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Appendix FF

Fire safety study

Fire Safety Study

Woodlawn Advanced Energy Recovery Centre, 619 Collector Rd, Tarago NSW

Veolia Environmental Services (Australia) Pty Ltd
Document No. RCE-21129_WoodlawnARC_FSS_Final_10Jun22_Rev(4)
Date 10/06/2022

Fire Safety Study

Woodlawn Advanced Energy Recovery Centre, 619 Collector Rd, Tarago NSW

Veolia Environmental Services (Australia) Pty Ltd

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Document No. RCE-21129_WoodlawnARC_FSS_Final_10Jun22_Rev(4)
Date 10/06/2022

Quality Management

Rev	Date	Remarks	Prepared By	Reviewed By
A	24th August 2021	Draft issue for comment	Lucy Jimenez	Renton Parker
0	14th September 2021	Final issued		
1	8th October 2021	General upates		
2	27th October 2021	Updated drawings		
3	7th June 2022	Updates to figures and tables		
4	10th June 2022	Updated figures		

Executive Summary

Background

Veolia Environmental Services (Australia) Pty Ltd (Veolia) have proposed to develop the Woodlawn Advance Energy Recovery Centre (ARC), an Energy Recovery Facility (ERF) to be located at Woodlawn Eco Precinct in Tarago NSW. As the facility will be handling large volumes of combustible waste there is the potential for fires to occur in storages or other areas around the site associated with the site operations. To ensure the facility is designed with the appropriate fire protection requirements it is necessary to review the facility against the Fire & Rescue NSW (FRNSW) Fire Safety in Waste Facilities Guidelines (Ref. [1]) and to assess the fire scenarios and review the fire protection required to control the identified scenarios.

Ricardo, on behalf of Veolia, has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a Fire Safety Study (FSS) for the facility. This document represents the FSS study for the Veolia Woodlawn ARC at Tarago NSW.

Conclusions

The proposed Woodlawn ARC to be located at 619 Collector Road, Tarago was subjected to a Fire Safety Study to identify potential fire hazards at the site per the requirements of the FRNSW Fire Safety in Waste Facilities Guidelines (Ref. [1]). The analysis identified several fire scenarios which may result in substantial radiant heat impacts which may render fire protection systems inoperable. Where fire protection systems may be affected by fire scenarios recommendations were made regarding the location of installed fire protection. Based on analysis, it is concluded that should the protection systems be located per the recommendations of this report, the services should be capable of combating the modelled fire scenarios.

Recommendations

The following recommendations have been made:

Tipping Hall and Waste Bunker

- The waste bunker shall be protected by sufficient monitor(s) to ensure a deep-seated fire within the waste bunker can be combat effectively.
- The hydrant system shall be designed to provide full coverage of the waste bunker. Hydrants should be placed at the Feed Hopper level to avoid impact with the grapple cranes in the Bunker.
- Hydrants shall be located such that they provide full coverage to the waste bunker; they shall be located such that hydrants designed to combat fires in the waste bunker are located outside of the impact distance shown in **Figure 5-1**.
- Monitor(s) installed to protect against a fire in the waste bunker shall be remotely operated to ensure monitor(s) can be effectively utilised in a fire event.
- The site shall be subject to regular housekeeping practices to prevent the accumulation of dust on surfaces.
- Consider the design and installation of a visual fire detection system (i.e. infrared detection or image based fire detection).

Boiler Hall / Fuel Hopper

- The hydrant and monitor system shall be designed to provide full coverage of the fuel hopper and chute.

PAC Silo

- The PAC silo shall be subject to a HAC as per the requirements of AS/NZS 60079.10.2:2011.
- Where electrical equipment is required to be installed within the PAC hazardous area it shall be controlled per the requirements AS/NZS 60079.14.1:2017 (Ref. [2]).
- Installation of explosion vent panels shall be considered on the PAC silos as part of the design review.

Turbine Hall

- The hydrant system shall be designed to provide full coverage to the turbine.
- Inclusion of a sprinkler system to protection the fluid lines, turbine and generator bearings, and areas beneath the turbine which may be subject to oil flow should be considered as part of the design review.
- The area beneath the turbine should be bunded to contain any oil flows preventing a spreading fire impacting other areas of the facility.

Diesel Tanks

- The hydrant system shall be designed to provide full coverage to diesel tanks
- Impact protection (e.g. bollards) should be installed around the tanks.
- The diesel storage tanks shall comply with the requirements AS 1940-2017 (Ref. [3]).
- Hydrants shall be located such that they provide full coverage to both diesel tanks. They shall be located such that hydrants designed to combat diesel tank fires are located outside of the impact distance shown in **Figure 5-4.**
- The use of integrally bunded tanks for the storage of diesel shall be considered.

Fire Water

- The site shall be designed to contain at least 1,233 m^3 of potentially contaminated water. This may be achieved by discharge to the Stormwater Pond.
- An additional detailed hydraulic analysis be performed by qualified hydraulic engineers to ensure that adequate containment is available given the use of fire water by hydrants, sprinklers and FRNSW in the event of a fire**.**
- Once a detailed design has been completed for the hydrant system pressure, loss calculations shall be prepared for the most hydraulically disadvantaged hydrant to demonstrate compliance with the requirements of AS 2419.1-2017 (Ref. [4]).
- The report shall be updated to include the pressure loss calculations.

General Recommendations

- Fire hydrants shall not be located within 10 m of stockpiled storage (i.e Waste Bunker, PAC Silo) and must be accessible to firefighters entering from the site and/or building entry points.

- The building shall be fire protected per the requirements of the Building Code of Australia.
- An Emergency Response Plan (ERP) shall be prepared in accordance with the Hazardous Industry Planning Advisory Paper No. 1 and the Work Health and Safety Regulation 2017.
- The ERP shall be accompanied by an Emergency Services Information Package (ESIP) which shall be laminated and stored in the site emergency box.

Table of Contents

List of Figures

List of Tables

List of Appendix Figures

List of Appendix Tables

Abbreviations

Abbreviation	Description
ADG	Australian Dangerous Goods Code
AS	Australian Standard
ARC	Advanced Energy Recovery Centre
APCr	Air Pollution Control Residues
BCA	Building Code of Australia
CBD	Central Business District
C&I	Commercial and Industrial Waste
CCIMF	Crisp Creek Intermodal Facility
DA	Development Application
DGs	Dangerous Goods
DPE	Department of Planning and Environment
ERF	Energy Recovery Facility
FGT	Flue Gas Treatment
FRNSW	Fire and Rescue New South Wales
FSS	Fire Safety Study
HIPAP	Hazardous Industry Planning Advisory Paper
HSE	Health and Safety Executive
LFG	Landfill Gas
MSW	Municipal Solid Waste
PAC	Powdered Activated Carbon
RFS	Rural Fire Service
SEP	Surface Emissive Power
SEPP	State Environmental Planning Policy
SSC	Spread Sheet Calculator
tpa	Tonne per annum

1.0 Introduction

1.1 Background

Veolia Environmental Services (Australia) Pty Ltd (Veolia) have proposed to develop the Woodlawn Advance Energy Recovery Centre (ARC), an Energy Recovery Facility (ERF) to be located at Woodlawn Eco Precinct in Tarago NSW. As the facility will be handling large volumes of combustible waste there is the potential for fires to occur in storages or other areas around the site associated with the site operations. To ensure the facility is designed with the appropriate fire protection requirements it is necessary to review the facility against the Fire & Rescue NSW (FRNSW) Fire Safety in Waste Facilities Guidelines (Ref. [1]) and to assess the fire scenarios and review the fire protection required to control the identified scenarios.

Ricardo, on behalf of Veolia, has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a Fire Safety Study (FSS) for the facility. This document represents the FSS study for the Veolia Woodlawn ARC at Tarago NSW.

1.2 Objectives

The objectives of the FSS are to:

- Assess the nature of materials delivered to the site and the operations of the ERF plant.
- Identify potential incidents that may occur during the operation of the plant including storage of combustible waste and incineration and develop scenarios for each of the incidents identified.
- Determine the consequences of identified scenarios and determine the potential impacts on the surrounding areas and the fire protection systems.
- Review the fire safety provisions and determine the locations of required fire services on the site in relation to identified hazards.
- Develop a report detailing the findings of the study.

1.3 Scope of Services

The scope of work is for the preparation of an FSS for the subject Veolia Woodlawn ARC to assess the potential hazards at the site to determine the adequacy of fire protection systems against the identified hazards.

The FSS focuses on the storage of commodities at the site as required by HIPAP No. 2 and determines whether additional fire safety solutions are necessary to be installed on the site. The following components are covered by this report:

- Determination of risk and consequences from fire or explosion scenarios throughout the facility;
- The preparation of a report on fire prevention, fire detection, fire alarm and fire suppression systems for the site;
- Firewater storage capacity for compliance with Australian Standards and Regulations
- Hydrant hydraulic design screening calculations for the fire water system including the fire main sizing; and
- Recommendations based upon the study for implementation in the final design.

2.0 Methodology

2.1 Fire Safety Study Approach

The following methodology was used in the preparation of the FSS for the facility. The methodology is to follow items required by HIPAP No. 2 (Ref. [5]).

- The fire hazards associated with the facility were identified to determine whether there were any fire or explosion hazards that may impact offsite or result in a potential to escalate. Where fire hazards with the potential to impact offsite or escalate were identified, these were carried forward for consequence assessment.
- The heat radiation impacts or overpressure impacts (consequences) from each of the postulated incidents from the proposed equipment were then estimated and potential impacts on surrounding areas assessed.
- Impacts of the fires from the proposed equipment were plotted on a layout plan of the proposed facility, to determine whether heat radiation impacts any critical areas (i.e. adjacent storage areas, fire services, safety systems, etc.) and whether such impact affected the ability of fire fighters to respond to the postulated fire. The heat radiation impact from incidents at adjacent sites on the buildings and structures at the facility were then assessed against the maximum permissible levels in HIPAP No. 4 (Ref. [6]).
- The firefighting strategies were then assessed to determine whether these strategies require update in light of the location of the proposed equipment and storage areas.
- The response times for NSW RFS in the immediate vicinity were assessed. Further outlying RFS stations were included also, in the event that the closest fire brigade was unable to attend.
- Review of the FRNSW Fire Safety in Waste Facility Guidelines. (Ref. [1])
- A report was then developed for submission to the client and the regulatory authority.

2.2 Limitations and Assumptions

In this instance, the FSS 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 1.1**.
- The report is based on the information provided by Veolia.
- The report does not provide guidance in respect of incidents that relate to sabotage or vandalism of fire safety systems.
- The assessment is limited to the objectives of the FSS as provided in the guidelines issued as HIPAP No. 2 (Ref. [5]) 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 scope of this report. 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.

3.0 Site Description

3.1 Site Location

The Woodlawn Advanced Energy Recovery Centre (ARC) is to be located within the Woodlawn Eco Precinct at 619 Collector Road, Tarago NSW. It is approximately 7 km west of Tarago town centre, and 45 km north-east of Canberra ACT. **Figure 3-1** shows the regional location of the site in relation to Canberra. Provided in **Figure 3-2** and **Figure 3-3** is the proposed layout of the site. Note, these layouts are currently under review, and will take into consideration the findings of this study.

Figure 3-1: Site Location

3.2 Adjacent Land Uses

The site is located within an industrial area, with the following adjacent land uses:

- North: Veolia Land
- South: Woodlawn Zinc and Copper Mine
- East: Woodlawn Zinc and Copper Mine
- West: Existing Woodlawn Operations (LFG Power Station, Bioreactor Landfill, and Aquaculture & Horticultural Operations)

3.3 General Description

The Woodlawn ARC will receive residual Municipal Solid Waste (MSW) and Commercial & Industrial (C&I) waste from Greater Sydney. The facility has been designed to process 380,000 tonnes of waste per year. Waste will be delivered via trains twice per day, operating from 6 am to 10 pm, Monday to Saturday. Container Handlers are used to unload waste containers from the wagons on the train, onto the container storage area. Trucks will also be used to transport containers from Crisp Creek Intermodal Facility (CCIMF) to the Woodlawn Eco-Precinct.

Container handlers will be used to load trucks that will transfer waste from the container storage area into the Waste Bunker, through dedicated access into the Tipping Hall. Containers will unload waste into any one of four waste tipping bays in the Tipping Hall. An additional fifth waste bay will be used for the removal of non-conforming waste from the bunker. The bunker has an estimated capacity of 12,375 m^3. It will be constructed of concrete fire walls and is only accessible through the tipping hall. It is noted that the waste turnover program has been designed to minimise the potential for spontaneous combustion within the fuel bunker.

Waste will be transferred from the Waste Bunker to the Feed Hopper and Chute by one of two overhead cranes with grapple attachments. The hopper will be monitored by CCTV to ensure operators can manage any non-conforming waste. The waste will be discharged from the feed hopper and chute onto a moving air-cooled grate and into the combustion chamber. Combustion air is supplied from air collected from the waste receival and fuel bunkers. The ARC has been designed to process 47.5 tonnes of waste per hour. The chamber operates at minimum of 850°C to minimise the formation of Volatile Organic Compounds (VOCs) and Poly Aromatic Hydrocarbons (PAHs) and other undesired products of combustion. In addition, ammonia solution (25% v/v) or Urea will be injected into the combustion chamber to prevent the generation of nitrous oxides (NO_x).

Flue gases will be passed through a series of heat recovery boilers to generate steam (60 bar, 420°C) to power turbines and generate electricity. After passing through the boilers, the flue gas will pass through Flue Gas Treatment (FGT) to remove Volatile Organic Compounds (VOCs) and Poly Aromatic Hydrocarbons (PAHs). Powdered Activated Carbon (PAC) will be added to remove dioxins, furans and heavy metals, and then calcium hydroxide (lime) will be injected to remove hydrogen chloride (HCl) and sulfur oxides (SO_x). Prior to discharge to atmosphere, PAC and lime will be removed from the flue gas stream through a series of bag filters. These Air Pollution Control Residues (APCr) will be stored in an APCr Silo prior to stabilisation and disposal in an encapsulation cell on site.

Incinerator bottoms ash (IBA) generated in the combustion chamber will be quenched, then transferred via conveyors to the IBA Area. Ferrous and non-ferrous metals will be removed using an overband magnetic separator and an eddy current separator. The metals will be stored in dedicated bays, then transferred onto trucks for sale. The remaining inert material will be transferred to the IBA Area via a conveyor. The IBA will be stored in stockpiles for approximately one month to ensure the quality of the material, and then it will be disposed in the existing Woodlawn Bioreactor Landfill or reused for daily cover or other beneficial use.

3.4 Material Quantities

Provided in **Table 3-1** is a summary of the materials and Dangerous Goods (DGs) to be stored and utilised at the site.

Table 3-1: Quantities of Materials Stored and Handled

Material Description	Class	Packing Group	Quantity
Powdered Activated Carbon (PAC)	4.2	III	24,000 kg
Ammonia Water (25%)	8	III	50,000 L

Material Description	Class	Packing Group	Quantity
Diesel	C1	n/a	2 x 100,000 L tanks
Calcium Hydroxide (Hydrated Lime)	Non-DG	n/a	90,000 kg (per week)
MSW and C&I	Non-DG	n/a	7,300 tonne (per week)
IBA	Non-DG	n/a	76,000 tpa
APCr*	Non-DG	n/a	15,200 tpa

*APCr is stabilised with cement and transported to proposed encapsulation cell

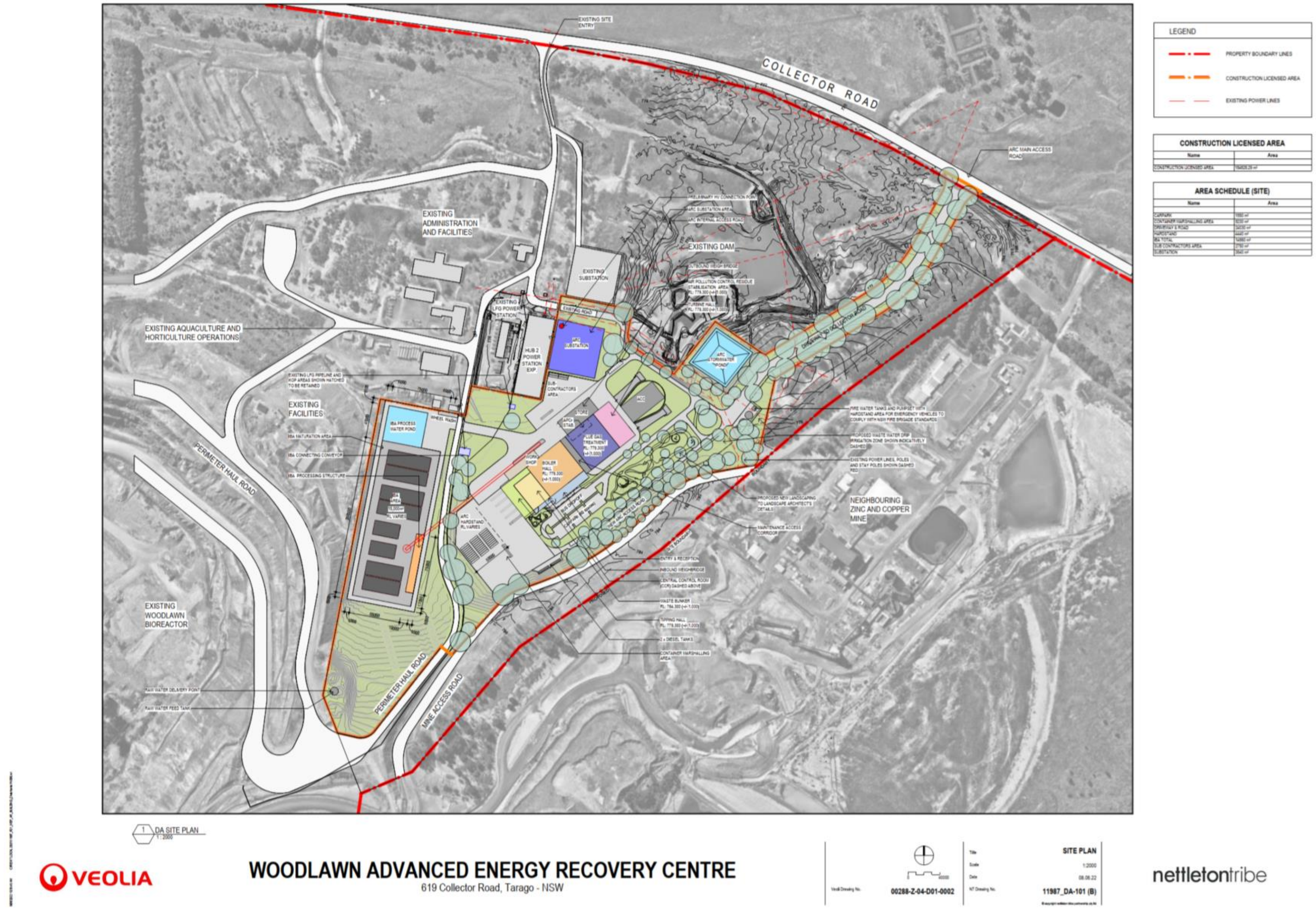

Figure 3-2: Proposed Site Layout

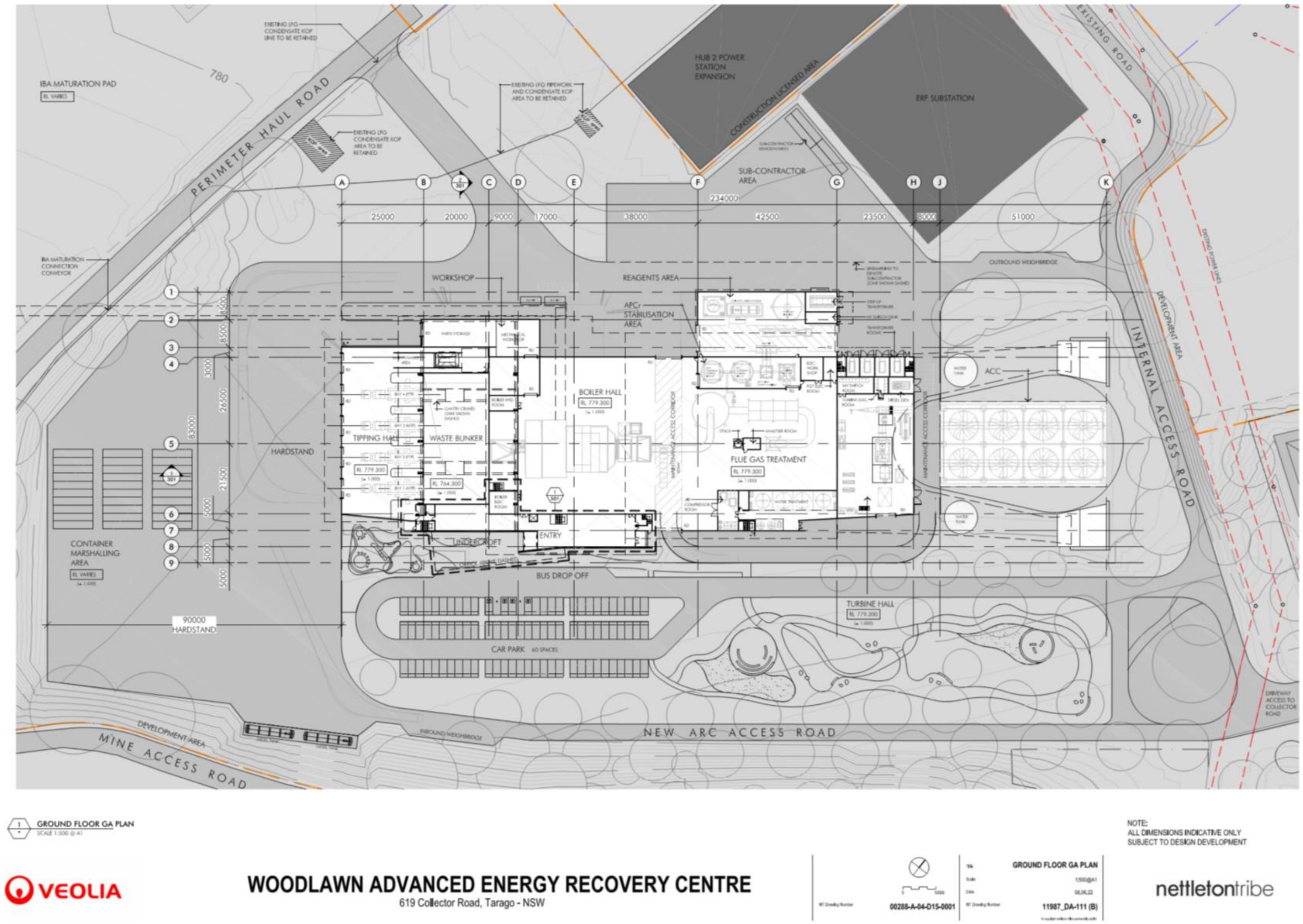

Figure 3-3: Proposed Detailed Site Layout

4.0 Hazard Identification

4.1 Introduction

A hazard identification table has been developed and is presented at **Appendix A**. Those hazards identified to have a potential fire or explosion impact are assessed in the following sections of this document.

4.2 Properties of Dangerous Goods and Hazardous Materials

The type of DGs and other hazardous materials, stored and used at the site has been described in Section 3. **Table 4-1** provides a description of the materials stored and handled at the site, including the DG class (if relevant), and the hazardous material properties.

Table 4-1: Properties* of Hazardous Materials Stored at the Site

Material	Hazardous Properties
Class 4.2 – Powdered Activated Carbon	Activated Carbon is classified as a Class 4.2 PGIII DG under the ADG* code (UN No. 1362). It poses an explosive hazard as it is stored as a fine combustible dust, which under the right conditions and an ignition source of sufficient magnitude, the dust may ignite resulting in a dust cloud explosion.
Class C1 Combustible Liquids. (Transformer Oil and Diesel)	Combustible liquids are typically long chain hydrocarbons with flash points exceeding 60.5°C. Combustible liquids are difficult to ignite as the temperature of the liquid must be heated to above the flash point such that vapours are generated which can then ignite. This process requires either sustained heating or a high-energy ignition source. Transformer oil is not classified as a DG by the ADG, however, it is classified as a combustible liquid under the provisions of AS 1940 (Ref. [3]).
Non-DG, MSW and C&I	Municipal Solid Waste (MSW) and Commercial and Industrial (C&I) waste is combustible material which will burn if ignited. Note, this material is not classified as a Dangerous Good by the ADG
Non-DG, Calcium Hydroxide	Calcium hydroxide is not classified as a Dangerous Good by the ADG. It is used heavily within the cement industry.

* The Australian Code for the Transport of Dangerous Goods by Road and Rail (Ref. [7])

4.3 Hazard Identification

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

- Ignition of waste in the tipping hall / waste bunker hall and bunker fire
- Ignition of waste in the fuel hopper and chute
- PAC dust liberation, ignition and explosion (storage silo)
- PAC dust cloud explosion within bag filters
- PAC ignition in bag filters and fire
- PAC dust cloud explosion within residue silo

- Steam turbine fire
- Transformer oil spill, ignition and bund fire
- Release of process oils, ignition and fire
- Diesel tank leak, spill, immediate ignition and pool fire

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

4.4 Ignition of Waste in the Tipping Hall/Waste Bunker and Fire

Waste delivered to the site is deposited into the waste bunker through the tipping hall. As with any waste collection, there is the potential for prohibited items to be present within the fuel sources such as; flammable liquids and aerosols which may pose an increased fire hazard due to the greater volatility of these products. The presence of non-conforming items is unlikely as the waste will be from Veolia's transfer terminals in Sydney, which are license to receive putrescible waste. The waste is inspected for non-conforming items by Veolia prior to compaction at waste transfer terminals before delivery to the site. However, in the unlikely event that an ignition source came into contact with a flammable liquid spill or gas release (e.g. from an aerosol) within the tipping hall / bunker, a fire may occur.

There is also potential for spontaneous ignition of waste within the bunker. Veolia has established a procedure for segregation of hot-loads at the transfer terminals in the event of the decomposition of waste during transit, minimising the likelihood that a hot-load will be delivered to the Waste Bunker. In addition, a turnover programme will be designed to minimise the potential for spontaneous combustion within the bunker. Furthermore, anecdotal evidence indicates that ignition in landfills where MSW and C&I are currently disposed have a very low ignition frequency, particularly due to the high moisture content of the waste.

In the event of a fire, the bunker is protected with smoke detectors and ceiling mounted sprinklers. However, if the fire seat develops deep within the bunker, combat efforts may be inhibited by the waste overburden above the fire seat. Hence the bunker will also be protected by at least three monitors (water cannons), with a capacity of 11.25 m^3/min, infrared cameras for fire detection and spray water nozzles. The monitors will be operated remotely in an automated and programmed response.

To ensure fire protective equipment is located such that it can be used in the event of a fire, this incident has been carried forward for further analysis.

Based on the potential for a deep-seated fire which may grow to consume the entire waste bunker, the following recommendation has been made:

- The waste bunker shall be protected by sufficient monitor(s) to ensure a deep-seated fire within the waste bunker can be combat effectively.
- The hydrant system shall be designed to provide full coverage of the waste bunker. Hydrants should be placed at the Feed Hopper level to avoid impact with the grapple cranes in the Bunker.

The tipping process may result in the generation of substantial amounts of dust which may accumulate. Due to the nature of the waste collected, this dust is not expected to be combustible, however it may interfere with function of smoke detectors. The Bunker and Tipping Hall are subject to negative pressure air extraction system, minimising the accumulation of dust.

Notwithstanding this, the following recommendations have been made:

- The site shall be subject to regular housekeeping practices to prevent the accumulation of dust on surfaces.
- Consider the design and installation of a visual fire detection system (i.e. infrared detection or image based fire detection).

4.5 Ignition of Waste in the Fuel Hopper and Chute

Waste will be loaded from the bunker into the feed hopper using overhead grapple cranes, and then transported into the feed chute before entering the combustion chamber. There is a potential for waste to ignite in the feed hopper and chute, which would be difficult to combat externally. A review of the system design indicates there are several protection systems currently included in the design, including the following:

- The feed hopper and chute create an air-block in the feed, effectively generating an oxygen depleted environment which does not support combustion.
- The feed hopper is monitored by CCTV, such that if an oversized item is loading into the hopper, operators are able to observe and extract it using the overhead grapples
- The opening of the feed chute is protected by a ring of sprinklers

Based on the above protection systems, it is considered that the fuel hopper and chute are adequately protected for the automatic systems. In addition, a fire in this location would be enclosed and would have a minimal impact on the surrounding area; hence, hydrants would be available for use by the fire authorities. Notwithstanding this, the following recommendation has been made:

- The hydrant and monitor system shall be designed to provide full coverage of the fuel hopper and chute. Hydrants should be placed at the Feed Hopper level to avoid impact with the grapple cranes.

As a fire in this location would be unlikely to have substantial impact external to the unit, this incident has not been carried forward for further analysis.

4.6 PAC Dust Cloud Explosion in the Storage Silo

PAC is classified as a Class 4.2 PGIII DG, which has the potential to spontaneously combust, causing a smouldering fire, in specific conditions. Activated carbon is a combustible dust and is stored as a fine dust which may burn on the surface of equipment/components or in the form of a dust cloud.

There a several requirements which must be met for a combustible dust to be involved in a dust cloud explosion. These are:

- Fuel,
- Oxygen,
- Confinement,
- Dispersion, and
- An Ignition Source.

As noted above, PAC is combustible, and oxygen is present in the atmosphere. The dust (24 tonne) will be stored in 1 silo with a capacity of 80 m^3 which may provide necessary confinement of the dust. Dispersion of the dust may occur during delivery of activated carbon into the silo. In addition to the other 4 requirements, an ignition source must be present for the dust to ignite and escalate into an explosion. This may be mitigated by a hazardous area classification (HAC) per the requirements of AS/NZS 60079.10.2:2011 (Ref. [8]).

The nature of a dust explosion is that if there is an accumulation of dust on surfaces (or dust pile within silo), an initial explosion may disperse this layer into the air, which may be ignited by residual heat from the primary explosion resulting in a potentially larger secondary explosion (Ref. [9]). Either explosion (primary or secondary) may impact protection systems; therefore, this incident has been carried forwards for consequence analysis. Notwithstanding this, the following recommendations have been made:

- The PAC silo shall be subject to a HAC as per the requirements of AS/NZS 60079.10.2:2011.
- Where electrical equipment is required to be installed within the PAC hazardous area it shall be controlled per the requirements AS/NZS 60079.14.1:2017 (Ref. [2]).
- Installation of explosion vent panels shall be considered on the PAC silos as part of the design review.

4.7 PAC Ignition in the Silo and Fire

As PAC is a spontaneously combustible substance, there is also a potential for the PAC in the storage silo to be ignited, resulting in a localised fire. As discussed in **Section 4.6**, the probability of ignition is incredibly low due to the confined nature of the storage and the elimination of ignition sources via a hazardous area classification. If a fire were to occur, it would be initially contained within silo and the APCr and Reagents Building, which is constructed of concrete fire walls. Hence, the fire would likely be limited in size, and it would be unlikely to prevent localised fire protection from being utilised. However, the fire may be difficult to extinguish externally, hence it has been carried forward for consequence analysis for conservatism.

4.8 PAC Dust Cloud Explosion in FGT Bag Filters

PAC is input into the flue gas streams to remove dioxins, furans and heavy metals, and is collected in bag filters prior to emission of the flue gases from the stack. Also collected in the bag filters is calcium hydroxide (injected into the flue gas for de-acidification), and non-combustible particulates generated from the combustion of the waste within the furnaces. The mixture of these materials is referred to as Air Pollution Control Residues (APCr).

A review of Dust Explosion Prevention and Protection (Ref. [10]) indicates that diluting the combustible contents in a dust stream will prevent the generation of a dust explosion by reducing the propagation of a flame within the dust stream. The non-combustible dust forms the majority of the residue within the filter bags and acts as a diluent which would prevent a dust concentration in air achieving the Lower Explosive Limit (LEL) therefore eliminating the potential for a dust explosion. This has been confirmed by Veolia's APCr classification report, which has found the materials to be non-combustible (Ref. [11]).

In addition, the air stream is cooled to 400^oC prior to addition of the PAC which ensures that the PAC is not exposed to temperatures above the autoignition temperature of 600^oC (Ref. [12]). Hence in normal operation, the process temperature would not be sufficient to ignite the dust.

As the potential to achieve the LEL has been eliminated by dilution of the combustible dust with non-combustible dust, the risks of a PAC explosion within the bag filters is considered to be very unlikely, and this incident has not been carried forward for consequence analysis.

4.9 PAC Ignition in FGT Bag Filters and Fire

There is also potential for the ignition of PAC in the bag filters, resulting in a smouldering, localised fire. As discussed in **Section 4.8,** once the PAC is diluted with other materials in the FGT (collectively APCr), the material is no-longer considered combustible, as characterised in WSP's Ash Management Report (Ref. [11]). Therefore, ignition of the PAC in the bag filters is not a credible scenario, and hence this incident has not been carried forward for consequence analysis.

4.10 PAC Dust Cloud Explosion in APCr Silo

Once collected in the bag filters, PAC along with other residues (collectively APCr) will be transferred to a storage silo prior to treatment and disposal in a purpose built monocell on site. As previously discussed, the non-combustible material forms the majority of the residue, such that the APCr has been characterised as a non-combustible material (Ref. [11]). As the APCr has been found to be non-combustible, the risks associated with the PAC in the residue silo are considered very low, and this incident has not been carried forward for consequence analysis.

4.11 Steam Turbine Fire

Steam turbines spin at high revolutions to produce electricity. While turbines are generally monitored for vibration to ensure balanced rotation and oil is tested to ensure sufficient lubrication, numerous incidents within the industry indicate this is not always effectively monitored or acted upon. Therefore, steam turbines can operate with imbalances which impact the bearings which may heat and vapourise lubricating oils. The oils may ultimately ignite or the turbine may blow itself apart if a gas accumulation occurs within the bearing housing prior to ignition. Subsequently, a turbine fire is a real possibility which may be difficult to combat as the fire may be shielded within the bearing housing. While the building containing the turbines are sprinkler protected, this will only be beneficial in cooling down the exterior of the turbine minimising the potential for propagation.

In addition, the lubricating lines associated with the turbine may rupture resulting in oil flow which may ignite resulting in a liquid flow fire. This could impact adjacent fluid lines or the turbine itself resulting in damage or spreading fire. Note, the Steam Turbine Hall is constructed of concrete fire walls, limiting the potential damage from a turbine fire. However, as a fire involving the turbine is a real possibility, the following recommendations have been made:

- The hydrant system shall be designed to provide full coverage to the turbine.
- Inclusion of a sprinkler system to protection the fluid lines, turbine and generator bearings, and areas beneath the turbine which may be subject to oil flow should be considered as part of the design review.
- The area beneath the turbine should be bunded to contain any oil flows preventing a spreading fire impacting other areas of the facility.

4.12 Transformer Oil Spill, Ignition, and Bund Fire

The transformers used on site will either be dry-type transformers or transformer insulated using natural esters. If dry-type transformers are used, the potential for a fire to occur is highly unlikely, as they do not contain flammable insulating materials, and are often constructed of fire resistant/

self-extinguishing materials. Therefore, a fire occurring from a dry-type transformer is not a credible scenario.

Alternatively, the transformers may be insulated using natural esters. As natural esters have a flash point exceeds 300°C (Ref. [13]) they are classified as non-dangerous goods under the Australian Dangerous Goods Code. Therefore, ignition of the fluid is extremely difficult, and a fire occurring from a natural ester insulated transformer is not a credible scenario.

As there are no credible scenarios resulting in a transformer fire, this incident has not been carried forward for further analysis.

4.13 Diesel Tank Leak/Spill, Ignition, and Pool Fire

Diesel will be stored on site for start-up and shut-down in two above ground double-skinned tanks, each with 100,000 L capacity. A diesel release may occur in the event of vehicle collision with the tanks, or during tank refilling. As diesel is a combustible liquid (flash point above 61°C), vapour cloud formation and subsequent flash fire or explosion is not possible. Although combustible liquids are difficult to ignite in ambient conditions, there is potential for a pool fire to occur if the spill has prolonged exposure to ignition sources. Given the large volume of diesel stored, a pool fire may generate sufficient heat radiation to impact fire-fighting equipment. Hence, this incident has therefore been carried forward for consequence analysis.

Notwithstanding this, the following recommendation has been made:

- The hydrant system shall be designed to provide full coverage to diesel tanks
- Impact protection (e.g. bollards) should be installed around the tanks.
- The diesel storage tanks shall comply with the requirements AS 1940-2017 (Ref. [3]).

5.0 Consequence Analysis

5.1 Incidents Carried Forward for Consequence Analysis

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

- Ignition of waste in the tipping hall / waste bunker and bunker fire
- PAC dust liberation, ignition and explosion in the storage silo
- PAC ignition and fire in the storage silo
- Steam turbine fire
- Diesel tank leak, spill, immediate ignition and pool fire

Each incident has been assessed in the following sections.

5.2 Ignition of Waste in the Tipping Hall/Waste Bunker and Fire

As discussed in **Section 4.4,** in the event of a fire in the waste bunker, radiant heat may render hydrant or monitor access inoperable. A detailed analysis of the heat radiation from a waste bunker fire has been performed in **Appendix B** with the results summarised in **Table 5-1**. Note, the Waste Bunker is constructed of concrete walls fire walls (27 m) and is only accessible through one of four Tipping Hall Access Bays. Each bay is 5 m wide and 9 m high

Table 5-1: Heat Radiation Impacts from a Waste Bunker Fire

Heat Radiation (kW/m^2)	Distance (m)
35	Not observed
23	Not observed
12.6	2.1
4.7	5.5
3.0	7.2

The radiant heat impacts at 3.0 kW/m^2 are provided in **Figure 5-1**. Note, as the Waste Bunker is constructed concrete fire walls, 3.0 kW/m^2 of radiant heat is not observed at ground level on the sides without openings.

The 3.0 kW/m^2 contour only the impacts the Tipping Hall and does not impact other process area. The fire may only render hydrants or monitors inoperable if they are only located within the vicinity of the waste bunker and tipping hall. Therefore, the following recommendations have been made:

- Hydrants shall be located such that they provide full coverage to the waste bunker; they shall be located such that hydrants designed to combat fires in the waste bunker are located outside of the impact distance shown in **Figure 5-1**.
- Monitor(s) installed to protect against a fire in the waste bunker shall be remotely operated to ensure monitor(s) can be effectively utilised in a fire event.

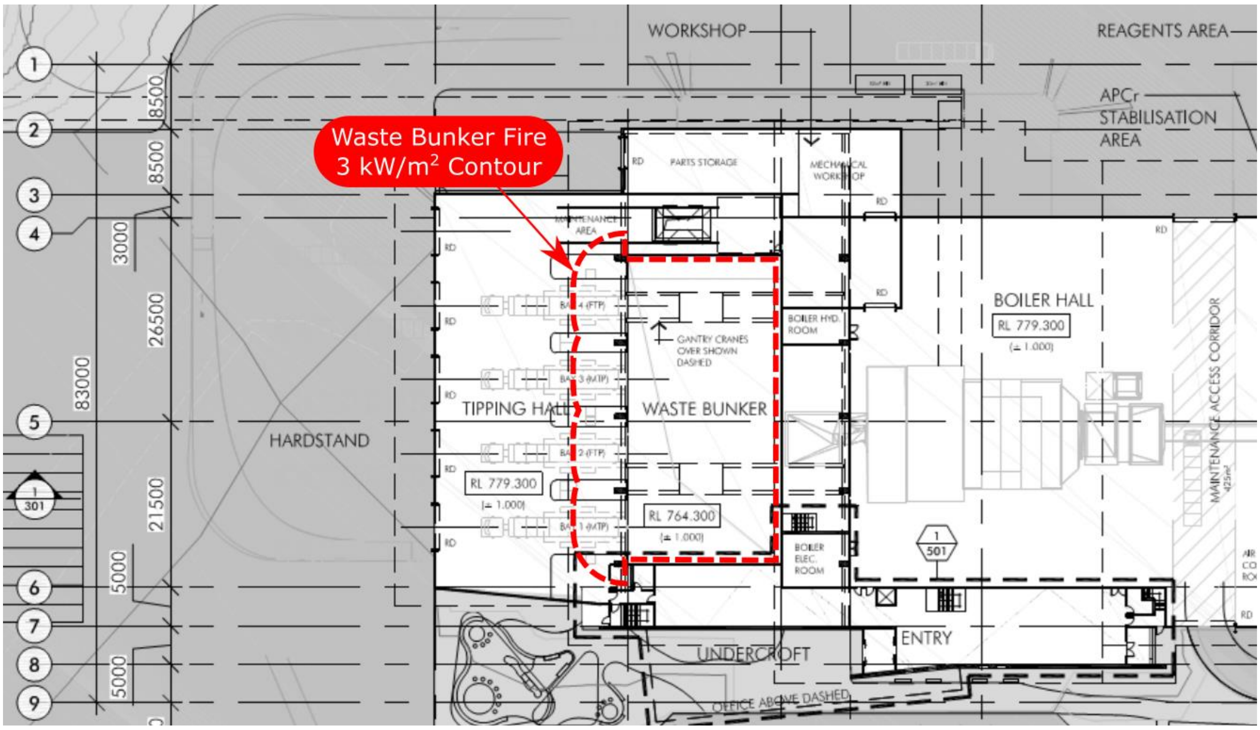

Figure 5-1: Radiant Heat Impacts from a Waste Bunker Fire

5.3 PAC Dust Liberation, Ignition, and Explosion in the Storage Silo

As discussed in **Section 4.6,** there is the potential for activated carbon dust to be liberated within the storage silo which may ignite resulting in an explosion which may have substantial impacts on protective equipment which may render it inoperable to extinguish follow on events from the initial explosion (i.e. fire). A detailed analysis has been performed in **Appendix B** with the results summarised in **Table 5-2**. It is noted that the analysis conducted for the silo explosion has been performed without the constriction of the silo enclosure (i.e a free air explosion). This will provide a conservative result as the initial confinement of the silo enclosure will reduce the overall overpressure. Furthermore, the PAC silo is located within the APCr and Reagent Building, which is constructed of concrete fire walls. Hence the force of the explosion would primary be directed towards through the roof of the structure. Therefore, the results reported in **Table 5-2** are very conservative.

Table 5-2: Overpressure Impacts from a PAC Storage Silo

Overpressure (kPa)	Distance (m)
70	9.9
35	15.7
21	20.9
14	26.1
7	41.8

Damage to storage tanks and structures may occur at 21 kPa overpressure; hence, this contour has been used to estimate where damage to fire protection systems may occur, and to determine whether there would be acceptable hydrant coverage to extinguisher residual fires from the initial explosion. The overpressure contour is provided in **Figure 5-2**.

A review of the 21 kPa impact contour indicates that impacts would not be significantly extensive and that hydrants located around the site would be unaffected by the damaging overpressure. Hence, firefighting equipment would be accessible to combat residual fires following an explosion. As there will be sufficient fire protection available no further recommendations have been made.

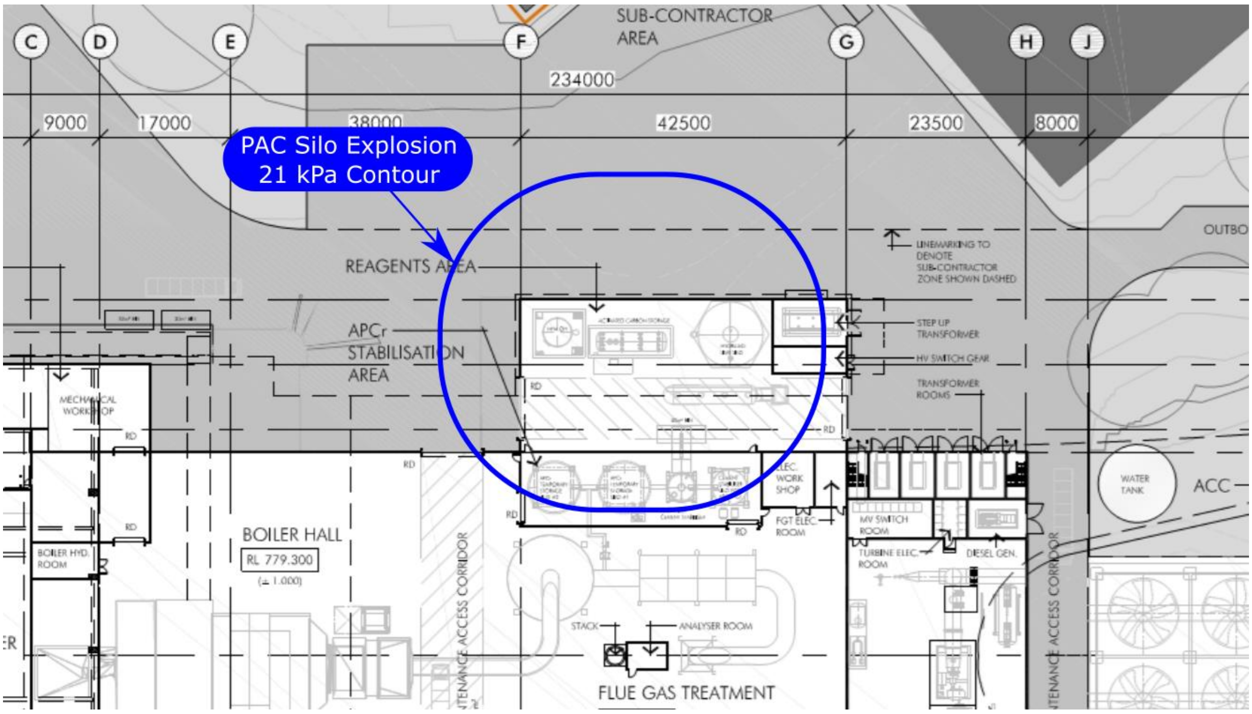

Figure 5-2: Overpressure Impacts from a PAC Silo Explosion

5.4 PAC Ignition and Fire in the Storage Silo

As discussed in **Section 4.7**, there is the potential for a fire to occur within PAC storage silo. In the event of a fire, radiant heat may render hydrants inoperable. A detailed analysis has been performed in **Appendix B** with the results summarised in **Table 5-3**.

Table 5-3: Heat Radiation Impacts from a PAC Silo Fire

Heat Radiation (kW/m^2)	Distance (m)
35	not observed and ground level
23	not observed and ground level
12.6	not observed and ground level
4.7	9.7
3.0	13.1

The PAC silo is located within the APCr and Reagent Building, which is constructed of concrete fire walls. This significantly reduces the radiant heat impact of the fire, such that 3.0 kW/m^2 of radiative heat is not observed at ground level adjacent to the fire walls. The radiant heat impacts at 3.0 kW/m^2 are provided in **Figure 5-3**. From this figure it can be seen the 3.0 kW/m^2 contour has minimal impact distance; hence, fire protection equipment is unlikely to be impacted by a fire in the PAC Silo. As there will be sufficient protection to combat a PAC silo fire no recommendations have been made.

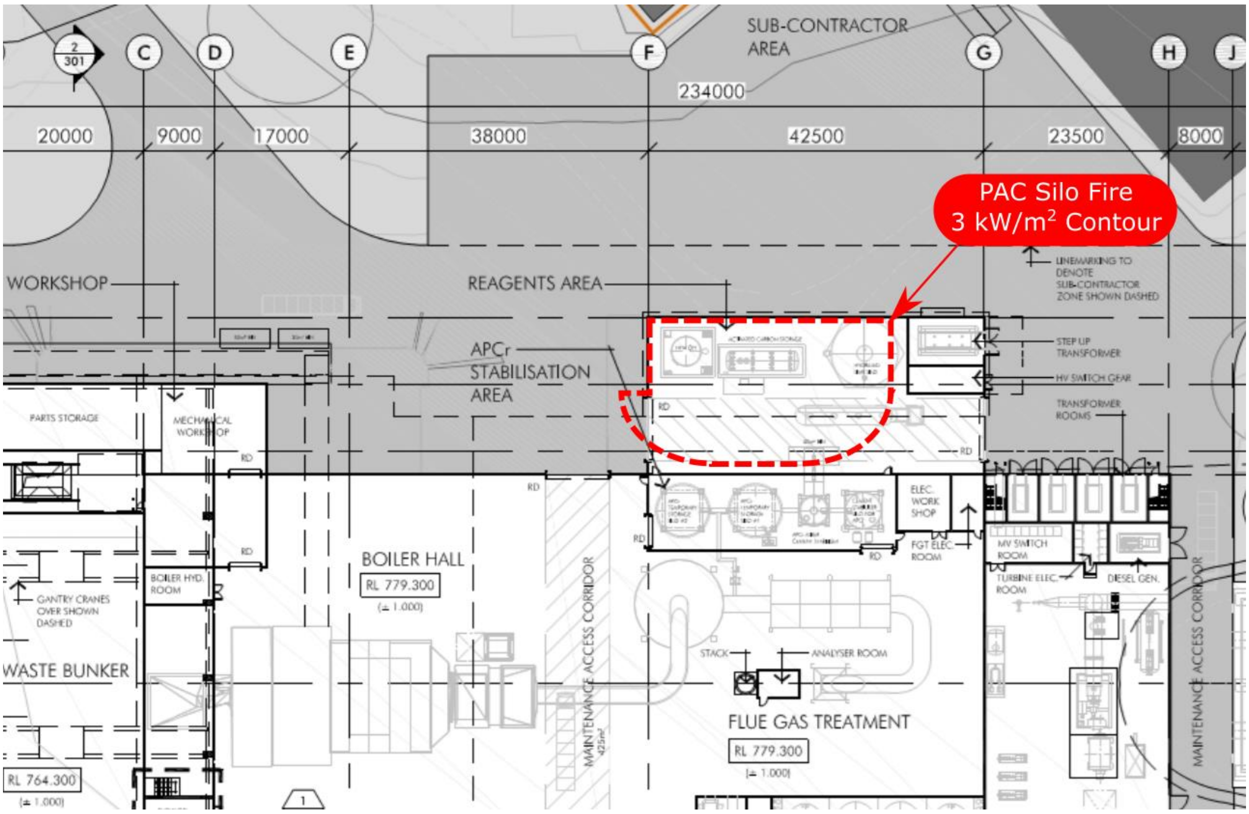

Figure 5-3: Radiant Heat Impacts from a PAC Silo Fire

5.5 Steam Turbine Fire

As discussed in **Section 4.11** ,there is the potential for a release of lubricating oil or overheating of a bearing in the steam turbine to occur, resulting in a spill, ignition and fire. If this were to occur, radiant heat will be emitted which may render hydrant or monitor access inoperable. A detailed analysis has been performed in **Appendix B** with the results summarised in **Table 5-4**.

Table 5-4: Heat Radiation Impacts from a Steam Turbine Fire

Heat Radiation (kW/m^2)	Distance (m)
35	not observed at ground level
23	not observed at ground level
12.6	not observed at ground level
4.7	not observed at ground level
3.0	not observed at ground level

The steam turbine hall is constructed of 20 m high concrete fire walls, which significantly reduces the radiant heat impact of the fire, such that 3.0 kW/m^2 of radiative heat is not observed at ground level. The maximum heat observed is 1.56 kW/m^2 at 17.3 m from the turbine hall. This amount of heat would not prevent FRNSW from accessing fire hydrants in the vicinity of the steam turbine hall. Notwithstanding this, the following recommendation has been made:

- Hydrants shall be located such that they provide full coverage to the turbine hall;
- The fire protection requirements contained with the FM Global Data Sheet 7-79 shall be considered and incorporated where applicable.

5.6 Diesel Tank Leak, Spill, Immediate Ignition, and Pool Fire

As discussed in **Section 4.13,** there is potential that the diesel tanks may leak resulting in a combustible liquid spill contained within the dimensions of the bund. If the spill is ignited, a pool fire with the dimensions of the bund will occur. A detailed analysis has been conducted in **Appendix B** and the radiant heat impact distances estimated for this scenario are shown in **Table 5-5**. Note, the worst-case scenario (leak of total contents of tank) was modelled for conservatism.

Table 5-5: Radiant Heat Impact Distances from a Diesel Bund Fire

Heat Radiation (kW/m^2)	Distance (m)
35	2.9
23	4.9
12.6	8.8
4.7	18.6
3.0	24.9

The radiant heat impacts at 3.0 kW/m^2 are provided in **Figure 5-4**. From this figure it can be seen that although the 3.0 kW/m^2 contour has substantial impact distances, it does not impact on any of the main parts of the facility. Hence, it may only render hydrants inoperable if they are located within the vicinity of the diesel tanks. Therefore, the following recommendation has been made:

- Hydrants shall be located such that they provide full coverage to both diesel tanks. They shall be located such that hydrants designed to combat diesel tank fires are located outside of the impact distance shown in **Figure 5-4.**
- The use of integrally bunded tanks for the storage of diesel shall be considered.

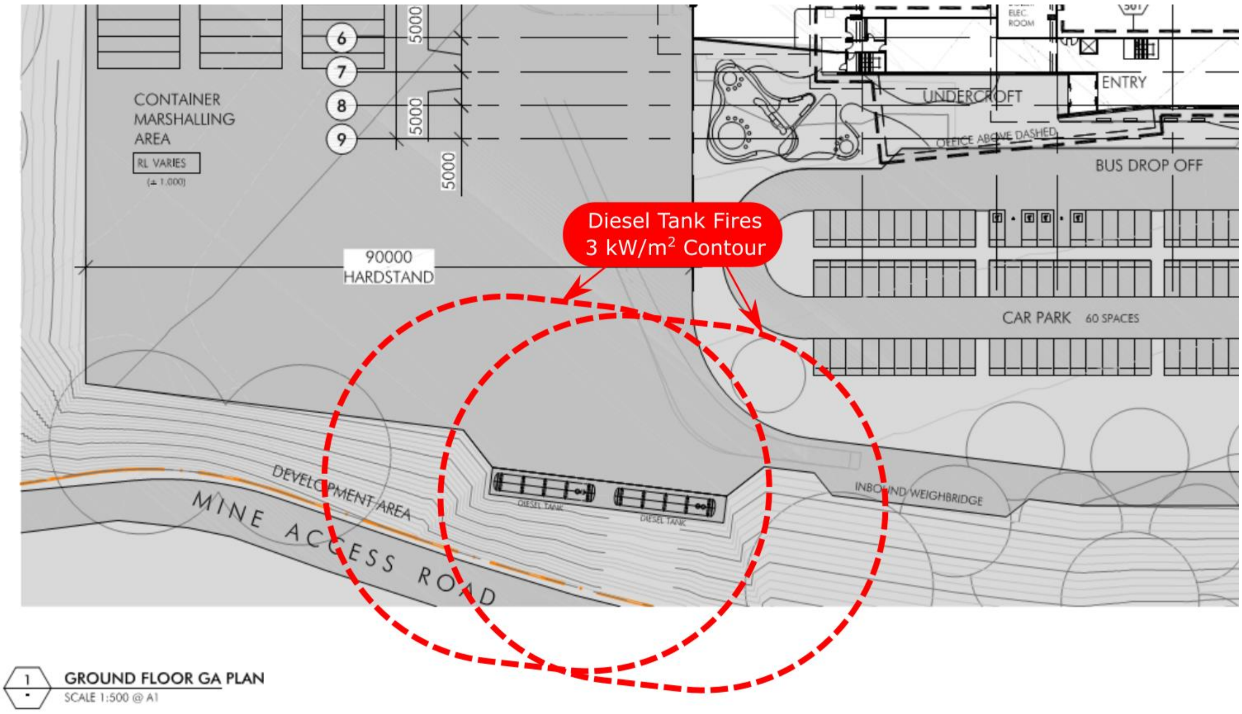

Figure 5-4: Radiant Heat Impacts from a Diesel Fire

5.7 Overview of All Incidents

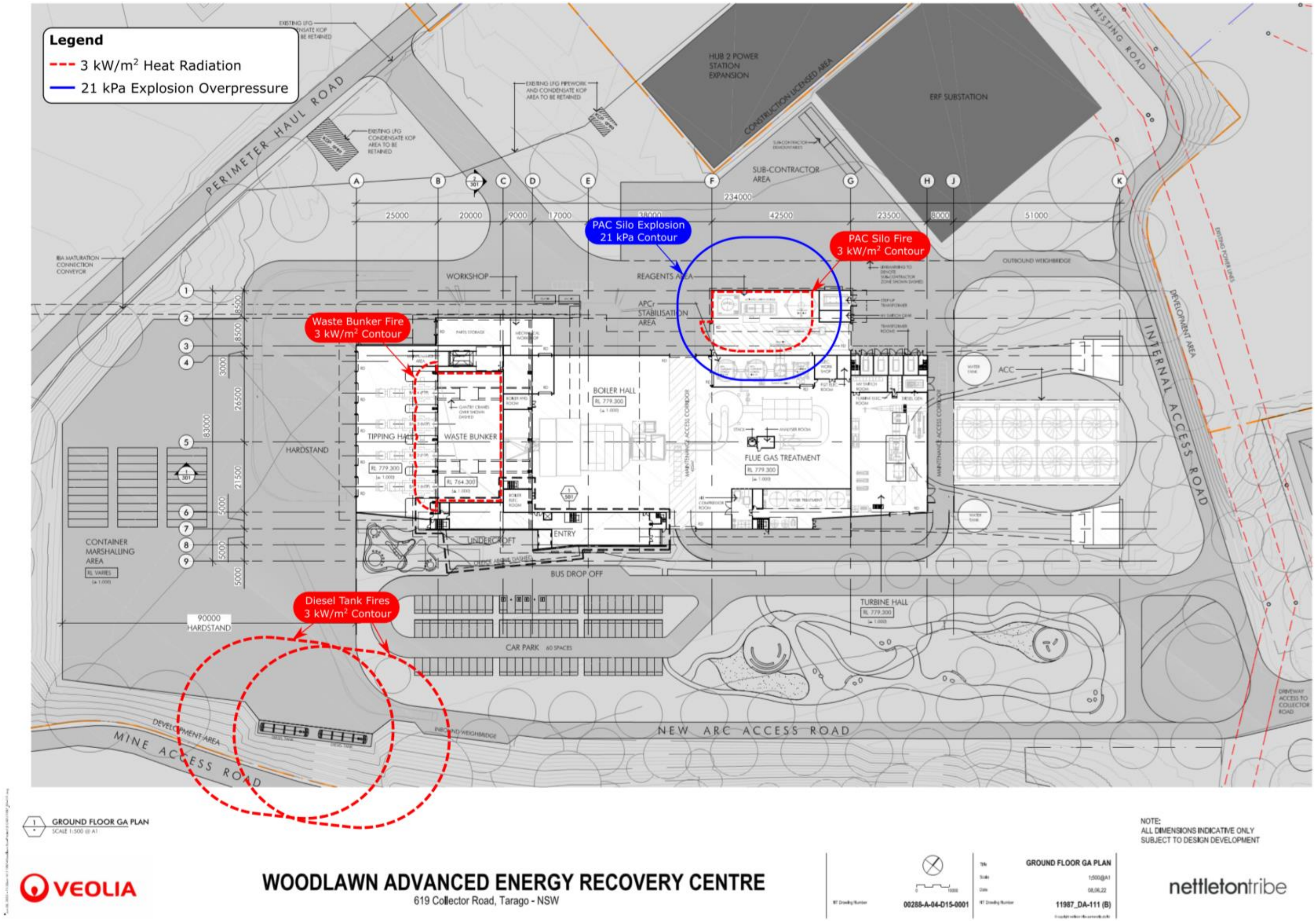

Figure 5-5: Overview of Radiant Heat Impacts and Explosion Overpressure from all incidents

6.0 Details of Prevention, Detection, Protection and Mitigation Measures

The fire safety systems at the site can be split into four main categories:

- **Fire Prevention –** systems, installed to prevent the conditions that may result in initiating fire.
- **Fire Detection** – systems installed to detect fire and raise alarm so that emergency response can be affected (both evacuation and firefighting)
- **Fire Protection –** systems installed to protect against the impacts of fire or explosion (e.g. fire walls)
- **Fire Mitigation** – systems installed to minimise the impacts of fire and to reduce the potential damage (e.g. fire water application)

Each category has been reviewed in the following sections, with respect to the existing systems incorporated into the design and those to be provided as part of the recommendations herein.

6.1 Fire Prevention

This section describes the fire prevention strategies and measures that will be undertaken at the site.

6.1.1 Control of Ignition Sources

The control of ignition sources reduces the likelihood of igniting a release of material. The site has a number of controls for ignition sources. These include controls for fixed potential ignition sources and controls for introduced ignition sources.

- A permit to work or clearance system will be used - hot work will be controlled as part of the permit to work system.
- Hazardous area classification for areas containing flammable liquids or combustible dusts per the requirements of AS/NZS 60079.10.1:2009 (Ref. [14]) and AS/NZS 60079.10.2:2011 (Ref. [8]).
- Electrical equipment selected for the classified hazardous area. Equipment is installed per the requirements of AS/NZS 60079.14:2017 (Ref. [2]).
- Designated smoking areas within the site (i.e. external from facility areas).

Table 6-1 presents the potential ignition sources and incidents for the facility which may lead to ignition and fire. The table also summarises the controls that will be used to reduce the likelihood of these potential sources of ignition and incidents resulting in a fire.

Table 6-1: Summary of Control of Ignition Sources

Ignition Source	Control
Smoking	No smoking policy for the site (i.e. within the facility). Note: A designated smoking area shall be provided adjacent to the carpark.
Housekeeping	The site will operate a housekeeping procedure to ensure accumulation of combustible material in delivery and processing areas (i.e. in the Tipping Hall and around the Feeding Chute) does not occur.
Arson	The site has a security fence and will be staffed during operational hours.

Ignition Source	Control
Electrical	Fixed electrical equipment to be designed and installed to AS/NZS 3000:2007 (Ref. [15]).
Hot Work	A permit to work system and risk assessment prior to starting work will be provided for each job involving the introduction of ignition sources.

6.1.2 Separation of Incidents

The separation of incidents is used to minimise the impacts of a hazardous incident on the surrounding operations or the generation of potential "domino" effects. The processing area, main flammable liquids bunker and bulk tanks are separated from the facility to minimise the potential for interaction between products which may lead to a fire.

6.1.3 Housekeeping

The risk of fire or explosion can be significantly reduced by maintaining high standards of housekeeping. The site shall maintain a high housekeeping standard, ensuring all debris (e.g., waste, dust) that is released during delivery of materials, storage and processing is cleaned up and removed from the areas.

6.1.4 Work Practices

The following work practices will be undertaken to reduce the likelihood of an incident. They include;

- DG identification
- Placarding & signage within the site
- Forms of chemical and DG information
- Availability of Safety Data Sheets
- HAZCHEM code adherence
- Safe work practices adhered to
- Emergency response plan and procedures
- First aid fire equipment
- Personal hygiene requirements
- Security
- Training of personnel
- Compatibility, segregation and safe storage of Dangerous Goods
- Waste Acceptance Procedure for non-compliant waste materials (noting waste is inspected for non-compliant materials at transfer terminals prior to delivery to Woodlawn ARC)

6.1.5 Emergency Plan

An emergency plan, prepared in accordance with HIPAP No. 1 – Industry Emergency Planning Guidelines (Ref. [16]), will be developed for the site as required by the Work Health and Safety Regulations 2017 (Ref. [17]). The emergency plan will clearly identify potential hazardous fire or explosion incidents and develop procedures fire response. The plan will also include evacuation procedures and emergency contact numbers as well as an onsite emergency response structure with allocated duties to various personnel on site. This will provide readiness response in the unlikely event of an incident at the site. Notwithstanding this, the requirement for the preparation of an Emergency Response Plan has been included as a recommendation:

- An Emergency Response Plan (ERP) shall be prepared in accordance with the Hazardous Industry Planning Advisory Paper No. 1 and the Work Health and Safety Regulation 2017.
- The ERP shall be accompanied by an Emergency Services Information Package (ESIP) which shall be laminated and stored in the site emergency box.

6.1.6 Site Security

Maintaining a secure site reduces the likelihood either of a fire being started maliciously by intruders or by accident. Access to the site will be restricted at all times and only authorised personnel will be permitted within the site.

6.2 Detection Procedures and Measures

This section discusses the detection and protection from fires for the hazardous incidents previously identified. These include detection of fire pre-conditions, detection of a fire suppression activated condition and prevention of propagation. This assessment includes identification of the detection and protection systems required.

6.2.1 Detection of Leaks

The detection of leaks and spills minimises the likelihood of a hazardous incident. It is recommended that the site shall undertake manual inspection of the facility daily to ensure the integrity of delivery, storage and processing areas.

6.2.2 Detection of Fire

In the event of a fire in the waste bunker, FGT, and turbine hall, the fire detection system will detect the presence of the fire via smoke detection. The waste bunker will be additionally monitored by IR camera system. Both systems will activate alarms to notify building occupants and FRNSW, and activate fire suppression system (i.e. sprinklers). Manual alarm points should also be installed in clearly visible and accessible locations, such that staff can initiate early alarm.

6.3 Fire Protection

To ensure that the correct fire protection is available to combat the identified fires at the site, an analysis of the required fire protection based on standards or best practice was conducted for each incident identified in **Section 5.0**. The analysis is shown in the following sub-sections.

6.3.1 Waste Bunker Fire

As discussed in **Section 4.4**, a fire in the waste bunker may be difficult to combat as the fire seat may be protected from intervention by waste over burden. To combat a fire in the bunker it may be necessary to remove the over burden to directly combat the fire seat. Hence, the waste bunker will be additionally protected by firefighting monitors, supplying 10 L/min/m^2 of surface area. Given the area of the bunker is 1,125 m^2, the monitors shall supply 11,250 L/min. A typical remote controlled firefighting monitor has a capacity of up to 4,500 L/min at 16 bar (Ref. [18]). Hence to provide the required amount of water, at least three monitors shall be installed, each with a capacity of at least

3,750 L/min. The monitors shall be installed at the level of the Feed Chute, on three of the four corners of the Waste Bunker.

The following recommendations have been made regarding the installation of monitors in the waste bunker:

- Three monitors should be installed, each with a capacity of at least 3,750 L/min;
- Monitors shall be operated remotely.

6.3.2 PAC Fire

As discussed in **Section 4.6** to **Section 4.9**, there is a potential for a PAC fire or explosion. PAC is classified as a Class 4.2 dangerous good, hence the protection required should be determined from AS 1940-2017 (Ref. [3]). However, the standard does not specify what fire protection equipment is required. Instead, it has been assumed that the sprinkler and hydrant requirements from the Building Code of Australia (BCA) are sufficient to suppress and control a PAC fire.

6.3.3 Turbine Hall Fire

As discussed in **Section 4.11**, the steam turbines contain lubricating oils which are classified as combustible liquids, hence the protection required for each transformer has been determined from AS 1940-2017 (Ref. [3]). The fire protection requirements were determined as per Clause 11.11.1 of the standard. It was assumed that the turbine will contain less than 60 m^3 of oil. Hence, for indoor tanks containing less than 60 m^3 of combustible liquids, the following protection is required:

- 20 L/s fire hydrant system (Table 11.4 of the standard).

6.3.4 Diesel Tank Fire

As discussed in **Section 4.13,** two diesel tanks (100 m^3 each) will be stored outdoors on the east side of the facility, adjacent to each other. As diesel is a combustible liquid, the protection required for each tank has been determined from AS 1940-2017 (Ref. [3]). As per clause 11.12.4 for Class C1 above-ground outdoor tanks with a capacity between 60 m^3 and 2000 m^3, the following protection is required:

- A hose reel and foam-making equipment, for use when water supply is inadequate.
- Two powder type extinguishers (rating of at least 2A 60B(E)) for each tank, located within 15 m of the tanks.

6.3.5 BCA Fire Protection Requirements

In addition to the previously discussed requirements, the Building Code of Australia (BCA) specifies further fire protection requirements. The relevant clauses have been summarised in **Table 6-2.**

Table 6-2: BCA Fire Protection Requirements

	Description
Fire Hydrants	A fire hydrant system shall be installed in accordance with Clause E1.3 of the BCA, and the relevant provisions of AS 2419.1:2005 (Ref. [4]).
Fire Hose Reels	A fire hose reel system shall be installed in accordance with Clause E1.4 of the BCA, and the relevant provisions of AS 2441:2005
Portable Fire Extinguisher	Portable fire extinguishers shall be installed in accordance with Clause E1.6 of the BCA, and the relevant provisions of AS 2444:2001.

	Description
Sprinkler System	Fire sprinkler system shall be installed in accordance with Clause E1.5 of the BCA, and the relevant provisions of AS 2118.1 (Ref. [19])
Smoke Detection	A smoke detection system shall be installed in accordance with the with BCA E2.2, Clause 4 of BCA Specification E2.2a and AS 1670.1:2018.
Building Occupant Warning System	A building occupant warning system shall be installed in accordance with Building Code of Australia Clause E2.2a and AS 1670.1:2018. The evacuation signal 1 shall include the words such as "Fire" and "Evacuate" inserted in the time period provided in ISO 8201, or a site-specific voice message as provided for in AS 4428.16.
Emergency Lighting and Exit Signs	Emergency lighting and exit signs shall be installed in accordance with Clauses E4.2, E4.4, E4.5, E4.6 and E4.8 of the BCA, and the relevant provisions of AS 2293.1:2005.

6.4 Fire Mitigation

6.4.1 Fire Water Supply

The hydrant and sprinkler system will be supplied from an on-site water storage supply tank via diesel and electric pumps. The tank will contain 1,350 m^3.

7.0 Local Brigade Access and Egress

7.1 Overview

In order to assess the likely fire brigade response times an indicative assessment of fire brigade intervention has been undertaken based on the methods defined in the Fire Brigade Intervention Model (FBIM, Ref. [20]). **Figure 7-1** illustrates the building layout with entry points to the site and fire services infrastructure.

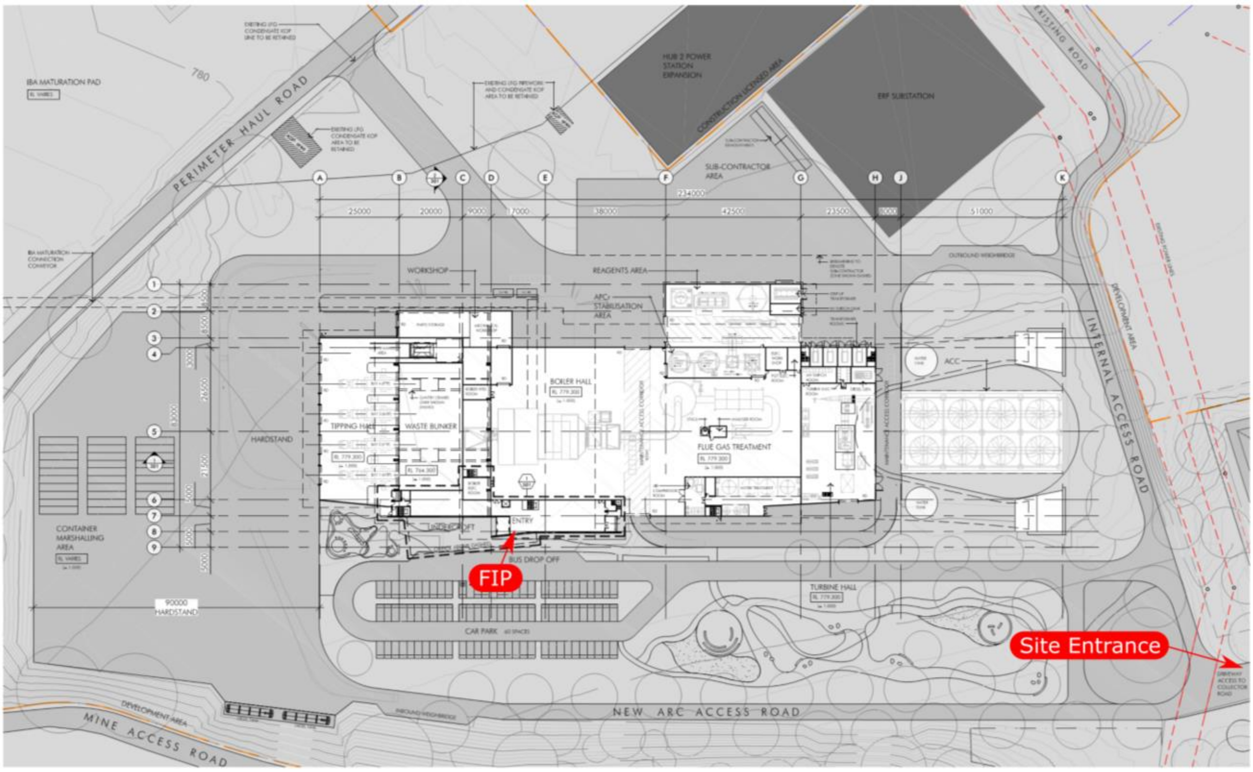

Figure 7-1: Fire Brigade Access and Site Facilities

In the event of a fire, FRNSW will respond to a major incident as they are equipped with Hazardous Materials (HAZMAT) training and appliances. The closest FRNSW stations to the site are described in **Table 7-1**. The expected route from FRNSW Goulburn Station (closest station) to the Woodlawn site is illustrated in **Figure 7-2.**

Table 7-1: Station Locations

Station Name	Station Address	Distance (km)
FRNSW Goulburn Fire Station	161/157 Bourke St, Goulburn NSW 2580	49
FRNSW Queanbeyan Fire Station	41 Campbell St, Queanbeyan NSW 2620	60
FRNSW Braidwood Fire Station	13 Park Ln, Braidwood NSW 2622	61

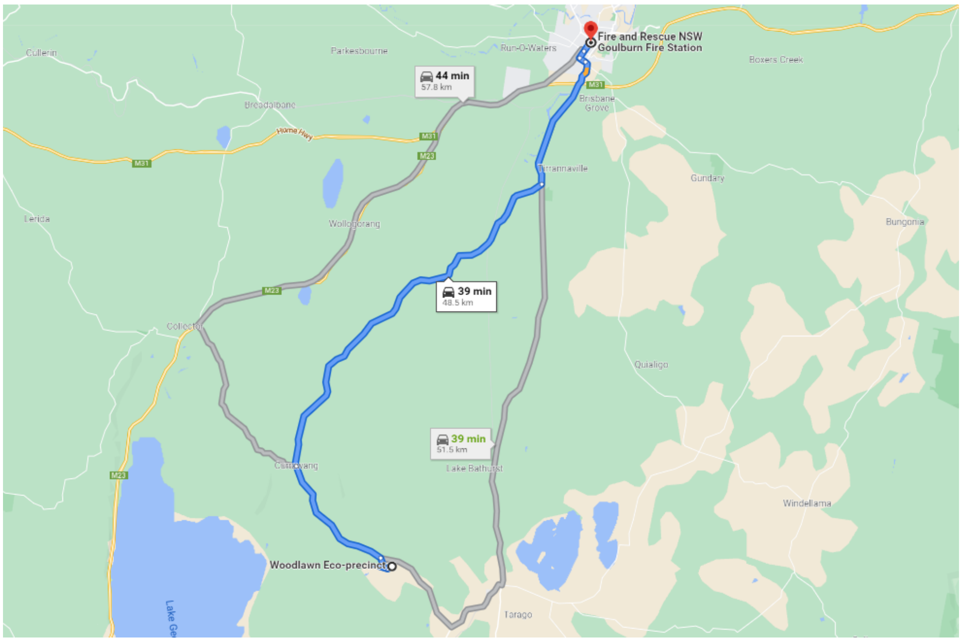

Figure 7-2: Location of Site with Respect to Closest Fire Brigade Stations

7.2 Response Time – Fire Brigade Intervention Model (FBIM)

Due to the nature of the Fire Brigade Intervention Model (FBIM, Ref. [20]), it is necessary to justify the results through the inclusion of assumptions. The accuracy of results weighs heavily upon the measure of which assumptions are made and the sources from which they are derived. The model produced details the time it will take for brigade personnel within the aforementioned location to receive notification of a fire, time to respond and dispatch resources, time for resources to reach the fire scene, time for the initial determination of the fire location, time to assess the fire, time for fire fighter travel to location of fire, and time for water setup such that suppression of the fire can commence. The following are details of the assumptions utilised in this FBIM:

7.2.1 Location of Fire

This FBIM will only be an indicative model of one fire scenario within the facility. For conservative purposes, the FBIM will consider a fire in the furthest incident from the point of entry.

7.2.2 Time between Ignition and Detection

- It is assumed that the initial brigade notification is via the smoke detection system. or activation of other fire protection system (i.e. sprinklers/deluge)
- The alarm time of the smoke detectors has been calculated using Alpert's Correlation to determine a time of 92 seconds at a worst credible scenario using the highest point within the facility, at a maximum distance due to the detector spacing.

7.2.3 Time for Initial Brigade Notification

- Fire brigade notification is expected to occur via a direct monitored alarm.
- Time for alarms/fire verification and any notification delays is 20 seconds based on Table B of the Fire Brigade Intervention Model (Ref. [20]).
- Therefore, the time from ignition at which the fire brigade will be notified is (92+20) = 112 seconds after flaming combustion has commenced.

7.2.4 Time to Dispatch Resources

- The fire station is considered to be manned at the time of the fire.
- Based on FRNSW response times statistics from the 2019/2020 annual report (Ref. [21]), the average time for the fire brigade to respond to an emergency call (including call processing, turnout time and travel time) is 8 minutes as shown in **Figure 7-3**. The 90th percentile of response time is less than 12 minutes.

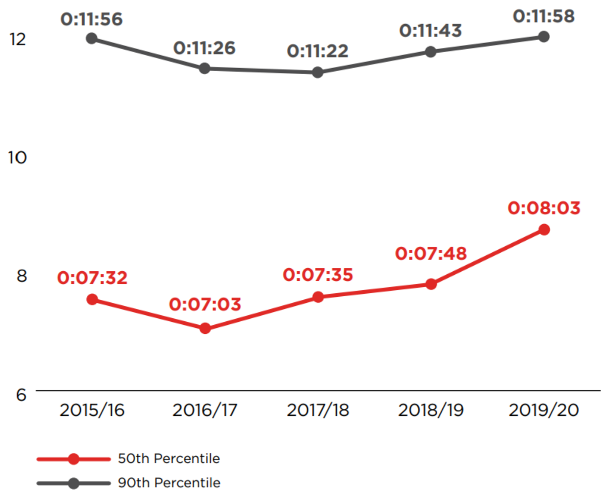

Figure 7-3: FRNSW Response Time from 2019/2020 Annual Report

- As the site is located in a rural area, additional travel time should be taken into account. The travel time has been assumed to be 39 minutes (2340 seconds), as per **Figure 7-2.**
- Therefore, with a brigade call out time of 112 seconds, response time of 720 seconds, and travel time of 2340 seconds (39 minutes), the fire brigade can be expected to arrive on site 3172 seconds after fire ignition.

7.2.5 Time for Initial Determination of Fire Location

- On arrival, the fire location may not be visible to the approaching brigade personnel, thus requiring information to be obtained from the Fire Indicator Panel (FIP) and evacuating occupants.
- Fire brigade personnel assemble at the FIP in the office area.
- Fire brigade tactical fire plans will be provided.
- It is assumed that a fire would occur during business hours and that staff are present on-site, providing assistance to fire brigade personnel in relation to identifying the fire location and entry into the building. As such, forced entry into the building is not required.

7.2.6 Time to Assess the Fire

- Horizontal egress speeds have been based on fire brigade personnel dressed in turnout uniform in BA. An average travel speed of 1.4 m/s with a standard deviation of 0.6 m/s as shown in **Table 7-2**. As such, for the purposes of the calculations, a horizontal travel speed of 1.40 – (1.28x0.6) = 0.63 m/s is utilised.

Table 7-2: FBIM data for Horizontal Travel Speeds

Graph	Travel Conditions	Speed	
		Mean	SD*
Q1	Dressed in turnout uniform	2.3	1.4
Q2	Dressed in turnout uniform with equipment	1.9	1.3
Q3	**Dressed in turnout uniform in BA with or without equipment**	**1.4**	**0.6**
Q4	Dressed in full hazardous incident suit in BA	0.8	0.5

*Standard Deviation

Horizontal travel distances will include the following:

- Travel from kerb side adjacent to the main building and to Fire Indicator Panel (FIP) is approximately 60 m.
- Travel from FIP to the farthest point is 265 m.
- Based on the above, the total horizontal travel distance of 325 m coupled with an egress speed of 0.63 m/s results in a horizontal travel time of up to 516 seconds.

7.2.7 Time for Water Setup

- The first appliance would be expected to commence the initial attack on the fire.
- Time taken to connect and charge hoses from on-site hydrants to the fire area is based on V3 Table V of the Fire Brigade Intervention Model Guidelines, which indicates an average time of 45.3 seconds, and a standard deviation of 17.1 seconds. Using a 90th percentile approach as documented in the FBIM (Ref. [20]), the standard deviation is multiplied by a constant *k*, in this case being equal to 1.28. Therefore, the time utilised in this FBIM is 45.3 + (1.28x17.1) = 68 s.

7.2.8 Search and Rescue

Search and Rescue of the site will consist of a perimeter search of storage and processing areas. This will provide firefighting personnel with an additional 250 m of travel. At a speed of 0.63 m/s, this will take firefighting personnel approximately 397 seconds.

7.2.9 Summary

As summarised in **Table 7-3** the FBIM (Ref. [20]) indicates that the arrival times of the brigade from the nearest fire stations is approximately 53 minutes after fire ignition, and it is estimated that it takes another 9 minutes for the fire brigade to carry out activities including the determination of fire location and preparation of firefighting equipment. As such, the initial attack on the fire is expected to commence approximately 63 minutes after fire ignition (note rounding affects the basic addition of the reported figures).

Table 7-3: Summary of the Fire Brigade Intervention Model (FBIM)

Fire Station	Alarm Time	Travel Time	Time for Access & Assessment	Set-up Time	Time of Attack	Time for Search & Rescue
Goulburn Fire Station	112 s	3060 s	516 s	68 s	3756 s (63 minutes)	397 s

8.0 Fire Water Supply & Contaminated Fire Water Retention

8.1 Detailed Fire Water System Assessment

At this stage of the design a detailed hydrant layout has not been prepared; hence, a detailed hydraulic pressure analysis has not been completed. Therefore, the following recommendation has been made:

- Once a detailed design has been completed for the hydrant system pressure, loss calculations shall be prepared for the most hydraulically disadvantaged hydrant to demonstrate compliance with the requirements of AS 2419.1-2017 (Ref. [4]).
- The report shall be updated to include the pressure loss calculations.

8.2 Contaminated Water/Fire Water Retention

Where fire occurs in the presence of hazardous materials or Dangerous Goods there is the potential for the water to become contaminated which may result in an environmental incident if released into the water ways. To ensure environmental damage does not occur, the facility shall be designed to contain a volume of liquid to prevent discharge from the site.

A review of the proposed protection indicates the facility will be protected by a combination of sprinklers, monitors, and hydrants. The Waste Bunker fire presents the worst-case fire scenario, requiring the highest demand of all three protection systems. The following assumptions have been made to estimate the volume of liquid that may be discharged per minute for the worst-case fire scenario (Waste Bunker Fire):

- Sprinkler system discharging at 5 m^3/min
- Monitors discharging at 7.5 m^3/min (2 monitors discharging at 3.75 m^3/min)
- Hydrant hoses discharging at a total of 1.2 m^3/min (2 hydrants discharging at 10 L/s)

The combined discharge operating 13.7 m^3/min. Assuming minimum operating time of 90 minutes, the total discharge is 13.7 m^3/min x 90 = 1,233 m^3.

Based on this volume, the following recommendation has been made:

- The site shall be designed to contain at least 1,233 m^3 of potentially contaminated water. This may be achieved by discharge to the Stormwater Pond.

Notwithstanding the above, it is also recommended that an additional detailed hydraulic analysis be performed by qualified hydraulic engineers to ensure that adequate containment is available given the use of fire water by hydrants, sprinklers and FRNSW in the event of a fire.

9.0 FRNSW Fire Safety in Waste Facility Guidelines Review

It is necessary to review the facility against the Fire & Rescue NSW (FRNSW) Fire Safety in Waste Facilities Guidelines (Ref. [1]), to ensure the facility is designed with the appropriate fire protection. A detailed review of the guidelines has been carried out in **Appendix C** and has been summarised in **Table 9-1.**

Table 9-1: Summary of FRNSW Fire Safety in Waste Facility Guidelines Requirements

Clause	Waste Facility Guidelines Requirement	Details of Compliance
7.2	Preparation of an FSS	This report satisfies the requirement for an FSS.
7.4	<u>Firefighting Intervention</u> Firefighter access should be provided to the facility, including to any fire safety system or equipment provided for firefighting intervention. The facility should cater for large emergency service response, including containment of fire water run-off.	These requirements have been addressed in the following sections: • **Section 7.0** – Brigade access • **Section 6.2** – Fire detection and alarm • **Section 6.3** – Fire protection • **Section 8.2** – Recommended that a hydraulic pressure analysis is conducted.
7.5	<u>Fire Hydrant System</u> The fire hydrant system should consider facility layout and operations, with fire hydrants being located to provide compliant coverage and safe firefighter access during a fire. The fire hydrant system is to have a minimum water supply and capacity providing the maximum hydraulic demand (i.e. flow rate) for not less than four hours.	The consequences and risk contours of credible fire scenarios have been outlined in **Section 5.0**, indicating recommended areas in which hydrants should not be located. The details of fire water supply have been outlined in **Section 6.4.** and **Section 8.2.** It is recommended that a detailed hydraulic pressure assessment is conducted once the hydrant layout is finalised (**Section 8.1**).
7.6	<u>Automatic Fire Sprinklers Systems</u> The waste facility is to have an automatic fire sprinkler system installed in any fire compartment that has a floor area greater than 1,000 m^2 and contains combustible waste materials. The fire sprinkler system is to have minimum water supply and capacity providing maximum hydraulic demand for not less than two hours.	The Tipping Hall, Waste Bunker, Boiler Hall, Flue Gas Treatment and the Steam Turbine shall be protected by automatic fire sprinkler system. The sprinkler system shall be designed by qualified fire engineers. The details of fire water supply have been outlined in **Section 6.4.** and **Section 8.2**
7.7	<u>Fire Detection and Alarms</u> The waste facility is to have a fire detection and alarm system installed appropriate to the risks and hazards identified. The alarm should activate any required alarm (warning occupants of fire, evacuation etc.), and activate fire suppression system and warn all occupants of the fire.	Details of detection have been outlined in **Section 6.2.**

Clause	Waste Facility Guidelines Requirement	Details of Compliance
7.8	Smoke Hazard Management Buildings containing combustible waste material are to have an automatic smoke hazard management system appropriate to the potential fire load and smoke production rate installed within the building.	The Tipping Hall and Waste Bunker shall be protected by smoke detection system and fitted with dust and smoke extraction. It is recommended that an automatic smoke hazard management system is designed by a qualified fire engineer.
7.9	Fire Water Run-off Containment The facility should have effective and automatic means of containing fire water run-off, with primary containment having a net capacity not less than the total hydraulic demand of installed fire safety systems.	Details of containment and recommendations have been outlined in **Section 8.2**
8.2/8.3	Storages and Stockpiles The guidelines limit of the size, volume and location of combustible waste stockpiles to ensure FRNSW access in the event of a fire. It also outlines requirements for monitoring the temperature of self-heating stockpiles to minimise the risk of autoignition	The site will not contain stockpiles of combustible materials. Regardless, a turnover programme will be designed to minimise the potential for spontaneous combustion (**Section 4.4**), and it has been recommended that the IR sensors are installed in the Waste Bunker.
8.6	Operations Plan The waste facility should develop and implement a written operations plan outlining the daily operations for the waste facility.	An operations plan shall be prepared, as recommended in **Section 10.2.**
9.3	Emergency Plan The PCBU is required to develop an emergency plan for the waste facility, in accordance with AS 3745-2010.	An Emergency Response Plan (ERP) shall be prepared, as recommended in **Section 6.1.5**
9.4	Emergency Services Information Package (ESIP) An ESIP, as detailed in FRNSW guideline Emergency services information package and tactical fire plans, should be developed and provided by the PCBU.	An ESIP shall be prepared, as recommended in **Section 6.1.5**

10.0 Conclusion and Recommendations

10.1 Conclusions

The proposed Woodlawn ARC to be located at 619 Collector Road, Tarago was subjected to a Fire Safety Study to identify potential fire hazards at the site per the requirements of the FRNSW Fire Safety in Waste Facilities Guidelines (Ref. [1]). The analysis identified several fire scenarios which may result in substantial radiant heat impacts which may render fire protection systems inoperable. Where fire protection systems may be affected by fire scenarios recommendations were made regarding the location of installed fire protection. Based on analysis, it is concluded that should the protection systems be located per the recommendations of this report, the services should be capable of combating the modelled fire scenarios.

10.2 Recommendations

The following recommendations have been made:

Tipping Hall and Waste Bunker

- The waste bunker shall be protected by sufficient monitor(s) to ensure a deep-seated fire within the waste bunker can be combat effectively.
- The hydrant system shall be designed to provide full coverage of the waste bunker. Hydrants should be placed at the Feed Hopper level to avoid impact with the grapple cranes in the Bunker.
- Hydrants shall be located such that they provide full coverage to the waste bunker; they shall be located such that hydrants designed to combat fires in the waste bunker are located outside of the impact distance shown in **Figure 5-1**.
- Monitor(s) installed to protect against a fire in the waste bunker shall be remotely operated to ensure monitor(s) can be effectively utilised in a fire event.
- The site shall be subject to regular housekeeping practices to prevent the accumulation of dust on surfaces.
- Consider the design and installation of a visual fire detection system (i.e. infrared detection or image based fire detection).

Boiler Hall / Fuel Hopper

- The hydrant and monitor system shall be designed to provide full coverage of the fuel hopper and chute.

PAC Silo

- The PAC silo shall be subject to a HAC as per the requirements of AS/NZS 60079.10.2:2011.
- Where electrical equipment is required to be installed within the PAC hazardous area it shall be controlled per the requirements AS/NZS 60079.14.1:2017 (Ref. [2]).
- Installation of explosion vent panels shall be considered on the PAC silos as part of the design review.

Turbine Hall

- The hydrant system shall be designed to provide full coverage to the turbine.
- Inclusion of a sprinkler system to protection the fluid lines, turbine and generator bearings, and areas beneath the turbine which may be subject to oil flow should be considered as part of the design review.
- The area beneath the turbine should be bunded to contain any oil flows preventing a spreading fire impacting other areas of the facility.

Diesel Tanks

- The hydrant system shall be designed to provide full coverage to diesel tanks
- Impact protection (e.g. bollards) should be installed around the tanks.
- The diesel storage tanks shall comply with the requirements AS 1940-2017 (Ref. [3]).
- Hydrants shall be located such that they provide full coverage to both diesel tanks. They shall be located such that hydrants designed to combat diesel tank fires are located outside of the impact distance shown in **Figure 5-4.**
- The use of integrally bunded tanks for the storage of diesel shall be considered.

Fire Water

- The site shall be designed to contain at least 1,233 m^3 of potentially contaminated water. This may be achieved by discharge to the Stormwater Pond.
- An additional detailed hydraulic analysis be performed by qualified hydraulic engineers to ensure that adequate containment is available given the use of fire water by hydrants, sprinklers and FRNSW in the event of a fire.
- Once a detailed design has been completed for the hydrant system pressure, loss calculations shall be prepared for the most hydraulically disadvantaged hydrant to demonstrate compliance with the requirements of AS 2419.1-2017 (Ref. [4]).
- The report shall be updated to include the pressure loss calculations.

General Recommendations

- Fire hydrants shall not be located within 10 m of stockpiled storage (i.e Waste Bunker, PAC Silo) and must be accessible to firefighters entering from the site and/or building entry points.
- The building shall be fire protected per the requirements of the Building Code of Australia.
- An Emergency Response Plan (ERP) shall be prepared in accordance with the Hazardous Industry Planning Advisory Paper No. 1 and the Work Health and Safety Regulation 2017.
- The ERP shall be accompanied by an Emergency Services Information Package (ESIP) which shall be laminated and stored in the site emergency box.

11.0 References

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Appendix A

Hazard Identification Table

A1. Hazard Identification Table

Appendix Table A-1: Hazard Identification Table

ID	Area/Operation	Hazard and Cause	Hazard Consequence	Safeguards	Carried forward for further analysis?
1	Tipping Hall / Waste Bunker	• Storage of combustible material which may be contaminated with flammable liquids or gases • Hot loads – smoldering waste in trucks • Decomposition of waste in the bunker – smoldering waste • Ignition sources in waste bunker	• Ignition of waste in truck, truck on fire • Deposit of smoldering waste into bunker and bunker fire • Ignition of waste in the bunker and bunker fire	• Bunker contained within concrete pit within building. • Firefighting equipment – Hydrant System, Monitor(s) • Waste bunker is sprinkler protected, with smoke detectors • Waste is inspected by Veolia at transfer terminals prior to be sent to the facility. • Waste is processed prior to delivery to site – reduced likelihood of prohibited waste being delivered into the bunker • Turnover programme designed to minimise the potential for spontaneous combustion	Yes
2	Feed Chute and Hopper (Boiler Hall)	• Storage of combustible material and transfer into combustion chamber	• Ignition of waste in hopper, chute and magazine	• Feed chute ramps create an air-block, creating an oxygen depleted environment which does not support combustion. • Chute opening is protected by a ring of sprinklers • Boiler Hall is sprinkler protected • Feed chute is protected by a sprinkler ring • Firefighting equipment – Hydrant System, Monitor(s)	No
3	PAC Silo storage	• Storage of PAC (Class 4.2 – spontaneously combustible materials)	• Potential for dust cloud within storage silo	• APCr and Reagents Building is constructed of concrete fire walls	Yes

ID	Area/Operation	Hazard and Cause	Hazard Consequence	Safeguards	Carried forward for further analysis?
			ullage space, ignition and explosion	• Hazardous Area Classification (HAC) in accordance with AS/NZS 60079.10.1:2009 (Ref. [14]) • Control of ignition sources – Smoking is prohibited on site. • Firefighting equipment – Hydrant System	
4	PAC Silo storage	• Storage of PAC (Class 4.2 – spontaneously combustible materials)	• Potential for ignition of accumulated PAC and bag filter fire	• APCr and Reagents Building is constructed of concrete fire walls • Hazardous Area Classification (HAC) in accordance with AS/NZS 60079.10.1:2009 (Ref. [14]) • Control of ignition sources – Smoking is prohibited on site. • Firefighting equipment – Hydrant System	Yes
5	Calcium Hydroxide Storage	• Damaged silo	• Release of calcium hydroxide	• Solid state – limit spread of release • Not classified as DG	No
6	FGT Bag Filters	• Accumulation of PAC (Class 4.2 – spontaneously combustible materials)	• Potential for PAC dust dispersal in bag filter, ignition and explosion	• Diluent material (calcium hydroxide) minimising combustibility of dust dispersion • Firefighting equipment – Hydrant System, Monitor(s) • FGT Hall is sprinkler protected • Bag Filter maintenance (i.e. filter replacement), general housekeeping • Hazardous Area Classification (HAC) in accordance with AS/NZS 60079.10.1:2009 (Ref. [14])	No PAC is sufficiently diluted by addition of calcium hydroxide

ID	Area/Operation	Hazard and Cause	Hazard Consequence	Safeguards	Carried forward for further analysis?
				• Control of ignition sources – Smoking is prohibited on site.	
7	FGT Bag Filters	• Accumulation of PAC (Class 4.2 – spontaneously combustible materials)	• Potential for ignition of accumulated PAC and bag filter fire	• Diluent material (calcium hydroxide) minimising combustibility of dust dispersion • Firefighting equipment – Hydrant System, Monitor(s) • FGT Hall is sprinkler protected • Bag Filter maintenance (i.e. filter replacement), general housekeeping • Hazardous Area Classification (HAC) in accordance with AS/NZS 60079.10.1:2009 (Ref. [14]) • Control of ignition sources – Smoking is prohibited on site.	No PAC is sufficiently diluted by addition of calcium hydroxide
8	APCr Store	• Storage of PAC (Class 4.2 – spontaneously combustible materials)	• Potential for dust cloud within storage silo ullage space, ignition and explosion	• Diluent material (calcium hydroxide) minimising combustibility of dust dispersion • Firefighting equipment – Hydrant System, Monitor(s) • APCr Store is sprinkler protected • Hazardous Area Classification (HAC) in accordance with AS/NZS 60079.10.1:2009 (Ref. [14]) • Control of ignition sources – Smoking is prohibited on site.	No PAC is sufficiently diluted by addition of calcium hydroxide
9	Steam Turbines	• Misaligned rotational equipment	• Overheating of bearing, heating	• Turbine maintenance and vibrational testing • Firefighting equipment – Hydrant System	Yes

ID	Area/Operation	Hazard and Cause	Hazard Consequence	Safeguards	Carried forward for further analysis?
		• Damaged lubricating pipework	of lubricating oil, ignition and fire • Release of lubricating oils, ignition and fire	• Turbine hall is constructed of concrete fire walls	
10	Transformers	• For natural ester transformers - arcing within transformer, vaporisation of fluid and rupture of fluid reservoir	• Transformer fluid release spill, ignition and fire	• Natural esters have a very high flash point such that ignition is very unlikely to occur. • Bunded • Firefighting equipment – Hydrant System • Electrical protection for transformer faults • Dry-type transformers may be used, which do not contain combustible material	No
11	Diesel Storage Tanks	• Deterioration or failure of tank shell/nozzles or pipework resulting in a leak • Vehicle impact on tank • Failure of valves/nozzles during tank filling, resulting in a leak	• Diesel release, ignition and pool fire	• Tanks are tested according to AS 1692-2006 (Ref. [22]) • Double-skinned tanks designed to contain minor spills • Tanks and bunded area designed to contain spills within the delivery area as per AS 1940-2017 (Ref. [3]) • Exclusion of ignition sources as per AS 1940-2017 • Tanks are located outdoors, not adjacent to any buildings • Firefighting equipment – Hydrant System	Yes

Appendix B
Consequence Analysis

B1. Incidents Assessed in Detailed Consequence Analysis

The following incidents are assessed for consequence impacts.

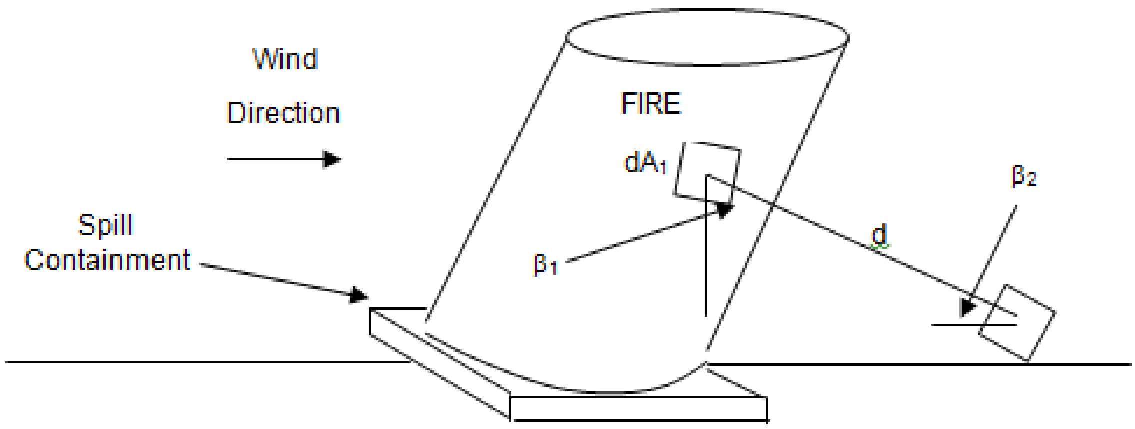
- Ignition of waste in the tipping hall / waste bunker and bunker fire
- PAC dust liberation, ignition and explosion (storage silo)
- PAC ignition in bag filters and explosion
- Release of process oils, ignition and fire
- Steam turbine fire
- Transformer oil spill, ignition and bund fire
- Diesel tank leak, spill, immediate ignition and pool fire

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. [23]).

$$Q = EF\tau \qquad \textbf{Equation B-1}$$

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. [23]). 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^o 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^o 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^o 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^o, sin(γ) is 1.0, meaning that the projected area is 100% of the actual area.

Before the value of θ reaches 90^o 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**):

$$VF = \Delta A \frac{\sin\gamma \times \cos\alpha}{\pi \times X4 \times X4}$$ **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 ∆A term. This sum is then multiplied by ∆A 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. [24] & Ref. [23]) 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**.

$$SEP = E_{max}e^{-sD} + E_s(1 - e^{-sD})$$ **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. [23]) 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. [25]).

$$\tau = 1.006 - 0.01171(\log_{10} X(H_2O) - 0.02368(\log_{10} X(H_2O))^2 - 0.03188(\log_{10} X(CO_2) + 0.001164(\log_{10} X(CO_2))^2$$ **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. [6]).

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

Heat Radiation (kW/m²)	Impact
	• Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure • 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)
3.0	• FRNSW criteria for accessing equipment

Appendix Table B-2: Overpressure and Associated Physical Impacts

Overpressure (kPa)	Impact
70	• Threshold of lung damage • 100% chance of fatality for a person in a building or in the open • Complete demolition of houses
35	• House uninhabitable • Wagons and plant items overturned • Threshold of eardrum damage • 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open
21	• Reinforced structures distort • Storage tanks fail • 20% chance of fatality to a person in a building
14	• House uninhabitable and badly cracked
7	• Damage to internal partitions and joinery but can be repaired • Probability of injury is 10%. No fatality
3.5	• 90% glass breakage • No fatality and very low probability of injury

B3. Ignition of Waste in the Tipping Hall / Waste Bunker and Fire

There is potential that a fire could develop within the waste bunker. A fire in this location may be difficult to combat as the fire seat may be shielded by waste overburden. All the materials within the bunker are combustible and so there is potential that a fire may grow to consume the entire waste storage. Note, the Waste Bunker is constructed of concrete walls fire walls (27 m) and is only accessible through one of four Tipping Hall Access Bays. Each bay is 5 m wide and 9 m high.

The dimensions of the bunker are 20 m x 40 m which has a high aspect ratio which reduces the accuracy of the modelling which is based on circular fires. Therefore, to model the heat radiation of a fire in the waste bunker, the bunker has been broken down into 2 segments each with dimensions of 20 m x 20 m. This gives an area of 20x20 = 400 m^2, which is equivalent to a circular pool with a diameter 22.6 m.

The following data was input into the SSC:

- Fire diameter –22.6 m
- Tank height – -12 m (As the bottom of the bunker is 12 m below ground level)
- Burning rate – 0.022 kg/m^2.s (conservatively applying the burning rate for a combustible liquid to a solid fuel, Ref. [24])

The following information was obtained from the SSC:

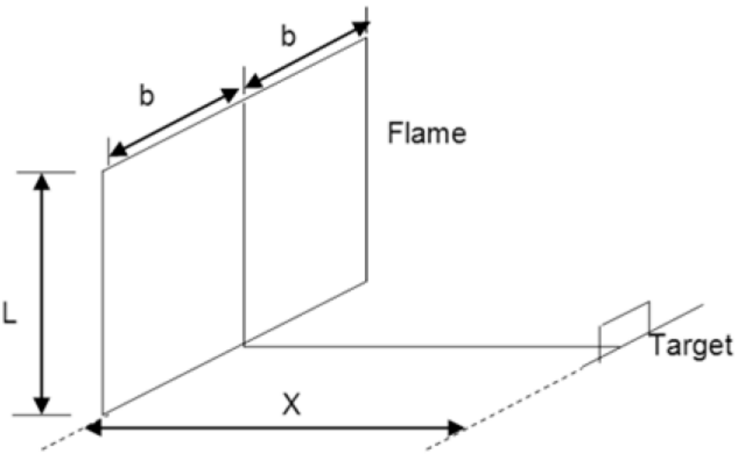
- SEP – 28.0 kW/m^2
- Flame height – 15.9 m

As heat will only emanate from the four openings to the bunker, the view factor was estimated for the 'flat surface' using the dimensions of the openings.

The view factor can be read from a graph (**Appendix Figure B-3**) by calculating the following equations:

$L_r = \frac{L}{b}$ and $X_r = \frac{X}{b}$

Where X is the distance to the fire, L is the height of the flame and b is the radius of the flame, as shown in **Appendix Figure B-2**.



Appendix Figure B-2: View Factors for Flat Radiating Panel

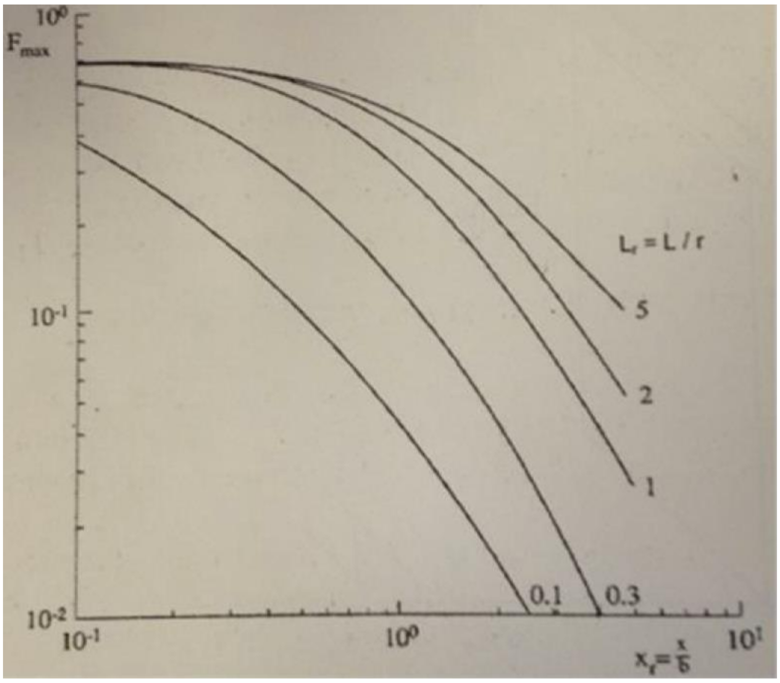
Given that the height of the flame was determined to be 16 m and the floor of the bunker is 12 m below ground level, the height of the flame visible from the openings is 4 m. Each opening is 5 m wide, therefore the radius of the fire was taken as 5/2 = 2.5 m. The distance from the fire was unknown and was iterated until the target radiant heat values were found.

L_r and X_r were computed as follows:

$$L_r = \frac{4}{2.5} = 1.8$$

$$X_r = \frac{X}{2.5} = ?$$

A value of Lr = 2 was used on **Appendix Figure B-3,** and various distances to the fire were iterated to estimate the view factors. For each distance and view factor, the transmissivity was estimated using **Equation B-7**, and the radiant heat was calculated using **Equation B-1.**



Appendix Figure B-3: View Factor Graph

The results of the analysis are shown in **Appendix Table B-3**.

Appendix Table B-3: Radiant Heat Impacts from a Waste Bunker Fire

Heat Radiation (kW/m^2)	Distance (m)	Xr	View Factor (F_{max})	Transmissivity
35	Maximum heat flux is 20.45	-	Max: 0.7	-
23	Maximum heat flux is 20.45	-	Max: 0.7	-
12.6	2.1	0.84	0.48	0.939
4.7	5.5	2.2	0.19	0.890
3.0	7.2	2.9	0.122	0.875

B4. PAC Dust Liberation, Ignition, and Explosion (Storage Silo)

If PAC dust is ejected into the air with sufficient dispersion, containment, oxygen and an ignition source, a dust cloud explosion could occur. Similar to vapour cloud explosions, dust clouds have a lower explosive limit based on the concentration and the strength of the ignition source, under which the dust won't ignite. Unlike vapour clouds, dust clouds do not have well-defined upper explosive limits, although it has been estimated that above 2-3 kg/m^3 an explosion will not occur (Ref. [9]).

There exists a variant of the TNT equivalent model to estimate the over pressure of a dust cloud explosion. To estimate the amount of dust that can contribute to the explosion the stoichiometry of the reaction must be reviewed as the carbon can only react with the total concentration of oxygen in the air. The reaction between carbon and oxygen is:

$$C + O_2 \rightarrow CO_2$$

Therefore, for everyone 1 molecule of carbon, 1 molecule of oxygen is required. The dust cloud explosion has been modelled as if a delivery has just occurred (resulting in dust dispersion in the air space in the silo) and has been filled to 75%. The silo has a volume of 80 m^3 and at 75% full leaving an air space of 20 m^3. To estimate the amount of oxygen available in this air space, the ideal gas law has been used which is shown in **Equation B-8.**

$$PV = nRT \qquad \textbf{Equation B-8}$$

The following information has been used:

- P = Pressure (1 atm)
- V = Volume (20,000 L)
- n = Moles of gas
- R = 0.08206 $L.atm.K^{-1}.mol^{-1}$
- T = Temperature (298 K)

Rearranging **Equation B-8** to make the number of moles (n) the subject and using the information above, the number of moles of oxygen available in the air space to participate in the explosion can be estimated. The results of this calculation show that there are 818 moles of oxygen present. Using the stoichiometry ratio, 818 moles of carbon could participate in the explosion which gives a carbon in air mass of 9.8 kg or 0.5 kg/m^3.

To estimate the explosion overpressure, the TNT equivalent method is used. This method equates the quantity of gas in the cloud to an equivalent quantity of TNT by **Equation B-9.**

$$W_{TNT} = \alpha\left(\frac{WH_c}{H_{TNT}}\right) \qquad \textbf{Equation B-9}$$

The other parameters required in this equation are:

- W = mass of fuel in the dust cloud (9.8 kg)
- H_c = heat of combustion of the fuel (32,800 kJ/kg for carbon Ref. [26])
- H_{TNT} = TNT blast energy (5420 kj/kg) (Ref. [23])
- α = explosion efficiency (conservatively estimated to be 0.3 for dusts, Ref. [9])

Inputting the above information into **Equation B-9** gives an equivalent mass of TNT of 17.8 kg.

Overpressure is now calculated using a scaled distance curve, based on actual distance from the blast and the TNT equivalent mass, this is given **Equation B-10.**

$$Z = \frac{R}{(W_{TNT})^{\frac{1}{3}}} \qquad \textbf{Equation B-10}$$

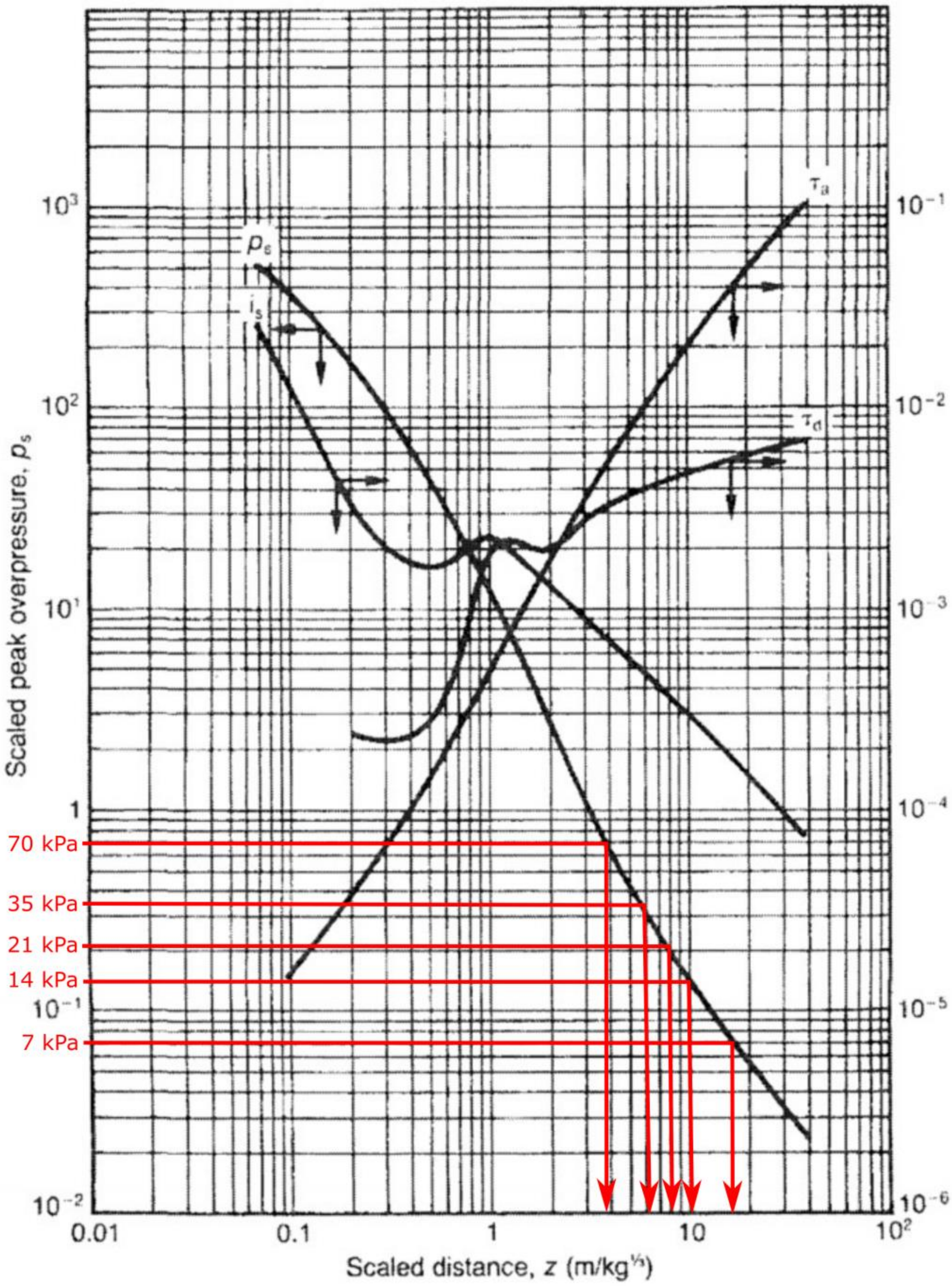
Where:

- Z = scaled distance ($m/kg^{1/3}$)
- R = distance from the blast (m)
- W_{TNT} = kg equivalent of TNT (17.8 kg)

Appendix Table B-4 shows the distance for subject overpressure based on solving for R taking Z from **Appendix Figure B-2.**

Appendix Table B-4: Overpressure from a Silo Explosion

Overpressure (kPa)	Scaled Distance, Z ($m/kg^{1/3}$)	Distance, R (m)
70	3.8	9.9
35	6	15.7
21	8	20.9
14	10	26.1
7	16	41.8



Appendix Figure B-4: Scaled Parameter Plots for TNT Explosions (Ref. [23])

B5. PAC Ignition Fire in the PAC Silo

There is also the potential for a fire to occur within PAC storage silo. The dimensions of the silo were estimated to be 9.3 m x 2.7 m from the site layout. This gives a fire with an area 9.3 x 2.7 = 24.6 m, equivalent to a circle with diameter 5.6 m. Taking the silo volume 80 m^3, the height of the silo was assumed to be 3.75 m.

The following data was input into the SSC:

- Fire diameter – 5.6 m
- Tank Height – 3.75 m
- Burning rate – 0.022 kg/m^2.s (conservatively applying the burning rate for a combustible liquid to a solid fuel, Ref. [24])

The following information was obtained from the SSC:

- SEP – 81.3 kW/m^2
- Flame height – 6.0 m

The results of the analysis are shown in **Appendix Table B-5.**

Appendix Table B-5: Radiant Heat Impacts from PAC Silo Fire

Heat Radiation (kW/m^2)	Distance (m)
35	not observed
23	not observed
12.6	not observed
4.7	9.7
3.0	13.1

B6. Steam Turbine Fire

Poor lubrication or unbalanced blades may result in localised heating of bearings and failure of the lubricant seals and subsequent release of oil. Alternatively, lubricating pipework may fail resulting in a release of oil into the turbine area. If the spill ignites, a pool fire will occur with the dimensions of the bund. The turbine room has dimensions of 23.5 m x 37 m. This gives an area of 23.5x37 = 870 m^2, which is equivalent to a circular pool with a diameter 33.3 m. The turbine hall is constructed of concrete fire walls, with an estimated height of 20 m.

The following data was input into the SSC:

- Fire diameter – 33.3 m
- Tank height – 20 m (wall height)
- Burning rate – 0.022 kg/m^2.s (combustible liquid)

The following information was obtained from the SSC:

- SEP – 22.2 kW/m^2
- Flame height – 20.9 m

The results of the analysis are shown in **Appendix Table B-6**. Note, the maximum radiant heat was found to be 1.56 kW/m^2 at 17.3 m from the turbine hall walls.

Appendix Table B-6: Radiant Heat Impacts from a Turbine Fire

Heat Radiation (kW/m^2)	Distance (m)
35	not observed
23	not observed
12.6	not observed
4.7	not observed
3.0	not observed

B7. Diesel Tank Leak, Spill, Immediate Ignition, and Pool Fire

Two tanks storing 100 m^3 of Diesel each will be located outdoors, adjacent to the tipping hall. The tanks will be above ground and double-skinned, and therefore will not be bunded. In the unlikely event of a spill during refilling or a vehicle collision, operators would be present to react to situation. Therefore, the scenario has been modelled conservatively assuming that 50% of the contents were released.

A methodology for calculating the pool size of a spill has been outlined in American Institute of Chemical Engineering CEP Magazine, January 2005 issue (Ref. [27]). The methodology considers how a liquid spilled on a flat surface will progress through 3 regimes:

1) Gravity-inertia regime – fluid spreads due to gravity and is opposed by the inertia of the fluid.
2) Gravity viscous regime – fluid spreads due to gravity and is opposed by viscosity of the fluid.
3) Viscous-surface tension regime – fluid viscosity is opposed by surface tension and the fluid no longer spreads.

The maximum size of the pool will occur once the fluid reaches the viscous-surface tension regime, after which the pool size will decrease due to evaporation. The time required to enter the viscous-surface tension regime is found by **Equation B-11.**

$$t_{vs} = 0.023462\left(\frac{gV\rho\mu}{\sigma}\right)$$ **Equation B-11**

Where:

- t_{vs} = Time required to enter viscous-surface tension regime (s)
- g = Gravitational acceleration (ft/s^2)
- V = Volume of spill (ft^3)
- ρ = Density (lb/ft^3)
- μ = Viscosity (cP)
- σ = Surface tension (dyne/cm)

The radius of spill at time 0 (i.e. the onset of evaporation) is then found using **Equation B-12**.

$$a_0 = 1.413142\left(\frac{\sigma V t_{vs}}{\mu}\right)^{\frac{1}{4}}$$ **Equation B-12**

The following information was substituted into **Equation B-11** and **Equation B-12** to determine the pool size of a 100 m^3 diesel spill:

- g = 9.8 m/s = 32.17 ft/s^2
- V = 50 m^3 = 1,766 ft^3
- ρ = 850 kg/m^3 = 53.06 lb/ft^3
- μ = 2.5 cP
- σ = 15.98 dyne/cm

Inputting in the above information into the equations gives the radius of the spill to be 13.9 m, and the area of the spill (assumed circular) was found to be 605 m^2.

Hence, the following data was input into the SSC:

- Fire diameter – 13.9 m
- Burning rate – 0.022 kg/m^2.s (combustible liquid, Ref. [24])

The following information was obtained from the SSC:

- SEP – 24.3 kW/m^2
- Flame height – 18.4 m

The results of the analysis are shown in **Appendix Table B-7.**

Appendix Table B-7: Heat Radiation Impacts from Diesel Bund Fire

Heat Radiation (kW/m^2)	Distance (m)
35	2.9
23	4.9
12.6	8.8
4.7	18.6
3	24.9

Appendix C

Detailed Review of FRNSW Fire Safety in Waste Facility Guidelines

C1. Review of FRNSW Fire Safety in Waste Facility Guidelines

Appendix Table C-1: Detailed Review of FRNSW Fire Safety in Waste Facility Guidelines

Clause	FRNSW Waste Facility Guideline Requirement	Details of Compliance
	7.2 Designing for Special Hazard	
7.2.1	Combustible waste should be considered a special hazard and consent authorities should impose the conditions on development that Clause E1.10 and E2.3 of the NCC be complied with to the satisfaction of the fire brigade.	
7.2.3	All fire risks and hazards of the waste facility should be identified. A fire safety study is the be done in accordance with HIPAP No. 2 if deemed appropriate by the relevant consent authority.	This report satisfies the requirement for an FSS. **Sections 4.0** and **Section 5.0** identify and assess all fire risks and hazards
7.2.5	All reasonable and foreseeable combustible waste materials should be identified and considered in any performance solution.	Combustible materials have been identified in **Section 3.0.**
	7.4 Firefighting Intervention	
7.4.1	The waste facility is to provide safe, efficient, and effective access as detailed in FRNSW guideline *Access for fire brigade vehicle and firefighters*.	
7.4.4	The facility should cater for large emergency service response, if the potential hazard may result in a large emergency, including containment of fire water run-off.	Details of detection and alarm have been outlined in **Section 6.2,** fire protection details have been outlined in **Section 6.3,** and details of containment have been outlined in **Section 8.2**
7.4.6	Any development application should be accompanied by a flow rate and pressure test of the water main connected to the fire hydrant system.	It has been recommended that a hydraulic pressure analysis in **Section 8.1**
7.4.7	Firefighter access should be provided to buildings, structures, and storage areas, including to any fire safety system or equipment provided for firefighting intervention	Details of brigade access have been outlined in **Section 7.0**
	7.5 Fire Hydrant System	
7.5.1	The waste facility is to have a fire hydrant system installed appropriate to the risk and hazard for the waste facility.	
7.5.2	The fire hydrant system should consider facility layout and operations, with fire hydrants being located to provide compliant coverage and safe firefighter access during a fire, including having external fire hydrants to protect any open yard storage	**Section 5.0** outlines the risk contours of credible fire scenarios, and the recommended areas in which hydrants should not be located.
7.5.4	Fire hydrants are not to be located within 10 m of stockpiled storage and must be accessible to	Recommendation has been included in **Section 10.2**

Clause	FRNSW Waste Facility Guideline Requirement	Details of Compliance
	firefighters entering from the site and/or building entry points.	
7.5.5	Where appropriate to protect against high risks and hazards, suitable on-site fixed external fire monitors may be provided as part of the fire hydrant system	Monitors have been recommended to protect the Waste Bunker and Fuel Hopper. Details of the recommendation have been outlined in **Section 6.3**
7.5.6	The fire brigade booster assembly is to be located within sight of the designated site entry point, or other location approved by the fire brigade, and be protected from radiant heat from any nearby stockpile	
7.5.7	The fire hydrant system is to have a minimum water supply and capacity providing the maximum hydraulic demand (i.e. flow rate) for not less than four hours.	The details of fire water supply have been outlined in **Section 6.4.** and **Section 8.2.** It has been recommended that a detailed hydraulic pressure assessment is conducted in **Section 8.1**
7.5.8	The fire hydrant system should incorporate fire hose reels installed in accordance with Clause E1.4 of the NCC to enable effective first attack of fires by appropriately trained staff.	Compliance requirements from the NCC has been outlined in **Section 6.3.5**
	7.6 Automatic Fire Sprinklers Systems	
7.6.1	The waste facility is to have an automatic fire sprinkler system installed in any fire compartment that has a floor area greater than 1000 m^2 and contains combustible waste materials	The Tipping Hall, Waste Bunker, Boiler Hall, and Flue Gas Treatment area shall be protected by automatic fire sprinkler system. The sprinkler system shall be designed by qualified fire engineers.
7.6.5	The fire brigade booster assembly for the fire sprinkler system should be co-located with the fire hydrant system booster within sight of the designated site entry point, or in a location approved by the fire brigade	-
7.6.6	The fire sprinkler system is to have minimum water supply and capacity providing maximum hydraulic demand for not less than two hours.	The details of fire water supply have been outlined in **Section 6.4.** and **Section 8.2**
	7.7 Fire Detection and Alarms	
7.7.1	The waste facility is to have a fire detection and alarm system installed appropriate to the risks and hazards identified for each area of the building.	Details of detection and alarm have been outlined in **Section 6.2.**
7.7.2	The fire detection and alarm system should warn all occupants of fire and to evacuate the facility, with each component being appropriate to the environment.	Details of detection and alarm have been outlined in **Section 6.2.**

Clause	FRNSW Waste Facility Guideline Requirement	Details of Compliance
7.7.3	Upon positive detection of fire, the system is to activate any required alarm, fire suppression system, passive measures (e.g., fire door, fire shutter) or plant/machinery override as appropriate to the detector.	Details of detection and alarm have been outlined in **Section 6.2.**
7.7.4	Manual alarm points should be provided in clearly visible locations as appropriate to the environment so that staff can initiate early alarm of fire.	Details of detection and alarm have been outlined in **Section 6.2.**
	7.8 Smoke Hazard Management	
7.8.1	Buildings containing combustible waste material are to have an automatic smoke hazard management system appropriate to the potential fire load and smoke production rate installed within the building	The Tipping Hall and Waste Bunker shall be protected by smoke detection system and fitted with dust and smoke extraction. It is recommended that an automatic smoke hazard management system is designed by a qualified fire engineer.
7.8.4	Any smoke exhaust system installed should be capable of continuous operation of not less than two hours in a sprinkler-controlled fire scenario, or four hours in any non-sprinkler-controlled fire scenario.	
	7.9 Fire water run-off containment	
7.9.1	The waste facility should have effective and automatic means of containing fire water run-off, with primary containment having a net capacity not less than the total hydraulic demand of installed fire safety systems	The required containment has been outlined in **Section 8.2**
7.9.4	The containment system, which includes the base of any storage area, should be impermeable (i.e. sealed) and prevent fire-water run-off from entering the ground or any surface water course.	The has been recommended in **Section 8.2**
7.9.6	Pollution control equipment such as stormwater isolation valves, water diversion, booms, drain mats, should be provided as necessary for the facility's emergency response procedures, and be kept readily accessible for the event of fire.	The has been recommended in **Section 8.2**
	8.2 Storages and Stockpiles / 8.3 Movement of Stockpiles	
8.2.3	The maximum height of any stockpile, loose piled or bales, should not exceed 4 m.	Combustible materials will not be kept in stockpiles, noting IBA is not combustible.
8.3.1	Stockpiles of combustible waste material should be rotated to dissipate any generated heat and minimise risk of auto-ignition as required.	Although the waste bunker is not a stockpile, a turnover programme will be designed to minimise the potential for spontaneous combustion, as outlined in **Section 4.4**,

Clause	FRNSW Waste Facility Guideline Requirement	Details of Compliance
8.3.2	Any stockpile of combustible waste material prone to self-heating should have appropriate temperature monitoring to identify localised hotspots; procedures outlined in the operations plan should be implemented to reduce identified hotspots.	Although it is not a stockpile, it has been recommended that the IR sensors are installed in the Waste Bunker.
8.3.4	Procedures for stockpile rotation and monitoring of temperature during hot weather are to be included in the operations plan.	An operations plan shall be prepared, as recommended in **Section 10.2.**
	8.6 Operations Plan	
8.6.1	The waste facility should develop and implement a written operations plan outlining the daily operations for the waste facility, including describing the combustible waste materials likely, and the method of storage, handling or process at the facility.	An operations plan shall be prepared, as recommended in **Section 10.2.**
	9.3 Emergency plan	
9.3.1	The PCBU is required to develop an emergency plan for the waste facility, in accordance with AS 3745-2010	An ERP shall be prepared, as recommended in **Section 6.1.5**
	9.4 Emergency Services Information Package (ESIP)	
9.4.1	An ESIP, as detailed in FRNSW guideline Emergency services information package and tactical fire plans, should be developed and provided by the PCBU	An ESIP shall be prepared, as recommended in **Section 6.1.5**