OAKDALE SOUTH ESTATE, PRECINCT 6 - SSDA 6917 MOD 10

SECTION 4.55 (1A) MODIFICATION

10 MAY 2019
FINAL
POOO9093
PREPARED FOR GOODMAN

URBIS

URBIS STAFF RESPONSIBLE FOR THIS REPORT WERE:

Director	Jacqueline Parker
Consultant	Andrew Hobbs and Dayle Bennett
Project Code	P%9093
Report Number	FINAL

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FIGURES:

1. INTRODUCTION

This Modification Report has been prepared by Urbis on behalf of the applicant, Goodman Property Services (Aust) Pty Ltd, and is submitted to the New South Wales Department of Planning and Environment (DP&E) in support of a modification under section 4.55(1A) of the *Environmental Planning & Assessment Act, 1979* (EP&A Act) to a State Significant Development (SSD) approval SSD6917 issued on 26 October 2016, and as subsequently modified, for the Staged Development of the Oakdale South Estate (OSE).

SSD 6917 sought approval for the Concept Proposal and Stage 1 Works relating to the overall development of the OSE including the establishment of road layouts, site levels, subdivision and infrastructure delivery. This section 4.55(1A) modification application to SSDA 6917 seeks approval to enable the storage of Dangerous Goods (DG) within Warehouse 1D and is herein referred to as MOD 10.

The Modification Report describes the site and the proposed modifications, provides relevant background information, and assesses the development against relevant legislation, environmental planning instruments, and planning policies.

A Preliminary Hazard Analysis has been provided in support of this section 4.55(1A) modification application and has informed assessment of the potential environmental impact resulting from the proposal.

The proposed modification to the approval seeks to:

- Amend SSD 6917 to enable storage of dangerous goods within Warehouse 1D.

It is noted that no change is proposed to the approved architectural plans, only to the internal racking layout shown within Warehouse 1D, which does not require approval under this Modification.

The following supporting specialist reports have been included in this request at **Appendix A-C**:

- **Appendix A:** Preliminary Hazard Assessment Report.
- **Appendix B:** Fire Safety Strategy.
- **Appendix C:** BCA Report.

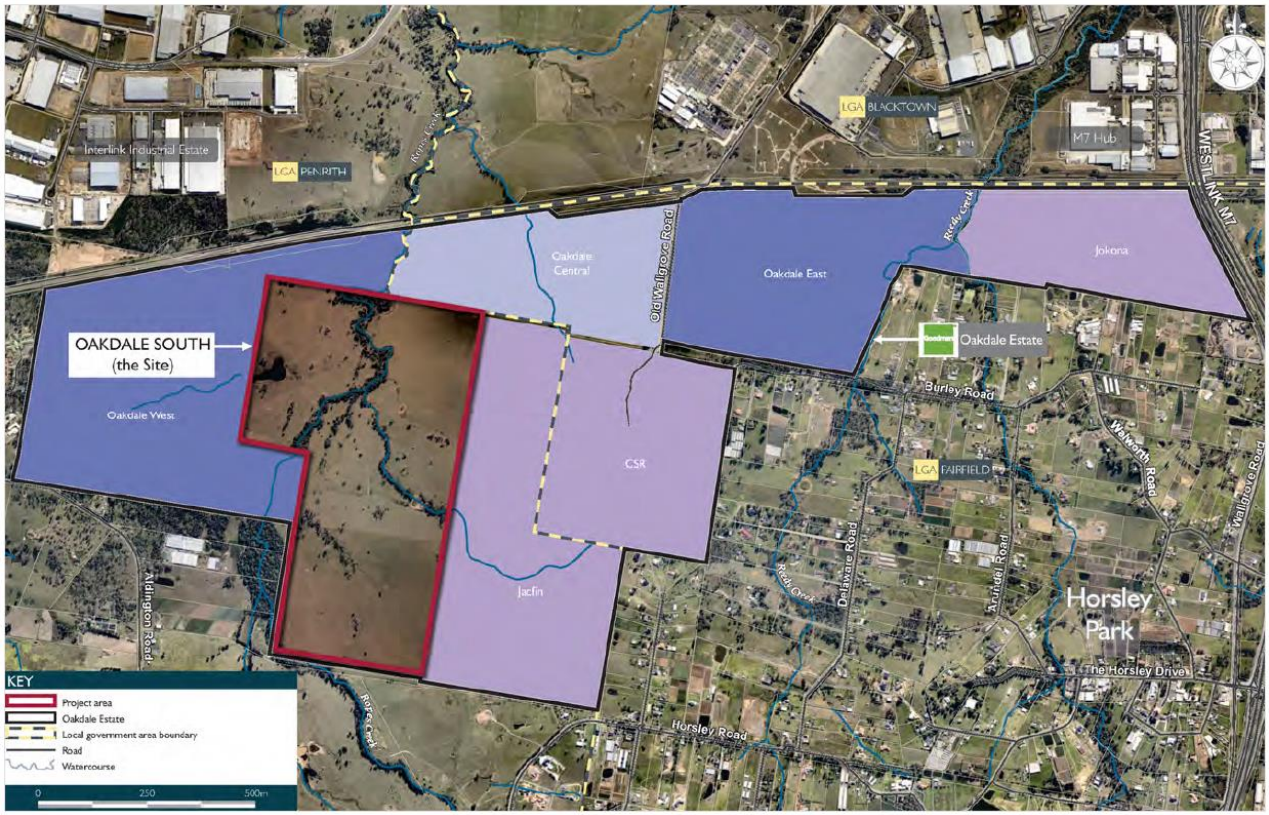
These reports demonstrate that the proposed changes do not result in a material change to the intensity of the development, nor to known environmental impacts resulting from the development.

The proposal is consistent with the relevant legislative and policy framework including the *Environmental Planning and Assessment Act 1979* and *State Environmental Planning Policy (Western Sydney Employment Area) 2009*.

1.1. SUBJECT SITE

The OSE is a 117ha site located within the Western Sydney Employment Area (WSEA) and is the second of four stages of the broader 'Oakdale Estate' under the management of Goodman Limited. Refer to **Figure 1** which depicts the Oakdale Estate and the OSE.

Figure 1 – Oakdale Estate Lands

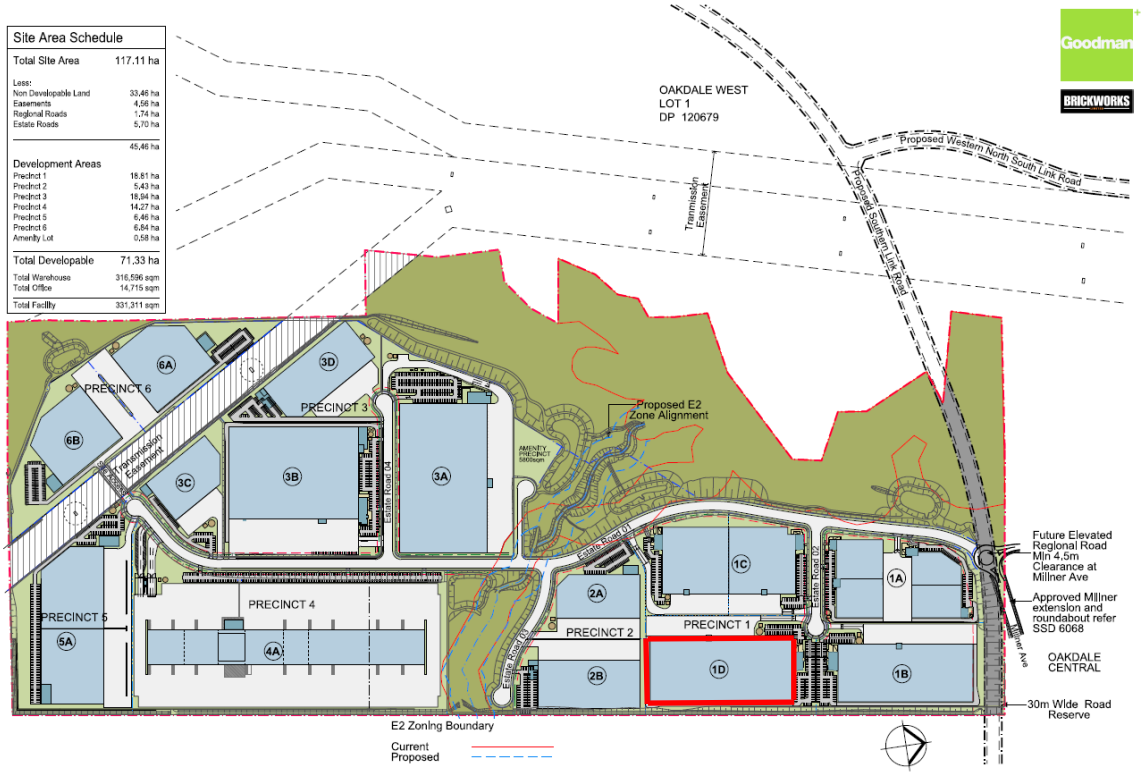


The portion of the estate in which the site is located is referred to as Precinct 1. Refer to Figure 2 which depicts the location of Warehouse 1D within Precinct 1. The site has previously been levelled through introduced fill and retaining and is void of vegetation. The overall OSE site parameters are included below:

Table 1 – OSE Site Parameters

Parameter	Description
Address	3 Imperata, Kemps Creek NSW 2178
Legal Description	Lot 5 DP 1229850
Site Area (approx..)	36.42 Hectares

Figure 2 - Oakdale South Estate Approved Layout, Subject Site Highlighted in Red



Source: SBA Architects

2. CONSENT FRAMEWORK

The development of the OSE is part of the development of the broader Western Sydney Employment Area (WSEA) and, within that, the wider Oakdale Estate.

2.1. SSD 6917 – STAGED SSDA FOR THE OSE

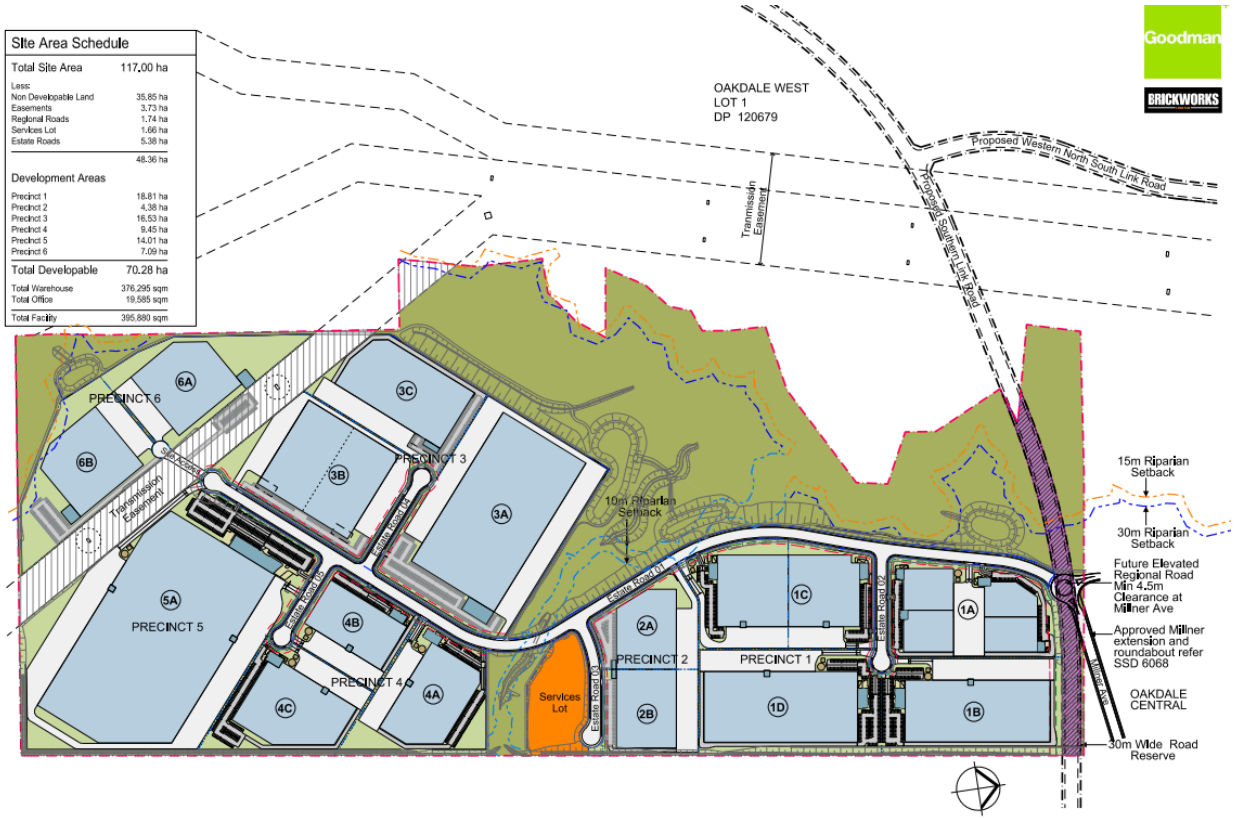
A State Significant Development approval (SSD6917) was issued on 26 October 2016 for Concept Plan and Stage 1 Estate and Precinct Development works within the OSE. This approval was amended by SSD 6917 MOD 1 approved on 21 April 2017. Specifically, this consent authorised the concept proposal for the estate and detailed stage 1 development works detailed below:

OSE Concept Proposal

The Concept Proposal included site master plan to guide the staged development of the OSE along with core development controls that will form the basis for design and assessment of future development applications on the site (Refer to **Figure 3** below).

Determination of the Concept Proposal included detailed consideration of impacts generated by the proposed future use of the site, including an assessment of estate-wide traffic generation and infrastructure demand, impact on Aboriginal and non-Indigenous heritage, impact on flora and fauna, riparian lands and creeks, acoustic, visual and air quality impact and overall consistency of the proposal with the strategic objectives of the WSEA SEPP and metropolitan planning strategy.

Figure 3 – Originally Approved OSE Masterplan



Stage 1 Development

- Stage 1 Estate Works:

  Site preparation, civil and infrastructure work across the entire OSE, required to facilitate the staged development of the OSE.

  This included bulk earthworks for Estate Road construction and interim development site pad levels, staged subdivision, provision of services infrastructure to the future development lots, construction of stormwater drainage within the Estate Road, and civil works for realignment of the Ropes Creek Tributary.

Stage 1 works also include vegetation and archaeological site clearance across the site.

- Stage 1 Precinct Development works:

  This included construction and operational consent for built form, use and operational parameters of development lots within Precincts 1, 4 and 5.

2.2. MOD 1 – SSD 6917

Consent SSD 6917 MOD 1 was approved on 21 April 2017. MOD 1 modified the Concept Proposal and Stage 1 DA Layout including;

- Revised lot, building envelope and internal road layout under the Concept Proposal and Stage 1 DA,
- Addition of a 5,800sqm amenity lot;
- Amended subdivision layout;
- An increase of the total developable area for the estate from 70.28ha to 71.33ha;
- Amended bulk earthworks, estate infrastructure and landscaping works;
- Amended creek re-alignment works;
- Construction of extended noise walls; and
- Removal of all warehouse building construction in precincts 3,4 and 5 from the Stage 1 DA.

The approved lot layout of the Oakdale South Estate is shown at **Figure 2.**

2.3. SUBSEQUENT MODIFICATIONS

Nine (9) modification applications have been submitted to modify SSD 6917 since the approval. These are described briefly as follows:

- **Mod 1 – Approved**. MOD 1 modified the Concept Proposal and Stage 1 DA Layout including;
    - Revised lot, building envelope and internal road layout under the Concept Proposal and Stage 1 DA,
    - Addition of a 5,800sqm amenity lot;
    - Amended subdivision layout;
    - An increase of the total developable area for the estate from 70.28ha to 71.33ha;
    - Amended bulk earthworks, estate infrastructure and landscaping works;
    - Amended creek re-alignment works;
    - Construction of extended noise walls; and
    - Removal of all warehouse building construction in precincts 3,4 and 5 from the Stage 1 DA.
- **MOD 2 – Withdrawn.** This (then) section 96(1) modification application was sought to amend Condition D16(e) of SSD 6917 to require Fire and Rescue NSW endorsement and approval by the Secretary prior to commencement of on-lot building works in Precinct 1, 4 or 5, rather than the Stage 1 Construction Certificate.
- **MOD 3 – Approved.** This (then) section 96(1A) modification application was determined on 5 October 2017 and amended Condition E27 of SSD 6917 to extend the permissible Standard Construction Hours to carry out importation of fill activities during the hours of 7pm to 5am from Monday to Friday.

  The extension specifically relates to the supply and importation of fill materials from the Westconnex M4 East project to the OSE site as required to support the bulk earthworks for OSE. Capacity constraints at the Westconnex project necessitated an approval for that project to carry out exportation of fill outside of regular construction hours. The condition amendment facilitates the importation of fill to OSE for the bulk earthworks.

- **MOD 4 – Approved.** This (then) section 96(1A) modification application was determined on 18 December 2017 and amended the layouts and areas of Precincts 1 and 2, altered the layout of the estate road network to reflect changes to Precincts 1 and 2, included the addition of estate road between Precinct 1 and 2 and modifications to the built form within Precinct 1.
- **MOD 5 – Approved.** This (then) section 96(1) modification application was determined on 23 November 2017 and amended Condition E37 of SSD 6917 to remove a contradiction in the wording of the consent.
- **MOD 6 – Approved.** This (then) section 96(1A) modification was determined on 15 June 2018 and updated the Vegetation Management Plan (VMP) and Biodiversity Offset Strategy (BOS), in addition to updating conditions E46 and E47 concerning ecosystem credits and the VMP.
- **MOD 7 – Approved.** This s4.55(1A) modification was determined on 11 December 2018 and sought to amend the approved concept plan for SSD 6917 to replace the landscaped corner of Lot 3A with hardstand (on land that has recently been rezoned from E2 to IN1).
- **MOD 8 – Approved.** This s4.55(1A) was determined on 12 December 2018 and sought to increase the maximum height limit for a warehouse within Precinct 5 from 15m to 16.5m to accommodate roof plant.
- **MOD 9 – Approved.** This s4.55(1A) was determined on 21 February 2019 and sought to make amendments to the built form and layout of structures within Precinct 6.

2.4. RATIONALE FOR THE PROPOSED MODIFICATION (MOD 10)

The approved OSE development comprises a regional warehouse and distribution hub that will ultimately operate as part of an integrated and synergistic network of custom designed, state of the art facilities incorporating all of the Oakdale Estate lands within the Western Sydney Employment Area (WSEA).

The approved development includes a Concept Proposal to guide the staged development of the entire estate as well as a Stage 1 development comprising earthworks, construction of roads and infrastructure and the construction, fit out and use of buildings within Precinct 1. Development approval for all other warehouses outside of Precinct 1 are subject to subsequent DA approval.

The approved OSE development was designed to accommodate generic warehousing and distribution facilities, without knowledge of the specific needs of individual operators that may ultimately occupy the site. The minor amendment will seek to enable Dangerous Goods (DG) storage within the approved building footprint. There is no change to the approved built form.

Consultation was undertaken with officers from the DP&E who confirmed that no Secretary's Environmental Assessment Requirements (SEARs) were required to inform this modification request. It was further confirmed that in support of the request, a Preliminary Hazard Analysis was required which must:

- Estimate the risks from the facility and demonstrate that the facility can comply with Hazardous Industry Planning Advisory Paper No. 4, 'Risk Criteria for Land Use Safety Planning', and
- Be set in context of existing risk profiles for the Oakdale Central and Oakdale South areas and demonstrate that the facility will not increase the cumulative impacts or risks of the areas to unacceptable levels.

A Preliminary Hazard Analysis detailing the above is included at **Appendix A**.

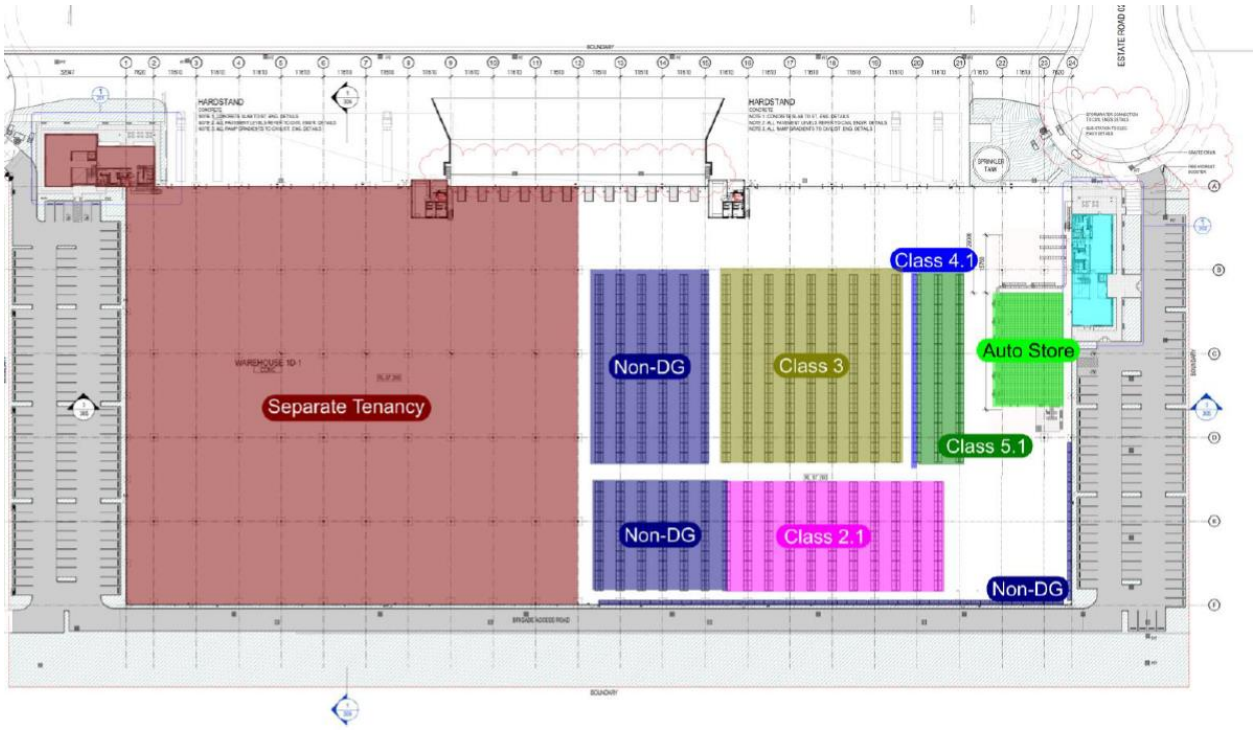
3. DESCRIPTION OF PROPOSED MODIFICATIONS

3.1. MODIFICATIONS TO THE APPROVAL

The proposed modification to the approval seeks to amend SSD 6917 to enable storage of dangerous goods within Warehouse 1D. No change is proposed to the approved architectural plans, only to the internal racking layout shown within Warehouse 1D, which is not sought for approval under this application.

The proposed internal layout as shown in the Preliminary Hazard Analysis is depicted in **Figure 4** below:

Figure 4 – Building 1D internal layout



Source: RiskCon Engineering

As shown in **Figure 4** the proposal seeks to enable storage of Dangerous Goods (DGs) within Warehouse1D. The quantities of storage as prescribed in the Preliminary Hazard Analysis are detailed below:

Table 2 – Dangerous Goods Stored Onsite

Area	Class	Packing Group	Quantity (L or kg)
General Warehouse	2.1 (aerosols)	N/A	556,554 L / 139,139 kg*
	3	II & III	494,678 L
	4.1	II & III	7,051
	5.1	III	58,724
	2.1 (aerosols)	N/A	~290* kg
Autostore	3	II & III	16,750 L
	4	II & III	70 L

Area	Class	Packing Group	Quantity (L or kg)
	8	II & III	5 L
	5.1	II & III	450 L
	9	III	72 L

**Assuming a density of 1,000 kg/m3 and 25% of the aerosol product is propellant (LPG)*

3.1.1. Preliminary Hazards Assessment

A review of the application guide to *State Environmental Planning Policy No. 33* (SEPP33, Ref. [1]) indicates the facility would exceed the threshold criteria for the storage of DGs resulting in a classification for the site as potentially hazardous. To demonstrate that the proposed storage arrangements will not exceed the threshold criteria, it is necessary to prepare a Preliminary Hazard Analysis (PHA) for the site in support of the Development Application (DA).

A Preliminary Hazard Analysis has been prepared by RiskCon Engineering and is included at **Appendix A**. Recommendations have been made within the report in relation to design of the facility and will be incorporated into the detailed design stage of the proposal, which include the following:

- Maximum quantity of certain materials to be stored in one area.
- Location and quantity of spill kits to be located around the site.
- Drainage design in relation to potential spills on site.

Based on the analysis conducted within the PHA report, it is concluded that, subject to operating the facility in accordance with the recommendations, the risks at the site boundary are not considered to exceed the acceptable risk criteria. Accordingly, the facility would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

3.1.2. Fire Safety Strategy

A Fire Engineering Report has been prepared by Core Engineering Group and attached at **Appendix B**. The report nominates proposed alternative solutions for assessing compliance with the nominated Performance Requirements of the Building Code of Australia 2015 (BCA) in accordance with the methodologies defined in the International Fire Engineering Guideline (IFEG). Importantly, the report outlines a number of preventive and protective measures in relation to building specific fire and smoke control measures, along with detection, warning and suppression systems such as:

- Provide both manual and automatic smoke clearance systems within Warehouse 1D.
- Limit impact of fire spread by utilising Type C construction and providing caged enclosure for aerosol storage.
- Provide sprinkler systems throughout the building.
- Provide emergency lighting and exit signage to assist with evacuation.
- Provide fire hydrants, automatic link to fire brigade, vehicular perimeter access and control equipment to assist the fire brigade.

The report concludes that, subject to adoption of the fire safety measures recommended, the development will be able to operate safely.

3.1.3. Building Code of Australia (BCA)

Full details of the Building Code of Australia (BCA) assessment can be found in the BCA Assessment Report prepared by Blackett Maguire Goldsmith provided at **Appendix C**.

The report includes a preliminary review of the proposed development against the deemed-to-satisfy (DTS) provisions of the Building Code of Australia 2016 (BCA) pursuant to the provisions of clause 145 of the *Environmental Planning & Assessment Regulation 2000* and clause 18 of the Building Professionals Regulation 2007.

The aim of the BCA report is to:

- Undertake an assessment of the proposed warehouse facility against the Deemed-to-Satisfy (DtS) Provisions of the BCA 2016 Amendment 1 to identify the key issues that are relevant to the project.
- Identify any BCA compliance issues that require resolution/attention for the proposed development at the CC Application stage.

The BCA report concludes that compliance with the relevant DTS provisions and Performance Requirements identified are readily achievable. Where compliance matters are proposed to comply with the Performance Requirements (rather than DtS Provisions), the development of an Alternative Solution Report will be required prior to the issue of the Construction Certificate.

The BCA report concludes that the following fire safety measures (refer to Figure 5) are required the proposal.

Figure 5 – Fire Safety Measures

Statutory Fire Safety Measure	Design / Installation Standard
Alarm Signaling Equipment	AS 1670.3 – 2004
Automatic Fire Suppression Systems**	BCA Spec. E1.5 & AS 2118.1 – 1999 or AS 2118.1 – 2017
Building Occupant Warning System activated by the Sprinkler System	BCA Spec. E1.5, Clause 8 and / or Clause 3.22 of AS 1670.1 – 2015
Emergency Lighting	BCA Clause E4.4 & AS 2293.1 – 2005
Exit Signs	BCA Clauses E4.5, E4.6 & E4.8; and AS 2293.1 – 2005
Fire Control Centre	BCA Spec E1.8
Fire Doors	BCA Clause C2.12, C2.13 and AS 1905.1 – 2015 and manufacturer's specification
Fire Hose Reels	BCA Clause E1.4 & AS 2441 – 2005
Fire Hydrant Systems**	BCA Clause E1.3 & AS 2419.1 – 2005
Fire Seals	BCA Clause C3.15, AS 1530.4 – 2014 & AS 4072.1 – 2005 and manufacturer's specification
Lightweight Construction	BCA Clause C1.8 & AS 1530.3 – 1999 and manufacturer's specification
Paths of Travel	EP&A Regulation Clause 186
Perimeter Vehicular Access**	BCA Clause C2.4
Portable Fire Extinguishers	BCA Clause E1.6 & AS 2444 – 2001
Required Exit Doors (power operated)	BCA Clause D2.19(b)
Smoke Hazard Management Systems**	BCA Part E2 & AS/NZS 1668.1 –2015
Warning & Operational Signs	Section 183 of the EP&A Regulation 2000, AS 1905.1 – 2015, BCA Clause C3.6, D3.6 & E3.3

** Indicates fire safety measures that may be affected by Performance Solutions and the proposed Dangerous Goods Storgae.

Source: Blackett Maguire + Goldsmith

3.2. PROPOSED MODIFICATIONS TO THE CONDITIONS OF APPROVAL

The proposed amendments to the Concept and Stage 1 approval necessitate certain changes to the conditions of the SSD 6917 consent. For ease of reference, all amendments required are shown in red text.

The Development Consent is proposed to be modified as follows.

Table 3 – Modified Condition

No.	Condition
E53.	**HAZARDS AND RISK** **Dangerous Goods** *The storage of Dangerous Goods shall not exceed the thresholds outlined in the Hazardous and Offensive Development Application Guidelines: Applying SEPP33, except for Building 1D located in Precinct 1. Dangerous Goods on this site are to be stored, handled and managed in accordance with the recommendations contained within the reports titled:* • *Preliminary Hazard Analysis by RiskCon Engineering (revision A dated 16 April 2019)* • *Fire Safety Strategy by Core Engineering Group (revision 908 dated 02/05/19)* • *BCA Report by Blackett Maguire + Goldsmith (revision 1 dated 09.05.19)*

4. SECTION 4.55 (1A) OF THE EP&A ACT 1979

Section 4.55 of the EP&A Act provides a mechanism for the modification of development consents. This section of the Act sets out the statutory requirements and heads of consideration for the assessment of modification applications, depending on whether the application is made under section 4.55(1A), 4.55(1) or 4.55(2).

As is relevant to this application, pursuant to section 4.55(1A), a consent authority may, subject to and in accordance with the Regulations, modify a development consent if:

> *(a) it is satisfied that the proposed modification is of minimal environmental impact, and*
>
> *(b) it is satisfied that the development to which the consent as modified relates is substantially the same development as the development for which the consent was originally granted and before that consent as originally granted was modified (if at all), and*
>
> *(c) it has notified the application in accordance with:*
>
> > *(i) the regulations, if the regulations so require, or*
> >
> > *(ii) a development control plan, if the consent authority is a council that has made a development control plan that requires the notification or advertising of applications for modification of a development consent, and*
>
> *(d) it has considered any submissions made concerning the proposed modification within any period prescribed by the regulations or provided by the development control plan, as the case may be.*
>
> *Subsections (1), (2) and (5) do not apply to such a modification.*

4.1. MINIMAL ENVIRONMENTAL IMPACT

The proposed modification is to enable the storage of Dangerous Goods within Warehouse 1D in Precinct 1 only. No external built form changes are proposed. As such the proposal will not alter the context, scale, built form or amenity of the approved development. As demonstrated by the accompanying Preliminary Hazard Assessment, the Dangerous Goods will be stored and contained in a manner such that they will not exceed the threshold criteria stipulated by SEPP 33.

SSDA 6917 as proposed to be modified by MOD 10 will therefore not create any material impacts to operation of the site or amenity of adjoining operators. It is therefore considered to be of minimal environmental impact.

4.2. SUBSTANTIALLY THE SAME DEVELOPMENT

From a quantitative and qualitative perspective, the proposed modifications will not substantially alter the approved development for the following reasons:

- The proposal will retain the same use of the OSE as a warehouse and distribution hub, consistent with the aims of the WSEA SEPP;
- The changes to the estate layout and built form remain unchanged;
- There is no change to the overall developable area of 70.89ha;
- The only change to the development is that the facility will now store Dangerous Goods (DGs) including flammable gases and liquids.
- The level of environmental impact resulting from this section 4.55(1A) modification application (MOD 10) is minimal and consistent with that originally approved for Precinct 1 by way of SSD 6917.

5. STATUTORY PLANNING FRAMEWORK

This section assesses and responds to the relevant legislative and policy frameworks in accordance with the EP&A Act, Regulations and the SEARs applicable to the project. The following environmental planning instruments, policies and guidelines have been considered in the assessment of this modification proposal:

- *Environmental Planning and Assessment Act 1979;*
- *State Environmental Planning Policy (State and Regional Development) 2011;*
- *State Environmental Planning Policy (Western Sydney Employment Area) 2009;*
- *State Environmental Planning Policy (Infrastructure) 2007;*
- *State Environmental Planning Policy No.33 (Hazardous and Offensive Development); and*
- *State Environmental Planning Policy No.55 (Remediation of Land).*

5.1. ASSESSMENT OF ENVIRONMENTAL PLANNING INSTRUMENTS

The proposed modifications to the approval of SSD6917 are such that it is considered there will be no material alteration to the level of compliance achieved with the above Environmental Planning Instruments (EPI), as explained below.

Table 4 – Statement of Consistency with Environmental Impacts

Schedule/Clause	Provision	Consistency
SEPP (State and Regional Development)		
Schedule 1	Schedule 1, Group 12 of the SRD SEPP identifies development for the purposes of 'warehouses or distribution centres' to be SSD if it: *'has a capital investment value of more than **$50 million for the purpose of warehouse or distribution centres** (including container storage facilities) at one location and related to the same operation.'* The works comprising Stage 1 of the SSDA for the OSE (incorporating infrastructure and building works) will have a value of approximately $398,534,000 million.	The proposed modification to the approval of SSD6917 will remain consistent with this SEPP and is appropriately characterised as SSD.
SEPP (Western Sydney Employment Area) 2009		
Clause 3 – Aims	Aims to protect and enhance the land to which the Policy applies (the Western Sydney Employment Area) for employment purposes.	The proposal continues to seek consent for employment uses consistent with the overarching aim of the WSEA SEPP.
Clause 10 – Land Use Zoning	The OSE is zoned IN1 – General Industry and E2 – Environmental Conservation pursuant to this clause.	All uses are consistent with the appropriate zone.

Clause 18 – Development Control Plans	Requires that a DCP be in place before consent can be granted for development within the WSEA	A site specific DCP was approved by way of SSD 6917. No changes are proposed to these development controls.
Clause 20 – Ecologically Sustainable Development	The consent authority must not grant consent to development on land to which this Policy applies unless it is satisfied that the development contains measures designed to minimise: The consumption of potable water, and Greenhouse gas emissions.	No changes are proposed to the ESD measures approved by way of SSD 6917.
Clause 21 – Height of Buildings	The consent authority must not grant consent to development on land to which this Policy applies unless it is satisfied that: Building heights will not adversely impact on the amenity of adjacent residential areas, and Site topography has been taken into consideration.	No changes are proposed to the maximum height of buildings.
Clause 22 – Rainwater Harvesting	The consent authority must not grant consent to development on land to which this Policy applies unless it is satisfied that adequate arrangements will be made to connect the roof areas of buildings to such rainwater harvesting scheme (if any) as approved by the Director-General.	No changes are proposed to the provisions for rainwater harvesting.
Clause 23 – Development Adjoining Residential Land	This clause applies to any land to which this Policy applies that is within 250 metres of land zoned primarily for residential purposes.	No changes are proposed to the building envelopes.
Clause 24 – Development Involving Subdivision	The consent authority must not grant consent to the carrying out of development involving the subdivision of land unless it has considered the following: The implications of the fragmentation of large lots of land, Whether the subdivision will affect the supply of land for employment purposes, Whether the subdivision will preclude other lots of land to which this Policy applies from having reasonable access to roads and services.	The proposed modification to SSD6917 does not include any changes to the approved subdivision boundaries.
Clause 25 – Public Utility Infrastructure	The consent authority must not grant consent to development on land to which this Policy applies unless it is satisfied that any public utility	Provision of public utility infrastructure will be maintained. These services

	infrastructure that is essential for the proposed development is available or that adequate arrangements have been made to make that infrastructure available when required.	will continue to be provided within the Estate in a manner consistent with that originally approved.
Clause 26 – Proposed Transport Infrastructure Routes	The consent authority must, before determining any such development application, consider any comments made by the Director-General as to the compatibility of the development to which the application relates with the proposed transport infrastructure route concerned.	No changes are proposed to the provision of transport infrastructure routes as part of this modification application.
Clause 29 – Industrial Release Area	Despite any provision of this Policy, the consent authority must not grant consent to development on land to which this clause applies unless the Director-General has certified in writing to the consent authority that satisfactory arrangements have been made to contribute to the provision of regional transport infrastructure and services (including the Erskine Park Link Road Network) in relation to which this Policy applies.	A current VPA arrangement is in place for Oakdale South Estate and sets out the required SIC contributions.
Clause 31 – Design Principles	In determining a development application that relates to land to which this Policy applies, the consent authority must take into consideration whether or not: The development is of a high quality design, and A variety of materials and external finishes for the external facades are incorporated, and High quality landscaping is provided, and The scale and character of the development is compatible with other employment-generating development in the precinct concerned.	The adopted site specific DCP is not being modified. A high-quality landscape will be provided to reflect the modified Estate layout, to a quality consistent with the original approval.
State Environmental Planning Policy (Infrastructure) 2007		
Schedule 3 – Traffic Generating Developments to be referred to the RMS	The *Infrastructure SEPP* aims to facilitate the effective delivery of infrastructure across the State by providing a consistent planning regime for infrastructure and the provision of services. The SEPP deals with traffic generating development and requires referral and concurrence of the NSW RMS for certain development which is expected to generate significant traffic.	The SSD as modified by MOD 10 will maintain the approved warehousing GFA. The project was referred to the RMS as part of the SSDA process. Subsequent referral may occur as part of this modification application.

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development		
Part 3 – Potentially hazardous or potentially offensive development	*SEPP 33* requires the consent authority to consider whether an industrial proposal is a potentially hazardous or a potentially offensive industry. In doing so, the consent authority must give careful consideration to the specific characteristics and circumstances of the development, its location and the way in which the proposed activity is to be carried out. Any application to carry out potentially hazardous development must be supported by a preliminary hazard analysis (PHA)	The proposed modification does slightly increase the amount of hazardous materials that will be stored in the approved building. To demonstrate the facility is not hazardous, a Preliminary Hazard Analysis has been prepared for the site. The PHA confirms that, subject to adherence with the recommendations of the report in respect to material quantities and storage/transport arrangements, the resulting development does not create an unacceptable hazard to surrounding life or property and is therefore acceptable for the site. A further review of this report has been included in **Section 6.6.1** below.
State Environmental Planning Policy No. 55 (Remediation of Land)		
Clause 7- Contamination and remediation to be considered in determining development application	*SEPP 55* seeks to provide a State-wide planning approach to the remediation of contaminated land. Clause 7(1)(a) of the SEPP requires that the consent authority, when assessing a development application, consider whether the land is contaminated and whether it is suitable for the proposed use. It also requires that consent authority review a report specifying the findings of a preliminary contamination investigation of the land concerned when considering an application which involves a change of use of the land.	The original ESA findings apply consistently to the proposed modifications. The proposed development does not result in a change of use to the land from that approved under SSDA 6917. Potential contamination and its management has been considered and documented in the original EIS and SSDA. There will be no change to the location of development pads as approved – as a result there is no change to the contamination status of the soils since completion of the ESA submitted with the original SSDA.

6. SECTION 4.15 ASSESSMENT

This section assesses the development as proposed to be modified by MOD 10 against the heads of Section 4.15(1) of the Act.

6.1. ENVIRONMENTAL PLANNING INSTRUMENTS

The proposed modification has been assessed against all relevant environmental planning instruments as detailed at **Section 5.**

6.2. DRAFT ENVIRONMENTAL PLANNING INSTRUMENTS

There are no relevant draft environmental planning instruments.

6.3. DEVELOPMENT CONTROL PLANS

Development Control Plans are not applicable to this SSD DA. The proposal has been assessed against the site-specific development controls contained within SSD 6917 and is consistent with these provisions.

6.4. PLANNING AGREEMENT

Planning agreements are in place for the Oakdale South Estate and will not be affected by the proposed modification.

6.5. THE EP&A REGULATION 2000

All relevant regulations have been considered in the preparation of this modification application.

6.6. LIKELY IMPACTS OF THE DEVELOPMENT

6.6.1. Dangerous Goods

The environmental impact resulting from the introduction of the storage of dangerous goods at the site increases the potential risk to life and property on the surrounding sites. Accordingly, a Preliminary Hazard Analysis (PHA) has been prepared in support of this request. The PHA involves identifying potential hazards that may be present at the site based on its operation or storage of materials and compiling them into a hazard identification table. Based on the identified hazards, scenarios were hypothesised to assess their potential for offsite impacts. Any scenarios that did impact offsite were then progressed to a consequence analysis.

For this site, the consequence analysis showed that there was only one scenario that would impact the site boundary and adjacent land use. This was referred to as the ‘full warehouse fire’ scenario. This incident was carried forward for frequency analysis and risk assessment and concluded that the probability of a fatality from a full warehouse fire at the site boundary is within the acceptable risk criteria as published by New South Wales Department of Planning and Environment titled *Hazardous Industry Planning Advisory Paper No 4*.

In addition, the distance to the closest buildings is 23 m which would allow attenuation of radiant heat from luminous spots and would not result in sustained radiant heat such that spread to adjacent facilities would occur.

Review of the estate proposal indicates this development is the only one of its kind contributing to the risk profile, hence, cumulative risk was not considered in the report.

The PHA report confirmed that based on the analysis conducted, it is concluded that the risks at the site boundary are not considered to exceed the acceptable risk criteria; hence, the facility would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

In addition, the following recommendations were made:

- The site shall be designed to contain any spills or contaminated water from a fire incident within the boundaries of the site.
- Multiple spill kits be provided around the DG storage areas to ensure spills can be cleaned up immediately following identification.
- Aerosols shall be stored in a dedicated storage area which prevents rocketing cans from escalating the incident (i.e. storage in an aerosol cage, separate storage area, or in palletised aerosol cages).
- The warehouse and/or site boundaries shall be capable of containing 612 m3 which may be contained within the warehouse footprint, site stormwater pipework and any recessed docks or other containment areas that may be present as part of the site design.
- The civil engineers designing the site containment shall demonstrate the design is capable of containing at least 612 m3.
- 6A storm water isolation point (i.e. penstock isolation valve) shall be incorporated into the design. The penstock shall automatically isolate the storm water system upon detection of a fire (smoke or sprinkler activation) to prevent potentially contaminated liquids from entering the water course.

6.7. SUITABILITY OF THE SITE

As demonstrated within this report and the original EIS prepared by Urban Advisory Services in respect to the approved SSD 6917, the proposed development as modified is expected to provide positive employment impacts both locally and in the broader economy. It is envisaged that the proposal will provide between 1,500 and 2,000 jobs.

The site is located within the Western Sydney Employment Area and aligns with the desired future land use outcomes for this area, particularly in promoting economic development for major warehousing and distribution uses in an industrial setting with access to the road network connecting to the broader metropolitan area.

Modifications the subject of this request do not alter the site suitability.

6.8. SUBMISSIONS

Any submission received as part of the public notification period must be considered in accordance with the Section 4.15(1)(d) of the EP&A Act. If submissions are made, the Proponent would respond to them as required by the Department.

6.9. PUBLIC INTEREST

The proposal has been assessed against the current planning framework for the site and is consistent with the objectives of the Western Sydney Employment Area. The assessment has demonstrated that no significant adverse impacts will result to the surrounding area. The proposal is in the public interest.

7. CONCLUSION

This section 4.55(1A) application seeks consent for modifications to the Concept Plan approved in SSDA 6917 as previously modified for the Staged Development of the Oakdale South Estate. The proposal continues to support the delivery of the estate and essential infrastructure and services.

These key issues relevant to the proposed modifications have been assessed within the Modification Report and amended specialist sub-consultant reports submitted with this application.

The proposed modification to the approved Concept Proposal and Stage 1 Development of the OSE has been considered and assessed in accordance with the requirements of the *EP&A Act 1979*. The Modification Report has assessed the relevant matters prescribed under this Act and its Regulation, and those matters identified in the SEARs for the proposal.

The modifications align with the strategic direction and objectives established for the site and surrounding lands under the WSEA SEPP. The modification has been assessed as being of minimal environmental impact and substantially the same as the original approved SSDA as required under section 4.55(1A) of the *EP&A Act 1979*.

Based upon a balanced review of key issues and in consideration of the benefits and residual impacts of the proposal, the staged development of the OSE as proposed under the approved SSDA and this modification, is considered justified and warrants approval subject to the implementation of the management and mitigation measures described in this report and attached supporting documents.

APPENDIX A PRELIMINARY HAZARD ANALYSIS

RiskCon Engineering

Preliminary Hazard Analysis

Oakdale South 1D, Kemps Creek

Linfox Australia Pty Ltd
Document No. RCE-19027_Linfox_PHA_Final_20May19_Rev(0)
Date 20/05/2019

Preliminary Hazard Analysis

Oakdale South 1D, Kemps Creek

Linfox Australia Pty Ltd

Prepared by

RiskCon Engineering Pty Ltd
Unit 19/5 Pyrmont Bridge Road
Camperdown, NSW 2050
www.riskcon-eng.com
ABN 74 626 753 820

RiskCon Engineering

Quality Management

Rev	Date	Remarks	Prepared By	Reviewed By
A	16 April 2019	Draft issue for comment	Renton Parker	Steve Sylvester
0	20 May 2019	Issued Final		

Executive Summary

Background

Linfox proposes to develop a new warehouse within the Oakdale Industrial Estate to be located at Oakdale South 1D in Kemps Creek, NSW. The project will comprise a warehouse with hardstand and awnings, including the provision for offices and other ancillary areas. The facility will store Dangerous Goods (DGs); including flammable gases and liquids.

A review of the application guide to State Environmental Planning Policy No. 33 (SEPP33, Ref.) indicates the facility would exceed the threshold criteria for the storage of DGs resulting in a classification for the site of potentially hazardous. To demonstrate that the facility is not in fact hazardous, it is necessary to prepare a Preliminary Hazard Analysis (PHA) for the site in support of the Development Application (DA).

Linfox has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a PHA for the facility. This document represents the PHA study for the Linfox warehouse at Kemps Creek.

Conclusions

A hazard identification table was developed for warehouse facility to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with a potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment. Scenarios not eliminated were then carried forward for consequence analysis.

Incidents carried forward for consequence analysis were assessed in detail to estimate the impact distances. Impact distances were developed into scenario contours and overlaid onto the site layout diagram to determine if an offsite impact would occur. The consequence analysis showed that one of the scenarios (full warehouse fire) would impact over the site boundary and into the adjacent land use; hence, this incident was carried forward for frequency analysis and risk assessment.

The frequency analysis and risk assessment showed that the full warehouse fire would have a fatality risk of 7.06 chances per million per year (pmpy) at the site boundary, with lesser risk at further distances from the boundary. HIPAP No. 4 (Ref. [1]) publishes acceptable risk criteria at the site boundary of 50 pmpy (for industrial sites). Therefore, the probability of a fatality from a full warehouse fire at the site boundary is within the acceptable risk criteria.

In addition, the only incident which may result in impacts to adjacent structures was a full warehouse fire. Due to the fire size there will be considerable smoke emitted which would obscure the flame surface reducing the average surface emissive power (SEP) and subsequently it would not exceed 23 kW/m^2. In addition, the distance to the closest buildings is 23 m which would allow attenuation of radiant heat from of luminous spots and would not result in sustained radiant heat such that propagation to adjacent facilities would occur.

Review of the estate proposal indicates this development is the only contributor to the risk profile; hence, cumulative risk is not a consideration at this stage. The cumulative risk at the site is therefore the reported 7.06 chances pmpy which is below the 50 chances pmpy limit. Therefore, the development of the Linfox warehouse does not increase the cumulative risk of the estate to an unacceptable level.

Based on the analysis conducted, it is concluded that the risks at the site boundary are not considered to exceed the acceptable risk criteria; hence, the facility would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

Recommendations

Notwithstanding the conclusions following the analysis of the facility, the following recommendations have been made:

1. The site shall be designed to contain any spills or contaminated water from a fire incident within the boundaries of the site.
2. Multiple spill kits be provided around the DG storage areas to ensure spills can be cleaned up immediately following identification.
3. Aerosols shall be stored in a dedicated storage area which prevents rocketing cans from escalating the incident (i.e. storage in an aerosol cage, separate storage area, or in palletised aerosol cages).
4. The warehouse and/or site boundaries shall be capable of containing 612 m^3 which may be contained within the warehouse footprint, site stormwater pipework and any recessed docks or other containment areas that may be present as part of the site design.
5. The civil engineers designing the site containment shall demonstrate the design is capable of containing at least 612 m^3.
6. A storm water isolation point (i.e. penstock isolation valve) shall be incorporated into the design. The penstock shall automatically isolate the storm water system upon detection of a fire (smoke or sprinkler activation) to prevent potentially contaminated liquids from entering the water course.

RiskCon Engineering

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Abbreviations

Abbreviation	Description
ADG	Australian Dangerous Goods Code
AS	Australian Standard
CBD	Central Business District
CCPS	Centre for Chemical Process Safety
DA	Development Application
DGs	Dangerous Goods
DGS	Dangerous Goods Store
DPE	Department of Planning and Environment
FRNSW	Fire and Rescue New South Wales
HIPAP	Hazardous Industry Planning Advisory Paper
HSE	Health and Safety Executive
LPG	Liquefied Petroleum Gas
PFD	Probability of Failure on Demand
PHA	Preliminary Hazard Analysis
Pmpy	Per million per year
RDC	Retail Distribution Centre
SEP	Surface Emissive Power
SEPP	State Environmental Planning Policy
SMSS	Storage Mode Sprinkler System
SSC	Spread Sheet Calculator
VF	View Factor

1.0 Introduction

1.1 Background

Linfox proposes to develop a new warehouse within the Oakdale Industrial Estate to be located at Oakdale South 1D in Kemps Creek, NSW. The project will comprise a warehouse with hardstand and awnings, including the provision for offices and other ancillary areas. The facility will store Dangerous Goods (DGs); including flammable gases and liquids.

A review of the application guide to State Environmental Planning Policy No. 33 (SEPP33, Ref. [1]) indicates the facility would exceed the threshold criteria for the storage of DGs resulting in a classification for the site of potentially hazardous. To demonstrate that the facility is not in fact hazardous, it is necessary to prepare a Preliminary Hazard Analysis (PHA) for the site in support of the Development Application (DA).

Linfox has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a PHA for the facility. This document represents the PHA study for the Linfox warehouse at Kemps Creek.

1.2 Objectives

The objectives of the PHA project, for the proposed Linfox facility at Oakdale South 1D, Kemps Creek, NSW, include:

- Complete the PHA according to the Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 – Hazard Analysis (Ref. [3]);
- Assess the PHA results using the criteria in HIPAP No. 4 – Risk Criteria for Land Use Planning (Ref. [1]); and
- Demonstrate compliance of the site with the relevant codes, standards and regulations (i.e. NSW Planning and Assessment Regulation 1979, WHS Regulation, 2011 Ref. [4]).

1.3 Scope of Services

The scope of work is to complete a PHA study for the Linfox Warehouse located at Oakdale South 1D, Kemps Creek, required by the Planning Regulations for the proposed development. The scope does not include any other assessments at the site or any other Linfox facilities.

2.0 Methodology

2.1 Multi-Level Risk Assessment

The Multi-Level Risk Assessment approach (Ref. [3]), although published by the NSW Department of Planning and Environment, has been used as the basis for the study to determine the level of risk assessment required. The approach considered the development in context of its location, the quantity and type (i.e. hazardous nature) Dangerous Goods stored and used, and the facility's technical and safety management control. The Multi-Level Risk Assessment Guidelines are intended to assist industry, consultants and the consent authorities to carry out and evaluate risk assessments at an appropriate level for the facility being studied.

There are three levels of risk assessment set out in Multi-Level Risk Assessment which may be appropriate for a PHA, as detailed in **Table 2-1**.

Table 2-1: Level of Assessment PHA

Level	Type of Analysis	Appropriate If:
1	Qualitative	No major off-site consequences and societal risk is negligible
2	Partially Quantitative	Off-site consequences but with low frequency of occurrence
3	Quantitative	Where 1 and 2 are exceeded

The Multi-Level Risk Assessment approach is schematically presented in **Figure 2-1**.

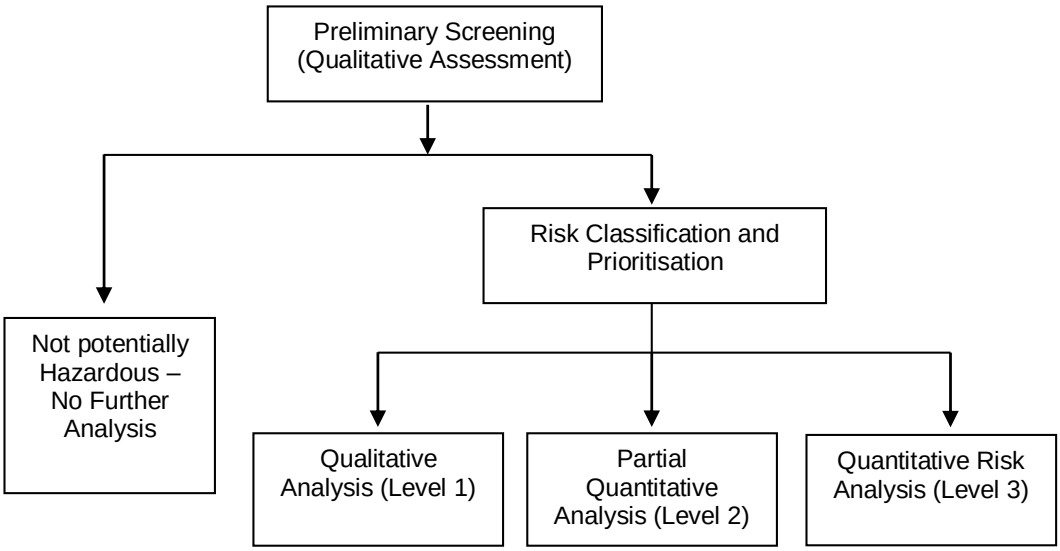

Figure 2-1: The Multi-Level Risk Assessment Approach

Based on the type of DGs to be used and handled at the proposed facility, a **Level 2 Assessment** was selected for the Site. This approach provides a qualitative assessment of those DGs of lesser quantities and hazard, and a quantitative approach for the more hazardous materials to be used on-site. This approach is commensurate with the methodologies recommended in "Applying SEPP 33's" Multi Level Risk Assessment approach (DPE, 2011).

2.2 Risk Assessment Study Approach

The methodology used for the PHA is as follows;

Hazard Analysis – A detailed hazard identification was conducted for the site facilities and operations. Where an incident was identified to have a potential off-site impact, it was included in the recorded hazard identification word diagram (**Appendix A**). The hazard identification word diagram lists incident type, causes, consequences and safeguards. This was performed using the word diagram format recommended in HIPAP No. 6 (Ref. [4]).

Each postulated hazardous incident was assessed qualitatively in light of proposed safeguards (technical and management controls). Where a potential offsite impact was identified, the incident was carried into the main report for further analysis. Where the qualitative review in the main report determined that the safeguards were adequate to control the hazard, or that the consequence would obviously have no offsite impact, no further analysis was performed. **Section 3.1** of this report provides details of values used to assist in selecting incidents required to be carried forward for further analysis.

Consequence Analysis – For those incidents qualitatively identified in the hazard analysis to have a potential offsite impact, a detailed consequence analysis was conducted. The analysis modelled the various postulated hazardous incidents and determined impact distances from the incident source. The results were compared to the consequence criteria listed in HIPAP No. 4 (Ref. [2]). The criteria selected for screening incidents is discussed in **Section 3.1**.

Where an incident was identified to result in an offsite impact, it was carried forward for frequency analysis. Where an incident was identified to not have an offsite impact, and a simple solution was evident (i.e. move the proposed equipment further away from the boundary), the solution was recommended, and no further analysis was performed.

Frequency Analysis – In the event a simple solution for managing consequence impacts was not evident, each incident identified to have potential offsite impact was subjected to a frequency analysis. The analysis considered the initiating event and probability of failure of the safeguards (both hardware and software). The results of the frequency analysis were then carried forward to the risk assessment and reduction stage for combination with the consequence analysis results.

Risk Assessment and Reduction – Where incidents were identified to impact offsite and where a consequence and frequency analysis was conducted, the consequence and frequency analysis for each incident were combined to determine the risk and then compared to the risk criteria published in HIPAP No. 4 (Ref. [2]). Where the criteria were exceeded, a review of the major risk contributors was performed, and the risks reassessed incorporating the recommended risk reduction measures. Recommendations were then made regarding risk reduction measures.

Reporting – on completion of the study, a draft report was developed for review and comment by Linfox. A final report was then developed, incorporating the comments received by Linfox, for submission to the regulatory authority.

3.0 Site Description

3.1 Site Location

The site is located at Oakdale South 1D in Kemps Creek which is approximately 44 km west of the Sydney Central Business District (CBD). **Figure 3-1** shows the regional location of the site in relation to the Sydney CBD. Provided in **Figure 3-2** is the layout of the site in Kemps Creek.

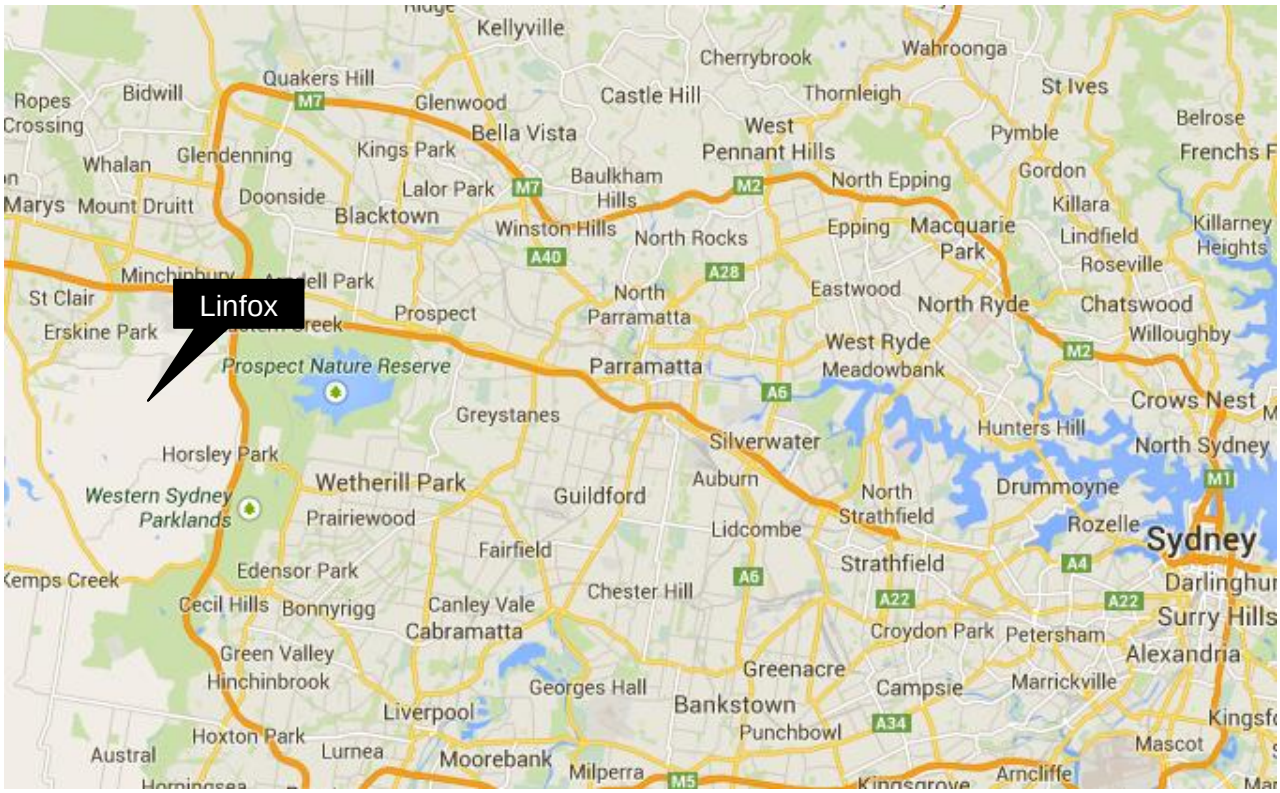

Figure 3-1: Linfox Site Location

3.2 Adjacent Land Uses

The land is located in an industrial area surrounded by the following land uses, which are adjacent to the site:

- North – Industrial warehousing
- South – Industrial warehousing
- East – Industrial warehousing
- West – Industrial warehousing

3.3 General Description

The building will consist of an office area, amenities and warehouse area including a Dangerous Goods (DG) storage area and automated packing / picking store (The Autostore). The office area will house staff and general operations, and the warehouse will be designed to contain a mixture

of general products stored in racking. DG classes and volumes are discussed in **Section 3.4**.

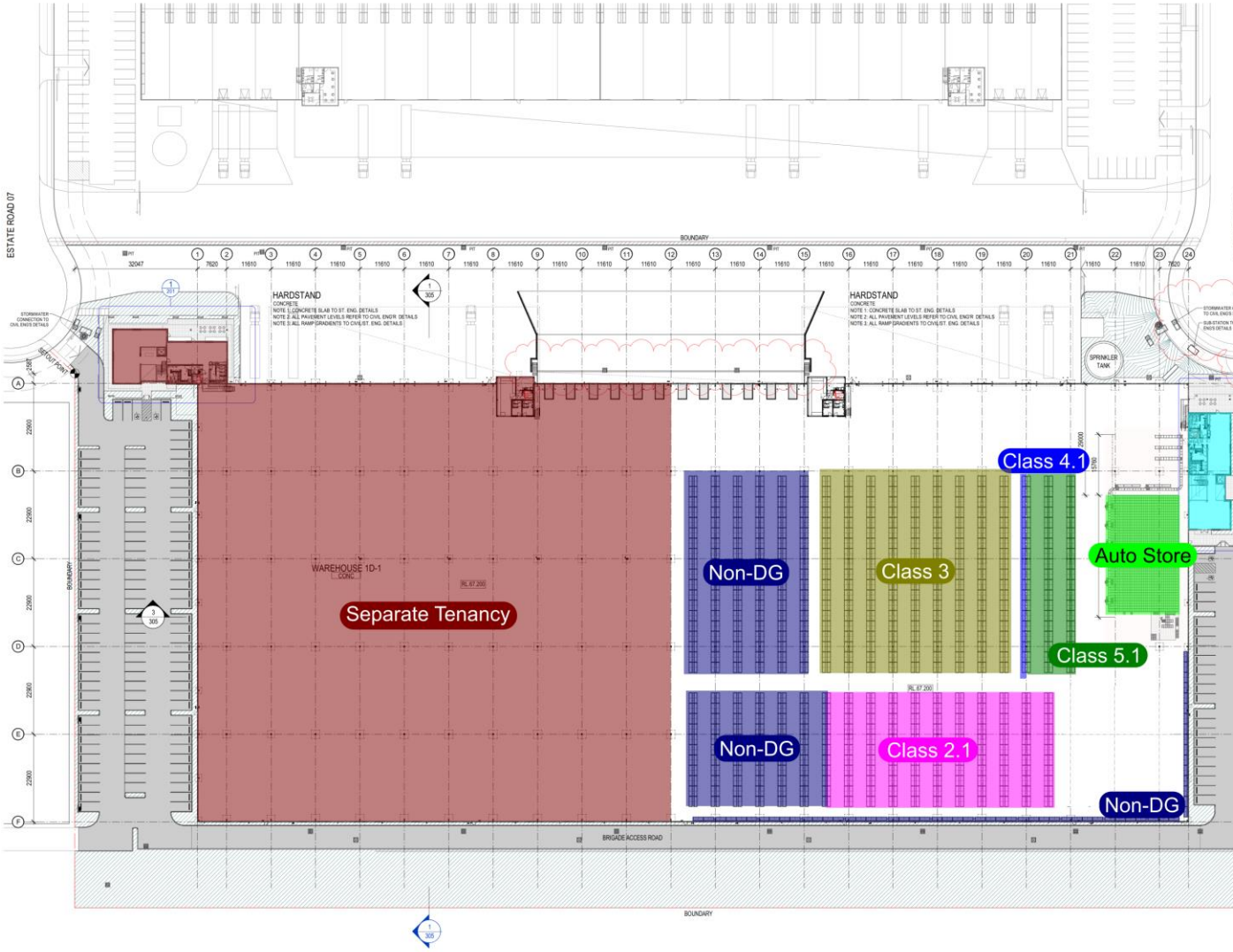

Figure 3-2 can be used to assist in understanding the description provided below.

3.4 Warehouse Detailed Description

The warehouse will have a total floor area of approximately 15,369 m^2 which will house general racking, raking dedicated to DG storage and the Autostore. The warehouse layout also includes additional space for offices, amenities, lunch rooms, etc. The DG component of the warehouse will be designed and operated in accordance with the Retail Distribution Centre (RDC) requirements of AS/NZS 3833:2007 (Ref. [5]).

DG classes will be stored in designated areas within the warehouse as shown in **Figure 3-2** with the Class 2.1 (aerosols) being stored within in a caged area to prevent rocketing of cans throughout the facility in the event of a fire which can rapidly accelerate fire spread throughout the warehouse.

All DG products will be protected by base building specified Storage Mode Sprinkler System (SMSS) sprinklers and the aerosols will be protected by in-rack sprinklers scheme A sprinkler systems designed according to FM Global Data Sheet 7-31 (Ref. [6]). All DG areas will be protected by hose reel coverage in addition to hydrant coverage.

The whole site will be capable of containing at least 90 minutes of potentially contaminated fire water as required by AS/NZS 3833:2007 (Ref. [5]) and the NSW "*Best Practice Guidelines for Contaminated Water and Retention Systems*" (Ref. [7]). The water will be contained via isolation of the stormwater system which is performed by the actuation of a penstock valve upon fire detection.

The warehouse areas will be naturally ventilated via the presence of louvres but will not have forced mechanical ventilation which is permissible under AS/NZS 3833:2007 (Ref. [5]) due to the reduced risk of spill posed by retail products. Ignition sources through the Class 2 and 3 storage areas will be controlled according to AS/NZS 60079.14:2009 of standards (Ref. [8]).

The Autostore will house a range of mixed products of goods including DG and non-DG products. The Autostore operates by storing products in purpose built totes which come in either full, half or quartered totes allowing for separation of products within the tote. The totes are full enclosed on all sides except the top which is open to air. The totes are stacked within the Autostore via robots which traverse along the top of the store rearranging the totes within the store as required.

The structure of the Autostore is essentially close compact vertical shafts which contain the totes with minimal separation between one vertical shaft and another shaft. The shafts are capable of containing up to sixteen (16) totes stacked vertically. Restriction on the packing of the Autostore are included in the programming of the robots which allows for products with low turnover to be stored at the base of a store with high frequency products stored close to the top to minimise item movements. Included within the programming is designation of DG storage locations within the Autostore to allow for adequate separation between DG products within the store. The maximum quantities that can be stored in each zone are summarised in **Table 3-1**.

While separation between the DG classes and other products has been provided, the potential for a spill within the totes and within the store is low as products are only moved in one direction at a time (i.e. vertically followed by horizontal movements) and that the totes themselves act as a bund as they are enclosed. Therefore, any spills that may occur within a tote are contained and would not impact adjacent totes. In addition, products within the totes are separated from each other further minimising the potential for cross contamination of DG with non-DG products.

3.5 Site Staffing and Operational Hours

The site will have approval for 24 / 7 operation; however, during operation the warehouse 2 site will be manned over 2 shifts of 8 hours resulting in an operational time of 16 hours a day, 6 days a week. The site will employ a total of 116 people working across the 2 shifts separated as follows:

- Distribution Centre: 40
- Office: 20

3.6 Quantities of Dangerous Goods Stored and Handled

The dangerous goods stored at the warehouse are retail products store prior to distribution to retail stores. As the individual chemical types are expected to list in the hundreds, within the warehouse, the materials have been represented as DG Classes for simplicity. A list of the classes, packing groups and expected quantities are shown in **Table 3-1**. The location of the DGs within the warehouse are shown in **Figure 3-2.**

Table 3-1: Dangerous Goods Stored at the Linfox Site

Area	Class	Packing Group	Quantity (L or kg)
General Warehouse	2.1 (aerosols)	N/A	556,554 L / 139,139 kg*
	3	II & III	494,678 L
	4.1	II & III	7,051
	5.1	III	58,724
Autostore	2.1 (aerosols)	N/A	~290* kg
	3	II & III	16,750 L
	4	II & III	70 L
	8	II & III	5 L
	5.1	II & III	450 L
	9	III	72 L

*Assuming a density of 1,000 kg/m^3 and 25% of the aerosol product is propellant (LPG)

3.7 Aggregate Quantity Ratio

Where more than one class of dangerous goods are stored and handled at the site an AQR exists. This ratio is calculated using **Equation 3-1:**

$$AQR = \frac{q_x}{Q_x} + \frac{q_y}{Q_y} + [\ldots] + \frac{q_n}{Q_n}$$ **Equation 3-1**

Where:

x,y […] and n are the dangerous goods present

q_x, q_y, […] and q_n is the total quantity of dangerous goods x, y, […] and n present.

Q_x, Q_y, […] and Q_n is the individual threshold quantity for each dangerous good of x, y, […] and n

Where the ratio AQR exceeds a value of 1, the site would be considered a Major Hazard Facility (MHF). The threshold quantities for each class is taken from Schedule 15 of the Work Health and Safety (WHS) Regulation 2017 (Ref. [9]). These are summarised in **Table 3-2** noting Class 2.2, 4.1(II & III), 5.1 (III) 8, and 9 are not subject to MHF legislation.

Table 3-2: Major Hazard Facility Thresholds

Class	Packing Group	Threshold (tonnes)	Storage (tonnes)
2.1	n/a	200	139.43
3	II & III	50,000	511.43

A review of the thresholds and the commodities and packing groups listed in **Table 3-1** indicates only Class 2.1, and 3 are assessable against the MHF thresholds. Therefore, substituting the storage masses into **Equation 3-1** the AQR is calculated as follows:

$$AQR = \frac{139.14}{200} + \frac{511.43}{50000} = 0.706$$

The AQR is less than 1; hence, the facility would not be classified as an MHF.

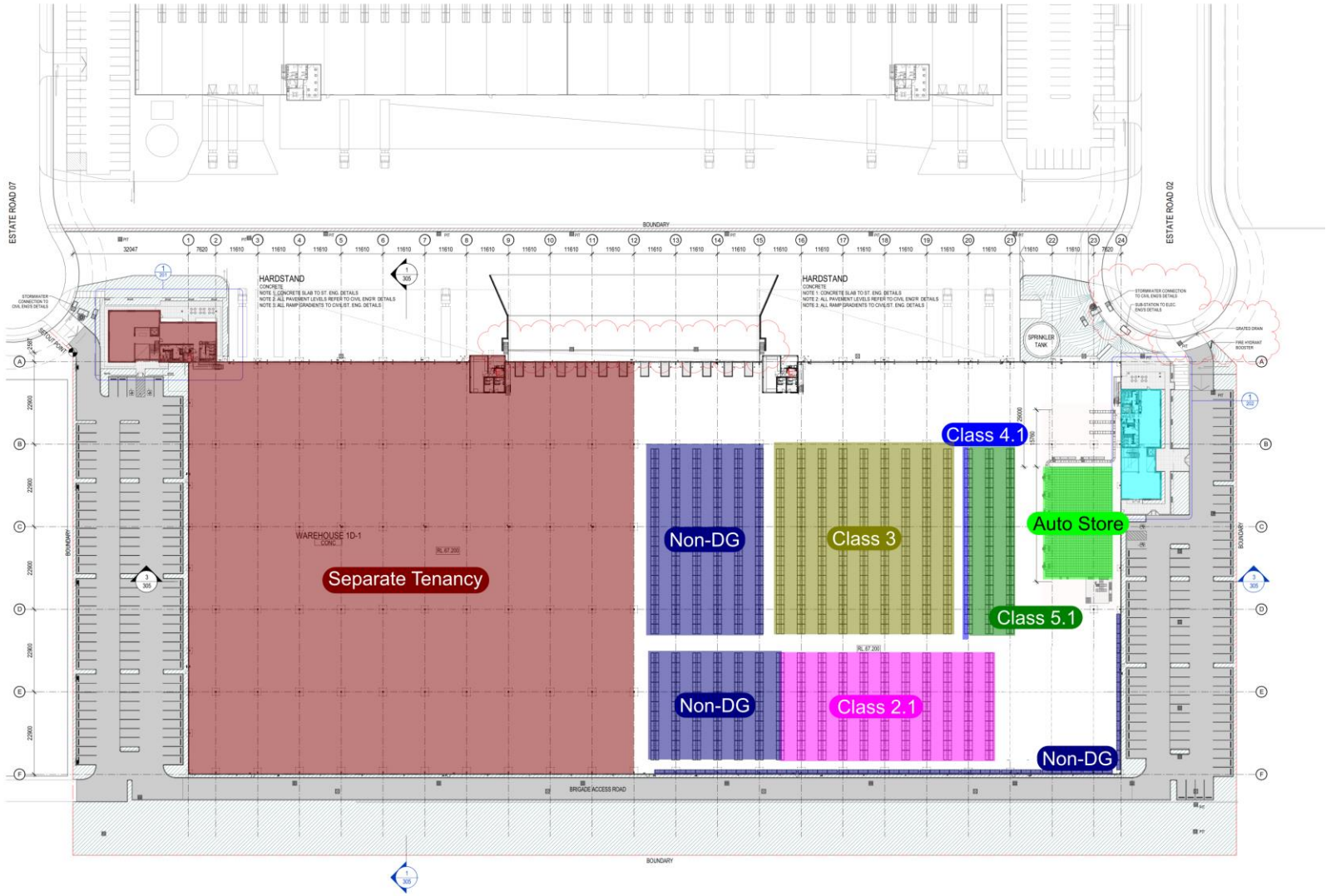

Figure 3-2: Linfox Site Layout

4.0 Hazard Identification

4.1 Introduction

A hazard identification table has been developed and is presented at **Appendix A**. This table has been developed following the recommended approach in Hazardous Industry Planning Advisory Paper No .6, Hazard Analysis Guidelines (Ref. [4]). The Hazard Identification Table provides a summary of the potential hazards, consequences and safeguards at the site. The table has been used to identify the hazards for further assessment in this section of the study. Each hazard is identified in detail and no hazards have been eliminated from assessment by qualitative risk assessment prior to detailed hazard assessment in this section of the study.

In order to determine acceptable impact criteria for incidents that would not be considered for further analysis, due to limited impact offsite, the following approach has been applied:

- *Fire Impacts* - It is noted in Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 (Ref. [2]) that a criterion is provided for the maximum permissible heat radiation at the site boundary (4.7 kW/m^2) above which the risk of injury may occur and therefore the risk must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk, for this study, incidents that result in a heat radiation less that at 4.7 kW/m^2, at the site boundary, are screened from further assessment.

  Those incidents exceeding 4.7 kW/m^2 at the site boundary are carried forward for further assessment (i.e. frequency and risk). This is a conservative approach, as HIPAP No. 4 (Ref. [2]) indicates that values of heat radiation of 4.7 kW/m^2 should not exceed 50 chances per million per year at sensitive land uses (e.g. residential). It is noted that the closest residential area is more than several hundred meters from the site, hence, by selecting 4.7 kW/m^2 as the consequence impact criteria (at the adjacent industrial site boundary) the assessment is considered conservative.

- *Explosion* - It is noted in HIPAP No. 4 (Ref. [2]) that a criterion is provided for the maximum permissible explosion over pressure at the site boundary (7 kPa) above which the risk of injury may occur and therefore the risk must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk, for this study, incidents that result in an explosion overpressure less than 7 kPa, at the site boundary, are screened from further assessment. Those incidents exceeding 7 kPa, at the site boundary, are carried forward for further assessment (i.e. frequency and risk). Similarly, to the heat radiation impact discussed above, this is conservative as the 7 kPa value listed in HIPAP No. 4 relates to residential areas, which are over more than several hundred meters from the site.

- *Toxicity* – No toxic gases have been proposed to be stored at the site; hence, toxicity has not been assessed in this study.

- *Property Damage and Accident Propagation* - It is noted in HIPAP No. 4 (Ref. [2]) that a criterion is provided for the maximum permissible heat radiation/explosion overpressure at the site boundary (23 kW/m^2/14 kPa) above which the risk of property damage and accident propagation to neighbouring sites must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk to incident propagation, for this study, incidents that result in a heat radiation heat radiation less than 23 kW/m^2 and explosion over pressure less than 14 kPa, at the site boundary, are screened from further assessment. Those incidents

exceeding 23 kW/m^2 at the site boundary are carried forward for further assessment with respect to incident propagation (i.e. frequency and risk).

- *Societal Risk* – HIPAP No. 4 (Ref. [2]) discusses the application of societal risk to populations surrounding the proposed potentially hazardous facility. It is noted that HIPAP No. 4 indicates that where a development proposal involves a significant intensification of population, in the vicinity of such a facility, the change in societal risk needs to be taken into account. In the case of the facility, there is currently no significant intensification of population around the proposed site; however, the adjacent land has been rezoned residential; hence, there will be housing located approximately more than several hundred meters from the site. Therefore, societal risk has been considered in the assessment.

4.2 Properties of Dangerous Goods

The type of DGs and quantities stored and used at the site has been described in **Section 3**. **Table 4-1** provides a description of the DGs stored and handled at the site, including the Class and the hazardous material properties of the DG Class.

Table 4-1: Properties* of the Dangerous Goods and Materials Stored at the Site

Class	Hazardous Properties
2.1 – Flammable Gas	Class 2.1 includes flammable gases which are ignitable when in a mixture of 13 per cent or less by volume with air or have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. Ignited gas may result in explosion or flash fire. Where gas released under pressure from a hole in a pressurised component is ignited, a jet fire may occur.
2.2 – Non-Flammable, Non-Toxic Gases	Class 2.2 includes non-flammable and non-toxic gases which are asphyxiant (dilute or replace the oxygen normally in the atmosphere).
3 – Flammable Liquids	Class 3 includes flammable liquids which are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc.) which give off a flammable vapour at temperatures of not more than 60^{o}C closed-cup test or not more than 65.6^{o}C open-cup test. Vapours released may mix with air and if ignited, at the right, concentration will burn resulting in pool fires at the liquid surface.
4.1 – Flammable Solids	Flammable solid materials are materials that may burn when exposed to an ignition source, examples of flammable solids include matches and some waxes.
5.1 -Oxidising Agents	Class 5.1 materials will not combust but these materials include substances which can in a fire event, liberate oxygen and could accelerate the burning of other combustible or flammable materials. Releases to the environment may cause damage to sensitive receptors within the environment.
6.1 – Toxic Substances	Substances liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact.
8 – Corrosive Substances	Class 8 substances (corrosive substances) are substances which, by chemical action, could cause damage when in contact with living tissue (i.e. necrosis), or, in case of leakage, may materially damage, or even destroy, other goods which come into contact with the leaked corrosive material. Releases to the environment may cause damage to sensitive receptors within the environment.

Class	Hazardous Properties
9 – Miscellaneous DGs	Class 9 substances and articles (miscellaneous dangerous substances and articles) are substances and articles which, during transport present a danger not covered by other classes. Releases to the environment may cause damage to sensitive receptors within the environment.

* The Australian Code for the Transport of Dangerous Goods by Road and Rail (Ref. [10]

4.3 Hazard Identification

Based on the hazard identification table presented in **Appendix A**, the following hazardous scenarios have been developed:

- Flammable liquid or gas release, delayed ignition and flash fire or explosion.
- Flammable material spill, ignition and racking fire.
- LPG release (from aerosol), ignition and racking fire.
- Full warehouse fire and radiant heat.
- Full warehouse fire and toxic smoke emission.
- Fire within the autostore.
- Dangerous goods liquid spill, release and environmental incident.
- Warehouse fire, sprinkler activation and potentially contaminated water release.

Each identified scenario is discussed in further detail in the following sections.

4.4 Flammable Liquid or Gas Release, Delayed Ignition and Flash Fire or Explosion

As noted in **Section 3.0**, flammable liquids will be held at the site for storage and distribution. There is potential that a flammable liquid spill could occur in the warehouse area due to an accident (packages dropped from forklift, punctured by forklift tines) or deterioration of packaging. If a flammable liquid spill occurred, the liquid may begin to evaporate (depending on the material flashpoint and ambient temperature). Where materials do evaporate, there is a potential for accumulation of vapours, forming a vapour cloud above the spill.

If the spill is not identified, the cloud may continue to accumulate, eventually contacting an ignition source. If the cloud is confined (i.e. pallet racking and stored products) the vapour cloud may explode if ignited, or, if it is unconfined, it may result in a flash fire which would burn back to the flammable liquid spill, resulting in a pool fire.

A similar scenario could occur with the release of Liquefied Petroleum Gas (LPG) from an aerosol; however, the formation of a gas cloud would occur immediately as the LPG would instantly flash to gas following release from the canister. It is noted that the potential for a release of LPG is low as aerosol canisters are pressure tested during manufacture and filling, hence, release would predominately result from damaged product rather than deterioration.

A review of the product list to be stored indicates the products are small retail packages as defined by AS/NZS 3833:2007 (Ref. [5]). Therefore, the release from a single flammable liquid container would result in a release <20 L. For flammable gas canisters, the quantity of flammable gas

released would be <1 L in the worst-case release. The associated vapour cloud formed by the release of gas or flammable liquid would be insufficient to result in offsite impacts from ignition.

Packages are inspected for damage upon receipt at the loading dock before they are transported into the warehouse. This minimises the likelihood a damaged package is incorrectly stored. Once stored inside the warehouse, deterioration or damage are unlikely to occur.

To minimise the likelihood a flammable vapour cloud may contact an ignition source, the electrical equipment within the DG store hazardous zone will be installed according to the requirements of AS/NZS 60079.14:2009 (Ref. [8]).

It has been proposed to seek approval to operate the site 24 hours a day 7 days a week however the site will be unlikely to be used for these proposed hours of operation. Therefore, if a spill occurred, it would be identified by personnel working in the warehouse where it could be immediately cleaned up. To ensure appropriate cleaning equipment is available, the following recommendation has been made:

- Multiple spill kits be provided around the DG storage areas to ensure spills can be cleaned up immediately following identification.

Based on the warehouse design (controlled ignition sources, etc.), operation practices and the storage of small packages, the risk of a vapour cloud being generated that is large enough to ignite and impact over the site boundary, by way of a vapour cloud explosion or a flash fire, is considered to be low (if not negligible); hence, this hazard has not been carried forward for further analysis.

4.5 Flammable Material Spill, Ignition and Racking Fire

As noted in **Section 4.4**, it is considered that there is a low potential for a package to leak resulting in a flammable material spill and there are several controls in place to minimise the likelihood of a damaged container entering the warehouse and additional controls to minimise the potential that ignition of a flammable material spill could occur.

If a flammable material spill was to occur (e.g. dropped pallet or package during handling) and it was ignited (e.g. by the forklift), the fire would initially be small due to the majority of packages stored being 20 L or less. While a fire would be limited in size, heat generated may impact adjacent packages which may deteriorate and release their contents contributing additional fuel to the fire. As the fire grows Storage Mode Sprinkler System (SMSS) would activate controlling the fire within the sprinkler array and cooling adjacent packages preventing deterioration and reducing the potential for fire growth.

Based on the limited fire size, the design of the warehouse and the installed fire systems, the risks of this incident impacting over the site boundary are considered to be low. Notwithstanding this, this incident has been carried forward for further analysis to demonstrate that the likely impact of an SMSS controlled fire is within the site boundary.

4.6 LPG Release (from Aerosol), Ignition and Racking Fire

As noted in **Section 4.4**, the potential for release of LPG from an aerosol is considered low due to the quality assurance testing on aerosol canisters during the filling process. The release of LPG would likely result from damage to aerosols during transport and storage rather than from deterioration. Packages are inspected upon delivery and an accident involving aerosols would

trigger an additional inspection to verify that damage had not occurred prior to storage within the warehouse.

Notwithstanding this, there is the potential for a release of LPG to occur within the storage racking. Due to the hazardous area rated equipment within the area and protocols, it is considered unlikely for an ignition to occur; however, in the event that an ignition of an LPG release did occur a fire could result.

The fire would consume the packaging with the generated heat impacting the adjacent aerosols. As the LPG within the adjacent aerosols expands the canisters may rupture releasing LPG which would ignite and rocket the canister throughout the aerosol cage potentially spreading the fire.

As the fire grows, the SMSS is expected to activate to suppress the fire and cool adjacent packages to minimise the potential for aerosol rupture and rocketing. Activation of this system would control the fire within the sprinkler array.

A sprinkler controlled fire within the aerosol racking would be unlikely to impact over the site boundary; notwithstanding this, this incident has been carried forward for consequence analysis.

Notwithstanding the above, the following recommendation has been made:

- Aerosols shall be stored in a dedicated storage area which prevents rocketing cans from escalating the incident (i.e. storage in an aerosol cage, separate storage area, or in palletised aerosol cages).

4.7 Full Warehouse Fire and Radiant Heat

There is potential that if a fire occurred and the fire protection systems failed to activate, a small fire may escalate as radiant heat impacts adjacent packages resulting in deterioration and release of additional fuel. While it is considered unlikely for a fire to occur simultaneously with the sprinkler system failing to operate there is the potential for this scenario to occur. Therefore, this incident has been carried forward for further analysis.

4.8 Full Warehouse Fire and Toxic Smoke Emission

As discussed in **Section 4.7** there is the potential for a full warehouse fire to occur in the event of sprinkler failure. During combustion toxic products of combustion may be generated which will be dispersed in the smoke plume which may impact downwind from the site. Depending on the toxicity of the bi-products, this may result in injury or fatality. Therefore, this incident has been carried forward for further analysis.

4.9 Fire Within the Autostore

The Autostore will contain a range of mixed products including DG products which are stored in totes and shuffled through the Autostore via overhead robotic units. The totes are composed of plastic PPE and are fully enclosed on all sides except for the top. The enclosed nature of the totes will prevent any spills within a tote from impacting packages in adjacent totes. The DG products are segregated within the Autostore to prevent interaction in the unlikely event that a spill does occur and is somehow released from the enclosed tote.

Notwithstanding this, there is always the potential that a release could occur and could be ignited (i.e. static). If this were to occur the fire would initially be small and would likely smoulder for some time as oxygen availability is restricted due to the tight spacing between totes both laterally and

vertically. However, as heat accumulates it will impact adjacent totes which will begin to heat up transferring heat into the plastic totes which may heat up and begin to melt, smoulder, or ignite.

As the spacing is tight within the Autostore the fire will likely take a substantial time to develop which will also prevent activation of the overhead sprinkler system. However, as the fire will likely progress slowly in a low oxygen environment black smoke will be generated which will alert operators to the presence of a fire who can alert Fire & Rescue NSW (FRNSW) to attend the site to control fire growth.

While it is anticipated the fire will progress slowly based on a smouldering fire growth it could progress quickly given the fire risks associated with these types of store are relatively unknown as these products are only entering the market. Therefore, for the purposes of modelling the risk, it must be assumed that the fire can grow throughout the Autostore as the close packed nature of the store will prevent the overhead sprinklers from extinguishing fire in the base. Therefore, this incident has been carried forward for further analysis.

4.10 Dangerous Goods Liquid Spill, Release and Environmental Incident

There is potential that a spill of the liquid DGs (Class 3, 5.1, 8 and 9) could occur at the site which if not contained could be released into the public water course resulting in a potential environmental incident.

To prevent spills escaping from the site per the requirements of AS/NZS 3833:2007 (Ref. [5]) the following recommendation has been made:

- The site shall be designed to contain any spills or contaminated water from a fire incident within the boundaries of the site.

The site will also be designed to prevent the release of any spills from the site, including potentially contaminated water. Therefore, the potential for a release is considered unlikely as this is expected to be contained within the footprint of the warehouse. Nonetheless, in the event of a catastrophic scenario and spills are released from the footprint of the warehouse, it will be necessary to prevent this from being released into the public water course. Therefore, the following recommendation has been made:

- A storm water isolation point (i.e. penstock isolation valve) shall be incorporated into the design. The penstock shall automatically isolate the storm water system upon detection of a fire (smoke or sprinkler activation) to prevent potentially contaminated liquids from entering the water course.

As noted, the volumes of the packages are small (< 20 L) and the site will be designed with a drain isolation system, allowing the containment of any spills within the premises; hence, in the event of a release the full volume will be contained within the warehouse area. As a spill would be contained within the bund/site drainage there is no potential for an environmental incident to occur; hence, this incident has not been carried forward for further analysis.

4.11 Warehouse Fire, Sprinkler Activation and Potentially Contaminated Water Release

In the event of a fire, the SMSS will activate discharging fire with water to control and suppress the fire. Contact of the fire water with DGs may result in contamination which, if released to the local watercourse, could result in environmental damage. The SMSS system delivers approximately 5

m^3/min of water which, if operated for a long period, may result in overflow of site bunding and potential release. The facility has been designed to be able to contain all DG spills and liquid effluent resulting from the management of an incident (i.e. fire) within the premises.

The site will hold 60 minutes of water storage on site as required by FM Global standards; hence, to allow for additional conservatism, following a risk assessment methodology as outlined by the Department of Planning document "*Best Practice Guidelines for Potentially Contaminated Water Retention and Treatment Systems"* (Ref. [7]), an allowance of 90 minutes of potentially contaminated water has been selected noting this includes all sources of application (i.e. onsite storage and towns mains) thus far exceeding the 60 minute on site storage. In a DG fire scenario, the following protection systems are likely to be discharging:

- SMSS at 5 m^3/min.
- 3 hydrant hoses at 1.8 m^3/min.

The total water discharge would be 6.8 m^3/min. Therefore, operation for 90 minutes would result in a total discharge of 612 m^3. The following recommendation has been made:

- The warehouse and/or site boundaries shall be capable of containing 612 m^3 which may be contained within the warehouse footprint, site stormwater pipework and any recessed docks or other containment areas that may be present as part of the site design.
- The civil engineers designing the site containment shall demonstrate the design is capable of containing at least 612 m^3.

As noted in **Section 4.10**, an automatic isolation valve has been recommended to be incorporated into the design to prevent the release of potentially contaminated water. Therefore, the volume within the stormwater system can also be used in calculation total volume contained.

Based on the design and containment for the premises, there is adequate fire water retention to meet the '*Best Practice Guidelines for Contaminated Water Retention and Treatment Systems*" (Ref. [7]), hence, this incident has not been carried forward for further analysis.

5.0 Consequence Analysis

The following incidents were identified to have potential to impact off site:

5.1 Incidents Carried Forward for Consequence Analysis

The following incidents were identified to have potential to impact off site:

- Flammable material spill, ignition and racking fire.
- LPG release (from aerosol), ignition and racking fire.
- Full warehouse fire and radiant heat.
- Full warehouse fire and toxic smoke emission.
- Fire within the autostore.

Each incident has been assessed in the following sections.

5.2 Flammable Material Spill, Ignition and Racking Fire

There is the potential for a fire to develop involving flammable material stored within the warehouse resulting in a racking fire. As the fire grows the SMSS would activate suppressing and controlling the fire while cooling adjacent packages minimising the potential for lateral spread due to radiant heat. A detailed analysis has been conducted in **Appendix B** and the radiant heat impact distances estimated for this scenario are presented in **Table 5-1**.

Table 5-1: Heat Radiation from a Flammable Liquid Racking Fire

Heat Radiation (kW/m^2)	Distance (m)	
	Base Case	Sensitivity
35	4.6	8.5
23	5.6	10.3
12.6	7.5	13.7
4.7	12.0	22.2

The closest site boundary to the warehouse is to the west and is located 21.7 m from the warehouse structure. A review of the Class 3 or 4.1 DG storage locations indicates the distance to the site boundary would be in excess of 30 m in all directions. Therefore, a fire originating in this area of the warehouse would not result in offsite impacts at 4.7 kW/m^2 in both the base case and

the sensitivity case scenarios as illustrated in

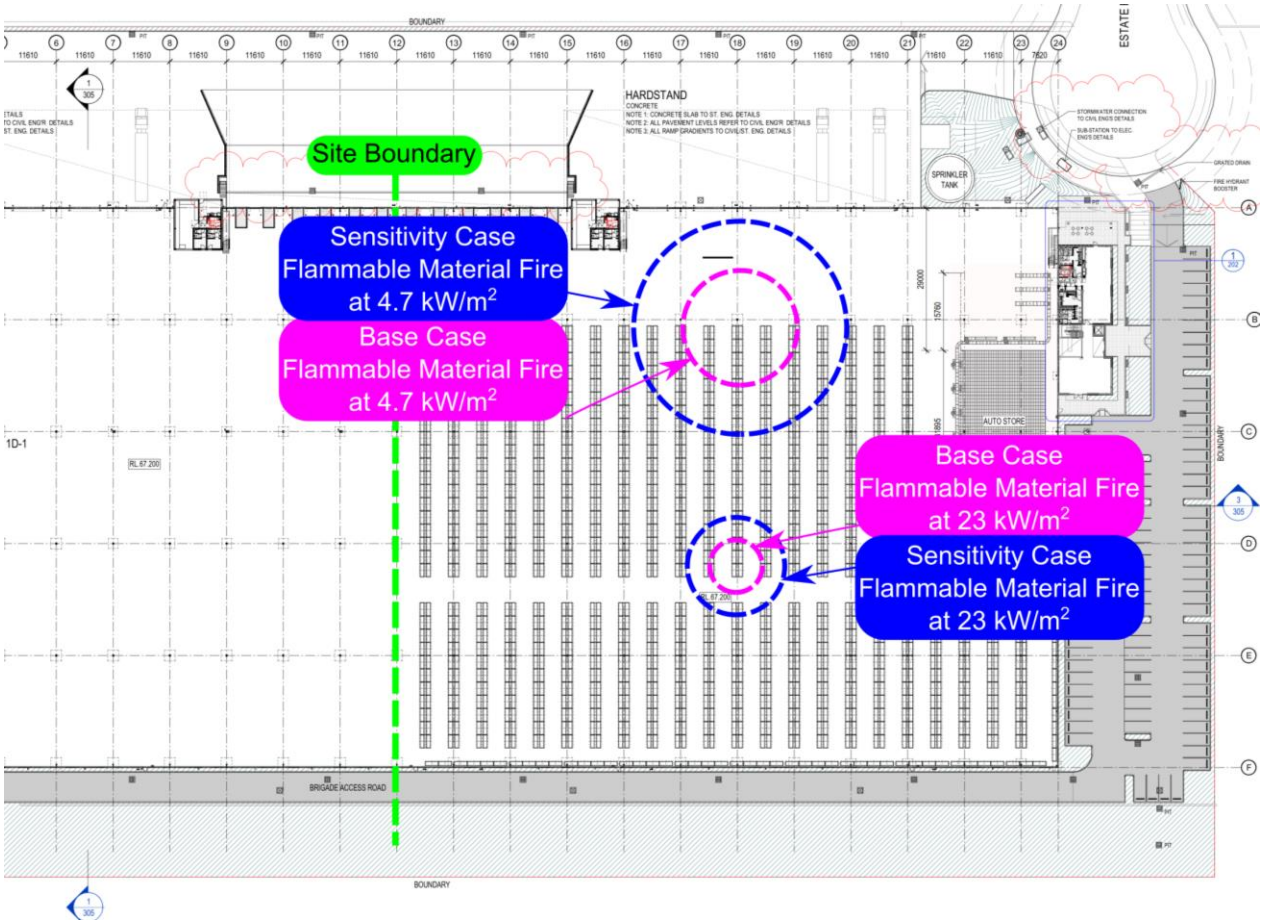

Figure 5-1.

A review of the 23 kW/m^2 impact distance indicates an offsite impact would not occur as neither contour for base case nor sensitivity case impact over the site boundary. Therefore, it is not considered that a propagation risk is present based on the radiant heat levels observed for this fire scenario.

As no offsite impacts for the scenario at 4.7 kW/m^2 nor 23 kW/m^2 were identified, this incident has not been carried forward for further analysis.

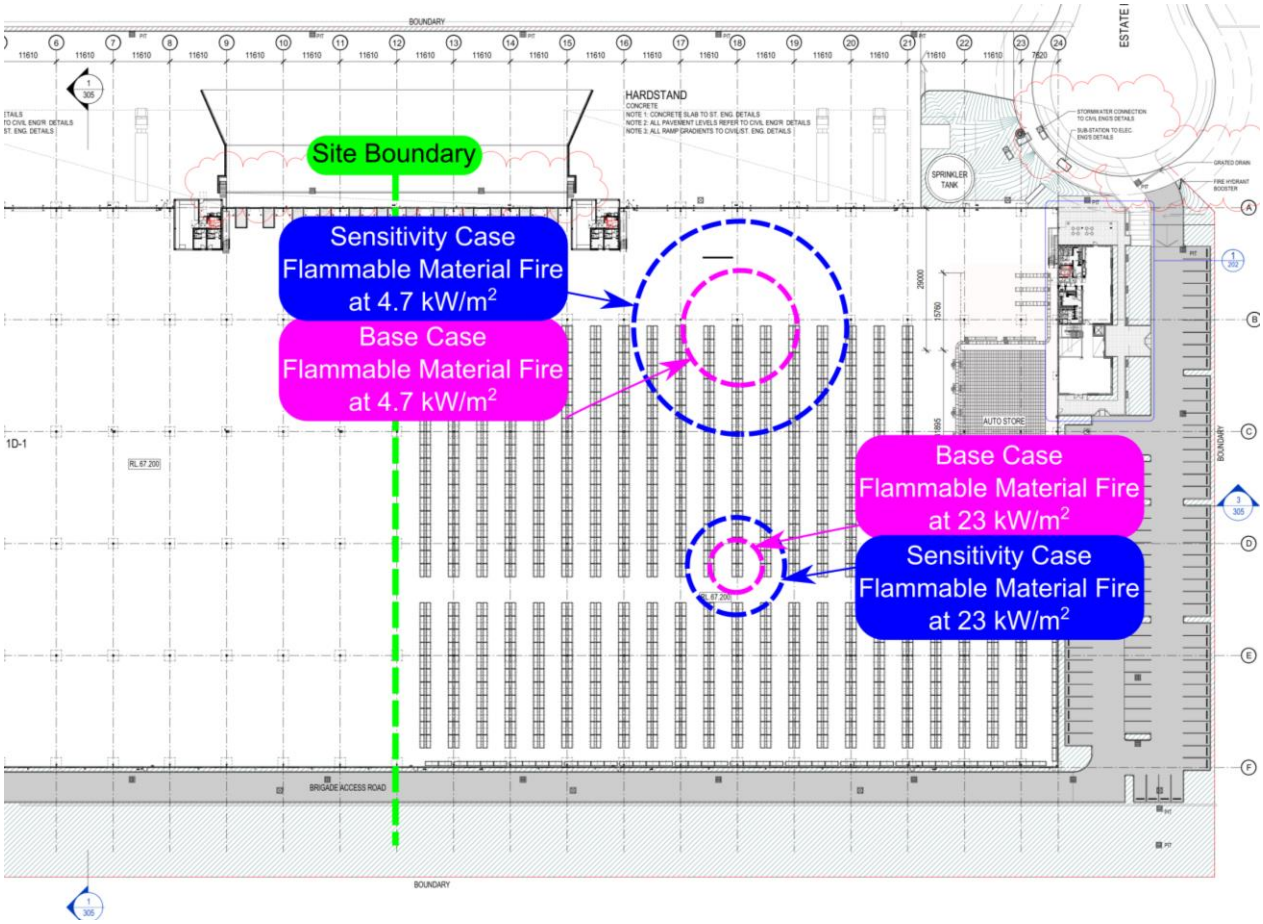

Figure 5-1: Sprinkler Controlled Flammable Material Fire Radiant Heat Contours

5.3 LPG Release (from Aerosol), Ignition and Racking Fire

A damaged aerosol canister could result in the release of LPG which if ignited may result in a fire. As the fire grows the radiant heat may impact adjacent aerosol storage heating the LPG within aerosol cans which may rupture rocketing the canisters around the aerosol store. The heat generated from the fire will activate the SMSS which will suppress and control the fire while cooling adjacent packages minimising the potential for lateral fire spread due to radiant heat. A detailed analysis has been conducted in **Appendix B** and the radiant heat impact distances estimated for this scenario are presented in **Table 5-2**.

Table 5-2: Heat Radiation from an Aerosol Racking Fire

Heat Radiation (kW/m^2)	Distance (m)	
	Base Case	Sensitivity
35	5.4	10.1
23	6.5	12.1
12.6	8.6	15.9
4.7	13.7	25.5

The closest site boundary to the warehouse is to the west and is located 21.7 m from the warehouse structure. A review of the Class 2.1 DG storage location indicates the distance to the site boundary

would be approximately 21.7 m (located on the eastern side of the warehouse). Therefore, a fire originating in this area of the warehouse would not result in offsite impacts at 4.7 kW/m^2 in both the base case and the sensitivity case scenarios as illustrated in **Figure 5-2**.

A review of the 23 kW/m^2 impact distance indicates an offsite impact would not occur as neither contour for base case nor sensitivity case impact over the site boundary. Therefore, it is not considered that a propagation risk is present based on the radiant heat levels observed for this fire scenario.

As no offsite impacts for the scenario at 4.7 kW/m^2 nor 23 kW/m^2 were identified, this incident has not been carried forward for further analysis.

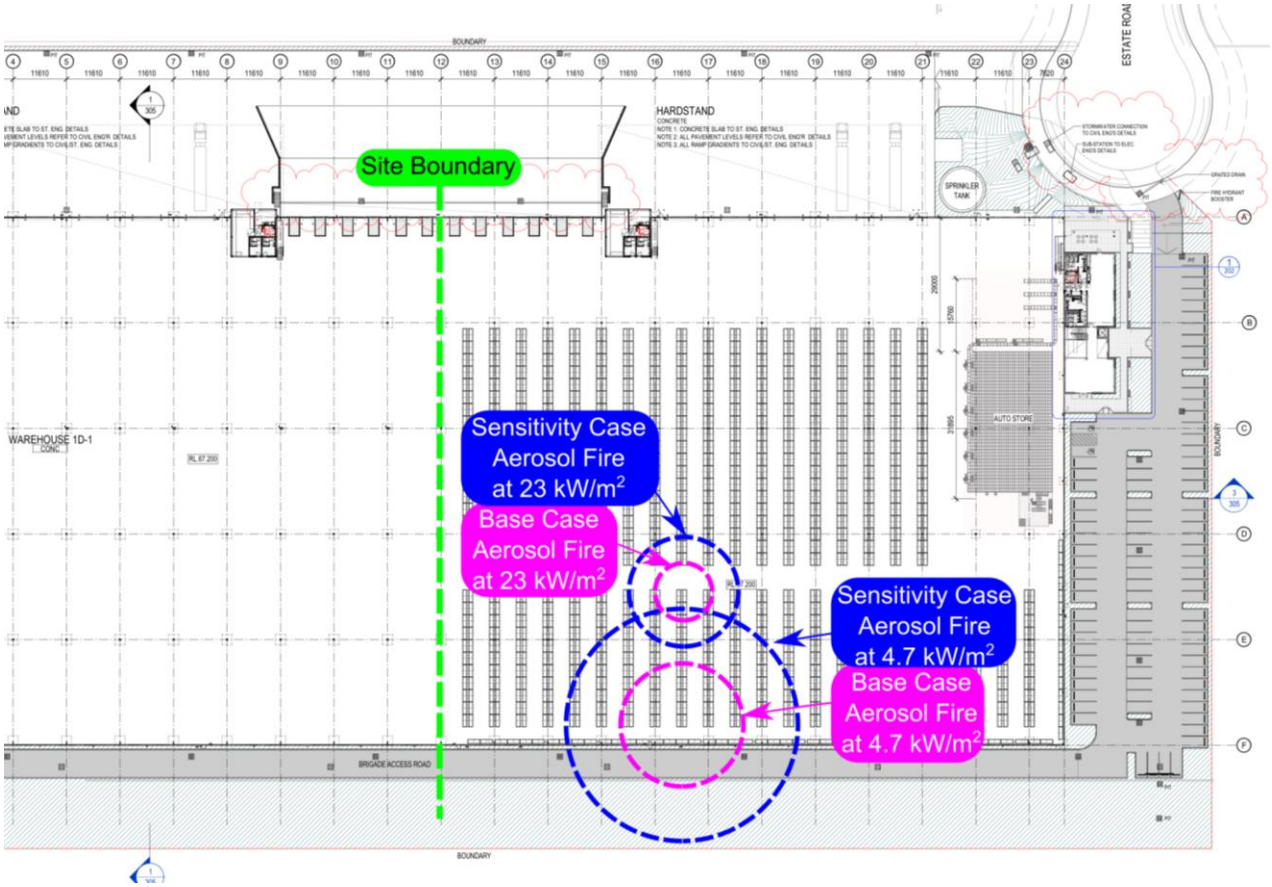

Figure 5-2: Sprinkler Controlled Aerosol Fire Radiant Heat Contours

5.4 Full Warehouse Fire and Radiant Heat

If a fire occurs within the DG store and the sprinkler systems fail to activate, the fire will spread throughout the warehouse and is unlikely to be contained and would likely consume the entire warehouse. A detailed analysis has been conducted in **Appendix B** and the radiant heat impact distances estimated for this scenario are presented in **Table 5-3**.

Table 5-3: Radiant Heat Impact Distances from a Full Warehouse Fire

Heat Radiation (kW/m^2)	Distance (m)
35	Maximum heat flux is 20*
23	Maximum heat flux is 20*

12.6	32.0
4.7	72.0

*Based on the research by Mudan & Croche reported in Lees (Ref. [11]) & Cameron/Raman (Ref. [12])

As shown in **Figure 5-3**, the radiant heat impacts at 4.7 kW/m^2 extend over the site boundary; hence, there is the potential for a fatality at the site boundary to occur. Therefore, this incident has been carried forward for further analysis.

It is noted that due to the fire size there will be considerable smoke emitted which would obscure the flame surface reducing the average surface emissive power (SEP) and subsequently it would not exceed 23 kW/m^2. In addition, the distance to the closest buildings is 23 m which would allow attenuation of radiant heat from of luminous spots and would not result in sustained radiant heat such that propagation to adjacent facilities would not occur.

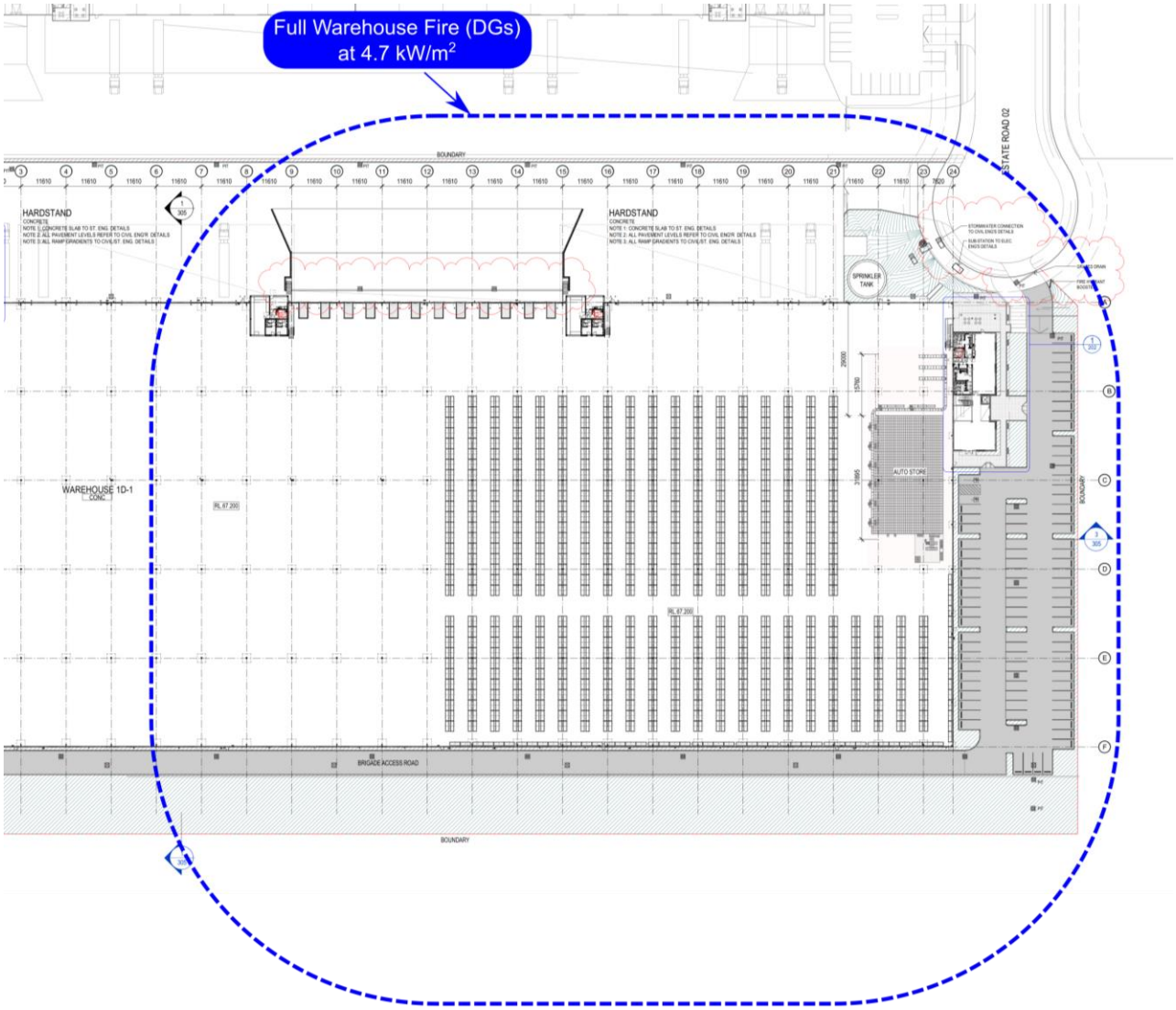

Figure 5-3: Full Warehouse Fire Radiant Heat Contours

5.5 Full Warehouse Fire and Toxic Smoke Emission

A detailed analysis has been performed in **Section B6** of **Appendix B** to estimate the impact of toxic products of combustion on the surrounding area. In addition, it was concluded that due to the relatively low quantity of toxic products that may be stored in the warehouse, and a substantial portion of toxic products involved in a fire will actually be combusted, the results generated from the assessment of toxic bi-products would provide a conservative analysis when applied to uncombusted toxic products.

Provided in **Table 5-4** is a summary of several toxic products of combustion which may be present in the smoke plume and their acceptable concentration of exposure for the Acute Exposure Guideline Levels (AEGL). These levels provide guidance on exposure concentrations for general populations, including susceptible populations over a range of exposure times to assist in the assessment of releases which may result in a toxic exposure.

Provide below is a summary of the AEGL tiers of exposure:

- **AEGL-3** is the airborne concentration, expressed as parts per million (ppm) or milligrams per cubic meter (mg/m^3), of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
- **AEGL-2** is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- **AEGL-1** is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

Selection for fatality or serious injury is based on an AEGL-3 values with injury values selected as those based on AEGL-2. It is noted the report AEGL values are based on 30-minute exposure.

Table 5-4: Concentrations of Toxic Products of Combustion from a Smoke Plume

Pollutant	Fatality or Serious Injury (ppm)	Injury (ppm)	Concentration (ppm)
Carbon monoxide	600	150	13.1
Nitric Dioxide	25	15	12.2
Hydrogen cyanide	21	10	13.6
Hydrogen chloride	210	43	10.1
Sulphur dioxide	30	0.75	5.7

The analysis indicates all quantities are below the AEGL-3 values. It is noted the analysis conducted is based on the primary toxic bi-product (carbon monoxide) which forms at rates higher than other toxic bi-products. Therefore, application of this result to other components is considered conservative. As these concentrations are taken at the point of release, they will disperse downwind resulting in substantially lower concentrations at the residential areas.

With reference to injury, all values except for sulphur dioxide are below the AEGL-2 concentration. Similar to the above discussion, the concentrations are likely to disperse substantially prior to impacting the residential populations; hence, an injury is unlikely to occur.

Based on the analysis conducted, it is considered that the concentrations at the residential area are likely to be lower than the fatality and injury concentration levels based on the comparison to the fatality and injury targets at the point of release. Therefore, it is considered that fatality and injury are unlikely to occur as a result of this incident. Not withstanding this, this incident has been carried forward for conservatism.

5.6 Fire Within the Autostore

If a fire occurs within the DG store and the sprinkler systems fail to activate, the fire will spread throughout the warehouse and is unlikely to be contained and would likely consume the entire warehouse. A detailed analysis has been conducted in **Appendix B** and the radiant heat impact distances estimated for this scenario are presented in **Table 5-3**.

Table 5-5: Radiant Heat Impact Distances from an Autostore Fire

Heat Radiation (kW/m^2)	Distance (m)
35	Maximum heat flux is 25.6*
23	6.9
12.6	12.2
4.7	25.7

A review of site boundaries with reference to the Autostore DG storage location indicates the closest boundary is 34.5 m away (located on the northern side of the warehouse). Therefore, a fire originating in the Autostore would not result in offsite impacts at 4.7 kW/m^2 as illustrated in **Figure 5-4**.

A review of the 23 kW/m^2 impact distance indicates an offsite impact would not occur this contour has a smaller impact distance than the 4.7 kW/m^2 contour which was shown to not impact offsite. Therefore, it is not considered that a propagation risk is present based on the radiant heat levels observed for this fire scenario.

As no offsite impacts for the scenario at 4.7 kW/m^2 nor 23 kW/m^2 were identified, this incident has not been carried forward for further analysis.

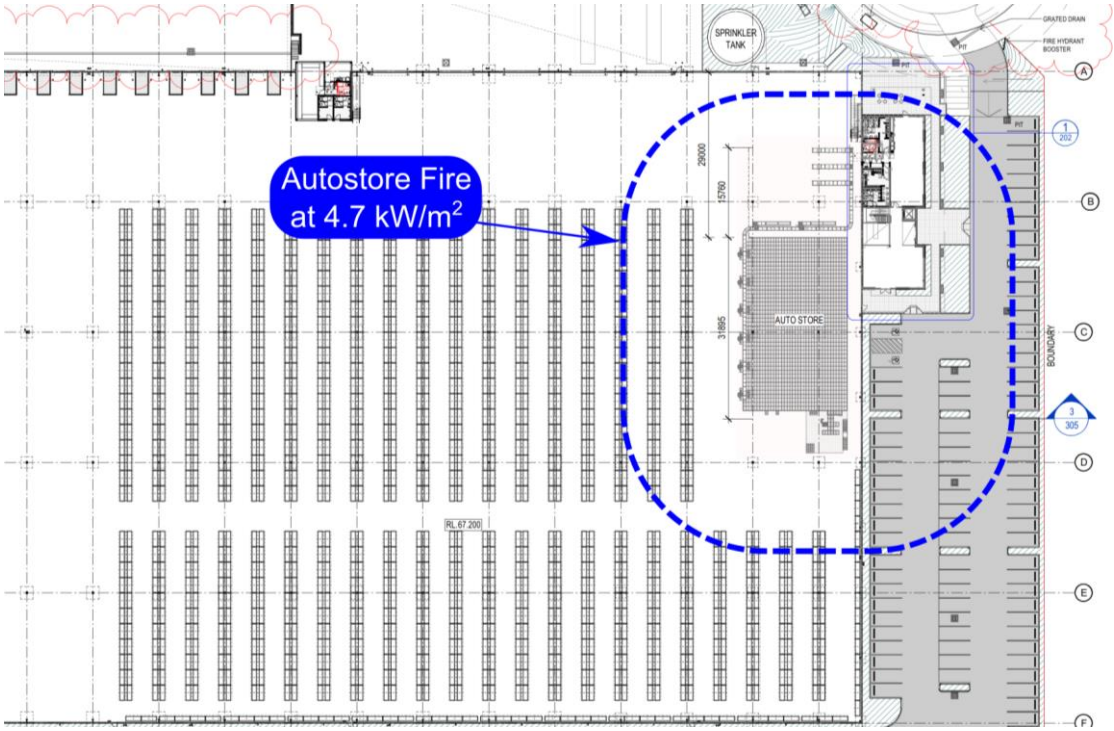

Figure 5-4: Autostore Fire Radiant Heat Contours

6.0 Frequency Analysis

6.1 Incidents Carried Forward for Frequency Analysis

The following item has been carried forwards for frequency analysis;

- Full warehouse fire.
- Full warehouse fire and toxic smoke emission.

This incident has been assessed in the following section.

6.2 Full Warehouse Fire Frequency and Risk Assessment

The frequency of a full warehouse fire at the site can be estimated from a number of sources (e.g. general warehouse fire frequencies or the summation of individual fire frequencies for each of the initiating fire events). As this is a preliminary hazard analysis, the fire frequency has been selected from general fire frequency data.

A detailed fire frequency analysis has been conducted in **Appendix C**. The results of this analysis indicate that an initiating fire frequency would be in the order of $1x10^{-3}$ p.a.

It is noted that the Linfox site is fitted with multiple automatic sprinkler systems that will initiate on fire detection, controlling the fire and preventing the fire growth to a full warehouse fire. The Centre for Chemical Process Safety (CCPS) provides failure rate data for water fire protection systems including all components (pump, distribution system, nozzles, seals, piping, controls and base plate) of 9.66 per 10^6 hours (Ref. [13]). The hourly failure rate is converted to failures per annum by:

Failures per Annum = Failures per hour x 8760 hours per year

Failures per Annum = $9.66x10^6$ x 8760 = 0.085

The system will only operate when a fire is detected; hence, the system operates in demand mode. The protection system will be tested monthly totalling 12 tests per annum. The probability of failure on demand (PFD) is estimated using:

$$PFD = \frac{1}{2}\lambda_{du}\left(\frac{1}{t}\right)$$

Where:

λ_{du} = dangerous undetected failures of a component

t = 1/number of test intervals per annum

PFD = 0.5 (0.085) (1/12) = 0.00353

Hence, the frequency of a full fire within the warehouse is the frequency of an initiating fire x the probability of fail on demand (PFD) of the automatic fire fighting system as shown in **Figure 6-1**.

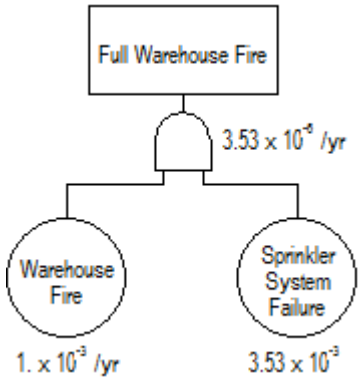

Figure 6-1: Full Warehouse Fire Fault Tree

Conservatively assuming a 100% chance of fatality at the site boundary for a person exposed to radiant heat from a full warehouse fire, the probability of fatality at the site boundary becomes $3.53x10^{-6}$ x 1 = $3.53x10^{-6}$ chances of fatality per year or 3.53 chances of a fatality in a million per year (pmpy).

6.3 Full Warehouse Fire and Toxic Smoke Emission Frequency and Risk Assessment

The toxic smoke emission (or toxic bi-products of combustion) is based on the initiating event which is the formation of a full warehouse fire. Therefore, the frequency of the toxic smoke emission is the same as that of the full warehouse which was identified to be $3.53x10^{-6}$ p.a.

For conservatism, it has been assumed exposure to the smoke will result in an fatality at the site boundary; therefore, the fatality risk of exposure to the toxic smoke becomes $3.53x10^{-6}$ x 1 = 3.53 chances pmpy.

6.4 Total Fatality Risk

The total fatality risk in the most conservative location becomes the sum of all incidents which may result in a fatality at the site boundary. Therefore, the total fatality risk becomes 3.53 + 3.53 = 7.06 chances pmpy.

6.5 Comparison Against Risk Criteria

The NSW Department of Planning and Environment has issued a guideline on the acceptable risk criteria (Ref. [2]). The acceptable risk criteria published in the guideline relates to injury, fatality and property damage. The values in the guideline present the maximum levels of risk that are permissible at the land use under assessment. The adjacent land use would be classified as an industrial site as it is restricted access and only industrial operations are permitted to occur in this area. For industrial facilities, the maximum permissible fatality risk is 50 pmpy. The assessed highest fatality risk is 7.06 pmpy at the closest site boundary (eastern boundary); hence, the highest risk is within the permissible criteria and therefore all other risk points beyond the boundary would be within the acceptable criteria.

Based on the estimated injury risk, conducted in the analysis above, the risks associated with injury and nuisances at the closest residential area are not considered to be exceeded.

6.6 Cumulative Assessment

A review of the surrounding area indicates this would be the first development to occur at the estate. It is proposed to develop an adjacent warehouse which will not store any DGs. Due to the low level of development and the proposal of the adjacent uses, cumulative risks are not considered to be a risk at this stage.

7.0 Conclusion and Recommendations

7.1 Conclusions

A hazard identification table was developed for warehouse facility to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with a potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment. Scenarios not eliminated were then carried forward for consequence analysis.

Incidents carried forward for consequence analysis were assessed in detail to estimate the impact distances. Impact distances were developed into scenario contours and overlaid onto the site layout diagram to determine if an offsite impact would occur. The consequence analysis showed that one of the scenarios (full warehouse fire) would impact over the site boundary and into the adjacent land use; hence, this incident was carried forward for frequency analysis and risk assessment.

The frequency analysis and risk assessment showed that the full warehouse fire would have a fatality risk of 7.06 chances per million per year (pmpy) at the site boundary, with lesser risk at further distances from the boundary. HIPAP No. 4 (Ref. [2]) publishes acceptable risk criteria at the site boundary of 50 pmpy (for industrial sites). Therefore, the probability of a fatality from a full warehouse fire at the site boundary is within the acceptable risk criteria.

In addition, the only incident which may result in impacts to adjacent structures was a full warehouse fire. Due to the fire size there will be considerable smoke emitted which would obscure the flame surface reducing the average surface emissive power (SEP) and subsequently it would not exceed 23 kW/m^2. In addition, the distance to the closest buildings is 23 m which would allow attenuation of radiant heat from of luminous spots and would not result in sustained radiant heat such that propagation to adjacent facilities would occur.

Review of the estate proposal indicates this development is the only contributor to the risk profile; hence, cumulative risk is not a consideration at this stage. The cumulative risk at the site is therefore the reported 7.06 chances pmpy which is below the 50 chances pmpy limit. Therefore, the development of the Linfox warehouse does not increase the cumulative risk of the estate to an unacceptable level.

Based on the analysis conducted, it is concluded that the risks at the site boundary are not considered to exceed the acceptable risk criteria; hence, the facility would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

7.2 Recommendations

Notwithstanding the conclusions following the analysis of the facility, the following recommendations have been made:

- The site shall be designed to contain any spills or contaminated water from a fire incident within the boundaries of the site.
- Multiple spill kits be provided around the DG storage areas to ensure spills can be cleaned up immediately following identification.

- The warehouse and/or site boundaries shall be capable of containing 612 m^3 which may be contained within the warehouse footprint, site stormwater pipework and any recessed docks or other containment areas that may be present as part of the site design.
- The civil engineers designing the site containment shall demonstrate the design is capable of containing at least 612 m^3.
- A storm water isolation point (i.e. penstock isolation valve) shall be incorporated into the design. The penstock shall automatically isolate the storm water system upon detection of a fire (smoke or sprinkler activation) to prevent potentially contaminated liquids from entering the water course.

1.

8.0 References

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Appendix A

Hazard Identification Table

A1. Hazard Identification Table

Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
Warehouse / Autostore	• Dropped pallet • Damaged packaging (receipt or during storage) • Deterioration of packaging	• Release of Class 2.1, 3, 4.1, 5.1, and other DGs to the environment	• Small retail sized packages (< 250 mL) • Inspection of packages upon delivery to the site. • Trained forklift operators (including spill response training). • Storage of DGs within AS/NZS 3833:2007 compliant store (Ref. [5])
	• Dropped pallet • Damaged packaging (receipt or during storage) • Deterioration of packaging	• Spill of flammable liquids, evolution of flammable vapour cloud ignition and vapour cloud explosion/flash fire • Spill of flammable liquids, ignition and pool fire/racking fire	• Small retail sized packages (< 250 mL) • Inspection of packages upon delivery to the site • Control of ignition sources according to AS/NZS 60079.14:2009 (Ref. [8]) • Automatic fire protection system (in-rack and SMSS) • First attack fire-fighting equipment (e.g. hose reels & extinguishers) • Fire detection systems • Storage of DGs within AS/NZS 3833:2007 compliant store (Ref. [5])
	• Heating of Class 2.1 from a general warehouse fire	• Rupture, ignition and explosion/rocketing of cylinder within warehouse spreading fire	• Aerosols stored in 240/240/240 FRL bunker • In-rack sprinklers according to FM Global Data Sheet 7-31 (Ref. [6]) • Automatic fire protection system
Sprinkler activation	• Fire activates SMSS resulting in fire water release and potential contaminated fire water offsite	• Environmental impact to surrounding areas (e.g. stormwater drainage)	• Dangerous Goods Stores are bunded to contain in excess of the maximum required fire water, per AS/NZS 3833:2007 (Ref. [5])

Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
			• Site drainage to comply with the Best Practice Guide for Potentially Contaminated Water Retention and Treatment Systems (Ref. [7])
Pallet Loading/Unloading	• Dropped containers from the pallet • Impact damage to containers on the pallet (collision with racks or other forklifts)	• Spill of flammable liquids, evolution of flammable vapour cloud ignition pool, fire under the pallet • Full pallet fire as a result of fire growth	• Trained & licensed forklift drivers • First attack fire-fighting equipment (hose reels & extinguishers) • SMSS if incident occurs internally • No potential for fire growth beyond the single pallet (limited stock externally)

Appendix B

Consequence Analysis

B1. Incidents Assessed in Detailed Consequence Analysis

The following incidents are assessed for consequence impacts.

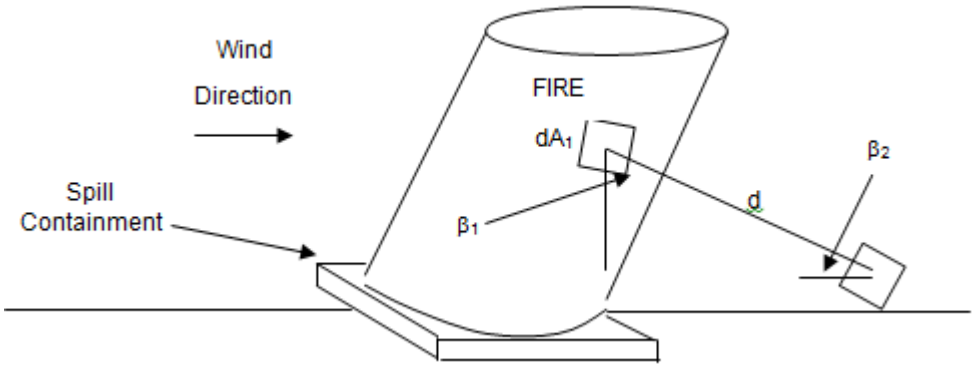
- Flammable material spill, ignition and racking fire.
- LPG release (from aerosol), ignition and racking fire.
- Full warehouse fire and radiant heat.
- Full warehouse fire and toxic smoke emission.
- Fire within the autostore.

Each incident has been assessed in the sections below.

B2. Spreadsheet Calculator (SSC)

The SSC is designed on the basis of finite elements. The liquid flame area is calculated as if it is a circle to find the radius for input into the SSC model.

The SSC is designed on the basis of finite elements. The liquid flame area is calculated as if it is a circle to find the radius for input into the SSC model. **Appendix Figure B-1** shows a typical pool fire, indicating the target and fire impact details.



Appendix Figure B-1: Heat Radiation on a Target from a Cylindrical Flame

A fire in a bund or at a tank roof will act as a cylinder with the heat from the cylindrical flame radiating to the surrounding area. A number of mathematical models may be used for estimating the heat radiation impacts at various distances from the fire. The point source method is adequate for assessing impacts in the far field; however, a more effective approach is the view factor method, which uses the flame shape to determine the fraction of heat radiated from the flame to a target. The radiated heat is also reduced by the presence of water vapour and the amount of carbon dioxide in air. The formula for estimating the heat radiation impact at a set distance is shown in **Equation B-1** (Ref. [12]).

$$Q = EF\tau$$ **Equation B-1**

Where:

- Q = incident heat flux at the receiver (kW/m^2)
- E = surface emissive power of the flame (kW/m^2)
- F = view factor between the flame and the receiver

- τ = atmospheric transmissivity

The calculation of the view factor (F) in **Equation B-1** depends upon the shape of the flame and the location of the flame to the receiver. F is calculated using an integral over the surface of the flame, S (Ref. [12]). The formula can be shown as:

$$F = \int\int s \frac{\cos\beta_1 \cos\beta_2}{\pi d^2}$$ **Equation B-2**

Equation B-2 may be solved using the double integral **or** using a numerical integration method in spread sheet form. This is explained below.

For the assessment of pool fires, a Spread Sheet Calculator (SCC) has been developed, which is designed on the basis of finite elements. The liquid flame area is calculated as if the fire is a vertical cylinder, for which the flame diameter is estimated based on the fire characteristics (e.g. contained within a bund). Once the flame cylindrical diameter is estimated, it is input into the SSC model. The model then estimates the flame height, based on diameter, and develops a flame geometric shape (cylinder) on which is performed the finite element analysis to estimate the view factor of the flame. **Appendix Figure B-1** shows a typical pool fire, indicating the target and fire impact details.

The SSC integrates the element dA_1 by varying the angle theta θ (the angle from the centre of the circle to the element) from zero to 90° in intervals of 2.5 degrees. Zero degrees represents the straight line joining the centre of the cylinder to the target (x0, x1, x2) while 90° is the point at the extreme left hand side of the fire base. In this way the fire surface is divided up into elements of the same angular displacement. Note the tangent to the circle in plan. This tangent lies at an angle, gamma, with the line joining the target to where the tangent touches the circle (x4). This angle varies from 90° at the closest distance between the liquid flame (circle) and the target (x0) and gets progressively smaller as θ increases. As θ increases, the line x4 subtends an angle phi Φ with x0. By similar triangles we see that the angle gamma γ is equal to 90- θ - Φ . This angle is important because the sine of the angle give us the proportion of the projected area of the plane. When γ is 90°, sin(γ) is 1.0, meaning that the projected area is 100% of the actual area.

Before the value of θ reaches 90° the line x4 becomes tangential to the circle. The fire cannot be seen from the rear and negative values appear in the view factors to reflect this. The SSC filters out all negative contributions.

For the simple case, where the fire is of unit height, the view factor of an element is simply given by the expression in **Equation B-3** (Derived from **Equation B-2**):

$$VF = \Delta A \frac{\sin\gamma}{\pi \times X4 \times X4}$$ **Equation B-3**

Where ΔA is the area of an individual element at ground level.

Note: the denominator (π. x4. x4) is a term that describes the inverse square law for radiation assumed to be distributed evenly over the surface of a sphere.

Applying the above approach, we see the value of x4 increase as θ increase, and the value of sin(γ) decreases as θ increase. This means that the contribution of the radiation from the edge of the circular fire drops off quite suddenly compared to a view normal to the fire. Note that the SSC adds up the separate contributions of **Equation B-3** for values of θ between zero until x4 makes a tangent to the circle.

It is now necessary to do two things: (i) to regard the actual fire as occurring on top of a fire wall (store) and (ii) to calculate and sum all of the view factors over the surface of the fire from its base to its top. The overall height of the flame is divided into 10 equal segments. The same geometric technique is used. The value of x4 is used as the base of the triangle and the height of the flame, as the height. The hypotenuse is the distance from target to the face of the flame (called X4'). The angle of elevation to the element of the fire (alpha α) is the arctangent of the height over the ground distance. From the cos(α) we get the projected area for radiation. Thus there is a new combined distance and an overall equation becomes in **Equation B-4 (**(Derived from **Equation B-3**):

$$VF = \Delta A \frac{\sin\gamma \times \cos\alpha}{\pi \times X4 \times X4} \qquad \textbf{Equation B-4}$$

The SCC now turns three dimensional. The vertical axis represents the variation in θ from 0 to 90º representing half a projected circle. The horizontal axis represents increasing values of flame height in increments of 10%. The average of the extremes is used (e.g. if the fire were 10 m high then the first point would be the average of 0 and 1 i.e. 0.5 m), the next point would be 1.5 m and so on).

Thus the surface of the flame is divided into 360 equal area increments per half cylinder making 720 increments for the whole cylinder. Some of these go negative as described above and are not counted because they are not visible. Negative values are removed automatically.

The sum is taken of the View Factors in **Equation B-3**. Actually the sum is taken without the ΔA term. This sum is then multiplied by ΔA which is constant. The value is then multiplied by 2 to give both sides of the cylinder. This is now the integral of the incremental view factors. It is dimensionless so when we multiply by the emissivity at the "face" of the flame (or surface emissive power, SEP), which occurs at the same diameter as the fire base (pool), we get the radiation flux at the target.

The SEP is calculated using the work by Mudan & Croche (Ref. [11] & Ref. [12]) which uses a weighted value based on the luminous and non-luminous parts of the flame. The weighting is based on the diameter and uses the flame optical thickness ratio where the flame has a propensity to extinguish the radiation within the flame itself. The formula is shown in **Equation B-5**.

$$SEP = E_{max}e^{-sD} + E_s(1 - e^{-sD}) \qquad \textbf{Equation B-5}$$

Where;

E_{max} = 140

S = 0.12

E_s = 20

D = pool diameter

The only input that is required is the diameter of the pool fire and then estimation for the SEP is produced for input into the SSC.

The flame height is estimated using the Thomas Correlation (Ref. [12]) which is shown in **Equation B-6**.

$$H = 42 d_p \left[\frac{\dot{m}}{\rho_a \sqrt{g d_p}}\right]^{0.61}$$ **Equation B-6**

Where;

d_p = pool diameter (m)

ρ_a = density of air (1.2 kg/m^3 at 20^{o}C)

$\dot{m}$ = burning rate (kg/m^2.s)

g = 9.81 m/s^2

The transmissivity is estimated using **Equation B-7** (Ref. [12]).

$$\tau = 1.006 - 0.01171(\log_{10} X(H_2O) - 0.02368(\log_{10} X(H_2O))^2 - 0.03188(\log_{10} X(CO_2) + 0.001164(\log_{10} X(CO_2))^2$$ **Equation B-7**

Where:

- τ = Transmissivity (%)
- X(H_2O) = $\frac{R_H \times L \times S_{mm} \times 2.88651 \times 10^2}{T}$
- X(CO_2) = $\frac{L \times 273}{T}$

and

- R_H = Relative humidity (% expressed as a decimal)
- L = Distance to target (m)
- S_{mm} = saturated water vapour pressure in mm of mercury at temperature (at 25^{o}C S_{mm} = 23.756)
- T = Atmospheric temperature (K)

Appendix Table B-1 provides noteworthy heat radiation values and the corresponding physical effects of an observer exposed to these values (Ref. [2]).

Appendix Table B-1: Heat Radiation and Associated Physical Impacts

Heat Radiation (kW/m^2)	Impact
35	• Cellulosic material will pilot ignite within one minute's exposure • Significant chance of a fatality for people exposed instantaneously
23	• Likely fatality for extended exposure and chance of a fatality for instantaneous exposure • Spontaneous ignition of wood after long exposure • Unprotected steel will reach thermal stress temperatures which can cause failure • Pressure vessel needs to be relieved or failure would occur
12.6	• Significant chance of a fatality for extended exposure. High chance of injury • Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure

Heat Radiation (kW/m^2)	Impact
	• Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure
4.7	• Will cause pain in 15-20 seconds and injury after 30 seconds exposure (at least second degree burns will occur)
2.1	• Minimum to cause pain after 1 minute

B3. Flammable Material Spill, Ignition and Racking Fire

In the event that a flammable liquid package is damaged and flammable liquid is released the volatile component will vaporise which may contact an ignition source resulting in a pool fire. As the fire grows it may accelerate the deterioration of other packages resulting in failure and release of additional flammable material and combustion of packaging.

As heat and smoke is generated from the fire, the in-rack sprinklers and the SMSS will activate. Two sprinkler activation scenarios have been assessed:

- A worst credible (WC) scenario whereby the first row of the SMSS activates and controls the spread of a fire.
- A sensitivity scenario whereby the first row of sprinklers fails to activate and the fire is instead controlled by the second row of the SMSS.

The first row of sprinklers has an approximate diameter of 3 m with the second row having an approximate diameter of 9 m. These diameters are used to estimate the flame height and SEP for the fire scenarios. To estimate the flame height and SEP the following information was substituted into the models:

- Equivalent fire diameter: WC – 3 m, Sensitivity - 9 m
- Burning rate – 0.0667 $kg/m^2.s$ (this value encompasses a large range of flammable liquid burning rates and is considered conservative due to the nature of the flammable liquids stored, Ref. [11])

The selection of a flammable liquid burning rate is considered appropriate and conservative as a the fire will be composed of burning flammable liquids and packaging. The packaging is a solid material that will yield a lower burning rate than selected as it requires an additional phase change prior to combustion reducing the rate at which the product burns.

Furthermore, the analysis is considered incredibly conservative as it assumes a 100% burning area; however, as the subject areas will encompass aisle spaces, which will have no combustible material stored these locations. Therefore, it is considered the results generated from this analysis would substantially overestimate the radiant heat impacts from the identified scenarios.

The results for flame height and SEP for each scenario are summarised in **Appendix Table B-2**.

Appendix Table B-2: Flame Height and SEP for a Flammable Material Sprinkler Controlled Fire

Output	Base Case	Sensitivity
Flame Height (m)	7.7	16.5
SEP (kW/m^2)	103.7	60.8

The inputs summarised in **Appendix Table B-2** were input in to the SSC with the results for each scenario shown in **Appendix Table B-3**.

Appendix Table B-3: Heat Radiation from a Flammable Material Sprinkler Controlled Fire

Heat Radiation (kW/m^2)	Distance (m)	
	Base Case	Sensitivity
35	4.6	8.5
23	5.6	10.3
12.6	7.5	13.7
4.7	12.0	22.2

B4. LPG Release (From Aerosol), Ignition and Racking Fire

The release of LPG from a damaged package could result in a fire if the release ignited. The fire would begin to grow expanding LPG within other aerosols which may rupture, ignite and rocket around the aerosol store. The store is fitted with SMSS and in-rack sprinklers to suppress the fire and cool adjacent packages to minimise the potential for rocketing.

As heat and smoke is generated from the fire, the in-rack sprinklers and the SMSS will activate. Two sprinkler activation scenarios have been assessed:

- A worst credible (WC) scenario whereby the first row of the SMSS activates and controls the spread of a fire.
- A sensitivity scenario whereby the first row of sprinklers fails to activate and the fire is instead controlled by the second row of the SMSS.

The first row of sprinkler has an approximate diameter of 3 m with the second row having an approximate diameter of 9 m. These diameters are used to estimate the flame height and SEP for the fire scenarios. To estimate the flame height and SEP the following information was substituted into the models:

- Equivalent fire diameter: WC – 3 m, Sensitivity - 9 m
- Burning rate – 0.099 kg/m^2.s (the burning rate for LPG, Ref. [11]).

The selection of a LPG burning rate is considered appropriate and conservative as a fire involving aerosols will be composed predominantly of packaging (i.e. plastic wrapping and cardboard) which will be punctuated by rupturing of cans and combustion of the released LPG. The packaging is a solid material that will yield a lower burning rate than selected as it requires an additional phase change prior to combustion reducing the rate at which the product burns.

Furthermore, the analysis is considered incredibly conservative as it assumes a 100% burning area; however, as the subject areas will encompass aisle spaces, there will be no combustible material stored in these locations. Therefore, it is considered the results generated from this analysis would substantially overestimate the radiant heat impacts from the identified scenarios.

The results for flame height and SEP for each scenario are summarised in **Appendix Table B-4**.

Appendix Table B-4: Flame Height and SEP for Class 2.1 Sprinkler Controlled Scenarios

Output	Base Case	Sensitivity
Flame Height (m)	7.7	21.0
SEP (kW/m^2)	103.7	60.8

The inputs summarised in **Appendix Table B-4** were input in to the SSC with the results for each scenario shown in **Appendix Table B-5**.

Appendix Table B-5: Heat Radiation from Class 2.1 Sprinkler Controlled Scenarios

Heat Radiation (kW/m^2)	Distance (m)	
	Base Case	Sensitivity
35	5.4	10.1
23	6.5	12.1
12.6	8.6	15.9
4.7	13.7	25.5

B5. Full Warehouse Fire

The main storage area has an approximate floor area of 9,500 m^2 which is the area that is assumed to participate in the fire. The equivalent diameter for the fire can be calculated by:

$$D = \sqrt{\frac{4 \times 9500}{\pi}} = 110\ m$$

Provided in **Appendix Table B-6** is a summary of the classes of materials stored within the facility, the applicable burning rates based on commodities stored and the contribution of each product to the total burning rate

Appendix Table B-6: Estimation of Average Burning Rate

Class	Quantity (L)*	% of Total Quantity	Burning Rate (kg/m^2.s)	Burning Rate Based on %
2.1	556,554	49.8	0.099	0.0493
3	494,678	44.3	0.0667	0.0295
4.1	7,051	0.60	0.022	0.0001
5.1	58,724	5.30	0.022	0.0012
Total	1,117,007	100	-	**0.0802**

*Assumed density of 1,000 kg/m^3

The following information was input into the models;

- Equivalent fire diameter – 110 m
- Burning rate – 0.0802 kg/m^2.s
- Fire wall height: no fire wall

The models provided the following information for the warehouse fire;

- SEP – 20 kW/m^2
- Flame Height – 105 m (from model without roof restriction)

Provided in **Appendix Table B-7** are the results generated by the SSC.

Appendix Table B-7: Heat Radiation Impacts from a Full Warehouse Fire

Heat Radiation (kW/m^2)	Distance (m)
35	Maximum heat flux is 20*
23	Maximum heat flux is 20*
12.6	32.0
4.7	72.0

* Research conducted in relation to large fires (Ref. [12]) indicates that where a large fire occurs, it is difficult for complete combustion to occur towards the centre of the fire due to the lack of air being unable to reach the centre of the flames. Hence, combustion tends to occur effectively at the fire surface, but poorly towards the centre of the fire. This generates large quantities of black smoke, which shields the flame surface as the smoke from the centre of the fire escapes towards the outer fire surface. The research presented in Lees (Ref. [11]) indicates that fires will generate a SEP within a range of between 20 kW/m^2 for larger fires and 130 kW/m^2 for smaller fires. Hence, a full warehouse fire would be of significant dimensions, generating large quantities of black smoke, shielding the flames at the fire surface. Hence, for the analysis of a full warehouse fire in this study, an SEP value of 20 kW/m^2 has been used.

B6. Full Warehouse Fire and Smoke Emission

During the fire, uncombusted toxic products may be present in the smoke plume or toxic bi-products may be generated which will be dispersed in the smoke plume. It is necessary to assess the associated impacts of the smoke plume downwind of the facility as it may have far reaching impacts on the wider community. When assessing the downwind impacts of the fire plume, the main contributors to the dispersion are:

- The fire size (diameter) and energy released as convective heat
- The atmospheric conditions such as wind speed, relative humidity, atmospheric stability and ambient temperature.

These parameters interact to determine the buoyancy of the smoke plume (vertical rise) which is controlled by the convective energy within the smoke plume in addition to the atmospheric conditions. The atmospheric conditions will vary from stable conditions (generally night time) to unstable conditions (high insolation from solar radiation) which results in substantial vertical mixing which aids in the dispersion. Contributing to this is the impact of wind speed which will limit the vertical rise of a plume but may exacerbate the downwind impact distance.

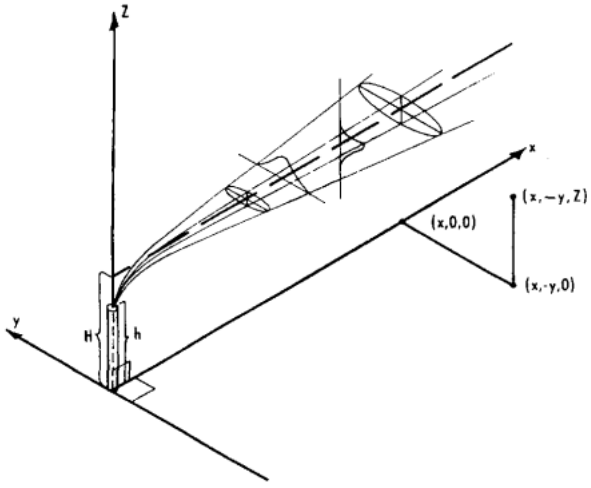
The atmospheric conditions are classified as Pasquill Guifford's Stability categories which are summarised in **Appendix Table B-8** (Ref. [12]).

Appendix Table B-8: Pasquill's Stability Categories

Surface wind speed at 10 m height (m/s)	Insolation			Night	
	Strong	Moderate	Slight	Thinly overcast or ≥50% cloud	<50% cloud.
<2	A	A-B	B	-	-
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
>6	C	D	D	D	D

Generally, the most onerous conditions are F conditions which result in stable air masses and typically have inversion characteristics. Inversion characteristics occur when a warm air mass sits above a cold air mass. Typically, hot air will rise due to lower density than the bulk air; however, in an inversion, a warm air mass sits above the cooler denser air; hence, as the warm air rises through the cold mass it hits a 'wall' of warmer air preventing vertical mixing above this point. In a fire scenario, the hot smoke plume will cool as it rises; however, if it encounters an inversion, it will begin to run along this boundary layer preventing vertical mixing and allowing the smoke plume to spread laterally for substantial distances.

A smoke plume is buoyant, and will disperse laterally and vertically as it rises essentially following a Gaussian dispersion as shown in **Appendix Figure B-2** (Ref. [12]).



Appendix Figure B-2: Co-ordinate System for Gas Dispersion

Ian Cameron, professor of Risk Engineering at the University of Queensland, has developed a risk assessment tool known as Risk Assessor produced by DAESIM Technologies. The tool has numerous risk engineering applications; however, the component of interest for this assessment is the smoke plume modelling from fire scenarios. The model has been developed based on a Gaussian dispersion model accounting for modifications to the plume drag coefficients required to model a plume dispersion from a warehouse fire (Ref. [12]).

The model requires several inputs which have been summarised in **Appendix Table B-9** with the associated value input as part of this modelling exercise. As noted, the more onerous conditions

occur during stable air conditions which allow far reaching effects with reduced dispersion due to low air velocities and vertical mixing. The industry standard for modelling this scenario is selection of F1.5 (F stability at 1.5 m/s wind velocity) which has been adopted for this assessment.

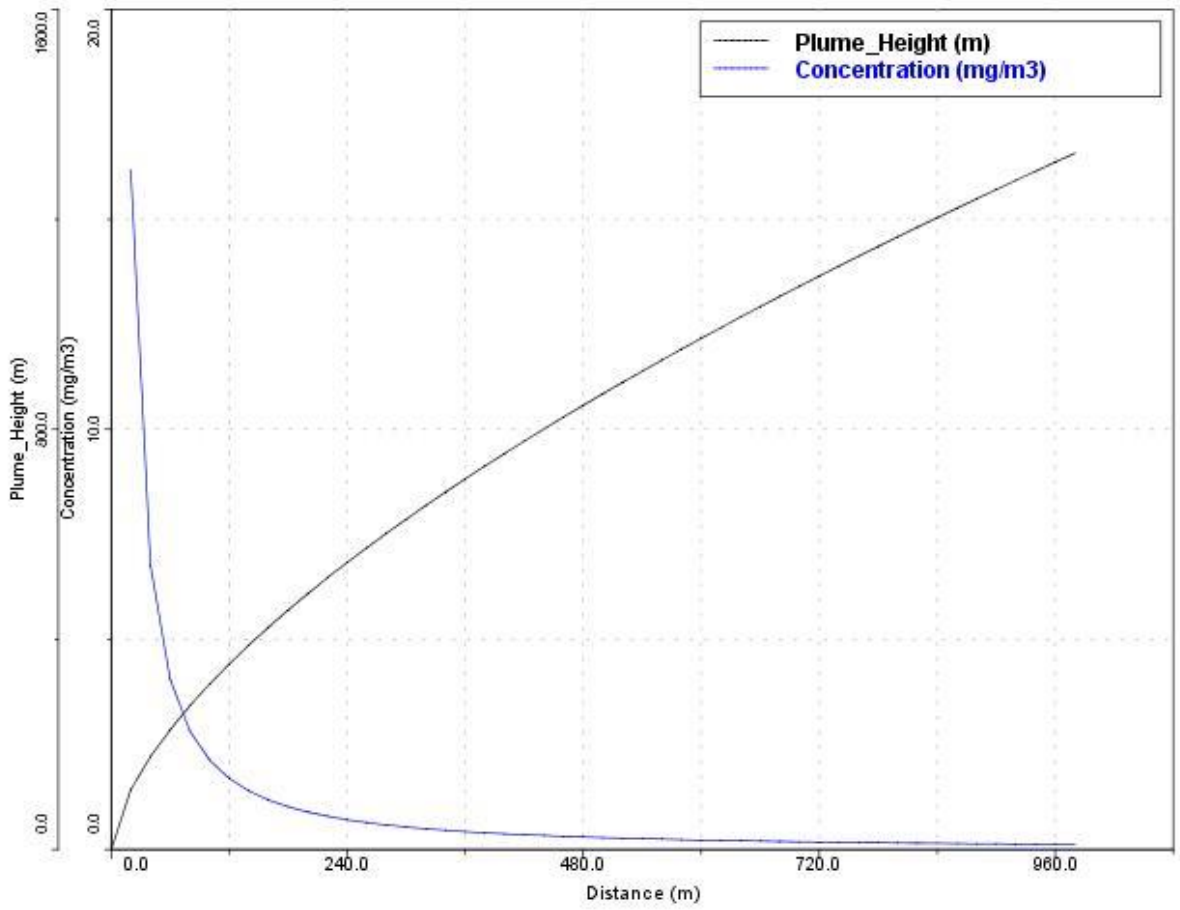
Appendix Table B-9: Input Data for Plume Gaussian Dispersion

Input	Selected Values	Justification
Max burning rate (kg/m^2.s)	0.0802	Taken from full warehouse fire above
Fire equivalent Diameter (m)	110	Equivalent diameter of the warehouse
Heat of combustion (kJ/kg)	45,000	Heat of combustion for combustible liquid (diesel) Ref. [14]
Fraction energy radiated	0.5	Conservative assumption based on high radiant heat blocking which occurs from dense smoke
Pollutant Rate (kg/s)	32,000	Burning rate multiplied by area multiplied by 7 (number of racks) multiplied by 6 (number of surfaces on a pallet that can burn)
Wind speed (m/s)	1.5	Industry standard
Stability	F	Industry standard

Provided in **Appendix Figure B-3** is an overlayed plot of plume smoke concentrations and plume height with distance. The analysis is based on the F stability; however, the Gaussian dispersion is unable to model temperature inversions. The response of the smoke plume to an inversion will depend on the height that the plume interacts with the inversion. At low altitudes, the smoke plume will have substantial heat and will 'punch through' the inversion and continue a Gaussian dispersion as expected. However, with increasing height, the plume will cool which may equalise at a temperature less than the inverted air mass. Subsequently, the plume will level out at the point of the inversion.

The worst-case concentration occurs in the initial phases of the fire and rapidly decrease with distance from the fire. It has been assumed that an inversion occurs at low level and the plume has insufficient heat to 'punch through' the inversion and remains trapped relatively close to the ground. A maximum value of 15 mg/m^3 has been selected per **Appendix Figure B-3** that may impact the surrounding area with regards to potential toxic bi-products of combustion.

Toxic products are a minor quantity of materials stored within the warehouse. Therefore, the mass of other products burning generating toxic bi-products of combustion far exceeds the quantity of toxic products that could be release in the smoke plume considering the majority of the toxic products will be combusted. Therefore, it is considered conservative to apply the toxic bi-products of combustion concentration to any toxic products stored in the warehouse.



Appendix Figure B-3: Plume Concentration and Plume Height vs Distance

Provided in **Appendix Table B-10** is a summary of several toxic products of combustion which may be present in the smoke plume and their acceptable concentration of exposure for the Acute Exposure Guideline Levels (AEGL). These levels provide guidance on exposure concentrations for general populations, including susceptible populations over a range of exposure times to assist in the assessment of releases which may result in a toxic exposure.

Provide below is a summary of the AEGL tiers of exposure:

- **AEGL-3** is the airborne concentration, expressed as parts per million (ppm) or milligrams per cubic meter (mg/m^3), of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
- **AEGL-2** is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- **AEGL-1** is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

Selection for fatality or serious injury is based on an AEGL-3 values with injury values selected as those based on AEGL-2. It is noted the report AEGL values are based on 30-minute exposure.

Appendix Table B-10: Concentration of Toxic Products of Combustion in Smoke Plume

Pollutant	Fatality or Serious Injury (ppm)	Injury (ppm)	Concentration (ppm)
Carbon monoxide	600	150	13.1
Nitric Dioxide	25	15	12.2
Hydrogen cyanide	21	10	13.6
Hydrogen chloride	210	43	10.1
Sulphur dioxide	30	0.75	5.7

B7. Fire Within the Autostore

The Autostore has approximate dimensions of 17 m x 30 m which is assumed to participate in a fire should one occur within the Autostore. The equivalent diameter for the fire can be calculated by:

$$D = \sqrt{\frac{4 \times 17 \times 30}{\pi}} = 25.5\ m$$

Provided in **Appendix Table B-9** is a summary of the classes of materials stored within the facility, the applicable burning rates based on commodities stored and the contribution of each product to the total burning rate

Appendix Table B-11: Estimation of Average Burning Rate

Class	Quantity (L)*	% of Total Quantity	Burning Rate (kg/m^2.s)	Burning Rate Based on %
2.1	1,160	6.300	0.099	0.0062
3	16,750	90.50	0.0667	0.0604
4.1	70	0.004	0.0667	0.0003
5.1	450	0.024	0.022	0.0005
8	5	0.000	0.022	0.0000
9	72	0.004	0.022	0.0001
Total	18,507	100	-	**0.0675**

*Assumed density of 1,000 kg/m^3

The following information was input into the models;

- Equivalent fire diameter – 25.5 m
- Burning rate – 0.0675 kg/m^2.s
- Fire wall height: no fire wall

The models provided the following information for the warehouse fire;

- SEP – 25.6 kW/m^2

- Flame Height – 34.3 m (from model without roof restriction)

Provided in **Appendix Table B-7** are the results generated by the SSC.

Appendix Table B-12: Heat Radiation Impacts from an Autostore Fire

Heat Radiation (kW/m^2)	Distance (m)
35	Maximum heat flux is 25.6*
23	6.9
12.6	12.2
4.7	25.7

* Research conducted in relation to large fires (Ref. [12]) indicates that where a large fire occurs, it is difficult for complete combustion to occur towards the centre of the fire due to the lack of air being unable to reach the centre of the flames. Hence, combustion tends to occur effectively at the fire surface, but poorly towards the centre of the fire. This generates large quantities of black smoke, which shields the flame surface as the smoke from the centre of the fire escapes towards the outer fire surface. The research presented in Lees (Ref. [11]) indicates that fires will generate a SEP within a range of between 20 kW/m^2 for larger fires and 130 kW/m^2 for smaller fires. Hence, a full warehouse fire would be of significant dimensions, generating large quantities of black smoke, shielding the flames at the fire surface. Hence, for the analysis of a full warehouse fire in this study, an SEP value of 20 kW/m^2 has been used.

Appendix C

Warehouse Fire Frequency Estimation

C1. Estimation of the Frequency of a Full Warehouse Fire

A review of readily available warehouse fire frequency information was conducted and a number of direct sources were identified. These were:

- Health and Safety Executive (HSE) in the United Kingdom [Hymes & Flynn, UKAEA - SRD/HSE R578, 2002] – this document lists the major warehouse fire frequency to be $2.5x10^{-3}$ p.a.;
- Baldwin, Accident Analysis and Prevention (Vol.6) – indicates a serious fire frequency in warehouses to be in the order of $1x10^{-3}$ p.a.;
- Environmental Impact Assessment Report for the Commission of Inquiry into Proposed Manufacturing Plant by WR Grace Australia Ltd., Kurnell, Sydney, October 1987 – indicates a fire frequency of $4.6x10^{-3}$ per warehouse year; and
- VROM 2005, Guidelines for quantitative risk assessment CPR 18E (Purple Book), Publication Series on Dangerous Substances (PGS 3), The Netherlands. – $4x10^{-4}$ p.a.

It is noted that the mix of overseas data and local data (albeit some is dated) correlates to indicate a fire frequency in warehouses to be in the order of $1x10^{-3}$ to $4x10^{-4}$. The data presented in the reports reviewed was for general warehouses, where stringent controls for spill and ignition sources (such as flame and explosion proof fittings, bunding, smoking and naked flame controls, isolation of power supplied on warehouse closure, etc.) were not part of the warehouse hazard controls. Hence, for a DG warehouse, containing specific ignition and fire control systems, it would be expected that a major fire would occur with a lesser frequency than that of general warehouses. Notwithstanding this, to ensure a conservative assessment has been provided within the study, the estimated initiating fire frequency for the DHL facility has been estimated as $1x10^{-3}$ p.a. (i.e. the upper end of the range).

Selected Initiating Fire Frequency = $1x10^{-3}$ p.a.

APPENDIX B FIRE SAFTEY STRATEGY

Core Engineering Group • Fire • Risk • Emergency Management

Goodman
Level 17, 60 Castlereagh Street
Sydney NSW 2000

2 May 2019 | Final Issue | Report No. 20191_FSS_08

Fire Safety Strategy

Lot 1A, 1B, 1C and 1D

Oakdale South Industrial Estate, Horsley Park

Sydney

Suite 401, Grafton Bond Building
201 Kent Street, Sydney NSW 2000

Phone | +61 2 9299 6605
Fax | +61 2 9299 6615
Email | sydney@coreengineering.com.au

Melbourne

Suite 107, 480 Collins Street
Melbourne VIC 3000

Phone | +61 3 8548 1818

Email | melbourne@coreengineering.com.au

www.coreengineering.com.au

Report Details

Project: Lot 1A, 1B, 1C and 1D
Oakdale South Industrial Estate, Horsley Park, NSW
Document: Fire Safety Strategy
Report No.: 20191_FSS_08

Report Revision History

REV	DATE ISSUED	COMMENT	PREPARED BY	REVIEWED BY	VERIFIED BY
01	02/09/15	Draft Issue for comment	**Jun Liu** *PhDEng (Chemical Engineering)*	**Graham Morris** *MEng (Structural and Fire Safety Engineering)*	
02	31/05/16	Updated Draft	**Dean Watt** *BEng (Chemical Engineering)*	**Colin Thomson** *BEng (Chemical Engineering)*	
03	03/06/16	Updated Draft (with Revised Drawings & Areas)			
04	25/07/16	Updated Master Plan			
05	27/07/16	Final Issue			**Sandro Razzi** *BE (Building)* *Grad Dip (Performance Based Building & Fire Codes)* *Accredited Fire Engineer* *BPB 0501* *FIEAust* *CPEng 2180287*
06	21/09/16	Final Issue with *Updated Master Plan*			
07	04/05/17	Final Issue *Update to include revised Precinct 1 Masterplan & BCA Non-Compliances*		**Sandro Razzi** *BE (Building)* *Grad Dip (Performance Based Building & Fire Codes* *Accredited Fire Engineer*	
08	02/05/19	Final Issue *Update to consider Dangerous Goods storage within Warehouse 1D*	**Dean Watt** *BEng (Chemical Engineering)*	**Graham Morris** *MEng (Structural and Fire Safety Engineering*) *MIEAust, CPEng, NER (Fire Safety)*	

TABLE OF CONTENTS

1 INTRODUCTION

1.1 OVERVIEW

This Fire Engineering Report has been undertaken to nominate proposed Alternative Solutions for assessing compliance with the nominated Performance Requirements of the Building Code of Australia 2015 (BCA) [1] in accordance with the methodologies defined in the International Fire Engineering Guideline IFEG [3].

In order to develop and assess the nominated non-compliances the following flowchart process is to be adopted.

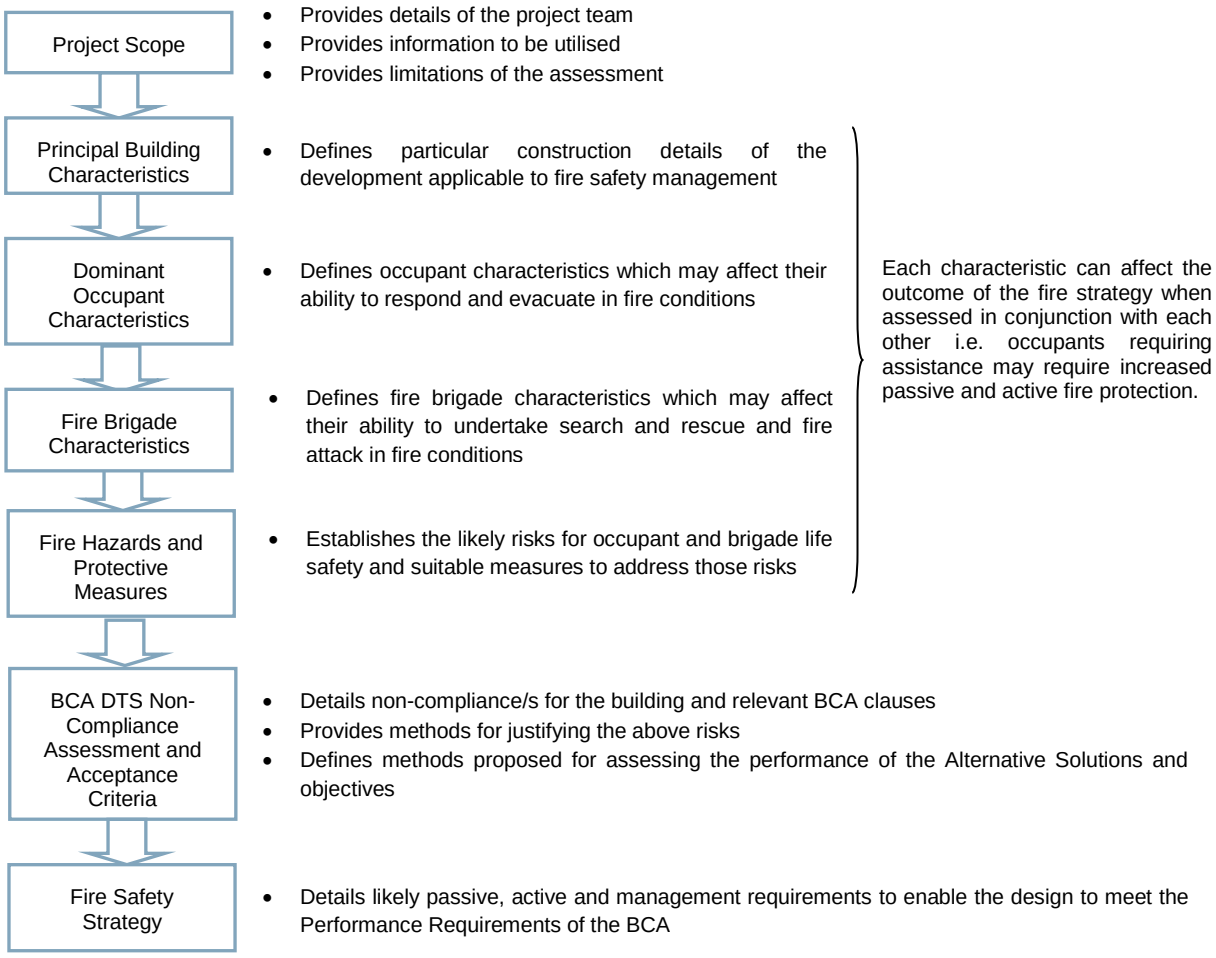


Figure 1-1: Fire Safety Strategy Process

The scope of the Fire Safety Strategy is to detail the nominated non-complying BCA Deemed-to-Satisfy (DTS) provisions with the performance requirements of the BCA and provide methodologies for establishing a workable and safe Fire Safety Strategy through a trial design.

1.2 FIRE SAFETY OBJECTIVES

The objective of this Fire Engineering Assessment is to develop a Fire Safety System, which satisfies the performance requirements of the BCA whilst maintaining an acceptable level of life safety, protection of adjacent property and adequate provisions for Fire Brigade intervention. At a community level, fire safety objectives are met if the relevant legislation and regulations are complied with. As stated in the BCA, "*A Building Solution will comply with the BCA if it satisfies the Performance Requirements*". In addition to this, certain non-regulatory objectives exist as detailed below.

1.2.1 Building regulatory objectives

The following items are a summary of the fire and life safety objectives of the BCA:

- **Life safety of occupants -** the occupants must be able to leave the building (or remain in a safe refuge) without being subject to hazardous or untenable conditions. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would minimise the risk of exposing building occupants to hazardous or untenable conditions in an event of a fire.
- **Life safety of fire fighters -** fire fighters must be given a reasonable time to rescue any remaining occupants before hazardous conditions or building collapse occurs. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would facilitate fire brigade intervention and minimise the risk of exposing fire fighters to hazardous or untenable conditions in an event of a fire.
- **Protection of adjoining buildings** - structures must not collapse onto adjacent property and fire spread by radiation should not occur. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would minimise the risk of fire spreading from one building to another.

1.2.2 Fire Brigade objectives

The overall philosophical Fire Brigade objectives throughout Australia are to protect life, property and the environment from fire according to the Fire Brigade Intervention Model (FBIM) [11] as per the Fire Services State and Territory Acts and Regulations.

Over and above the requirements of the BCA, the Fire Brigade has functions with regard to property and environmental protection and considerations regarding occupational health and safety for its employees.

1.2.3 Non-prescribed objectives

Fire Engineering has an overarching benefit to many facets of the built environment where non-prescribed objectives can have an influence on the Fire Safety Strategy adopted. Although not assessed within, the following can be considered if requested.

- **Business continuity -** will the loss of a particular facility due to fire / smoke damage result in excessive financial impact on the client? For example, is the facility critical to business continuity?
- **Public perception -** should a fire occur within the facility is there likely to be questionable public perception about the safety and operation of the facility?
- **Environmental protection -** fires of excessive sizes can have significant effects on the environment which may require a detailed risk assessment to minimise such outcomes.
- **Heritage salvation -** buildings can have a heritage value for both cultural and educational purposes which can be destroyed by insufficient fire protection.
- **Risk mitigation / insurance limitations -** are there specific limitations on insurance with respect to risk mitigation and fire safety design? i.e. Does the relevant insurer have concerns with respect to open voids through the building?
- **Future proofing (isolation of systems) -** what flexibility is required in the overall design to allow for future development or changes in building layout?
- **Occupational Health and Safety (OHS) requirements -** buildings may have specific fire safety requirements pertaining to OHS requirements.

1.3 REGULATORY FRAMEWORK OF THE FIRE ENGINEERING ASSESSMENT

1.3.1 Building Code of Australia

One of the goals of the BCA is the achievement and maintenance of acceptable standards of safety from fire for the benefit of the community. This goal extends no further than is necessary in the public interest and is considered to be cost effective and not needlessly onerous in its application.

Section A0.5 of the BCA [1] outlines how compliance with the Performance Requirements can be achieved. These are as follows:

(a) complying with the Deemed-to-Satisfy Provisions; or

(b) formulating an Alternative Solution which –

(i) complies with the Performance Requirements; or

(ii) is shown to be at least equivalent to the Deemed-to-Satisfy Provisions or

(c) a combination of (a) and (b).

Section A0.9 of the BCA provides several different methods for assessing that an Alternate Solution complies with the Performance Requirements. These methods are summarised as follows:

(a) Evidence to support that the use of a material, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision.

(b) Verification Methods such as:

(i) the Verifications Methods in the BCA; or

(ii) such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements.

(c) Comparison with the Deemed-to-Satisfy Provisions.

(d) Expert Judgment.

Section A0.10 of the BCA provides methods for complying with provisions A1.5 (to comply with Sections A to J of the BCA inclusive). The following method must be used to determine the Performance Requirements relevant to the Alternative Solution: These methods are summarised as follows:

(a) Identify the relevant Deemed-to-Satisfy Provision of each Section or Part that is to be the subject of the Alternative Solution.

(b) Identify the Performance Requirements from the same Section or Part that are relevant to the identified Deemed-to-Satisfy Provisions.

(c) Identify Performance Requirements from the other Sections and Parts that are relevant to any aspects of the Alternative Solution proposed or that are affected by the application of the Deemed-to-Satisfy Provisions that are the subject of the Alternative Solution.

1.3.2 International Fire Engineering Guidelines

The IFEG [3] document has been developed for use in fire safety design and assessment of buildings and reflects world's best practice. The document is intended to provide guidance for fire engineers as they work to develop and assess strategies that provide acceptable levels of safety.

The document is particularly useful in providing guidance in the design and assessment of Alternative Solutions against the Performance Requirements of the BCA. The prescribed methodology set out in the IFEG has been generally adopted in the Fire Engineering Report.

2 PROJECT SCOPE

2.1 OVERVIEW

Core Engineering has been engaged to develop a Fire Safety Strategy for the construction of Lot 1A, 1B, 1C and 1D at Oakdale South Industrial Estate, Horsley Park NSW. The purpose of this fire safety strategy is to outline the fire engineering principles that will be utilised in ensuring that the prescriptive Deemed-to-Satisfy (DTS) non-compliances noted in the Building Code of Australia (BCA) report are resolved in order to conform to the building regulations and permit development approval.

The complete fire engineered analysis will be included within the Fire Engineering Report, and as such is not documented herein. This document does however outline the construction and management requirements considered necessary to achieve an acceptable level of life safety within the building as a result of the Alternative Solution and to satisfy the Performance Requirements of the BCA.

2.2 RELEVANT STAKEHOLDERS

This Alternative Solution has been developed collaboratively with the relevant stakeholders as identified below:

Table 2-1: Relevant Stakeholders

ROLE	NAME	ORGANISATION
Planning Manager	Guy Smith	Goodman
Principal Certifying Authority/BCA Consultant	Dean Goldsmith Tony Heaslip	Blackett Maguire + Goldsmith
Architect	Greg Baird Michael Harris	SBA Architects
Fire Engineer	Dean Watt Graham Morris	Core Engineering
C10 Accredited Fire Engineer	Sandro Razzi	

It should be noted that at times some parties may have a vested interest in the outcome of the Fire Engineering assessment. Such parties can include local fire brigades, insurers, Environmental Protection Authority (EPA), project control groups, end users and community representatives. Although not always a legislative requirement, the design team should give due consideration to their inclusion in the Fire Engineering process. Where not required by legislation it is the client's decision to involve such parties, especially local fire brigade, to ensure a transparent and adequate fire safety solution for all. Where we are not notified of the inclusion of such parties it is assumed the client / representative has given due consideration to the above.

2.3 SOURCES OF INFORMATION

The following sources of information have been provided by the design team:

- The BCA report provided by Blackett Maguire + Goldsmith, Revision 3 dated 03/05/2017.
- Architectural plans provided by SBA Architects, as indicated in Table 2-2.
- Preliminary Hazard Analysis provided by RiskCon Engineering, Revision 0, dated 23 April 2019.

Table 2-2: Drawings

DRAWING NO.	DESCRIPTION	ISSUE	DATE
OAK SOU MP02	Precinct Master Plan	HH	24/04/2017
OAK SOU MP04	Precinct 1 Plan	P	21/04/2017
OAK SOU 1B DA20	Proposed Industrial Facility – Building 1B Site Plan	P	21/04/2017

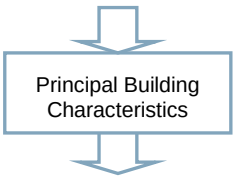
2.4 LIMITATIONS AND ASSUMPTIONS

In this instance the Fire Safety Strategy is developed based on applicable limitations and assumptions for the development which are listed as follows:

- The report is specifically limited to the project described in Section 3.
- The report is based on the information provided by the team as listed above in Section 2.3.
- Building and occupant characteristics are as per Section 3 and 4 respectively of this report. Variations to these assumptions may affect the Fire Engineering Strategy and therefore they should be reviewed by a suitably qualified Fire Engineer should they differ.
- As per any building design, DTS or otherwise, the report is limited to the fire hazards and fuel loads as prescribed in Section 6.2 and 6.4 respectively. The report does not provide guidance in respect of areas, which are used for Dangerous Good storage, processing of flammable liquids, explosive materials, multiple fire ignitions or sabotage of fire safety systems.
- The development complies with the fire safety DTS provisions of the BCA [1] with all aspects for fire and life safety unless otherwise stated in this report. Where not specifically mentioned, the design is expected to meet the BCA DTS requirements of all relevant codes and legislation at the time of construction and / or at the time of issue of this report.
- The assessment is limited to the objectives of the BCA and does not consider property damage such as building and contents damage caused by fire, potential increased insurance liability and loss of business continuity.
- Malicious acts or arson with respect to fire ignition and safety systems are limited in nature and are outside the objectives of the BCA. Such acts can potentially overwhelm fire safety systems and therefore further strategies such as security, housekeeping and management procedures may better mitigate such risks.
- This report is prepared in good faith and with due care for information purposes only, and should not be relied upon as providing any warranty or guarantee that ignition or a fire will not occur.
- The Fire Engineering Strategy is only applicable to the completed building. This report is not suitable, unless approved otherwise, to the building in a staged handover.
- Where parties nominated in Section 2.2 have not been consulted or legislatively are not required to be, this report does not take into account, nor warrant, that fire safety requirements specific to their needs have been complied with.

3 PRINCIPAL BUILDING CHARACTERISTICS

3.1 OVERVIEW



Building characteristics are assessed as part of the Fire Engineering Review due the following:

1. The location can affect the time for fire brigade intervention and potential external fire exposure issues.
2. The structure will impact on the ability to resist a developing fire and support condition to allow occupants to escape the building and the fire brigade to undertake firefighting to the degree necessary.
3. The floor area determines the potential fire size and area required to be evacuated in the event of a fire.
4. BCA details such as Type of Construction, Class and Height will dictate passive and active fire safety systems.

3.2 SITE LOCATION

The development site is located in Horsley Park, approximately 41km north-west of Sydney's central business district. The Oakdale South Industrial Estate consists of six precincts and is located on Estate Road connecting to Milner Avenue. This report is for Precinct 1 within the estate.

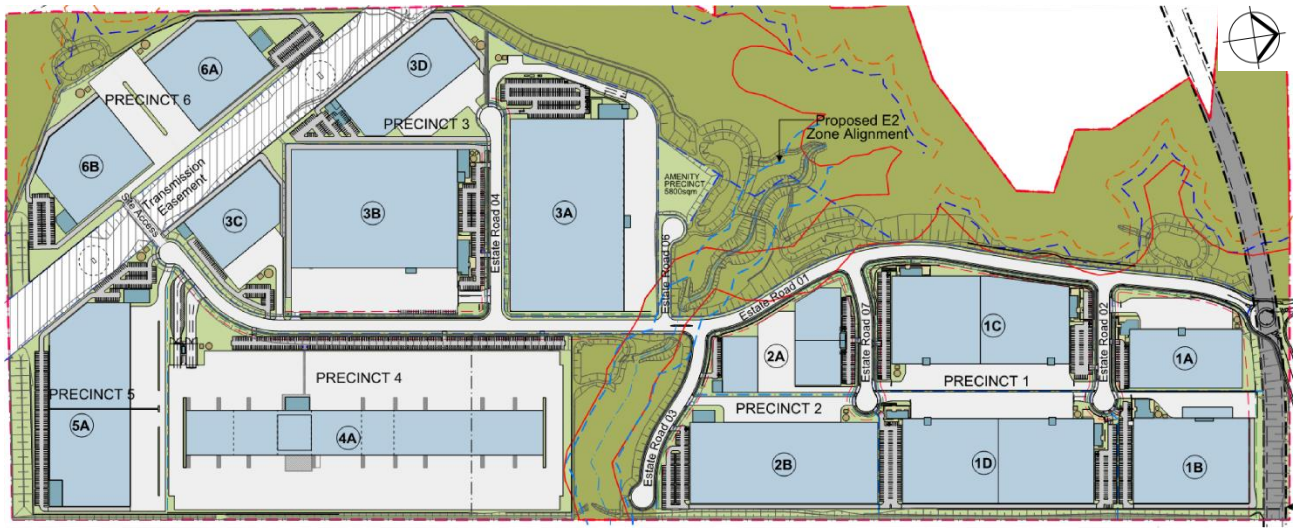


Figure 3-1: Estate Plan **Source: www.googlemaps.com.au**

Precinct 1 consists of four buildings on four sites, i.e. Lot 1A to 1D. Lots 1C and 1D consist of two warehouses adjoining one another to constitute a single building (Figure 3-2).

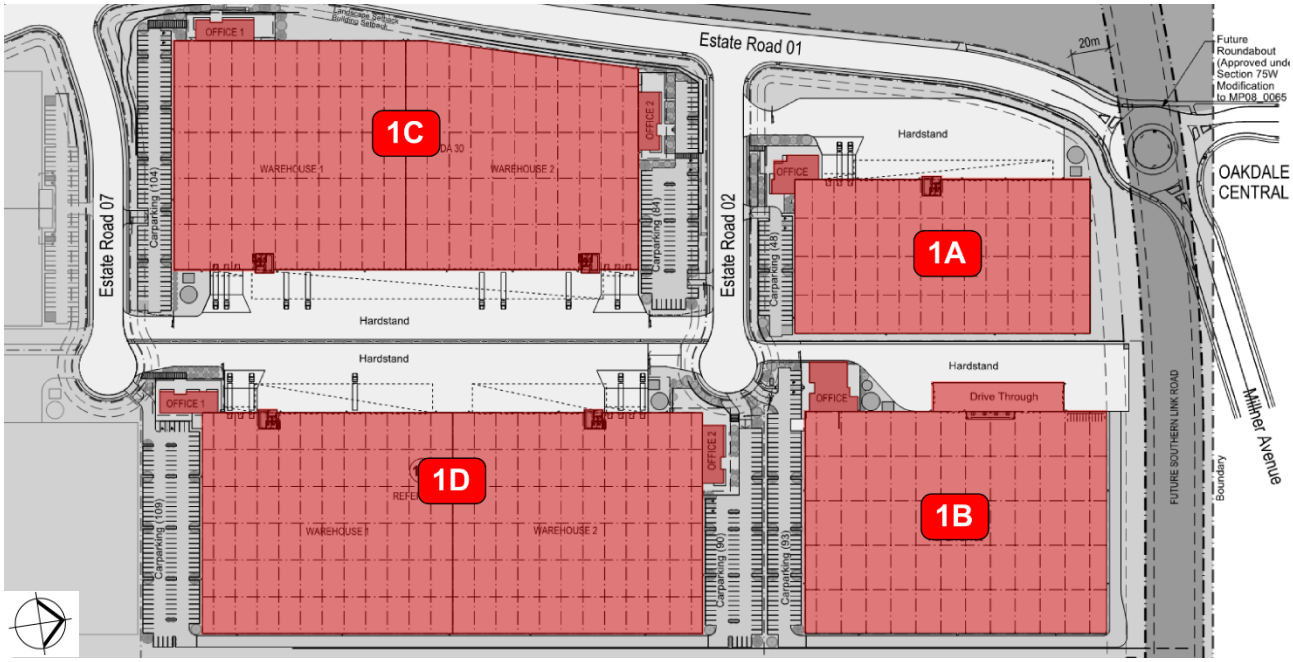


Figure 3-2: Precinct 1 Layout

The building site influences the likely fire brigade intervention times, and given the close proximity to the nearest fire station is expected to facilitate a relatively convenient and expedient fire brigade response. Furthermore, being located in an outer suburb of a major city, the development is provided with the services and facilities expected in an urban setting. The two nearest fire brigade stations provided with permanent staff are Huntingwood and Mount Druitt approximately 10.7km and 10.9km from the site respectively when considering actual driving directions.

3.3 SITE LAYOUT

The Lot 1A building consists of a single warehouse (12,130m^2). The total building floor area is approximately 12,964m^2. Also provided is a 2-storey ancillary office (739m^2) and single-storey dock office (95m^2). Figure 3-3 illustrates the floor areas of warehouse and ancillary offices.

Onsite external carparking is available to the north, east and south of the site. Loading docks and associated hardstands for the warehouses are located in the centre of the site.

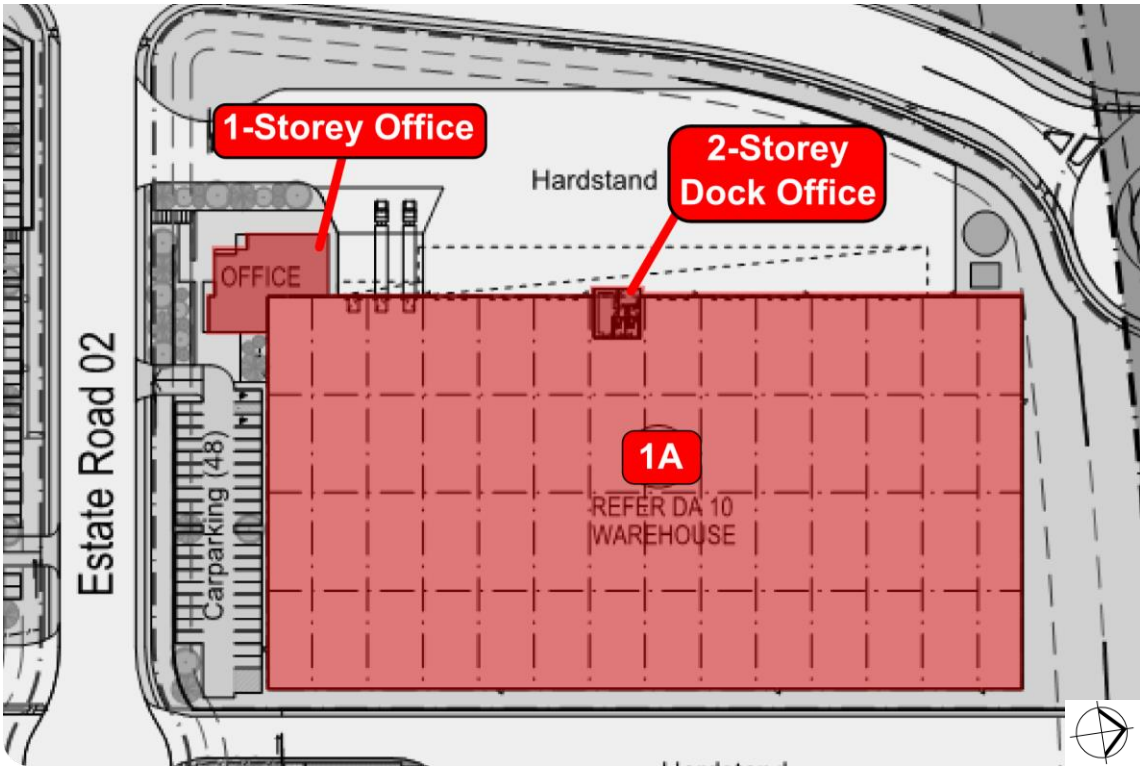


Figure 3-3: Site Plan of Lot 1A

The Lot 1B building has a total floor area of approximately 19,532m^2, consisting of a warehouse (17,900m^2), single-storey office (532m^2) and single-storey dock office (100m^2). Onsite external carparking is available to the south of the site. Loading docks and associated hardstands for the warehouse are provided to the west. A drive-through area is also provided adjacent to the dock office on the hardstand (1,000m^2).

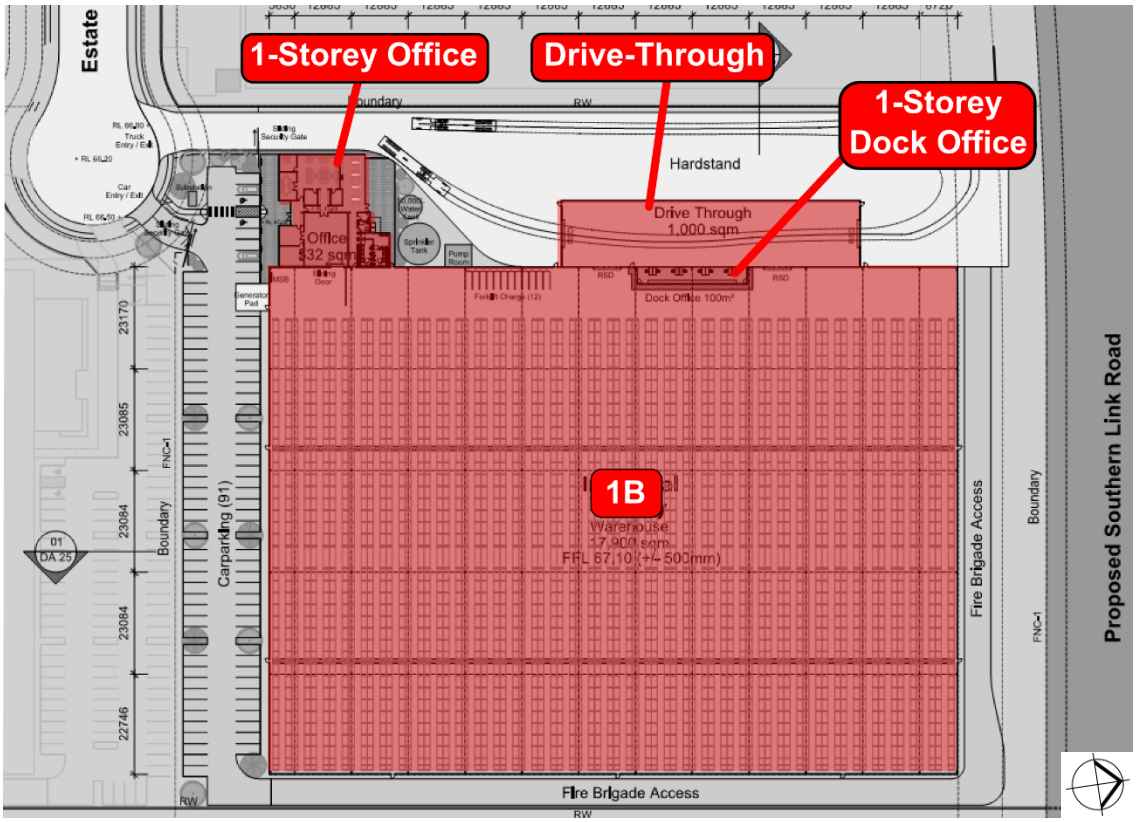


Figure 3-4: Site Plan of Lot 1B

The Lot 1C building consists of 2 adjoining warehouses with the total floor area of approximately 29,404m^2. Warehouse 1 and 2 have a floor area of 14,180m^2 and 13,460m^2 respectively. Each warehouse is provided with a 2-storey office (692m^2) and a 2-storey dock office (190m^2).

Onsite external carparking is available to the north and south of the site. Loading docks and associated hardstands for the warehouses are located in the east of the site.

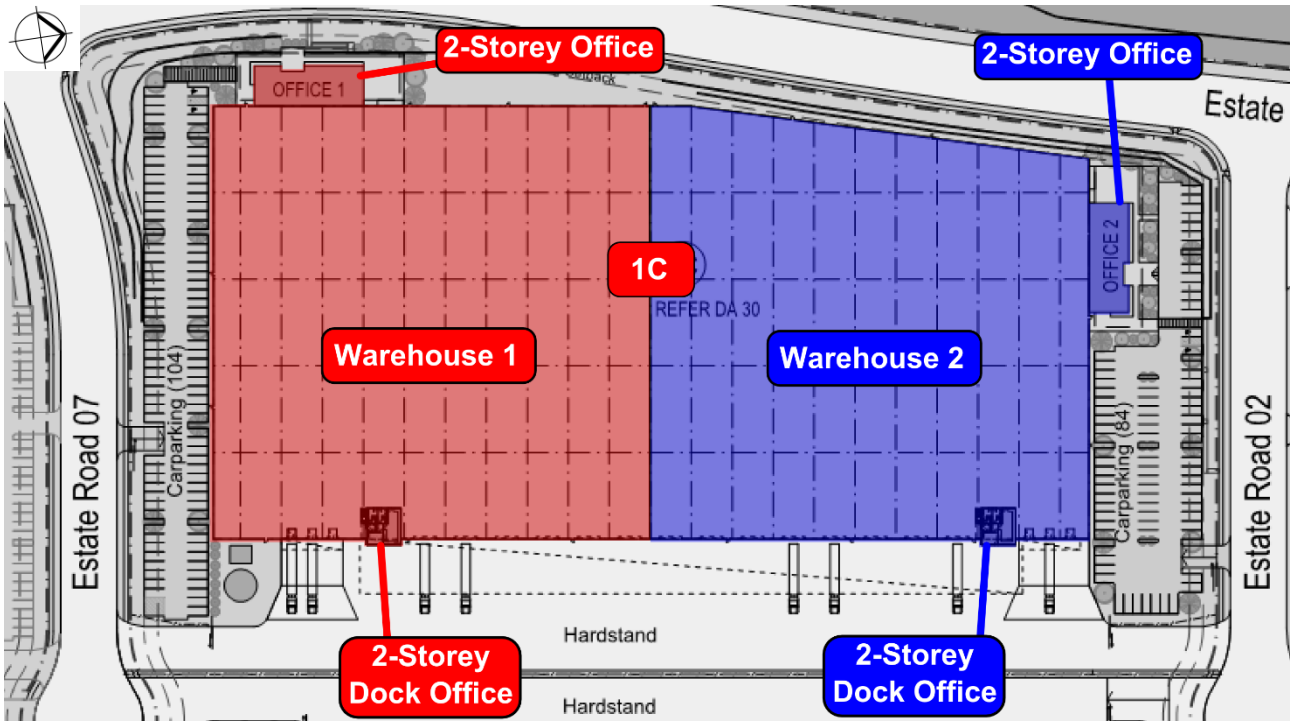


Figure 3-5: Site Plan of Lot 1C

The Lot 1D building has a total floor area of approximately 31,330m^2, consisting of two adjoining warehouses (14,750m^2 each), with each warehouse being provided with a 2-storey office (758m^2 and 692m^2) and a 2-storey dock office (190m^2 each). It is proposed to incorporate Dangerous Goods storage within Tenancy 2 (see Section 6.7.5).

Onsite external carparking is available to the north and south of the site. Loading docks and associated hardstands for the warehouses are located on the west.

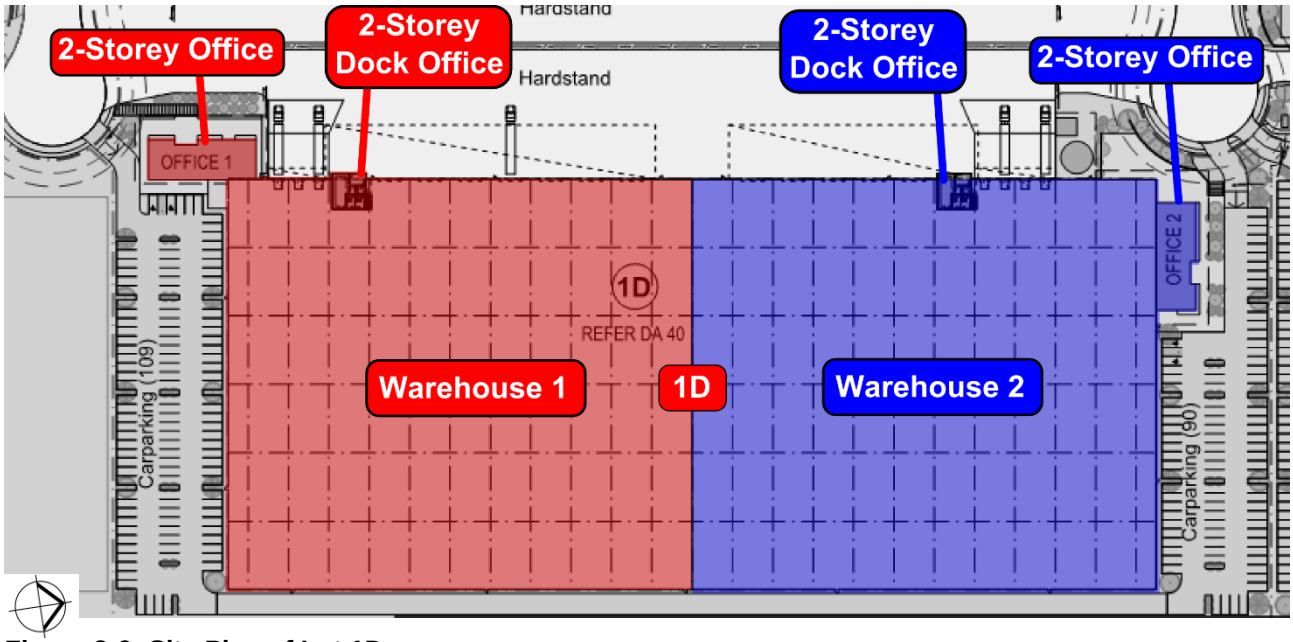


Figure 3-6: Site Plan of Lot 1D

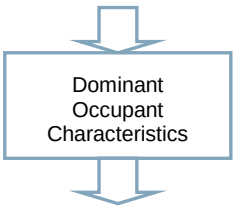
3.4 BCA ASSESSMENT SUMMARY

Table 3-1: BCA Building Characteristics

CHARACTERISTIC	DESCRIPTION
Classification	Class 7b (Warehouse), Class 5 (Office) for each building
Construction Type	Type C Construction (*Large Isolated Building*) for each building
Rise in Storeys	Two (2) for each building
Effective Height	Less than 12m for each building
Floor Area	The total floor area of the building is detailed below. **Lot 1A** • Warehouse: 12,130 m² • Two-storey office: 739 m² • One-storey dock office: 95 m² ***TOTAL: 12,964 m²*** **Lot 1B** • Warehouse: 17,900 m² • One-storey office: 532 m² • One-storey dock office: 100 m² • Drive through: 1000 m² ***TOTAL: 19,532 m²*** **Lot 1C** • Warehouse 1: 14,180 m² • Two-storey office 1: 692 m² • Two-storey dock office 1: 190 m² • Warehouse 2: 13,460 m² • Two-storey office 2: 692 m² • Two-storey dock office 2: 190 m² ***TOTAL: 29,404 m²*** **Lot 1D** • Warehouse 1: 14,750 m² • Two-storey office 1: 758 m² • Two-storey dock office 1: 190 m² • Warehouse 2: 14,750 m² • Two-storey office 2: 692 m² • Two-storey dock office 2: 190 m² ***TOTAL: 31,330 m²***

4 DOMINANT OCCUPANT CHARACTERISTICS

4.1 OVERVIEW



The occupant characteristics are assessed within the Fire Engineering Report due to the following:

1. Population numbers can dictate the time required to evacuate the building and the required life safety systems to be provided due to evacuation times.
2. Physical and mental attributes affect the occupants' capacity to respond to various fire cues and react accordingly.
3. Familiarity of occupants can affect the time taken to evacuate the building and subsequent active / passive requirements.

4.2 OCCUPANT NUMBERS AND DISTRIBUTION

The BCA assumes the following occupant densities per an area's function and use according to Table D1.13:

- Warehouse: 30m^2 per person
- Office: 10m^2 per person

These values result in the following estimated populations based on the floor areas provided in Section 3.4.

Table 4-1: Estimated Building Population (DTS Table D1.13)

LOT NO	BUILDING PART	FLOOR AREA	OCCUPANT NUMBER
1A	Warehouse	12,130m^2	404
	Office	739m^2	73
	Dock Office	95m^2	9
1B	Warehouse	18,000m^2	600
	Office	532m^2	53
	Dock Office	100m^2	10
1C	Warehouse 1	14,180m^2	472
	Warehouse 2	13,460m^2	448
	Office 1/2	692m^2	69
	Dock Office 1/2	190m^2	19
1D	Warehouse 1/2	14,750m^2	491
	Office 1	758m^2	75
	Office 2	692m^2	69
	Dock Office 1/2	190m^2	19

In the absence of specific occupant numbers provided by the tenant, the population estimated from Table D1.13 of the BCA DTS Provisions will be utilised in the analysis, therefore providing a conservative population in the warehouse parts.

4.3 OCCUPANT ATTRIBUTES

Occupants in the building may be of mixed age, although the elderly and children are generally not expected to be present. The population is therefore expected to be that of the general working public and be adults between the ages of 16 to 70. Due to the nature of the work conducted the majority of occupants are assumed to be able bodied people with a small number of less mobile occupants requiring assistance during an evacuation.

All occupants are expected to be awake and alert adults or in the direct company of an adult, capable of entering the leaving the building under their own volition. Occupants in all of these areas are not expected to

be adversely impaired by drugs, alcohol, fatigue or other adverse conditions to degrees greater than in other warehouse and office buildings.

- ***Staff and Security*** are expected to be mobile with normal hearing and visual abilities, and occupants in this group are considered to take and implement decisions independently, and require minimal assistance during evacuation in a fire emergency. This occupant group is expected to be awake and fully conscious at all times when inside the building; and
- ***Clients / Visitors*** are expected to be mobile with normal hearing and visual abilities, this occupant group are expected to be capable of making and implementing decisions independently however may require assistance in locating the nearest and safest egress path in an emergency; and
- ***External Maintenance Contractors*** are expected to be mobile with normal hearing and visual abilities and occupants in this group are considered to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. The contractors are expected to be awake and aware of their surroundings at all times when inside the building; and
- ***FRNSW*** are expected to be equipped with safety equipment and will be educated in firefighting activities and the dangers associated with fire incidents. This occupant group would be expected to be in a position to assist other occupants requiring assistance to evacuate. It is not expected that this occupant group would be present in the building at the time of fire ignition; however, they are expected to enter the building at a later stage to assist with the evacuation of occupants, if required, and to undertake fire suppression activities.

4.4 OCCUPANT FAMILIARITY

The majority of occupants within the building are expected to be staff and therefore the population in general are likely to react favourably in an emergency situation.

- ***Staff, Maintenance and Security*** can be expected to have a good familiarity with the building and the fire safety systems provided and may be trained in emergency procedures; and
- ***Clients / Visitors*** may or may not be familiar with the layout of the building and may require assistance in locating the exits; and
- ***External Maintenance Contractors*** this occupant group is expected to have a reasonable familiarity with the building as they would have to undergo site specific induction prior to commencement of work on site; and
- ***FRNSW*** are not expected to have any familiarity of the building layout, however are assumed to obtain the required information from the site block plans and tactical fire plans available prior to entering the building. Notwithstanding this they will be equipped with breathing apparatus and specialist equipment to prevent them from being adversely affected by fire hazards.

4.5 EMERGENCY TRAINING

Occupants should be familiar with escape procedures through fire drills and designated fire wardens being appointed to mitigate risks under Workplace Health and Safety legislation (AS 3745:2010). Clear escape routes should be maintained with doors unlocked, and no obstructions or rubbish to hinder evacuation.

Staff and visitors are not expected to have fire suppression training and such training is not relied upon for this building population; however, staff are expected to possibly attempt to extinguish a fire or limit fire spread by removing objects in the vicinity of the fire in order to defend their belongings.

5 FIRE BRIGADE CHARACTERISTICS

5.1 OVERVIEW

The fire brigade characteristics are assessed within the Fire Engineering Report due to the fact that Fire Brigade characteristics can dictate the time required for fire brigade intervention including search and rescue and fire attack.

5.2 FIRE BRIGADE ASSESSMENT

The following figures illustrate the site plan with fire services provided on the site. These include vehicular perimeter access, the Fire Control Centres (FCCs), main FIPs, Sub FIPs, sprinkler tanks and pump rooms.

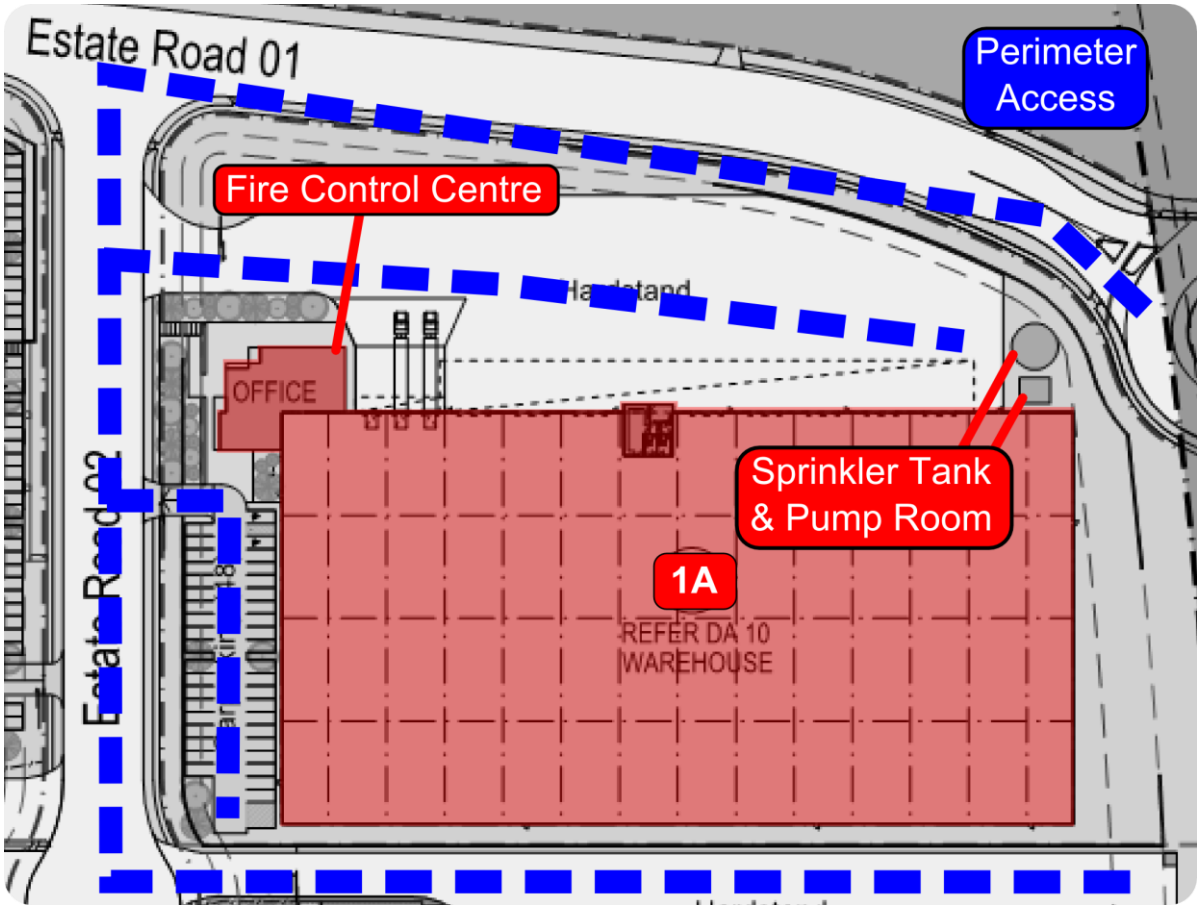


Figure 5-1: Fire Brigade Access and Site Facilities for Lot 1A

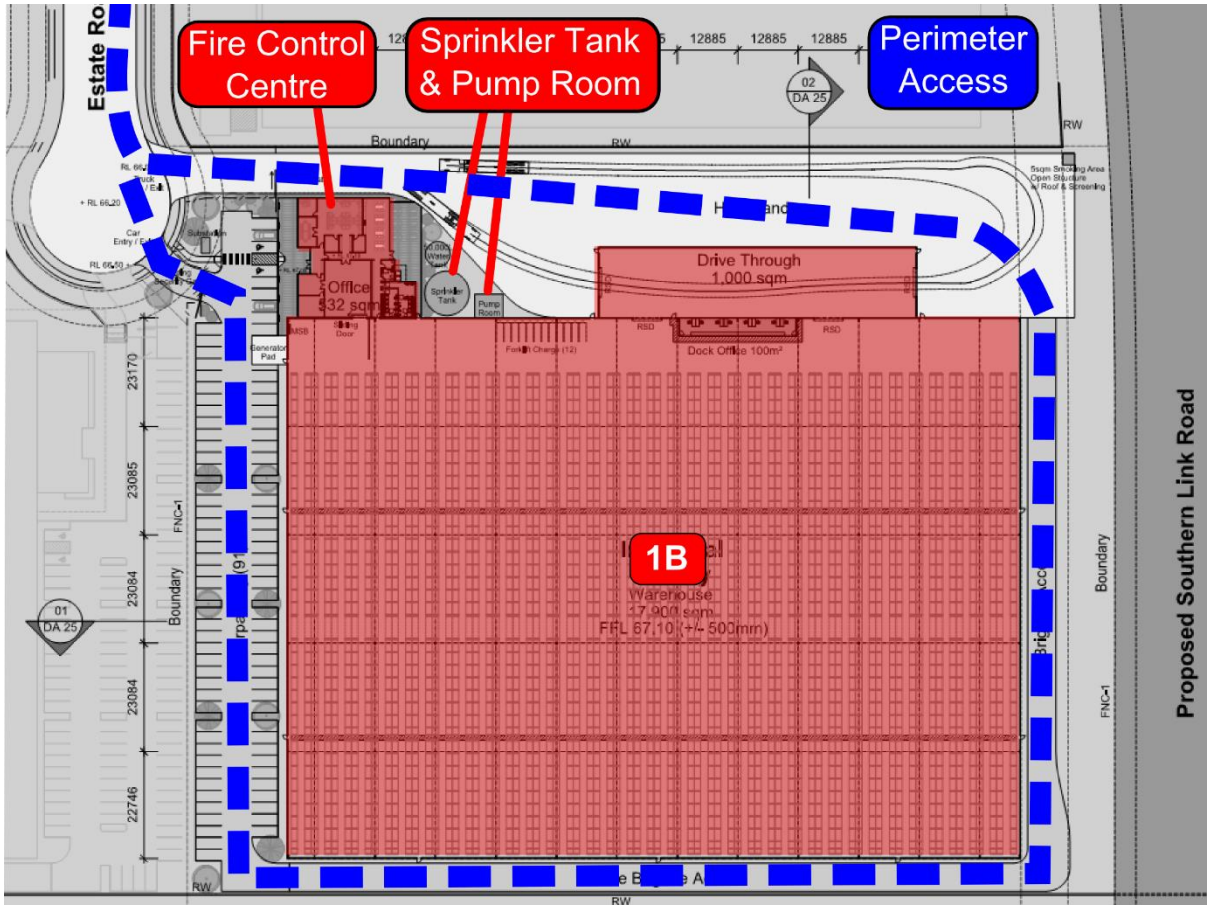


Figure 5-2: Fire Brigade Access and Site Facilities for Lot 1B

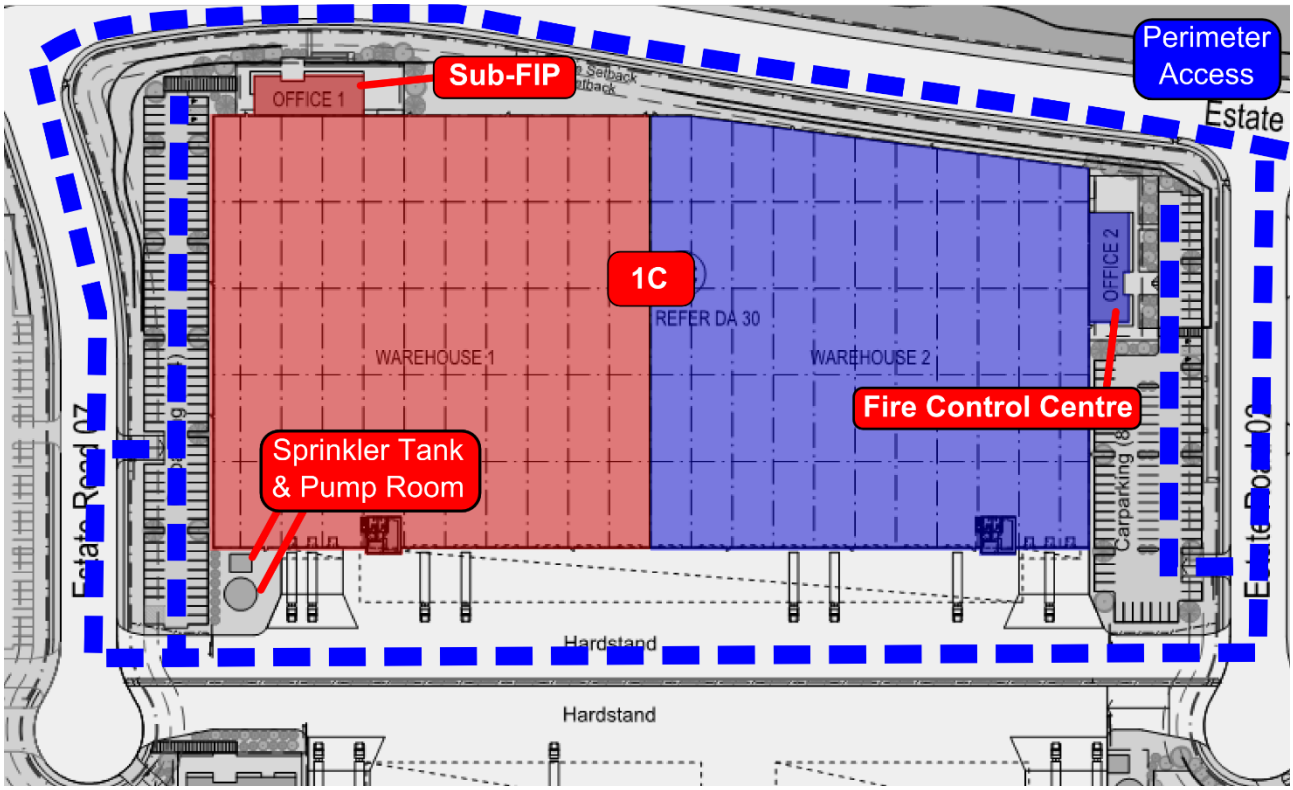


Figure 5-3: Fire Brigade Access and Site Facilities for Lot 1C

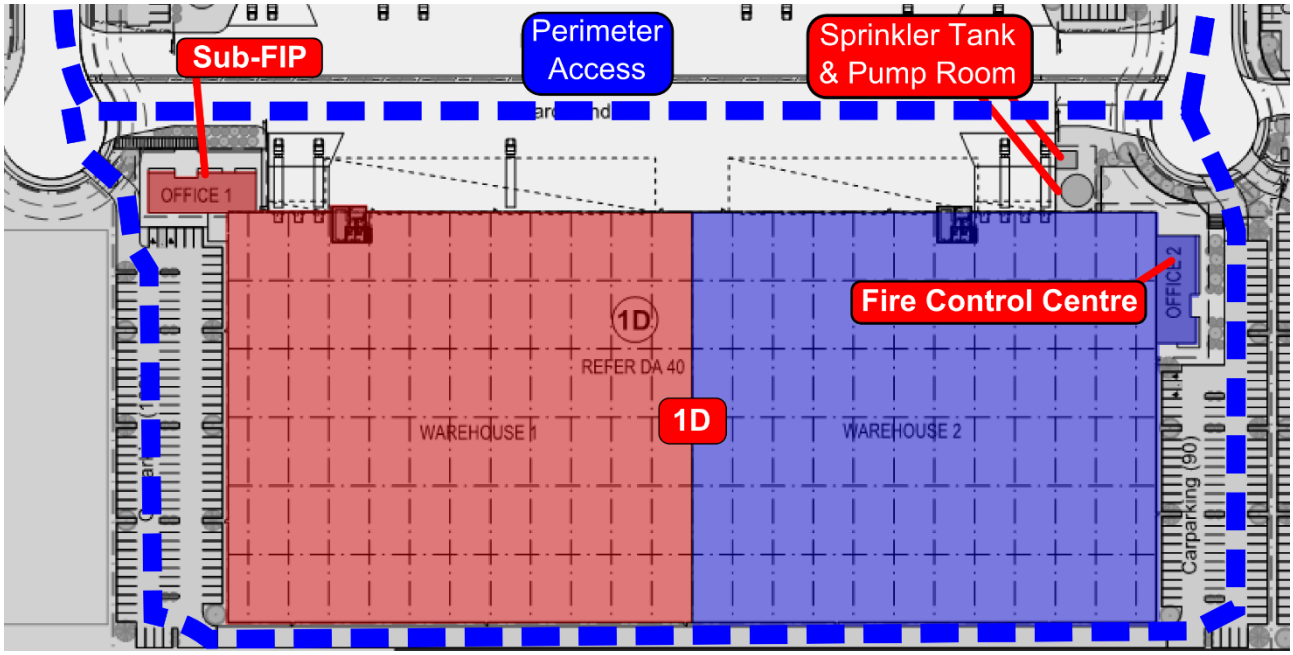


Figure 5-4: Fire Brigade Access and Site Facilities for Lot 1D

The building is located within the Fire and Rescue New South Wales (FRNSW) jurisdictional turnout area. The closest two fire stations to the site that are provided with permanent staff are located in Huntingwood and Mount Druitt approximately 10.7km and 10.9km.

6 FIRE HAZARDS AND PROTECTIVE MEASURES

6.1 OVERVIEW

The fire hazard analysis forms the basis for the review of non-compliances within the building. In assessing expected and statistically validated hazards, preventative and protective measures are developed commensurate with those expected risks. The following section reviews applicable hazards and recommends possible measures to address those risks. Furthermore, hazards identified can form a justified basis for selected scenarios.

6.2 FIRE STATISTICS

In order to assess the most likely fire hazards within the building, and subsequently the risk presented by these hazards it is necessary to develop an understanding of the factors that have an influence on the fire safety of building occupants. The best method in doing so is to review existing statistical data.

Existing data is an invaluable tool in providing an overview of the situations in which occupant deaths have, and are likely to occur, and factors that contribute to more severe fires. This aids in understanding, and helps evaluate the effectiveness of, and the need for various fire safety systems. Reference is made to the American database as it is significantly larger than Australian data sets, but is generally considered to be representative of the Australian situation.

Table 6-1: Fire Statistics in all Building Types [5]

STRUCTURE USE	FIRES PER YEAR	CIVILIAN FATALITIES PER YEAR	CIVILIAN FATALITIES PER 1000 FIRES
Hospitals	1,288	0	0
Schools	4,060	0	0
Public assembly	14,650	5	0.34
Retail/Department Store	1,150	1	0.87
Business offices	2,890	3	1.04
Manufacturing	5,303	7	1.32
Vehicle Storage/Garage	6,200	10	1.61
24-hour nursing homes	2,749	5	1.82
Hotels or motels	3,610	11	3.05
Warehouse	1,270	4	3.15
Apartments	106,380	410	3.85
Homes	260,180	2165	8.32

From the NFPA ‘Structure Fires by Occupancy 2007-2011’ Report [5], The civilian fatality rates from 2007 to 2011 highlighted in Table 6-1 show that storage warehouses have a medium risk to life compared to other property types with 3.15 civilian deaths per 1000 fires on average. This indicates a much greater risk per fire than other non-residential occupancies; however, this is balanced by the relatively low number of fires that occur.

6.2.1 Warehouse and Storage Facilities

From the National Fire Protection Association (NFPA) report on ‘Structure Fires in U.S. Warehouses’ [6] statistics specific to warehouses can be analysed.

A total of 1,270 structure fires were reported in warehouses between 2007 and 2011. The fires recorded resulted in 4 occupant fatalities, 23 occupant injuries and $188 million in direct property damage per year. Overall, 19% of fires were intentionally set, however no civilian injuries were reported from these fires. Shop tools and industrial equipment caused 8% of fires; however, these fires resulted in 27% of the civilian injuries recorded annually. The leading area of fire origin in warehouses comes from unclassified storage areas, resulting in 13% of fires and 18% civilian injuries.

Figure 6-1 illustrates the leading cause of structure fires in warehouses, while Figure 6-2 indicates the leading areas of origin.

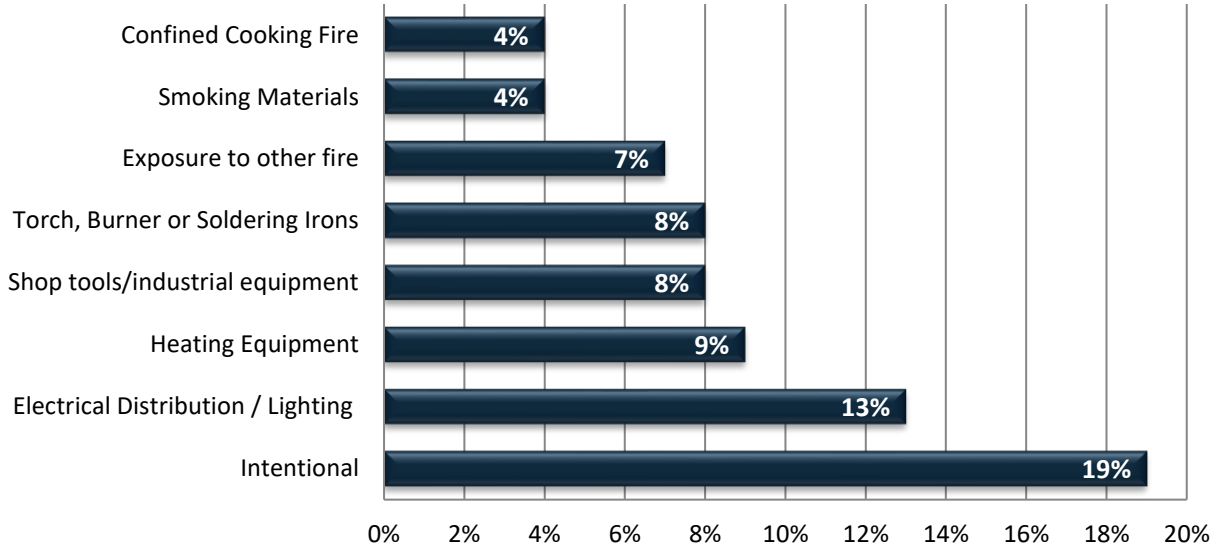


Figure 6-1: Leading Causes of Structure Fires in Warehouses

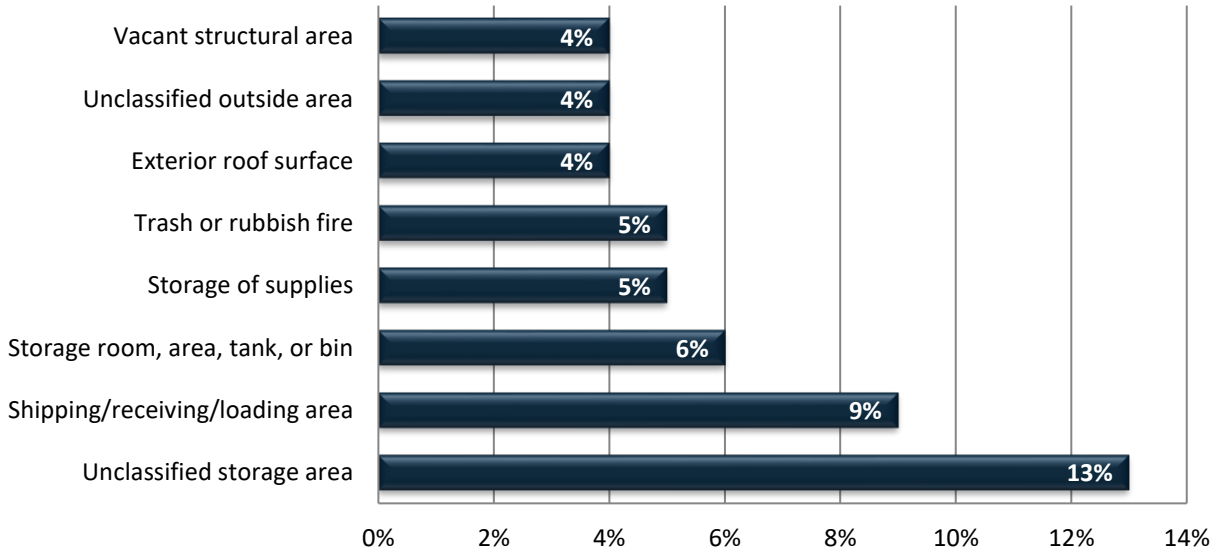


Figure 6-2: Structure Fires in Warehouse Structures by Area of Origin

6.2.2 Office Areas

From the National Fire Protection Association (NFPA) report on 'U.S Structure Fires in Office Properties' [7] statistics specific to building types relevant to this development can be analysed.

A total of 3,340 structure fires occurred in offices with 4 occupant fatalities, 44 occupant injuries and $112 million in direct property damage per year from 2007-2011.

The potential fire hazards in terms of leading areas of origins of fires and most frequent causes of fires in the office area of this building are investigated by using statistics for similar buildings. Campbell [7] reports that the leading cause of office fires in the US between 2007 and 2011 was cooking equipment followed by electrical/lighting equipment, and heating equipment. This is highlighted in Figure 6-3 with the areas of origin illustrated in Figure 6-4 compounding this data with the most common area of fire origin being in a cooking space. With only 4 civilian fatalities per year in office buildings, fatality data is deemed not to accurately represent risk and so has been omitted from the graphs.

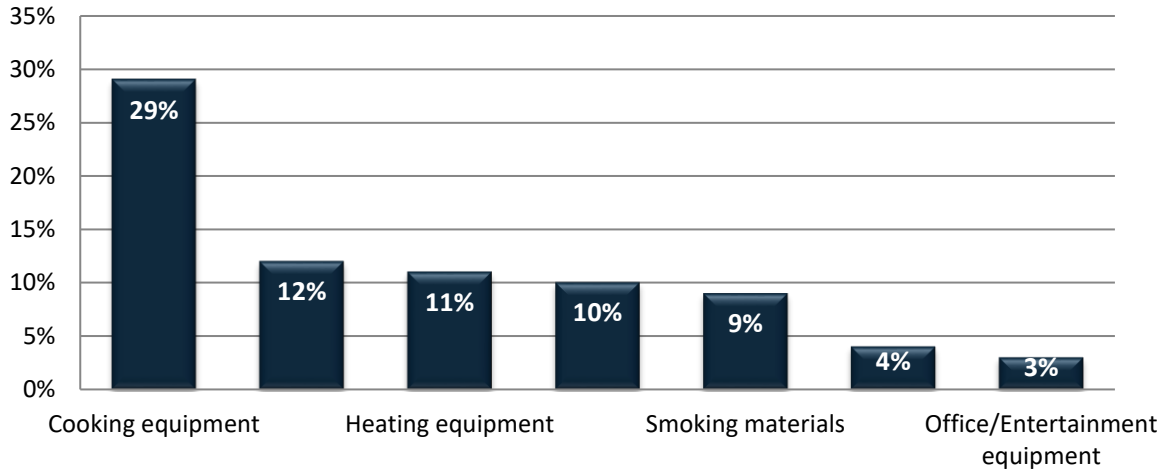


Figure 6-3: Leading Causes of Office Fires [7]

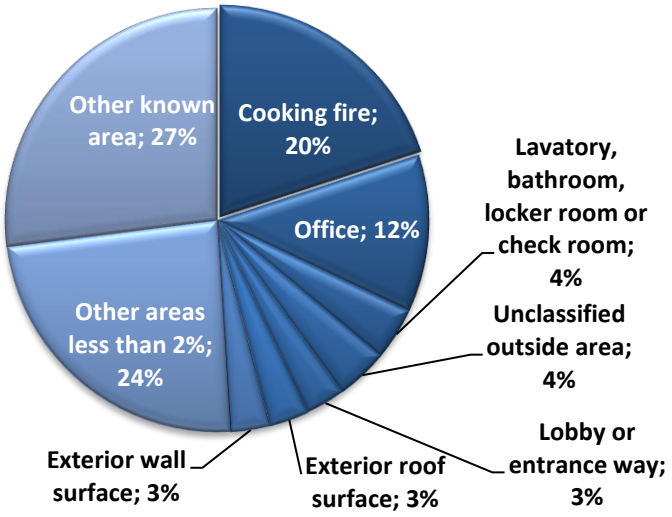


Figure 6-4: Areas of Origin for Office Fires [7]

6.3 SPRINKLER EFFECTIVENESS & RELIABILITY

The effectiveness of automatic fire sprinklers in general in limiting fire spread and growth is supported by statistics and studies undertaken into the effects of automatic fire sprinklers within buildings. These studies show that fire sprinkler systems operate and control fires in 81% to 99.5% of fire occurrences [3]. The lower reliability estimates of 81.3% [16] as well as some of the higher values of 87.6% [17] appear to reflect significant bias in data in terms of the small number of fire incidents and the lack of differentiation between fire sprinklers and other fire suppression systems. A number of the lower figures are results of dated studies.

It must be noted that the higher reliability of fire sprinklers reported by Marryatt [19] of 99.5% reflect fire sprinkler systems where inspections, testing and maintenance exceeded normal expectations and applies to installations specifically in Australia and New Zealand. The statistical data indicate that sprinklers with

appropriate maintenance are highly effective in reducing the loss of life and limiting fire spread and in particular the storage (ESFR) system has an exemplary record.

With reference to FM Global data sheet (2-2) as of 2002 [14] there had been six known fires involving suppression mode sprinkler protection.

In all of these incidents, the sprinkler system was successful in suppressing the fire and no more than four sprinkler heads operated. Therefore, for the purposes of this assessment, on the activation of the ESFR fire sprinkler system, the fire growth is considered to be suppressed within the area of activation.

FM Global Data Sheet 2-0 states, *"loss history over the past twenty years indicates approximately 25% of the time, the operation of a single sprinkler will control or suppress a fire if the sprinkler system has been properly designed and installed."* This percentage increases to approximately 50% of the time with the operation of 3 or fewer sprinklers, and 75% of the time with the operation of nine or fewer sprinklers.

In addition, analysis of the likelihood of sprinkler failure shows that most sprinkler system failures are due to impaired water supplies such as closed valves, blocked pipes, impaired sources, etc., which tend to affect sections of or the entire system [17]. As such, system reliability can be increased by active monitoring of water supplies and controls. The general consensus within the fire protection industry is that problems with individual sprinkler heads are rare. This information combined with sprinkler reliability data is favourable when compared with the reliability of fire compartmentation [3].

Moinuddin and Thomas [17] have found that masonry fire rated construction had a reliability of 81-95%, and gypsum 69-95%, with the upper level in both instances having been reported within the IFEG [3]. Both reported ranges are considered to be less than that offered by automatic sprinkler systems. Table 6-2 lists the effectiveness of sprinkler systems in the event of a fire growing to a size that facilitates sprinkler head activation [17].

Table 6-2: Effectiveness of Sprinkler systems

PROPERTY TYPE	EFFECTIVENESS OF SPRINKLERS IN EVENTS WHERE SPRINKLERS OPERATE
Public Assembly	90%
Educational	93%
Health care / Correctional Centre	95%
Residential (average)	97%
Office / Retail	91%
Manufacturing	93%
Storage	86%
Cold Storage	89%

Statistics for general sprinkler effectiveness in storage properties is provided in the table below which is drawn from the research of Rohr [20]. The data indicates over 77% of storage fires and 84% of manufacturing facility fires are confined to the area of fire origin where sprinklers are fitted.

Table 6-3: The Effectiveness of Sprinkler in Storage Facilities

EXTENT OF FLAME DAMAGE	FIRES WITH SPRINKLER PROTECTION	FIRES WITHOUT SPRINKLER PROTECTION
Confined to object of origin	50.0%	19.9%
Confined to area of origin	27.8%	14.1%
Confined to room of origin	6.7%	4.9%
Confined to fire-rated compartment of origin	1.1%	0.6%
Confined to floor of origin	2.4%	1.1%
Confined to structure of origin	10.0%	45.0%
Extended beyond structure of fire origin	2.2%	14.3%
Total:	900 fires	29,330 fires

According to the tests undertaken by FM Global Property Loss Prevention Data Sheets [14], automatic smoke exhaust systems would operate prior to an installed sprinkler system. This would result in the removal of hot smoke from the ceiling causing a critical delay in sprinkler operation. As such, FM Global recommends that a sprinkler system should not be installed in conjunction with automatic smoke exhaust systems.

It is considered likely that the BCA DTS smoke management would hinder and prevent the activation of the sprinkler system as discussed in the FM Global Property Loss Prevention Data Sheets. The failure of the sprinkler system would allow fire development and cause uncontrolled spread throughout the building leading to a more rapid onset of untenable conditions, significant property loss, and restriction of fire fighter access into the building.

Furthermore, rapid fire development and spread could eventually overrun the sprinkler system by resulting in the activation of several fast response sprinkler heads, over and above the system design requirement, potentially depleting the water supply. In this instance, the system may be rendered ineffective and unable to hydraulically perform as intended. As such, it is recommended that the removal of the BCA DTS smoke management system would allow hot smoke to build up in the ceiling leading to the activation of the sprinkler system as intended by design parameters which are based on tested systems and therefore improving the likelihood of fire control and/or suppression.

6.4 FIRE LOAD

The fire load within a room or compartment will influence the duration and severity of a fire and resultant hazard to occupants. The effective fire load for the building has been estimated by consideration of the typical spaces within the building.

The following fire loads have been extracted from Chapter 3.4 of the International Fire Engineering Guidelines [3] and are listed in Table 6-4. This data is derived from Switzerland, however is also deemed applicable to buildings in Australia of similar use.

The warehouses are considered to generally contain mixed types of commodities, where in some cases cellulosic materials are mixed with plastics and non-combustible materials on the same racks. There is a large amount of data concerning the burning rates of items and materials; however, this information is not often presented such that it is sufficiently generic to be universally adopted.

Also, while the current tenant and stored commodities may be known during the design stages of the development the length of their occupancy cannot be definitively identified. Therefore, while what can be representative of the current fuel loadings for the enclosure, these may not be the case in the future use of the building. Therefore, it would be a rare assessment in which the specific items forming the fuel load had been tested to provide the fire heat release data. As such it is considered that the application of generic burning rates, translated through simplified mathematical expression (time squared growth rates) is a suitable means of estimating fire development.

Table 6-4: Fire Load Densities

TYPE OF OCCUPANCY	AVERAGE FIRE LOAD
Office, Business	800 MJ/m^2
Forwarding facility dealing in; Beverages, food, furniture, glassware, plastic product, printed goods, varnish/polish.	Range from: 200 MJ/m^2 - 1700 MJ/m^2
Storage of rubber products	5000 MJ/m^2 per metre stored height
Storage of paper	1000 MJ/m^2 per metre stored height

6.5 FIRE GROWTH RATE AND INTENSITY

As the fire increases in size, the rate of fire growth accelerates. The growth rate of a fire can result in various hazards for occupants due to the following:

- Protective and preventative measures may not be adequate.
- Occupants may have insufficient time to evacuate.
- Occupants may perceive a reduced threat from slow growing fires.

The rate of fire growth is generally expressed in terms of an energy release rate. The most commonly used relationship is what is commonly referred to as a quadratic time-squared fire. The basis of the time squared fire arises from the fact that the growth during the flaming stage can be approximated by a smooth curve that can be expressed mathematically. The rate of heat release is given by the expression:

$$Q = (t/k)^2$$

Where: t = time from after ignition of the fire (seconds)

K = the growth time (seconds)

Q = a heat release output of 1.055 MW.

Studies of actual fires have led to the adoption of five (5) standard fire growth rates covering a wide range of potential fire scenarios and fuel loads. It should be noted; the times of fire incubation are not included in the time-squared growth fire models. National Fire Protection Association Standard NFPA 92B [17] provides information on the relevance of time-squared approximation to real fire as depicted in the figure below.

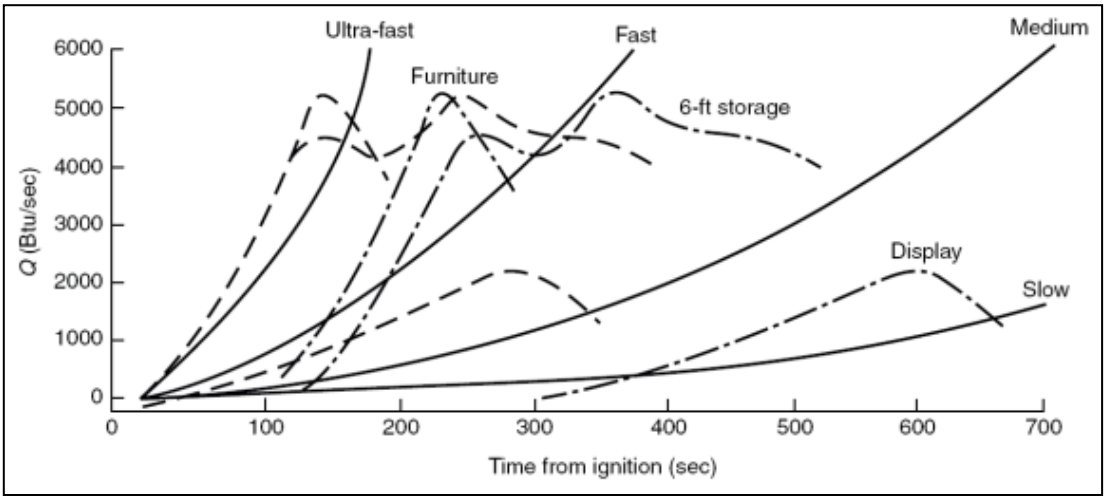


Figure 6-5: NFPA 92B: T-squared fire, rates of energy release

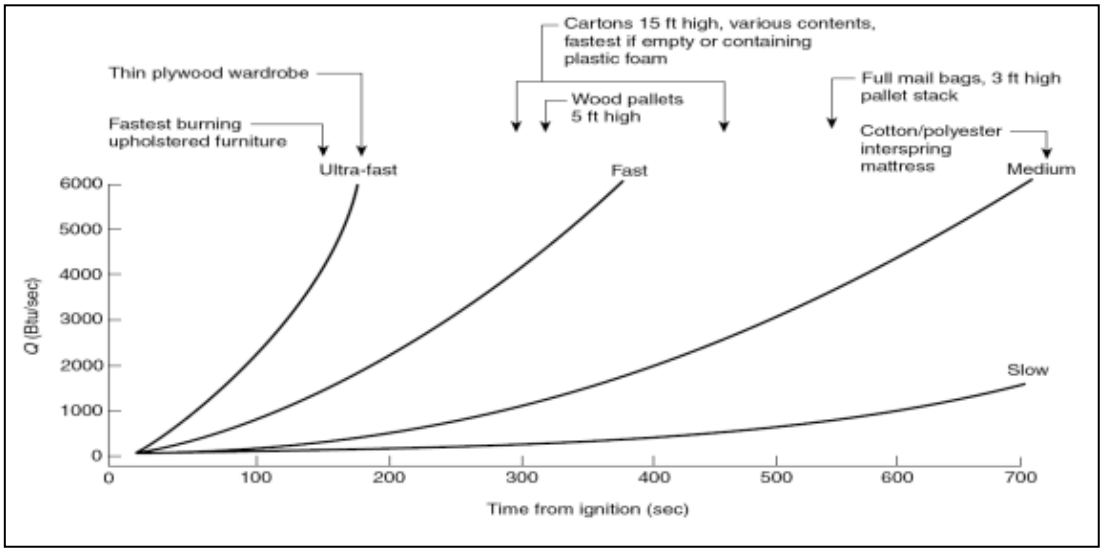


Figure 6-6: NFPA 92B: Relation of t-squared fires to some fire tests

The rate of fire growth can also be estimated from data published in British Standard (BS) 9999:2008 [4] as shown below in Table 6-5, and Table 6-6.

Table 6-5: Summary of Fire Growth Rates per Building Type

BUILDING AREA PROVIDING FUEL	GROWTH RATE	BUILDING AREA PROVIDING FUEL	GROWTH RATE
Reception area	Slow	Restaurant/Canteen	Medium
Office	**Medium**	Teaching Laboratories	Fast
Shop	Fast	Meeting Room	Medium
Warehouse	**Medium – Ultra Fast**	Waiting Room	Slow

The variation in warehouse growth rates can be understood from the following table illustrating the types of stored items.

Table 6-6: Fire Growth Rates as described in BS 9999:2008

FIRE GROWTH RATE	STORED MATERIALS
Slow t^2	Banking hall, limited combustible materials.
Medium t^2	Stacked cardboard boxes, wooden pallets.
Fast t^2	**Baled thermoplastic chips, stacked plastic products, and baled clothing.**
Ultra-Fast t^2	**Flammable liquids, expanded cellular plastics and foam.**

From the above tables (and figures) it is concluded that the likely fire scenarios in the high bay racking may be approximated by an Ultra-Fast standard time-squared fire growth rate curve, while the office areas can be approximated with a Medium time-squared fire growth rate.

6.6 FIRE SOOT YIELD

The materials that make up the fuel load will determine the soot yield of a fire. The fire soot yield should be assessed with respect to hazard due to the following:

- Soot yield can affect visibility for occupants trying to escape a fire.
- Soot yield can be directly related to other products of combustion which may cause untenable conditions.

The NFPA Fire Protection Handbook provides test values of soot yield for some common plastics which vary from 0.012 to 0.23kg/kg [9]. Data for polyurethane is provided in the SFPE handbook which quotes a range between 0.104-0.227kg/kg [8]. As the quantity of fuel in any particular building is expected to be of mixed type, taking the upper value in the range of plastics is considered overly conservative in representing the entire fuel load. The soot yield, quoted by various sources, for wood is 0.015kg/kg which confirms that utilising 0.1kg/kg is a conservative average for fire modelling in pre-flashover conditions where a mixture of plastic and cellulosic fuel is expected.

6.7 FIRE HAZARDS

Subsequent to a review of the relevant fire statistics and hazards presented in Section 6.2, the fire hazards are specific to this building are summarised below.

6.7.1 General Layout

Exits are provided around the buildings' perimeter to allow for multiple alternative egress opportunities. Due to the open nature of the warehouse, there are limited dead end travel routes to exits, however due to the building's large area, extended travel distances to the nearest exit and between alternative exits are present.

No hazards to adjoining buildings have been identified and internal hazards are minimal. Due to the open space and multiple egress opportunities, internal fire exposures are also expected to be minimal as occupants in the area of fire origin are likely to immediately become aware of fire and are likely to commence evacuation.

6.7.2 Activities

It is not expected that regular hot work processes, use of highly flammable materials, manufacturing processes or operation of high friction or high temperature machinery will be performed within the building. The development is a storage facility likely to contain a large number of high piled and racking containing combustibles.

6.7.3 Ignition Sources

Based on the statistical review contained in Section 6.2 ignition sources relevant to this site, in order of occurrence:

Warehouse

- Intentional
- Electrical distribution / lighting
- Heating equipment
- Shop tools / industrial equipment

6.7.4 Fuel Sources

Quantity of Materials

- Warehouse - The racked storage areas are likely to have the densest fire load, with between 200MJ/m^2-1700MJ/m^2 expected depending on the type of items stored.
- Office - 800MJ/m^2 with isolated peak values reaching 1600MJ/m^2.

Location of Materials

Products in high storage racking, store room, waste and rubbish containers. The lobbies, stairways and corridors are to be maintained clear of furniture, stored items and the like and constructed with materials and assemblies in accordance with C1.10 to reduce fire spread and smoke production in the event of fire in common areas. Significant fuel loads will therefore be generally limited to the warehouse and offices.

Fire Behaviour

Fire growth rates will vary with fuel type and conditions of ventilation and compartmentation. The most likely outcome of any fire outbreak within the building is a sprinkler controlled fire. This would be expected to grow at an ultra-fast time-squared fire growth rate until sprinkler activation in the warehouse areas, at which point the sprinklers are expected to suppress or control the fire. A medium t^2 fire growth rate is expected in the office areas.

6.7.5 Dangerous Goods

Dangerous Goods cannot be discounted from being present in the 1A, 1B and 1C warehouse buildings. Where present, the quantity will be limited by the space available and relevant workplace health and safety regulations will apply governing storage allowances (quantity) and requirements.

However, it is proposed to store Dangerous Goods within the Tenancy 2 of Warehouse 1D as per the Preliminary Hazard Analysis (prepared by RiskCon Engineering) and the design brief for the facility. The classes and quantities of Dangerous Goods stored are summarised as follows in Table 6-7. As identified within the PHA, these quantities are below that which would constitute their storage to be classified as a Major Hazard Facility.

Relevant to these identified classes of Dangerous Goods, Table 6-8 includes a discussion on each class present and their potential impact in a fire scenario.

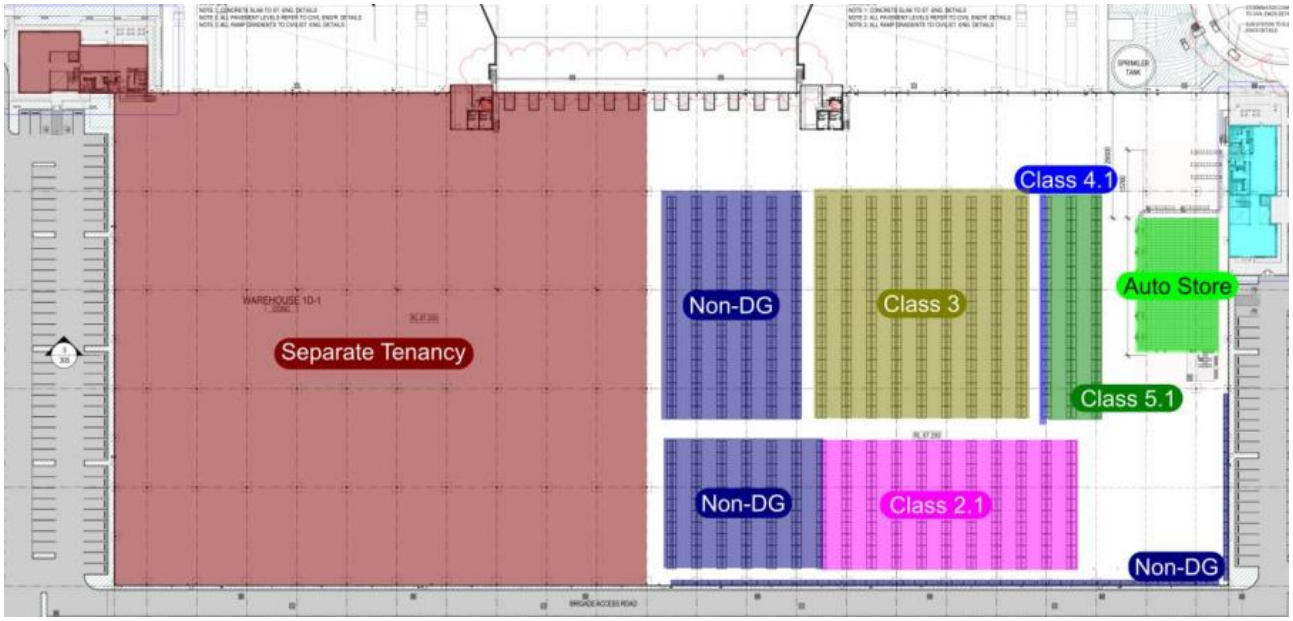


Figure 6-7: Warehouse 1D Site Layout & Proposed Storage Arrangement of Dangerous Goods

Table 6-7: Dangerous Goods Stored within Tenancy 2 of Warehouse 1D

AREA	CLASS	PACKING GROUP	QUANTITY (L or kg)
General Warehouse	2.1 (aerosols)	--	556,554 L / 139,139 kg*
	3	II & III	494,678 L
	4.1	II & III	7,051
	5.1	III	58,724
Autostore	2.1 (aerosols)	--	~290 kg*
	3	II & III	16,750 L
	4	II & III	70 L
	5.1	II & III	450 L
	8	II & III	5 L
	9	III	72 L

**Assuming a density of 1,000 kg/m³ and that 25% of the aerosol product is propellant (LPG)*

Within the Preliminary Hazard Analysis, RiskCon Engineering notes the following measures to ensure that all appropriate standards are met:

- The volume of the identified Class 3 (small retail) packages are generally less than 20 L and will be in accordance with AS/NZS3883:2007 to manage the risk of spills and flammable vapour hazards.
- Class 2 aerosols shall be stored in a separate caged enclosure.
- In-rack sprinkler protection is to be provided where required to accommodate the storage of Class 2 & 3 Dangerous Goods adjacent to the intertenancy wall. Otherwise, the storage of these materials is to be excluded from this zone.
- Additional features and training are to be provided to meet the details for control of risks associated with Dangerous Goods in accordance with AS/NZS3883 and AS1940.

These and any further measures are to be confirmed with the Dangerous Goods consultant to ensure that suitable provisions are incorporated, as documented within the PHA.

Table 6-8: DG Classifications Present

CLASS	DESCRIPTION
2.1 Flammable Gases (Aerosols)	This Class encompasses compressed gases, liquefied gases, dissolved gases, refrigerated liquefied gases, mixtures of one or more gases with one or more vapours of substances of other classes, articles charged with a gas and aerosols. Class 2.1 flammable gases are defined by dangerous goods regulations as substances which have a vapour pressure of 300 kPa or greater at 50°C, or which are completely gaseous at 20°C at standard atmospheric pressure. Generally, the base products have a high water content and alone are not highly flammable, however those products are projected from a nozzle of the can using compressed liquefied petroleum gas (LPG). LPG is a flammable gas that is heavier than air. In the event of a can rupturing, the LPG could ignite resulting in a fire or explosion. The quantity of LPG in each aerosol can is generally relatively small and as a result a fire from a single can would be localised and short in duration. The heat generated from a single can explosion could however also cause a chain reaction rupturing adjacent cans and facilitating a series of small explosions.
3 Flammable Liquids	Paint, paint related materials (e.g. thinners), lacquers, ethanol, perfume, etc., are classified as Class 3 flammable liquids. Gels/foams may also be classified as flammable liquids but are predominantly non-dangerous goods.

CLASS	DESCRIPTION
	Flammable liquids are defined by dangerous goods regulations as liquids, mixtures of liquids or liquids containing solids in solution or suspension which give off a flammable vapour (have a flash point) at temperatures of not more than 60-65°C. Flammable liquids contain component chemicals that vaporise when exposed to air. The vaporisation rate is a function of the ambient temperature at the time of the release, the temperature of the flammable liquid released and the flash point of the liquid. When released flammable vapours could form clouds that mix with ambient air that may ignite and burn forming a flash fire, explosion or pool fire over the liquid released. When a container is ruptured, the liquid will spill onto the stock below before forming a pool on the ground. This potentially flaming pool may then spread to the adjoining materials and facilitate in fire spread, through which the fire can grow beyond a size easily manageable by personnel.
4.1 Flammable Solids	Class 4.1 materials are solids that are readily combustible, or are self-reactive to undergo an exothermic reaction. Items under this classification include matchsticks or firelighters. In the unlikely event that one of these packages ignites, the minimal package size should reduce the likelihood of a sustained fire and the resulting possibility of facilitating fire spread to adjacent packages
5.1 Oxidising Agents	Oxidizers are defined by dangerous goods regulations as substances which may cause or contribute to combustion, generally by yielding oxygen as a result of a redox chemical reaction. Oxidising agents are manufactured in solid form (such as powders, granules or tablets) and liquid form (such as sprays, gels or foams). By themselves oxidising agents are not flammable or combustible and as a result pose no fire risk. However when introduced to a flammable or combustible material fire (e.g. pallets, packaging, etc.) the oxidising agent will act as a catalyst by providing additional oxygen to enhance the fire intensity.
6.1 Toxic Substances	These are substances liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact. These materials do not pose a risk to fire ignition, however when released they may pose a threat to occupants in the building or the surrounding area, and the environment.
8 Corrosive Substances	Class 8 corrosive materials incorporate both acidic and alkaline substances. A corrosive material is a liquid or solid that causes destruction of a material when coming in contact for a specified period of time. Corrosives cause severe damage when in contact with living tissue or, in the case of leakage, damage or destroy surrounding materials. These materials do not pose a risk to fire ignition, however when released they may pose a threat to occupants in the building or the surrounding area, and the environment.
9 Miscellaneous DGs	Miscellaneous dangerous goods are substances and articles which during transport present a danger or hazard not covered by other classes. The definition of this class encompasses, but is not limited to, environmentally hazardous substances, substances that are transported at elevated temperatures, miscellaneous articles and substances and (depending on the method of transport) magnetised materials and aviation regulated substances. Similarly to Class 8 goods, these items will not pose an additional risk to fire ignition.

The potential risk of a fire presented by the Dangerous Goods items on site shall be minimised through the following fire safety measures:

- The caged enclosure for the storage area dedicated to Class 2 aerosols.
- In-rack sprinkler protection is to be provided where required to accommodate the storage of Dangerous Goods.
- Limited package sizes, being small retail packages.

- The containers (totes) within the Autostore storage each function as their own bund, reducing the likelihood of spills.
- Automated functions within the Autostore are to automatically shut down upon fire trip within Warehouse 1D.

Considering the above discussion on the various classes of Dangerous Goods, it can be seen that their presence within the Warehouse 1D enclosure and potential impact in a fire scenario have been suitably addressed.

6.8 PREVENTATIVE AND PROTECTIVE MEASURES

6.8.1 Fire Initiation and Development and Control (Sub-System A)

To minimise the risk of fires initiating and growing to a size which may impact on building occupants, fire safety systems are provided within the building as listed in the following sections, as well as the below measures:

6.8.2 Smoke Development and Spread and Control (Sub-System B)

It is recognised that smoke is one of the most serious threats to life safety in the event of a fire. To address this risk, the following is considered:

- The volume of each building acts as a large smoke reservoir to increase the available evacuation time for occupants.
- A manual smoke clearance system is provided in each of Warehouses 1A, 1B, 1C and Tenancy 1 of Warehouse 1D.
- An automatic smoke exhaust system is provided within Tenancy 2 of Warehouse 1D.

6.8.3 Fire Spread and Impact and Control (Sub-System C)

To limit the extent and impact of fire spread through the buildings, the following are implemented in the building.

- Type C construction.
- Caged enclosure for aerosol storage (within Warehouse 1D).
- Sprinkler systems documented in Sub System D.
- Automated functions within the Autostore shut down automatically on fire trip.

6.8.4 Fire Detection, Warning and Suppression (Sub-System D)

The following active systems provided within the buildings to facilitate occupant warning and suppress a potential fire.

- Occupant Warning System.
- Detection within Tenancy 2 of Warehouse 1D (as Dangerous Goods are proposed to be stored).
- Ceiling-level storage mode sprinkler system to warehouses.
- In-rack sprinkler protection to Warehouse 1D where required to accommodate Dangerous Goods storage.
- Sprinkler system to offices and beneath awnings.
- Fire Hose Reels.
- Fire Extinguishers.

6.8.5 Occupant Evacuation and Control (Sub-System E)

The building is provided with the following systems to assist in the evacuation of occupants:

- Emergency Lighting.
- Exit Signage.

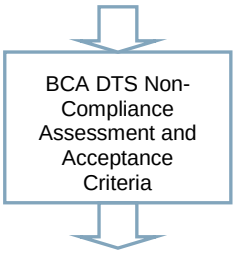
6.8.6 Fire Services Intervention (Sub-System F)

The building is provided with the following systems to assist in fire brigade intervention:

- Fire Hydrants.
- Automatic Link to Fire Brigade.
- Vehicular perimeter access with minor non-conformances.
- Control & Indicating Equipment.

7 BCA DTS NON-COMPLIANCE ASSESSMENT

7.1 OVERVIEW



In this instance the BCA DTS non-compliances have been formulated based on the regulatory review as provided by the principal certifying authority. Where not listed herein the building is required to achieve compliance with relevant DTS provisions or if existing, comply with relevant codes, reports and / or Standards approved at the time of consideration.

The following table lists the departures from the DTS provisions of the BCA for the proposed building and the analysis methodology proposed for the Fire Engineering assessment, which is to be generally in accordance with the IFEG [3].

7.2 BCA DTS NON-COMPLIANCE ASSESSMENT

Table 7-1: Summary of Alternative Solutions

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
Vehicular Perimeter Access ***BCA DTS Provisions*** C2.4: Requirements for open spaces and vehicular access ***Performance Requirement(s)*** CP9	***BCA DTS Provision*** Clause C2.4: The building must be provided with continuous perimeter vehicular access with no part of the roadway less than 6m in width and no more than 18m from the building. The pathway must also permit the passage and operations of fire brigade appliances. ***DTS Non-conformance*** The following non-conformances have been identified: • Access paths along Estate Road and some hardstands are greater than 18m from the buildings (Lot 1A, 1B, 1C and 1D). • Continuous vehicular access is not provided around the entire building (to the north of Lot 1A). ***Alternative Solution*** The acceptance of the above non-conformances is based on the following fire safety systems/measures provided. • The areas greater than 18m from the building are accessible for pedestrians and smaller vehicles via the carpark hardstand and dedicated pathways. • For Lot 1A, access is provided in a forward direction around the remaining three sides, with access on the eastern side being via on Lot 1B. • For Lot 1C, access is available to the Lot via Estate Road 02 before Estate Road 07, reducing the reliance upon traveling via the south-western which is greater than 18m from the building. ***Assessment Methodology*** The assessment methodology follows Clauses A0.5(b)(i), A0.9(b)(ii) and A0.10 of the BCA. An absolute and qualitative approach fire safety engineering assessment shall be completed to establish that the design matches the relevant Performance Requirement in facilitating direct adequate access and entry into the building to undertake fire and emergency intervention activities.
Extended Travel Distances & Smoke Hazard Management – Non-Dangerous	***BCA DTS Provision*** Clause D1.4 travel distance to the nearest exit must not exceed 40 metres. Clause D1.5 travel distance between alternative exits must not exceed 60 metres. Clause E2.2 *(Table E2.2a)* requires an automatic smoke exhaust system be installed in the buildings exceeding 108,000m^3 in volume.

<table>
<tr><th>BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT</th><th>PERFORMANCE BASED SOLUTION</th></tr>
<tr><td>Goods Tenancies

BCA DTS Provisions
Clause D1.4: Distance to the nearest exit.
Clause D1.5: Distance between alternative exits.
Clause E2.2: Smoke hazard management

Performance Requirement(s)
DP4 & EP2.2</td><td>DTS Non-conformances
The following non-conformances have been identified in the following warehouses:
The travel distances to nearest exits and between alternative exits exceed 40m and 60m respectively.
<table><tr><th>LOT</th><th>TRAVEL DISTANCE TO NEAREST EXITS</th><th>TRAVEL DISTANCE BETWEEN ALTERNATIVE EXITS</th></tr><tr><td>1A</td><td>65m</td><td>130m</td></tr><tr><td>1B</td><td>80m</td><td>160m</td></tr><tr><td>1C</td><td>95m</td><td>180m</td></tr><tr><td>1D
(Tenancy 1 only)</td><td>85m</td><td>175m</td></tr></table>
A manual smoke clearance system shall be installed in each warehouse, in lieu of the DTS required automatic smoke exhaust.
Alternative Solution
The Alternative Solution will rely upon the volume of the warehouse enclosure to act as a smoke reservoir for hot combustion products with significant reserve so as to provide the population with adequate time to safely evacuate the building prior to the onset of untenable conditions. Furthermore, exits are evenly distributed around the perimeter access.
Assessment Methodology
The assessment methodology will adhere to Clauses A0.5(b)(i), A0.9(b)(ii), and A0.10 of the BCA. The analysis will be absolute and quantitative where the results of the deterministic assessment are measured directly against the agreed acceptance criteria, with a supporting qualitative argument.
Computational Fluid Dynamic (CFD) programs will be used to simulate the fire development and smoke spread in the warehouses with these results utilised in an ASET/RSET time-line analysis.</td></tr>
<tr><td>Extended Travel Distances & Smoke Hazard Management – Warehouse 1D Tenancy 2 (Dangerous Goods)

BCA DTS Provisions
Clause D1.4: Distance to the nearest exit.
Clause D1.5: Distance between alternative exits.
Clause E1.10: Provision for special hazards</td><td>BCA DTS Provision
Clause D1.4 travel distance to the nearest exit must not exceed 40 metres.
Clause D1.5 travel distance between alternative exits must not exceed 60 metres.
Clause E1.10 suitable additional provision must be made if special problems of firefighting could arise because of the nature or quantity of materials stored.
Clause E2.2 (Table E2.2a) requires an automatic smoke exhaust system be installed in the buildings exceeding 108,000m^3 in volume.
Clause E2.3 Additional smoke hazard management measures may be necessary due to the special characteristics, special function, special type or quantity of materials stored, or special mix of classifications within a building or fire compartment.
DTS Non-conformances
The following non-conformances have been identified in Tenancy 2 of Warehouse 1D:
The travel distances to nearest exits and between alternative exits are up to 85 m and 175 m in lieu of 40m and 60m, respectively.
Smoke exhaust rates are to be rationalised.
Smoke zones exceed an area of 2,000 m^2.
Alternative Solution
The volume of the warehouse enclosures act as a smoke reservoir for hot combustion products, providing the population with adequate time to safely evacuate the building</td></tr>
</table>

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
Clause E2.2: Smoke hazard management Clause E2.3: Provision for special hazards ***Performance Requirement(s)*** DP4 & EP2.2	prior to the onset of untenable conditions. Additionally, the sprinkler system is expected to limit the fire growth upon activation, whilst the automated smoke exhaust system is seen to increase the tenability period for occupant evacuation. Furthermore, exits are evenly distributed around the perimeter access and occupants are provided with prompt occupant warning due to the smoke detection system. ***Assessment Methodology*** The assessment methodology will adhere to Clauses A0.5(b)(i), A0.9(b)(ii), and A0.10 of the BCA. The analysis will be absolute and quantitative where the results of the deterministic assessment are measured directly against the agreed acceptance criteria, with a supporting qualitative argument. Computational Fluid Dynamic (CFD) programs will be used to simulate the fire development and smoke spread in the warehouse tenancy with these results utilised in an ASET/RSET time-line analysis.
Exit Sign Height ***BCA DTS Provisions*** Clause E4.6 – Direction signs (inter-alia AS2293.1: 2005) ***Performance Requirement(s)*** EP4.2	***BCA DTS Provision*** BCA DTS Clause E4.6 (NSW) states that if an exit is not readily apparent to persons occupying or visiting the building, then exit signs must be appropriately provided in accordance with AS2293.1. AS2293.1 Clause 6.8.1 requires exit signs be mounted not less than 2m and not more than 2.7 above floor level. ***DTS Non-conformance*** The exit lighting design shall incorporate directional signage in the warehouse positioned above a height of 2.7m to permit the passage of picking machinery below. Exit sign height to be up to 4.5m above ground level. Final exit signs, located above warehouse doors, may be positioned up to 1m above the door to allow greater visibility of the signs past the block storage arrangement. ***Alternative Solution*** The Alternative Solution shall rely upon the volume of the warehouse enclosures to provide an improved duration compared to a DTS design to allow the building population to evacuate prior to the directional exit signs becoming compromised by the hot smoke layer. Further to this, the simplicity of the racking layouts and the familiarity of the occupants within the building shall provide for a rapid evacuation along familiar egress routes. Jumbo size exit signs shall be provided in locations where signage is required above 2.7m from FFL. ***Assessment Methodology*** The assessment methodology will adhere to Clauses A0.5(b)(ii), A0.9(b)(ii) and A0.9(c), and A0.10 of the BCA. The analysis will consist of a semi quantitative and qualitative comparative discussion to demonstrate compliance with the relevant Performance Requirements. The assessment will demonstrate that the risk associated with obscuration of the exit signs is equivalent to the risk in a DTS Solution.

8 PROPOSED FIRE SAFETY STRATEGY

8.1 OVERVIEW

The fire safety strategy outlined below has been proposed to satisfy the fire and life safety objectives specified for this project by the relevant stakeholders. In addition, the fire safety strategy is required to adequately address the specific fire and life safety hazards identified for the proposed development, and as such have been generally derived from the preventative and protective measures outlined within the BCA, and fire engineering literature and research. Where items of non-compliance have not been identified by the design team in the concept design it is considered that those items are expected to be deemed-to-satisfy solutions.

This Section provides guidance for the design and application of fire safety measures. It highlights specific design considerations for a range of fire safety measures that will undergo analysis as part of the Fire Engineering Report to ascertain whether the relevant Performance Requirements of the BCA are satisfied. Design guidance (general informative details and specific requirements) for a range of specific fire safety measures is provided. This list is not exhaustive and the use of other fire safety measures including new technologies will require additional review.

8.2 PASSIVE FIRE PROTECTION

8.2.1 Type of Construction Required

Each building shall be built as a large-isolated building, and therefore in accordance with the BCA DTS provisions for Type C fire-resisting construction.

- Within tenancy 2 of Warehouse 1D, aerosols are to be stored in a separate caged enclosure.

8.3 EGRESS PROVISIONS

8.3.1 Evacuation Strategy

Activation of any sprinkler heads or detectors shall initiate the evacuation of all areas of each building. Dedicated fire wardens from each warehouse and office shall ensure that all clients, visitors, and staff are promptly evacuated.

8.3.2 Egress Provisions

In each warehouse, travel distances to the nearest exit and between alternative exits must be compliant with the BCA DTS requirements with the following exceptions identified and illustrated in the following figures:

- The travel distances to nearest exits and between alternative exits exceed 40m and 60m respectively.

Table 8-1: Non-conformant Travel Distances

LOT	TRAVEL DISTANCE TO NEAREST EXITS	TRAVEL DISTANCE BETWEEN ALTERNATIVE EXITS
1A	65m	130m
1B	80m	160m
1C	95m	180m
1D	85m	175m

These non-conformances shall be addressed through an Alternative Solution.

Additional exits shall be provided as necessary to ensure that occupant travel distances do not exceed the limitation defined by Fire & Rescue NSW, ***"no point in a fire compartment is to be more than 100 m from a hydrant external to that compartment"*.**

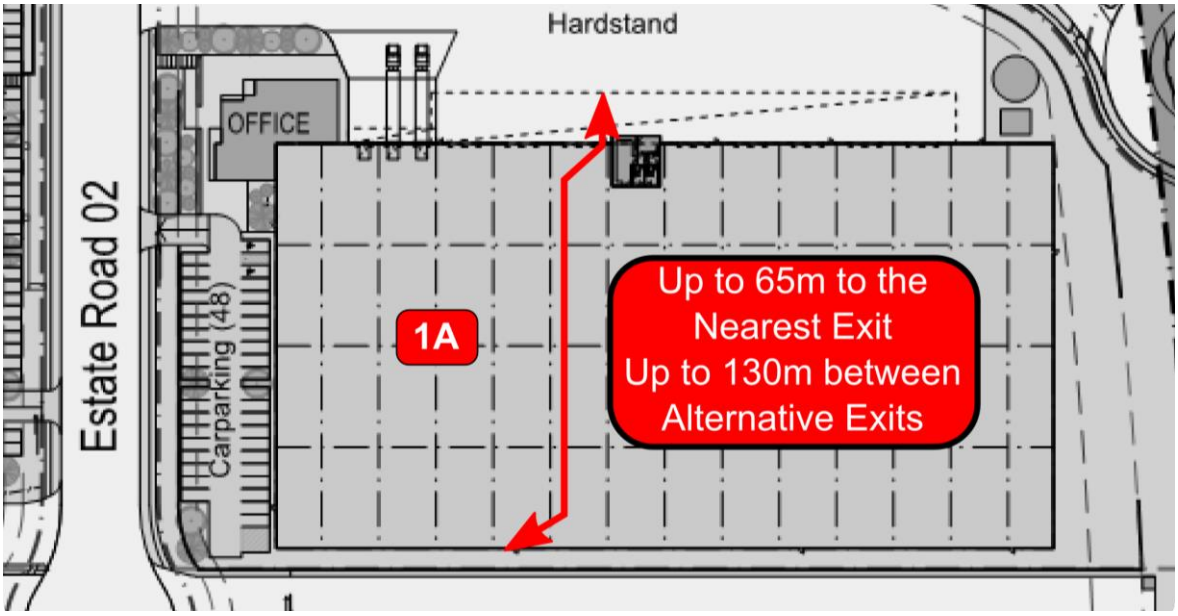


Figure 8-1: DTS Non-Compliant Travel distances on Lot 1A

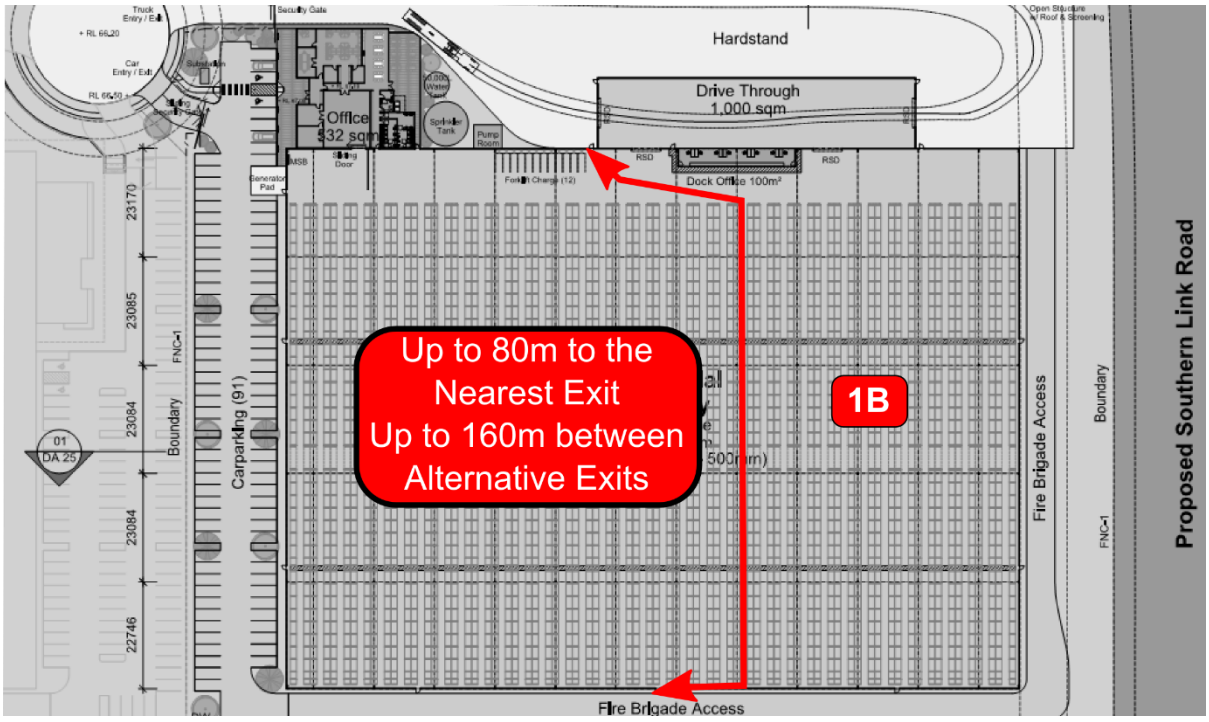


Figure 8-2: DTS Non-Compliant Travel distances on Lot 1B

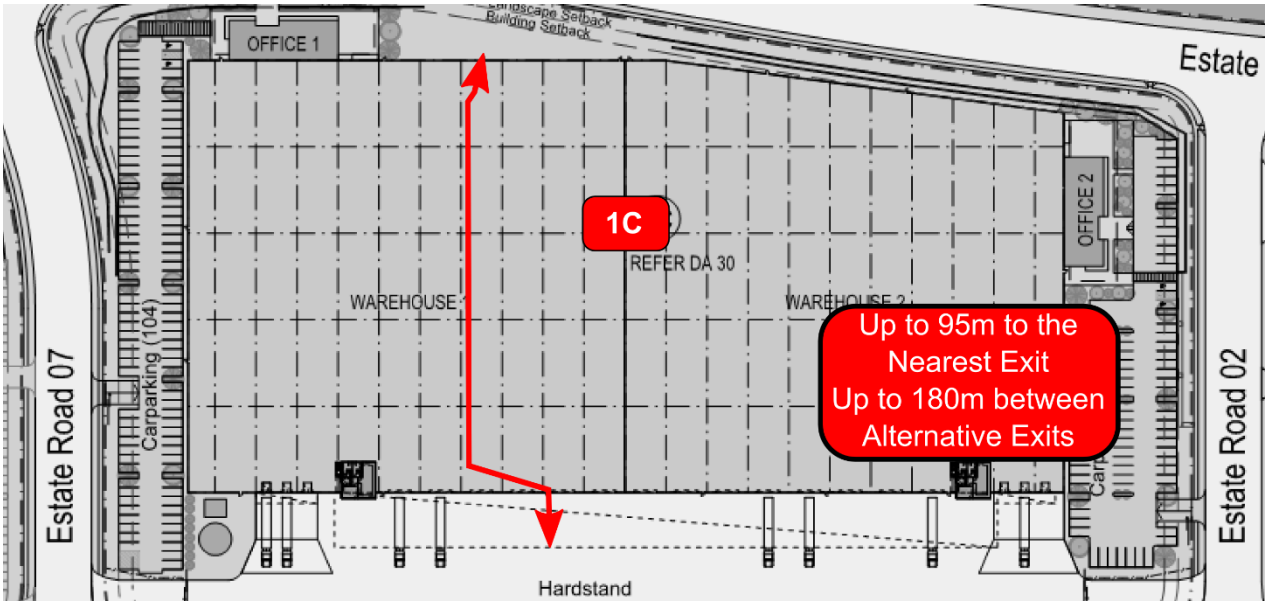


Figure 8-3: DTS Non-Compliant Travel distances on Lot 1C

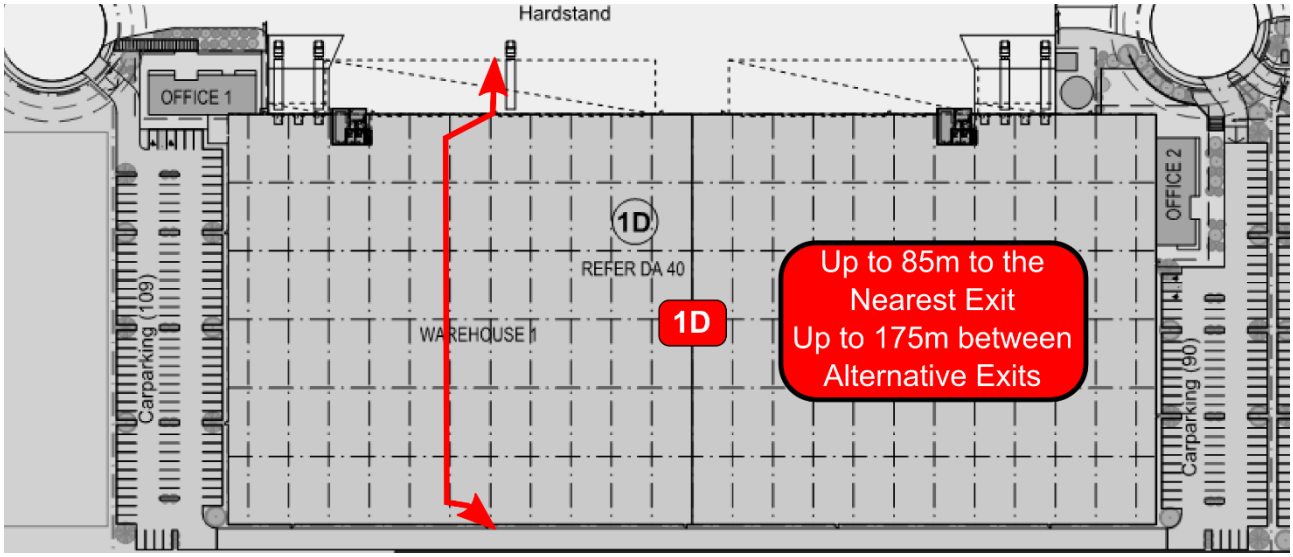


Figure 8-4: DTS Non-Compliant Travel distances on Lot 1D

8.3.3 Door Hardware, Operation and Mechanisms

All exit doors and doors in a path of travel to an exit are required to be DTS compliant throughout each building. This includes the swing of doors, the applied latching and locking mechanisms and the force required on mechanism used to open sliding doors.

8.3.4 Signage and Lighting

Emergency lighting is to be provided throughout each building in accordance with DTS Provisions E4.2 and E4.4 of the BCA 2015 and AS2293.1:2005.

Exit signage is to be provided throughout each building in accordance with the DTS Provisions E4.5, E4.6, E4.8 of the BCA 2015 and AS2293.1:2005 with the directional signage at the end of the racking aisles and above block storage areas permitted to be installed at a height greater than 2.7m.

- Exit signs and directional signs shall be “Jumbo size” to increase the visibility to occupants.
- The final height and location of the directional exit signs shall be determined through the fire engineering analysis.

8.4 ACTIVE FIRE PROTECTION SYSTEMS

8.4.1 Building Occupant Warning System

A building occupant warning system shall be provided throughout all parts of each warehouse building. The system shall be in accordance with the prescriptive requirements of Specification E1.5 and Clause 6 of Specification E2.2a of the BCA and AS1670.1:2015.

- The occupant warning alarm shall be sounded throughout all areas of each warehouse building upon activation of the smoke detection or sprinkler systems.

8.4.2 Smoke Detection System

It is our experience that a smoke detection system for occupant warning is unlikely to be required throughout the warehouses due to their large volume. This is to be confirmed through detailed fire engineering analysis, but it is expected that:

- In the event of future subdivisions of warehouse buildings into smaller tenancies, there might arise a need for smoke detection.
- In the event of travel distances in excess of the DtS Provisions being present in the building offices, detection will likely be required throughout each affected office in accordance with AS1670.1:2015.

Within Tenancy 2 of Warehouse 1D, an automatic detection system is required due to the storage of Dangerous Goods, provided to activate automatic smoke exhaust and occupant warning.

- Given the nature of the tenancy, it is recommended that roof level detectors will be required for the benefit of occupant evacuation. The following design requirements are expected, and should be reviewed and confirmed through the detailed fire engineering analysis:
  - These detectors shall be spaced in accordance with DtS Specification E2.2b Clause 8 and Specification E2.2a Clause 5, i.e. no greater than 20 m apart and no greater than 10 m from a wall or bulkhead.
  - Within specific Dangerous Goods enclosures, detectors shall be located on 10 m maximum spacings (5 m from walls or baffles).
- The detector obscuration threshold installed must not exceed 8% smoke obscuration per metre.
- Throughout the warehouse areas, detection shall activate the smoke exhaust as per Specification E2.2b (Clause 8) in the area of activation.
- Any detector activation shall sound the occupant warning system throughout the building.
- Any smoke detector activation shall initiate direct brigade notification.

8.4.3 Fire Sprinkler System

A fire sprinkler system shall be provided throughout each building in accordance with the relevant regulatory requirements. The site shall have an independent system with dedicated fire pump, water supply tanks and booster assemblies. Confirmation of the below requirements should be sought from a qualified fire services designer.

- In the offices and beneath the warehouse awnings the system shall comply with BCA Specification E1.5 and AS2118.1:1999.
- In the warehouse a storage mode system shall be provided in accordance with BCA Specification E1.5 and AS2118.1:1999, with the sprinkler head location, spacing and design capacity in accordance with Factory Mutual Guidelines 2-0 and 8-9 (or NFPA regulations). Sprinkler activation temperature must be no greater than 101°C and have a Response Time Index (RTI) of less than $50m^{1/2}s^{1/2}$ (i.e. fast response type).
- In-rack sprinkler protection is to be provided where required to accommodate the storage of Dangerous Goods.

Upon detection of a fire the building occupant warning alarm shall be initiated throughout the affected building and the direct brigade notification activated. Additionally, automated functions within the Autostore are to automatically shut down upon fire trip within Warehouse 1D.

Note that at the time of the construction certificate application, the adoption of the new sprinkler standard AS2118.1:2017 will be necessary.

8.5 FIRST AID FIRE FIGHTING

8.5.1 Fire Hose Reels

Fire hose reel shall be provided throughout each building in accordance with Clause E1.4 of the BCA and AS2441:2005.

Locations should be signposted and readily accessible to occupants. Use of facilities should be monitored for abuse, mistreatment and servicing. The fire hose reels shall be located within 4m of an exit and provide coverage to all areas of each building based on a 36m hose length with a 4m water stream (i.e. maximum 40m coverage from the hose location).

Where coverage is not achieved by fire hose reels located at exits, additional fire hose reels shall be provided along travel paths to ensure coverage.

8.5.2 Portable Fire Fighting Equipment

Portable fire extinguishers are to be provided throughout each building in accordance with Table E1.6 of the BCA and selected, located, and distributed in accordance with AS2444:2001. As a guide:

• General office areas	Dry Powder (ABE type)	2.5Kg
• Computer/server rooms	CO_2	3.5 Kg
• Plant rooms	Dry Powder (ABE)	2.5 Kg
• Designated exits	Dry Powder (ABE)	4.5 Kg
• Adjacent each fire hose reel cabinet	Dry Powder (ABE)	4.5 Kg

8.6 FIRE BRIGADE INTERVENTION

8.6.1 Fire Indicator Panels

A Fire Control Centre will be provided to Lot 1A, 1B, 1C and 1D. Each lot shall be provided with a Main Fire Indicator Panel (FIP) within a compliant fire control centre.

The Main FIPs must be installed in accordance with BCA Specification E2.2a and AS1670.1:2015 and have the following capabilities.

- The FIP panel must be capable of isolating, resetting, and determining the fire location within each building.
- A red strobe shall be installed at the entry door to the FIP to alert arriving fire brigade of the fire alarm origin and FIP location.
- Smoke clearance fan controls shall be provided at the FIP, if a separate fire fan control panel is provided it shall include a display to indicate the operation or otherwise of the fans.
- The panel shall include clear signalling of the operational status of the fans. A local fire fan control panel shall include override controls of smoke clearance and supply fans.
- Sub-FIP panels shall be provided to:
  - Office 1 on Lot 1C.
  - Office 1 on Lot 1D.

8.6.2 Fire Hydrants

A dedicated hydrant system, with independent booster assembly, must be provided for each lot.

The fire hydrant system shall be in accordance with BCA Clause E1.3 and AS2419.1:2005 with the following specifications:

- Hydrants located beneath the warehouse awnings shall be considered as *internal hydrants*.
- The systems must be capable of providing coverage to all parts of the building based on a 30m (internal hydrant connections) and a 60m (external hydrants) hose length with an additional 10m water stream.
- As far as possible the hydrant system should consist of external hydrant points, with internal hydrants only provided to achieve coverage to those areas not able to achieve coverage from external hydrant points.
- Each system shall incorporate a ring main with isolation valves that are external to the building and numbered with the corresponding numbers indicated on the blockplan at the booster assembly.

- External hydrant connections shall be provided with the heat shields per the requirements of AS2419.1 (i.e. FRL 90/90/90 2m either side, and 3m above the hydrant connection point) or be setback more than 10m from the building.
- All hydrant connection points and the booster assembly must be fitted with Storz hose couplings which comply with Clause 7.1 and 8.5.11 AS2419.1:2005. Further information is available from the FRNSW Guide Sheet No.4 '*Hydrant system connectors*' available at www.fire.nsw.gov.au.
- Per the request of FRNSW, where internal hydrants are installed within the warehouse these shall be designed to allow progressive movement through the building such that an internal hydrant is within 50m of an external hydrant and 25m of an internal hydrant.
- If within or affixed to the external wall of the building, the booster shall be within sight of the main entrance to the building and separated from the building by a 90/90/90 FRL construction for a distance of not less than 2m each side and 3m above the upper hose connections in the booster assembly.
- If remote from the building, the hydrant booster shall be located not less than 10m from the external wall of the building, adjacent to the principal vehicular access to the site, at the boundary of the site, and be within sight of the main entrance of the building.

8.6.3 Manual Smoke Clearance System

In lieu of the BCA required automatic smoke exhaust system, Warehouse 1A, 1B, 1C and Tenancy 1 of Warehouse 1D shall be provided with a manually operated smoke clearance system. The smoke clearance system shall be designed to achieve the following minimum performance requirements.

- Initiation switches shall be located on the Main FIP, or an adjacent panel, at the office's main entry.
- Signs alerting the Fire Brigade to the operation of the smoke clearance system must be provided.
- Fire rated fans and fire rated cabling shall be designed to operate at 200°C for a period no less than 60 minutes.
- System capacity must be capable of an exhaust rate equal to one enclosure air change per hour.
- It is recommended that multiple fans be provided and be evenly distributed to otherwise comply with the requirements of Specification E2.2b Clause 5 of the BCA.
- Adequate make-up air shall be provided at low level to facilitate the clearance system's designed operational capacity. The make-up air shall be provided at low level by:
  - Permanently open natural ventilation louvers; and/or
  - Perforated roller shutters; and/or
  - Mechanically operated louvers that open upon activation of the fans. All motors and cables to automatic louvers, vents or supply fans must be fire rated to operate at 200°C for a period of 60-minutes.

  ***Note** that manual opening of the dispatch rollers doors is not considered an acceptable method of achieving the required makeup air supply.*

8.6.4 Automatic Smoke Exhaust System

Specific to Tenancy 2 of Warehouse 1D only, an automatic smoke exhaust system shall be provided with requirements as follows:

- On-Auto-Off switches should be located at the FIP.
- Signs and a mechanical block plan alerting the fire brigade to the operation of the smoke exhaust system must be provided.
- The system capacity must be capable of an exhaust rate equal to one enclosure air change per hour. Note that this exhaust rate is subject to change following completion of the detailed fire engineering analysis.
- The make-up air for the enclosure is to be designed on the basis of limiting the inlet velocity to less than 2.5 m/s.
- Fire-rated fans and fire rated cabling should be designed to operate at 200°C for a period no less than 60 minutes.
- The system shall be connected to an essential power supply.
- It is recommended that multiple fans be provided and be evenly distributed to otherwise comply with the requirements of Specification E2.2b Clause 5 of the BCA.

- It is not anticipated that AS1940 mechanical ventilation systems will be required in this instance. However, should they be provided, these systems are to automatically shut down upon activation of smoke exhaust system.

8.6.5 Vehicular Perimeter Access

The vehicular perimeter access pathway shall be provided around the whole of the building. These shall be designed and constructed in all-weather surface capable of supporting all FRNSW appliances in accordance with BCA Clause C2.4 and NSW Fire Brigade Policy No. 4 '*Guidelines for emergency vehicle access*', available at http://www.fire.nsw.gov.au/gallery/files/pdf/guidelines/vehicle_access.pdf with the following exception permitted:

- Access paths along Estate Road and some hardstands are greater than 18m from the buildings (Lot 1A, 1B, 1C and 1D).
- Continuous vehicular access is not provided around the entire building (to the north of Lot 1A).

To facilitate the perimeter access non-conformances, the following measures shall be provided as part of the Alternative Solution:

- The areas greater than 18m from the building are accessible for pedestrians and smaller vehicles via the carpark hardstand and dedicated pathways.
- All gates, security fencing and boom gates shall be readily openable by the fire authorities. This can be achieved through one, or a combination of, the following –
  - Fitted with locks that are openable with a 003 key; and/or
  - Fitted with locks / latches that are openable with a master key, swipe or badge with copies of these keys/swipes/badges provided to the two local fire brigade stations; and/or
  - Mechanical gates and boom gates shall open on fire trip and power failure.

8.7 BUILDING MANAGEMENT PROCEDURES

The ongoing management of each building is as important in maintaining a high level of life safety as the provisions recommended during the design phase of each building.

8.7.1 Maintenance of Fire Safety Equipment

The fire detection systems, fire sprinkler systems, emergency warning systems, fire hydrants, hose reels, portable fire extinguishers, emergency lighting and any other fire safety equipment shall be tested and maintained in accordance with Australian Standard AS1851 or other relevant testing regulatory.

The smoke clearance system shall be tested in accordance with the AS1851 requirements for an automatic smoke clearance system as applicable.

8.7.2 Evacuation Plan

An evacuation plan should be developed for the sites in accordance with AS3745:2010. Standard fire orders should be displayed throughout each building.

9 REFERENCES

1. ABCB, “Building Code of Australia, Volume One”, CanPrint Communications, Canberra 2015.
2. ABCB, “Guide to the BCA 2014”, CanPrint Communications, Canberra 2015.
3. ABCB, “International Fire Engineering Guidelines”, ABCB, Canberra, 2005.
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APPENDIX C BCA REPORT

BCA ASSESSMENT REPORT

OAKDALE SOUTH ESTATE, HORSLEY PARK
BUILDING 1D

PREPARED FOR:

GOODMAN PROPERTY SERVICES (AUST) PTY LTD

Revision 2

Date: 15 April 2019

Project No.: 190034

Address | Suite 2.01,
22-36 Mountain St
Ultimo NSW 2007

Contact | Ph: 02 9211 7777
Fax: 02 9211 7774

CONTENTS

REPORT STATUS				
DATE	**REVISION**	**STATUS**	**AUTHOR**	**REVIEWED**
19.02.2019	0	Preliminary Assessment – For client & consultant review	DG	TJ
09.05.2019	1	Updated Assessment – Including proposed Dangerous Goods Storage	DG	TJ
15.05.2019	2	Updated Assessment – Including proposed Dangerous Goods Storage & client comments	DG	TJ

Prepared by:

Dean Goldsmith
Director
Blackett Maguire + Goldsmith

A. INTRODUCTION

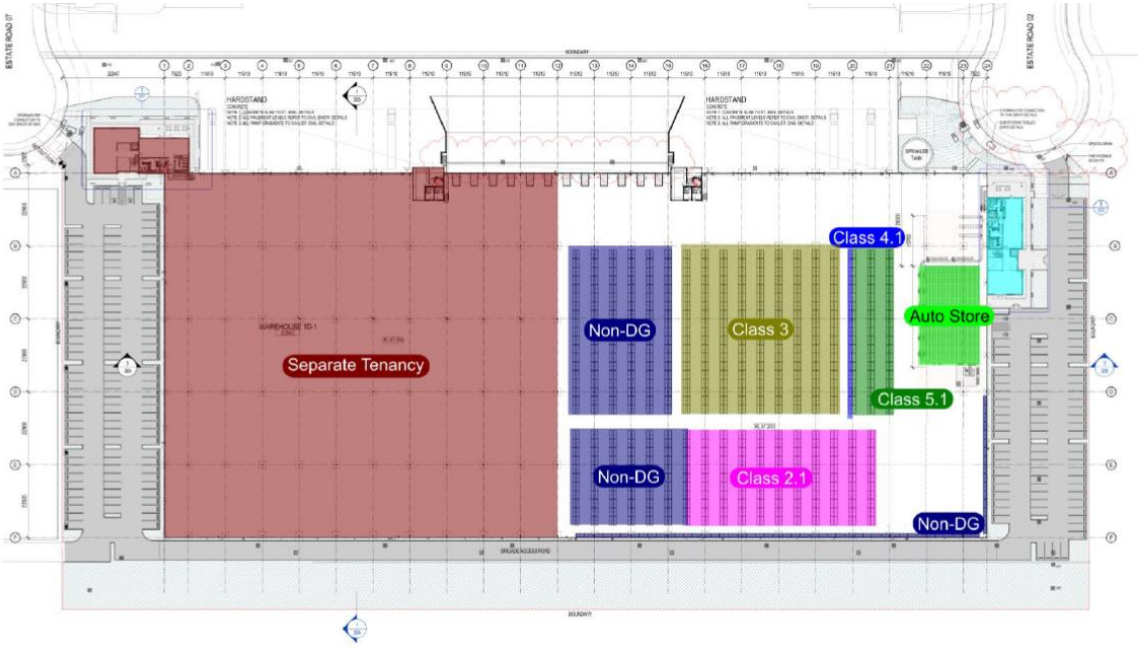
A.1 BACKGROUND / PROPOSAL

Blackett Maguire + Goldsmith Pty Ltd (BM+G) have been commissioned by Goodman Property Services to undertake a preliminary review of the proposed development, against the deemed-to-satisfy (DTS) provisions of the Building Code of Australia 2016 Amendment 1 (BCA) pursuant to the provisions of clause 145 of the *Environmental Planning & Assessment Regulation 2000* and clause 18 of the *Building Professionals Regulation 2007*.

The proposed development comprises the construction of Building 1D at the Oakdale South Estate including a warehouse facility containing two tenancies, each with two two-storey offices, two two-storey dock offices, hardstand areas, light duty areas, loading docks, awnings and external car parking.

Note 1: It is understood that the proposed tenant in the northern tenancy (1D-2) is proposing to store Dangerous Goods within the warehouse area that exceed the SEPP 33 thresholds (as shown in the mark-up below) and a MOD Application is currently being lodged with the Department for this proposed change to the current approved use of the building

Note 2: No comments have been included regarding the automated equipment in the designated 'Auto Store' area as no details of the proposed equipment have been provided. This will be assessed in a future revision of this report when appropriate details are provided.



Source: RiskCon Engineering PHA dated 23/4/19

A.2 AIM

The aim of this report is to:

- Undertake an assessment of the proposed warehouse facility against the Deemed-to-Satisfy (DtS) Provisions of the BCA 2016 Amendment 1 to identify the key issues that are relevant to the project.
- Identify any BCA compliance issues that require resolution/attention for the proposed development at the CC Application stage.

A.3 PROJECT TEAM

The following BM+G Team Members have contributed to this Report:

- Dean Goldsmith (Director) – Author
- Tom Johnston (Building Surveyor) – Peer Review

A.4 DOCUMENTATION

The following documentation has been reviewed, referenced and/or relied upon in the preparation of this report:

- BCA 2016 Amendment 1
- Guide to the BCA 2016 Amendment 1
- Preliminary Hazard Analysis prepared by RiskCon Engineering dated 23/4/19.
- Architectural plans prepared by SBA Architects submitted with CC1 Application:

A.5 REGULATORY FRAMEWORK

Pursuant to clause 145 of the Environmental Planning and Assessment (EPA) Regulation 2000 all new building work must comply with the current BCA however the existing features of an existing building need not comply with the BCA unless upgrade is required by other clauses of the legislation.

A.6 LIMITATIONS & EXCLUSIONS

The limitations and exclusions of this report are as follows:

- The following assessment is based upon a review of the architectural documentation.
- No assessment has been undertaken with respect to the Disability Discrimination Act (DDA) 1992. The building owner should be satisfied that their obligations under the DDA have been addressed. In this regard, however, the provisions of the DDA Access to Premises – Buildings Standards have been considered as they are generally consistent with the accessibility provisions of the BCA.
- The Report does not address matters in relation to the following:
  i. Local Government Act and Regulations.
  ii. NSW Public Health Act 1991 and Regulations.
  iii. Occupational Health and Safety (OH&S) Act and Regulations.
  iv. Work Cover Authority requirements.
  v. Water, drainage, gas, telecommunications and electricity supply authority requirements.
  vi. DDA 1992.
- BM+G Pty Ltd do not guarantee acceptance of this report by Local Council, FRNSW or other approval authorities.
- No part of this document may be reproduced in any form or by any means without written permission from BM+G Pty Ltd. This report is based solely on client instructions, and therefore, should not be used by any third party without prior knowledge of such instructions.
- This report is intended to cover the key issues associated with the masterplan of the site and as such, separate BCA assessment reports will be required to be undertaken for each building individually.

A.7 TERMINOLOGY

Alternative Solution

A Building Solution which complies with the Performance Requirements other than by reason of satisfying the DtS Provisions.

Building Code of Australia (BCA)

Document published on behalf of the Australian Building Codes Board. The BCA is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia and is adopted in New South Wales (NSW) under the provisions of the EPA Act and Regulation. Building regulatory legislation stipulates that compliance with the BCA Performance Requirements must be attained and hence this reveals BCA's performance based format.

Construction Certificate

Building Approval issued by the Certifying Authority pursuant to Part 4A of the EP&A Act 1979.

Construction Type

The construction type is a measure of a buildings ability to resist a fire. The minimum type of fire-resisting construction of a building must be that specified in Table C1.1 and Specification C1.1, except as allowed for—
(i) certain Class 2, 3 or 9c buildings in C1.5; and
(ii) a Class 4 part of a building located on the top storey in C1.3(b); and

(iii) open spectator stands and indoor sports stadiums in C1.7.

Note: Type A construction is the most fire-resistant and Type C the least fire-resistant of the types of construction.

Climatic Zone

Is an area defined in BCA Figure A1.1 and in Table A1.1 for specific locations, having energy efficiency provisions based on a range of similar climatic characteristics.

Deemed to Satisfy Provisions (DtS)

Provisions which are deemed to satisfy the Performance Requirements.

Effective Height

The height to the floor of the topmost storey (excluding the topmost storey if it contains only heating, ventilating, lift or other equipment, water tanks or similar service units) from the floor of the lowest storey providing direct egress to a road or open space.

Fire Resistance Level (FRL)

The grading periods in minutes for the following criteria-
(a) structural adequacy; and
(b) integrity; and
(c) insulation,

and expressed in that order.

Fire Source Feature (FSF)

The far boundary of a road which adjoins the allotment; or a side or rear boundary of the allotment; or an external wall of another building on the allotment which is not a Class 10 building.

National Construction Code Series (NCC)

The NCC was introduced 01 May 2011 by the Council of Australian Governments. The BCA Volume One (Class 2 to 9 Buildings) is now referenced as the National Construction Code Series Volume One — BCA.

Occupation Certificate

Building Occupation Approval issued by the Principal Certifying Authority pursuant to Part 4A of the EPA Act 1979.

Open Space

A space on the allotment, or a roof or other part of the building suitably protected from fire, open to the sky and connected directly with a public road.

Performance Requirements of the BCA

A Building Solution will comply with the BCA if it satisfies the Performance Requirements. A Performance requirement states the level of performance that a Building Solution must meet.

Compliance with the Performance Requirements can only be achieved by-
(a) complying with the DtS Provisions; or
(b) formulating an Alternative Solution which-
  (i) complies with the Performance Requirements; or
  (ii) is shown to be at least equivalent to the DtS Provisions; or
(c) a combination of (a) and (b).

Sole Occupancy Unit (SOU)

A room or other part of a building for occupation by one or joint owner, lessee, tenant, or other occupier to the exclusion of any other owner, lessee, tenant, or other occupier and includes a dwelling.

B. BUILDING CHARACTERISTICS

B.1 BUILDING CLASSIFICATION

The following table presents a summary of relevant building classification items of the proposed warehouse development:

▪ **BCA Class:**	Class 5 Office Class 7b Warehouse
▪ **Rise in Storeys:**	Two (2)
▪ **Effective Height:**	Less than 12m
▪ **Type of Construction:**	Type C Construction
▪ **Climate Zone:**	Zone 6
▪ **Maximum Floor Area / Volume:**	Greater than 18,000m^2 / 108,000m^3 Note: The building is designated as a Large Isolated Building under BCA Clause C2.3.

B.2 FIRE SOURCE FEATURE

The distances from the nearest Fire Source Features are:

Boundary	Distance to Fire Source Feature
Northern Boundary	**>3m**
Southern Boundary	**>3m**
Eastern Boundary	**>3m**
Western Boundary	**>3m**

C. BCA ASSESSMENT

C.1 BCA DEEMED-TO-SATISFY COMPLIANCE ISSUES:

The following comments have been made in relation to the relevant BCA provisions relating to the compliance issues associated with the proposed warehouse facility.

SECTION B- STRUCTURE

1. Part B1 – Structural Provisions

Structural engineering details prepared by an appropriately qualified structural engineer to be provided to demonstrate compliance with Part B1. This will include the following Australian Standards (where relevant):

1. AS 1170.0 – 2002 General Principles
2. AS 1170.1 – 2002, including certification for balustrading (dead and live loads)
3. AS 1170.2 – 2011, Wind Actions
4. AS 1170.4 – 2007, Earthquake Actions in Australia
5. AS 3700 – 2011, Masonry Structures
6. AS 3600 – 2009, Concrete Structures
7. AS 4100 – 1998, Steel Structures
8. AS 4600 – 2005, Cold Formed Steel Structures.
9. AS 2159 – 2009, Piling – Design and Installation

10. AS 1720.1 – 2010, Design of Timber Structure
11. AS/NZS 1664.1 and 2 – 1997, Aluminium Structures
12. AS 2047 – 2014, Windows and External Glazed Doors in Buildings
13. AS 1288 – 2006, Glass in Buildings - Selection and Installation

Comments: Structural design details and certification will be required at CC application stage.

SECTION C – FIRE RESISTANCE

FIRE RESISTANCE AND STABILITY

2. Clause C1.1 – Type of Construction Required

The minimum type of fire-resisting construction of a building must be that specified in Table C1.1 and Specification C1.1 except as allowed for in this clause.

Comments: Type C Construction applies the proposed warehouse building as it has a rise in storeys of two (2) – see notes under Spec. C1.1 below.

3. Clause C1.2 – Calculation of Rise in Storeys

The rise in storeys of a building is the sum of the greatest number of storeys at any part of the external walls of the building and any storeys within the roof space calculated in accordance with the requirements set out in this clause.

Comments: The building has a rise in storeys of two (2).

4. Clause C1.10 – Fire Hazard Properties

The fire hazard properties of the following linings, materials and assemblies in a Class 2 to 9 building must comply with **Specification C1.10** and the additional requirements of the **NSW Provisions** of the Code.

Note: See NSW C1.10(a) & (b).

Comments: Design certification required at CC application stage.

COMPARTMENTATION AND SEPARATION

5. Clause C2.2 – General Floor Area and Volume Limitations

Sets out the parameters for the area and volume of Class 5, 6, 7, 8 & 9 buildings as required by sub-clauses (a), (b) & (c).

Note: Table C2.2 maximum size of Fire Compartments or Atriums.

Comments: The proposed building is a Class 5 & 7b Large Isolated Building of Type C construction and as such the provisions for maximum fire compartment size under Table C2.2 do not apply. Refer to comments under C2.3 & C2.4 below in relation to the Large Isolated Building provisions applicable to the proposed Warehouse.

6. Clause C2.3 – Large Isolated Buildings

A Large Isolated Building that contains Class 5, 6, 7, 8 or 9 parts, is required to be—

(i) protected throughout with a sprinkler system complying with Specification E1.5; and

(ii) provided with a perimeter vehicular access complying with C2.4(b).

Comments: The proposed warehouse building is required to be sprinkler protected throughout and provided with perimeter vehicular access in accordance with Clause C2.4 (see notes below) pursuant to the Large Isolated Building designation under this clause.

7. Clause C2.4 – Requirements for Open Spaces & Vehicular Access

An open space and vehicular access required by C2.3 must comply with the requirements of sub-clauses (a) & (b) of this Part as that they must be 6m wide within 18m of the building and of a suitable bearing capacity and unobstructed height to permit the operation and passage of F&RNSW vehicles.

Comments: The proposed warehouse building does not comply with the provisions of C2.4 insofar as the vehicular access path is greater than 18m from the external wall of the building in the areas circled in red on the below mark-up. This non-compliance is required to be addressed as an alternative solution prepared

by the Fire Safety Engineer to demonstrate compliance with Performance Requirement CP9. Note: Any proposed Performance Solution will need to take into consideration that additional hazard that may result from the inclusion of Dangerous Goods Storage in the subject building.

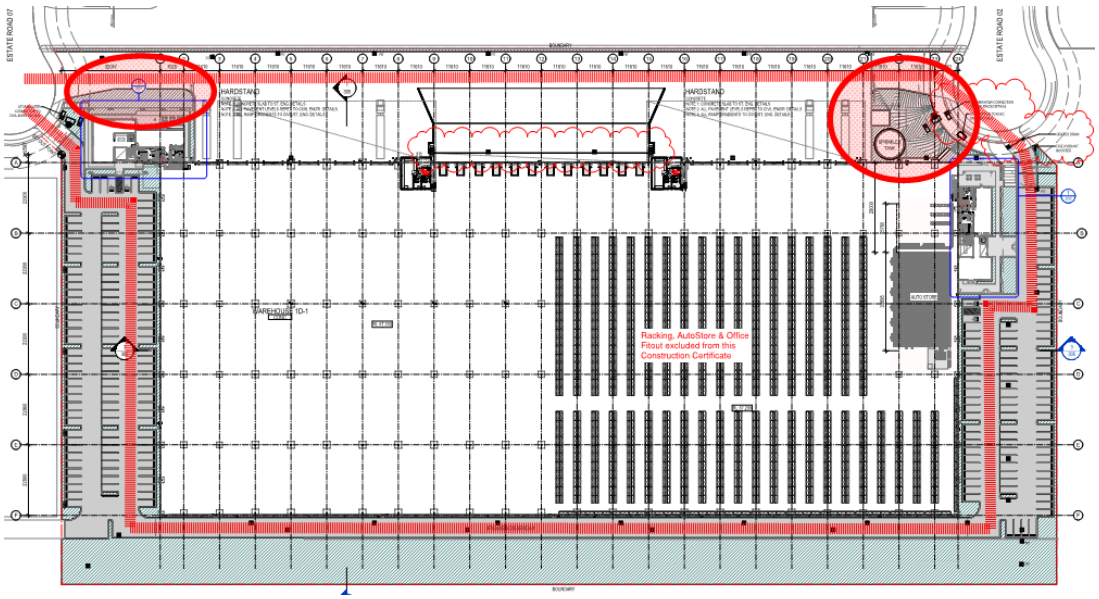


Figure 1 – Areas of Non-Compliant Perimeter Vehicular Access per BCA C2.4.

Note 1: The road providing vehicular perimeter access must be designed with adequate loading capacities to withstand a fire truck and in accordance with NSWFB Policy No. 4: Guidelines for Emergency Vehicle Access.

Note 2: If the perimeter access path is reduced to less than 6m at any security gates it is required to be referenced in the above Performance Solution.

8. Clause C2.8 – Separation of Classifications in the Same Storey

If a building has parts of different classifications located alongside one another in the same storey, each element must have the required higher FRL for the classifications concerned.

Alternatively, the parts must be separated by a fire wall having the higher FRL for the classifications prescribed in Table 3 or 4 of BCA Specification C1.1 (for Type a or Type B Construction), or Table 5 for Type C Construction.

*Comments: As the proposed building is of Type C Construction the same FRL requirements apply to both the Class 5 and Class 7b parts. Given the above, the provisions of C2.8(a) may be applied and in turn a fire wall between the Class 5 and Class 7b parts **is not** required.*

9. Clause C2.12 – Separation of Equipment

Equipment as listed below must be separated from the remainder of the building with construction complying with (d), if that equipment comprises –

(i) Lift motors and lift control panels; or
(ii) Emergency generators used to sustain emergency equipment operating in the emergency mode; or
(iii) Central smoke control plant; or
(iv) Boilers; or
(v) A battery or batteries installed in the building that have a voltage exceeding 24 volts and a capacity exceeding 10 ampere hours.

Note: Separating construction must have –

(A) an FRL as required by Specification C1.1, but not less than 120/120/120; and
(B) any doorway protected with a self-closing fire door having an FRL of not less than -/120/30.

Comments: Where appropriate, details demonstrating compliance are to be included in the CC Application plans for the proposed warehouse building.

10. Clause C2.13 – Electricity Supply System

To ensure certain types of electrical equipment to operate during an emergency the requirements of sub-clauses (a), (b), (c), (d) & (e) must be complied with relating to sub-stations, sub-mains and main switchboards.

(a) An electricity substation located within a building must –
  (i) Be separated from any other part of the building by construction having an FRL of not less than 120/120/120; and
  (ii) Having any doorway in that construction protected with a self-closing fire door having an FRL of not less then -/120/30
(b) A main switchboard located within the building which sustains emergency equipment operating in the emergency mode must –
  (i) Be separated from any other part of the building by construction having an FRL of not less than 120/120/120.
  (ii) Have any doorway in that construction protected with a self-closing fire door having an FRL of not less than -/120/30.
(c) Electrical conductors located within a building that supply –
  (i) A substation located within the building which supplies a main switchboard covered by (b); or
  (ii) A main switchboard covered by (b),

Must –

  (iii) Have a classification in accordance with AS/NZS 3013 of not less than –
    (A) If located in a position that could be straight to damage by motor vehicles – WS53W; or
    (B) Otherwise – WS52W; or
  (iv) Be enclosed or otherwise protected by construction having an FRL of not less than 120/120/120

Comments: Where appropriate, details demonstrating compliance are to be included in the CC Application plans for the proposed warehouse building.

SPECIFICATIONS

11. Specification C1.1 – Fire Resisting Construction

The new building works are required to comply with the requirements detailed under Table 5 of Specification C1.1 for Type C Construction. In this regard, the proposed building elements are required to comply.

Comments: Given the location of the building on the site there are no fire rating requirements in Table 5 of Spec. C1.1 that are applicable to the project.

SECTION D – ACCESS & EGRESS

PROVISION FOR ESCAPE

12. Clause D1.4 – Exit Travel Distances

This clause specifies the permitted travel distances allowable from Class 2 to Class 9 buildings. Sub-clauses (a) to (f) specify the maximum distances to be taken into account for the various uses in each Class of building.

Comments: The exit travel distances in the building are considered to be non-compliant with the requirements of Clause D1.4 in the warehouse areas where egress to the nearest exit is up to 80m.

The above non-compliance is required to be addressed as an alternative solution prepared by the Fire Safety Engineer to demonstrate compliance with Performance Requirements DP4 & EP2.2. Note: Any proposed Performance Solution will need to take into consideration that additional hazard that may result from the inclusion of Dangerous Goods Storage in the subject building.

13. Clause D1.5 – Distances Between Alternative Exits

Exits required as alternative exits must be –

(a) not less than 9m apart; and

(b) not more than – 60m apart.

(c) Located so that the alternative paths of travel do not converge such that they become less than 6m apart.

Comments: The distances between alternative exits are considered non-compliant with the requirements of D1.5 in the warehouse areas where egress between alternative exits measured through a point of choice is up to 160m.

The above non-compliance is required to be addressed as an alternative solution prepared by the Fire Safety Engineer to demonstrate compliance with Performance Requirements DP4 & EP2.2. Note: Any proposed Performance Solution will need to take into consideration that additional hazard that may result from the inclusion of Dangerous Goods Storage in the subject building.

14. Clause D1.6 – Dimensions of Exits

This clause details the minimum dimensions such as height and width of paths of travel from Class 2 to 9 buildings. It also specifies the minimum dimensions of doorways from the various compartments and the width of exit doors from buildings depending on the uses and functions carried out within them.

Comments: Population numbers for the building will be required to be provided by Goodman at the CC Application stage to facilitate an assessment of the provisions of D1.6. In this regard, however, a calculation has been done in accordance with Clause D1.13 below and it is considered compliance is readily achievable.

15. Clause D1.9 – Travel by Non-fire-isolated Stairways or Ramps

Sub-clauses (a) to (f) set out the prescribed travel distances to be provided in required exits of Class 2 to 9 buildings and Class 4 parts of buildings. The sub-clauses set out the maximum distances to be taken into account for the various uses in each Class of building.

Comments: The proposed exit stairs from the Level 1 Main Offices & Dock Offices are capable of achieving compliance with D1.9. Further details are to be provided at CC application stage including confirmation that the distance from any point on a floor to a point of egress to a road or open space does not exceed 80 m per Clause D1.9(c).

16. Clause D1.10 – Discharge from Exits

Requires that an exit must not be blocked at the point of discharge. Barriers such as bollards must be installed to prevent vehicles from blocking the discharge from exits.

This clause also provides the methods of construction, location and separation, at exit discharge points for all building Classes.

Comments: All discharge points from the building are required to be protected in accordance with the requirements of this clause. Additionally, a 1m wide egress path per D1.10(b) is required from the egress door adjacent to the sprinkler tank to the estate road.

17. Clause D1.13 – Number of Persons Accommodated

Clause D1.13 and Table D1.13 are used to calculate the anticipated number of people in particular types of buildings so that minimum exit widths and the required number of sanitary and other facilities can be calculated. This clause and table are not to be used for non-BCA purposes.

Comments: The following population numbers have been calculated for the Class 5 and 7b parts of the building in accordance with Table D1.13:

- *Office (including Dock Office) – 190 persons (1,913m^2 at 10m^2/person)*
- *Warehouse – 490 persons (29,000m^2 at 60m^2/person).*

  Note: It is considered that the above population numbers for the Warehouse areas may be excessive considering its proposed use and as such confirmation of the proposed population numbers are to be provided by Goodman at CC Application stage.

CONSTRUCTION OF EXITS

18. Clause D2.7 – Installations in Exits & Paths of Travel

This clause restricts the installation of certain services in fire-isolated exits, non-fire-isolated exits and certain paths of travel to exits. Sub-clauses (a) to (e) prescribes which services **shall not be installed** as well as the circumstances in which certain services **may be installed** in fire-isolated and non-fire-isolated exits.

Comments: This requirement applies to all cupboards containing electrical distribution boards or comms. equipment that are located in a path of travel to an exit. In this regard, such cupboards are to be enclosed in non-combustible materials and are to be suitably sealed against the spread of smoke.

19. Clause D2.8 – Enclosure of Space under Stairs and Ramps

The space below a required fire-isolated stairway or ramp in a fire-isolated shaft must not be enclosed to form a cupboard or other enclosed space. If the required stairway or ramp is non-fire-isolated, (including

an external stairway) any cupboard underneath must have an FRL of 60/60/60, with a self-closing -60/30 door.

Comments: *Any proposed enclosures under the stairs to the Level 1 Offices will need to achieve an FRL of 60 minutes and the doorway will need to be fitted with a self-closing -/60/30 fire door.*

20. Clause D2.13 – Goings & Risers

This clause sets out the detailed requirements for the construction and geometry of the goings and risers in required stairways. These details are set out in sub-clauses (a) to (c) and Table D2.13 Riser and Going Dimensions.

Note: NSW D2.13(a)(ix)(x)(xi).

Comments: All stairs are to have solid risers, and are to have contrasting nosings, slip resistant surfaces throughout in accordance with clause 11 of AS1428.1-2009. Refer to the slip resistance for stairs below under Clause D2.14.

Riser and Going Dimensions (mm)			
	Riser (R)	**Going (G)**	**Quantity (2R + G)**
Maximum	190	355	700
Minimum	115	250	550

21. Clause D2.14 – Landings

The dimensions and gradients of landings in stairways are set out in this clause; the configuration will depend on the proposed use of a building.

Landing surfaces must be slip resistant OR have slip resistant nosings not less than that listed in Table D2.14 when tested in accordance with AS4586.

Comments: Architect to note.

Application	**Surface conditions**	
	Dry	**Wet**
Ramp steeper than 1:14	P4 or R11	P5 or R12
Ramp steeper than 1:20 but not steeper than 1:14	P3 or R10	P4 or R11
Tread or landing surface	P3 or R10	P4 or R11

22. Clause D2.15 – Thresholds

The threshold of a doorway must not incorporate a step or ramp at any point closer to the doorway than the width of the door leaf unless –

(i) the doorway opens to a road or open space, external stair landing or external balcony; and
(ii) the door sill is not more than 190mm above the finished surface of the ground, balcony, or the like, to which the doorway opens.

Comments: Architect to note. Details demonstrating compliance will be required to be included in the CC plans.

23. Clause D2.16 – Balustrades or Other Barriers

This clause details where balustrades are required to be provided and sets out in specific detail the construction requirements. Typically, the following will apply to this class of building:

+ Balustrades are required where the fall to the level below is more than 1m in height. The minimum height of a balustrade is 1m above the floor of the landing, walkway or the like; and 865mm above the floor of a stairway or a ramp.
+ For a fall of more than 4m to the surface level below, a window sill must be a minimum of 865mm in height above the height of the floor surface.
+ Where the floor is more than 4m above the surface beneath the balustrade any horizontal or near horizontal members between 150mm and 760mm above the floor must not facilitate climbing.
+ Balustrades must be constructed so as to not permit a sphere of 125mm diameter to pass through. The exception to this is within fire isolated exits within the building, or within a class 7 or 8 building,

where the rails can be positioned a maximum of 460mm apart, so long as a bottom rail is located so a sphere of 150mm cannot pass through the opening between the nosing of the stair treads and the rail or between the floor of the landing, balcony or the like.

Comments: Details demonstrating compliance are to be submitted with the CC Application drawings for assessment against the above criteria.

24. Clause D2.17 – Handrails

This Clause sets out the requirements regarding the location, spacing and extent of handrails required to be installed in buildings.

Comments: Details of the proposed handrails are to be provided for assessment with the application for the Construction Certificate. Note: Refer to Part D3 for additional requirements for handrails associated with accessible compliant stairways.

25. Clause D2.19 – Doorways and Doors

This clause applies to all doorways and refers to the types of doors that cannot be used in buildings of prescribed uses, the use of power operated doors and the force required to operate sliding doors.

If the door is also power operated, it must be opened manually under a force of not more than 110N if there is a malfunction or failure to the power source; or upon the activation of a fire or smoke alarm anywhere in the fire compartment served by the door.

Comment: Architect to note – compliance readily achievable.

26. Clause D2.20 – Swinging Doors

A swinging door in a required exit or forming part of a required exit must be installed to the requirements of sub-clauses (a), (b) & (c). This clause only applies to swinging doors in doorways serving a required exit or forming part of a required exit. It does not apply to other doorways – see notes in the Guide to the BCA.

Comments: The proposed egress doors are required to swing in the direction of egress in accordance with D2.20(a) – compliance is readily achievable.

27. Clause D2.21 – Operation of Latch

A door in a required exit or forming part of a required exit and in a path of travel to a required exit must be readily openable without a key from the side that faces a person seeking egress, by a single downward action or pushing action on a single device which is located between 900mm & 1.1m from the floor. This clause prohibits the use of devices such as deadlocks and knobs where knobs must be operated in a twisting motion in accordance with sub-clauses (a) & (b). D2.21 also sets out exceptions in relation to buildings where special security arrangements are required in relation to the uses carried out.

Comments: Architect to note. Details demonstrating compliance will be required to be included in the CC plans.

ACCESS FOR PEOPLE WITH A DISABILITY

28. Clause D3.2 – Access to Buildings

This part requires accessways to be provided to accessible buildings from the main points of pedestrian entry at the allotment boundary and any accessible car parking space or accessible associated buildings connected by a pedestrian link.

Comments: Compliant Access is required throughout all areas in the proposed building in accordance with AS 1428.1-2009. Refer to D3.3 and D3.4 below.

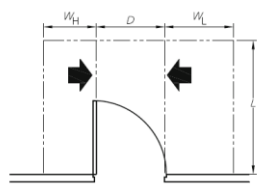
29. Clause D3.3 – Parts of the Building to be Accessible

This part specifies the requirements for accessways within buildings which must be accessible.

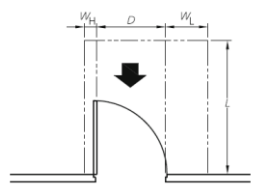
Comments: As indicated above, the proposed building is required to be accessible throughout in accordance with AS1428.1-2009. In addition to the matters outlined below, compliant access is also required to be provided from the main pedestrian entry to the site from the footpath/allotment boundary, through to the main entry of the building, from any accessible parking spaces on the site to the main entry and throughout all areas required to be accessible. It is noted that compliance with the requirements of D3.3 and AS 1428.1-2009 is readily achievable; however, details and design certification will be required to be provided at CC Application stage.

The following is a summary of some of the key matters which need to be considered from Clause D3.3 and AS 1428.1-2009:

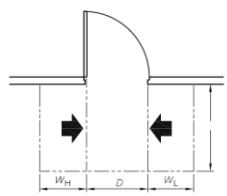
- *Access for persons with disabilities must be provided, at a minimum, to and within all areas normally used by the occupants. This includes to and within all common areas.*
- *An accessway is required to be provided to the 2x main office entries from Estate Road 07 and from Estate Road 02. It is understood a Performance Solution is proposed by a suitably qualified Access Consultant to omit the provision of a compliant accessway from Estate Rd 02 to the norther main office entrance.*
- *As the combined floor area of the Level 1 Dock Office areas is less than 200m^2, a passenger lift or ramp is not required to serve these areas per D3.3(f).*
- *The minimum width of an accessible doorway must have a clear opening width of not less than 850mm in accordance with AS1428.1.*
- *All doorways on a continuous path of travel shall have a minimum luminance contrast of 30% provided between: door leaf and door jamb; or door leaf and adjacent wall; or architrave and wall; or door leaf and architrave; or door jamb and adjacent wall. The minimum width of the area of luminance contrast shall be 50mm.*
- *In accordance with Clause D3.3; the non-fire-isolated stairways must comply with Clause 11 of AS 1428.1-2009.*
- *Clause D3.3(g) and (h) requires that the pile height or pile thickness shall not exceed 11mm and the carpet backing thickness shall not exceed 4mm. Moreover, the carpet pile height or pile thickness dimension shall not exceed 11mm, the carpet backing thickness dimension shall not exceed 4mm and their combined dimension shall not exceed 15mm.*
- *Circulation space to the new doorways that are required to be accessible are to comply with Section 13 of AS1428.1-2009, as detailed below:*



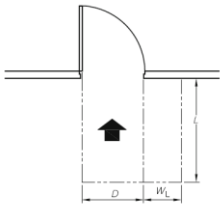
Dimension D	Dimension L	Dimension W_H	Dimension W_L
850	1670	660	900
900	1670	610	900
950	1670	560	900
1000	1670	510	900



Dimension D	Dimension L	Dimension W_H	Dimension W_L
850	1450	110	530
900	1450	110	530
950	1450	110	530
1000	1450	110	530



Dimension D	Dimension L	Dimension W_H	Dimension W_L
850	1240	560	660
900	1210	510	660
950	1175	460	660
1000	1155	410	660



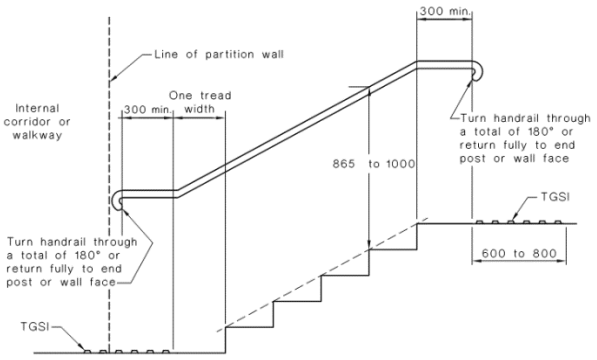
Dimension D	Dimension L	Dimension W_H	Dimension W_L
850	1450	0	510
900	1450	0	510
950	1450	0	510
1000	1450	0	510

<u>*Circulation space requirements at doorways*</u>

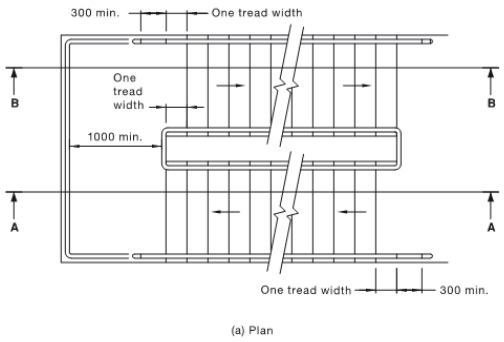
- *Turning Spaces and Passing Spaces in all areas are required to be provided on each level of the building in accordance with Clauses 6.4 & 6.5 of AS 1428.1-2009.*

<u>*Stairways*</u>

- *Every common area stairway must be constructed in accordance with Clause 11 of AS1428.1, except if they are within a fire isolated exit. As such, the stairways must be designed to comply with the accessibility requirements of Clause 11 of AS1428.1-2009 and details will need to be confirmed on the plans for CC. This should be reviewed prior to submission.*



SECTIONAL VIEW

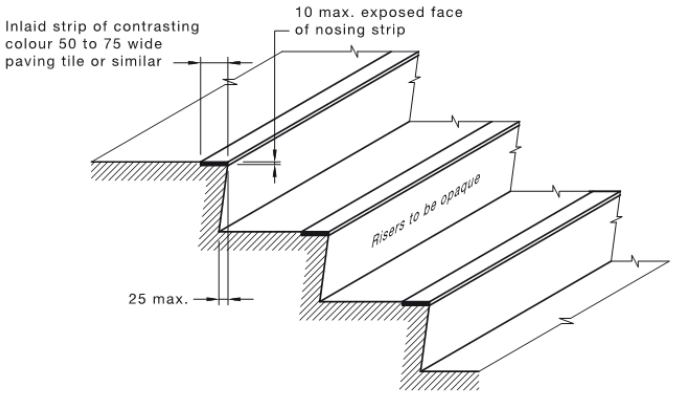


(a) Plan

DIMENSIONS IN MILLIMETRES

Stairway and handrail requirements

- *Stairs shall have opaque risers (i.e. Solid)*
- *Stair nosing's shall comply with the following diagram, which achieve a colour contrast luminance of 30% to the background (tread):*



DIMENSIONS IN MILLIMETRES

Stairway nosing requirements

- *Stairways are to be served by Tactile Ground Surface Indicators in accordance with AS1428.4.1, except if they are within a fire isolated exit.*

Handrails

- *Handrails shall be installed along stairways as follows:*
  - *Shall be continuous through the flight and where practicable, around landings and have no obstruction on or above up to a height of 600mm,*
  - *Installed along both sides of the stairway (giving consideration also to 1m unobstructed width),*
  - *Shall have a compliant hand clearance in accordance with Figure 29 of AS 1428.1-2009.*

30. Clause D3.4 – Exemptions

This part provides exemptions to the Deemed-to-Satisfy provisions for access by people with a disability. This part provides details on buildings or parts of buildings not required to be accessible under the BCA where providing access would be inappropriate because of the nature of the area or the tasks undertaken.

Comments: It is recommended that advice be obtained from an accredited Access Consultant at the CC Application stage, however, consideration to an exemption for the warehouse areas (on health & safety risk basis) may be appropriate on this project. Confirmation from Goodman will be required that includes a request for concession, where this would be applied and the reasons why it would be inappropriate for access for people with disabilities within the facility.

31. Clause D3.5 – Accessible Carparking

This part provides details of the number of accessible carparking spaces required in a carpark depending on the classification of the building.

Comments: In the case of Class 5 & 7b building, 1 compliant accessible space is required for every 100 parking spaces or part thereof. In this regard the building is considered to achieve compliance with 2 accessible parking spaces provided to each of the main offices.

32. Clause D3.6 – Signage

This section provides requirements for signage in buildings required to be accessible by Part D3.

Comments: Signage will be required to identify accessible facilities, an ambulant accessible facility and the paths to accessible pedestrian entries (where required).

33. Clause D3.8 – Tactile Indicators

This clause provides for the installation of tactile indicators in buildings required to be accessible and must be provided to warn people who are blind or have a vision impairment that they are approaching a stairway, escalator, passenger conveyor, ramp, overhead obstruction or an accessway meeting a vehicular way, except for areas exempted by D3.4.

Comments: Compliant tactile indicators are required in all areas of the building to all ramps, stairs, paths approaching a driveway and any overhead obstructions less than 2m in height.

34. Clause D3.11 – Ramps

Ramps may be used as part of an accessway where there is a change of level and must comply with the requirements set out in AS1428.1.

Comments: Architect to note. Details demonstrating compliance will be required to be included in the CC plans.

35. Clause D3.12 – Glazing on an Accessway

On an accessway, where there is no chair rail handrail or transom, all frameless or fully glazed doors, sidelights and any glazing capable of being mistaken for a doorway or opening, must be clearly marked in accordance with AS 1428.1.

Comments: Glazing capable of being mistaken for an opening as listed above must be clearly marked for its full width with a solid and non-transparent contrasting line being not less than 75mm wide and the lower edge must be located between 900mm and 1000mm above the plane of the finished floor level.

SECTION E – SERVICES AND EQUIPMENT

FIRE FIGHTING EQUIPEMENT

36. Clause E1.3 – Fire hydrants

E1.3(a) – A fire hydrant system must be provided to serve a building having a total floor area greater than 500m² and where a fire brigade is available to attend a building fire.

E1.3(b) – Requires that the fire hydrant system must be installed in accordance with the provisions of AS2419.1 and also details where internal hydrants must be located.

Comments: The proposed warehouse building is required to be served by a compliant hydrant system incorporating a ring main. Details demonstrating compliance with the provisions of AS 2419.1-2005 are required to be provided at CC Application stage.

Hydrant booster assemblies are required to be accessible to the brigade, located within sight of the main entry of the building and either greater than 10m from the building or affixed to the external wall of the building and protected by construction having an FRL of not less than 90/90/90 extending 2m each side and 3m above the assembly. In addition, the hydrant booster must be located at least 10m from any proposed substations.

Where the location of hydrant booster departs from the above provisions, the location of the booster assembly will need to be addressed as a Fire Engineered Alternative Solution to demonstrate compliance with Performance Requirement EP1.3. It is noted an Alternative Solution is likely to be required for the location of the booster assembly given it is not able to be located within site of the main entrance of both main offices.

Additionally, where hydrants that are located outside the building but are not open to the sky (e.g. located under an awning or the like) are proposed to be treated as external hydrants, an Alternative Solution from the Fire Engineer will be required demonstrating compliance with Performance Requirement EP1.3.

Note: Any proposed Performance Solution will need to take into consideration that additional hazard that may result from the inclusion of Dangerous Goods Storage in the subject building.

37. Clause E1.4 – Fire hose reels

A fire hose reel system must be provided to serve a building where one or more internal fire hydrants are installed or in a building with a floor area greater than 500m².

This clause requires that the fire hose reel system must be installed in accordance with AS 2441 and sets out the detail for location and uses of fire hose reels.

Comments: The proposed building is required to be served by a compliant fire hose reel system. Details demonstrating compliance are to be provided at the CC application stage.

38. Clause E1.5 – Sprinklers

A sprinkler system must be installed in a building or part of a building when required by Table E1.5 and comply with Specification E1.5. Table E1.5 sets out which types of building occupancies and Classes which require to have sprinkler systems installed in them.

Specification E1.5 sets out requirements for the design and installation of sprinkler systems.

Comments: The proposed Large Isolated Building is required to be sprinkler protected throughout in order to address the requirements of Clause C2.3 and Table E1.5. Details demonstrating compliance with AS2118.1 – 1999 or AS2118.1-2017 are to be provided at the CC application stage.

39. Clause E1.6 – Portable fire extinguishers

Portable fire extinguishers must be provided as listed in Table E1.6 and must be selected, located and distributed in accordance with Sections 1, 2, 3 and 4 of AS 2444.

Comments: Fire extinguishers will be required to be installed in the proposed building in accordance with Table E1.6.

40. Clause E1.8 – Fire Control Centres

A fire control centre facility in accordance with Specification E1.8 must be provided for a building having an effective height of more than 25m and in a Class 6, 7, 8 or 9 building with a total floor area of more than 18,000m².

Specification E1.8 describes the construction and content of required fire control centres or rooms.

Comments: As the floor area of the building exceeds 18,000m², it is required to be provided with a Fire Control Centre facility that complies with Clauses 2-5 of Spec. E1.8. Further details which demonstrate compliance with the requirements of Spec. E1.8 will be required to be included on the Construction Certificate application plans.

Note: If access into the Fire Control Centre results in a level change that exceeds 300mm a Fire Engineered Alternative Solution to demonstrate compliance with Performance Requirement EP1.6 will be required.

41. Clause E1.10 – Provision for Special Hazards

Suitable provisions are to be made for fire fighting in a building if special problems of fighting fire could arise due to the nature or the quantity of goods stored, displayed or used; and/or the proximity of the building to a fire fighting water supply.

Comments: As indicated in the RiskCon PHA additional measures are to be incorporated into the design of the building including the provision of spill kits, caging of Class 2.1 aerosol storage areas, and fire water containment. In addition, confirmation/certification will be required from the both the sprinkler system designer and fire hydrant system designer that the design of these systems is suitable for the proposed additional hazard that may result from the proposed Dangerous Goods Storage and the water supply to each system has been designed to allow for a period time that will facilitate additional fire fighting activities on site.

Details of the above will be required to be provided with the Construction Certificate Application and will need to be documented by the Fire Engineer in their Performance Solutions for both perimeter vehicular access and occupant egress.

SMOKE HAZARD MANAGEMENT

42. Clause E2.2 – General Requirements

Class 2 to 9 buildings must comply with the provisions of this Clause to remove smoke during a fire, to control the operation of air handling systems and to prevent the spread of smoke between compartments.

Buildings must comply with the provisions of **Table E2.2a**, as applicable to Class 2 to 9 buildings. It deals with the design and construction of air handling systems that are part of a smoke hazard management system and air handling system that are not part of a smoke hazard management system.

The details relating to the installation and operation of the systems are set out in **Specifications E2.2a**, **E2.2b** and **E2.2c**.

Comments: As the floor area / volume of the warehouse building is greater than 18,000m^2 / 108,000m^3 and the ceiling height of the fire compartment exceeds 12m, an automatic smoke exhaust system in accordance with Spec E2.2b is required. In this regard, consideration may be given to an alternative solution to rationalise the required smoke hazard management requirements and in turn any such alternative solution will need to be prepared by the Fire Engineer and will need to demonstrate compliance with Performance Requirement EP2.2. Note: Any proposed Performance Solution will need to take into consideration that additional hazard that may result from the inclusion of Dangerous Goods Storage in the subject building.

43. Clause E2.3 – Provision for Special Hazards

Additional smoke hazard management measures may be required in a building to address any additional risk that result from special characteristics, functions, type of quantities of storage or mix of classifications within a fire compartment.

Comments: As indicated in E2.2 above the provision of smoke hazard management (smoke exhaust) systems to the subject building is likely to be addressed as a Performance Solution by the Fire Engineer. Any such Performance Solution will need to take into consideration any additional hazard/risk to occupants and fire fighters as a result of the proposed Dangerous Goods Storage in the building. Note: See comments under E1.10 also in relation to the proposed Dangerous Goods Storage.

LIFT INSTALLATIONS

44. Clause E3.3 – Warning Against use of Lifts in Fire

Warning signs required be provided must be displayed where they can be readily seen and must comply with the details and dimensions of **Figure 3.3**.

Comments: Lift Contractor to note.

45. Clause E3.5 – Landings

Access and egress to and from lift well landings must comply with the Deemed-to-Satisfy Provisions of Part D.

Comments: Lift Contractor to Note.

46. Clause E3.6 – Passenger Lifts

In an accessible building, every passenger lift must be one of the types identified in **Table E3.6a,** have accessible features in accordance with **Table E3.6b** and not rely on a constant pressure device for its operation if the lift car is fully enclosed.

Comments: Lift Contractor to note. Minimum lift floor dimensions of 1100mm wide x 1400mm deep required.

EMERGENCY LIGHTING, EXIT SIGNS AND WARNING SYSTEMS

47. Clause E4.2 – Emergency Lighting Requirements

This clause details when emergency lighting must be installed in Class 2 to 9 buildings. The requirements for buildings and parts of buildings are detailed in sub-clauses (a) to (i) and each sub-clause must be considered as more than one may apply to any single building

Comments: Emergency Lighting is required throughout the building in accordance with E4.2, E4.4 and AS/NZS 2293.1-2005.

48. Clause E4.5 – Exit Signs

An exit sign must be clearly visible to persons approaching the exit and must be installed on, above or adjacent to each door providing egress from a building. Sub-clauses (a) to (d) set out the situations where exit signs are required to be installed.

Comments: Electrical Consultant to note. Details demonstrating compliance will be required to be included in the CC plans.

49. Clause E4.6 – Direction Signs

If an exit is not readily apparent to persons occupying or visiting the building then exit signs must be installed in appropriate positions in corridors, hallways, lobbies, and the like, indicating the direction to a required exit.

Comments: Electrical Consultant to note. Details demonstrating compliance will be required to be included in the CC plans.

SECTION F – HEALTH & AMENITY

DAMP AND WEATHERPROOFING

50. Performance Requirement FP1.4

A roof and external wall (including openings around windows and doors) must prevent the penetration of water that could cause

a) Unhealthy or dangerous conditions, or loss of amenity for occupants; and
b) Undue dampness or deterioration of building elements.

Note 1: There are no Deemed-to-Satisfy provisions for this Performance Requirement in respect to External Walls.

Note 2: Refer to Clause F1.5 for roof coverings.

Comments: Design statement and a documented Performance Solution is to be provided with the Construction Certificate application, either by using:

- *The Verification Methods in Clause FV1; or*
- *Other verification methods deemed acceptable by the Certifier; or*
- *Evidence to support that the use of the material or product, form of construction or design meets the Performance Requirements or the DTS provisions, such as a Certificate of Conformity (eg. CodeMark); or*
- *By way of Expert Judgement.*

51. Clause F1.1 – Stormwater drainage

Stormwater drainage must comply with AS/NZ 3500.3.

Comments: Details of stormwater disposal are required to be prepared by a suitably qualified consultant and submitted with documentation for the CC.

52. Clause F1.5 – Roof Coverings

This clause details the materials and appropriate standards, with which roofs must be covered with. The roofing requirements are set out in sub-clauses (a), (b) (c), (d), (e) & (f) which set out the types of materials that may be used and the adopted Australian Standards that apply to their quality and installation.

Comments: Note.

53. Clause F1.6 – Sarking

Sarking-type materials used for weatherproofing of roofs must comply with AS/NZS 4200 parts 1 and 2.

Comments: Note.

54. Clause F1.7 – Waterproofing of Wet Areas

This clause requires that wet areas in Class 2 to 9 buildings must be waterproofed. It prescribes the standards to which the work must be carried out in sub-clauses (a) to (e) with emphasis in sub-clauses (c), (d) & (e) on the construction of rooms containing urinals and their installation.

Note: Figures F1.7(1) & F1.7(2) of the Guide to the BCA contain diagrams indicating the areas of walls and floors to be protected around baths, washbasins and showers.

Comments: Note.

SANITARY AND OTHER FACILITIES

55. Clause F2.2 – Calculation of Number of Occupants & Facilities

This clause sets out the requirements for the calculation of the number of occupants and the number of sanitary facilities required to be installed in Class 2 to 9 buildings. The parameters for the calculation are set out in sub-clauses (a) to (d).

Comments: Noted – refer to D1.13.

56. Clause F2.3 – Facilities in Class 3 to 9 Buildings

This clause provides the requirements for sanitary facilities to be installed in Class 3, 5, 6, 7, 8 and 9 buildings in accordance with **Table F2.3**. The requirements and variations are set out in sub-clauses (a) to (h).

Comments: As indicated above the proposed population numbers are to be provided by Goodman to assess if the proposed toilet facilities within the building are adequate to achieve compliance with Table F2.3.

Notwithstanding, the proposed facilities have been assessed against the population calculation under Clause D1.13 to determine compliance as follows:

Warehouse (amenities in GF main offices and dock offices):

- *Males – 14 Closet Pans, 8 Urinals & 14 Washbasins – Allows for 280 persons – complies.*
- *Females – 14 Closet Pans & 14 Washbasins – Allows for 210 persons – does not comply based on a 50/50 split between males and females (clarification of proposed population numbers should be provided).*

Office (amenities in Level 1 main offices):

- *Males – 8 Closet Pans, 5 Urinals & 6 Washbasins – Allows for 150 persons – complies.*
- *Females – 8 Closet Pans & 6 Washbasins – Allows for 120 persons – complies.*

57. Clause F2.4 – Accessible Sanitary Facilities

Accessible unisex sanitary compartments must be provided, in accordance with **Table F2.4(a)** and unisex showers must be provided in accordance with **Table F2.4(b)**, in buildings or parts that are required to be accessible. The details for the provision of disable facilities and the standard, AS 1428.1, are set out in sub-clauses (a) to (i).

Comments: The number of accessible unisex sanitary compartments are considered compliant with the requirements of this clause. The proposed accessible toilet facilities and ambulant sanitary facilities are required to achieve compliance with the provisions of Table F2.4. Details demonstrating that the design of each facility complies with AS 1428.1 are to be provided at CC application stage, however, compliance is readily achievable.

58. Clause F2.5 – Construction of Sanitary Compartments

(a) Other than in an early childhood centre sanitary compartments must have doors and partitions that separate adjacent compartments and extend –

  (i) from floor level to the ceiling in the case of a unisex facility; or

  (ii) a height of not less than 1.5m above the floor if primary school children are the principal users; or

  (iii) 1.8 above the floor in all other cases.

(b) The door to a fully enclosed sanitary compartment must-

  (i) open outwards; or

  (ii) slide: or

  (iii) be readily removable from the outside of the sanitary compartment,

unless there is a clear space of at least 1.2m, measured in accordance with **Figure F2.5** between the closet pan within the sanitary compartment and the doorway.

Comments: Details demonstrating compliance are to be submitted with documentation for the CC Application.

59. Clause F3.1 – Height of Rooms and Other Spaces

The ceiling heights in Class 2 to 9 buildings must not be less than required in sub-clauses (a) to (f) of this clause.

The ceiling heights are prescribed and should be checked for all classes and parts during assessment or the design process.

The minimum ceiling heights for a Class 5 & 7 buildings are as follows:

+ Corridor or Passage, Bathroom, Storeroom, etc. – 2.1m
+ Remainder – 2.4m.

Comments: Architect to ensure compliance. Ceiling heights to be reviewed at the CC application stage with the detailed section drawings.

LIGHT AND VENTILATION

60. Clause F4.4 – Artificial Lighting

Artificial lighting is required where it is necessary to minimise the hazard to occupants during an emergency evacuation. Sub-clauses (a), (b) & (c) sets out the places where artificial lighting is always required in all classes of buildings and the standard to which it must be installed.

Comments: Design certification to be submitted at CC Application Stage.

61. Clause F4.5 – Ventilation of Rooms

A habitable room, office, shop, factory, workroom, sanitary compartment, bathroom, shower room, laundry and any other room occupied by a person for any purpose must have natural ventilation complying with F4.6 **or** a mechanical or air-conditioning system complying with AS1668.2 and AS/NZS 3666.1.

Note: NSW F4.5(b) a mechanical ventilation or air-conditioning system complying with AS 1668.2 – the reference to AS/NZS 2666.1 is deleted from the BCA in NSW as the need to comply with this standard is regulated under the relevant section of the Public Health Act 1991.

Comments: Design certification to be submitted at CC Stage.

SECTION J – ENERGY EFFICIENCY

62. Part J1 – Building Fabric

The provision of insulation of the building envelope will be required in the proposed Building, in accordance with **Clauses J1.0 to J1.**6, and the **Tables therein**, including Thermal Construction General, Roof and Ceiling Construction, Rooflights, Walls, and Floors. Design details and/or certification of design will be required to be provided in this regard.

Comments: This section applies to any air-conditioned spaces proposed within the warehouse building. Design details and/or certification of building envelope design will be required to be submitted with the application for a Construction Certificate.

63. Part J2 – Glazing

Glazing within the external building envelope will be required to be assessed/designed to achieve compliance with **Clauses J2.0 to J2.5**, including the **Tables therein**, having regard to the maximum aggregate air-conditioning energy attributable to each façade of the proposed building. A calculation demonstrating that the proposed design of the building complies with the requirements of **Part J2** is required to be provided in this regard.

*Comments: This section applies to any air-conditioned spaces proposed within the warehouse building. A calculation demonstrating that the proposed design of the glazing in each building complies with the requirements of **Part J2** is required to be submitted with the application for a Construction Certificate.*

64. Part J3 – Building Sealing

The proposed building envelope will be required to be sealed to prevent air infiltration in accordance with the requirements of **Clauses J3.0 to J3.6**. Details or certification that the proposed building design complies with the requirements of **Part J3** is required to be provided.

*Comments: This section applies to any air-conditioned spaces proposed within the warehouse building. Details or certification that the proposed design complies with the requirements of **Part J3** will need to be submitted with the application for a Construction Certificate.*

65. Part J5 – Air-Conditioning & Ventilation Systems

Details and/or design certification which confirm that any proposed air-conditioning system or unit within the proposed building achieves compliance with the relevant requirements of **Part J5** will be required to be provided from the mechanical engineer.

Comments: Details or certification demonstrating compliance will need to be submitted with the application for a Construction Certificate.

66. Part J6 – Artificial Light & Power

Details and/or design certification which confirm that all artificial lighting, power control, and boiling/chilled water units within the proposed building achieves compliance with the relevant requirements of **Part J6** will be required to be provided from the electrical engineer.

Comments: Details or certification demonstrating compliance will need to be submitted with the application for a Construction Certificate.

67. Part J7 – Hot Water Supply, & Swimming Pool & Spa Pool Plant

Details and/or design certification which confirm that any proposed hot water supply system within the proposed building achieves compliance with the relevant requirements of **Part J7** (Section 8 of AS 3500.4) will be required to be provided from the hydraulic engineer.

Comments: Details or certification demonstrating compliance will need to be submitted with the application for a Construction Certificate.

68. Part J8 – Facilities for Energy Monitoring

Provision for monitoring of energy consumption must be provided to a building where the floor area exceeds 500m², and must be capable of recording the consumption of gas and electricity. In addition, where the floor area of the building exceeds 2,500m² the energy monitoring facilities must be capable of individually recording air-conditioning, lighting, appliance power, central hot water supply, lifts/escalators, and other ancillary plant.

Comments: Details or certification demonstrating compliance will need to be submitted with the application for a Construction Certificate.

C. CONCLUSION

This report contains an assessment of the referenced architectural documentation for the proposed Warehouse Building 1D at Oakdale South Estate, Horsley Park (including the proposed Dangerous Goods Storage) against the Deemed-to-Satisfy Provisions of the BCA 2016. Arising from the review, it is considered that the proposed development can readily achieve compliance with the relevant provisions of the BCA. Where compliance matters are proposed to comply with the Performance Requirements (rather than DtS Provisions), the development of an Alternative Solution Report will be required prior to the issue of the Construction Certificate.

The following fire safety measures are required for the new building works:

Statutory Fire Safety Measure	**Design / Installation Standard**
Alarm Signaling Equipment	AS 1670.3 – 2004
Automatic Fire Suppression Systems**	BCA Spec. E1.5 & AS 2118.1 – 1999 or AS 2118.1 – 2017
Building Occupant Warning System activated by the Sprinkler System	BCA Spec. E1.5, Clause 8 and / or Clause 3.22 of AS 1670.1 – 2015
Emergency Lighting	BCA Clause E4.4 & AS 2293.1 – 2005
Exit Signs	BCA Clauses E4.5, E4.6 & E4.8; and AS 2293.1 – 2005
Fire Control Centre	BCA Spec E1.8
Fire Doors	BCA Clause C2.12, C2.13 and AS 1905.1 – 2015 and manufacturer's specification
Fire Hose Reels	BCA Clause E1.4 & AS 2441 – 2005
Fire Hydrant Systems**	BCA Clause E1.3 & AS 2419.1 – 2005
Fire Seals	BCA Clause C3.15, AS 1530.4 – 2014 & AS 4072.1 – 2005 and manufacturer's specification
Lightweight Construction	BCA Clause C1.8 & AS 1530.3 – 1999 and manufacturer's specification
Paths of Travel	EP&A Regulation Clause 186
Perimeter Vehicular Access**	BCA Clause C2.4
Portable Fire Extinguishers	BCA Clause E1.6 & AS 2444 – 2001
Required Exit Doors (power operated)	BCA Clause D2.19(b)
Smoke Hazard Management Systems**	BCA Part E2 & AS/NZS 1668.1 –2015
Warning & Operational Signs	Section 183 of the EP&A Regulation 2000, AS 1905.1 – 2015, BCA Clause C3.6, D3.6 & E3.3

** Indicates fire safety measures that may be affected by Performance Solutions and the proposed Dangerous Goods Storgae.

APPENDIX 1

Table 5 TYPE C CONSTRUCTION: FRL OF BUILDING ELEMENTS

Building element	Class of building—FRL: (in minutes)			
	Structural adequacy*/ *Integrity*/ *Insulation			
	2, 3 or 4 part	**5, 7a or 9**	**6**	**7b or 8**
EXTERNAL WALL (including any column and other building element incorporated therein) or other external building element, where the distance from any *fire-source feature* to which it is exposed is—				
Less than 1.5 m	90/ 90/ 90	90/ 90/ 90	90/ 90/ 90	90/ 90/ 90
1.5 to less than 3 m	–/–/–	60/ 60/ 60	60/ 60/ 60	60/ 60/ 60
3 m or more	–/–/–	–/–/–	–/–/–	–/–/–
EXTERNAL COLUMN not incorporated in an *external wall*, where the distance from any *fire-source feature* to which it is exposed is—				
Less than 1.5 m	90/–/–	90/–/–	90/–/–	90/–/–
1.5 to less than 3 m	–/–/–	60/–/–	60/–/–	60/–/–
3 m or more	–/–/–	–/–/–	–/–/–	–/–/–
COMMON WALLS and FIRE WALLS—	90/ 90/ 90	90/ 90/ 90	90/ 90/ 90	90/ 90/ 90
INTERNAL WALLS-				
Bounding *public corridors*, public lobbies and the like—	60 / 60/ 60	–/–/–	–/–/–	–/–/–
Between or bounding *sole-occupancy units*—	60/ 60/ 60	–/–/–	–/–/–	–/–/–
Bounding a stair if *required* to be rated—	60/ 60/ 60	60/ 60/ 60	60/ 60/ 60	60/ 60/ 60
ROOFS	–/–/–	–/–/–	–/–/–	–/–/–