REPORT

PIPELINE HAZARD ANALYSIS

INDIGENOUS CENTRE OF EXCELLENCE

SSD-64916225

WESTERN SYDNEY UNIVERSITY

PREPARED FOR: **Western Sydney University**

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ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
BoM	Bureau of Meteorology
CBD	Central Business District
DoC	Depth of Cover
DPHI	Department of Planning, Housing and Infrastructure
EIS	Environmental Impact Statement
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
HA	Hazard Analysis
HAZID	Hazard Identification
HIPAP	Hazardous Industry Planning Advisory Paper
HSE	Health and Safety Executive (UK)
ICoE	Indigenous Centre of Excellence
LFL	Lower Flammability Limit
LoC	Loss of Containment
MAOP	Maximum Allowable Operating Pressure
NSW	New South Wales
PHA	Preliminary Hazard Analysis
RUP	Rupture
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SMS	Safety Management Study
SSD	State Significant Development
SSDA	State Significant Development Application
TfNSW	Transport for NSW
UFL	Upper Flammability Limit
WISER	Wireless Information System for Emergency Responders
WSU	Western Sydney University

1. EXECUTIVE SUMMARY

The Applicant seeks development consent for the construction of a new state-of-the-art Indigenous Centre of Excellence (ICoE) as a new tertiary education facility on campus. The new ICoE will be an important asset for both Western Sydney University (WSU/the University) and local community alike, providing a space for the commitment to advancing Indigenous education, leadership, and reconciliation.

This report responds to the Secretary's Environmental Assessment Requirements (SEARs) number 16, *Hazards and Risks*, of SSD-64916225, which was issued by the Department of Planning, Housing and Infrastructure (DPHI) on 21 November 2023. The SEARs for *Hazards and Risks* requires the following:

> *If the development is adjacent to or on land in a pipeline corridor, report on consultation outcomes with the operator of the pipeline, and prepare a hazard analysis.*

The Hunter Pipeline, a high-pressure liquid petroleum pipeline operated by Ampol Ltd (Ampol) and licensed under AS 2885, runs along Railway Street in the vicinity of the ICoE. Hence to address the above SEARs, consultation with the pipeline operator and a Pipeline Hazard Analysis (HA) for input to the EIS were required.

In completion of the Pipeline HA, WSU consulted with Ampol to obtain details of the Hunter Pipeline for inclusion in the study. Further, WSU provided the ICoE layout and population details, and details of the proposed temporary car parks. The study was completed using the risk management process outlined in AS ISO 31000, Ref [1], with the risk evaluated using the risk criteria for development in the vicinity of potentially hazardous facilities in the New South Wales (NSW) Hazardous Industry Planning Advisory Paper (HIPAP) No. 10 *Land Use Safety Planning*, Ref [2].

The following results were found with respect to the risk assessment:

- The individual fatality risk criteria was met for the ICoE, as the maximum fatality risk level was below the 5.0×10^{-6} per year level for commercial developments, including retail centres, offices and entertainment centres.
- The societal risk criteria was met for the ICoE, as the incremental societal risk from the development remained in the 'Negligible' region of the F-N curve.

Hence, all the required risk criteria in NSW HIPAP No. 10 are met and no safety-related land use planning conflicts were identified for the impact of the Hunter Pipeline on the ICoE.

2. INTRODUCTION

2.1. Background

The Applicant seeks development consent for the construction of a new state-of-the-art Indigenous Centre of Excellence (ICoE) as a new tertiary education facility on campus. The ICoE project is funded by the New South Wales (NSW) Government's Western Sydney Infrastructure Grants Program in association with Western Sydney University (WSU/the University). The new ICoE will be an important asset for both the University and local community alike, providing a space for the commitment to advancing Indigenous education, leadership, and reconciliation. The ICoE will stand as a symbol of recognition of Indigenous land and the University's relationship with Indigenous communities. The ICoE will represent a celebration of tens of thousands of years of Indigenous knowledges and histories, a legacy that the University is honoured to nurture and promote through further education opportunities for students and communities.

Through the ICoE, the University will aim to drive positive change, increase Indigenous participation in higher education, and contribute to the preservation and sharing of Indigenous cultures.

The ICoE is a State Significant Development (SSD) under the *State Environmental Planning Policy (SEPP) (Planning Systems) 2021* and requires an Environmental Impact Statement (EIS) to accompany the State Significant Development Application (SSDA) submission. This SSDA specifically seeks detailed approval for the following works:

- Site preparation including demolition of the existing car park, tree removal and installation of inground utility infrastructure services.
- Construction of a four-storey Indigenous Centre of Excellence encompassing:
  - Ground level facilities, including but not limited to: a dedicated arrival area, outdoor amphitheatre, cinema and lecture theatre, performance space, artist studios and exhibition space. Associated workspaces, meeting areas, lounge areas and other amenities are to be provided throughout the ground floor.
  - First level upwards comprising dedicated educational facilities including library facilities, learning areas and teaching spaces.
  - Second level comprising staff/student foyer, offices, meeting rooms and collaboration spaces.
  - Third level comprising a multi-functional recreational sports court, with associated ancillary amenities, alongside an astronomy garden and BBQ area.
  - Roof level plant and services.
- Construction of internal driveway with hardstand area to provide 13 car parking spaces.
- Landscaping works to provide outdoor educational and recreational spaces.

Additionally in response to matters received during the exhibition period of the ICoE SSDA, a proposal was raised to provide additional temporary car parking along Fifth Street. The proposed temporary car parks will comprise 288 spaces across the Western Car Park and Eastern Car Park.

This report responds to the Secretary's Environmental Assessment Requirements (SEARs) number 16, *Hazards and Risks*, of SSD-64916225, which was issued by the Department of Planning, Housing and Infrastructure (DPHI) on 21 November 2023. The SEARs for *Hazards and Risks* requires the following:

> *If the development is adjacent to or on land in a pipeline corridor, report on consultation outcomes with the operator of the pipeline, and prepare a hazard analysis.*

The Hunter Pipeline, a high-pressure liquid petroleum pipeline operated by Ampol Ltd (Ampol) and licensed under AS 2885, runs along Railway Street in the vicinity of the ICoE. For the purposes of the SEARs, the site is considered to be adjacent to a pipeline corridor, and hence consultation with the pipeline operator and a Pipeline Hazard Analysis (HA) are required. WSU has retained Sherpa Consulting Pty Ltd (Sherpa) to undertake the Pipeline HA for input to the EIS.

Note that this assessment requirement is consistent with Division 12A, Subdivision 2 of the *SEPP (Transport and Infrastructure) 2021* (Infrastructure SEPP), Ref [3], which provides context and specifies the notification and assessment requirements for development adjacent to a pipeline corridor.

2.2. Objectives

The objectives of this HA are to:

- Conduct a quantitative risk assessment to provide information on the risk posed by the Hunter Pipeline on the ICoE.
- Determine whether the risk posed by the Hunter Pipeline complies with the individual fatality, injury and societal risk criteria specified in the NSW Hazardous Industry Planning Advisory Paper (HIPAP) No. 10 *Land Use Safety Planning*, Ref [2].

2.3. Scope

The study scope was limited to the portion of the Hunter Pipeline which runs east of the ICoE along Railway Street, and the potential risk exposure to the proposed population. As is convention when calculating societal risk for comparison with land use planning risk criteria, the study will cover a 1 km pipeline section, approximately 500 m in each direction with the ICoE located in the centre.

2.4. Exclusions and limitations

The exclusions, assumptions and limitations that apply to this study are summarised in Table 2.1.

Table 2.1: Exclusions, assumptions and limitations

Item	Scope area	Exclusion/assumption/limitation
1	Other *Hazards and Risks* assessment requirements	A preliminary risk screening will be undertaken by WSU and is excluded from the scope of work for this assessment. Requirement for a Preliminary Hazard Analysis (PHA) is subject to the outcome of the preliminary risk screening. This is also excluded from the scope of work for this report.
2	AS 2885.6 Safety Management Study (SMS)	This study does not constitute any of the following types of SMS for existing pipelines in the context of AS 2885.6 Section 5.5: • Land use change SMS. • Encroachment SMS. • Change of operating conditions SMS. • Failure event SMS. These are separate studies that may be required by Ampol.
3	Escalation risk	As per the site survey, Ref [4], there are no adjacent pipelines to the Hunter Pipeline when it is next to the proposed ICoE. The Hunter Pipeline is adjacent to an underground low pressure 100 kPa gas pipeline along Railway St south of Fifth St. At the intersection of Railway St and Fifth St, the Hunter Pipeline runs north along the eastern side of the proposed ICoE while the gas pipeline runs west along the southern side of the proposed ICoE. Therefore, escalation risk from the Hunter Pipeline to adjacent pipelines was not assessed.
4	Societal risk	The study will only assess incremental societal risk associated with the proposed development, as allowed in HIPAP No. 10, Ref [2]. Cumulative societal risk assessment (accounting for existing populations and other risk sources in the area surrounding the Hunter Pipeline) is excluded from the scope of work.
5	Construction phase risk	Risks during the construction phase are excluded from this assessment. Risk issues related to construction phase are generally addressed in a construction SMS report.
6	Risk treatment options	Identification and assessment of risk treatment options are excluded from the scope of this report.
7	Requirements of Division 12A, Subdivision 2 of the *SEPP (Transport and Infrastructure) 2021* (Infrastructure SEPP), Ref [3], to consider risks to the pipeline	Whilst it is not expected that the development will present a risk to the pipeline, this Pipeline HA does not assess risk to the pipeline from the development. This assessment requires knowledge of Ampol's current controls and details of the final built design and construction techniques. Risks to the pipeline should be assessed with Ampol as the design and construction details are developed and take into consideration and specific controls required by Ampol.

3. METHODOLOGY

The study was completed following the risk management process outlined in AS ISO 31000:2018 *Risk management – Guidelines*, Ref [1], which includes the following:

- Establishment of context and criteria

  The following activities were completed:

  - Review of the development information.
  - Identification of pipeline details and operating conditions.
  - Identification of applicable risk criteria.

- Risk identification

  Risk identification was completed using a Hazard Identification (HAZID) Word Diagram to identify events that may lead to loss of containment (LoC) from the pipeline.

- Risk analysis

  Risk analysis combines consequence and frequency analysis to determine the risk posed by the pipeline. As part of risk analysis, the following were undertaken:

  - Consequence analysis: to determine the consequence impact following LoC events from the pipeline, i.e. fires. This was undertaken using Gexcon Effects v12.5.2, a commercially available software model.
  - Frequency analysis: to determine the failure frequency of the pipeline based on identified failure mechanisms using industry databases.

  Individual fatality, injury and societal risk posed by the pipeline were quantified using Gexcon Riskcurves v12.5.2, a commercially available software model. Population data used to quantify the societal risk was provided by WSU.

- Risk evaluation

  The individual fatality, injury and societal risk was assessed against the relevant criteria in HIPAP No. 10 *Land Use Planning*, Ref [2].

4. CONTEXT AND CRITERIA

4.1. Communication and consultation

This risk assessment was undertaken in consultation with WSU, who provided:

- the operational and physical equipment basis for the assessment, in consultation with Ampol (Section 4.4)
- the expected use and occupancy of the site (Section 4.5).

All consultation and documentation provided by WSU is listed in APPENDIX A.

4.2. Site description and location

The WSU South Parramatta Campus is located at 171 Victoria Road, Parramatta.

The site comprises one singular allotment, which is legally described as Lot 100 in DP 816829. The project site is known as the P1 Car Park in the northern portion of the wider site campus. The project site is approximately 12,150 m^2 in size and is broadly rectangular in shape. It currently comprises a hardstand area that accommodates approximately 284 car parking spaces. There is an existing single storey Central Energy Plant to the west of the development area which serves the wider campus; it remains outside the scope of this SSDA. Additionally, the proposed development includes the temporary car parking along Fifth Street, comprising 288 spaces across the Western Car Park and Eastern Car Park.

The site is strategically positioned to the northern boundary of the WSU South Parramatta Campus, fronting Victoria Road (the A40). The wider campus comprises a significant landholding size of approximately 20 ha containing a series of buildings of differing heights and massing forms which are used for educational purposes. The buildings contained within the wider campus site are dissected by a series of open, at grade car parks, internal roads, pathways, and landscaped areas. The Campus sits to the north of the Parramatta River.

The site is located approximately 3 km east of the Parramatta Central Business District (CBD), which is an area undergoing a process of significant transformation. It is also located approximately 500 m from the Parramatta Light Rail Corridor, with the construction of new Yallamundi Light Rail now completed and awaiting operation by Transport for NSW (TfNSW).

The site within the context of the WSU South Parramatta Campus is shown in Figure 4.1.

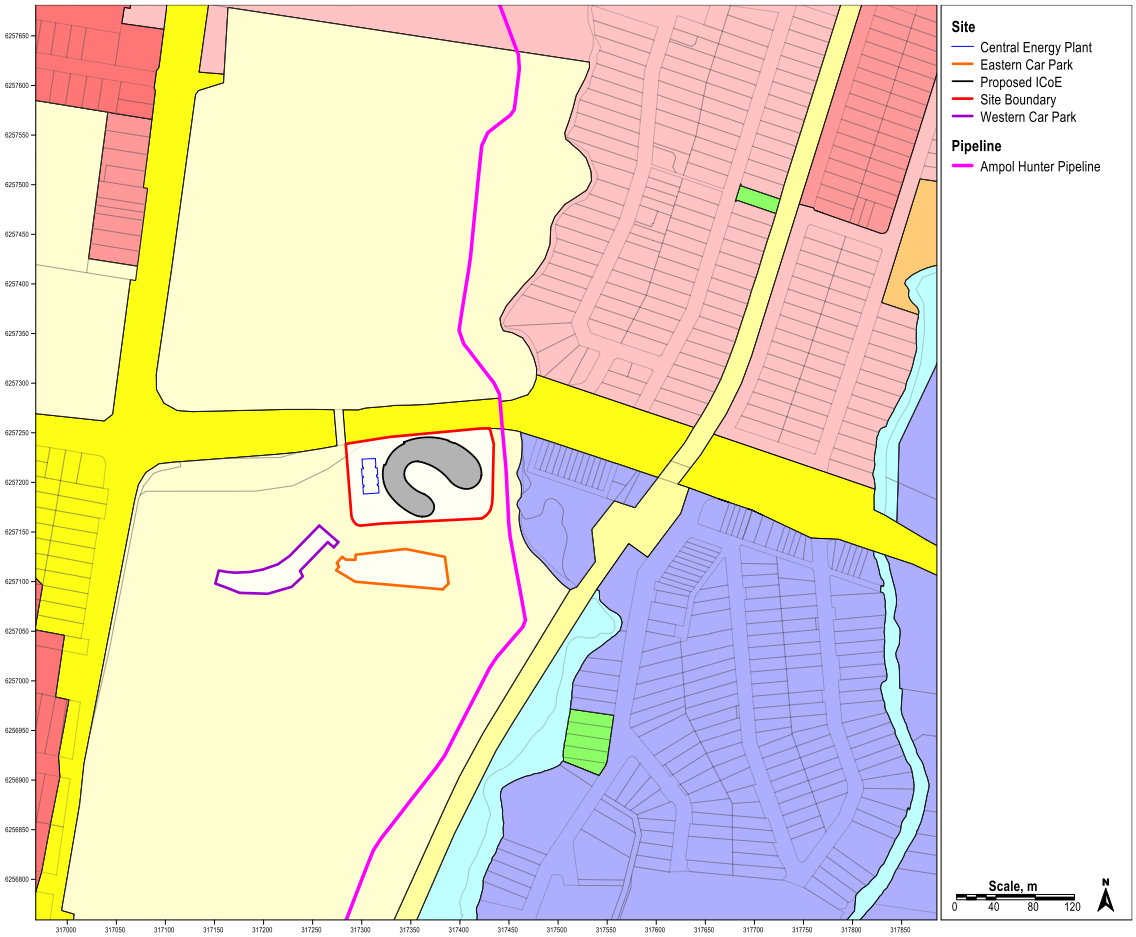
Figure 4.1: WSU South Parramatta Campus locational context

Source: Nearmap/Ethos Urban

4.3. Surrounding land uses

Land to the north of the proposed site is zoned SP2 Infrastructure – Educational Establishment, and the land to the east is zoned E4 General Industrial. Further to the north-east across Victoria Road, the land is zoned R2 Low Density Residential. The closest location that may be deemed 'sensitive' is the WSU Parramatta South Campus, where the closest building is located approximately 100 m south of the site. All surrounding land uses are shown in Figure 4.2.

Figure 4.2: Land use zoning



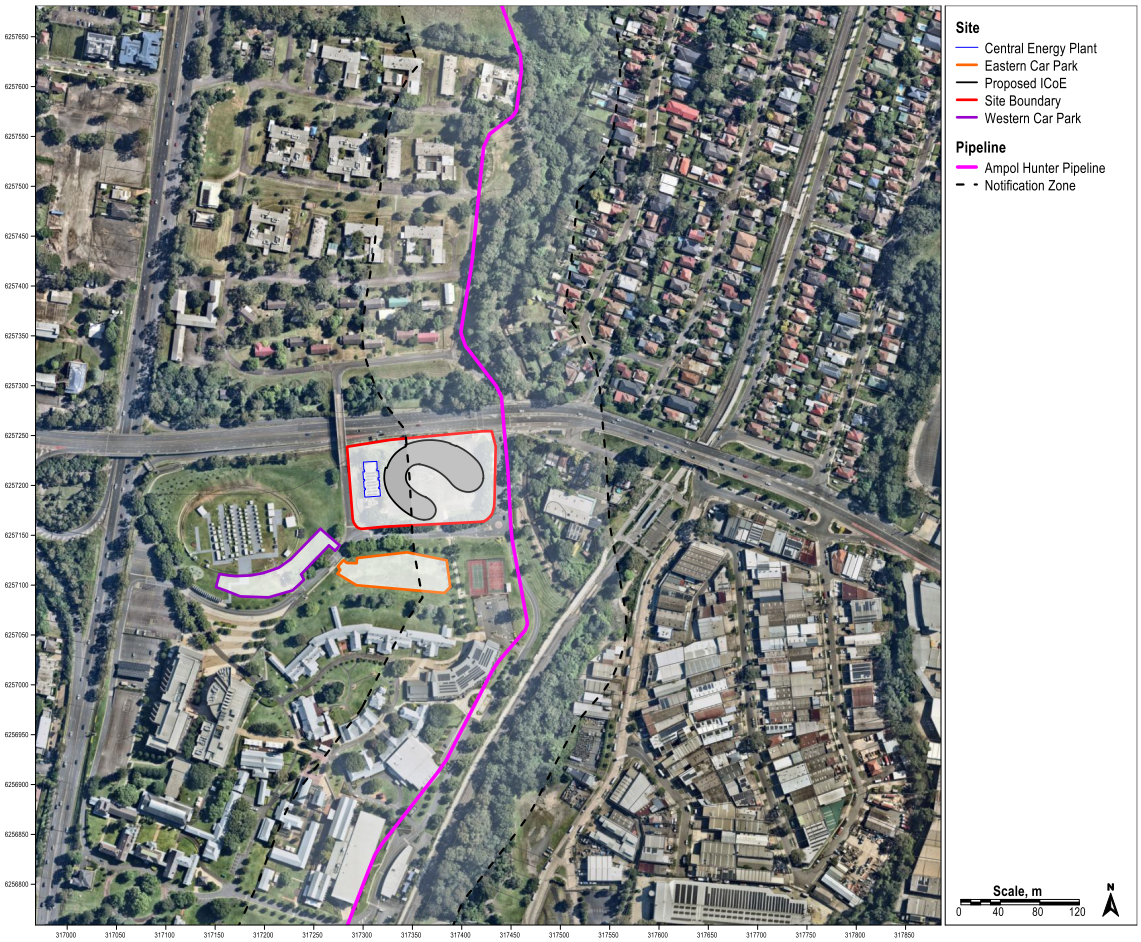
4.4. Hunter Pipeline

The Hunter Pipeline, owned and operated by Ampol, traverses a dedicated easement along Railway Street to the east of the development site. The section of the Hunter Pipeline within the scope of this assessment is shown in Figure 4.3. Part of the ICoE and Eastern Car Park are within the notification zone of the Hunter Pipeline.

The Maximum Allowable Operating Pressure (MAOP) and maximum throughputs were used for the assessment; though the pipeline would not be operating at these pressures and throughputs 100% of the year, they are conservative best estimates for modelling purposes. Additionally, while the Hunter Pipeline is used for transporting both gasoline

(various grades) and diesel, it was assumed to only be transporting gasoline as the more flammable material as a conservative assumption for the assessment. Parameters of the pipeline used for modelling are summarised in APPENDIX B, Section B1.

Figure 4.3: Hunter Pipeline route and notification zone



4.5. Populations

Population data for the proposed development was supplied by WSU. This includes:

- The operating times and indicative occupancy expected in the ICoE.
- Any expected transient population (a large population present for a specified period only), e.g. community events or exhibitions, and how often these events occur.

The model accounts for populations within defined locations of the ICoE, with allowances made for day and night changes and indoor/outdoor areas. The key population assumptions are detailed in APPENDIX B, Section B2.

4.6. Risk criteria

The NSW DPHI describes quantitative criteria for developments in the vicinity of potentially hazardous facilities in HIPAP No. 10, Ref [2], for individual fatality, injury and societal risk.

Individual risk criteria are summarised in Table 4.1, and societal risk criteria is shown in Figure 4.4.

The ICoE is not explicitly categorised by DPHI into a land use prescribed in Table 4.1 (taken from HIPAP No. 10). Based on the available land use categories, the ICoE was assessed under the category of 'commercial developments including retail centres, offices and entertainment centres'. It is noted that the ICoE may host events with sensitive populations (children and the elderly) present, however the ICoE is not a hospital, school, child-care facility or old age housing. As the ICoE was considered a commercial land use, the individual injury criteria was not applicable and hence not assessed.

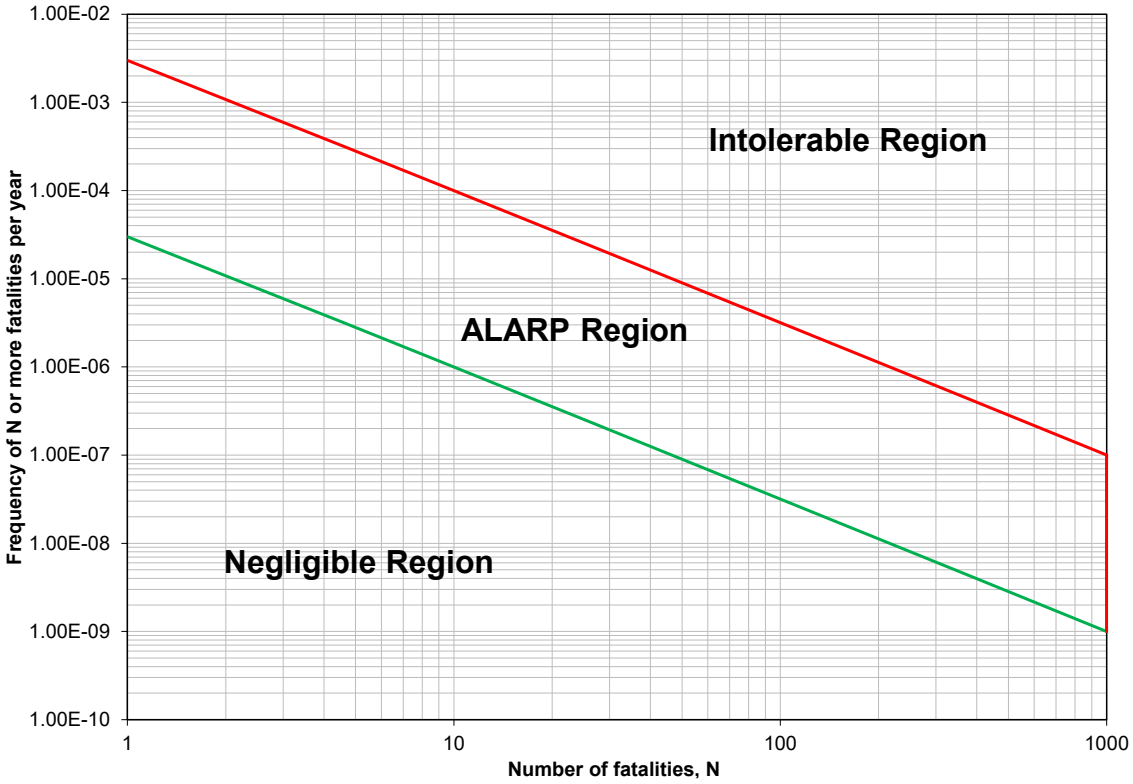
As the ICoE will result in a significant intensification of population in the vicinity of the Hunter Pipeline, the change in societal risk is required to be assessed. Based on guidance in HIPAP No. 10 if the incremental societal risk lies within:

- the 'As Low As Reasonably Practicable' (ALARP) region, options should be considered to relocate people away from the affected areas
- the 'Negligible' region, development should not be precluded.

Table 4.1: Individual risk criteria

Land use	Criteria (per year)
Individual fatality	
Hospitals, schools, child-care facilities, old age housing	5×10^{-7}
Residential, hotels, motels, tourist records	1×10^{-6}
Commercial developments including retail centres, offices and entertainment centres	5×10^{-6}
Sporting complexes and active open space	1×10^{-5}
Industrial	5×10^{-5}
Individual injury[(a)]	
Incident heat flux radiation exceeding 4.7 kW/m^2 at residential and sensitive use areas	5×10^{-5}
Notes: (a) Toxic and overpressure criteria were excluded as they are not applicable to this study.	

Figure 4.4: Societal risk criteria



4.7. Meteorological conditions

Historical meteorological data was obtained from the Bureau of Meteorology (BoM) weather station at Sydney Olympic Park (BoM No. 066212), which is approximately 4.6 km south-east of the development. The acquired data set was based on hourly readings over the period of March 2014 to March 2024.

The temperature and humidity were based on the following data:

- Historical average temperature: 18.1°C
- Historical average humidity (3pm): 49%

The wind rose map and consolidated data used in the risk model are presented in APPENDIX B, Section B3.

5. RISK IDENTIFICATION

5.1. Overview

Risk identification is the process of establishing the scenarios that could result in an adverse impact, together with their causes, consequences and existing safeguards. The focus of this study was releases from the Hunter Pipeline.

Risk identification comprised the following key steps:

- Identification of hazardous materials associated with the Hunter Pipeline.
- Identification of hazardous scenarios, recorded in a HAZID Word Diagram.

5.2. Hazardous materials

Materials transported in the Hunter Pipeline comprise gasoline (various grades) and diesel. These materials have a range of properties with regard to flammability, with gasoline being the more flammable and hence used as the basis for the assessment. The hazardous material properties of both materials are summarised in Table 5.1.

Table 5.1: Hazardous material properties

Property	Gasoline[(a)]	Diesel[(b)]
Australian Dangerous Goods Class	3 PGII Flammable	n/a – exempted from classification
Globally Harmonized System of Classification and Labelling of Chemicals (GHS) hazard category	Flammable liquid category 1	Flammable liquid category 4
Hazard statement	Extremely flammable liquid and vapour	Combustible liquid
Boiling point (atm) (°C)	25 - 210	160 - 360
Liquid density (kg/m^3 at 15°C)	720	Not available
Vapour density (relative to air at 0°C)	3 - 4	Not available
Vapour pressure (kPag at 20°C)	30 - 99.7	Not available
Auto-ignition temperature (°C)	280	257
Flash point (°C)	< -35	52 - 96
Lower Flammability Limit (LFL) (vol%)	1.4	1
Upper Flammability Limit (UFL) (vol%)	7.6	6
Flammable?	Yes	No – combustible
Toxic?	No	No

Notes:
(a) From *Lees' Loss Prevention in the Process Industries*, Ref [5].
(b) From the Wireless Information System for Emergency Responders (WISER) application v6.2.15, database v6.2.1.

5.3. Hazard Identification

A HAZID word diagram was developed in APPENDIX C, and contains the following information:

- hazardous events
- causes
- consequences
- prevention measures.

The HAZID showed that there were credible causes of LoC from the Hunter Pipeline which could lead to consequences with the potential to impact the ICoE.

6. CONSEQUENCE ANALYSIS

6.1. Overview

Consequence analysis of the identified hazardous scenarios (i.e. underground pipeline fires) was undertaken using Gexcon Effects v12.5.2. No aboveground pipeline features were identified the area.

6.2. Modelling approach and assumptions

For releases of gasoline, two types of pool fires were assumed for this study:

- Early pool fires, which correspond to the immediate ignition of a release where the spill rate into the pool is equal to the burn from the pool.
- Late pool fires, which correspond to the delayed ignition of a release where the fire size is proportional to its maximum spreading area.

Consequence modelling was also conducted for flash fires. However, the flammable vapours generated from gasoline releases did not reach the LFL concentration. Hence, only pool fires were considered in the risk model.

The following assumptions were made for consequence modelling:

- The representative material used for modelling gasoline was ‘Raw Gasoline Sample’ from Gexcon’s database of sample mixtures.
- For LoC downstream of a pump, the maximum release rate was limited to 150% of the process design flow rate to account for the pump running off its curve, Ref [6].
- The pool diameter was limited to a maximum pool radius equivalent to the width of Railway Street, i.e. 15 m, as it was assumed that a spill from the Hunter Pipeline near the proposed location of the ICoE would be limited by the kerbs, median strip and drainage on either side of the street along which it traverses.

6.3. Depth of Cover

Consequence modelling results from pipeline releases were not adjusted to account for Depth of Cover (DoC). It was assumed that if a leak went undetected, there was the potential for a release from any depth to percolate to the surface with a resulting surface pool fire.

6.4. Hole sizes

LoC from underground pipelines was modelled for the representative range of hole sizes in Table 6.1. The hole size selected for the ranges are the geometric means, which give a weighting towards the lower band, since smaller sized leaks tend to occur more frequently. The hole sizes were assigned as relevant to specific process equipment based on a parts count.

Table 6.1: Representative hole sizes for modelling LoC

Representative hole size (mm)	Process equipment hole diameter range (mm), Ref [7]
5 mm	Pinhole release (≤ 25 mm)
43 mm	Small hole release (25-75 mm)
91 mm	Large hole release (75-110 mm)
Pipeline diameter	Rupture (> 110 mm)

6.5. Vulnerability criteria

For fire scenarios, people are vulnerable to fire through:

- engulfment by fire
- heat radiation from a fire.

A vulnerability relationship for heat radiation is presented in the TNO Green Book, Ref [8], and the equation is shown below:

$$Pr = -36.38 + 2.56(Q^{4/3}t)$$

where,	Pr	probit corresponding to probability of death	(-)
	Q	heat radiation level	(W/m^2)
	t	exposure time	(s)

There is a range of guidance regarding exposure durations to be used in a quantitative assessment. For heat radiation exposures this typically ranges from 20-60 seconds, as follows:

- The NSW DPHI does not specify but states that 'the interpretation of "fatal" should not rely on any one dose-effect relationship, but involve a review of available data', Ref [9].
- The Queensland State code 21, Ref [10], does not recommend a heat radiation exposure duration but defines a dangerous dose to human health as 4.7 kW/m^2.
- TNO (Dutch guidelines) recommends 20 seconds for heat radiation exposures on the basis that the average escape time is 20 seconds which includes 5 seconds reaction time and then escaping at 4 metres per second, Ref [11].
- The Singapore government recommends that anything less than 30 seconds requires justification, Ref [12].

For this study, 60 seconds was adopted as the maximum heat radiation exposure duration and used to determine heat radiation levels for consequence modelling. The consequence criteria (i.e. levels of harm) used in this study are shown in Table 6.2.

Table 6.2: Vulnerability criteria for fire scenarios

Event	Level	Probability of fatality assumed in assessment[(a)]	Other effects
Pool fire	Within fire envelope	100%	Escalation due to direct impingement.
	35 kW/m^2	100%	Significant chance of fatality for people exposed instantaneously.
	23 kW/m^2	100%	-
	12.6 kW/m^2	91%	Escalation due to heat radiation.
	4.7 kW/m^2	2%	Burn injury after 30 seconds exposure.
Notes: (a) Based on exposure duration of 60 seconds.			

Societal risk mitigation factors from the TNO Purple Book, Ref [6], were applied to the vulnerability of people to flame effects and heat radiation, as per Table 6.3.

Table 6.3: Societal risk mitigation factors

Effect	Indoor/ outdoor	Mitigation factor	Justification
Pool fire – within fire envelope and heat radiation ≥ 35 kW/m²	Indoor/ outdoor	1	Engulfment with sustained fuel supply. No mitigation factor applied.
Pool fire – heat radiation < 35 kW/m²	Indoor	0	Indoor populations protected by building from lower heat radiation levels.
	Outdoor	0.14	Effect of clothing accounted for in outdoor populations.

6.6. Results

The results of the consequence analysis are tabulated in APPENDIX D.

The maximum effect distances to the 4.7 kW/m^2 heat radiation level (injury level, limit of fatalities) were 58 m from the pipeline centreline. Hence, heat radiation effects only impact the eastern part of the ICoE and do not impact either of the proposed temporary car parks.

7. FREQUENCY ANALYSIS

7.1. Overview

The frequency of an event is defined by the number of occurrences of the scenario over a specified time period, generally taken as one year. Frequency analysis involves estimating the likelihood of occurrence of each of the consequences identified in this study using historical equipment failure data and populating the event trees developed to characterise the accident pathways.

The following supporting data is included in APPENDIX E:

- historical equipment leak frequencies
- online time probability
- probability of ignition
- scenario frequencies.

7.2. Effect of safeguards

The main safeguarding for the Hunter Pipeline relates to prevention of LoC rather than mitigation of potential consequences. In determining pipeline leak frequencies, no adjustment factors were quantified, such as accounting for the effect of the wall thickness and minimum DoC.

Detection of LoC from the Hunter Pipeline would rely on third-party reporting to Ampol. Following shutdown, the release would still be pressurised for a period of time, so the release would continue. Due to the lack of reliability of third-party detection and the delay in depressurisation of the Hunter Pipeline, the effect of shutdown was not accounted for in this assessment.

8. RISK EVALUATION

8.1. Overview

Risk analysis was performed using Gexcon Riskcurves v12.5.2, which combines the consequences and frequencies of the identified hazardous scenarios. Assessment of the risk results against relevant risk criteria was then conducted in terms of:

- individual fatality risk
- societal risk.

8.2. Individual fatality risk

Individual fatality risk contours from the Hunter Pipeline are shown in the vicinity of the proposed ICoE in Figure 8.1. Of the risk levels shown in Table 4.1, only the 5.0×10^{-7} per year (sensitive land uses) criterion generated a risk contour. The 5.0×10^{-7} per year contour extends <5 m onto the footprint of the ICoE building and does not impact either of the temporary car parks.

Additionally, an individual fatality risk transect was obtained along the Hunter Pipeline at the proposed site for the ICoE, shown in Figure 8.2. The results in Figure 8.3 show that the maximum individual fatality risk for the pipeline at the proposed ICoE location is 7.8×10^{-7} per year, which is below the individual risk criterion of 5.0×10^{-6} per year for commercial land uses.

Therefore, the individual fatality risk criteria is met for the ICoE.

Figure 8.1: Individual fatality risk contours

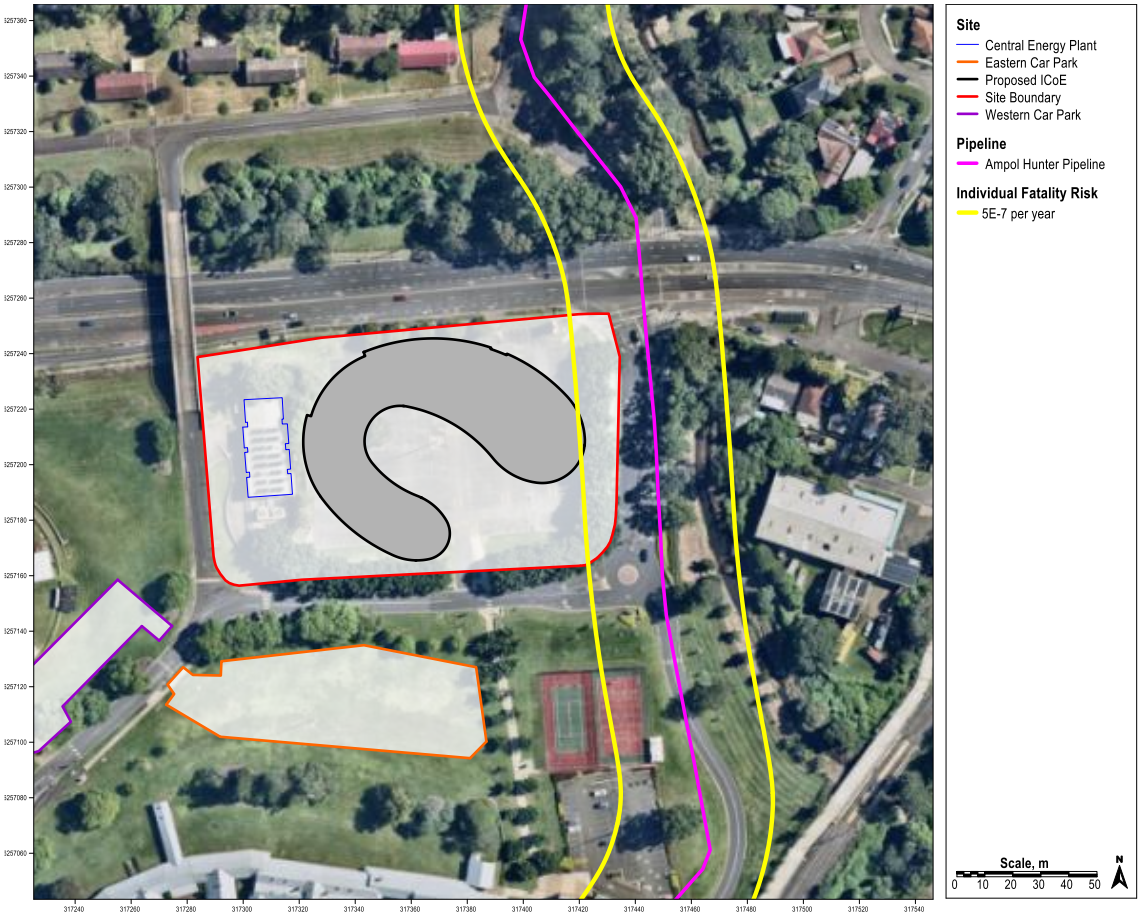


Figure 8.2: Risk transect map

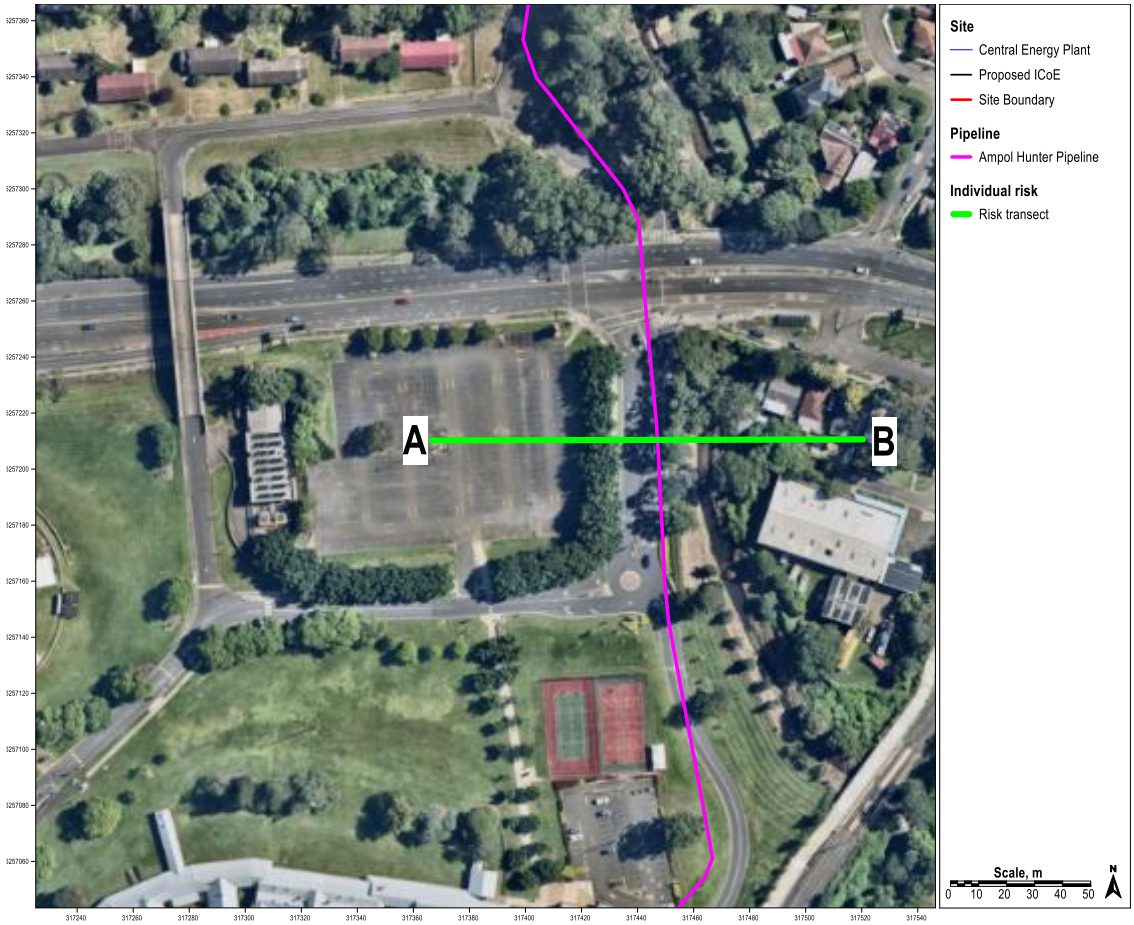
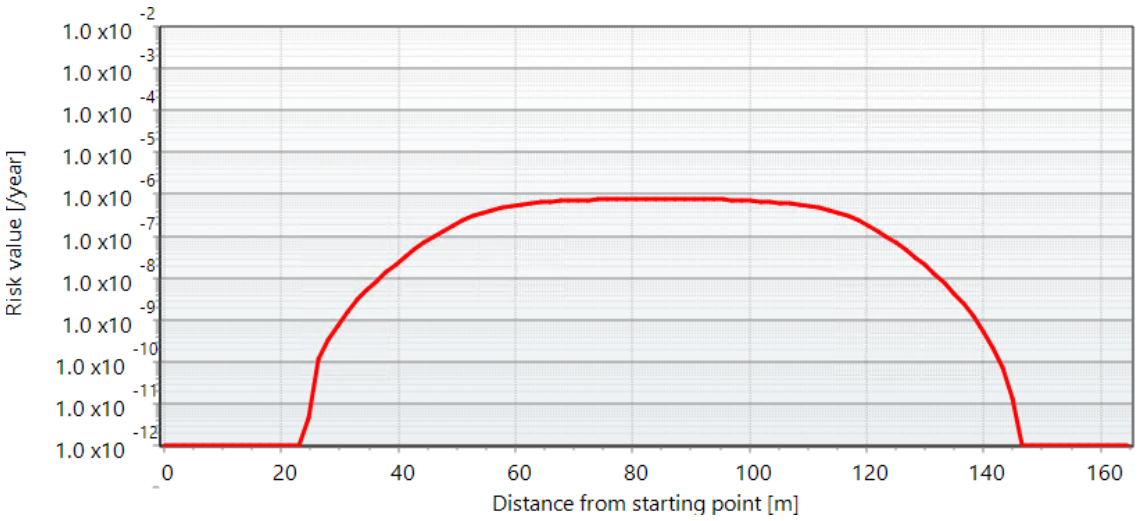


Figure 8.3: Risk transect



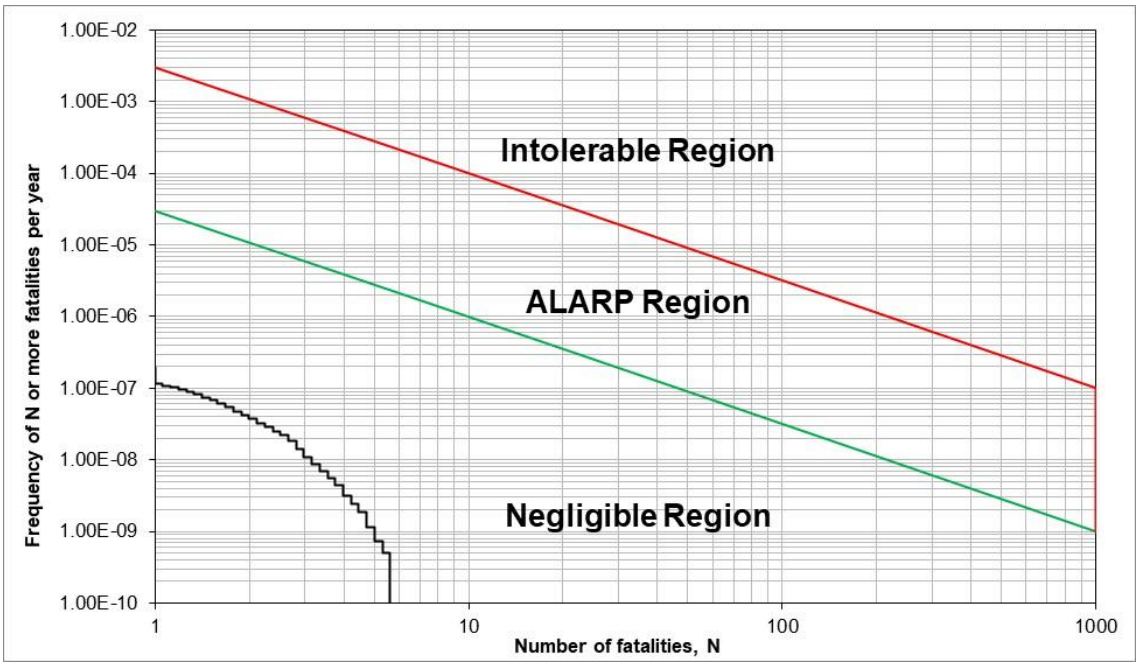
8.3. Societal risk

Societal risk is a measure of the probability of incidents affecting an actual population, which accounts for the number of people exposed to risk. The societal risk profile is presented as a curve representing the cumulative frequency of events against the

expected number of fatalities (an 'F-N' curve) and accounting for populations and their probability of presence. The population assumptions used to determine societal risk are detailed in APPENDIX B, Section B2.

The study found that the societal risk generated remained within the 'Negligible' region, as shown in Figure 8.4. The main contributor to the societal risk was from the transient populations at the Outdoor Function Space and Multi-Purpose Court, as indoor populations are protected from heat radiation levels. Based on the description in HIPAP No. 10, Ref [2], since the societal risk remains in the 'Negligible' region, development should not be precluded based on societal risk.

Figure 8.4: Societal risk profile



9. CONCLUSION

A Pipeline HA was prepared in response to SEARs number 16, *Hazards and Risks*, of SSD-64916225, which was issued by the DPHI on 21 November 2023 for the construction of the ICoE. The SEARs for *Hazards and Risks* required the following:

> *If the development is adjacent to or on land in a pipeline corridor, report on consultation outcomes with the operator of the pipeline, and prepare a hazard analysis.*

The Hunter Pipeline, a high-pressure liquid petroleum pipeline operated by Ampol and licensed under AS 2885, runs along Railway Street in the vicinity of the ICoE. Hence to address the above SEARs, consultation with the pipeline operator and a Pipeline HA for input to the EIS were required.

In completion of the Pipeline HA, WSU consulted with Ampol to obtain details of the Hunter Pipeline for inclusion in the study. Further, WSU provided the ICoE layout and population details, and details of the proposed temporary car parks. The study was completed using the risk management process outlined in AS ISO 31000, Ref [1], with the risk evaluated using the risk criteria for development in the vicinity of potentially hazardous facilities in the NSW HIPAP No. 10, Ref [2].

The following results were found with respect to the risk assessment:

- The individual fatality risk criteria was met for the ICoE, as the maximum fatality risk level was below the 5.0×10^{-6} per year level for commercial developments including retail centres, offices and entertainment centres.
- The societal risk criteria was met for the ICoE, as the incremental societal risk from the development remained in the 'Negligible' region of the F-N curve.

Hence, all the required risk criteria in NSW HIPAP No. 10 are met and no safety-related land use planning conflicts were identified for the impact of the Hunter Pipeline on the ICoE.

APPENDIX A. CORRESPONDENCE

Table A.1 lists all relevant documents provided to Sherpa in consultation with WSU.

Table A.1: Documents list

Title	Revision/Date	Date received
Western Sydney University Indigenous Centre of Excellence Scoping Report	16-Nov-2023	12-Feb-2024
Planning Secretary's Environmental Assessment Requirements for SSD-64916225	21-Nov-2023	12-Feb-2024
Email correspondence from Ampol to WSU	n/a	22-Mar-2024
WSU Indigenous Centre of Excellence Level 01/02/03/04/05 Plan – Burramattagal Country	Concept Design Development	09-Apr-2024
WSU Consultant Standard Text	Final	09-Apr-2024
Indicative ICoE Occupancy Levels	n/a	17-Apr-2024
ICoE Indicative Occupancy Review	3	17-Apr-2024
Western Sydney University - Plan of Detail and Levels Over Lot 100 DP816829 "Car Park P1" Fifth Street, Parramatta (Reference no. 52042 001DT)	4	31-Jul-2024

APPENDIX B. BASIS INFORMATION

B1. Hunter Pipeline

The process for obtaining details for the Hunter Pipeline was:

- Sherpa provided a table of required parameters to WSU.
- WSU forwarded the table to Ampol.
- Ampol reviewed and provided the required information to WSU.
- WSU forwarded Ampol's response to Sherpa.

A summary of the parameters provided are listed in Table B.1. At the request of Ampol, the data is not provided in this report but can be confirmed, if required.

Table B.1: Hunter Pipeline details

Parameter	Value
Material transported	Agreed in consultation with Ampol
Size of easement (on either side of pipeline)	
Operating pressure at ICoE location	
MAOP	
Usage time	
DoC	
Diameter	
Flow rate	
Confirmation of no anomalies	

B2. Population

Indicative population levels were provided by WSU and have been reproduced in Table B.2. The following sections describe the populations included in the model and the assumptions made for the following factors:

- day/night distribution
- indoor/outdoor fraction
- utilisation time.

Table B.2: Indicative ICoE occupancy levels

Area	Maximum Capacity	Mon-Fri (9am - 6pm)	Sat-Sun (9am - 1pm)	Day Event (6 /month)	Night/Weekend Event (4 /month)
Level One	**1,212**	**490**	**250**	**1,134**	**1,101**
Elder's Lounge	8	4	1	2	0
Concierge. Cloaking & Operations	4	4	1	4	4
Care	18	10	0	10	0
Discovery	126	40	20	80	80
Art is for Kids' & Collection Showcase	30	15	0	15	0
Artist Studios	8	6	0	6	0
Art Curation and Prep	4	1	1	4	4
Project Space	50	30	30	50	50
Exhibition Galleries	200	50	100	200	200
Reheat Kitchen	5	2	2	5	5
Theatre BOH	12	2	2	12	12
Theatre	350	150	0	350	350
Rehearsal	30	10	5	30	30
Pre-Function Space + Outdoor Function Space	60	15	15	60	60
Cinema/Lecture Theatre	100	75	0	100	100
Quiet Reflection	2	1	1	1	1
Community and Arrival	100	50	50	100	100
Outdoor Amphitheatre	100	20	20	100	100
Café	5	5	2	5	5
Level Two	**181**	**142**	**57**	**142**	**57**
Teaching and Learning Spaces	116	100	40	100	40
Library	63	40	15	40	15

Area	Maximum Capacity	Mon-Fri (9am - 6pm)	Sat-Sun (9am - 1pm)	Day Event (6 /month)	Night/Weekend Event (4 /month)
Bio-Box	2	2	2	2	2
Level Three	**135**	**125**	**15**	**96**	**25**
DVCIL	26	26	5	26	15
Boardroom	30	30	0	10	0
Indigenous Research Institute	38	28	5	30	5
Badanami	41	41	5	30	5
Level Four	**155**	**80**	**25**	**65**	**50**
Astronomy and Gathering Space	30	30	5	25	30
Multi-Purpose Court	125	50	20	40	20
TOTAL	**1,683**	**837**	**347**	**1,437**	**1,233**

Notes:
(a) Assumed to be total population per day.

B2.1. Populations included in the model

Only areas within the 1 x 10^{-15} per year individual fatality risk contour shown in Figure B.1, were included in the model as populations, as additional population outside this contour would have a negligible effect on the societal risk. The 1 x 10^{-15} per year contour is shown to impact only a section of the ICoE and not reach either of the temporary car parks.

The populations across all four levels of the ICoE within the 1 x 10^{-15} per year contour are listed in Table B.3 and were included in the model as:

- permanent populations to account for typical occupancy during normal business hours (i.e. Mon-Fri 9am-6pm and Sat-Sun 9am-1pm)
- transient populations to account for expected additional occupancy during day and night/weekend events.

As a conservative estimation, the permanent population was assumed as the maximum for any day of the week.

Figure B.1: Individual fatality risk contour – 1 x 10^{-15} per year

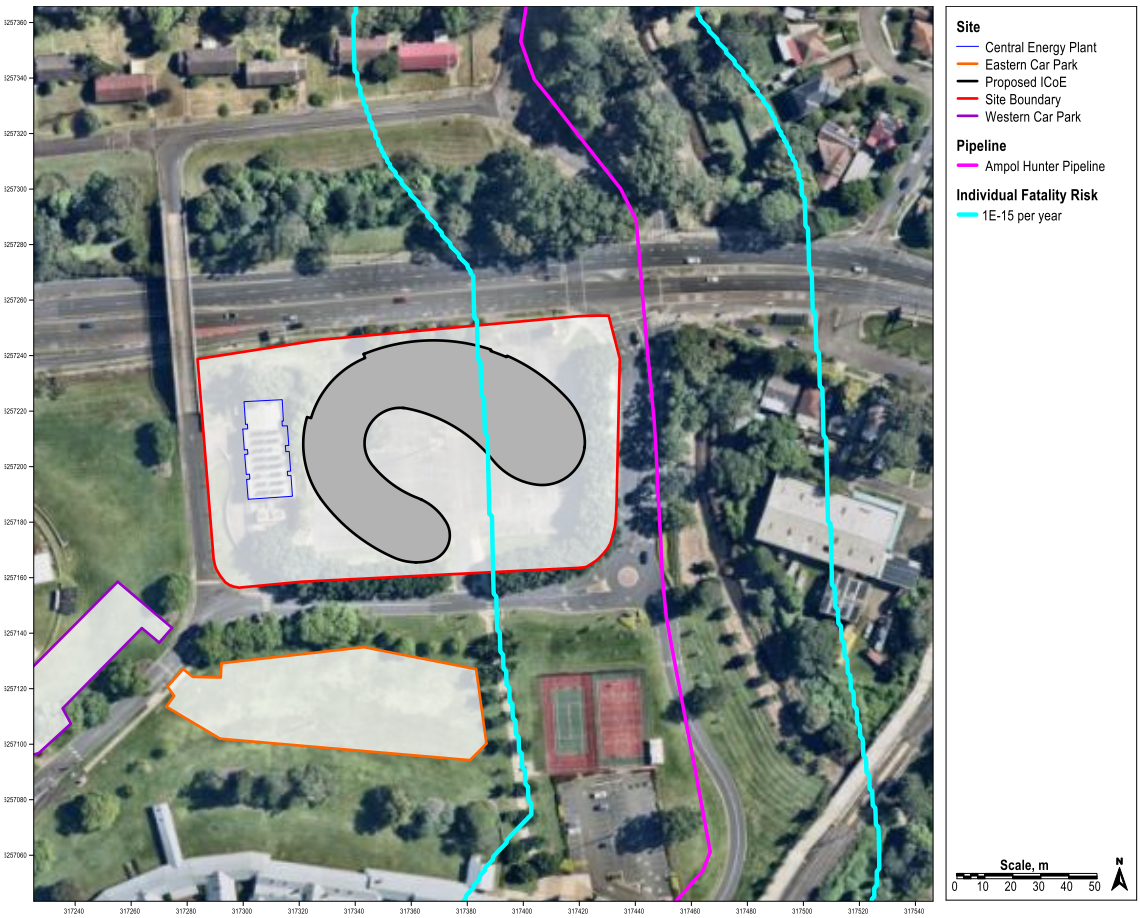


Table B.3: Populations included in the model

Level	Area	Typical population during the week (people per day)	Events population (people per day)	
			Day	Night/ weekend
1	Care	10	10	0
	Exhibition Galleries	100	200	200
	Reheat Kitchen	2	5	5
	Theatre BOH	2	12	12
	Theatre	150	350	350
	Rehearsal	10	30	30
	Pre-Function Space + Outdoor Function Space	15	60	60
	Cinema/Lecture Theatre	75	100	100
2	Bio-Box	2	2	2
3	Badanami	41	30	5
4	Astronomy and Gathering Space	30	25	30
	Multi-Purpose Court	50	40	20

B2.2. Population by day/night

The following assumptions, based on TNO Purple Book, Ref [6], were made for population distribution between day and night-time:

- Daytime refers to the period from 8am to 6:30pm, and night-time refers to the period from 6:30pm to 8am.
- As the ICoE will be used for educational purposes, the fraction of the typical population present during daytime on Mon-Fri (9am-6pm) and Sat-Sun (9am-1pm) was 1.0.
- 'Day' events were assumed to only occur during daylight hours, while 'night/weekend' events were all assumed to only occur at night.

B2.3. Population by indoor/outdoor

The ICoE will be a fully enclosed building from Levels One to Three. Therefore, 100% of the total population was assumed to be indoors during the day and night, except for the following areas:

- the 'Care' area
- the Astronomy and Gathering Space
- the Multi-Purpose Court
- the Outdoor Function Space.

As the ‘Care’ area will be a garden area outside the ICoE building and the Astronomy and Gathering Space and the Multi-Purpose Court will be open to the air on Level Four, 100% of the population in these areas were assumed to always be outdoors. The population within the Outdoor Function Space were assumed to always be outdoors.

B2.4. Utilisation time

The following assumptions were made to account for the expected ICoE utilisation per year:

- Permanent populations will be present at the ICoE for 100% of the year.
- Transient populations will be present only when the ICoE is utilised for events, which were assumed to occur during the following times:
  - A ‘day event’ is assumed to occur over the entire day (i.e. from 8am to 6:30pm). As there are 6 day events expected per month, this is equivalent to 72 days per year.
  - A ‘night/weekend event’ is assumed to occur for 4 hours at night. As there are 4 night/weekend events expected per month, this is equivalent to 48 x 4-hour nights per year.

B3. Meteorological data

Analysis of meteorological data from the BoM was completed to consolidate the data into representative Pasquill stability classes. Using this approach, wind speed, solar radiation and cloud data are considered to determine atmospheric stability, Ref [13].

The source weather data was process and allocated one of four wind speed and Pasquill stability class groupings for the day and night. Wind was split into 12 possible directions. The wind rose is shown in Figure B.2 and the consolidated data is shown in Table B.4.

Figure B.2: Wind rose – Sydney Olympic Park (BoM No. 066212)

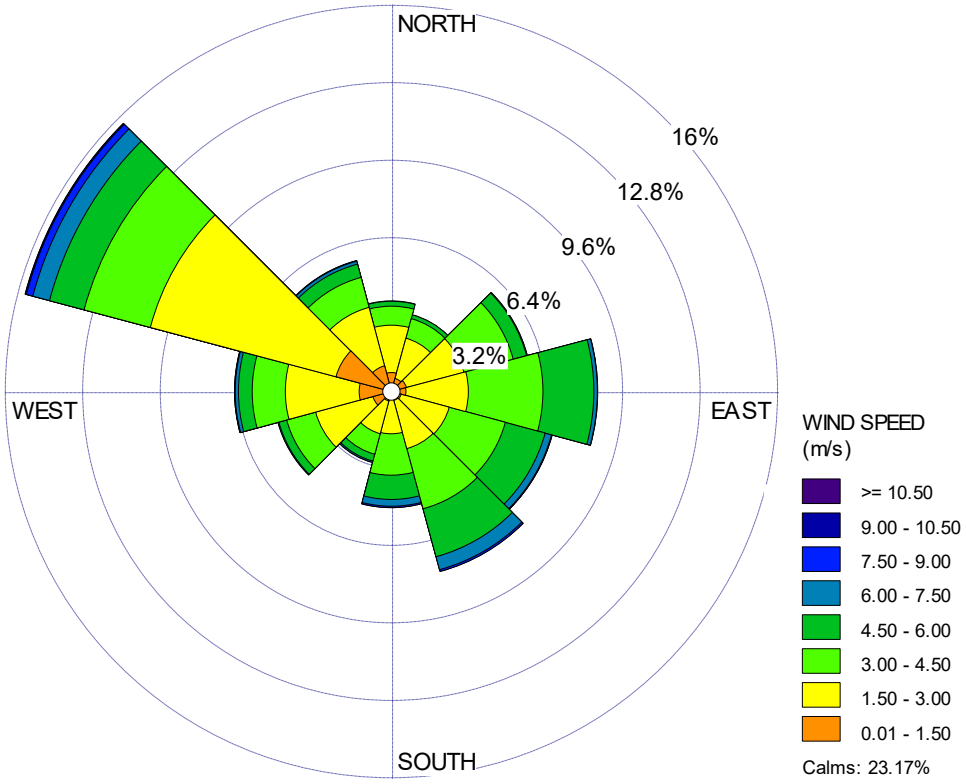


Table B.4: Weather stability data – Sydney Olympic Park (BoM No. 066212)

Direction wind from (degrees true)	B2		D5		E3		F0.7		Total Day	Total Night
	Day	Night	Day	Night	Day	Night	Day	Night		
0	4.55	0.00	0.52	0.19	0.00	0.95	0.00	5.23	5.07	6.37
30	3.36	0.00	0.31	0.34	0.00	1.41	0.00	5.11	3.67	6.86
60	5.24	0.00	1.43	0.75	0.00	2.68	0.00	5.46	6.67	8.89
90	6.99	0.00	5.22	1.32	0.00	2.28	0.00	5.17	12.22	8.76
120	5.20	0.00	4.16	1.32	0.00	2.18	0.00	4.85	9.36	8.34
150	4.71	0.00	4.62	2.41	0.00	2.60	0.00	5.00	9.33	10.01
180	4.09	0.00	2.49	1.17	0.00	1.67	0.00	4.13	6.57	6.97
210	3.56	0.00	0.82	0.28	0.00	1.02	0.00	4.33	4.38	5.63
240	5.40	0.00	0.93	0.28	0.00	1.38	0.00	5.67	6.32	7.33
270	7.13	0.00	1.61	0.47	0.00	1.18	0.00	6.52	8.75	8.16
300	15.27	0.00	4.54	1.69	0.00	3.35	0.00	10.37	19.81	15.42
330	6.26	0.00	1.60	0.44	0.00	1.23	0.00	5.59	7.86	7.27
Total	**71.75**	**0.00**	**28.25**	**10.66**	**0.00**	**21.93**	**0.00**	**67.41**	**100.00**	**100.00**

APPENDIX C. HAZID WORD DIAGRAM

Hazardous event	Cause	Consequence	Prevention measures	Carried forward
Release from pipework	Generic mechanical failures (including corrosion, impact, leaks from fittings and flanges)	Liquid release. Pool fire if ignited for all hole sizes.	- Pipeline is buried underground. - Compliance with AS 2885 SMS.	Yes
	Natural disaster (e.g. earthquake, flooding/ scouring)	Liquid release. Pool fire if ignited for all hole sizes.	- Compliance with AS 2885 SMS.	Yes
Damage to pipeline during maintenance	Impact due to unknown location during third party activity (e.g. excavation)	Liquid release. For underground section, pool fire if immediate ignition for all hole sizes. For aboveground section, pool fire if immediate ignition for large hole sizes, jet fire if immediate ignition for small hole sizes, flash fire if delay ignition for all hole sizes resulting in pipeline damage and potentially: • injury/fatality of personnel (if present) • injury to third parties (if present in the vicinity).	- Compliance with AS 2885 SMS.	Yes

APPENDIX D. CONSEQUENCE ANALYSIS

D1. Modelling parameters and assumptions

The parameters used for modelling fires from underground pipelines are summarised in Table D.1.

Table D.1: Standard modelling parameters

Item	Value	Basis
Ambient temperature	18.1°C	Weather data, average annual temperature.
Soil temperature	18.1°C	Assumed equal to ambient temperature.
Relative humidity	49%	Weather data, average 3 pm relative humidity.
Solar radiation	1 kW/m^2	Summer/winter insolation – estimated typical values (0.1 - 1 kW/m^2).
Ground roughness length	0.5 m	Ground roughness affects turbulent flow properties of wind, hence dispersion of a released material. Terrain effects are considered to some degree in dispersion modelling by use of a parameter known as surface roughness length. A surface roughness length of 0.5 m was used corresponding to an area with parkland, bushes and numerous obstacles.
Averaging time (flammables)	20 s	Effects default value.
Receptor height	1.5 m	Around face height. Taken as the height above ground level.

D2. Underground pipeline fires

Pool fire consequences were evaluated to determine the characteristics of ignited gasoline releases along the underground Ampol Hunter pipeline. The pool fires were categorised as early (immediate ignition) or late (delayed ignition).

Early and late pool fire results for the highest windspeed are summarised in Table D.2.

Table D.2: Underground pipeline pool fire consequence results

Pool fire type	Product	Modelled product	Hole size[(a)] (mm)	Release rate (kg/s)	Calculated pool diameter (m)	Distance (m) to heat radiation from centre of pool at D5.0 m/s			
						35 kW/m^2	23 kW/m^2	12.6 kW/m^2	4.7 kW/m^2
Early pool fire	Gasoline	Raw Gasoline Sample	5	1.3	4.7	6	7	10	14
			43	93.0	30.0	25	28	37	58
			91	109.4	30.0	25	28	37	58
			RUP	109.4	30.0	25	28	37	58
Late pool fire	Gasoline	Raw Gasoline Sample	5	1.3	19.0	18	20	27	41
			43	93.0	30.0	25	28	37	58
			91	109.4	30.0	25	28	37	58
			RUP	109.4	30.0	25	28	37	58

Notes:
(a) Rupture hole size (RUP) was modelled at the maximum pipeline diameter.

APPENDIX E. FREQUENCY ANALYSIS

E1. Historical equipment leak frequencies

Table E.1 shows leak frequencies from buried steel pipelines, based on data from the UK Health and Safety Executive (HSE), Ref [7]. For this study all causes of leaks were considered possible, hence the total leak frequencies used for each hole size was the summation of all the individual causes.

Table E.1: Leak frequencies for buried steel pipelines

Category	Leak frequency by hole size				Units
	5 mm	43 mm	91 mm	RUP	
Mechanical failure (d ≥ 305 mm)	8.20E-6	1.00E-5	1.00E-5	4.10E-6	per km-year
Corrosion (t < 10 mm)	1.20E-5	1.20E-5	1.20E-5	2.10E-6	per km-year
Ground movement	1.20E-5	2.50E-6	1.50E-7	2.50E-6	per km-year
Third Party Activity	2.20E-5	2.40E-6	1.00E-7	1.00E-7	per km-year
Total Leak Frequency	**5.42E-5**	**2.69E-5**	**2.23E-5**	**8.80E-6**	**per km-year**

E2. Online time probability

This assessment did not account for the time the pipeline would be static or transporting diesel products. Hence, the pipeline was assumed to be operating for 100% of the year with gasoline products, as a conservative estimate for modelling purposes.

E3. Probability of ignition

The ignition probability values used in this study were based on correlations published by Energy Institute, Ref [14]. The correlations consist of up to 3 gradients, each of the generic form:

$$\log_{10}(y) = m\log_{10}(x) + c\,,\ \text{rearranged as}\ \ y = 10^{[m\log_{10}(x)+c]}$$

where y is the ignition probability, m is the gradient of the correlation, x is the mass release rate (kg/s) and c is the y-axis 'offset' of the correlation.

For pipeline transported gasoline products, ignition probability correlation 3 (Pipe Gas LPG Industrial) was used as shown in Figure E.1.

An ignition probability split of 30% immediate ignition and 70% delayed ignition was used, Ref [15].

The ignition probabilities for all sections and relevant leak sizes assessed in this assessment are summarised in Table E.2.

Figure E.1: Ignition probability correlations used in assessment

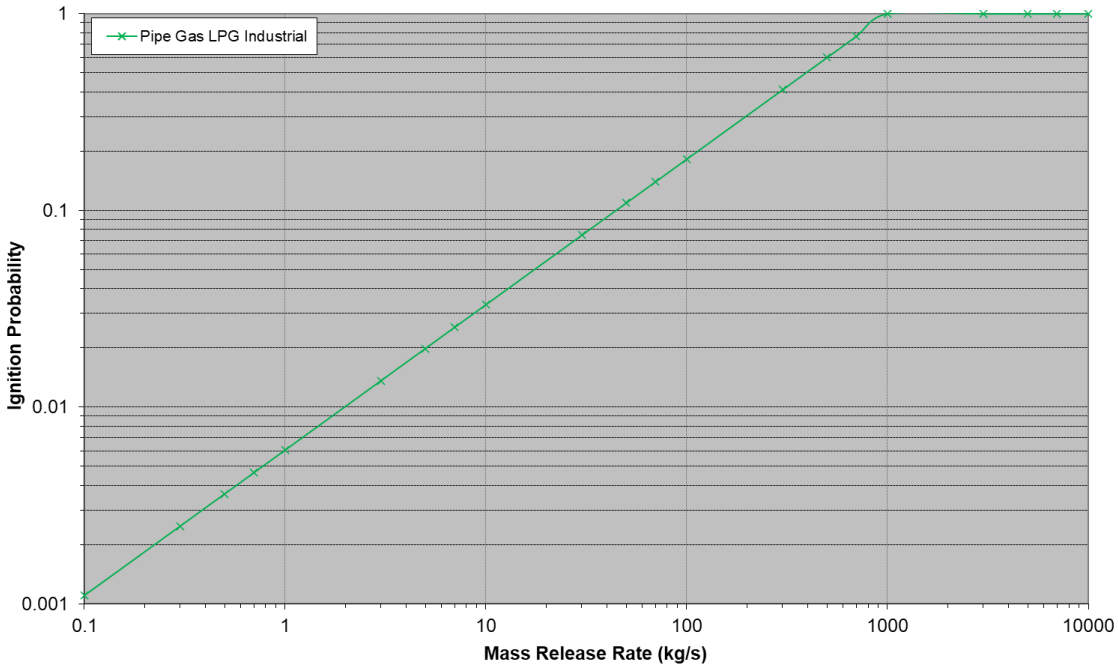


Table E.2: Ignition probabilities

Description	Hole size (mm)	Release rate (kg/s)	Ignition probability	
			Immediate	Delayed
Underground Ampol Hunter Pipeline (Gasoline)	5	1.3	0.0022	0.0052
	43	93.0	0.0518	0.1208
	91	109.4	0.0584	0.1362
	RUP	109.4	0.0584	0.1362

E4. Scenario frequencies

The fire frequencies for all scenarios are summarised in Table E.3.

Table E.3: Fire frequencies

Hole size (mm)	Early pool fire	Late pool fire	Unit
5	1.21E-7	2.82E-7	per km-year
43	1.39E-6	3.25E-6	per km-year
91	1.30E-6	3.03E-6	per km-year
RUP	5.14E-7	1.20E-6	per km-year

APPENDIX F. REFERENCES

[1] Standards Australia, “AS ISO 31000:2018 Risk management - Guidelines,” 2018.

[2] NSW Department of Planning, “Hazardous Industry Planning Advisory Paper No. 10 - Land Use Safety Planning,” 2011.

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[11] Ministry for Housing, Spatial Planning and the Environment (VROM), “Risk Analysis Methodology for CPR-15 Establishments,” 1997.

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