Ground Floor, Unit 3
19 Essex Street
FREMANTLE WA 6160

PO Box 1331
FREMANTLE WA 6959

T 08 9336 3156
F 08 9336 4156

www.acor.com.au

ENGINEERS

MANAGERS

INFRASTRUCTURE
PLANNERS

DEVELOPMENT
CONSULTANTS

Fire Safety Report

SSD8660 - Kariong Sand and Soil Supplies

Prepared for: **Jackson Environment and Planning Pty Ltd**

Document no: **PE200145-01**

Issue No: **R04**

Disclaimer

This Report has been prepared in accordance with the scope of services described in the contract or agreement between ACOR Consultants (WA) Pty Ltd and the Client. The Report relies upon data, surveys, measurements and results taken at or under the particular terms and conditions specified herein. Changes to circumstances or facts after certain information or material has been submitted may impact on the accuracy, completeness or currency of the information or material. This Report has been prepared solely for use by the Client, ACOR Consultants (WA) Pty Ltd accepts no responsibility for its use by other parties without the specific authorisation of ACOR Consultants (WA) Pty Ltd. ACOR Consultants (WA) Pty Ltd reserves the right to alter, amend, discontinue, vary or otherwise change any information, material or service at any time without subsequent notification. All access to, or use of, the information or material is at the user's risk and ACOR Consultants (WA) Pty Ltd accepts no responsibility for the results of any actions taken on the basis of information or material provided, nor for its accuracy, completeness or currency. Any reference to "Report" where used in this Disclaimer is also a reference to any plan, table, data or other document that has been created for the purposes of the "Report" and referred to in the "Report"

REVISIONS

Revision	Date	Purpose	Prepared By	Approved By
D1	13/09/19	Internal review	Mounica Achuthan	Michael Wakefield
D2	25/09/19	Client review	Michael Wakefield	Amanda Wylde
D3	01/10/19	Client review	Michael Wakefield	Amanda Wylde
D4	07/10/19	Updated with client comments	Michael Wakefield	Amanda Wylde
R1	30/10/19	Revised at client request	Michael Wakefield	Amanda Wylde
R2	18/11/19	Updates with client comments	Michael Wakefield	Amanda Wylde
R3	20/07/20	Update with new information	Michael Wakefield	Amanda Wylde
R4	20/11/20	Update with new information	Michael Wakefield	Amanda Wylde
R5	15/12/20	Update with new information	Michael Wakefield	Amanda Wylde

Review Panel	
Division/Office	**Name**
Jackson Environment and Planning	Dr Mark Jackson, Director

Unless otherwise advised, the parties who have undertaken the Review and Endorsement confirm that the information contained in this document adequately describes the conditions of the site located at 90 Gindurra Road, Somersby, NSW.

Table of Contents

List of Appendix

List of Figures

List of Tables

Abbreviations

Abbreviation	Definition
EIS	Environment Impact Statement
FH	Fire hydrant
FR	Fire hose reel
FRNSW	Fire and Rescue, NSW
GJ	Giga (10^9) joules
HIPAP	Hazardous Industry Planning Advisory Paper
HRR	Heat release rate
KSSS	Kariong Sand and Soil Supplies
kW/m^2	kilojoules of energy released per second per square metre of flame area
LDPE	Low density polyethylene
NBR	Natural butyl rubber blend
OSD	On-site detention
PVC	Polyvinyl chloride
TJ	Tera (10^{12}) Joules
tpa	Tonnes per annum

The Study

The scope of this study is to include:

- Identification of fire hazards and the consequences of possible fire incidents;
- Fire prevention strategies and measures;
- Analysis of the requirements for fire detection and protection;
- Identification of the specific measures to be implemented;
- Calculation of firefighting water supply and demand;
- Containment of contaminated firefighting water; and
- First aid fire protection requirements

The Report

Format of Report:

- Clear summary of findings and recommendations;
- Description of facility, including processes, layout and location drawings;
- Identification of flammable materials, fire scenarios that can arise and their consequences;
- Description of fire prevention and mitigation strategies;
- Description of fire system and adequacy to cope with identified fire scenarios; and
- Arrangements for containing contaminated firefighting water.

Summary of Findings

The Kariong Sand and Soil Supplies (KSSS) development at 90 Gindurra Road, Somersby will store on-site approximately 3,907 tonnes of combustible materials at any one time comprising six discrete locations. The fire load associated with these materials is equivalent to approximately 60,525 gigajoules of energy.

ACOR Consultants (WA) Pty Ltd (ACOR) has been requested by KSSS to undertake a fire study of the proposed combustible materials and to determine the potential impacts of thermal radiation, the risk mitigation strategies and the recommendations for fire detection and protection.

ACOR has identified that the open stockpiles of combustible materials stored in the yard (waste storage bays, processing area and landscape storage bays) are unlikely to cause an escalation of the fire event by direct thermal radiation. However, the risk from spread of burning embers could result in escalation. Consequently, methods to detect likely fire conditions and take preventative actions have been identified.

The Secondary Sorting Warehouse (SSW) has several stockpiles of combustible (recovered) materials with proximity to each other. A fire in any of the SSW stockpiles is likely to spread to each of the other stockpiles, meaning that the worst-case heat release rate (49MW) in the SSW is much lower than for the open yard stockpiles (96 – 3,817MW).

Diesel fuel and lube oil, stored in a 20m^2 x 0.3m bunded compound in the southwest corner of the SSW, are unlikely to cause escalation to other combustible materials within the SSW, with fully developed burn time lasting 1.75 hours at 75kW/m^2 thermal radiation. This level of flux will cause damage to the zincalume cladding but should not result in combustion initiation in the actual SSW infrastructure.

LPG cylinders stored at the northern end of the SSW will be impacted by thermal radiation from a fire in the process area at a thermal radiation flux less than 4.7kW/m^2, however, this is unlikely to result in gas venting, assuming that firefighting water can applied within 20 minutes of a fire commencing.

An LPG cylinder jet fire is unlikely to result in injury at distances beyond 10 metres from source.

Flame heights in the SSW will extend beyond the three (3) metre high, concrete, tilt-up panels and cause thermal stress failure of the zincalume cladding. Thermal radiation will then be able spread into the yard space closest to the heat source.

Similarly, the yard stockpiles will extend to one metre below the top of the concrete block walls, allowing flame height to extend above the masonry heat barrier. The only thermal radiation that is likely to escape from the KSSS yard originates in the waste storage bay holding only timber. The distance of this bay from the eastern boundary of the KSSS property (44 metres) and the presence of the five (5) metre high noise barrier allows a thermal shadow to prevent radiation within a minimum of 54 metres from the source, to the east and 95 metres from the source to the west. The furthest extent of thermal radiation from source is 25 metres.

The consequences of a fire event may results in:

- Injurious thermal radiation (30 seconds exposure) originating in the SSW will be blocked (shadowed) to an average distance of 13 metres beyond the site boundary (at ground level) to the east, by the five (5) metre high noise barriers, effectively negating impacts adjacent to the SSW;
- Injurious thermal radiation (after 30 seconds exposure) originating in the processing area will not extend beyond the boundary of the KSSS premises;
- Injurious thermal radiation (after 30 seconds exposure) originating in the central landscape storages will not extend beyond the boundary of the KSSS premises;

- Injurious thermal radiation (after 30 seconds exposure) originating in the waste storage bays will not extend beyond the boundary of the KSSS premises; and
- An LPG vapour cloud explosion, involving the contents of two 18kg LPG cylinders should not cause injury beyond the western and northern boundaries of the site. On the eastern boundary, injurious overpressure with up to a 10 per cent probability of injury will extend approximately 15 metres into the adjoining property adjacent to the SSW.

An LPG vapour cloud explosion, involving the contents of two 18kg LPG cylinders (one LPG cylinder will cause the two other LPG cylinders to explode generating a maximum overpressure from two LPG cylinders) should not cause injury beyond the western and northern boundaries of the site. On the eastern boundary, injurious overpressure with up to a 10 per cent probability of injury will extend approximately 15 metres into the adjoining property

The fire study indicates that additional fire hydrants and fire hose reels will need to be installed adjacent to the outside storage areas.

Firewater generated during a fire event will either be contained within the bunded compound of the SSW or will flow though dish and /or swale drains to the on-site detention (OSD) pond. Contaminated firewater captured in the OSD will be analysed prior to being discharged or removed from site by a licensed 3rd party waste contractor.

The estimated firewater application for a four hour duration fire in the SSW is approximately 288kL of which 50% is assumed to evaporate (144kL contaminated firewater, equivalent to a depth of 68mm over the SSW floor area. Consequently, a 70mm high bund wall will be installed internally, at each opening to the SSW.

The estimated firewater application for a four hour fire in one of the the processing area finished mulch bays is approximately 288kL of which 50% is assumed to evaporate (144kL contaminated firewater, equivalent to 2.9 per cent of the OSD pond ullage capacity).

ACOR has modelled outcomes that are consistent with low consequence and low probability and considers that the development can be managed to provide a risk outcome that is acceptable to persons, property and the environment.

1 Report Assumptions

In preparing this Fire Safety Report, ACOR Consultants (WA) Pty Ltd (ACOR) has made the following assumptions:

- The tip and spread bays will not store materials;
- Waste storage bays will store 904 tonnes of timber (1 x 378m^2 bays);
- Waste storage bays will store 791 tonnes of mixed building waste, of which 10% is combustible (1 x 378m^2 bays);
- Processing area (feed material) will store 206 tonnes of timber (643m^2 comprising stockpile);
- Processing area (finished mulch) will store 221 tonnes of timber (4 x 157m^2 bays);
- Central landscape storage bays will store 894 tonnes of wood mulch (4 x 93m^2 bays);
- 5,000 litres of diesel fuel and 5,600 litres of lube oil stocks will be stored in a 20.5m^2 x 0.3m bunded compound in the southwest corner of the approved SSW;
- The maximum number of three (3) of 18kg liquefied petroleum gas (LPG) cylinders stored in proximity to off-site residential buildings, to reduce the likelihood of on-site and off-site impacts. A location on the northern wall of the plant storage building allows consideration of impacts to the closest residential location;
- During an LPG gas explosion, the detonation of one cylinder will trigger the simultaneous detonation of the other cylinders;
- Conveyor belts are constructed from NBR;
- All fires will be extinguished within 4 hours from emergency services attendance on site;
- Fire hydrant flow of 10 litres per second; and
- 50% of applied firefighting water will evaporate.

2 Scope of Report

This fire safety report has been prepared for the proposed development of a facility at the Kariong Sand and Soil Supplies (KSSS) site at 91 Gindurra Road, Somersby. The site is currently used for storing and screening soil and sand, which is sold for landscaping. The site was originally approved as a Sand and Metal Recycling Facility on 28/02/1992.

In response to the public exhibition of the Environmental Impact Statement for SSD8660 for the proposed development, comments received from the Fire Safety section of the Fire and Rescue (FR) NSW indicated that the following recommendations should be considered:

- Availability of safe, efficient and effective access for emergency vehicles.
- Fire hydrant system installed appropriate to the identified hazards and risks.
- Installation of an automatic fire sprinkler system if a building has a floor area greater than 1000m^2 or contains ≥ 200m^3 of combustible waste material.
- Facility to install a fire detection and alarm system appropriate to the risks and hazards identified for each fire compartment.
- Buildings containing combustible material to install an automatic smoke hazard management system appropriate to the potential fire load and smoke production rate.
- Facility to have effective and automatic means of containing fire water run-off, with primary containment having a net capacity not less than the total (4 hour) hydraulic discharge of the worst-case fire scenario.

As a result of the FRNSW recommendations, KSSS commissioned this Fire Safety report to investigate the appropriate additional infrastructure required to achieve an acceptable level of risk based on the requirements of the Hazardous Industry Planning Advisory Paper (HIPAP) 2 – Fire Safety Study Guidelines.

This report summarises the findings and recommendations resulting from the hazard identification conducted according to HIPAP No. 2, details of the proposed fire safety system showing adequacy to cope with the hazards identified and arrangements for containing contaminated firefighting water.

3 Description of the Facility

The Kariong Sand and Soil Supplies development will involve the construction and operation of a best practice recycling and landscape supplies facility that will enable the receipt of up to 200,000 tonnes of sand, soil and building materials each year. The project will transform the site into a state-of-the-art facility turning sand, soil and building materials into 100% recycled building and landscaping supplies. The facility aims to produce a number of building and landscape products, providing them for re-use mainly in the Central Coast region.

The proposed development will seek to expand the current facility into a best-practice recycling plant that will assist the Central Coast in achieving the NSW Government's target of an 80% recycling rate for construction and demolition waste by 2021.

The project will involve the development of a largely undeveloped industrial site (refer to Figure 1), to enable the facility to be used to receive, process and recycle construction and demolition waste, as well as supply building and landscape supplies for local projects. All waste materials will be received and processed indoors, to minimise impacts on the environment and neighbours.

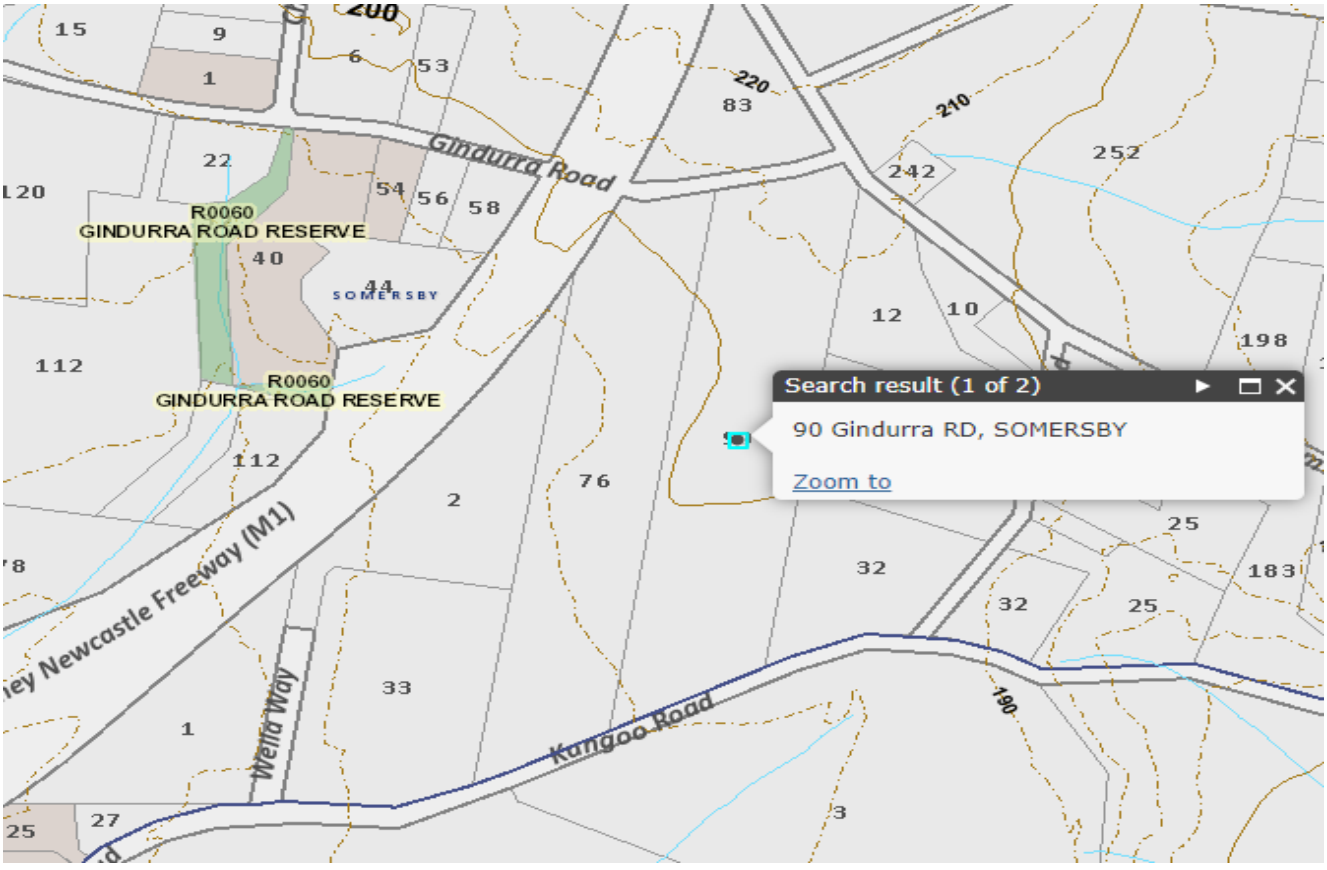


Figure 1 Aerial view of the entire subject site at 91 Gindurra Rd, Somersby. Lot boundaries are shown.

[Source: Central Coast Council]

The front part that will be visible from Gindurra Rd will be the landscaping supply operations, including landscaping along the road frontage and landscape storage bays behind the set-back area. A fully enclosed warehouse where sorting and recycling operations will be conducted will be visible from the front of the site. Along the eastern boundary, a noise barrier and a native landscape buffer will be planted to avoid noise impacts on nearly rural dwellings, and to provide an aesthetically pleasing interface between the edge of the Somersby Industrial Estate and nearby rural zone lots and dwellings.

Waste processing and recycling operations for selected materials, including crushing and mulching will be done on the southern section of the site, where processing will also be done in dedicated buildings to avoid any impacts on nearby land uses. These operations are to be conducted at maximum distance from any sensitive receptors. The southern section of the site will be retained as bushland to provide a natural buffer between the development and other residential areas more than a kilometre away from the southern boundary of the site.

Advanced water capture, rainwater harvesting, water treatment and dust suppression systems will be integrated in all buildings and outdoor areas to prevent dust being formed. The site will also include an advanced membrane filtration plant to enable much of the water captured from the site to be fully reused across the site for operational uses. The site will also include its own weather monitoring station, high volume air samplers for continuous air quality and dust analysis, and continuous noise loggers to confirm compliance with consent and licence conditions. The site will be fully serviced with fire suppression systems.

3.1.1 Site layout diagram

Figure 2 illustrates the proposed design of the recycling facility and the location of the proposed new processing building. The delivery truck onsite movements are indicated by the new road outlines with several loops to aid truck movements and avoid reversing manoeuvres.

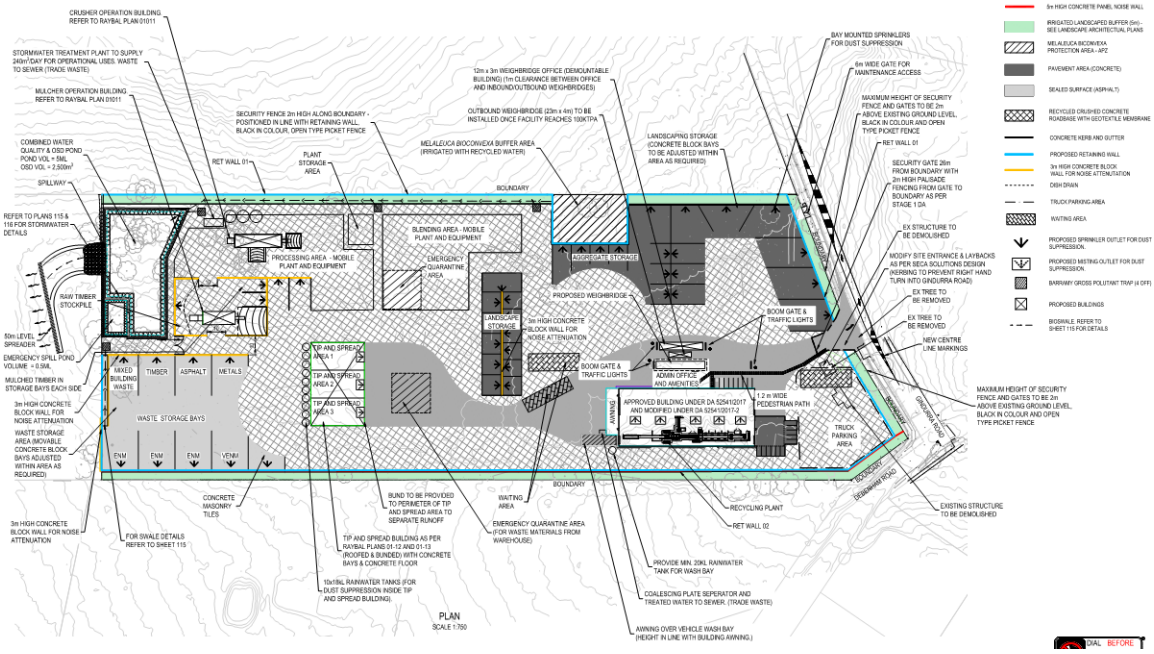


Figure 2 General Layout of the Site

For a more detailed and clearer image of the site refer to Appendix E of EIS.

Flow charts providing an operational overview of the proposed development is provided in Figure 3 (recycling operations) and Figure 4 (landscaping and building supplies operation).

The proposed construction activities are as shown in Table 1.

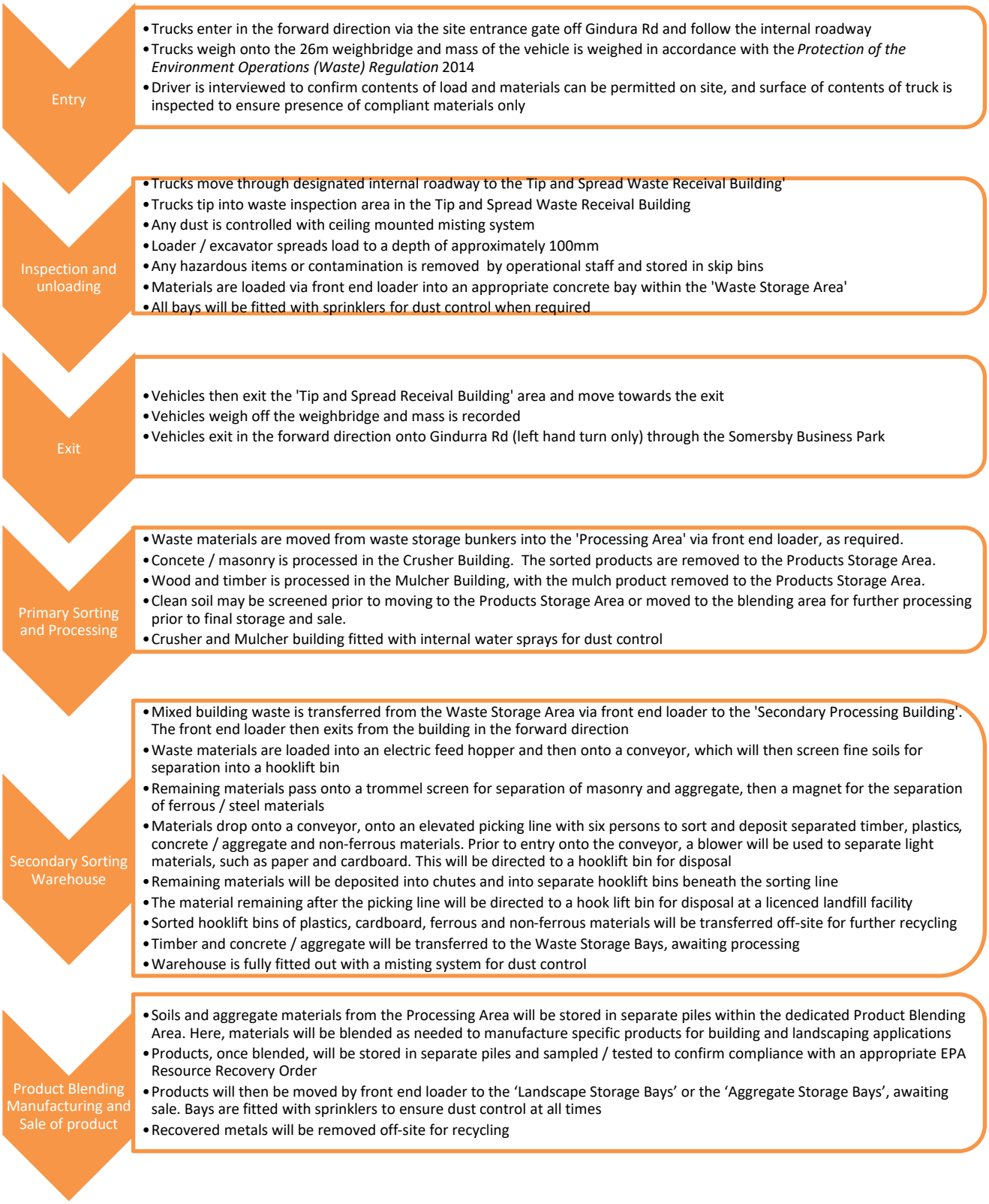


Figure 3 Process flow chart for recycling operations.

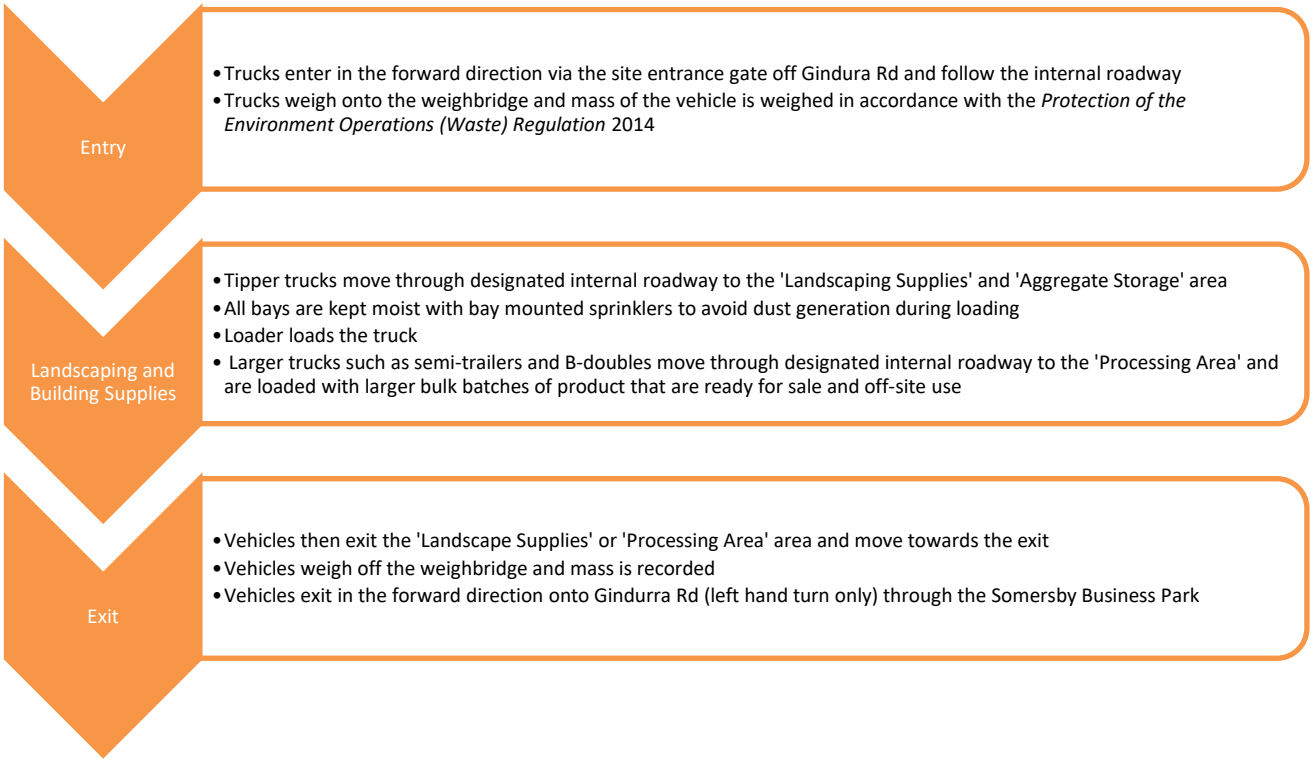


Figure 4 Process flow chart for landscaping and building supplies part of the operation.

Table 1 Summary of construction activities under Stage 1 and 2 on the site.

Stage		Description	Consent status
1	i.	Demolish existing corrugated iron sheds	Approved under DA52541/2017 and modified under DA52541/2017.2
	ii.	Construct office building and warehouse	
	iii	Construct car park next to buildings and new entrance	
	iv.	Install fence at front of site	
2	a.	Clear selected vegetation from the front half of the site as determined by the Fauna and Flora and Vegetation Management Plan	Approval sought under State Significant Development application SSD8660
	b.	Construct sediment control basin to capture run-off during construction	
	c.	Grading of site. Construct retaining walls. Install water, power and recycled water services across the site. Install hardstand across the operational areas of the site	
	d.	Install noise wall along eastern side of the site	
	e.	Construct onsite roads, new entrance and modifications to Gindurra Rd (turning lane).	

Stage		Description	Consent status
	f.	Construct stormwater drainage system, including pond, floating wetland, level rock spreader, bioswales, gross pollutant traps and a packaged recycled water plant	
	g.	Construct crusher building	
	h.	Construct mulcher building	
	i.	Construct tip and spread waste receival building, rainwater harvesting tanks and misting system	
	j.	Install dust and fire suppression systems across the site, including the SSW	
	l.	Construct waste storage bays, aggregate and landscape supply concrete bays, including bay mounted sprinkler system	
	m.	Install processing equipment in crusher building, mulcher building and SSW	
	n.	Install weighbridges, traffic control lights and boom gates on site	
	0.	Install environmental monitoring equipment (weather station, high volume air samplers, dust gauges, sound meters)	
	p.	Complete landscaping works	
	q.	Commissioning and testing of site plant, equipment and environmental control systems	
	r.	Commence formal operations for receival and recycling of waste materials up to 100,000 tonnes per annum	
	s.	Waste receival to increase to 150,000 tonnes per annum subject to the site demonstrating compliance with consent and EPA licence conditions and satisfactory environmental performance	
	t.	Waste receival to increase to a maximum of 200,000 tonnes per annum subject to the site demonstrating compliance with consent and EPA licence conditions	

3.2 Stormwater Water Containment

A 5,000m^3 on-site detention (OSD) pond will be constructed in the southwest corner of the site. This OSD pond will collect stormwater from the site through dish drains collecting from the north and east and grassed swale along the western boundary. Water within the pond will be continually drawn down and treated on site within a packaged treatment plant for operational purposes. The pond is projected to meet at least 60% of operational water requirements (see Water Impact Assessment by Sustainability Workshop, 2019). Whilst the pond will require a minimum volume of 1,000m^3 of stormwater to be

retained to ensure the survival of the floating wetland, approximately 4,000 m^3 of stormwater and firewater storage is supplied within the pond. The pond will require a design to ensure dedicate storage of at least 144m^3 for firewater containment as per firewater calculations in Section 6.3.2.

3.2.1 Emergency Vehicle Access

Figure 2 also shows the swept path analysis for B-double (26 metre) vehicles. The access will provide effective access for a typical fire appliance (15 metre) vehicle. Access paths will be a minimum of 4.5 metres wide with the following minimum turning circle radius:

- 7.5 metre (inner); and
- 14.6 metre (outer).

The distance between inner and outer turning circle radius will be not less than 7.5 metres. Access road will be compacted to allow for the movement of ten tonne axle loads.

Fire hydrants will be located along the access pathways at the locations indicated on drawing PE190247_DG.06_A (Appendix J).

3.2.2 Buildings description

3.2.2.1 Secondary Sorting Warehouse (SSW)

The proposed development will have one approved building under DA 52541/2017 and modified under DA 52541/2017-2. This building will have an administration office and amenities and be attached to the processing plant and equipment. The SSW will have a floor area of 2,100m^2 and will enclose the conveyor and screening equipment for sorting and separating the waste material. The Bushfire Hazard Assessment covers the construction requirements of this building.

3.2.2.2 Waste Storage Bays

The waste storage bays are constructed from concrete blocks. The bays are 21 metres wide x 18 metres deep. Combustible materials will not be stored closer than 2 metres from the front of the bays. Combustible materials will settle at their natural angle of repose (30 degrees) and will be stockpiled to allow the concrete blocks to extend past the top of the stockpile by at least 1 metre. Waste storage bays will be fitted with manually actuated sprinklers.

3.2.2.3 Processing Area

The processing area comprises two distinct stockpiles:

Feed Stockpile

A 643m^2 floor area x 4m high stockpile of mixed waste containing up to 10 per cent by volume of timber (206 tonnes of timber) used for temporary storage of received waste materials.

Finished Stockpile

Four stockpiles, each of 157m^2 floor area x 4m high, retained within concrete blocks containing mulched wood material (221 tonnes wood mulch per stockpile). Each stockpile is accessible on all sides of the outer perimeter.

3.2.2.4 Landscape Storage Bays (Centre)

The landscape storage bays are constructed from concrete blocks. The bays are 10 metres wide x 9 metres deep. Wood mulch will not be stored closer than 2 metres from the front of the bays. Wood mulch will settle at a natural angle of repose (30 degrees) and will be stockpiled to allow the concrete blocks

to extend past the top of the stockpile by at least 1 metre. Landscape storage bays will be protected by fixed fire hydrants.

3.2.2.5 Mulcher operational building

A building will be used to enclose the timber and wood mulching plant within the operational area to minimum noise and dust emissions. This building is located behind the waste storage bays at the southern end of the operational area. Openings will be provided for an input conveyor and output conveyors for mulched product. The 91m^2 building will be served with a dust suppression system. The building will be constructed of reinforced steel and clad in steel sheeting.

3.2.2.6 Crusher operation building

A building will be used to enclose the concrete grinding plant within the south west corner of the operational area to minimum noise and dust emissions. Openings will be provided for an input hopper and conveyor and output conveyors for aggregate product produced by the plant. The 140m^2 building will be served with a dust suppression system. The building will be constructed of reinforced steel and clad in steel sheeting.

3.3 Outline of The Materials and Quantities Which are, or Will Be Stored or Processed on Site

The 200,000 tonnes per annum received comprises the maximum on-site materials shown in Table 2.

3.3.1.1 Waste Materials

Table 2 Maximum Combustible Waste Materials on Site

Location	Distance To boundary		Area	Material
	East (m)	West (m)	m^2	tonnes
Waste storage bay (timber only)	43	82	378	904
Waste storage bay (mixed, 10% timber)	43	82	378	79.1
Processing area (feed material)	70	42	643	206
Processing area (finished mulch)	70	42	4 x 157	4 x 221
Landscape storage (mulch) - central	43	39	4 x 93	894
Secondary Sorting Warehouse (SSW)			2,100	
Timber	11	112	17	2.5
Wood mulch			17	2.5
Paper / cardboard			11	2.3
Plastics			11	1.8

3.3.1.2 Consumables

The site will also store the consumable chemicals shown in Table 3.

Table 3 Consumables

Chemical	Packaging	Total Quantity
Diesel fuel for plant and equipment	1 x 5,000 litre tank	5,000 litres
Hydraulic oils	28 x 200 litre drums	5,600 litres
Conveyor rubber	137 metres x 1.26m x 28mm	5,740 kilograms
LPG (north side SPW)	3 x 18 kilogram cylinders	54 kilograms

3.3.1.3 Third Party Sales

The facility anticipates taking in up to 10,000 tpa (28 tonnes/day) of landscaping materials from third party suppliers for sale from site (landscape storage). If it is assumed that wood mulch contributes 25 per cent of this tonnage, then the increased daily fire load in the landscape storage area will be equivalent to 527GJ.

3.3.2 Operations

At full capacity, the operation will employ 20 people full time

Hours of operation:

- Opening hours (staffed):
  7:00am to 6:00pm Monday to Saturday. Closed Sunday.
- Waste deliveries:
  7:00am to 6:00pm Monday to Saturday. Closed Sunday.
- Waste processing (sorting, crushing, grinding, screening):
  8:00am to 5:00pm Monday to Friday.
- Product sales:
  7:00am to 6:00pm Monday to Saturday. Closed Sunday.
- Public holidays and Sundays are closed

3.4 Surrounding Land Use

The proposed development site is surrounded by a number of property types and land use zonings, as shown in Table 4.

Table 4 Location of adjacent/surrounding residential properties

	Property Address
1	242 Debenham Road South, Sombersby
2	32 Acacia Road, Somersby
3	10 Acacia Road, Somersby
4	252 Debenham Road South, Sombersby
5	198 Debenham Road South, Somersby
6	10 Singleton Point Road, Clare
7	26 Old Mount Penang Road, Kariong
8	95 Mitchell Drive, Kariong

4 Hazards identified

The raw materials (refer to Table 5) and consumables (refer to Table 6) stored at the facility are classified as combustible materials according to NSW Planning – Storage and Handling of Dangerous Goods – Code of Practice 2005. 'Combustible material' is defined as 'any type of combustible material and includes without limitation C2 combustible liquids and empty combustible containers, such as paper bags, fibre board drums and boxes, plastic containers and liners for containers, and wooden boxes and barrels'.

Any material at the site that contains wood, paper, fibre, cardboard, plastic or organic material has been classified as 'Combustible material'. Combustible materials have the potential to ignite, burn, support combustion, or release flammable vapours.

Table 5 Waste Materials

Location	Material	Tonnes	Fire Load (GJ)	Burn time (min)*
Waste storage bay	timber	900	17,000	780
Waste storage bay	10% timber	80	1,500	680
Processing area	Feed	206	3,870	900
Processing area (per bay)	Finished mulch	221	4,110	660
Landscape storage (per bay)	wood mulch	221	4,160	1100
SSW	timber	2.5	50	180
	wood mulch	2.5	50	180
	paper	2.3	40	60
	plastics	1.8	60	210

***assumes no intervention by Fire and Rescue**

Table 6 Consumables

Chemical	Location reference	Packaging/ Storage type	Total Quantity	Fire Load (GJ)
Diesel fuel for plant and equipment	SSW	1 x 5,000 litre tank	5,000 litres	180
Hydraulic oils		28 x 200 litre drums	5,600 litres	220
Conveyor rubber		137 metres x 1.26m x 28mm	5,740 kilograms	290
LPG		3 x 18 kilogram cylinders	54 kilograms	4

A detailed hazard analysis was prepared and is provided at Appendix A. A high-level hazard identification summary is presented in Table 7. The table includes all identified occupational health and safety hazards that may present a risk to the public, employees and contractors working on the proposed development.

Table 7 Summary Hazard Analysis

Item	Hazard	Causes	Consequences
1	LPG storage, outdoors	Cylinders knocked over causing valve damage, gas release	Vapour cloud explosion
		Encroaching fire causes gas venting through PRV	Jet fire
2	Diesel storage, indoors	5,000L tank damaged by mobile equipment	Fire – thermal radiation Toxic fumes Contaminated firewater
3	Hydraulic oil, indoors	Knock-on from encroaching fire	Fire – thermal radiation Toxic fumes Contaminated firewater
4	Conveyor rubber, indoors	Ignition of combustible materials during crushing Bearing seizure (friction) Belt misalignment (friction) Fire transfer between belts Belt failure due to fire Inadequate maintenance	Fire – thermal radiation, conduction Toxic fumes Contaminated firewater
5	Plastics (PVC and LDPE) storage, indoors	Knock-on from encroaching fire Ignition during shredding	Fire – thermal radiation, conduction Toxic fumes Contaminated firewater
6	Paper storage, indoors	Knock-on from encroaching fire Inappropriate management of naked flames	Fire – thermal radiation Contaminated firewater
7	Solid wood storage, indoor bins	Knock-on from encroaching fire Inappropriate management of naked flames	Fire – thermal radiation Contaminated firewater
8	Shredded wood storage, indoor bins		Fire – thermal radiation Contaminated firewater
9	Solid wood storage, outdoors	Knock-on from encroaching fire Inappropriate management of naked flames Fire transfer from mobile equipment (brake fire, hydraulic oil fire). Due to inadequate maintenance	Fire – thermal radiation Contaminated firewater
10	Shredded wood storage, outdoors		Fire – thermal radiation Contaminated firewater

5 Consequences of Incidents

ACOR has undertaken modelling of each of the identified combustible materials under plausible event scenarios. Modelled combustion product dispersion contours (refer to Appendix B), thermal radiation contours (refer to Appendix C), and overpressure contours (refer to Appendix D), have been prepared under relevant climate and weather stability conditions (refer to Appendix I).

The contours indicate that:

- Injurious thermal radiation (30 seconds exposure) originating in the SSW will be blocked (shadowed) to an average distance of 13 metres beyond the site boundary (at ground level) to the east, by the five (5) metre high noise barriers, effectively negating impacts adjacent to the SSW;
- Injurious thermal radiation (after 30 seconds exposure) originating in the processing area will not extend beyond the boundary of the KSSS premises;
- Injurious thermal radiation (after 30 seconds exposure) originating in the central landscape storages will not extend beyond the boundary of the KSSS premises;
- Injurious thermal radiation (after 30 seconds exposure) originating in the waste storage bays will not extend beyond the boundary of the KSSS premises; and
- An LPG vapour cloud explosion, involving the contents of two 18kg LPG cylinders should not cause injury beyond the western and northern boundaries of the site. On the eastern boundary, injurious overpressure with up to a 10 per cent probability of injury will extend approximately 15 metres into the adjoining property adjacent to the SSW.

An LPG vapour cloud explosion, involving the contents of two 18kg LPG cylinders (one LPG cylinder will cause the two other LPG cylinders to explode generating a maximum overpressure from two LPG cylinders) should not cause injury beyond the western and northern boundaries of the site. On the eastern boundary, injurious overpressure with up to a 10 per cent probability of injury will extend approximately 15 metres into the adjoining property

5.1 Smoke Management

The generation of smoke has been modelled for the conveyor system rubber, the largest fire load within the Secondary Sorting Warehouse. Smoke will fill the ceiling void to a depth of four (4) metres above the floor level within two (2) minutes of the fire reaching steady combustion. A single extraction fan, located on the ridgeline, will be capable of exhausting 410 cubic metres of contaminated air per second at the smoke temperature of 484K.

6 Fire Prevention Strategies/Measures

6.1 Prevention and Detection

The first element of fire safety is prevention. Suitable design and layout of the facility and operating procedures and arrangement are important aspects of fire prevention. KSSS plans to prevent fire at the proposed facility by:

- Eliminating ignition sources near dusts and combustible material;
- Prohibit smoking and naked flame to designated smoking areas (no smoking policy for employees and signage for visitors);
- Employee induction and education on fire prevention;
- Regular inspection of stockpiles;

- Sprinkler systems will be installed, in permanent locations, to control dust to the point where potential for fire is minimised;
- Site security (fencing, locked gates when facility is closed, gate houses for visitors);
- Plant maintenance;
- Keeping maintenance and activities that can produce sparks, such as welding, away from combustible material piles;
- Avoiding conditions that can lead to spontaneous combustion (e.g., moisture between 25 – 45 percent and temperatures above about 93ºC in stockpiles);
- Keeping stockpiles low and turning them when the temperature exceeds 60ºC;
- Management of vegetation and debris; and
- Designing the facility for access by firefighting equipment, including clear aisles among stockpiles and access to an adequate water supply.

6.2 Fire Suppression and Control

Fire suppression and control is an essential element of preventing escalation of the risks of combustible material. All fire protection and detection equipment should conform to appropriate Australian Standards.

Equipment, such as couplings, firefighting media, hose reels, hydrants and monitors should be selected and installed in consultation with the Emergency Services to ensure compatibility. Firefighting equipment at the premises should be capable of being used with the equipment used by the local fire brigade, without adaptation or modification (e.g. all fittings and couplings need to be compatible).

Sufficient spacing between stockpiles will be maintained to allow access, in case of emergency, and to help prevent the spread of fire. This spacing should at least be equal to the height of the stockpile or adequate for emergency vehicle access, whichever is the greater.

It is recommended KSSS provide an emergency tipping area, such as the aggregate storage bays, for waste loads identified to be on fire or otherwise deemed to be an immediate risk.

6.2.1 Portable Fire Extinguishers

Portable fire extinguishers should be installed around the facility near operating machinery and entry/ exit points to the site, processing areas and sheds. Fire extinguishers are to be installed and maintained in conformance with appropriate Australian Standards.

At least 1 x 2A 60B(E), dry chemical powder, 4.5kg fire extinguisher to be installed on each piece of mobile equipment.

Fire protection systems and equipment should be inspected, pressure tested, serviced and recharged as necessary at regular intervals to ensure that it is always fully operational.

6.2.2 Location

Fire extinguishers should be wall mounted on a hook or bracket, or an unlocked cabinet, at a suitable height and with signage. Where the extinguisher could be subject to unauthorised interference, the cabinet may be locked providing it has a glass panel that can be broken to remove the extinguisher in the event of a fire.

Firefighting equipment should be located to achieve the following:

- All personnel, storage areas (including sheds and processing zones), equipment and other items being protected can be directly reached by the firefighting medium;

- It is readily accessible and unobstructed in the event of an incident, preferably adjacent to exit doors or on exit routes;
- It is in a conspicuous position (all firefighting equipment should be clearly marked and labelled in conformity with the relevant Australian Standards);
- All mobile plant is fitted with an appropriate type and size fire extinguisher consistent with its operation;
- All vehicles are fitted with an appropriate type and size fire extinguisher consistent with its operation;
- It is protected from damage (e.g. from vehicle collision and deterioration from the weather); and
- All operators/ site fire crew are trained in the use of fire protection equipment.

6.3 Contaminated Firewater

6.3.1 Secondary Sorting Warehouse (SSW)

The 2100m^2 floor area SSW may plausibly require four (4) hours of applied firefighting water from two (2) fire hydrants to quench an established fire, with a combined flow of 20 litres per second (288m^3 over 4 hours). Using the assumption that 50% of the applied water will evaporate, the volume of contaminated firefighting water required to be captured within the bunded area is 144m^3. This requires a bund wall height of 70mm.

Each of the access doorways (personnel access and roller doors) will have a 70mm high rolled concrete bund wall installed to prevent overflow during a worst-case fire event.

Contaminated firewater will be analysed by a NATA accredited laboratory and then either treated on site and disposed under the stormwater disposal procedures or removed from site by 3rd party licensed waste contractors.

6.3.2 Yard Storage

The developed facility will be contoured allowing downgradient overland flow of contaminated firewater to the western perimeter swale drains that then flow into the 5,000m^3 OSD pond.

ACOR has modelled the likely quenching time of a yard fire after the arrival of Fire and Rescue and the consequential water application and runoff. These results are shown in Table

Table 8 Water Application and Contaminated Water Collection (% of OSD Pond)

Fire Source	Applied Quench Water (kL)	Contaminated Water (kL)
Waste Storage Bay (timber)	125	63 (1.3%)
Waste Storage bay (mixed)	75	38 (0.8%)
Processing Area (feed)	140	70 (1.4%)
Processing Area (finished mulch)	288	144 (2.9%)
Landscape Storage (central)	200	100 (2.0%)

Contaminated firefighting water originating from yard areas will be captured similarly to spill management and stormwater. The site will be graded from east to west to ensure that stormwater run-off is directed to the OSD pond. The grading and stormwater drainage design will ensure all surface runoff is contained on site and conveyed to the OSD pond.

Contaminated firewater will be analysed by a NATA accredited laboratory and then either treated on site and disposed under the stormwater disposal procedures or removed from site by 3rd party licensed waste contractors.

6.4 Security

Businesses can protect themselves from fire by:[1]

- Maintaining site security, especially after work hours. Insecure, vacant or easily accessed premises may become a target for the opportunistic arsonist. An arsonist can be motivated by many factors including business rivalry, spite/revenge, vandalism, crime concealment or financial reward.
- Having a safety culture: Simple precautions can prevent many accidental fires. Accidents and neglect, poor housekeeping, discarded cigarettes, hot work equipment, chemicals or unsafe work practices can all have tragic consequences.
- Preparing and practicing an emergency evacuation plan: KSSS is near bushland. A bushfire hazard assessment has been completed and the recommendations will be implemented.

7 Detection and Protection

Ensure that maximum quantities of stockpile stored in a given area, based on the specifications of the features (separation walls) of the area, are such that:

- For bays storing combustible materials, the maximum height of the stockpile is maintained at one meter below the height of the walls surrounding the stockpile; and
- For bays storing combustible materials, the length of the stockpile such that the walls surrounding the stockpiles extends two meters beyond the outermost edge of the stockpile.

Ensure that all ignition sources are kept away from the stockpiles:

- Implement the movement of stockpiles as a part of the operational plan to allow flow of air it to maintain low temperatures of the stockpile;
- Ensure that all the equipment being used in this area are regularly inspected and maintained according to the OEM recommendations;
- Ensure that any hot works being carried out has work permits to do so and conduct all of the hot works as far as possible from the combustible materials;
- Train all the staff members, contractors and visitors about the designated smoking area and all the non-smoking areas; and
- Install control equipment that monitors the safety critical parameters of the stockpile such as the core temperature of the stockpile, the moisture content and volume/mass of the stockpile.

Ensure that all the staff, contractors, visitors are well trained and informed on the operational, housekeeping and safety procedures practiced on sites by:

- Implementing robust induction methods;

[1] DFES Safety Information

- Developing documentation for operational and safety procedures that are concise and provides correct instructions to the reader on their respective responsibilities without any ambiguity;
- Develop and implement a robust change management system that allows personnel to identify and implement any changes to the type of materials being stored, quantities, procedures being adapted to carry out tasks;
- Updating relevant documentation capturing any changes such that any discrepancies identified to the content of documentation provided to be communicated in an effective manner;
- Establish an effective communication or reporting system to raise any safety or operational related issues;
- Ensure security system is activated at all times i.e. during the work hours and non-working hours;
- Ensure fire prevention and detection strategies are maintained by; Install, inspect and maintain the right detection systems such as visual flame detectors, infrared detectors, smoke detectors;
- Installation of the alarm system with multiple layers of protection depending on its readings of the parameter;
- Having fire trained staff on site during all working hours and having the right equipment available to stop/prevent escalation of small fires;
- Audit the licenses and skills of the staff, contractors carrying out tasks; and
- Audit the operational, safety procedures, maintenance and inspection documents, any relevant checklists to make sure all changes are being captured.

Based on the location of the potentially combustible materials identified, there are four major fire compartments on the site which will require detection and protection to control and manage any fire hazards on site:

- Waste storage bays – Timber storage concrete bay;
- Landscape storage area – Mulch storage concrete bays;
- Tip and spread area – all the three concrete bays can potentially have combustible material as they are the first point of receival of the recyclables; and
- Recycling plant – the skip bins consisting of the plastics, paper, treated and untreated wood.

Detection of fire in these areas:

- Regular inspections of temperature of the stockpiles in these area with a probe and portable thermal cameras to detect high temperatures. This will be incorporated as a part of the operating procedures;
- Installation of the permanent thermal camera to identify hot spots in the tip and spread area to notice any high temperatures (i.e. > 60 C); and
- Relevant work instructions will be developed to be implemented upon identification and notification of temperature higher than normal (i.e. <60 C).

Protection:

- Based on reading from the ***Fire Safety guideline Fire safety in waste facilities*** According to section 7.5.3, table number 2: Minimum fire hydrants for non-sprinkled building and external storage;
- HIPAP 2 that determines that at 12.6 kJ/m^2 of heat radiation, the presence of any ignition source will start fire;

- The fire contours calculated and marked around the four major fire compartments on site 4.7 kJ/m^2.s – fire hydrant outside of this – HIPAP 4;
- 2 x 30m length of hose and 10 m throw – coverage; and
- The traffic flow as marked on the layout of the site

Based on AS2444, the following protection has been determined:

- Total of 4 hydrants will be installed (refer to Fire Study for location of these hydrants)
- 4 x fire hose reels – each with the length of 36m will be installed (refer to Fire Study for location of these fire hose reels)
- Manual sprinklers will be installed on top of the concrete block walls of the waste storage bays
- For SSW:
  - It will be installed with the automatic sprinkler system as it has a floor area greater than 1000m^2 and contains combustible material
  - If there is no provision of automatic sprinkler system, there will be a minimum of 3 hydrants and should have a dedicated quarantine area not less than four times the floor area of the largest internal stockpile to receive, breakdown and extinguish that stockpile.
  - **Largest internal stockpile area = 18m^2, therefore quarantine area = 72 m^2**
  - Installation of fire alarm system will warn all the occupants to evacuate the facility
  - Infrared detectors and visual alarms around noisy machinery will be installed
  - Manual alarm points will be provided in clearly visible locations at all the exits
  - The plant will be installed with an automatic smoke alarm hazard management system
  - Provision of vent or exhaust smoke so that in at least 90% of the compartment the smoke layer does not descend below 4m above the floor level
  - Any exhaust system will be capable of continuous operation of not less than two hours in a sprinkler fitted building or four hours in a non-sprinkler fitted building
- 2A 60B(E) 9 kg powder fire extinguishers will be installed on all the vehicles working in the vicinity of these four fire compartments
- 5 x 2A 60B(E) 9 kg powder fire extinguishers inside the recycling plant will be installed

Table 9 Fire Protection Summary for SSW

Phase 1	Phase 2
▪ Fire Hose Reel System has been designed to BCA Clause E1.4 & AS2441 – 2005 including; – A 150mm combined fire/domestic water connection to the authority main – A 65mm dedicated site water main with a 40mm building supply – Fire hose reels located within 4m of the exit doors in the Warehouse issuing a 4m spray from a 36m hose length to all areas – Fire hose reel located within 4m of the exit doors at the Office issuing a 4m spray from a 36m hose length to all areas – A pressure statement has been obtained from the Authorities. Pressure and flow has been achieved with a minimum of 220kPa at the connection to each fire hose reel. ▪ Onsite Fire Hydrant System has been designed to BCA Clause E1.3 & AS 2419.1 – 2005 including; – A 150mm combined fire/domestic water connection to the authority main – A 150mm fire hydrant booster valve assembly complete with appropriate backflow device – A 150mm dedicated site fire main with 100mm connections to individual on-site fire hydrants – 3 x External (attack) fire hydrants located 10m away from the Warehouse issuing a 10m spray from a 60m hose length to all areas of the Warehouse and Office building – A pressure statement has been obtained from the Authorities. Pressure and flow has been achieved with a minimum of 250kPa at the connection to each fire hydrant.	▪ It will be installed with the automatic sprinkler system as it has a floor area greater than 1000m^2 and contains combustible material ▪ If there is no provision of automatic sprinkler system, there will be a minimum of 3 hydrants and should have a dedicated quarantine area not less than four times the floor area of the largest internal stockpile to receive, breakdown and extinguish that stockpile. ▪ Installation of fire alarm system will warn all the occupants to evacuate the facility ▪ Infrared detectors and visual alarms around noisy machinery will be installed ▪ Manual alarm points will be provided in clearly visible locations at all the exits ▪ The plant will be installed with an automatic smoke alarm hazard management system ▪ Provision of vent or exhaust smoke so that in at least 90% of the compartment the smoke layer does not descend below 4m above the floor level ▪ Any exhaust system will be capable of continuous operation of not less than two hours in a sprinkler fitted building or four hours in a non-sprinkler fitted building

8 Water Supply and Demand

Additional fire protection will be required on site, as indicated in Appendix K -drawing PE190247_DG.06_A.

The additional 2 x dual fire hydrants will require a residual pressure of 150kPa at the most hydraulically disadvantaged hydrant, while all required hydrants are in use (min. flow of 10 litres per second per hydrants).

ACOR propose that the southern hydrant identified in the Raybal Constructions hydraulic services drawing is moved further south to the location marked to avoid conflict with thermal radiation contours.

9 First Aid Fire Protection

First aid firefighting allows control of a fire events in its initial stages by using whatever means is readily available.

This could be as simple as shovelling dirt onto a small fire or using a blanket to smother a flame by reducing oxygen. A pile of burning wood can be pulled apart to diminish the intensity of the flame and the heat.

Employees are not expected to fight fires unless they have been trained to do so, and the circumstances are manageable. Small fires can often be put out quickly by a well-trained individual with a portable fire extinguisher. However, to do this safely, you must understand the use and limitation of a portable fire extinguisher and the hazards associated with fighting fires.

Do not attempt to extinguish any fire without calling for help. To extinguish a fire with a portable extinguisher, a person must have immediate access to the extinguisher, know how to actuate the unit, and know how to apply the agent effectively.

Attempting to extinguish even a small fire carries some risk. Fires can increase in size and intensity in seconds, blocking the exit path and creating a hazardous atmosphere. In addition, portable fire extinguishers contain a limited amount of extinguishing agent and can be discharged in a matter of seconds.

10 Recommendations

It is recommended that KSSS:

- provide an emergency tipping area, such as the Secondary Sorting Warehouse (remove all plant and equipment) for waste loads identified to be on fire or otherwise deemed to be an immediate risk. The aggregate storage area adjacent to the weighbridge likely poses the least risk of escalation;
- use portable infrared detectors to check mulch stockpiles for thermal hotspots;
- Install fixed infrared cameras with audible alarm at tip and spread shed;
- Install fixed infrared cameras with audible alarm at recycling plant to view skip bins, concrete bays and conveyor belts;
- Install 3 x additional dual fire hydrants at locations as indicated in Appendix K -drawing PE190247_DG.06_A;
- Install 2 x additional fire hose reels at locations as indicated in Appendix K -drawing PE190247_DG.06_A;
- Install manually actuated sprinkler water spray system on top of Waste storage bays (holding wood) for use in controlling minor fire events; and
- Install fire sprinklers in accordance with concept design in Appendix K.

11 References

https://www.dfes.wa.gov.au/safetyinformation/fire/businessandindustry/Pages/default.aspx

https://www.dfes.wa.gov.au/safetyinformation/fire/arson/ArsonPublications/DFES-Arson-is-YourBusinessatRisk.pdf

Moghtaderi, B and Fletcher, D.F (1988): *Flaming Combustion Characteristics of Wood-Based Materials*, International Association of Fire Safety Science, p.209 – 219.

US Department of Transportation (1998): *Heats of Combustion of High-Temperature Polymers*

Zevenhoven, R et al (2011): *Combustion and Gasification Properties of Plastics Particles*, Journal of the Air & Waste Management Association, Vol 47, p.860 – 870

Perez, S et al (2006): *Comparison of Energy Potential of the Eucalyptus Globulus and the Eucalyptus Nitens*, Journal of Renewable energies and Power Quality, Vol 1(4), p.196 – 200

Karlos, V et al (2016): Analysis of the blast wave decay coefficient using the Kingery-Bulmash data, International Journal of protective Structures, Vol 7(3), p.409 – 429

National Fenestration Rating Council Incorporated (2014): *Appendix A Basic Set of Generic Thermophysical Property Values of Materials*, p.19 – 31

Satterfield, Z (2010): *Fundamentals of Hydraulics: Flow*, National Environmental Services Centre, Vol 10(1)

Lee's Loss Prevention in the Process Industries (2012): *Appendix 14 Failure and Event Data*, p. 2757 – 2795

NSW Fire & Rescue, Version 02.02 (2020): *Fire Safety Guideline – Fire safety in waste facilities*

Appendix A - Hazard Analysis

Area	Hazard scenario	Potential consequences	Prevention/Detection
Combustible wastes i.e. paper (ordinary fire risk), wood (ordinary fire risk) in the: • waste storage area • landscape storage area • Tip and Spread areas 1, 2 and 3	Irregular inspection of moving and stationary vehicles in the vicinity of these areas resulting in fire	• Overheated brakes (ignition source) resulting in fire • Hydraulic oil leakage adding to the fire risk of combustible material potentially resulting in fire	Prevention: • Regular maintenance of vehicles • Setting up guidelines and standards for the condition of the vehicles that can enter the site Detection: • Regular inspection of the vehicles being used • Regular auditing of the contractor methodologies to check compliance with company policies and procedures • Training staff in spill clean up • Monitoring core temperature of stockpiles Mitigation: • Vehicles to have appropriate hear shrouds and spark arrestors fitted and be kept, maintained and refuelled in designated areas away from combustible materials • Provision of firefighting equipment on the vehicle • Hot work procedures
	Encroaching fires from sites around the area (Borg manufacturing, Ausgrid, Gosford Quarries) and bush land	Burning embers from the surrounding fire become a source of ignition	Prevention: • Maintain low temperature of the stockpiles through different procedures such as moving the stockpile as required to allow flow of air, wetting the stockpiles. Implement this as a part of the operational procedures • monitor them continually at required regular intervals with the aid of proper controls

Area	Hazard scenario	Potential consequences	Prevention/Detection
			Detection: • Neighbourhood watch system Mitigation: • Development of an emergency plan and an ESIP (emergency service information package)
	• Unauthorised personnel entering prohibited areas tampering with equipment • Performing activities that are prohibited such as smoking in non-smoking areas, • Intentionally causing fire (arson)	• Unforeseen/unexpected faults of equipment that can potentially lead to equipment over heating causing fires • Introduced ignition sources	Prevention: • Installation of correct signage, placards, warning signs around the hazardous areas • Provision of safe walkways for the pedestrians to ensure restricted entry into hazardous areas • Conducting inductions for all the personnel: working staff members, contractors, visitors as required • Verification and upgrade of the licenses required for staff members to work in the prohibited areas • Spreading awareness of the consequences of fire to all personnel present on site – toolbox meetings • Security fence and restricted access to site • Provide a designated area for smoking and training staff to use ONLY that area for smoking Detection: • Installation of cameras monitoring the site during and after work hours (security procedures) Mitigation: • Installation of fire detection equipment and alarm systems

Area	Hazard scenario	Potential consequences	Prevention/Detection
	Hot workaround the area for maintenance or repair works	Sparks from equipment landing on the combustible stockpiles causing fire	Prevention: • Develop hot work procedures for repair works such as: ○ Conducting a risk assessment of the work being conducted ○ Obtain hot work permit based on the results of the assessment ○ Provide all the necessary safety gear/equipment required to perform the hot works ○ If sub-contracting – ensure that the contractor complies to the company procedures and conduct required audits on their procedures Detection: • Audit the procedures being carried out by the staff members carrying out the hot works and ensure it complies with the company policies and procedures Mitigation: • Carrying out hot work away from combustible materials • Carrying out hot works with the proper safety equipment such as flame proof screens to avoid any embers escaping the area
	Extreme weather conditions – hot atmospheric temperature, lighting	If there is no proper circulation of air during hot atmospheric temperatures the core temperature of the stockpile increases in hot weather resulting in combustion. Lightning strike resulting in fire	Prevention: • Maintain low temperature of the stockpiles through different procedures such as moving the stockpile as required to allow flow of air, wetting the stockpiles. • Lightning protection Detection: • Implement emergency response plan during non-working hours to avoid escalation of the fire

Area	Hazard scenario	Potential consequences	Prevention/Detection
			• Develop procedures for hot atmospheric conditions • Set up alarms system, detection system in appropriate areas as required. Mitigate: • Maintain stockpiles at volumes complying to the recommendations in *Fire safety guideline Fire safety in waste facilities* • Provision of firefighting equipment
	Spontaneous combustion resulting from not moving the pile for a long duration of time	The presence of heat energy due to high temperature along with production of volatile vapours released as by-product of the microbial activities in the dark and humid conditions at the core of the stockpile promotes spontaneous combustion	Prevention: • implement appropriate control measures to monitor the critical parameters that cause spontaneous combustion- temperature controls, moisture content, quantity (volume/mass) of each pile • Implement operational procedures for regular inspections of the stockpile safety critical parameters • Implement procedures that allows circulation of air through the core of the stockpile to maintain low temperatures Detection: • Installation of cameras, visual flame detectors, heat detectors probes and other appropriate detectors and alarms • Train staff on being responsive to any changes to any of the critical parameters of the combustible heaps and establish a reporting system to address the discrepancies Mitigate:

Area	Hazard scenario	Potential consequences	Prevention/Detection
			• Maintain stockpiles at volumes complying to the recommendations in *Fire safety guideline Fire safety in waste facilities*
	Faulty appliances/ electrical faults	Short circuits/ electrical failure causing sparks resulting in fire	Prevention: • implement robust quality checks on electrical items or appliances being used on site – usage of intrinsically safe electricals • Use skilled labour for any repair procedures to be conducted and audit their procedures ensuring the personnel are adhering to company policy Detection: • Monitor the electricals closely in case of a trip or any other electrical incidents Mitigation: • Use of flame proof wiring
	Inadequate training of staff on operational procedures and safety procedures leading to: • mishandling and/or improper maintenance of the equipment being used in that area • Lack of or inadequate quality	Unforeseen/unexpected faults of the equipment that can potentially lead to overheating of equipment resulting in fire	Prevention: • Implement thorough training on operational and safety procedures to all personnel on site: working staff members, visitors, contractors • Follow the OEM recommended inspection and maintenance procedure to ensure efficient functioning of the equipment • Develop quality assurance procedures Detection: • Have a reporting system for the regular update on the condition of the equipment being used

Area	Hazard scenario	Potential consequences	Prevention/Detection
	checks on new equipment being used in that area		• Train staff to follow the quality assurance procedures accurately, provide relevant documentation which is concise and lack ambiguity to perform quality checks • implement a reporting system to handle any equipment quality issues Mitigation: • Installation of the fire detection equipment and alarm systems
	Improper/inadequate/ lack of control equipment monitoring the critical parameters of the waste storage dumps such as volume/mass of wastes, moisture content, temperature at the core of the pile	This can result in severe uncontrollable fire incidents which can escalate causing secondary fires as the fire was not mitigated at the source when it was minor.	Prevention: • Installation of the correct control equipment monitoring the safety critical parameters of the stockpiles • Training staff to monitor these conditions and perform visual inspections of the stockpiles if and when required • Include maintenance of control equipment (as recommended by OME) as a part of the operational plan Detection: • Have a subject matter expertise supervising the operation and the conditions detected by control system • Establish a reporting system for these operations and data from control equipment to be verified on day-today basis Mitigation: • Installation of the fire detection equipment and alarm systems • Maintain stockpiles at volumes complying to the recommendations in *Fire safety guideline Fire safety in waste facilities*

Area	Hazard scenario	Potential consequences	Prevention/Detection
Ignition in the processing area – mobile plant and equipment	• Improper maintenance of the equipment due to under skilled and or under trained staff • Errors in operational procedures or maintenance manuals	Unforeseen/unexpected faults of the equipment that can potentially lead to overheating resulting in fire	Prevention: • Implement thorough training on operational and safety procedures to all personnel on site: working staff members, visitors, contractors • Follow the OEM recommended inspection and maintenance procedure to ensure efficient functioning of the equipment Detection: • Implement an audit system to ensure all staff members required to perform skilled tasks have all the necessary training and licensing required to carry on with a task, if not upgrade and train staff accordingly • Audit operational procedures and maintenance manual on regular basis and ensure that any changes within the facility has been captured and updated in all relevant documents Mitigation: • Installation of the fire detection equipment and alarm systems
	Electrical faults	Short circuit of electrical equipment resulting in sparks causing fire	Prevention: • implement robust quality checks on electrical items or appliances being used on site – usage of intrinsically safe electrical equipment • Use skilled labour for any repair procedures to be conducted and audit their procedures ensuring the personnel are adhering to company policy Detection:

Area	Hazard scenario	Potential consequences	Prevention/Detection
			• Monitor the electricals closely in case of a trip or any other electrical incidents different from usual Mitigation: • Use of flame proof wiring
Secondary Sorting Warehouse fire	Storage of incompatible chemicals next to each other	inleak/ spill can result in exothermic/ violent reactions releasing toxic vapours, possibly resulting in fire	Prevention: • Proper segregation of items from each other • Provide relevant training to staff which reflects the safe storage and handling of these chemicals ensuring content of the training is concise and lacks ambiguity Detection: • Alarm/smoke management system installed • Train staff to be able to notice any discrepancies in the area and establish appropriate reporting system to respond to any issue raised accordingly Mitigation: • Provision of firefighting equipment in the area accessible to the firefighting crew
	Improper housekeeping procedures	• Leaks from storage containers resulting in release of toxic chemical into the storage environment – contamination, toxic vapours	Prevention: • Implementation of robust housekeeping and safety procedures and training staff, update staff if any changes occur and bring awareness of the hazards • Provide relevant documentation to the staff which reflects the safe storage and handling of these chemicals ensuring content of the document is concise and lacks ambiguity

Area	Hazard scenario	Potential consequences	Prevention/Detection
		• unnoticed damages to the items in the storage area which can have consequences if damage is not identified and rectified before usage • exposure of chemicals to sunlight (when they are not supposed to be exposed) or stored at incorrect temperatures causing fires and release of toxic gases • wrong/damaged signage/labelling leading to contamination of the products, misuse of the products	Detection: • Train staff to be able to notice any discrepancies in the area and establish appropriate reporting system to respond to any issue raised accordingly Mitigation: • Provision of firefighting equipment in the area accessible to the firefighting crew • Provision of spill kits to contain the spillage of the chemicals • Provision of manual alarms in accessible areas for activation in the event of early fire detection
	Storage of any new items without carrying out a risk assessment on quantity limits and compatibilities	This can result in exothermic/violent reactions releasing toxic vapours exothermic reactions and explosions	Prevention: • Proper segregation of items from each other • Implementation of change management procedures Detection: • Train staff to be able to notice any discrepancies in the area and establish appropriate reporting system to respond to any issue raised accordingly

Area	Hazard scenario	Potential consequences	Prevention/Detection
			• Provide documentation ensuring content is concise and lacks ambiguity to report any new items identified other than the usual inventory list • Audit the staff procedures on regular basis ensuring compliance of staff to company policies and procedures Mitigation: • Provision of firefighting equipment in the area accessible to the firefighting crew • Provision of manual alarms in accessible areas in case of early detection fire
• Blending area – mobile plant and equipment • Recycling plant • Wash bay	• Under trained/under skilled staff not following operational procedures as required	Unforeseen/unexpected faults of the equipment that can potentially lead to overheating causing fires	Prevention: • Implement thorough training on operational and safety procedures to all personnel on site: working staff members, visitors, contractors • Follow the OEM recommended inspection and maintenance procedure to ensure efficient functioning of the equipment Detection: • Implement an audit system to ensure all staff members required to perform skilled tasks have all the necessary training and licensing required to carry on with a task, if not upgrade and train staff accordingly Mitigation: • Installation of the fire detection equipment and alarm systems • Provision of manual alarms • Provision of firefighting equipment

Area	Hazard scenario	Potential consequences	Prevention/Detection
	• Inadequate/incorrect control measures monitoring the processes	This can result in severe uncontrollable/challenging fire incidents which escalates causing secondary explosions/fires as the fire was not mitigated at the source when it is minor through proper detection system	Prevention: • Installation of the correct control equipment monitoring the safety critical parameters of the stockpiles • Training staff to monitor these conditions and visual inspections of the stockpiles if and when required • Include maintenance of control equipment (as recommended by OME) as a part of the operational plan Detection: • Have a subject matter expertise supervising the operation and the conditions/data detected by control system • Establish a reporting system for these operations and data from control to be verified on day-today basis Mitigation: • Installation of the fire detection equipment and alarm systems • Maintain stockpiles at volumes complying to the recommendations in *Fire safety guideline Fire safety in waste facilities*
	Changes to the scope of work – change in procedures, introduction of new technology/equipment, change in the quantities being processed	Unforeseen/unexpected faults of the equipment that can lead to overheating causing fires	Prevention/Detection: • Implementation of change management procedures Mitigation: • Installation of the fire detection equipment and alarm systems • Maintain stockpiles at volumes complying to the recommendations in *Fire safety guideline Fire safety in waste facilities*

Area	Hazard scenario	Potential consequences	Prevention/Detection
			• Provision of firefighting equipment
	Improper housekeeping	• Dust accumulation, blockages in the equipment causing improper functioning of the equipment which can result in high temperatures causing sparks of fire • Irregular lubrication of equipment such as the conveyor belt in the recycling plant can lead to friction at the joints resulting in ceasing of the equipment or increasing the temperatures • Use of incorrect chemicals for cleaning purposes releasing toxic vapours, exothermic reactions or reacting with the incompatible material for which it has been used for resulting in violent reactions causing fire/explosions	Prevention: • Implementation of robust housekeeping and safety procedures and training staff vigorously, update staff if any changes occur and bring awareness of the hazards Detection: • Train staff to be able to notice any discrepancies in the area and establish appropriate reporting system to respond to any issue raised accordingly • Provide documentation ensuring content is concise and lacks ambiguity to report any deviations identified from the usual operation • Audit the staff procedures on regular basis ensuring the company procedures are being followed Mitigation: • Provision of firefighting equipment in the area accessible to the firefighting crew • Provision of manual alarms in accessible areas in case of early detection fire

Area	Hazard scenario	Potential consequences	Prevention/Detection
	Mishandling of the equipment Not carrying out the required inspections at regular intervals as recommended by the OEM	Can lead to failures or malfunctioning of the equipment which can result in fire	Prevention: • Implement thorough training on operational and safety procedures to all personnel on site: working staff members, visitors, contractors • Follow the OEM recommended inspection and maintenance procedure to ensure efficient functioning of the equipment Detection: • Establish an audit process to check all staff are carrying out tasks as per the operational plan and implement a reporting system to help monitor and close any issue accordingly • Implement procedures and provide concise documentation to carry out inspections of the equipment and establish appropriate reporting system to address any issues raised Mitigation: • Installation of the fire detection equipment and alarm systems
	Improper storage and handling of flammables (3 x 18kg of LPG), , combustibles (diesel 1 x 5,000L and hydraulic oil 28 x 200L) in the SSW	• Leaks from storage containers resulting in release of flammable vapours into the storage environment • unnoticed damage to the items in the storage area which can have consequences if damage is not identified and rectified before usage	Prevention: • Implement procedures to ensure hazardous and highly combustible materials are stored in accordance with any relevant statutory requirement, code or standard and away from combustible materials • Provide concise documentation to carry out inspections of the storage containers and establish appropriate reporting system to address any issues raised Detection:

Area	Hazard scenario	Potential consequences	Prevention/Detection
		• wrong/ damaged signage/ labelling leading to misuse of the products	• Train staff to be able to notice any discrepancies in the area or the containers and establish appropriate reporting system to respond to any issue raised accordingly • Audit the staff procedures on regular basis to ensure their compliance to company procedures • Gas testers Mitigation: • Provision of firefighting equipment in the area accessible to the firefighting crew • Provision of proper ventilation to the areas to dilute any flammable vapours • Stopping work if harmful level of gas has been detected until it dilutes to safe levels
Fire in Tip and Spread area 1, 2 and 3 (waste receival area)	Contamination of the recyclables from the source with flammable/combustible material (pick up companies)	Presence of any combustible or flammables with very low flash points (not identified) will lead to fire	Prevention: • Levy stringent fines to the contracted companies that mix wastes other than what has been contractually agreed upon • Educate these companies on the potential consequences of contaminating the wastes with items other than what has been contractually agreed upon Detection: • Train staff on the contents of the recyclables received, processed and stored on site • Implement visual inspection when receiving, processing the recyclables and establish a reporting system that will allow staff to report any discrepancies from noticed

Area	Hazard scenario	Potential consequences	Prevention/Detection
			Mitigation: • Provision of firefighting equipment in the area accessible to the firefighting crew • Provision of manual alarms in accessible areas in case of early detection fire • Maintain stockpiles at volumes complying to the recommendations in *Fire safety guideline Fire safety in waste facilities*
Admin office and amenities	Electrical faults/ faulty appliances	Short circuits causing sparks of fire	Prevention: • implement robust quality checks on electrical items or appliances being used on site – usage of intrinsically safe electricals where required • Use skilled labour for any repair procedures to be conducted and audit their procedures ensuring the personnel are adhering to company policy Detection: • Monitor electricals closely in the event of a trip Mitigation: • Use of RCDs
	Improper housekeeping practices		Prevention: • Implementation of robust housekeeping and safety procedures and training staff vigorously, update staff if any changes occur and bring awareness of the hazards Detection:

Area	Hazard scenario	Potential consequences	Prevention/Detection
			• Train staff to be able to notice any discrepancies in the area and establish appropriate reporting system to respond to any issue raised accordingly • Provide the right concise and simple documentation that will allow the staff members to carry out the job safely without any discrepancies • Audit the staff procedures on regular basis to check compliance to the procedures Mitigation: • Provision of firefighting equipment in the area accessible to the firefighting crew
Fire in Truck parking area	Irregular inspection of moving and stationary vehicles in the vicinity of these areas	• Overheated brakes resulting in fire • Fuel leakage causing flammable vapours that can travel towards the combustible material	Prevention: • Regular maintenance of vehicles • Setting up guidelines and standards for the condition of the vehicles that can enter the site Detection: • Regular inspections of the vehicles being used • Regular auditing of the contractor methodologies to check compliance with company policies and procedures • Gas testers to detect the flammable vapours, training the staff to carry out his test in case of a leak spotted Mitigation: • Vehicles to have appropriate hear shrouds and spark arrestors fitted and be kept, maintained and refuelled in designated areas away from combustible materials

Area	Hazard scenario	Potential consequences	Prevention/Detection
			• Provision of firefighting equipment Instructions to ensure that the gas vapour detected is zero before resuming any work in that vicinity

Appendix B - Combustion Product Dispersion Modelling

Combustion products from the combustion of conveyor rubber, PVC and LDPE plastics and from wood products, natural and products containing urea-formaldehyde resins, were modelled using ALOHA version 5.4.7 for dispersion.

The dispersion modelling results against the immediately dangerous to life or health (IDLH) are shown in Table 8.

Table 10 ALOHA Modelling Outputs

Chemical	IDLH[2] (ppmv)	Dispersion Distance (m)		
		Conveyor Rubber	Plastics	Wood Products
Carbon monoxide (CO)	1,200	< 10	< 10	< 10
Sulphur dioxide (SO_2)	100	23	n/a	n/a
Nitrogen oxides (NO_x)	100	< 10	< 10	< 10
Polyaromatic hydrocarbons (PAH)	500	11	n/a	n/a
Hydrogen chloride (HCl)	50	n/a	189	n/a
Hydrogen cyanide (HCN)	50	n/a	n/a	39
Carbon dioxide (CO_2)	40,000	< 10	< 10	17

[2] US EPA

Appendix C - Thermal Radiation

Thermal flux from the combustion of conveyor rubber, PVC and LDPE plastics and from wood products, natural and products containing urea-formaldehyde resins, were modelled. The thermal flux modelling results against the HIPAP 4 criteria for thermal radiation are shown in Table 9 and Table 10.

The consequences of thermal radiation criteria values are shown in Appendix G

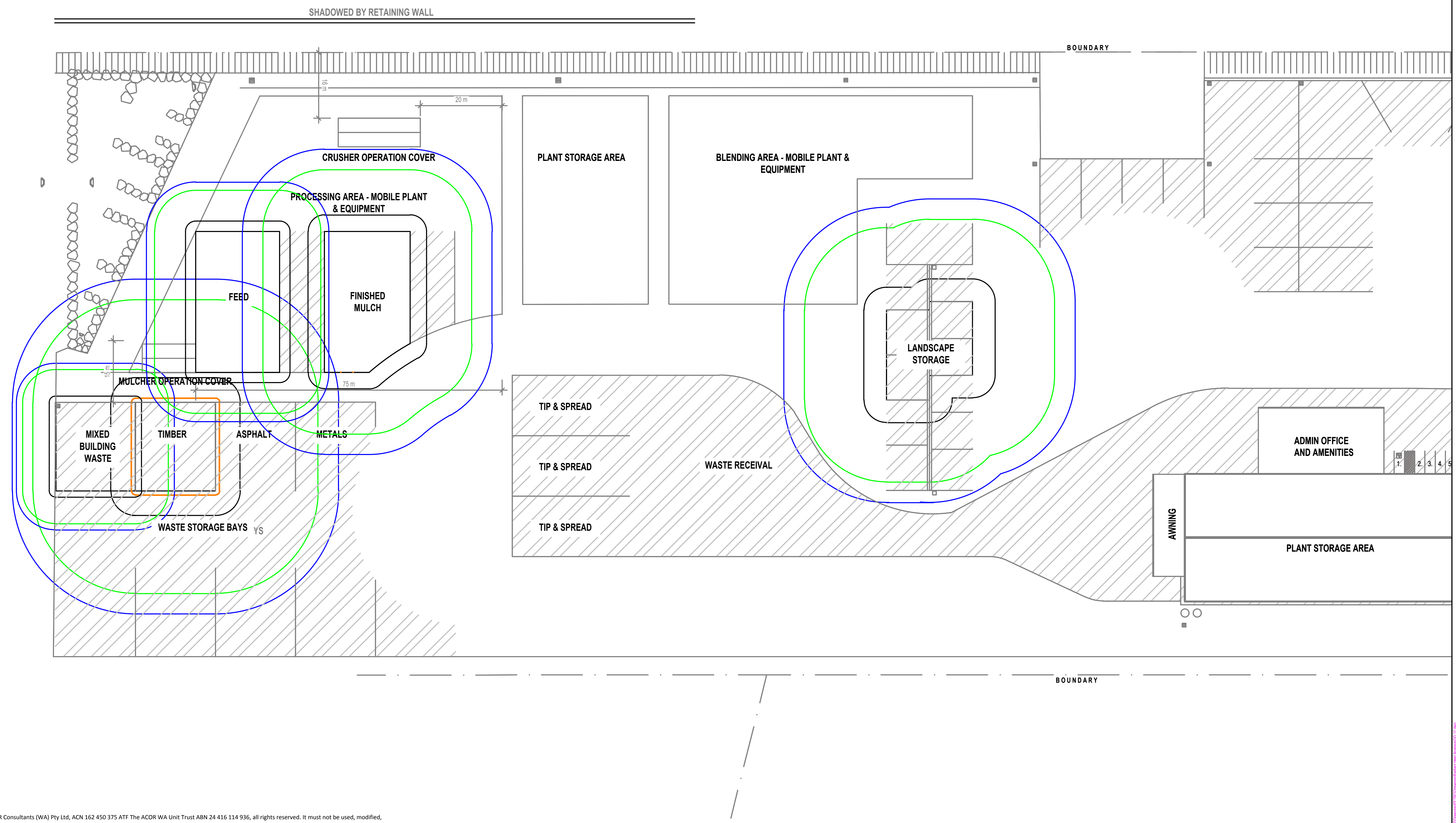
Table 11 Thermal Flux (kW/m^2) vs Distance (m), Yard Areas

Location	23kW/m^2	12.6kW/m^2	4.7kW/m^2
	Distance from Source (m)		
Waste storage bay (timber)	1.0	6.0	25
Waste storage bay (mixed)	-	1.5	8.0
Processing area (feed material)	-	2.5	10
Processing area (finished mulch)	-	4.0	20
Landscape storage (4 x bays), each	-	5.5	20

Table 12 Thermal Flux (kW/m^2) vs Distance (m), SSW

Substance	75kW/m2	35kW/m2	23kW/m2	12.6kW/m2	4.7kW/m2
	Distance from Source (m)				
Wood	-	-	-	1.5	8.0
Diesel	3.0	7.5	7.7	10	20
Lube oil	-	-	-	1.5	7.5
Paper	-	-	-	2.0	5.5
Plastics	5.0	8.0	10	15	25
Rubber	-	-	-	-	1.5
LPG	1.0	2.0	4.5	4.7	10

	RADIANT HEAT SCHEDULE					
	>75 kW/m²	35 kW/m²	23 kW/m²	12.6 kW/m²	4.7 kW/m²	2.1 kW/m²
	PURPLE	RED	ORANGE	BLACK	GREEN	BLUE
WASTE STORAGE BAYS (TIMBER)			1	6	25	30
WASTE STORAGE BAYS (MIXED)				1.5	8	9.5
PROCESSING AREA (FEED)				2.5	10	12
PROCESSING AREA (FINISHED)				4	15	20
LANDSCAPE STORAGE (CENTRAL)				5.5	20	25



3RD ANGLE PROJECTION DO NOT SCALE

This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by:

Issue	Description	Date	Drawn	Approved
B	ISSUE FOR INFORMATION	18.11.19	AC	MW
A	ISSUE FOR INFORMATION	14.11.19	AC	MW

North

Client

ISSUED FOR INFORMATION ONLY

ACOR Consultants (WA) Pty Ltd
Level 1, Unit 9, 19 Essex Street
Fremantle WA 6160
T +61 8 9336 3156
CONSULTANTS
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

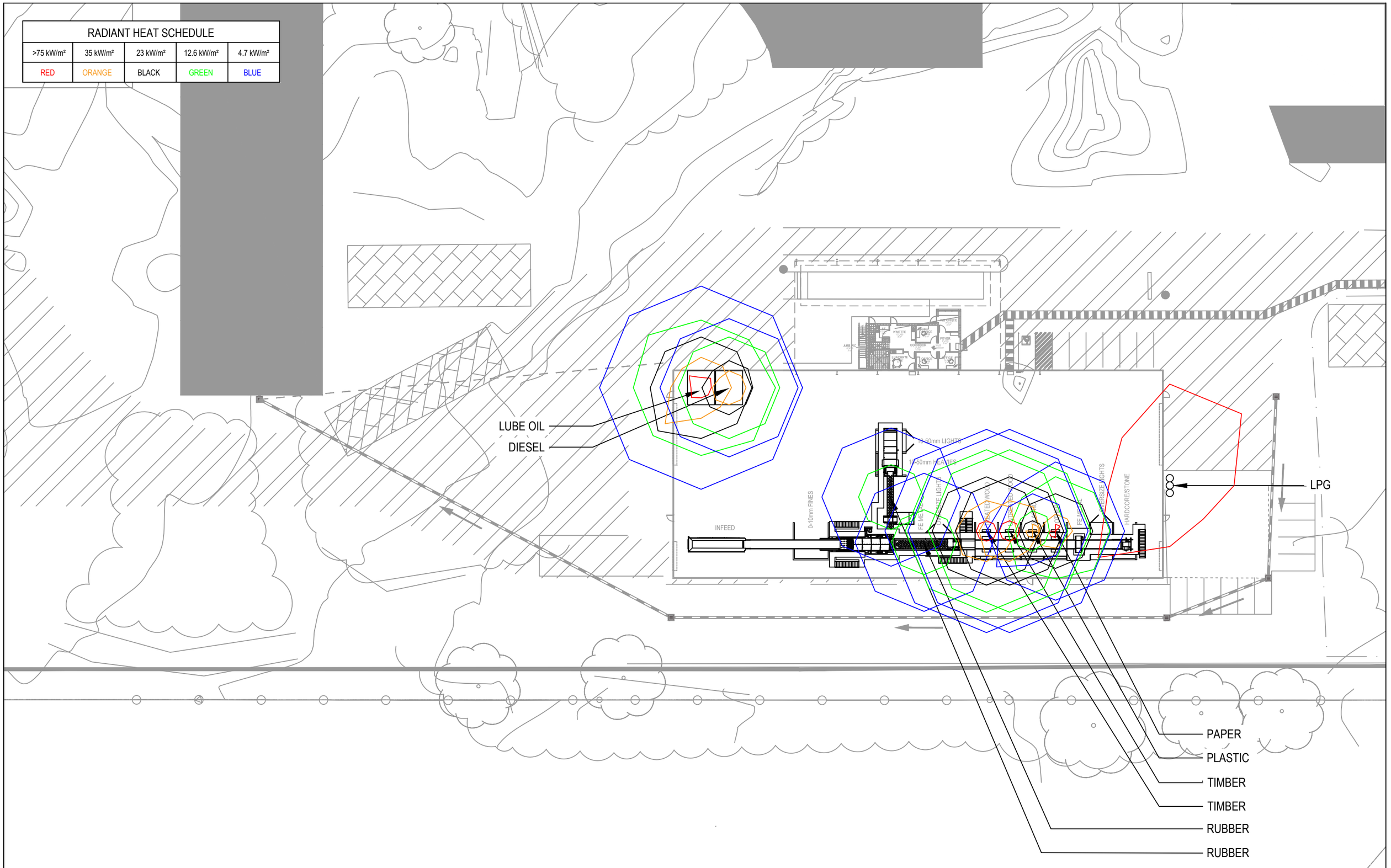
Project
INDUSTRIAL DEVELOPMENT

90 GINDURRA ROAD
SOMERSBY - LOT 4

Drawing Title
PROPOSED INDUSTRIAL DEVELOPMENT
DANGEROUS GOODS
RADIANT HEAT ANALYSIS - CALM WIND CONDITIONS

Drawn	Date	Scale A3	Q.A. Check	Date
AC	SEPT_2019	1:1000	-	
Designed	Project No.		Dwg. No.	Issue
MW	PE190247		DG.12	B

RADIANT HEAT SCHEDULE				
>75 kW/m²	35 kW/m²	23 kW/m²	12.6 kW/m²	4.7 kW/m²
RED	ORANGE	BLACK	GREEN	BLUE



3RD ANGLE PROJECTION
DO NOT SCALE

This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by:

Issue	Description	Date	Drawn	Approved
C	RE-ISSUED FOR INFORMATION ONLY	17.10.19	JMT	MW
B	RE-ISSUED FOR INFORMATION ONLY	25.09.19	JMT	MW
A	ISSUED FOR INFORMATION ONLY	13.09.19	AC	MW

0 5 10cm at full size 25cm 50cm

North

ISSUED FOR INFORMATION ONLY

ACOR Consultants (WA) Pty Ltd
Level 1, Unit 9, 19 Essex Street
Fremantle WA 6160
T +61 8 9336 3156

ACOR CONSULTANTS ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project
INDUSTRIAL DEVELOPMENT

90 GINDURRA ROAD
SOMERSBY - LOT 4

Drawing Title
PROPOSED INDUSTRIAL DEVELOPMENT
DANGEROUS GOODS
RADIANT HEAT ANALYSIS - CALM CONDITIONS

Drawn	Date	Scale	A3	Q.A. Check	Date
AC	SEPT_2019	1:500		-	
Designed	Project No.			Dwg. No.	Issue
MW	PE190247			DG.02	C

Appendix D - Explosion Overpressure

2 x 18kg cylinders of propane were estimated as having a TNT equivalence of 70.2kg. This TNT equivalence generated the peak side-on (P_{so}) overpressures against the criteria in HIPAP 4 as shown in Table 10.

Table 13 Peak Side on Overpressures vs HIPAP 4

P_{so} (kPa)	**Distance from Explosion (m)**
3.5	62
7	36
14	21
21	16
35	12
70	8

The consequences of overpressure criteria values are shown in Appendix

Appendix E - Explosion Overpressure

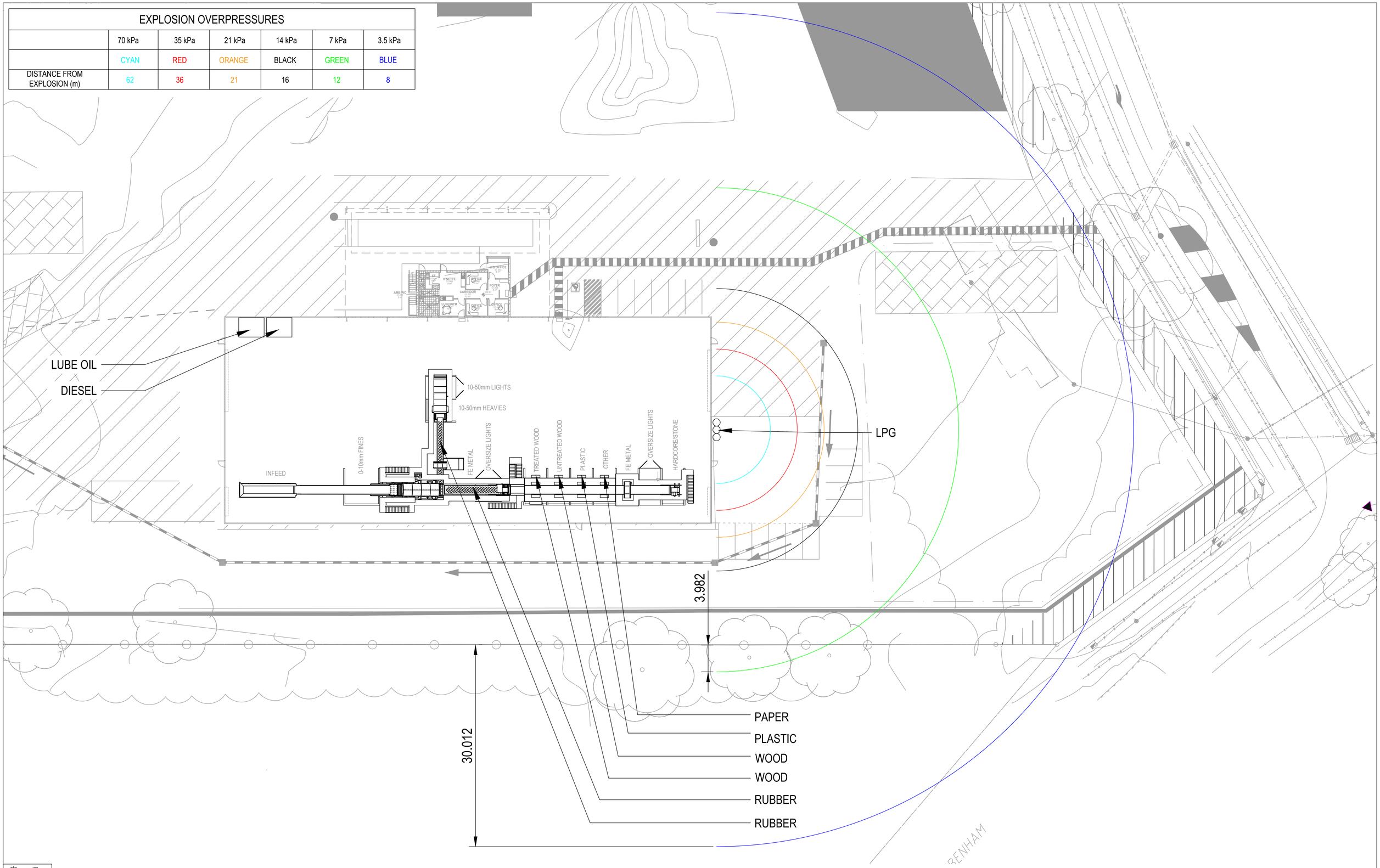
2 x 18kg cylinders of propane were estimated as having a TNT equivalence of 70.2kg. This TNT equivalence generated the peak side-on (P_{so}) overpressures against the criteria in HIPAP 4 as shown in Table 10.

Table 14 Peak Side on Overpressures vs HIPAP 4

P_{so} (kPa)	**Distance from Explosion (m)**
3.5	62
7	36
14	21
21	16
35	12
70	8

The consequences of overpressure criteria values are shown in Appendix H

EXPLOSION OVERPRESSURES						
	70 kPa	35 kPa	21 kPa	14 kPa	7 kPa	3.5 kPa
	CYAN	RED	ORANGE	BLACK	GREEN	BLUE
DISTANCE FROM EXPLOSION (m)	62	36	21	16	12	8



This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by:

Issue	Description	Date	Drawn	Approved
A	ISSUED FOR INFORMATION ONLY	13.09.19	CB	MW

0 1cm at full size 5cm 10cm

North

ISSUED FOR INFORMATION ONLY

ACOR Consultants (WA) Pty Ltd
Level 1, Unit 9, 19 Essex Street
Fremantle WA 6160
T +61 8 9336 3156

ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project
INDUSTRIAL DEVELOPMENT

90 GINDURRA ROAD
SOMERSBY - LOT 4

Drawing Title
PROPOSED INDUSTRIAL DEVELOPMENT
DANGEROUS GOODS
RADIANT HEAT ANALYSIS - CALM CONDITIONS APPLIED

Drawn	Date	Scale A3	Q.A. Check	Date
CB	SEPT_2019	1:500	-	-
Designed	Project No.		Dwg. No.	Issue
MW	PE190247		DG.05	A

Appendix F - Nomenclature

Notation	Explanation
f	fraction of thermal energy radiated
C_d	discharge coefficient, 0.61 for sharp edged orifice
Cp_a	Specific heat of air (1 kJ/kg.K)
D	Short side of rectangular burner (m)
d_p	Pool diameter (m)
E	surface emissive power of flame (kW/m^2)
F	geometric view factor
g	gravitational constant (9.80665 m/s^2)
Hc	Heat of combustion (kJ/kg)
H_f	flame height (m)
k	ratio of specific heats, Cp/Cv
M	burning rate (kg/s)
$\dot{m}$	mass burning rate per unit area ($kg/m^2.s$)
P_1	upstream (high) absolute pressure (Pa)
P_2	downstream (low) absolute pressure (Pa)
Q	Heat flux at distance (kW/m^2)
$\dot{Q}$	Heat release rate (kW)
r	distance from flame (m)
RH	Relative humidity
V_1	Specific volume at condition 1 (m^3/kg)
W	specific mass flow rate ($kg/m^2.s$)
w	Long side of rectangular burner
x	distance from centre of flame (m)
ρ_a	density of air (1.225 kg/m^3 @ sea level @ 15°C
ρ_L	density of liquid
τ	transmissivity of air
T_a	Ambient air temperature (°C)
U_{wind}	Wind velocity (m/s)

Appendix G - Calculations

G.1 Flame Height (Thomas, 1963)

$$H_f = 42.d_p.(\dot{m}/(\rho_a.(g.d_p)^{0.5}))^{0.61}$$

G.2 Gas Discharge Rate (W)

Sonic Flow, if $P_2/P_1 < (2/k+1)^{k/k-1}$

$$W = C_d.[(P_1.k/V_1).(2/(k+1))^{(k+1/k-1)}]^{0.5}$$

$$M = W.Area\ of\ flow$$

$$\dot{m} = Hc.10^{-3}/(Hv + Cp.\Delta T)$$

G.3 Heat Flux at Distance x from Fire Centre

$$\tau = log_{10}[14.1*(RH)^{-0.108}.r^{-0.13}]$$

$$Q = \dot{m}.Hc.f.\tau/(4.\pi.x^2)$$

G.4 View Factor Model

$$Q = \tau.E.F$$

G.5 Flame Tilt Angle

$$Fr = U_{wind}^2/(gD)$$

$$Q^* = Q/(\rho_a.Cp_a.T_a.g^{0.5}.D^{5/2})$$

$$r^* = (\text{burner area}/\pi)^{0.5}$$

$$Tan\theta = 2.73*Fr^{2/5}.Q^{*-0.6}.(w/r^*)^{-0.5}$$

G.6 Wind Effect on Flame Height

$H_f = D.\alpha.[Fr^{2/3}/Q^*]^{\beta}$, where $\alpha = 1.46$, $\beta = -2/5$ for continuous flame region

$\alpha = 1.85$, $\beta = -2/5$ for intermittent flame region

Appendix H - Consequence of Heat Radiation

Heat Radiation ($kJ/m^2.s$)	Injury and Fatality	Structural Damage
2.1	Causes pain after 60 seconds	
4.7	Causes pain in 15 seconds Causes injury after 30 seconds (2^{nd} degree burns)	
12.6	Fatality if extended exposure	Wood undergoes pyrolysis after long exposure Thin steel thermal stress failure
23	Chance of fatality for instantaneous exposure	Spontaneous ignition of wood after long exposure Unprotected steel thermal stress failure Pressure cylinders vent gas or will rupture
35	Significant chance of fatality for instantaneous exposure	Cellulosic materials will auto ignite after 60 seconds exposure

HIPAP 2 – Fire Safety, 2011

Refer to Heat Radiation contours attached, below.

Appendix I - Consequence of Explosion Overpressure

Overpressure (kPa)	Injury and Fatality	Structural Damage
3.5	Low probability of injury	90% glass breakage
7	10% probability of injury	Internal partitions and joinery damaged, but repairable
14	10% chance of fatality person in building	Masonry structures badly cracked
21	20% chance of fatality person in building	Reinforced structures distort
35	Eardrum damage 50% chance of fatality person in building 15% chance fatality person in open	Severe structural damage
70	Threshold of lung damage 100% chance of fatality	Complete demolition of structures

HIPAP 2 – Fire Safety, 2011

Refer to overpressure contours attached, below.

Appendix J - Pasquill-Gifford Stability Class

Wind Direction	Daily		Pasquill-Gifford Class				
			9 am data (day)		3pm data (night)		
	Solar Exposure MJ/m^2	U_{wind} m/s	Class	Stability	U_{wind} m/s	Class	Stability
North	7.888	1.511	B	unstable	2.042	E	stable
North East	12.064	1.672	A-B	unstable	3.575	E	stable
East	6.496	0.836	B	unstable	1.558	F	stable
South East	3.248	0.638	B	unstable	1.041	F	stable
South	7.888	1.629	B	unstable	2.467	E	stable
South west	12.064	2.203	B	unstable	3.539	E	stable
West	6.496	1.206	B	unstable	1.633	F	stable
North West	3.248	0.761	B	unstable	0.825	F	stable

Data from Gosford North (Glennie Street) Station

Average Annual temperature: 23.1^{o}C

Average annual relative humidity: 74%

Appendix K - Fire System Layout

The Kariong Sand and Soil Supplies Secondary Sorting Warehouse (SSW) has a floor area of 2100m^2 and an internal volume of 19,215m^3. The SSW will store and process combustible materials in stockpiles up to 20m^2 in area and an overall storage height of no more than 2.6 metres.

Based on Australian standard AS 2118.1:2017 Appendix A, the SSW would be classified as *Incidental High Hazard Storage* and can be protected (cl. A4.2.2) by an Ordinary Hazard (OH3) sprinkler system.

The following high-level sprinkler system specification is reliant upon an adequate supply of firefighting water, as described in Section 4 and Section 14 of the standard. Sprinkler system specifications:

- Number of Design arrays: 9
- Number of operating sprinkler heads on long side (parallel to ridgeline) of array: 6
- Design array area: 225m^2
- K factor: 8.0
- Sprinkler head type: fast, special or standard response – pendent, upright or sidewall
- Maximum area covered per sprinkler: 12m^2 (sidewall – 9m^2)
- Maximum standard spacing between sprinkler heads: 4.2m (sidewall – 3.6m)
- Minimum spacing between adjacent rows: 2m
- Maximum distance of sidewall sprinklers from end walls: 1.8m
- Maximum distance from walls and partitions: 2.1m
- Operating flow: 60 L/min from each sprinkler
- Number of operating sprinkler heads in each array: 24
- Pump-set maximum flow rate: 4
- Discharge density: 6.4mm/min

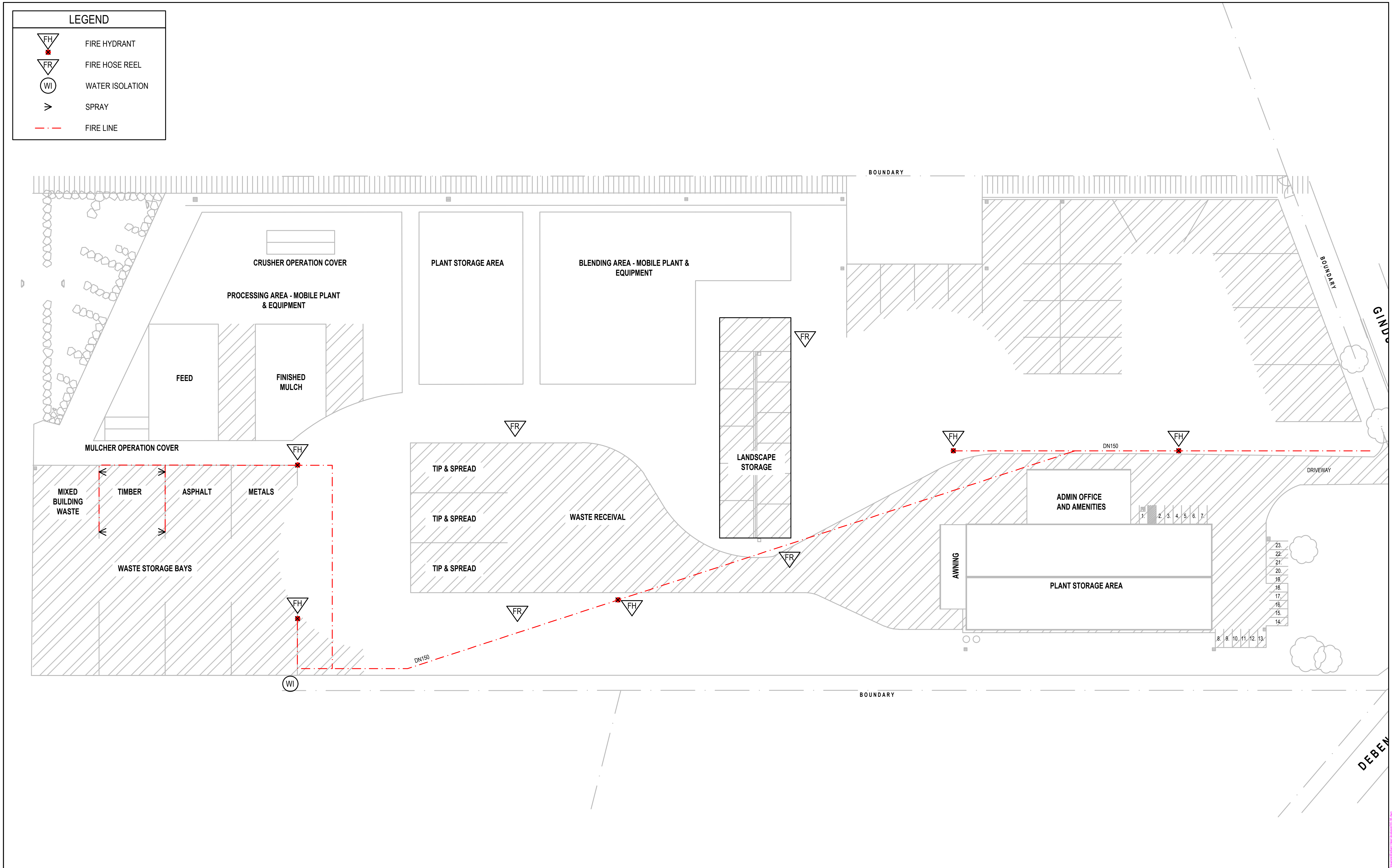
- DN100 ancillary valve on each range pipe
- DN100 flow switch on each range pipe

Control Assembly comprises:

- Installation side
  - Alarm valve
  - Audible alarm
  - Flow test assembly
- Supply side
  - Alarm valve
  - Pressure gauge
  - Stop valve
  - Jacking pump
  - DN15 test valve
  - DN50 drain valve

Total system pressure loss at most hydraulically disadvantaged array = 210kPa

Pump pressure: 600kPa



3RD ANGLE PROJECTION
DO NOT SCALE

This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by:

Issue	Description	Date	Drawn	Approved
C	RE-ISSUED FOR INFORMATION ONLY	19.11.19	JMT	MW
B	RE-ISSUED FOR INFORMATION ONLY	17.10.19	JMT	MW
A	ISSUED FOR INFORMATION ONLY	25.09.19	JMT	MW

North

Client

ISSUED FOR INFORMATION ONLY

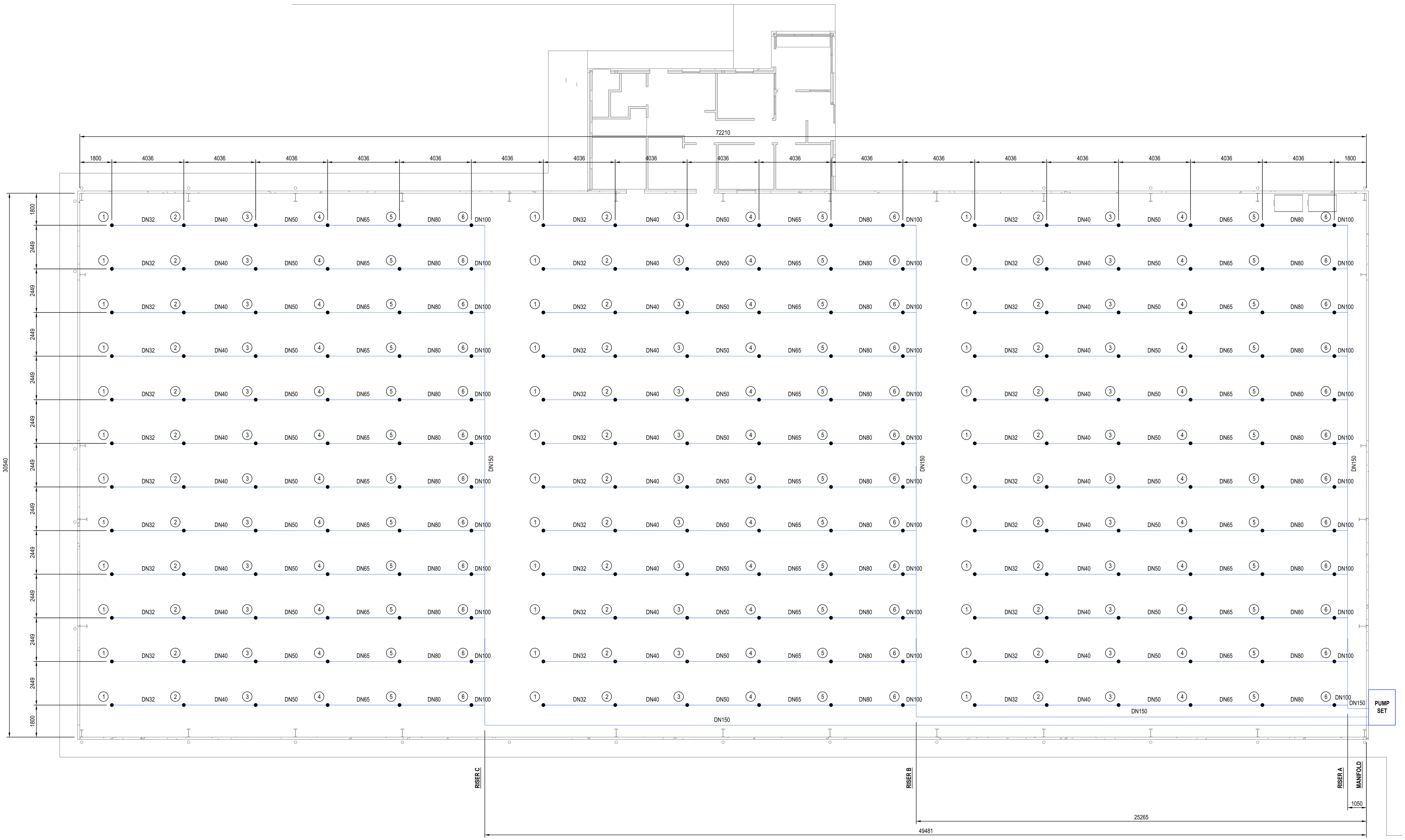
ACOR Consultants (WA) Pty Ltd
Level 1, Unit 9, 19 Essex Street
Fremantle WA 6160
T +61 8 9336 3156
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project
INDUSTRIAL DEVELOPMENT
90 GINDURRA ROAD
SOMERSBY - LOT 4

Drawing Title
PROPOSED INDUSTRIAL DEVELOPMENT
DANGEROUS GOODS
FIRE SYSTEM LAYOUT

Drawn	Date	Scale A3	Q.A. Check	Date
AC	SEPT_2019	1:1000	-	

Designed	Project No.	Dwg. No.	Issue
MW	PE190247	DG.06	C



SECONDARY PROCESS BUILDING - CONCEPTUAL SPRINKLER SYSTEM PLAN

SCALE 1:100

SCALE 1:100

ISSUED FOR INFORMATION ONLY

3RD ANGLE PROJECTION
DO NOT SCALE

This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by:

Issue	Description	Date	Drawn	Approved
A	ISSUED FOR INFORMATION ONLY	23.11.20	SLI	MW

North

ACOR Consultants (WA) Pty Ltd
Atwell Arcade, Level 1, Suite 101, 3 Cantonment Street
Fremantle WA 6160
T +61 8 9336 3156
CONSULTANTS ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project
INDUSTRIAL DEVELOPMENT
90 GINDURRA ROAD
SOMERSBY - LOT 4

Drawing Title
PROPOSED INDUSTRIAL DEVELOPMENT
SECONDARY PROCESS BUILDING
CONCEPTUAL SPRINKLER SYSTEM PLAN

Drawn	Date	Scale A1	Q.A. Check	Date
SLI	NOV 2020	1:100	-	-

Designed	Project No.	Dwg. No.	Issue
MW	PE190247	SK.01	A

P:\PE19\PE190247\Drawings\HYD\Sketch\PE190247_SK.01.dwg
Nov 23, 2020 - 2:38pm