.2. Proposed Capping Arrangements for Asbestos

The following capping arrangements are proposed:

- Beneath permanent concrete structures installation of a marker layer over contaminated fill material and permanent concrete slab as the physical barrier
- Permanent hardstand structures (i.e., concrete slabs, pile caps or asphaltic concrete or similar, footpaths, but not bricks or pavers) – installation of a marker layer overlying potentially contaminated material followed by sub-grade material validated as environmentally suitable materials for human exposure and then the permanent structure (e.g., exterior concrete footpaths, asphaltic roads, etc.)
- Unpaved areas – installation of the marker layer at a minimum depth of 500 mm below the final finished site levels, with a capping layer consisting of environmentally suitable materials for potential human and/or ecological exposure; and
- Within underground services trenches / services – service infrastructure will require remediation to 150 mm below the depth of services, with a marker layer and capping layer installed consisting of environmentally suitable materials for potential human and/or ecological exposure.

The marker layer shall consist of a bright orange coloured non-woven polyester continuous filament or PET (such as non-woven geotextiles). The marker layer will be placed across both portions of the site.

12.3. Vapour Barrier for Chlorinated Hydrocarbons and Mercury

A vapour barrier requires to be installed underlying the complete footprint of the proposed building on the site (across the extent of the larger portion of the site). The vapour barrier is recommended to be placed as a sprayed bituminous membrane across the extent of the affected building and placed underlying the building pavement. The detailed design of the vapour barrier, as prepared by an appropriately qualified and experienced specialist contractor, shall be included with the Construction Quality Assurance Plan (CQAP).

12.4. Materials Tracking

The movement of all mercury and CHC impacted materials (subject to long term containment) on the site is required to be subject to a Material Tracking Plan (MTP) if relocated during development works to confirm they are retained above groundwater levels. The MTP shall be administered by the

environmental consultant and provided to the Site Auditor for review prior to construction works, with the provision of all required information by the remediation contractor.

12.5. Evaluation of RAP

The Auditor has assessed the RAP by comparison with the checklist included in NSW EPA (2020) *Contaminated Land Guidelines, Consultants Reporting on Contaminated Land*. The RAP was found to address the required information, as detailed in **Table 12.1**.

Table 12.1: Evaluation of RAP

Remedial Action Plan	Auditor Comments
Remedial Goal/Objective The RAP states the objectives of the remediation are: • To make the site suitable from a human health perspective for the proposed industrial land-use; and • To manage the occupational risk as associated with asbestos as suitable for the site description as a workplace. Overall, the objective of the remediation is to remove risks posed by the identified contamination issues, such that the site is made suitable for the proposed development while ensuring the protection of human health and the surrounding environment. It is a further objective to undertake works, in accordance with applicable guidelines and legislation, in a manner which is concordant with the principles of ecologically sustainable development (ESD).	The objectives are commensurate with the data reviewed and the identified potential risks to human health and the environment with respect to relevant on and offsite receptors as determined by the CSM. The objectives are also aligned with the project and Audit objectives to demonstrate that the site can be rendered suitable for the proposed use.
Discussion of the Extent of Remediation Required The extent of remediation is discussed in **Sections 12.1 to 12.4** and shown on **Attachment 12**.	The extent of remediation is commensurate with the data reviewed and the identified potential risks to human health and the environment with respect to relevant on and offsite receptors as determined by the CSM.
Remedial Options The RAP considers the preferred hierarchy of options for site clean-up and/or management provided in NEPM (2013), which include: • On-site treatment so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level. • Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site. if the above are not practicable, • Consolidation and isolation of the soil on-site by containment within a properly designed barrier. • Removal of contaminated soil to an approved site or facility, followed where necessary, by replacement with appropriate material. or • Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.	A relevant range of options were considered in accordance with the preferred hierarchy provided in NEPM (2013).
Selected Preferred Option and Rationale The RAP provided an assessment of various remedial options and their applicability for use at the site (Table 4.1 of the RAP). On the basis of the assessment, the following remedial/management options are proposed for the site: • Management of asbestos impacted soils with the redevelopment of the site by onsite containment	The selected preferred remediation options are reasonable based on the data reviewed and should be technically feasible under the considered development scenario of large warehouse building(s) at grade. Adequate justification and rationale was provided in the RAP for the various options considered and those selected.

Remedial Action Plan	Auditor Comments
• Management of chlorinated hydrocarbon impacted soils by inclusion of vapour barriers to buildings constructed overlying; and • Inclusion of mercury contaminated soils with management of chlorinated hydrocarbon impacted soils and further retention of the impacted materials in shallow, unsaturated media below future hardstand. Should construction works result in the disturbance of the impacted materials, then they will require reinstatement at a level above groundwater (i.e. must be retained <2 mbgl unless groundwater encountered shallower) with diligent materials tracking protocol implemented.	
Description of Remediation to be Undertaken Descriptions of the remediation are provided in **Sections 12.2 and 12.3**.	The descriptions of remediation options are reasonable based on the data reviewed and should be technically feasible under the considered development scenario of large warehouse building. A MTP is to be prepared and reviewed by the Auditor prior to implementation.
Proposed Validation: <u>Overview</u> Validation works on the site shall include: • Validation of the appropriate installation of a vapour barrier on the site during construction works. This shall be undertaken by a CQAP and validation sampling above the vapour liner • Validation to confirm the containment of the asbestos hazard across the extent of the site • Material tracking to confirm appropriate relocation of impacted soils where undertaken, inclusive of the mercury affected soils, as in accordance with the requirements for material tracking. • Validation of imported materials. Validation criteria or metrics are discussed in **Sections 12.1 to 12.3** where relevant and in the following rows.	The framework for validation works is consistent with the remediation objectives. A MTP and CQAP are to be prepared by the consultant or remediation contractor and reviewed by the Auditor prior to implementation.
<u>Vapour Barrier</u> Validation of the vapour barrier during installation will include smoke tests and inspections, including hold points. Once installed, additional validation requirements are proposed consisting of vapour/indoor air sampling of the constructed building prior to site occupation. Two vapour samples shall be collected within the building, and a control sample location at a distance of greater than 30 m from the site. Samples shall be collected by 'Radiello Samplers' and consist of collection of 'indoor air'/ 'ambient air'. Levels of VOCs shall be assessed against the lower of vapour-based criteria provided in NSW EPA (2010) *Vapour Intrusion: Technical Practice Note*; and the lowest of the interim health investigation levels of vapour provided to NEPM (2013) for chlorinated constituents as divided by a factor of 10 with consideration of existing background/ambient levels for constituents assessed by non-threshold effects as measured at the background location. Validation samples will also be collected/analysed for mercury. A separate sampling tube (XAD) or summa canister will be required for the analysis of mercury. <u>Asbestos Containment</u> Visual inspection will be undertaken by the Environmental Consultant to verify the installation of the marker layer across the complete extent of the site where non-virgin excavated natural material (VENM) soils are present.	The proposed approach for validation is robust and consistent with the remediation objectives.

Remedial Action Plan	Auditor Comments
Photographic records and a survey prepared by the Project Surveyor of the marker layer installation, including vertical and lateral extents, will be included in the Validation Report. Material to be used as a capping layer (other than concrete pavement) must be validated by the Environmental Consultant to be environmentally suitable, consisting of VENM, excavated natural material (ENM), suitable on-site materials (i.e. materials from another portion of the development site that are non-impacted) or material considered suitable for beneficial reuse via a resource recovery exemption issued by NSW EPA. Additionally, contaminant concentrations in any capping layer material must not exceed the adopted site validation criteria for soils. Photographic records and a survey of the capping layer installation, which details the final thicknesses of the capping layer, including the vertical and lateral extents prepared by the Contractor will be retained for inclusion in the Validation Report.	
Validation of Imported Soil Sampling of the imported VENM (if required) will be undertaken at a minimum rate of three samples per source site subject to consideration of the source of the material, potential for contamination and homogeneity. Large quantities of VENM will be sampled at a rate of one sample per 500 m^3. The sampling rate may be required to be increased (i.e. one sample per 100 m^3, and potentially as detailed as one sample per 25 m^3 to prepare an appropriately reliable dataset of soils characterisation) where potential indicators of contamination and/or heterogeneity are observed. Soil samples will be analysed for TRH, BTEX, PAHs, heavy metals, OCPs, PCBs and asbestos. Sampling of imported ENM will be undertaken in accordance with the requirements of the POEO (Waste) Regulation 2005 – General Exemption under Part 6, Clause 51 and 51A for Excavated Natural Material Exemption. Similarly, if recycled fines, or another NSW EPA exempted product, are received on the site, the materials will require to have been sampled in accordance with the relevant exemption. Sampling and analysis shall further be undertaken for asbestos in all cases (if not undertaken at the source site). The RAP proposes reliance on sampling and analysis undertaken of the material prior to receipt on site where the Environmental Scientist confirms via an inspection of material on receipt at the site that the material is consistent with the physical description provided to the off-site characterisation description, and the material is free of anthropogenic materials or other indicators of contamination.	The proposed approach for imported materials validation is robust and consistent with the remediation objectives. The Auditor notes large quantities of imported fill such as for bulk earthworks are not anticipated under the proposed development.
Validation of Crushed Concrete (if required) Items of masonry construction may be crushed / re-used on site subject to preconfirmation of the contamination status of these materials. Chemical testing should include PFAS and mercury and further, it shall be confirmed by inspection that these materials are free of potential ACM.	It is understood that no concrete will be crushed/ reused on site. However, an adequate framework has been provided as a contingency.
Contingency Plan if Selected Remedial Strategy Fails The following scenarios have been identified by the RAP: <u>Unexpected Finds</u> The RAP includes an unexpected finds protocol (UFP) to be followed in the event of unexpected finds. This includes stopping work and seeking appropriate advice from the relevant experts to address the find. <u>Failure of the vapour liner</u> The success of the vapour barrier is proposed to be assessed by a program of indoor sampling undertaken during conditions where potential advective flow to site buildings will be maximised. Where these samples identify excessive levels of TCE, mercury, or any	The proposed contingencies are reasonable in the context of the CSM and the remediation strategies provided in the RAP. There is a low potential of failure of the vapour liner if installed by an experience contractor, following the approved CQAP.

Remedial Action Plan	Auditor Comments
other chlorinated hydrocarbon vapour assessed, as compared to the background sample also collected at the same time, then contingency actions to control vapour ingress to the site building will be activated. This will include re-mobilisation of the vapour liner contractor to the site and instruction to undertake repairs on the vapour liner. From discussions with vapour liner installation contractors these repairs can be undertaken – and are required to be undertaken in rare instances. Following completion of any repairs – all validation testing as nominated in the CQAP will be required. In the unlikely event that a vapour barrier repair is further unsuccessful in addressing the migration of vapours to buildings overlying the vapour barrier, then additional contingency actions would require to be implemented. It is proposed in this instance to install a venting system underlying the vapour barrier. The venting system would require to be sufficient to control advective flows of vapours from the sub-surface into the building. The detailed design of the venting system should be undertaken in consultation with the Auditor to agree vent pipe locations and discharge points relative to the building. The installation of the vent lines would need to be undertaken by directional drilling to install the points horizontally under the extent of the building. <u>Emissions/pollution complaints during storage and handling of high-level chlorinated hydrocarbon/mercury/asbestos contaminated soils</u> The Remediation Environmental Management Plan (REMP) proposed for remediation works shall contain provision for contingency actions where excessive emissions occur, however it is anticipated that one or more of the following actions will be considered: • Increased application of odour screening/masking chemicals on odorous materials • Disturbance of soils during meteorologically favourable periods only • Covering of impacted soils; and/or • Implementation of alternate construction methods.	
Interim Site Management Plan (before remediation) Interim management is not discussed by the RAP.	The site is an active facility within BIP and would be subject to management measures.
Site Management Plan (operation phase) including stormwater, soil, noise, dust, odour and WH&S The RAP requires a Work Health and Safety Management Plan (WHSP) and REMP to be prepared by the remedial contractor prior to commencement of remediation works. The REMP will document the environmental monitoring and management measures to be implemented during the remediation related activities associated with the construction of the site. The site is subject to development controls as specified in the Botany Bay Development Control Plan 2013 (DCP), which has reportedly been incorporated into the RAP (most specifically to the aspects of Contaminated Land Policy provided in part 3K of the DCP) and will require to be further adopted into the REMP to address (amongst other things): • Dust and Airborne Hazard Control • Emergency Response • Odour Control • Handling of Contaminated Soil and Groundwater • Soil Storage/Placement Areas • Sediment Control • Decontamination of Heavy Equipment • Security and Signage	The RAP provides an adequate framework for informing Site Management Plan requirements relating to contamination and remediation.

Remedial Action Plan	Auditor Comments
• Incident Reporting • Contact Details • Stockpiling	
Remediation Schedule and Hours of Operation Hours of operation will be consistent with the consent conditions. A schedule is not available. However, remediation is anticipated to be conducted in parallel with development.	Adequate.
Licence and Approvals The site is subject to development controls as specified in the DCP, which have been incorporated into the RAP and will require to be further adopted into the REMP. All asbestos works will require to be undertaken with the relevant requirements of Safe Work Australia (2020) *How to Manage and Control Asbestos in the Workplace Code of Practice*. Whilst only bonded fragments (of <10 m^2), it is recommended that the works be undertaken by a SafeWork Class A / B Accredited Asbestos Removal Contractor – noting that bonded/friable asbestos impacted soils have been reported in site soils elsewhere across BIP. During any remedial works which are inclusive of the disturbance of surface soils on the site, perimeter asbestos in air monitoring will be conducted at the applicable remedial works area boundary. Air monitoring will be conducted on a daily basis at relevant locations whilst disturbance of asbestos contaminated areas takes place. Air monitoring will be conducted during any ground disturbance activities within the site to verify that implementation of appropriate control measures have been successful at managing the risk of air borne fibre generation. Air monitoring will be undertaken in accordance with the requirements of the National Occupational Health and Safety Commission (NOHSC) Asbestos Code of Practice and Guidance Notes, in particular the Guidance note for the estimation of airborne asbestos dust [NOHSC 3002:2005].	Adequate.
Contacts/Community Relations Contacts were not provided, however, the RAP provides a framework which requires these details to be included in the REMP.	The RAP provides an adequate summary of the proposed contacts. Community consultation of the remedial works is not discussed. However, will occur through the development assessment/planning process.
Staged Progress Reporting Key additional documents to be prepared relating to remediation include the CQAP for the vapour barrier design. The CQAP should be prepared as part of the detailed design of the building vapour mitigation system and submitted to the Site Auditor for review and endorsement prior to commencement of construction. The CQAP shall be prepared by the vapour barrier installation contractor. MTP to address any relocation of soil onsite and other material tracking requirements, materials import, and waste disposal. The CQAP and MTP are to be reviewed and endorsed by the Auditor prior to finalisation.	Interim Audit Advice (IAA) reviewing the CQAP and MTP should be obtained. A Section A2 SAS and SAR reviewing a Validation Report and long term EMP (referred to by JBS&G as Site EMP or SEMP) should be obtained.
Long Term Environmental Management Plan A Long-Term EMP will be prepared for the site to ensure the retention of vapour liners / barriers as anticipated to be installed at the site to control potential exposures to CHC, mercury and asbestos. The EMP will define: • The location, extent and nature of residual contamination • The extent of the management area • Risk management and control measures to prevent potential exposures to groundwater contamination	Refer to **Section 12.6**.

Remedial Action Plan	Auditor Comments
• Contact persons for potentially affected persons to seek further information / assistance • Definition of roles and responsibilities in the implementation of the EMP • Requirements for reporting • Actions to be undertaken in the instances where the containment layer and/or vapour barrier require to be breached. The EMP is intended to be a live document that will be revised / updated consistent with the progress of the site redevelopment works and revisions to the site design/construction in the future. The EMP shall be made legally enforceable through the anticipated Development Consent for the site remediation/redevelopment requiring the engagement of a Site Auditor and preparation of a Site Audit Statement. The EMP will be included with the Site Audit Statement as prepared for the site. The EMP will be required to additionally manage the retention of asbestos impacted soils. The EMP shall be sufficient to control potential exposures to the soils and meet relevant requirements as specific to the management of asbestos in a workplace as advised to the *Work Health and Safety Act 2011*. This shall be inclusive of an Asbestos Management Plan (AMP) and an Asbestos Register.	
Waste Management The RAP proposes that the REMP shall include: • Waste classification reporting requirements in accordance with EPA (2014) *Waste Classification Guidelines* • Description of material handling and tracking plan including detailed description of the site cut/fill balance and the material tracking system to be implemented during site remediation works • Statements regarding materials being disposed via appropriately licenced facility or re-used under an order or exemption • Requirements for recording waste disposal dockets or other waste documentation for any disposed waste.	Evidence of lawful disposal will need to be provided in the Validation Report, including waste classification reports and disposal dockets from appropriately licensed facilities.

12.6. Overall Auditor's Opinion

The RAP provides an adequate framework to render the site suitable for the proposed development subject to competent implementation and successful validation. In my opinion the proposed remediation is adequate for the identified contamination and will not result in greater environmental or human health risks than leaving the site undisturbed.

The RAP proposes preparation of a CQAP and MTP. These should be provided to the Auditor for review.

A Section A2 SAS and SAR reviewing a Validation Report and long-term EMP (inclusive of an Asbestos Management Plan and Asbestos Register) should be obtained following remediation and redevelopment of the site. Based on the information reviewed, it appears reasonable to anticipate that an adequate EMP could be developed to document:

- The location, extent and nature of residual contamination at the site
- The extent of the management area
- Risk management and control measures to prevent potential exposures to groundwater contamination
- Contact persons for potentially affected persons to seek further information / assistance
- Definition of roles and responsibilities in the implementation of the EMP

- Requirements for reporting
- Actions to be undertaken in the instances where the containment layer and/or vapour barrier require to be breached

Further recommendations are discussed in **Section 14**.

13. COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

13.1. General

The Auditor has used guidelines currently made and approved by the EPA under section 105 of the CLM Act. The reporting was generally conducted in accordance NSW EPA (2020) *Contaminated Land Guidelines, Consultants Reporting on Contaminated Land* and SEPP R&H.

13.2. Development Approvals

This IAA #1 has been prepared to support resubmission of DA35/98-Mod-6 and to address corresponding requests from NSW EPA and Randwick City Council as summarised in **Section 1.1**.

13.3. Local Government Liaison

It is anticipated that the Audit will become a condition of development consent and therefore become a Statutory Audit. A Section A2 SAS and SAR reviewing a Validation Report and long term EMP (referred to by JBS&G as Site EMP or SEMP) is proposed. The EMP will be attached to the Section A2 SAS. The Section A2 SAS and SAR will be provided to Council by the Auditor as required for a Statutory Audit. Council would then be required to note the presence of the SAS on the Section 10 (2) Planning Certificate for the site.

13.4. EPA Liaison

Liaison by the Auditor with the NSW EPA will be required to be undertaken prior to completion of the anticipated Section A2 SAS and SAR following remediation and validation. This is required in accordance with EPA (2017) *Guidelines for the NSW Site Auditor Scheme (3rd Edition)* for sites that are regulated by the NSW EPA under the CLM Act.

13.5. Groundwater Abstraction

Groundwater quality has not been assessed and is not suitable for abstraction and beneficial use without further assessment. The site is located within Area 1 of the Botany Sands Groundwater Source and is subject to *The Temporary Water Restriction (Botany Sands Groundwater Source) Order 2024* which imposes a ban on groundwater use for domestic purposes. Holders of industrial groundwater extraction licences listed in the Order and those using water for non-domestic purposes in both Area 1 and 2 must also comply with conditions and requirements including demonstrating fit for purpose.

13.6. Duty to Report

The site is located within the area covered by Declaration of Remediation Site, Declaration Number 21074, Area Number 3203 (originally dated 9 February 2005 and subsequent amendments) and is currently regulated by the NSW EPA as described in **Sections 1.5**.

13.7. Waste Management

A framework for waste management is adequately described in the RAP.

13.8. Licenses

The RAP states all asbestos works will require to be undertaken with the relevant requirements of Safe Work Australia (2020) *How to Manage and Control Asbestos in the Workplace Code of Practice*. Whilst only bonded fragments (of <10 m^2), it is recommended that the works be undertaken by a SafeWork Class A / B Accredited Asbestos Removal Contractor – noting that bonded/friable asbestos impacted soils have been reported in site soils elsewhere across BIP.

13.9. Asbestos Register and Asbestos Management Plan

Asbestos impact remains in the subsurface soil and should be recorded on the Asbestos Register maintained at the site. The proposed EMP prepared at completion of remediation and validation of the site is to include an AMP and Asbestos Register.

13.10. Conflict of Interest

The Auditor has considered the potential for a conflict of interest in accordance with the requirements of Section 3.2.3 of the NSW EPA (2017) *Guidelines for the NSW Site Auditor Scheme (3rd Edition)*.

The Auditor considers that there are no conflicts of interest, given that:

1. The Auditor is not related to a person by whom any part of the land is owned or occupied.
2. The Auditor does not have a pecuniary interest in any part of the land or any activity carried out on any part of the land.
3. The Auditor has not reviewed any aspect of work carried out by, or a report written by, the site auditor or a person to whom the site auditor is related.

14. CONCLUSIONS AND RECOMMENDATIONS

The RAP concludes:

> *"A remedial approach has been developed and presented in this RAP which will facilitate the remediation and/or long term management of asbestos impacted soils, chlorinated hydrocarbon impacted soils, mercury impacted soils for the future industrial redevelopment of the site. …it is considered that the proposed actions outlined in this RAP conform to the requirements of the Contaminated Sites Guidelines for the NSW Site Auditor Scheme (3rd Edition) (EPA 2017) because they are: technically feasible; environmentally justifiable; and consistent with relevant laws policies and guidelines endorsed by NSW EPA.*
>
> *Subject to the successful implementation of the measures described in this RAP it is concluded that the site can be made suitable for the intended uses and that the risks posed by contamination can be managed in such a way as to be adequately protective of human health and the environment."*

The RAP recommends:

- *"An appropriate contractor is engaged specific to the installation of a Vapour Barrier for the entire footprint of the proposed site building and a Construction Quality Assurance Plan (CQAP) is prepared consistent with this. The Environmental Consultant and Site Auditor shall require to review and endorse the CQAP prior to commencement of building works*
- *A Work Health and Safety Management Plan (WHSP) and Remediation Environmental Management Plan (REMP) shall be prepared by the remedial contractor prior to commencement of remediation works*
- *The movement of all mercury and CHC impacted materials (subject to long term containment) on the site is required to be subject to a Material Tracking Plan (MTP) if relocated during*

development works to confirm they are retained above groundwater levels. The MTP shall be administered by the environmental consultant and provided to the Site Auditor for review prior to construction works; and

- *An EMP requires to be prepared for the site to ensure the long term integrity of the installed vapour barrier and preclusion of access to impacted soils retained underlying the site (including asbestos)."*

Based on the information presented in the reviewed reports and observations made on site, and following the Decision-making process for assessing urban redevelopment sites in NSW EPA (2017) *Guidelines for the NSW Site Auditor Scheme (3rd Edition)*, the Auditor concludes that the site can be made suitable for the purposes of the proposed development if remediated in accordance with the following remedial action plan:

- 'Remedial Action Plan, New Chlorine Liquefaction Plant, Denison Street, Banksmeadow, NSW', dated 5 February 2026, JBS&G.

The following recommendations are made with respect to implementation of the RAP for consideration by the Planning Authority when preparing consent conditions:

1. The CQAP and MTP are to be prepared prior to commencement of remediation and development. These should be provided to an EPA Accredited Auditor for review (documented in an Interim Audit Advice letter).
2. Any unexpected finds during works or deviations from the Auditor-endorsed documents must be discussed with an EPA Accredited Auditor at the earliest opportunity and endorsed prior to implementation.
3. At completion of the development, a Validation Report, long-term EMP (including an AMP and Asbestos Register) are to be prepared. The Validation Report and long-term EMP will be reviewed by an EPA Accredited Auditor prior to completion of a Section A2 SAS and SAR assessing the suitability of the development for the proposed use. The appropriate timing for this is prior to occupation given that parts of the development slabs will be components of the remediation.
4. Implementation of the long-term EMP as a condition of operation of the redeveloped site along with notation of a covenant on the land title to provide enforcement and notification of the long-term EMP.

Other recommendations and comments are as follows:

1. As part of the Audit process, an EPA Accredited Auditor will seek evidence that the responsible party (such as the owner or operator of the site) agrees to implement the long-term EMP.
2. If concrete is to be crushed on site for reuse during demolition, then a process will need to be in place to prevent cross contamination with asbestos (such as from historical formwork, etc.) and other contaminants (e.g. mercury and PFAS), including documentation in the Validation Report.

Groundwater has not been assessed for any beneficial re-use. The site is located within Prohibition Area 1 of the Botany Sands Groundwater Aquifer and is subject to *The Temporary Water Restriction (Botany Sands Groundwater Source) Order 2024.* Any future use of groundwater would require appropriate assessment and regulatory approvals from the NSW Office of Water.

Conditions for the implementation of a future long-term EMP stated under Section 3.4.6 of NSW EPA (2017) 'Guidelines for the NSW Site Auditor Scheme (3rd Ed.)' will be required to be met as part of the Audit. These are:

- The EMP has been reviewed by the Auditor.
- The EMP can reasonably be made to be legally enforceable in site redevelopment.

- There will be appropriate public notification of restrictions applying to the site.
- The remnant contamination is not considered to pose an unacceptable risk to onsite or offsite environments.

15. LIMITATIONS

This interim audit advice was conducted on behalf of IXOM for the purpose of assessing the suitability and appropriateness of a remedial action plan (RAP) to support the planning process. This summary report may not be suitable for other uses.

The Auditor has relied on the documents referenced in **Section 1.4** in preparing the Auditor's opinion. The consultants included limitations in their reports. This interim audit advice must also be subject to those limitations. The Auditor has prepared this document in good faith but is unable to provide certification outside of areas over which the Auditor had some control or is reasonably able to check. If the Auditor is unable to rely on any of those documents, the conclusions of this interim audit advice could change.

It is not possible to present all data which could be of interest to all readers of this interim audit advice. Readers are referred to the referenced reports for further data. Users of this document should satisfy themselves concerning its application to, and where necessary seek expert advice in respect to, their situation.

* * *

Consistent with the NSW EPA requirement for staged 'signoff' of sites that are the subject of progressive assessment, remediation and validation, I advise that:

- This advice letter does not constitute a Site Audit Report or Site Audit Statement.
- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation.
- This interim advice will be documented in the Site Audit Report.

Yours faithfully
Ramboll Australia Pty Ltd



Tom Onus
EPA Accredited Site Auditor 1505

D 02 9954 8133
M 0408 665 517
tonus@ramboll.com

Attachments:

1 - Site Locality

2a - Boundary and Layout of the ChlorAlkali Plant

2b - BIP Principal Inferred CHC Source Areas and Plumes

3a - Proposed Development Footprint

3b - Proposed Development Layout - Ground Floor of Plant

4 - Site Layout

5 - Historical Layout (1961)

6 - Historical Layout (1986)

7 - Areas of Environmental Concern

8 - Investigation Locations and Soil Vapour Exceedances

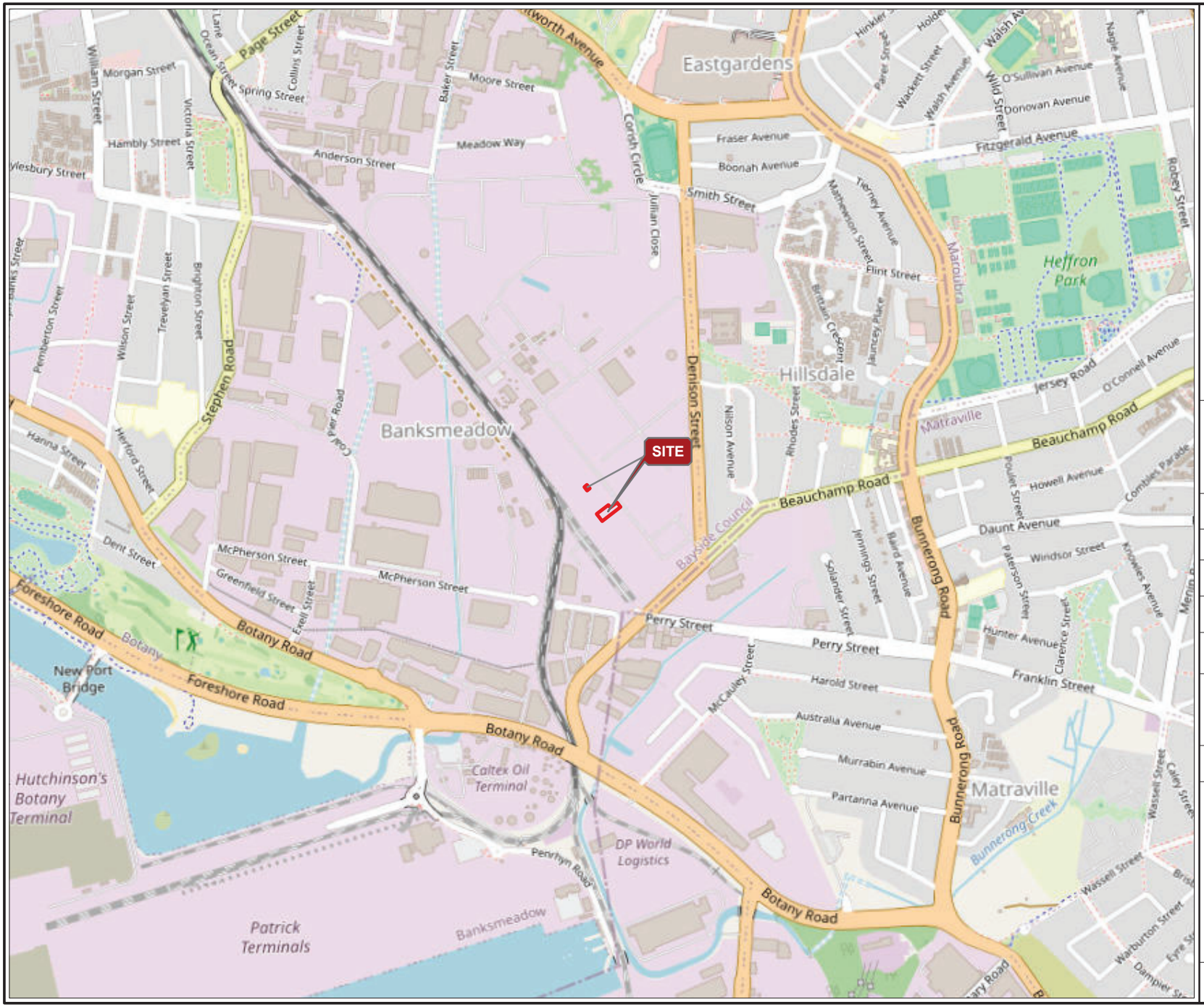
9 - Soil Results (11 pages)

10 - Leachate Results

11 – Soil Vapour Results

12 - Proposed Remediation Extent

Attachment 1 - Site Locality



Legend

Approximate Site Boundary

JBS&G

Job No: 67817	
Client: IXOM	
Version: R02 Rev A	Date 31/01/2025
Drawn By: RF	Checked By: CB

Scale 1:15,000

0 150 300

metres

Coord. Sys. GDA2020 MGA Zone 56

Botany BIP DSI, NSW

SITE LOCATION

FIGURE 1

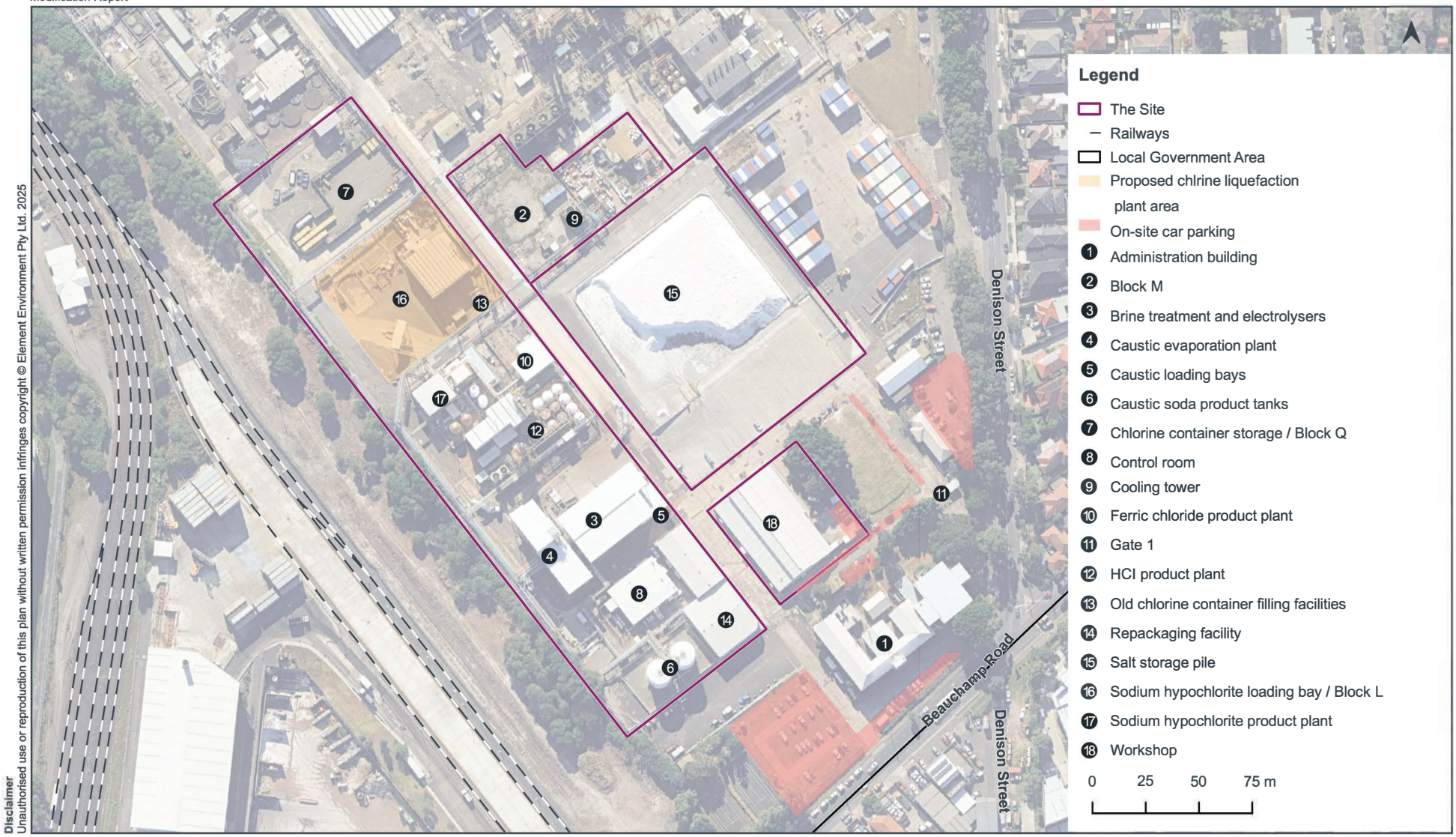
File Name: 67817_BIP_DSI_R02_RevA

Reference: © OpenStreetMap (and) contributors, CC-BY-SA

Attachment 2a - Boundary and Layout of the ChlorAlkali Plant

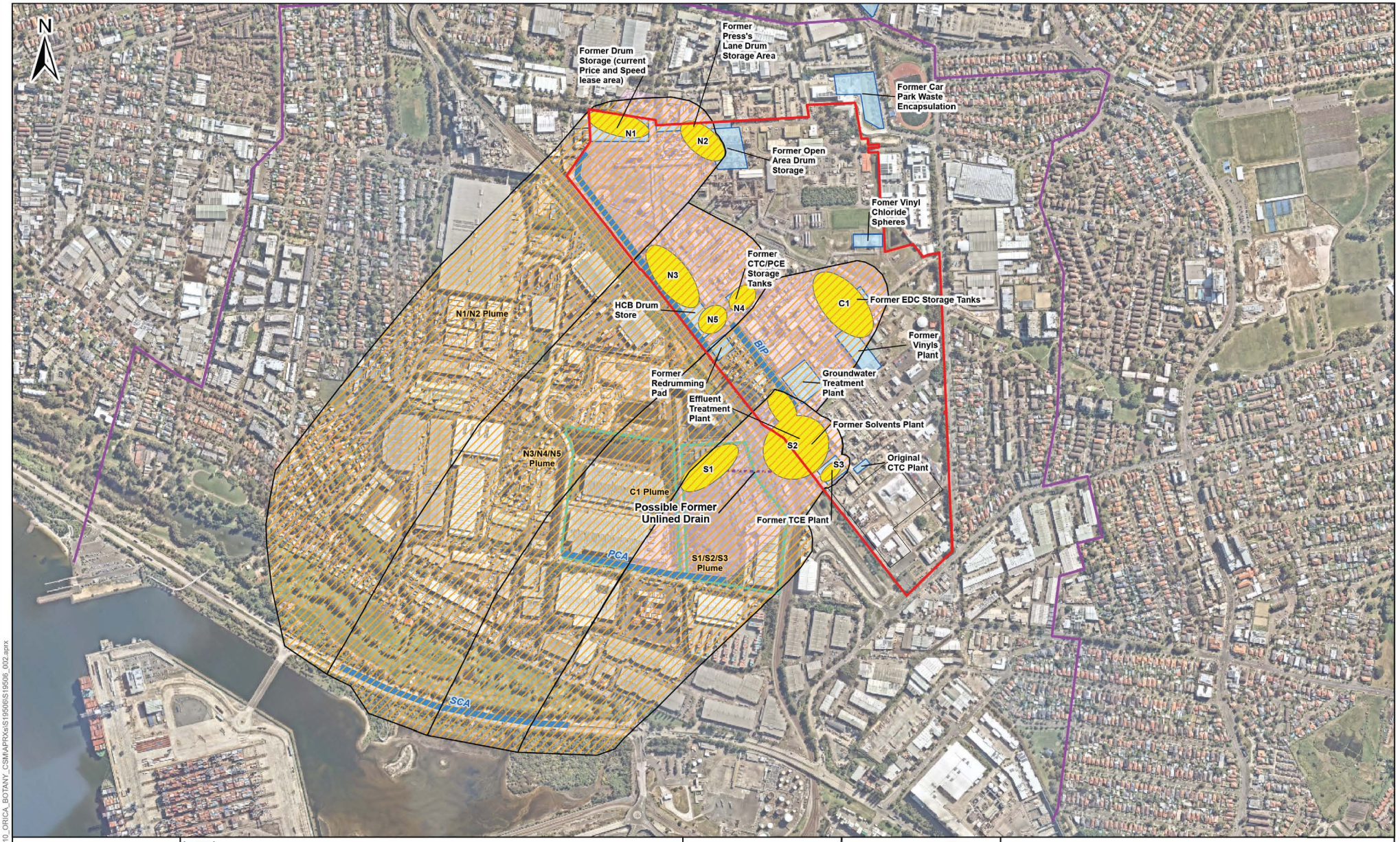
Figure 3.1
Site layout

Project Gemini
Modification Report



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Attachment 2b - BIP Principal Inferred CHC Source Areas and Plumes



Legend

- Botany Industrial Park Boundary
- Temporary Water Restriction (Botany Sands Groundwater Source) Area 1
- Former Botany Bay Shore Alignment (1943)
- Former Southlands
- Inferred DNAPL Source Plume
- Inferred DNAPL Source Zone
- Source Areas and Downgradient of Sources
- Relevant former and current operations
- Hydraulic Containment Lines

Notes:
Aerial Imagery (05/04/2022) © Nearmap

Created:	S. Wong	Date:	12/05/2022
Reviewed:	M. Agnew	Revision:	0
Approved:	A. Woinarski	Scale:	1:9,000 (A3)
File:	S19506_002_F004_Principal CHC Source Areas		

0 50 100 200 300 400 500 Metres

Coordinate System: GDA 1994 MGA Zone 56

Figure No: 4

Title: Principal Inferred CHC Source Areas and Plumes

Project: Orica Botany CSM

Location: Orica Botany

Client: Orica Australia Pty Ltd

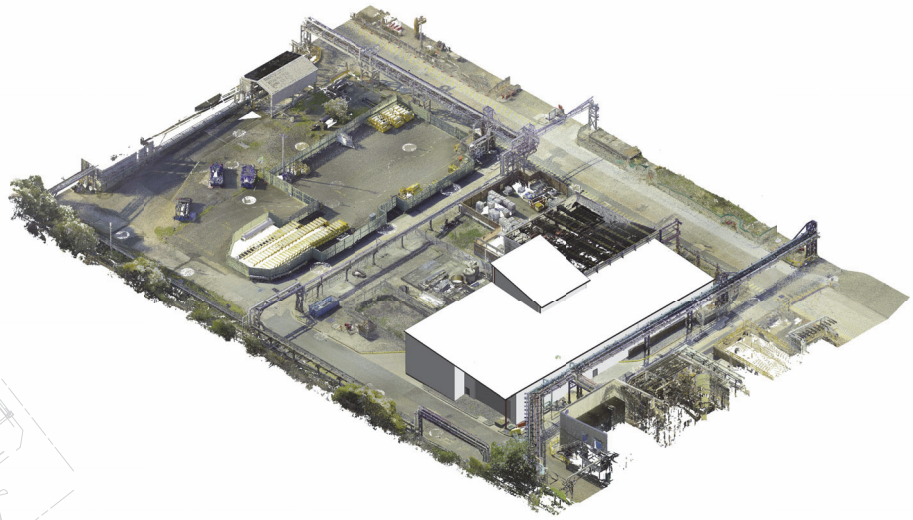
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© Senversa 2022

Attachment 3a - Proposed Development Footprint



LOCATION PLAN
SCALE 1 : 1000



ISOMETRIC VIEW
SCALE

DRAWING INDEX

DRAWING NUMBER	DRAWING NAME
PC.20301993-13-100	LOCATION PLAN
PC.20301993-13-101	SITE PLAN - EXISTING
PC.20301993-13-102	SITE PLAN - PROPOSED
PC.20301993-13-103	GRID SET OUT PLAN
PC.20301993-13-105	GENERAL ARRANGEMENT - GROUND FLOOR PLAN
PC.20301993-13-107	GENERAL ARRANGEMENT - CONCRETE OUTLINE PLAN
PC.20301993-13-109	GENERAL ARRANGEMENT - ROOF PLAN
PC.20301993-13-111	GENERAL ARRANGEMENT - ELEVATIONS - SHEET 1
PC.20301993-13-112	GENERAL ARRANGEMENT - ELEVATIONS - SHEET 2
PC.20301993-13-113	GENERAL ARRANGEMENT - SECTIONS - SHEET 1
PC.20301993-13-114	GENERAL ARRANGEMENT - SECTIONS - SHEET 2

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SCALE 1: 1000 SCALE IN mm

CHECK PRINT - INCOMPLETE REVISION
NOT AUTHORISED FOR USE
PLOT DATE: 20/11/2024 11:30:48 AM

NOT FOR CONSTRUCTION

REV	DESCRIPTION	DATE	POSITION	NAME	SIGNATURE
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			ORIGINATE/ DESIGN		
			INDEPENDENT CHECK		
			TECHNICAL APROVAL		
			PROJECT APPROVAL		
			CLIENT APPROVAL		

NOT AUTHORISED FOR USE

Kellogg Brown & Root Pty Ltd
Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317

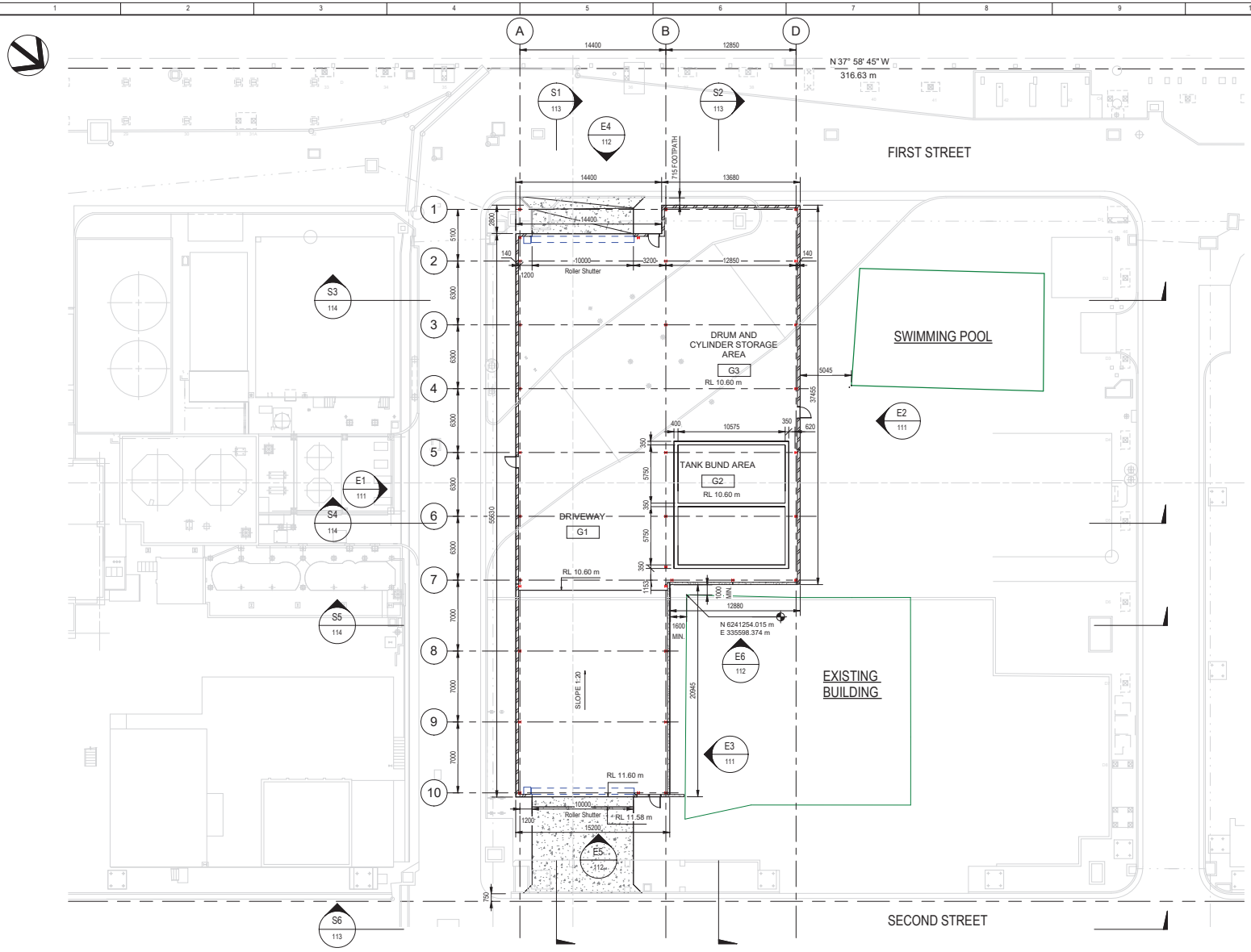
DRAWING SCALE 1 : 1000
ORIG. SIZE A1
DRAFTER: Author

TITLE
IXOM OPERATIONS PTY. LTD.
PROJECT GEMINI
ARCHITECTURAL
LOCATION PLAN

DRAWING NO. PC.20301993-13-100
REVISION

© Kellogg Brown & Root
DATE: 20/11/2024 11:30:48 AM
FILE: C:\Users\K146307\OneDrive - KBR\Documents\Project Gemini - Building_Jinoh Son\K.RVT

Attachment 3b - Proposed Development Layout - Ground Floor of Plant



ROOM SCHEDULE				
Department	Name	Number	Area	Volume
Driveway	DRIVEWAY	G1	771 m²	6093.16 m³
TANK	TANK BUND AREA	G2	203 m²	2472.92 m³
STORAGE	DRUM AND CYLINDER STORAGE AREA	G3	333 m²	3085.24 m³

GENERAL ARRANGEMENT PLAN - GROUND
SCALE 1 : 200

CHECK PRINT - INCOMPLETE REVISION
NOT AUTHORISED FOR USE
PLOT DATE: 20/11/2024 11:30:50 AM

FOR INFORMATION

REV	DESCRIPTION	DATE	POSITION	NAME	SIGNATURE
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			ORIGINATE/ DESIGN		
			INDEPENDENT CHECK		
			TECHNICAL APROVAL		
			PROJECT APPROVAL		
			CLIENT APPROVAL		

NOT AUTHORISED FOR USE

Kellogg Brown & Root Pty Ltd
Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317

TITLE
IXOM OPERATIONS PTY. LTD.
PROJECT GEMINI
ARCHITECTURAL
GENERAL ARRANGEMENT - GROUND FLOOR PLAN

DRAWING SCALE 1 : 200
ORIG. SIZE A1
DRAWING NO. PC.20301993-13-105
REVISION
DRAFTER: Author

FILE: C:\Users\K146307\OneDrive - KBR\Documents\Project Gemini - Building_Jinoh Son\M.RVT
DATE: 20/11/2024 11:30:50 AM
© Kellogg Brown & Root

Attachment 4 - Site Layout



ID	Site Layout 2024
1	New Chlor Alkali Plant
2	Salt Stockpile
3	Effluent Discharge
4	Hypo Tanker Loading Bay
5	Pit (Depot 60)
6	Raised Concrete Slab
ACM	ACM fragment on ground surface
A	Block A
G	Block G
L	Block L
M	Block M

Legend

- Approximate Site Boundary
- NSW Cadastre

Site Features

- Site Layout 2024
- Site Layout - Blocks A, G, L, M
- ACM Fragment
- Nant Street Tank Farm
- Site Utilities
- Southlands
- Surfectants Plant
- Sydney to Botany Goods Railway Line

JBS&G

Job No: 67817

Client: IXOM

Version: R01 Rev A | Date 21/11/2024

Drawn By: RF | Checked By: CB

Scale 1:2,750

0 25 50

metres

Coord. Sys. GDA2020 MGA Zone 56

BIP DSI
Botany, NSW

SITE LAYOUT AND SURROUNDING LAND-USE (2024)

FIGURE 2C

File Name: 67817_BIP_DSI_R01_RevA
Reference: Nearmap - www.nearmap.com (Capture Date: 20240921)

Attachment 5 - Historical Layout (1961)



ID	Site Layout 1961
1	Solvents Plant - Under Construction
2	TCE Plant
3	Boiler House
4	Product Store
5	Hydrogen Plant
6	CTC Plant
7	Carbon Bisulphide Tanks
8	Carbon Bisulphide Filling Platform
9	Sulphur Store
10	Charcoal Store
11	Carbide Store
12	Acetylene Gas Storage
13	Carbon Bisulphide Plant
14	Drum Storage
15	Chlorine Cells
16	Soda Ash
17	Solid Caustic Soda
18	Effluent Discharge
19	Acetylene Dry Plant
20	Rubber Chemical Plant
21	Methanol Tank
22	Butanol Tank
23	Formaldehyde Plant
24	Banksmeadow Sub-station
25	Herbicide Plant
26	Drum Storage
27	VCM Plant
28	VC Gas Storage
29	Corvic Plant
30	PVC Office
31	Laboratory
32	Change Room
A	Block A
G	Block G
L	Block L
M	Block M

Legend

- Approximate Site Boundary
- NSW Cadastre

Site Features

- Site Layout 1961
- Site Layout - Blocks A, G, L, M
- Southlands
- Sydney to Botany Goods Railway Line

JBS&G

Job No: 67817

Client: IXOM

Version: R01 Rev A | Date 21/11/2024

Drawn By: RF | Checked By: CB

Scale 1:2,750

0 25 50

metres

Coord. Sys. GDA2020 MGA Zone 56

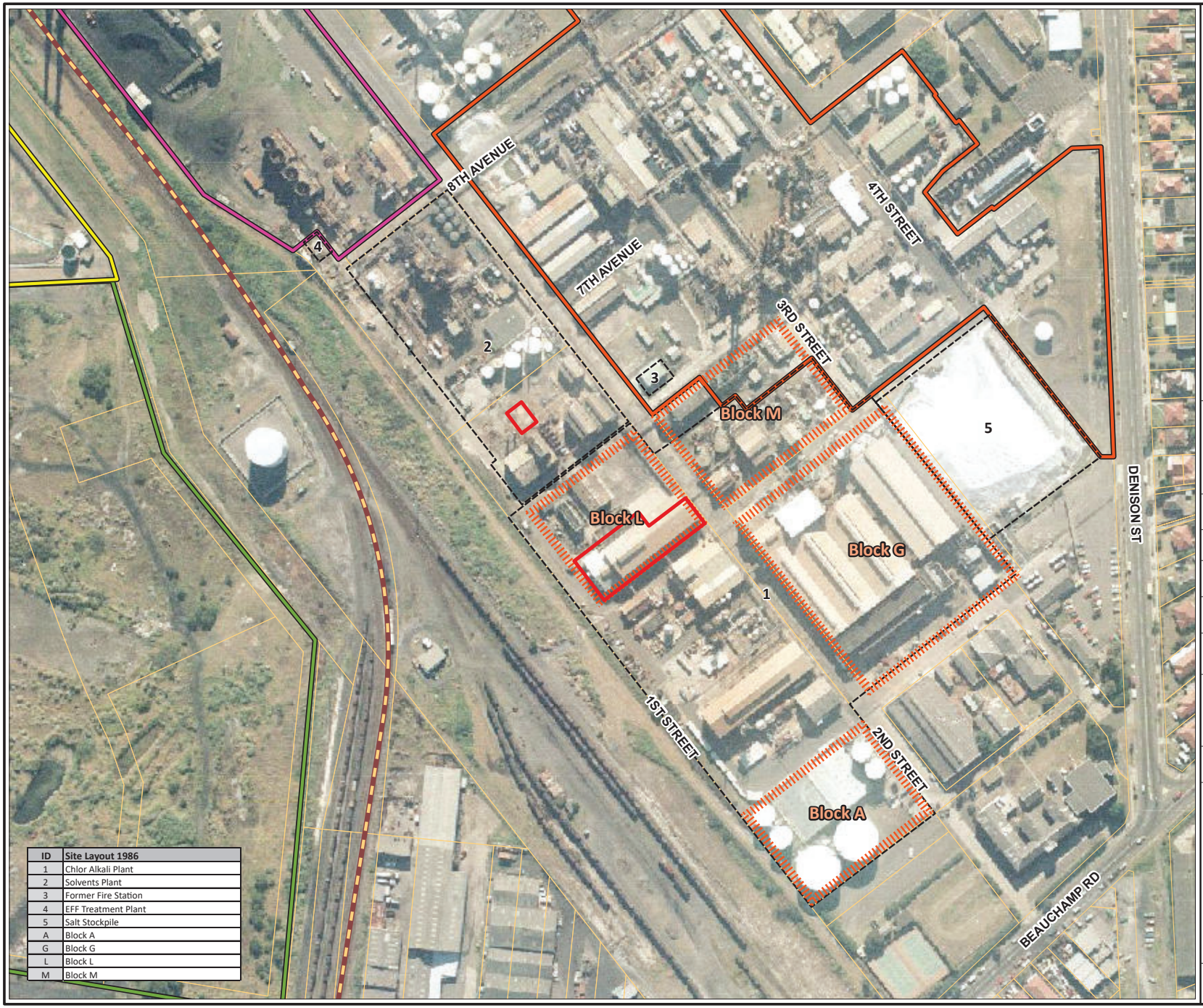
BIP DSI
Botany, NSW

SITE LAYOUT AND SURROUNDING LAND-USE (1961)

FIGURE 2A

File Name: 67817_BIP_DSI_R01_RevA
Reference: NSW Government | Copyright © Spatial Services 2024

Attachment 6 - Historical Layout (1986)



ID	Site Layout 1986
1	Chlor Alkali Plant
2	Solvents Plant
3	Former Fire Station
4	EFF Treatment Plant
5	Salt Stockpile
A	Block A
G	Block G
L	Block L
M	Block M

Legend

- Approximate Site Boundary
- NSW Cadastre

Site Features

- Site Layout 1986
- Site Layout - Blocks A, G, L, M
- Nant Street Tank Farm
- Site Utilities
- Southlands
- Surfectants Plant
- Sydney to Botany Goods Railway Line

JBS&G

Job No: 67817

Client: IXOM

Version: R01 Rev A | Date 21/11/2024

Drawn By: RF | Checked By: CB

Scale 1:2,750

0 25 50

metres

Coord. Sys. GDA2020 MGA Zone 56

BIP DSI
Botany, NSW

SITE LAYOUT AND SURROUNDING LAND-USE (1986)

FIGURE 2B

File Name: 67817_BIP_DSI_R01_RevA
Reference: NSW Government | Copyright © Spatial Services 2024

Attachment 7 - Areas of Environmental Concern



Legend

- Approximate Site Boundary
- NSW Cadastre

Areas of Environmental Concern

- AEC 1 - Whole of Site
- AEC 2 - Pit (Depot 60)
- AEC 3a - Block G
- AEC 3b - Block M
- AEC 3c - Block A
- AEC 3d - CTC Plant
- AEC 3e - Solvents Plant

JBS&G

Job No: 67817

Client: IXOM

Version: R01 Rev A	Date 21/11/2024
Drawn By: RF	Checked By: CB

Scale 1:2,750

0 25 50

metres

Coord. Sys. GDA2020 MGA Zone 56

BIP DSI
Botany, NSW

AREAS OF POTENTIAL CONTAMINATION

FIGURE 3

File Name: 67817_BIP_DSI_R01_RevA
Reference: Nearmap - www.nearmap.com (Capture Date: 20240921)

Attachment 8 - Investigation Locations and Soil Vapour Exceedances



BH5 Analyte	Date	Concentration
1,1,2-TCA	25-Oct-24	0.3 mg/m³
1,2-dibromo-3-chloropropane	25-Oct-24	0.3 mg/m³
1,2-DCA	25-Oct-24	0.2 mg/m³
CTC	25-Oct-24	1.1mg/m³
Tetrachloroethene	25-Oct-24	27.4 mg/m³
Trichloroethene	25-Oct-24	5.2 mg/m³
CFM	25-Oct-24	0.7 mg/m³
HCBD	25-Oct-24	2.6 mg/m³

HA2 Analyte	Date	Concentration
Mercury	25-Oct-24	25.8 mg/m³
Tetrachloroethene	25-Oct-24	3.1 mg/m³
Trichloroethene	25-Oct-24	0.3 mg/m³
CFM	25-Oct-24	0.6 mg/m³

BH3 Analyte	Date	Concentration
Mercury	25-Oct-24	0.7 mg/m³
Tetrachloroethene	25-Oct-24	1.4 mg/m³
Trichloroethene	25-Oct-24	0.2 mg/m³
CFM	25-Oct-24	0.1 mg/m³

HA3 Analyte	Date	Concentration
CTC	25-Oct-24	0.1 mg/m³
Tetrachloroethene	25-Oct-24	33.9 mg/m³
Trichloroethene	25-Oct-24	29 mg/m³
CFM	25-Oct-24	0.5 mg/m³

HA4 Analyte	Date	Concentration
CTC	25-Oct-24	0.1 mg/m³
Tetrachloroethene	25-Oct-24	12.7 mg/m³
Trichloroethene	25-Oct-24	13.6 mg/m³
CFM	25-Oct-24	0.3 mg/m³

BH2 Analyte	Date	Concentration
Tetrachloroethene	25-Oct-24	13.6 mg/m³
Trichloroethene	25-Oct-24	5.2 mg/m³
CFM	25-Oct-24	1.4 mg/m³

HA1 Analyte	Date	Concentration
Tetrachloroethene	25-Oct-24	1.3 mg/m³
Trichloroethene	25-Oct-24	0.2 mg/m³
CFM	25-Oct-24	0.1 mg/m³

BH4 Analyte	Date	Concentration
Tetrachloroethene	25-Oct-24	2.4 mg/m³
Trichloroethene	25-Oct-24	1.3 mg/m³
CFM	25-Oct-24	0.5 mg/m³

Legend

- Approximate Site Boundary
- NSW Cadastre

Areas of Environmental Concern

- AEC 1 - Whole of Site
- AEC 2 - Pit (Depot 60)
- AEC 3a - Block G
- AEC 3b - Block M
- AEC 3c - Block A
- AEC 3d - CTC Plant
- AEC 3e - Solvents Plant

Soil Sample Location

- Borehole
- Hand Auger
- ACM Fragment
- Historical Groundwater Monitoring Wells

NOTE: Exceedances - Tier 1 Screening Criteria

JBS&G

Job No: 67817

Client: IXOM

Version: R01 Rev 1 | Date 20/01/2026

Drawn By: RF | Checked By: CB

Scale 1:1,250

0 10 20

metres

Coord. Sys. GDA2020 MGA Zone 56

BIP DSI
Botany, NSW

SAMPLE LOCATIONS - SOIL VAPOUR

FIGURE 5

File Name: 67817_BIP_DSI_R01_Rev1
Reference: Nearmap - www.nearmap.com (Capture Date: 20240921)

Attachment 9 - Soil Results (11 pages)

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				Metals & Metalloids								TPHs (NEPC 1999)					TRHs (NEPC 2013)							BTEXN						
				Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc	C6- C9 Fraction	C10-C14 Fraction	C15-C28 Fraction	C29-C36 Fraction	C10-C36 Fraction (Sum of Total)	C6-C10	C10-C16	C16-C34	C34-C40	C10-C40 (Sum of total)	F1 (C6-C10 minus BTEX)	F2 (C10-C16 less Naphthalene)	Benzene	Toluene	Ethylbenzene	Xylene (o)	Xylene (m & p)	Xylene Total	Naphthalene_VOC
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				2	0.4	1	1	1	0.1	1	1	20	20	50	50	50	20	50	100	100	50	20	50	0.1	0.1	0.1	0.1	0.2	0.3	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil				3,000	900	3,600	240,000	1,500	730	6,000	400,000																			
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																						260		3					230	
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																						370		3						
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																	700	1,000	3,500	10,000										
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																														
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																														
PFAS NEMP 2020 Table 3 Interim EDE All land uses																														
PFAS NEMP 2020 Table 3 Interim EIE All land uses																														
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																											
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	**2.2**	<0.4	**27**	**18**	**150**	**43**	**9.3**	**83**	<20	<20	**93**	**56**	**149**	<20	<50	**140**	<100	**140**	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	**2.2**	<0.4	**6.2**	**21**	**67**	**28**	**7**	**83**	<20	<20	<50	<50	<50	<20	<50	<100	<100	<100	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	**3.8**	<0.4	**18**	**35**	**110**	**63**	**13**	**150**	<20	<20	<50	<50	<50	<20	<50	<100	<100	<100	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	**2.1**	<0.4	<5	<5	<5	**0.6**	<5	**5.4**	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<2	<0.4	<5	**9.5**	**55**	**6.7**	**7.4**	**63**	<20	<20	<50	<50	<50	<20	<50	<100	<100	<100	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	**3.8**	**0.4**	**41**	**270**	**250**	**15**	**110**	**710**	<20	<20	**95**	<50	**95**	<20	<50	**120**	<100	**120**	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	**2**	<0.4	**5.9**	**19**	**370**	**1**	**11**	**180**	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	<2	<0.4	<5	<5	<5	<0.1	<5	<5	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	**2.1**	<0.4	<5	<5	**41**	**0.8**	<5	**18**	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	<2	<0.4	<5	<5	**12**	**0.2**	<5	**7.1**	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<2	<0.4	**5.3**	**33**	**69**	**6.3**	<5	**66**	<20	<20	**350**	**410**	**760**	<20	<50	**700**	**200**	**900**	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	**2.1**	<0.4	**6.5**	**14**	**40**	**2.6**	<5	**97**	<20	<20	**91**	**79**	**170**	<20	<50	**150**	<100	**150**	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	**2**	<0.4	<5	**9.7**	**70**	**5.5**	<5	**95**	<20	<20	**82**	<50	**82**	<20	<50	**120**	<100	**120**	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<4	<0.4	**3**	**6**	**62**	**5.6**	**3**	**40**	<25	<50	<100	<100	<50	<25	<50	<100	<100	<50	<25	<50	<0.2	<0.5	<1	<1	<2	<1	<1
HA2_0-0.1	Soil	24 Oct 2024	1154010	**5.8**	<0.4	**16**	**62**	**450**	**190**	**42**	**250**	<20	<20	**93**	**60**	**153**	<20	<50	**130**	<100	**130**	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	**3.3**	**0.5**	**15**	**47**	**200**	**520**	**33**	**260**	<20	<20	**77**	**71**	**148**	<20	<50	**130**	<100	**130**	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<2	**2.5**	**7.3**	**11**	**30**	**0.8**	**9.8**	**44**	<20	<20	<50	<50	<50	<20	<50	<100	<100	<100	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	<2	<0.4	<5	<5	<5	<1	**7.1**	<5	<20	<20	<50	<50	<50	<20	<50	<100	<100	<100	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<2	<0.4	<5	<5	**6.7**	<1	<5	**8.9**	<20	<20	<50	<50	<50	<20	<50	<100	<100	<100	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	<2	<0.4	<5	<5	<5	<1	<5	**7.8**	<20	<20	<50	<50	<50	<20	<50	<100	<100	<100	<20	<50	<0.1	<0.1	<0.1	<0.1	<0.2	<0.3	<0.5

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				PAH																										
				PAHs (Sum of positives)	2-Methylnaphthalene	3-Methylcholanthrene	7,12-Dimethylbenz(a)anthracene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(a)pyrene TEQ calc (Half)	Benzo(b+j)fluoranthene	Benzo(b+j+k)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAHs (Sum of total)	2-(acetylamino) fluorene
				µg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				50	0.5	0.5	0.5	0.1	0.1	0.1	0.1	0.05	0.5	0.5	0.2	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil													40													4,000	
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																											
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																											
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																											
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																											
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																											
PFAS NEMP 2020 Table 3 Interim EDE All land uses																											
PFAS NEMP 2020 Table 3 Interim EIE All land uses																											
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																									
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	-	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	-	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	-	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	-	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<50	<0.5	<0.5	<0.5	<0.1	<0.1	<0.1	<0.1	<0.05	<0.5	-	<0.2	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.5
HA2_0-0.1	Soil	24 Oct 2024	1154010	-	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	-	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	-	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.6**	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				Organochlorine Pesticides																											
				Pentachlorophenol	4,4-DDE	a-BHC	b-BHC	d-BHC	g-BHC (Lindane)	Aldrin	Dieldrin	Aldrin + Dieldrin	Chlordane	Chlordane (cis)	Chlordane (trans)	DDT	DDD	DDT+DDE+DDD	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor	Heptachlor Epoxide	Hexachlorobenzene	Methoxychlor	Mirex	Toxaphene
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil				660								45	530					3,600				100			50		80	2,500	100	160
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																														
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																														
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																														
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																														
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																														
PFAS NEMP 2020 Table 3 Interim EDE All land uses																														
PFAS NEMP 2020 Table 3 Interim EIE All land uses																														
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																											
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.28**	<0.05	-	<0.5
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<10
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.5
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	-	<10
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<10
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	-	-
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.5
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	-
HA2_0-0.1	Soil	24 Oct 2024	1154010	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	-	-
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<10
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<10
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.5
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				Organophosphorus Pesticides																					
				Azinophos methyl	Bromophos-ethyl	Chlorpyrifos	Chlorpyrifos-methyl	Coumaphos	Diazinon	Dichlorvos	Dimethoate	Disulfoton	Ethion	Ethyl methanesulfonate	Fenitrothion	Fenthion	Malathion	Methidathion	Methyl parathion	Mevinphos (Phosdrin)	Phorate	Ronnel	Safrole	Tetramiphos	Parathion
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil						2,000																			
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																									
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																									
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																									
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																									
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																									
PFAS NEMP 2020 Table 3 Interim EDE All land uses																									
PFAS NEMP 2020 Table 3 Interim EIE All land uses																									
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																						
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5
HA2_0-0.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				Chlorinated Alkanes																					Chlorinated Alkenes											
				1,1,1,2-tetrachloroethane	1,1,1-trichloroethane	1,1,2,2-tetrachloroethane	1,1,2-trichloroethane	1,1-dichloroethane	1,2,3-trichloropropane	1,2-dibromo-3-chloropropane	1,2-dichloroethane	1,2-dichloropropane	1,3-dichloropropane	2,2-dichloropropane	Bromochloromethane	Carbon tetrachloride	Chloroethane	Chloromethane	Dichlorodifluoromethane	Dichloromethane	Hexachloroethane	Pentachloroethane	Trichlorofluoromethane	1,1-dichloroethene	1,1-dichloropropene	2-chlorotoluene	3-chloropropene	4-chlorotoluene	cis-1,2-dichloroethene	cis-1,3-dichloropropene	Tetrachloroethene	trans-1,2-dichloroethene	trans-1,3-dichloropropene	Trichloroethene	Vinyl Chloride
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil																																				
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																																				
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																																				
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																																				
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																																				
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																																				
PFAS NEMP 2020 Table 3 Interim EDE All land uses																																				
PFAS NEMP 2020 Table 3 Interim EIE All land uses																																				
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																																	
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	**3.9**	<0.5	<0.5	**0.7**	<0.5
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	**9.5**	<0.5	<0.5	**0.9**	<0.5
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	<0.5	<0.5	<0.5	<0.5	**1.4**	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	<0.5	<0.5
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	**8.2**	<0.5	<0.5	**0.8**	<0.5
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	<0.5	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
HA2_0-0.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	**1.9**	<0.5	<0.5	**1.4**	<0.5
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

	Semivolatile Organic Compounds																																
	1-Chloronaphthalene	2-Chloronaphthalene	Bis(2-chloroethoxy) methane	Hexachloropropene	Dibenz[a ,j]acridine	Acetophenone	Bis(2-chloroethyl)ether	Bis(2-chloroisopropyl) ether	4-Bromophenyl phenyl ether	4-Chlorophenyl phenyl ether	2,6-dinitrotoluene	2-Picoline	4-Aminobiphenyl	N-Nitrosomorpholine	N-Nitrosopiperidine	2-methyl-5-nitroaniline	N-nitrosodi-n-butylamine	N-nitrosodi-n-propylamine	1-Naphthylamine	2-Naphthylamine	3,3-Dichlorobenzidine	4-(dimethylamino) azobenzene	Azobenzene	Diphenylamine	Carbazole	Butyl benzyl phthalate	Dibenzofuran	Isosafrole	Methapyrilene	Phenacetin
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	1	0.5	0.5	2	1	1
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil																																	
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																																	
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																																	
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																																	
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																																	
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																																	
PFAS NEMP 2020 Table 3 Interim EDE All land uses																																	
PFAS NEMP 2020 Table 3 Interim EIE All land uses																																	

Field ID	Matrix Type	Date	Lab Report Number																																
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	-	-
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<2	<2	<1	<1	-	<1	-	<1	<1	-	<1	-	-	-
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	<0.5	-	-	-
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<2	<2	<1	<1	-	<1	-	<1	<1	-	-	-	-	-
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<2	<2	<1	<1	-	<1	-	<1	<1	-	<1	-	-	-
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<2	<2	<1	<1	-	<1	-	<1	<1	-	-	-	-	-
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	-	-	-	-
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<0.5	<0.5	<1	<0.5	-	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<2	<1	<1	-	-	-
HA2_0-0.1	Soil	24 Oct 2024	1154010	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<2	<2	<1	<1	-	<1	-	<1	<1	-	-	-	-	-
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<2	<2	<1	<1	-	<1	-	<1	<1	-	-	-	-	-
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<1	<1	<1	-	<1	<1	-	<1	<1	<1	<1	<1	<1	-	<1	-	<1	<1	<2	<2	<1	<1	-	<1	-	<1	<1	-	-	-	-	-
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	-	-	-	-
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	-	-	-	-
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<1	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	-	-	-	-

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				Polychlorinated Biphenyls							Phenols														
				Arochlor 1016	Arochlor 1221	Arochlor 1232	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	PCBs (Sum of total)	2,3,4,6-tetrachlorophenol	2,4,5-trichlorophenol	2,4,6-trichlorophenol	2,4-dichlorophenol	2,4-dimethylphenol	2,4-dinitrophenol	2,6-dichlorophenol	2-chlorophenol	2-Methylphenol	2-nitrophenol	3&4-Methylphenol (m&p-cresol)	4,6-Dinitro-2-methylphenol	4-Chloro-3-Methylphenol	4-nitrophenol	Phenol
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5	5	0.5	0.5	0.2	0.5	0.4	5	1	5	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil											7															240,000
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																										
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																										
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																										
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																										
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																										
PFAS NEMP 2020 Table 3 Interim EDE All land uses																										
PFAS NEMP 2020 Table 3 Interim EIE All land uses																										
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																							
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.2	<1	<0.4	<5	<1	<5	<0.5
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	<0.5	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.2	<1	<0.4	<5	<1	<5	<0.5
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<1	<1	<5	<1	<5	<2
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.2	<1	<0.4	<5	<1	<5	<0.5
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<1	<1	<5	<1	<5	<2
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<1	<1	<5	<1	<5	<2
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	<1	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<1	<1	<5	<1	<5	<2
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.2	<1	<0.4	<5	<1	<5	<0.5
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<0.1	<0.1	<0.1	<0.1	<0.1	**0.3**	<0.1	**0.3**	<1	<0.5	<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<1	<10	<5	<10	<0.5
HA2_0-0.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	<1	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<1	<1	<5	<1	<5	<2
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<1	<1	<5	<1	<5	<2
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<1	<1	<5	<1	<5	<2
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	<0.5	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.2	<1	<0.4	<5	<1	<5	<0.5
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.2	<1	<0.4	<5	<1	<5	<0.5
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	<0.5	<1	<1	<0.5	<0.5	<5	<0.5	<0.5	<0.2	<1	<0.4	<5	<1	<5	<0.5

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				PFAS																																		
				Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (NMeFOSA)	N-Ethyl perfluorooctane sulfonamide (NEtFOSA)	N-Methylperfluorooctanesulfonamidoethanol (N-MeFOSE)	N-ethylperfluorooctanesulfonamidoethanol (NEtFOSE)	N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA)	N-ethyl-perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	Perfluoropropanesulfonic acid (PFPrS)	Perfluorobutanesulfonic acid (PFBS)	Perfluoropentanesulfonic acid (PFPeS)	Perfluorohexanesulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctanesulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	1H-1H-2H-2H-perfluorohexanesulfonic acid (4:2 FTSA)	1H-1H-2H-2H-perfluorooctanesulfonic acid (6:2 FTSA)	1H-1H-2H-2H-perfluorodecanesulfonic acid (8:2 FTSA)	1H-1H-2H-2H-perfluorododecanesulfonic acid (10:2 FTSA)	Sum of PFHxS and PFOS	Sum of enHealth PFAS (PFHxS + PFOS + PFOA)*	Sum of US EPA PFAS (PFOS + PFOA)*	Sum of WA DWER PFAS (n=10)*	Sum of PFAS	Perfluorononanesulfonic acid
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/KG	mg/kg	mg/kg
EQL				0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.005	0.001	0.001	0.001	0.001	0.005	0.0002	0.0002	0.005	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0002	0.0001	0.005	0.0001	0.01	0.0001	0.005
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil																																						
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																																						
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																																						
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																																						
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																																						
PFAS NEMP 2020 Table 2 Health Industrial/Commercial								50																20		20						20						
PFAS NEMP 2020 Table 3 Interim EDE All land uses								10																		1												
PFAS NEMP 2020 Table 3 Interim EIE All land uses																										0.01												
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																																				
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<0.0002	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0002	<0.0002	-	<0.0001	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0002	<0.0001	<0.0001	<0.0002	<0.0002	**0.0001**	-	**0.0001**	-	**0.0001**	-
HA2_0-0.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.05	<0.005
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				MAH											Miscellaneous Hydrocarbons							Chlorinated Benzenes													Trihalomethanes				Herbicides & Fungicides			Phthalates					Nitrobenze	
				1,2,4-trimethylbenzene	1,3,5-trimethylbenzene	n-butylbenzene	n-propylbenzene	p-isopropyltoluene	sec-butylbenzene	Styrene	tert-butylbenzene	Total MAH	Bromobenzene	Isopropylbenzene	1,2-dibromoethane	Bromomethane	Cyclohexane	Dibromomethane	Iodomethane	4-Methyl-2-pentanone	Methyl Ethyl Ketone	1,2,3,4-tetrachlorobenzene	1,2,3,5-tetrachlorobenzene	1,2,3-trichlorobenzene	1,2,4,5-tetrachlorobenzene	1,2,4-trichlorobenzene	1,2-Dichlorobenzene	1,3,5-trichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene	Chlorobenzene	Pentachlorobenzene	Dibromochloromethane	Chloroform	Tribromomethane	Bromodichloromethane	Dinoseb	Pronamide	Trifluralin	Bis(2-ethylhexyl) phthalate	Diethylphthalate	Dimethyl phthalate	Di-n-butyl phthalate	Di-n-octyl phthalate	1,3-dinitrobenzene	Nitrobenzene
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.5	0.5	1	1	1	1	0.5	1	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	10	0.5	0.5	5	0.5	0.5	0.5	0.5	1	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil																																														
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																																													
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																																													
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																																													
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil																																													
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																																													
PFAS NEMP 2020 Table 3 Interim EDE All land uses																																													
PFAS NEMP 2020 Table 3 Interim EIE All land uses																																													
Field ID	**Matrix Type**	**Date**	**Lab Report Number**																																											
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	-	<1	<1	<5	<1	<1	<1	<1	<1	-	<1
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	-	<1	<1	<5	<1	<1	<1	<1	<1	-	<1
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	-	<1	<1	<5	<1	<1	<1	<1	<1	-	<1
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	-	<1	<1	<5	<1	<1	<1	<1	<1	-	<1
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	-	-	-	<0.5	-	<1	-	<0.5	<0.5	-	<0.5	<0.5	<1	<0.5	<1	<1	<1	<1	<10	-	-	<5	<1	<1	<5	<1	<1	<1	<0.5
HA2_0-0.1	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	-	<1	<1	<5	<1	<1	<1	<50	<1	-	<1
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	-	<1	<1	<5	<1	<1	<1	<5	<1	-	<1
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	-	<1	<1	<5	<1	<1	<1	<1	<1	-	<1
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

	Pentachloronitrobenzene
	mg/kg
EQL	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil	
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m	
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m	
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil	
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil	
PFAS NEMP 2020 Table 2 Health Industrial/Commercial	
PFAS NEMP 2020 Table 3 Interim EDE All land uses	
PFAS NEMP 2020 Table 3 Interim EIE All land uses	

Field ID	Matrix Type	Date	Lab Report Number	
BH2_0-1.0	Soil	23 Oct 2024	1154010	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<0.5
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	<0.5
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<1
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<0.5
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<1
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<1
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	<1
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<0.5
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	<1
HA2_0-0.1	Soil	24 Oct 2024	1154010	<1
HA2_0-0.5	Soil	24 Oct 2024	1154010	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<1
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<1
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5
HA4_0-1.0	Soil	24 Oct 2024	1154010	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<0.5
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5

TABLE A- Soil Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

	Nitrotoluenes	Anilines					Organic Sulfur Compounds	Organic Alcohols	Asbestos - Eurofins																Asbestos - Envirolab				Chlorinated Hydrocarbons		Halogenated Benzenes		Solvents		
	2,4-dinitrotoluene	2-Nitroaniline	3-Nitroaniline	4-Chloroaniline	4-Nitroaniline	Aniline	Carbon disulfide	Benzyl Alcohol	Approximate Sample Mass	Mass ACM	Mass Asbestos in ACM	Asbestos from ACM in Soil	Mass FA	Mass Asbestos in FA	Mass AF	Mass asbestos in AF	Mass Asbestos in FA & AF	ACM - Comment	FA- Comment	AF - Comment	Organic Fibres - Comment	Respirable Fibres - Comment	Synthetic Fibres - Comment	Asbestos Reported Result	Asbestos FA & AF in Soil	Asbestos ID in Soil	Total Asbestos	Asbestos (ACM >7mm) Estimation	Asbestos in soil (<2mm AF/FA) (%w/w)	Hexachlorocyclopentadiene	Hexachlorobutadiene	1,2,3,5 & 1,2,4,5 Tetrachlorobenzene	Phosalone	Acetone	Isophorone	Benzyl chloride
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	gm	gm	gm	% (w/w)	gm	gm	gm	gm	gm	Comment	Comment	Comment	Comment	Comment	Comment	Comment	% (w/w)	g/kg	g/kg	% (w/w)	% (w/w)	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.5	1	1	1	1	0.5	0.5	1																						1	0.5	1	0.5	0.5	1	0.5
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil																																				
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 0-1m																																				
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand, 1-2m																																				
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																																				
NEPM 2013 Table 7 Comm/Ind D Soil HSL for Asbestos in Soil												0.05													0.001			0.05	0.001						
PFAS NEMP 2020 Table 2 Health Industrial/Commercial																																				
PFAS NEMP 2020 Table 3 Interim EDE All land uses																																				
PFAS NEMP 2020 Table 3 Interim EIE All land uses																																				

Field ID	Matrix Type	Date	Lab Report Number																																	
BH2_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	**830**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	-	-	-	-	-	-	-	-	-	-
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	<0.5	<1	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<0.5	-	-	<0.5	-	<0.5
BH2_0.5-0.6	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2_1.0-1.2	Soil	23 Oct 2024	1154010	<0.5	<1	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<0.5	-	-	<0.5	-	<0.5
BH2_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH2_5.0-5.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH3_0-0.65	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	**738**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	-	-	-	-	-	-	-	-	-	-	-
BH3_0.5-0.6	Soil	23 Oct 2024	1154010	<1	<1	-	-	-	<1	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	<0.5	-	<1
BH3_3.0-3.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH3_5.0-5.1	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH3_5.9-6.0	Soil	25 Oct 2024	1154010	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH4_0-1.0	Soil	23 Oct 2024	1154010	-	-	-	-	-	-	-	-	**840**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	-	-	-	-	-	-	-	-	-	-	-
BH4_0.9-1.0	Soil	23 Oct 2024	1154010	<0.5	<1	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<0.5	-	-	<0.5	-	<0.5
BH4_2.0-2.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH4_4.0-4.1	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH5_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<1	-	-	-	<1	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	<0.5	-	<1
BH5_1.0-1.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH5_2.0-2.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH5_4.0-4.1	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
BH5_5.9-6.0	Soil	06 Nov 2024	1157566	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-
HA1_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	**798**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	-	-	-	-	-	-	-	-	-	-	-
QC_B (Duplicate of HA1_0-1.0)	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	**584**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	-	-	-	-	-	-	-	-	-	-	-
QA_B (Triplicate of HA1_0-1.0)	Soil	24 Oct 2024	365062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	<0.1	<0.01	<0.001	-	-	-	-	-	-
HA1_0.5-0.6	Soil	24 Oct 2024	1154010	<1	<1	-	-	-	<1	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	<0.5	-	<1
HA1_1.4-1.5	Soil	24 Oct 2024	1154010	<1	<1	-	-	-	<1	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	<0.5	-	<1
QC (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	1154010	<0.5	<1	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<0.5	-	-	<0.5	-	<0.5
QA (Duplicate of HA1_1.4-1.5)	Soil	24 Oct 2024	365062	-	<1	<1	<1	<1	<1	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<0.5	<1	<0.5	-	<1	-
HA2_0-0.1	Soil	24 Oct 2024	1154010	<1	<1	-	-	-	<1	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	<0.5	-	<1
HA2_0-0.5	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	**795**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	-	-	-	-	-	-	-	-	-	-	-
HA2_0.4-0.5	Soil	24 Oct 2024	1154010	<1	<1	-	-	-	<1	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	<0.5	-	<1
HA3_0.2-0.3	Soil	24 Oct 2024	1154010	<1	<1	-	-	-	<1	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	<0.5	-	<1
HA3_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<1	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<0.5	-	-	<0.5	-	<0.5
HA4_0-1.0	Soil	24 Oct 2024	1154010	-	-	-	-	-	-	-	-	**698**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	-	-	-	-	-	-	-	-	-	-	-
HA4_0.5-0.6	Soil	24 Oct 2024	1154010	<0.5	<1	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<0.5	-	-	<0.5	-	<0.5
HA4_1.4-1.5	Soil	24 Oct 2024	1154010	<0.5	<1	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<0.5	-	-	<0.5	-	<0.5

Attachment 10 - Leachate Results

TABLE B - Soil Leachate Analytical Results
Project Number: 67817
Project Name: 6, Denison Street, Banksmeadow, NSW

				Metals & Metalloids	Ionic Balance			
				Mercury	pH of Leaching Fluid	pH (after HCL)	pH (Final)	pH (Initial)
				mg/L	pH Units	pH Units	pH Units	pH Units
EQL				0.001	0.1	0.1	0.1	0.1
NSW 2014 General Solid Waste TCLP1 (leached)				0.2				
NSW 2014 Restricted Solid Waste TCLP2 (leached)				0.8				
Field ID	**Test Type**	**Date**	**Lab Report Number**					
BH3_2.0-2.1	TCLP	25 Oct 2024	1158728	0.017	-	1.8	5.3	8.9
BH3_2.0-2.1	ASLP	25 Oct 2024	1158728	0.093	7.7	-	8.9	9.1
BH3_3.0-3.1	TCLP	25 Oct 2024	1158728	0.006	-	1.7	5.1	7.5
BH3_3.0-3.1	ASLP	25 Oct 2024	1158728	0.013	7.7	-	6.9	8.4
BH3_4.0-4.1	TCLP	25 Oct 2024	1158728	0.003	-	1.8	5.2	7.6
BH3_4.0-4.1	ASLP	25 Oct 2024	1158728	0.003	7.7	-	7.6	8.0
BH3_5.9-6.0	TCLP	25 Oct 2024	1158728	0.002	-	1.7	5.1	7.5
BH3_5.9-6.0	ASLP	25 Oct 2024	1158728	0.029	7.7	-	6.6	8.3
HA2_0.4-0.5	TCLP	24 Oct 2024	1158728	0.067	-	2.1	6.0	9.0
HA2_0.4-0.5	ASLP	24 Oct 2024	1158728	0.33	7.7	-	8.0	8.6
HA2_0-0.1	TCLP	24 Oct 2024	1158728	0.031	-	1.8	5.3	9.1
HA2_0-0.1	ASLP	24 Oct 2024	1158728	0.074	7.7	-	8.1	8.3

Attachment 11 - Soil Vapour Results

TABLE C- Vapour Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

	Metals & Metalloids	BTEXN				PAH	Chlorinated Alkanes													
	Mercury	Benzene	Toluene	Ethylbenzene	Xylene Total	Naphthalene	1,1,1,2-tetrachloroethane	1,1,1-trichloroethane	1,1,2,2-tetrachloroethane	1,1,2-trichloroethane	1,1-dichloroethane	1,2,3-trichloropropane	1,2-dibromo-3-chloropropane	1,2-dichloroethane	1,2-dichloropropane	1,3-dichloropropane	2,2-dichloropropane	Bromochloromethane	Carbon tetrachloride	Trichlorofluoromethane
	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
EQL	0.002	0.08	0.08	0.08	0.24	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
NEPM 2013 Table 1A(2) Comm/Ind D Soil Vap VOCC HILs								230												
NEPM 2013 Table 1A(5) Comm/Ind D Soil Vapour HSL for Vapour Intrusion, Sand, 0-1m		4	4,800	1,300	840	3														
USEPA RSLs Industrial Air THQ=1.0 (x 10)	0.013	0.016	220	0.049	4.4	0.0036	0.017	220	0.0021	0.0077	0.077	0.013	0.00002	0.0047	0.0033			1.8	0.02	

Location Code	Field ID	Matrix Type	Date	Lab Report Number																			
BH3	BH3_SV_M	Gas	24 Oct 2024	365063	**0.74**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2	HA2_SV_M	Gas	24 Oct 2024	365063	**25.81**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2	BH2_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.19**
BH3	BH3_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**2.26**
BH4	BH4_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH4	QC_SV FRONT (duplicate of BH4)	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH5	BH5_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	**0.32**	<0.08	<0.08	**0.32**	**0.24**	<0.08	<0.08	<0.08	**1.08**	<0.08
HA1	HA1_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
HA2	HA2_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.47**
HA3	HA3_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.1**	<0.08
HA3	QA_SV (duplicate of HA3)	Gas	25 Oct 2024	365815	-	<0.32	<0.81	<0.81	-	<1.61	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	-
HA4	HA4_SV FRONT	Gas	25 Oct 2024	1153970	-	<0.08	<0.08	<0.08	<0.24	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.11**	<0.08

TABLE C- Vapour Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

					Chlorinated Alkenes											MAH									
					1,1-dichloroethene	1,1-dichloropropene	1,3-Dichloropropene(cis)	1,3-Dichloropropene(trans)	2-chlorotoluene	4-chlorotoluene	cis-1,2-dichloroethene	cis-1,3-dichloropropene	Tetrachloroethene	trans-1,2-dichloroethene	trans-1,3-dichloropropene	Trichloroethene	Vinyl Chloride	1,2,4-trimethylbenzene	1,3,5-trimethylbenzene	n-butylbenzene	n-propylbenzene	p-isopropyltoluene	sec-butylbenzene	Styrene	tert-butylbenzene	Bromobenzene	Isopropylbenzene
					mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
EQL					0.08	0.08	0.81	0.81	0.08	0.08	0.08	0.08	0.08	0.81	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.81	0.08	0.81	0.08
NEPM 2013 Table 1A(2) Comm/Ind D Soil Vap VOCC HILs											0.3		8			0.08	0.1										
NEPM 2013 Table 1A(5) Comm/Ind D Soil Vapour HSL for Vapour Intrusion, Sand, 0-1m																											
USEPA RSLs Industrial Air THQ=1.0 (x 10)					8.8								0.47			0.03	0.028	2.6	2.6		44			44		2.6	18
Location Code	**Field ID**	**Matrix Type**	**Date**	**Lab Report Number**																							
BH3	BH3_SV_M	Gas	24 Oct 2024	365063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2	HA2_SV_M	Gas	24 Oct 2024	365063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2	BH2_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**13.55**	-	<0.08	**5.16**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
BH3	BH3_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**1.37**	-	<0.08	**0.16**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
BH4	BH4_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**2.26**	-	<0.08	**1.26**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
BH4	QC_SV FRONT (duplicate of BH4)	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**2.42**	-	<0.08	**1.23**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
BH5	BH5_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	**0.1**	<0.08	**27.42**	-	<0.08	**5.16**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
HA1	HA1_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**1.32**	-	<0.08	**0.18**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
HA2	HA2_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**3.06**	-	<0.08	**0.26**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
HA3	HA3_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**33.87**	-	<0.08	**29.03**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08
HA3	QA_SV (duplicate of HA3)	Gas	25 Oct 2024	365815	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	-	**13.71**	<0.81	-	**19.35**	-	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81
HA4	HA4_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	**12.74**	-	<0.08	**13.55**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.81	<0.08	-	<0.08

TABLE C- Vapour Analytical Results
Project Number: 67817
Project Name: Denison Street, Banksmeadow, NSW

				Miscellaneous Hydrocarbons					Chlorinated Benzenes						Trihalomethanes				Chlorinated Hydrocarbons	NA		Other						
				1,2-dibromoethane	Cyclohexane	Dibromomethane	4-Methyl-2-pentanone	Methyl Ethyl Ketone	1,2,3-trichlorobenzene	1,2,4-trichlorobenzene	1,2-Dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene	Chlorobenzene	Dibromochloromethane	Chloroform	Tribromomethane	Bromodichloromethane	Hexachlorobutadiene	Ethyl acrylate	Methyl styrene (alpha)	1,2-butylacetate	3-Methylhexane	3-Methylpentane	Di-isobutyl Ketone	Dodecane	Methylcyclohexane	Methylcyclopentane
				mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
EQL				0.08	0.81	0.08	0.81	1.61	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
NEPM 2013 Table 1A(2) Comm/Ind D Soil Vap VOCC HILs																													
NEPM 2013 Table 1A(5) Comm/Ind D Soil Vapour HSL for Vapour Intrusion, Sand, 0-1m																													
USEPA RSLs Industrial Air THQ=1.0 (x 10)				0.0002	260	0.18	130	220		0.088	8.8		0.011	2.2		0.0053	0.11	0.0033	0.0056	0.35									
Location Code	**Field ID**	**Matrix Type**	**Date**	**Lab Report Number**																									
BH3	BH3_SV_M	Gas	24 Oct 2024	365063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HA2	HA2_SV_M	Gas	24 Oct 2024	365063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH2	BH2_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**1.35**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-
BH3	BH3_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.13**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-
BH4	BH4_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.53**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-
BH4	QC_SV FRONT (duplicate of BH4)	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.52**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-
BH5	BH5_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.71**	<0.08	<0.08	**2.58**	-	-	-	-	-	-	-	-	-	-
HA1	HA1_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.08**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-
HA2	HA2_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.58**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-
HA3	HA3_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.53**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-
HA3	QA_SV (duplicate of HA3)	Gas	25 Oct 2024	365815	<0.81	<0.81	-	<0.81	<1.61	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81	<0.81
HA4	HA4_SV FRONT	Gas	25 Oct 2024	1153970	<0.08	-	<0.08	-	-	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	**0.26**	<0.08	<0.08	<0.08	-	-	-	-	-	-	-	-	-	-

Attachment 12 - Proposed Remediation Extent



ID	Site Layout 2024
1	New Chlor Alkali Plant
2	Salt Stockpile
3	Effluent Discharge
4	Hypo Tanker Loading Bay
5	Pit (Depot 60)
6	Raised Concrete Slab
ACM	ACM fragment on ground surface
A	Block A
G	Block G
L	Block L
M	Block M

Legend

- Approximate Site Boundary
- NSW Cadastre
- Sydney to Botany Goods Railway Line
- Site Layout 2024
- Site Layout - Blocks A, G, L, M
- ACM Fragment
- Extent of Vapour Barrier
- Extent of Marker Layer

JBS&G

Job No: 67817

Client: IXOM

Version: R02 Rev 2 | Date 20/01/2026

Drawn By: RF | Checked By: CB

Scale 1:2,750

0 25 50

metres

Coord. Sys. GDA2020 MGA Zone 56

BIP DSI
Botany, NSW

EXTENT OF REMEDIATION)

FIGURE 3

File Name: 67817_BIP_DSI_R02_Rev2
Reference: Nearmap - www.nearmap.com (Capture Date: 20240921)

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE

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