Appendix M

Traffic and Transport Technical Report

Traffic and Transport
Dongmun Greentec Pty Ltd
02-Oct-2015

Deniliquin Ethanol Plant

Traffic and Transport Technical Report

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Traffic and Transport Technical Report

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Table of Contents

Executive Summary

This Traffic and Transport Technical Report has been prepared for Dongmun Greentec Pty Ltd (Dongmun Greentec) as part of the Environmental Impact Statement (EIS) for the construction and operation of an Ethanol Plant in Deniliquin, south western NSW.

This report describes the existing transport infrastructure surrounding the proposed Deniliquin Ethanol Plant (the Project) and provides an assessment of the potential impacts of the Project on these networks. The impact assessment anticipates the likely traffic generated throughout the various phases of the Project and considers potential mitigation measures to appropriately reduce or manage the level of impact in order to maintain the operational efficiency of the existing transport networks.

Existing transport infrastructure

The primary transport networks of relevance to the Project are the road and rail networks. The key transport corridors utilised by the proposed ethanol plant during the construction and operations phase would be the Riverina Highway, Cobb Highway and Deniliquin Barham Road. The main rail line servicing the area is the Deniliquin Rail Line (also known as the Echuca Line).

Traffic data provided by Deniliquin Council shows that the traffic volume along Deniliquin Barham Road is relatively low at the eastern end with around 11 percent heavy vehicles. The traffic volumes for the Cobb and Riverina Highway were also considered low with approximately 10 percent heavy vehicles. All three roads are considered have significant spare capacity in terms of a volume to capacity ratio.

On the Deniliquin Rail Line two to three passenger train services run daily from Melbourne to Echuca only. Freight trains operate from the Port of Melbourne to Deniliquin (and return) daily Monday to Friday.

Road and transport safety data from Deniliquin Council shows that there were only two recorded minor accidents between 2009 and 2014 within the vicinity of the Project Site (on Deniliquin Barham Road).

Project access and traffic generation

The preliminary site layout plan indicates the proposed access points which would require new intersections. Light vehicles would enter and exit the site through the office main gate from Deniliquin Barham Road. Heavy vehicles would enter the site via Deniliquin Barham Road and would exit the site via Line Road, connecting to Deniliquin Barham Road.

During the construction phase the key traffic generating activities would be the movement of materials, workforce and equipment/components required for the establishment of the facility and supporting infrastructure.

The proposal is to transport 70 percent of the raw materials and output products from the ethanol production using the rail network. The nearest rail siding facility is the Rice Growers rail siding approximately 3.5 km to the northeast. Product would be trucked to and from this siding using heavy vehicles. The remaining 30 percent of the raw materials and output would be trucked via the road network.

The key traffic movements related to the operations phase of the plant, apart from the movement of staff (mainly light vehicles), would be the transportation of raw materials required for processing to the site and the transportation of output products from the ethanol production process (e.g. ethanol and dried distillers grain in heavy vehicles) from the site.

Impacts

The construction workforce traffic generation, (light vehicles only), is approximately 244 per day mainly at the start and end of shifts. The number of daily construction-related heavy vehicle movements is likely to be around 56 vehicles per day. This relates to approximately six heavy vehicles per hour on average over a 10-hour period per day. The number of vehicles generated during the construction phase is considered to be relatively low and based on traffic count information there is capacity on the existing road network for this increase. This assessment demonstrates that there would not be a significant impact on the operation of the surrounding road network during the construction phase.

During the operations phase, the number of light vehicle movements is about 32 vehicles in each peak hour and heavy movements is around six to seven vehicles per hour per direction. As for construction, an assessment of the capacity of the surrounding road network (based on traffic count information and road type) indicates that

there is spare capacity for the increase. This assessment demonstrates that there would not be a significant impact on the operation of the surrounding road network during the operations phase.

It is estimated that the average number of train wagons required per day (based on 330 days per year) would be around 12 wagons per day inbound and 10 wagons per day outbound from Deniliquin. As part of the future discussions with the rail freight operator, the availability of line and train capacities have been confirmed with Qube Logistics.

Management and mitigation measures

A number of management and mitigation measures would be implemented during the construction phase. These include a Road Use Management Plan that will include for traffic management and control. Once more detail is known around the exact vehicles and routing, then more detailed vehicle swept path analysis would be undertaken along the heavy vehicle route if required. Additionally, road conditions would be monitored during the construction phase.

During the operations phase specific to the road transport of hazardous materials, the Project Transport Management Plan would include provisions relating to the transportation of hazardous materials. This plan would be developed in consultation with the consent authorities and in accordance with NSW Government's *Hazardous Industry Planning Advisory Paper No 11 on Route Selection, January 2011*.

Conclusions

This traffic impact assessment concluded that the traffic impact of the Project on the local and wider road network is likely to be minimal. The overall impact from an increase of both light vehicles and heavy vehicles on the surrounding road network during both the construction and operations phases is not considered to be significant.

There is the possibility of increased safety impacts due to large construction vehicles turning across the Deniliquin Barham Road at the site entrance and exit intersections. Traffic management measures would be in force to ensure vehicles could access and leave the site safely.

The impact of the additional traffic on existing road intersections is expected to be minimal. Proposed site access intersections would be designed in accordance with Austroads Guide to Road Design.

The impact from the heavy vehicles during the construction phase is less than the operations phase in terms of timeframe (14 to 16 months construction period) and heavy vehicle volume (with 56 heavy vehicles per day for construction phase and 130 heavy vehicles per day for the operations phase). As the magnitude of the heavy vehicle volumes has increased during the both the construction and operations phases (in terms of equivalent standard axles (ESA) on Deniliquin Barham Road), further discussions would be undertaken with Deniliquin Council to identify how to best ameliorate the potential pavement impact.

1.0 Introduction

1.1 Purpose

This Traffic and Transport Technical Report has been prepared for Dongmun Greentec Pty Ltd as part of the EIS for the construction and operation of an ethanol plant in Deniliquin, south western NSW.

1.2 Objectives

This report describes the existing transportation infrastructure within and surrounding the proposed Project and identifies potential impacts of the Project on the transport environment. The impact assessment forecasts the likely traffic generated during the construction and operations phases of the Project, and if required, considers potential mitigation measures to appropriately reduce the level of impact and to maintain the operational efficiency of the existing transport networks.

The primary transport network of relevance to the Project is the road and rail network; however, other transport modes have also been briefly described to identify their relevance to the Project in the context of moving materials to and from the Project Site.

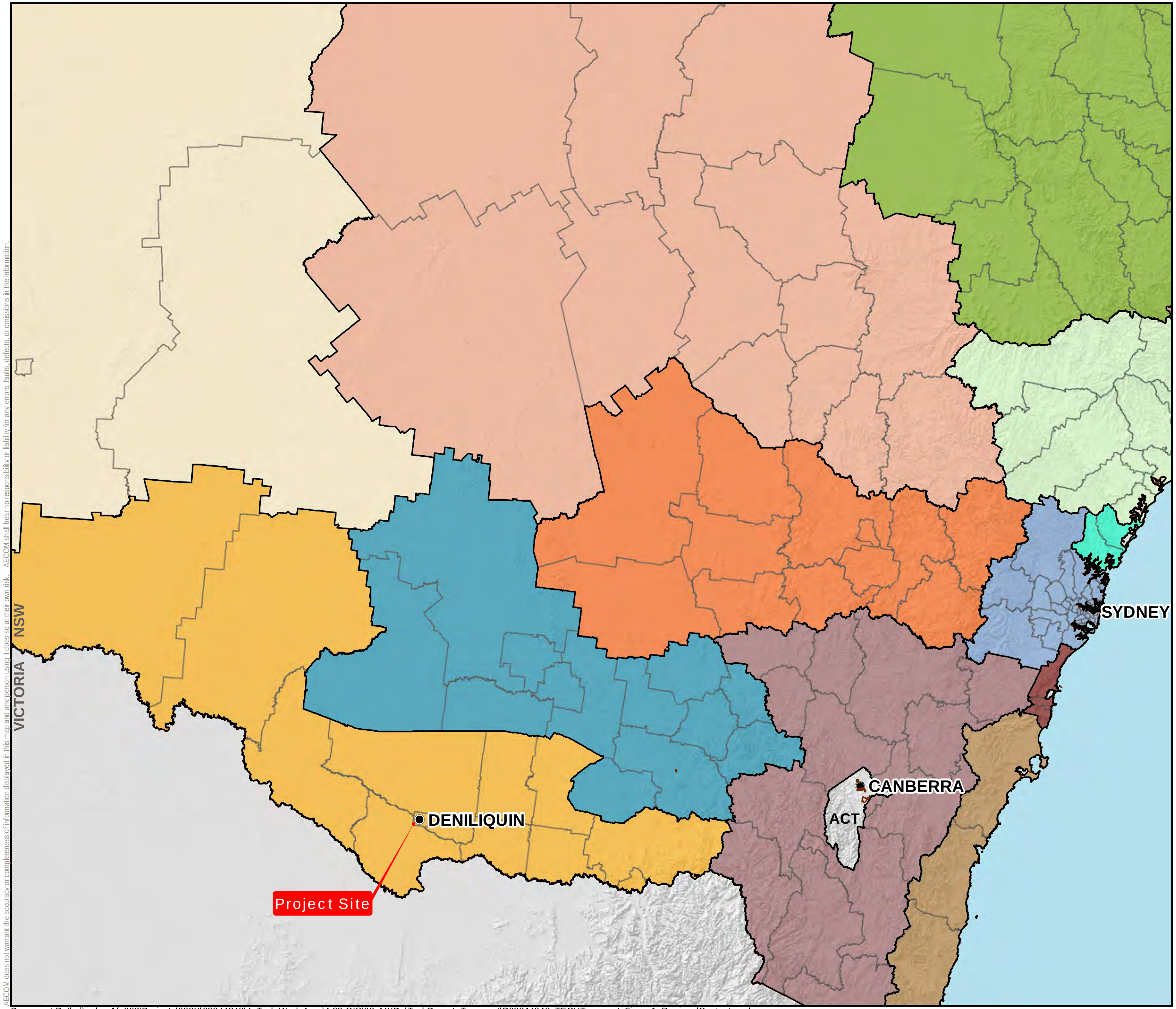
1.3 Site location

The proposed Project Site is located 5.5 km southwest of Deniliquin. The regional context of the site is shown in Figure 1. Deniliquin is a town in the Riverina region of NSW located at the intersection between the Riverina and Cobb Highways, approximately 725 km south west of Sydney and approximately 285 km north of Melbourne, Victoria.

The Project Site is approximately 120 hectares and is located on lots 234, 272 and 273 of DP 756325 along Deniliquin Barham Road. The site location is shown in Figure 2. The views from Deniliquin Barham Road are presented in Plate 1 and Plate 2.

Traffic and Transport Technical Report

FIGURE 1
REGIONAL CONTEXT



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LEGEND

- Cities / Towns
- Ocean
- State Boundary
- Project Site

Regional Development Areas

- Central Coast
- Central West
- Far West
- Hunter
- Illawarra
- Mid North Coast
- Murray
- Northern Inland
- Orana
- Riverina
- South Coast
- Southern Inland
- Sydney

Data Sources:
1. Roads, Railway, Parks, Drainage, Suburbs: @ Street Pro, 2011
2. Base Map Layer: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
3. Regional Development Areas: @ Government Australia website; https://rda.gov.au/files/rda_map_nsw.pdf

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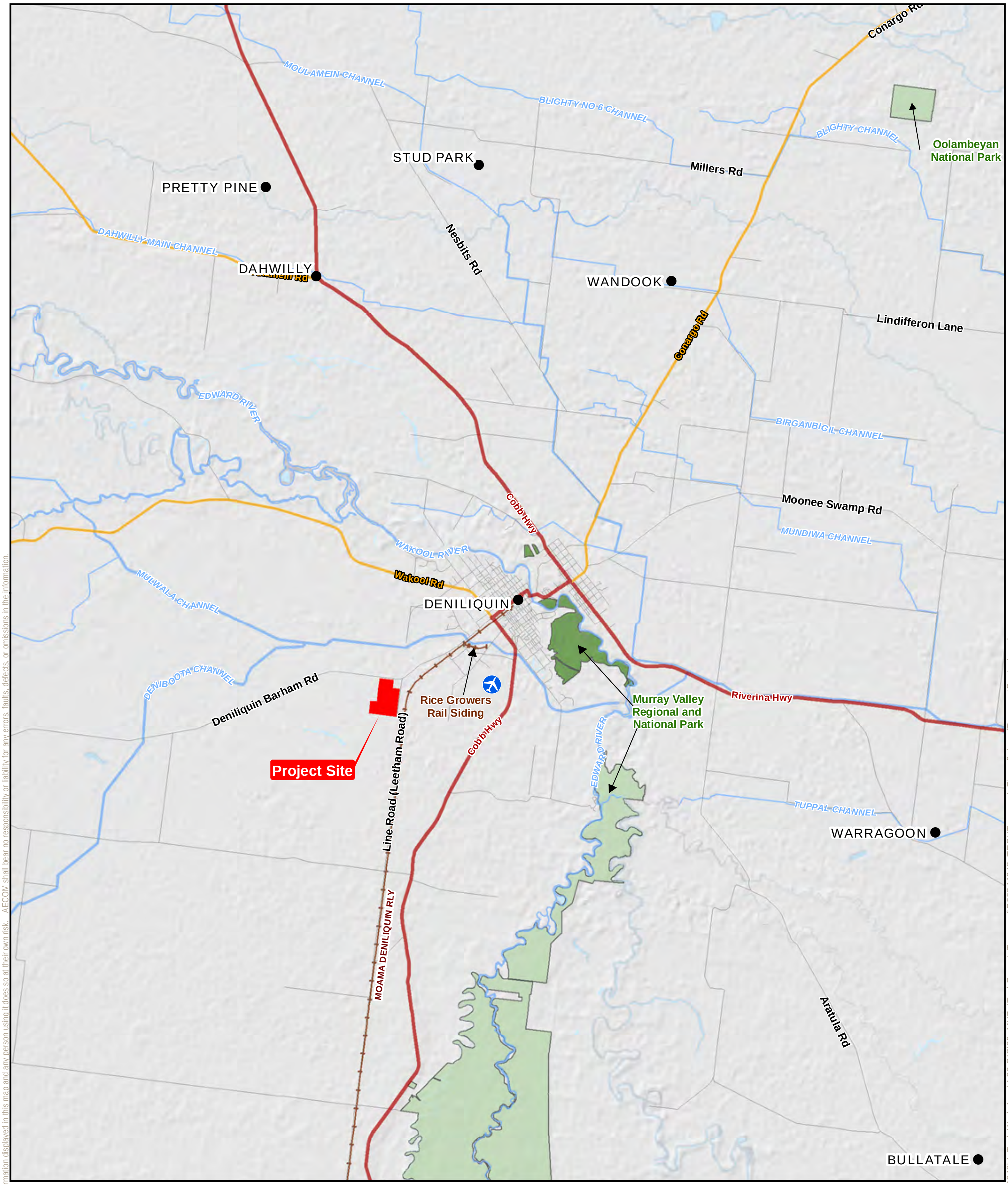
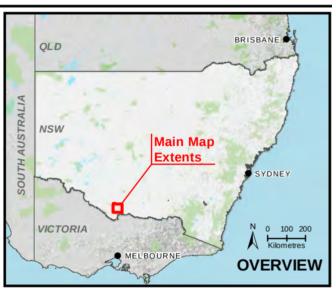
Local Transport Context





LEGEND

- Locality
- Airport
- Freeway; Highway
- Main Road
- Other Roads
- Railway
- Major River / Watercourse
- Minor Watercourse
- Project Site

NSW Protected Areas

- Regional Park
- National Park
- Nature Reserve

Data Sources:
1. Roads, Railway, Parks, Drainage, Suburbs: @ Street Pro, 2011
2. Base Map Layer: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
3. Parks and Reserves: An area of land, the boundaries of which have been determined by the Governor by proclamation in the Government Gazette, which has been reserved for various protection purposes defined in instruments administered by Department of Environment and Climate Change (Parks & Wildlife Division).

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Kilometres

FIGURE 2

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Plate 1 Proposed Project Site from Deniliquin Barham Road looking south west

Plate 2 Proposed Project Site from Deniliquin Barham Road looking south east

1.4 The Project

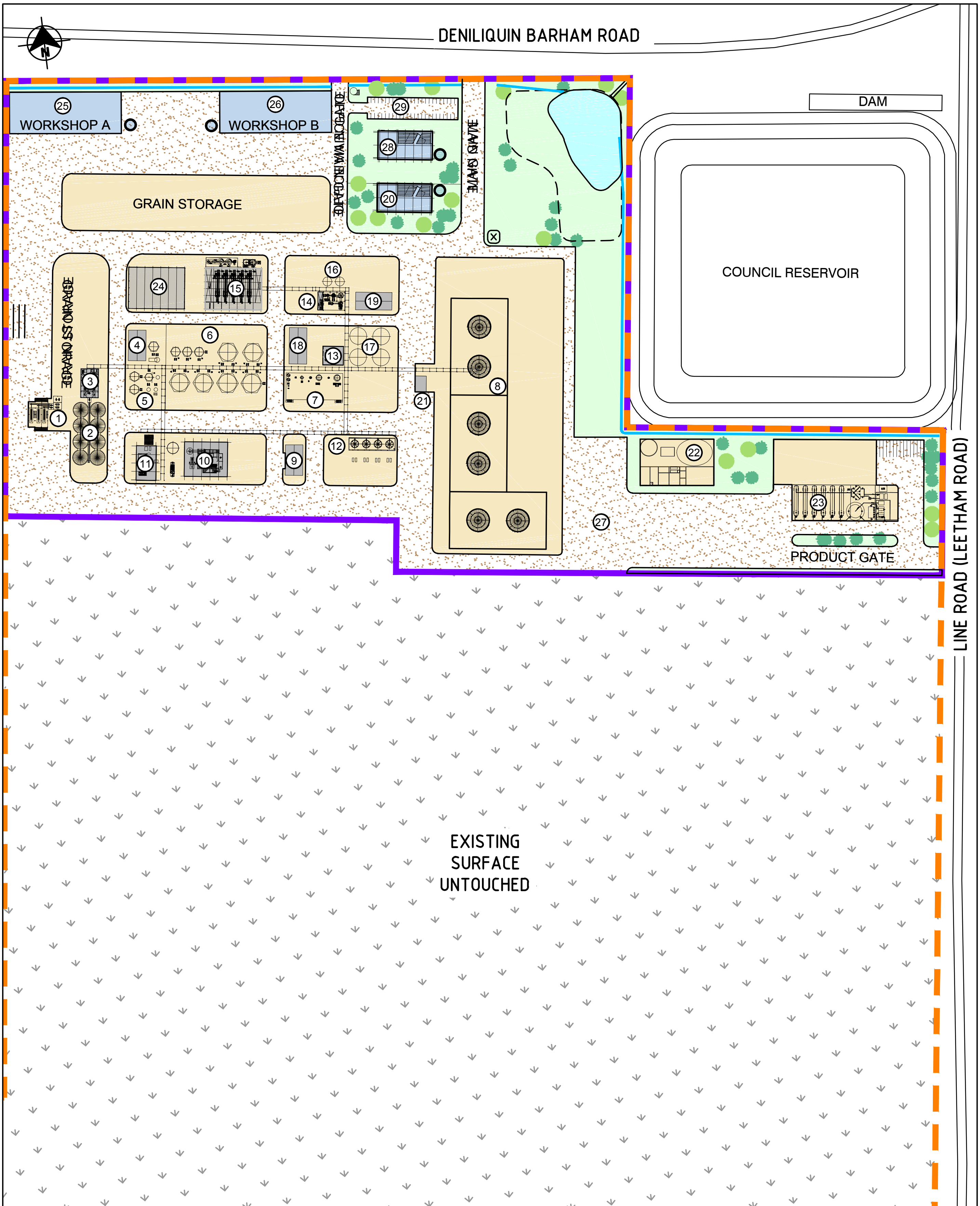
The proposal is to construct and operate a fuel grade ethanol production plant producing up to 115 ML of fuel grade ethanol per year as well as co-products of ethanol production.

The following general works are included as part of the overall site development:

- Construction and operation of infrastructure for processes including closed system grain milling; liquefaction of grain flour; fermentation; distillation and dehydration; and centrifuge and drying of dried distiller's grain.
- Construction and operation of a wastewater treatment plant including anaerobic and aerobic treatment processes and a 2 ML on-site aerated water treatment basin.
- Construction of associated office, control room and maintenance room.
- Storage area and silos for input grain.
- Storage area for dried distillers grain output.
- On-site ethanol storage.
- Staff car parking area.
- Associated internal roadworks.
- Access arrangement for office and production areas.

An indicative general layout of the site is as shown in Figure 3.

Site Layout



LEGEND

ROADWAY
SITE BOUNDARY
PROJECT BOUNDARY
LANDSCAPING
RAIN HARVESTING TANK
PAVEMENT AREA
HARDSTAND AREA
ROOFWATER CATCHMENT
BIO-RETENTION & FLOOD DETENTION BASIN
VEGETATED SWALE
STORMWATER HOLDING TANK
PARKING

1. Grain Intake
2. Grain Storage
3. Grain Preparation & Milling
4. Enzyme Storage
5. Gelatinization & Liquefaction
6. Fermentation
7. Distillation (Mash Tower, Rectifier Tower, Sieve Column & Dehydration)
8. Product Storage
9. Substation
10. Boiler & Air compressor
11. Water Treatment
12. Cooling Tower
13. Decanter
14. Evaporator
15. Dryer
16. Syrup Tank
17. Stillage Storage Tank
18. Control Room
19. Maintenance Room
20. Office
21. Ethanol Loading
22. Waste Water Treatment
23. Anaerobic Digestion
24. DDGS Storage & Loading Area
25. Workshop A
26. Workshop B
27. Impermeable Pavement
28. Training & Development Centre
29. Staff & Visitor Car Park

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0 100m

FIGURE 3

CAD REF: P:\603X\60344248\5. CAD\25-SKETCHES\60344248-FIGURE-3.DWG

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1.5 Assessment approach

1.5.1 Director-General's Requirements

The Director-General's Requirements (DGRs) for the proposed Deniliquin Ethanol Plant were issued on 23 December 2013 to guide the preparation of the Environmental Impact Statement (EIS) for the Project.

A methodology for assessment of the Project from a traffic and transport viewpoint was developed based on the DGRs as summarised below:

- Details of traffic and transport demands likely to be generated during construction and operation, including a description of haul routes.
- Details on access to the site from the road network including intersection location, design and sight distance.
- An assessment of predicted impacts on road safety and the capacity of the road network to accommodate the Project including the capacity of the surrounding road network to absorb the traffic related to the proposed development.
- Plans of road upgrades, rail and other infrastructure works or new roads required for the development.
- An assessment of where far-field road networks are required as a result of traffic impacts from the development.
- Details of proposed rail siding and associated rail traffic and assessment of the predicted impact of this on the rail network.
- Details of the proposed layout of the internal road network and parking on site in accordance with the relevant Australian standards.

1.5.2 Methodology

The following methods were adopted for the traffic and transport assessment of the Project's construction and operations phases in order to address the DGRs and include:

- Identification of the existing transport infrastructure in the region (i.e. regional roads and rail infrastructure) through a review of available mapping from online sources and provided by relevant departments.
- Consultation with relevant stakeholders and departments including Deniliquin Council, Roads and Maritime Services (RMS),Public Transport Victoria and V/Line and Qube Logistics to ascertain:
    - Road specific data including route status, speed limits and safety data.
    - Timetable information for train routes
    - Plans of any road upgrades, rail and other infrastructure works or new roads required for the Project
    - Current and future capacity of the existing routes.
- A review of relevant standards, policies and guidelines to inform the design and assessment including:
    - Guide to Traffic Generating Development (RTA), October 2002
    - Road Design Guide (RTA), various years
    - Australian Standards AS2890: Parking Facilities (AS2980)
    - Austroads Guide to Road Design (including Part 4A: Unsignalised and Signalised intersections and Part 3: Geometric Design).
- A quantitative assessment of the additional traffic generated as a result of Project activities during construction and operations phases, including the movement of Project related materials, plant, equipment and workforce along the Project's identified transport corridors.
- Development of plans of the proposed layout of the internal road network and parking on site in accordance with the relevant Australian standards.
- An assessment of the potential impacts from the Project on:
    - the existing road infrastructure and network, including road safety, road traffic generation, and the capacity of the road network to accommodate the likely increase, and cumulative impacts

  - the existing rail network, including potential rail traffic generation and the capacity of the rail network to accommodate the likely increase, and cumulative impacts
  - any other transportation mode that may be impacted (e.g. air, shipping)
- Identification of potential mitigation and management strategies which may be implemented during the Project's phases.
- Identification and assessment of the residual impacts (if any) resulting from the Project following the implementation of mitigation measures.

2.0 Existing context

2.1 Existing road network

The proposed ethanol plant is located in the Deniliquin Local Government Area (LGA). A map showing the classified road network from Roads and Maritime Services (RMS) is presented in Figure 4. The key transport links (both State and local government roads) to be used for accessing the site would be:

- Riverina Highway (B58)
- Cobb Highway (B75)
- Deniliquin Barham Road

2.1.1 State roads

Riverina Highway (B58)

The Riverina Highway runs parallel to the Murray River in NSW for 230 km through the Riverina region from Finley to Deniliquin. It begins in the east at Bethanga Bridge over the Murray River, near Albury, heading west through Albury and Howlong to near Corowa. From here the highway runs north for nearly 20 km before resuming its westerly course to Deniliquin via Berrigan and Finley connecting to the Cobb Highway (B58). On entry to Deniliquin, the Riverina Highway is a two-lane, single carriageway formation with a posted speed limit of 60 km/hr (urban areas) and travelling east from Deniliquin the speed limit is 100 km/hr (outside urban areas). The Riverina Highway is an approved AB-Triple route.

Cobb Highway (B75)

The Cobb Highway (B75) extends from the bridge over the Murray River at Moama, via Deniliquin, through Hay and Ivanhoe to meet with the Barrier Highway (A32) near Wilcannia. In the vicinity of Deniliquin, the Cobb Highway is a two-lane, single carriageway formation with a posted speed limit of 100 km/hr (outside urban areas). It is a RMS approved route for road trains and 4.6 m high vehicles. The Cobb Highway is an approved AB-Triple route north of Deniliquin and approved Road Train Route south of Deniliquin.

2.1.2 Council roads

Deniliquin Barham Road

The Deniliquin Barham Road starts at the Cobb Highway at Deniliquin, running through to Barham – Moama Road at Thule. The Deniliquin Barham Road is an unclassified regional council road which is a sealed, single carriageway with a posted speed limit of 100 km/hr in the rural areas. It is also an approved 19 m B-Double route.

Line Road

Line Road is a local road which is a sealed, single carriageway with a posted speed limit of 100 km/hr in the rural areas. Line Road connects Mathoura to Deniliquin Barham Road.

Ricemill Road

Ricemill Road is a local road which is a sealed, single carriageway with a posted speed limit of 60 km/hr in the rural areas. Ricemill road connects with Wirraway Drive and the Deniliquin Rice Growers siding is access off this road.

2.1.3 Existing intersections

The following intersections would be utilised by Project generated traffic on the preferred transport routes:

- Deniliquin Barham Road and Line Road: This is a priority intersection with basic right turn treatment on a two-lane rural road.
- Deniliquin Barham Road and Rice Grower’s Lane: This is a priority intersection with auxiliary right turn treatment for the traffic turning right into Ricemill Road (Type AUR).
- Deniliquin Barham Road and Cobb Highway: This is a large single lane roundabout connecting Deniliquin Barham Road with Cobb Highway which formed part of the B-Double Routes and A-Double Road Train Routes.

- Cobb highway and Riverina Highway: This is a large single lane roundabout connecting Cobb Highway with Riverina Highway which formed part of the B-Double Routes and A-Double Road Train Routes.

2.2 Rail network

In the vicinity of the proposed ethanol plant, the Moama Deniliquin Line (also known as the Deniliquin Line or the Echuca Line) connects Bendigo to Echuca and Deniliquin as shown in Figure 4. V/Line operates passenger services along the line as far as Echuca, as an extension of services to Bendigo from Southern Cross station in Melbourne with two to three passenger train services per day.

Freight trains operate on the Moama Deniliquin Line between Echuca and Deniliquin carrying mainly rice, grain and containers. The Moama Deniliquin Line is the nearest freight rail infrastructure (broad gauge) connecting Deniliquin to Bendigo (via Echuca).

Freight trains (operated by Qube logistics) run every Monday to Friday departing Melbourne around 5:00 am and arrive at Deniliquin Rice Growers Siding around 12:30 pm. Trains depart Deniliquin around 5:00 pm and arrive back at Westgate Port Siding around 12:40 am.

In general, the line operates with maximum speed of 80 km/hr between Bendigo and North Bendigo Junction, 65 km/hr between North Bendigo Junction and Echuca and 40 km/hr between Echuca and Deniliquin[1].

Primary traffic on the line is rice and containers. Red-gum sleepers are also loaded at Mathoura and Deniliquin.

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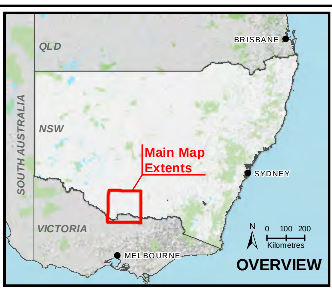
[1] http://vicsig.net/infrastructure/line/Deniliquin, accessed May 2015

Road and Rail Network



LEGEND

- Cities
- Watercourse
- Railway
- Highway; Freeway
- Main Road
- Local road
- Project Site
- National Park/ State Forest
- State Boundary

Data Sources:
1. Roads, Railway, Parks, Drainage, Suburbs: @ Street Pro, 2011
2. Base Map Layer: © OpenStreetMap (and) contributors, CC-BY-SA

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FIGURE 4

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2.2.1 Rail siding

There are rail sidings operating in the proximity of the Project Site namely:

- Deniliquin (Rice Growers Siding) as shown in Plate 3 – accessed via Ricemill Road off Deniliquin Barham Road
- Deniliquin Freighters Siding – accessed via Harfleur Street off Cobb Highway.

The rail crossings in the vicinity of these sidings are open type.

Source: http://railgallery.wongm.com/deniliquin-rice-train/E114_0785.jpg.html

Plate 3 Deniliquin rice growers siding

2.3 Existing traffic volumes

The key transport corridor utilised by the proposed ethanol plant during the construction and operations phase would be the Riverina Highway, Cobb Highway and Deniliquin Barham Road.

The proposed ethanol plant would connect directly to the Deniliquin Barham Road. Other key road links utilised as part of the transport routes for the Project are the Cobb Highway and Riverina Highway.

The daytime traffic volumes (observed between 8:00 am – 5:00 pm) on these key roads which would service the Project are presented in Table 1.

Table 1 Annual average daily traffic volumes

Road Name	Traffic volumes (hrs)	% Heavy vehicles
Riverina Highway	696	14%
Cobb Highway	2,179	7%
Deniliquin Barham Road (at Caldwell)	405	32.6%
Deniliquin Barham Road (west of Calimo Street)	1,696	10.6%

Source: Observed traffic counts conducted by Dongmun Greentec Pty Ltd in October 2013 for Riverina & Cobb Highways and Deniliquin Council June 2015 for Deniliquin Barham Road

The traffic data provided by Deniliquin Council in June 2015 shows that the traffic volume along Deniliquin Barham Road is relatively low (405 AADT) at the western end near Caldwell with around 33 percent heavy vehicles. The traffic volume increases to around 1,700 vehicles per day with around 11 percent heavy vehicles just south of Deniliquin.

For the purpose of traffic assessments (namely the volume over capacity ratio), the lower daily volume of 405 vehicles per day (as a worst case assumption) has been adopted for comparing against the traffic volumes generated by the proposed development during the construction and operations phases. However, both volumes along Deniliquin Barham Road (405 AADT and 1,700 AADT) have been used in the Level of Service assessment for the peak hours of the day.

2.4 Road safety and crash data

Accident data extracted from SNARL (based on information sourced from Transport for NSW) are presented in Table 2. There were two recorded accidents between 2009 and 2015 involving trucks with both accidents occurring on the Cobb Highway, north of Deniliquin.

Table 2 Crash data in the surrounding area (2009 – 2015)

Location	Date / Time	Hazard / Incident Type	Vehicle involved
Riverina Highway near Twin Rivers exit	Monday, 24 September 2012, 1:22:51 PM	Accident	Car
Riverina Highway at 25 Km East of Deniliquin	Wednesday, 20 June 2012, 12:53:13 PM	Accident	Car
Cobb Highway at 23 Km North of Deniliquin	Saturday, 21 April 2012, 6:13:08 PM	Accident	Truck
Hardinge St At George St	Monday, 4 July 2011, 6:54:06 PM	Accident	Car
Davidson Street Near Finley Road	Wednesday, 9 December 2009, 8:36:01 AM	Accident	Two cars
Cobb Highway Near Wanganella	Monday, 6 July 2009, 8:05:00 PM	Accident	Truck

Source: http://www.snarl.com.au/rss/suburb/nsw/deniliquin/ accessed May 2015

Based on the *Deniliquin Council Area Crash Statistics for 2012*, crash numbers in the Deniliquin Local Government Area have been reducing over a five year period with the last fatal crash in Deniliquin having occurred in 2010[2].

Along Deniliquin Barham Road, there were two minor accidents recorded in 2012 in the vicinity of the Project Site and one recorded in 2013 west of Caldwell according to crash data provided by Council from January 2009 to June 2014 (latest statistics available) as presented in Table 3.

Table 3 – Crash data along Deniliquin Barham Road

Location	Date / Time	Hazard / Incident Type	Vehicle involved
Deniliquin Barham Road at Calimo Street (west of Deniliquin)	Tuesday, 23 October 2012, 9:15 AM	Accident	Truck
Deniliquin Barham Road at Ricemill Road (west of Deniliquin)	Wednesday, 31 October 2012, 7:00 AM	Accident	Car / 4WD
Deniliquin Barham Road at Yallakool Road (west of Caldwell)	Saturday, 21 September 2013, 7:50 PM	Accident	B-double

Source: Extracts from crash report provided by Deniliquin Council for Murray Shire from January 2009 to June 2014 (latest statistic available)

[2] http://www.deniliquin.nsw.gov.au/images/documents/deniliquin/News%20Items/2012%20crash%20stats.pdf, accessed May 2015

As Deniliquin Barham Road is becoming more heavily used, Council is upgrading a 2 km section of the road from the Ochtertyre Street roundabout with Cobb Highway approximately 2.6 km along Deniliquin Barham Road to the east of the Project Site. The road is being widened, strengthened and resurfaced for the use of road trains and the upgrade would assist in maintaining a safer road network for Deniliquin and hence the upgrade would be a benefit to the Project.

2.5 Public transport

There are currently five bus and coach services (local bus routes and long distance coaches) as well as eight school bus routes servicing Deniliquin and surrounds. These routes are summarised in Table 4 below.

The bus operators would be consulted prior to the start of construction to ensure potential issues are discussed and appropriate mitigation measures adopted.

Table 4 Bus services

Services	Operator
Local Bus Routes	
DTS (Deniliquin Town Service)	Purtill Brothers Nominees Pty Ltd
Long Distance Coaches	
733 - Wagga Wagga - Lockhart - Echuca (Mo/We/Fr/Su)	NSW TrainLink
734 - Echuca - Lockhart - Wagga Wagga (Mo/We/Fr/Su)	NSW TrainLink
741 - Albury - Howlong - Echuca (Tu/Th/Sa)	NSW TrainLink
742 - Echuca - Howlong - Albury (Tu/Th/Sa)	NSW TrainLink
School Bus Routes	
Bunnaloo Special	P H & M F Bryans
Conargo Special	Purtill Brothers Nominees Pty Ltd
Deniliquin – Blighty	Purtill Brothers Nominees Pty Ltd
Deniliquin - Conargo	Purtill Brothers Nominees Pty Ltd
Deniliquin - Mayrung Rd	Purtill Brothers Nominees Pty Ltd
Deniliquin - Moonee Swamp Rd	Purtill Brothers Nominees Pty Ltd
Deniliquin - Tuppal Creek	Purtill Brothers Nominees Pty Ltd
Mayrung Special	

Source: http://www.countrytransport.131500.com.au/index.asp?InfoMode=TownReport&Town=Deniliquin, accessed May 2015

2.6 Planned infrastructure upgrades

Deniliquin Council has received funding for a $1.1 million upgrade to Deniliquin Barham Road. A 2 km section of the road from the Ochtertyre Street roundabout is being widened, strengthened and resurfaced for the use of road trains. The total project cost is $1.148 million, of which $574,000 would be funded through the Federal Government's Heavy Vehicle Safety and Productivity Program.

The remainder of the project cost would be funded by Deniliquin Council. Council is upgrading this section of Deniliquin Barham Road which was becoming more heavily used, and the upgrade would assist in maintaining a safer road network for Deniliquin.

2.7 Other significant projects

It is understood that the Deniliquin abattoir (approximately 3 km to the north east of the proposed ethanol plant site) is planning an expansion. This is a State significant development in the vicinity. No details of the scope or timing of the expansion and the potential increase in vehicle movements during construction and operation are publicly available. As such an analysis of the potential cumulative impacts on the road network that both projects might present has not been carried out for the purposes of this report. Depending on the release timing and detail of the abattoir's project development information a cumulative assessment of the potential traffic impacts could be carried out if required.

3.0 Proposed development

3.1 Description

The Project is the construction and operation of the Deniliquin Ethanol Plant, which would have a capacity of 115 ML annually and would include several grain storage silos, the ethanol processing plant and a wastewater treatment facility.

The plant would operate 24 hours per day, seven days a week for 330 days per year with scheduled shut down allowing for the maintenance of the equipment. It would be capable of processing a range of locally grown grain or wheat.

The primary output from the production is fuel graded ethanol to be sold to the major petroleum companies as additive to regular ULP to produce E10, or to be exported. The co-products of the ethanol production process would be a Dried Distillers Grain with Solubles (DDGS) and distiller's syrup.

DDGS would be sold as high nutrient protein meal. As it is dried, it has a long shelf life and can be transported and stored on farms. Distiller's syrup is a high protein (higher nutritional value) substitute for molasses, which is widely used in feedlots for livestock nutrition. The syrup also forms a basis for the production of highly effective liquid biological fertilizers that improve soil and plant health, reducing farmer's reliance on imported synthetic fertilizers. A portion of the syrup would be added to distiller's grain to improve quality, reduce energy use in drying and to help prevent dust.

3.2 Access arrangements

3.2.1 External access

There are two primary vehicular access points for the proposed development which are located along Deniliquin Barham Road, approximately 550 m west of the intersection between Deniliquin Barham Road and Line Road (Leetham Road). Deniliquin Barham Road provides the key connection to the State road network (connecting to the Riverina Highway and the Cobb Highway at Deniliquin).

One access point is to the main office area which is provided for light vehicles only, from which they may also exit from. The second separate access point is for heavy vehicle (access only) for the delivery of raw materials and empty heavy vehicles for picking up ethanol and other co-products. The heavy vehicles would leave the site from an exit point on Line Road.

All access and exit driveways are located along straight sections of road with good sight distances of over 250 m in both directions of the carriageway (both on Deniliquin Barham Road and on Line Road). The available sight distances would more than satisfy the requirement of 222 m for a 100 km/hr road (based on an 8 second gap).

Site access intersections

The design of the site access intersection configurations would be carried out as part of the detailed design phase. The access driveways and intersections would be designed in accordance with Austroads Guide to Road Design and/or Road Design Guide (RTA) for the light vehicle access to the main office as well as the heavy vehicle access and exit points, allowing for access of heavy rigid and articulated vehicles.

Detailed intersection analysis would be undertaken in consultation with Deniliquin Council as part of the future detailed design. For operational safety, the site access intersection along Deniliquin Barham Road would include the following turn treatments:

1) A westbound left turn deceleration lane from Deniliquin Barham Road to enter the site.
2) An eastbound right turn lane or a slip lane onto Deniliquin Barham Road.
3) A westbound left turn acceleration lane merging with Deniliquin Barham Road (for light vehicles exiting only).

The site access intersections would likely channelized right-turn and rural auxiliary left-turn treatments which would be confirmed at the detailed design stage of Project development.

3.2.2 Heavy vehicle route

The preferred transport route to access the proposed site would be along various State roads that access Deniliquin including the Cobb and Riverina Highways.

It is noted that the Riverina Highway is an approved AB-Triple route. The Cobb Highway is an approved AB-Triple route north of Deniliquin and approved Road Train Route south of Deniliquin. Deniliquin Barham Road is an approved 19 m B-Double route. It is anticipated that the transportation of raw material and outputs from the plant would use heavy vehicles up to the B-Double category which would conform with the approved B-Double transport routes connecting to the State road network. The key intersections along the preferred transport routes accessing the rail siding and the highways have been designed to cater for and are already being used by B-Doubles. The Line Road intersection with Deniliquin Barham Road will be used by exiting vehicles only (there will be no left and right hand turn from Deniliquin Barham Road to Line Road).

For the road transport of hazardous materials, the final selection and implementation of the Project Transport Management Plan (i.e. road transport routes) for the transportation of hazardous materials would be carried out in consultation with the consent authorities and in accordance with NSW Government's *Hazardous Industry Planning Advisory Paper No 11 on Route Selection, January 2011*.

3.2.3 Internal access and parking

The preliminary site layout plan in Figure 5 shows the internal access roads, the direction of flow and parking areas for on-site workers, site visitors (close to the main entrance) and for heavy vehicles (to the south west of the Project Site). The site layout and the internal road network would be further refined during detailed design and before the site configuration is finalised for construction. In order to optimise efficiency and reduce the potential safety issues regarding interaction of vehicles, heavy vehicle movements from the access point and while on the site would be in a forward direction and include exiting the site on Line Road which connects directly to Deniliquin Barham Road.

Car parks will be provided for both light vehicles and heavy vehicles (Figure 5). All car parks would be designed in accordance with Australian Standards AS2890.

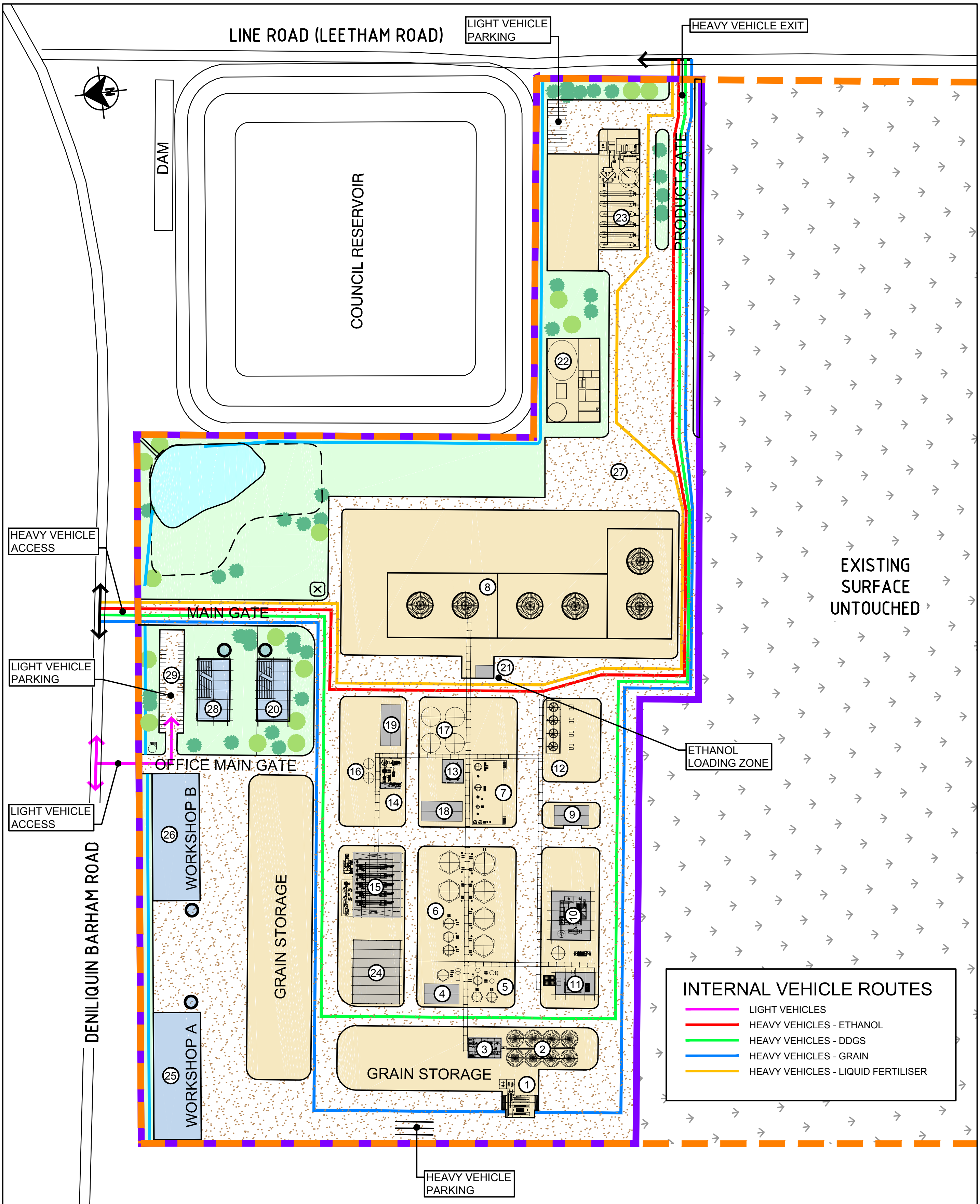
3.2.4 Rail transport

The proposal is to transport 70 percent of the raw materials and output products from the ethanol production using the rail network. The longer term plan is to provide a rail siding on the western boundary of the site which connects to the Deniliquin Railway line immediately to the east of the site.

For the short term, the raw materials and products would be trucked to/from the Rice Grower's siding approximately 3 km to the north east. This assumption has been adopted for the traffic assessments included in this report.

Qube Logistics, the sole operator of the rail line into Deniliquin has been consulted and has confirmed that there is available capacity on this line (either by existing and / or expanded services) for all the proposal's rail freight needs. Details around the specific requirements for transporting the ethanol product would be defined at the next stage of Project development.

Internal Vehicle Routes and Parking



LEGEND

ROADWAY
SITE BOUNDARY
PROJECT BOUNDARY
LANDSCAPING
RAIN HARVESTING TANK
PAVEMENT AREA
HARDSTAND AREA
ROOFWATER CATCHMENT
BIO-RETENTION & FLOOD DETENTION BASIN
VEGETATED SWALE
STORMWATER HOLDING TANK
PARKING

1 Grain Intake
2 Grain Storage
3 Grain Preparation & Milling
4 Enzyme Storage
5 Gelatinization & Liquefaction
6 Fermentation
7 Distillation (Mash Tower, Rectifier Tower, Sieve Column & Dehydration)
8 Product Storage
9 Substation
10 Boiler & Air compressor
11 Water Treatment
12 Cooling Tower
13 Decanter
14 Evaporator
15 Dryer
16 Syrup Tank
17 Stillage Storage Tank
18 Control Room
19 Maintenance Room
20 Office
21 Ethanol Loading
22 Waste Water Treatment
23 Anaerobic Digestion
24 DDGS Storage & Loading Area
25 Workshop A
26 Workshop B
27 Impermeable Pavement
28 Training & Development Centre
29 Staff & Visitor Car Park

AECOM

0 100m

FIGURE 5

4.0 Transport movements and impacts

4.1 Construction phase

4.1.1 Assumptions

For the construction phase of the Project, the following assumptions have been made:

- The construction period is between 14 to 16 months.
- It is estimated that the average number of construction workers on-site would be up to around 350 per day during periods of peak construction activity.
- The construction workforce would mostly reside in Deniliquin.
- For weekdays, the construction activities would be carried out between 7:00 am to 6:00 pm. For Saturdays, the allowable hours for construction activities would be limited to between 8:00 am to 1:00 pm. No construction activities would be carried out on Sundays and Public Holidays.
- The estimated number of overall daily vehicular trips is around 300 vehicles per day during periods of peak construction activities (i.e. 150 vehicles per day per direction based on 50 percent inbound and 50 percent outbound).
- The plant would be constructed on-site with no large pre-prefabricated equipment to be transported to site. Hence, there is not expected to be over-size and over-mass (OSOM) vehicles required to transport large equipment to the site.
- On average, the estimated breakdown of the daily total vehicles is approximately 80 percent workforce vehicles (244 light vehicle and shuttle bus trips) and around 20 percent construction related vehicles (56 heavy vehicle trips).
- For the purpose of the assessment, apart from personal light vehicles and shuttle buses, no other transport option has been included (in terms of road based transport for workforce).
- However, shuttle bus service (assumed 40 seater shuttle bus / coach) could be provided to transport the workforce living in Deniliquin to minimise the shorter distance trips between Deniliquin and the proposed Project Site. Each bus trip would be equivalent to removing 40 workers' vehicles from the road network.
- It is anticipated that a temporary concrete batching plant would be built on-site so the overall vehicle movements would include the delivery of cement, aggregate and sand from local quarry suppliers. Steel and other metal components would likely be delivered from Melbourne or Sydney.

4.1.2 Construction vehicle movements

The daily and hourly construction-related vehicle movements (both light and heavy vehicles) during the period of peak construction activities are presented in Table 5 and Table 6 respectively.

Table 5 Daily construction traffic volumes

Daily Total Vehicle Trips	
Period of Peak Construction Activities	
Daily Vehicle Trips	Up to 300 total vehicles per day (~150 vehicles per direction per day)
Workforce	On average 350 workers on-site per day
Construction Light Vehicles	
Workforce (Own Light Vehicle)	110 LV (110 workers)
Daily Workforce (Car)	220 car trips per day
Remaining Workforce using Shuttle Bus	240 workers catching shuttle buses (40-seater bus)
Shuttle Bus per Day	24 shuttle bus trips per day (12 shuttle bus trips per shift change with 6 bus trips per direction per shift)

Daily Total Vehicle Trips	
Traffic volume at start and end of shift (7:00 am and 6:00 pm)	**244 vehicle trips per day** (122 two-way trips per shift change with 110 car trips and 12 bus trips per shift change)
Construction Heavy Vehicles	
Construction Vehicles (HV)	**56 HV trips per day** (28 HV per direction per day)

Table 6 – Hourly construction traffic volumes

Hourly Total Vehicle Trips (During Shift Change)	
Period of Peak Construction Activities	
Hourly LV Vol. **(**based on **a** single **11-hour shift between 7:00 am and 6:00 pm)**	**110** LV per hour (110 inbound am peak and 110 outbound pm peak) **12** bus trips per hour during am and pm shift change
Hourly HV Vol.	**6** HV per hour (3 HV per direction per hour)
Total (LV + HV) Peak Hour Vol. **(**based on **a** single **11-hour shift between 7:00 am and 6:00 pm)**	**128** vehicles per hour <u>AM Peak</u> 119 vehicles inbound 9 vehicles outbound <u>PM Peak</u> 9 vehicles inbound 119 vehicles outbound

The peak daily traffic volumes for the construction phase are presented in Plate 4.

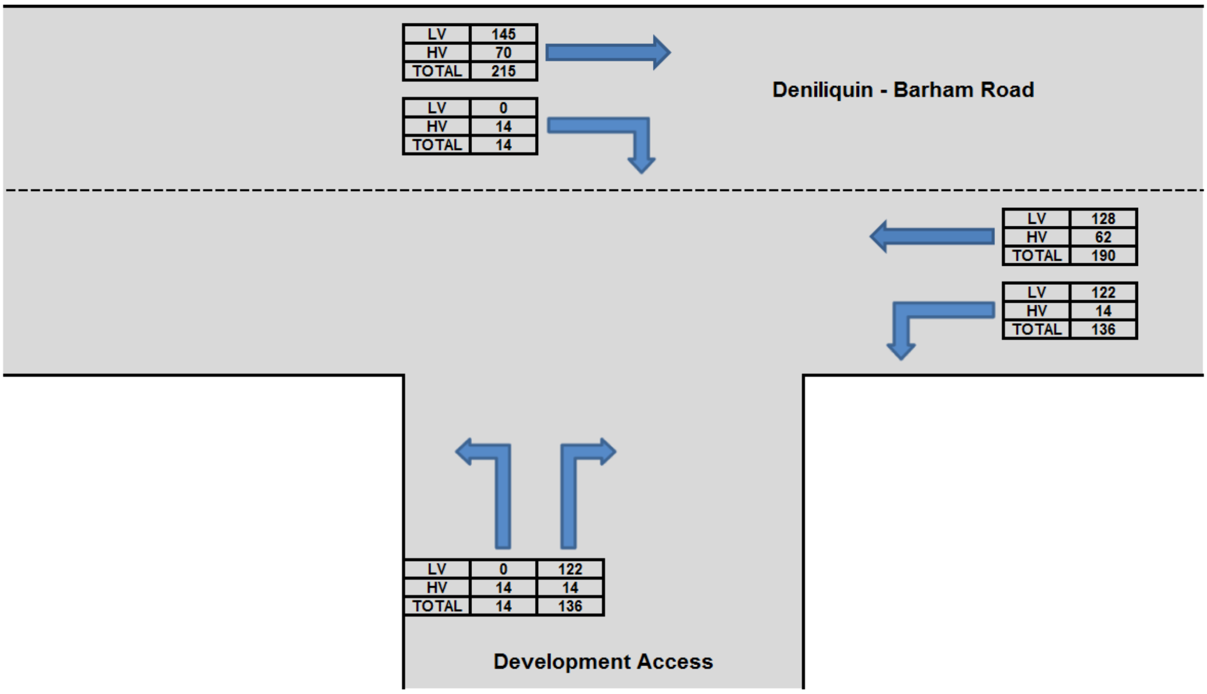


Plate 4 **Construction Phase Daily Traffic Generation**

Note: Background traffic volumes are based on observed traffic counts conducted by Dongmun Greentec Pty Ltd in January 2014 for Deniliquin Barham Road and pro rata to AADT data (405 AADT) provided by Deniliquin Council in June 2015 for Deniliquin Barham Road

4.2 Operations phase

Traffic movements related to the operations phase of the plant, apart from the movement of staff (mainly light vehicles), the key movements would be the transportation of raw materials required for the processing as well as the output products from the ethanol production process (mainly heavy vehicles).

4.2.1 Hours of operation

The plant would be operating 24 hours per day, seven days a week over 330 days per annum, allowing for annual plant maintenance when the plant would be shut down.

For the purpose of identifying the likely traffic generation and likely impact on the surrounding road network, it has been assumed, that the number of hours for movement of input/out materials would be during a period of 10 hours per day (generally between 8:00 am and 6:00 pm). This would also take into account the likely impact from the overall operation on the local commuter peak periods.

4.2.2 Workforce

It is anticipated that the workforce would comprise up to 50 full-time staff (including staff-rotation). The daily on-site workforce includes approximately eight administration staff that would be present only during standard working hours (i.e. 8:00 am to 5:00 pm). There would typically be three shifts per day for the technical staff with each shift employing around eight staff members. There would also be four Research and Development (R&D) staff per shift. Shifts would nominally be 7:00 am to 3:00 pm, 3:00 pm to 11:00 pm and 11:00 pm to 7:00 am. For the operations phase, the overall on-site workforce is summarised in Table 7 below.

Staff parking would be provided on site and be designed in accordance with the relevant Australian Standards.

Table 7 Workforce

Workforce	Numbers
Technical Staff (three shifts per day)	8 staff per shift
Research and Development Staff	4 staff per shift
Three shifts	7:00 am to 3:00 pm, 3:00 pm to 11:00 pm, 11:00 pm to 7:00 am
Admin staff (standard working hours)	8 office staff
Full-time staff	up to 50 full-time staff

4.2.3 Input materials / output products

Table 8 summarises the quantity of required input materials and volumes of output products from the process. The anticipated daily vehicle movements are also presented to provide a magnitude of overall traffic generation.

The transport of DDGS product could potentially use the same containers used to transport grains. For the purpose of identifying the likely traffic impacts, the heavy vehicle movements have been kept separate to present a worst case scenario.

Table 8 Annual input / output quantities

Annual Inputs / Outputs	Quantity
Grain (raw material)	
Annual consumption (source regionally)	300,000 tonnes per year
Operational days per year	330 days per year
Operational hours per day	24 hours per day
Daily consumption	909 tonnes per day
70% transport by rail	636 tonnes per day (road transport from siding)
Capacity of wagon	55 tonnes

Annual Inputs / Outputs	Quantity
Number of wagons per day	**approx. 12 wagons per day**
30% transport by road	273 tonnes per day
Capacity of heavy vehicle	30 tonnes
Number of heavy vehicles	**approx. 30 heavy vehicles per direction per day** (including daily trucking from Rice Growers siding)
Ethanol	
Annual capacity of ethanol production	115,000 kl (115 ML)
Operational days per year	330 days per year
Operational hours per day	24 hours per day
Daily production	348,500 litres per day
70% transport by rail	243,950 litres per day (road transport to rail siding)
Capacity per wagon	45,000 litres
Number of wagons per day	**approx. 6 wagons per day**
30% transport by road	104,550 litres per day
Capacity of heavy vehicle	40,000 litres
Number of heavy vehicles	**approx. 9 heavy vehicles per direction per day** (including daily trucking to Rice Growers siding)
Distiller's Dried Grains with Solubles (DDGS)	
Annual capacity of DDGS production	102,000 tonnes per year
Operational days per year	330 days per year
Operational hours per day	24 hours per day
Daily Output	309 tonnes per day
70% transport by rail	217 tonnes per day (road transport to rail siding)
Capacity per wagon	55 tonnes
Number of wagons per day	**approx. 4 wagons per day**
30% transport by road	92 tonnes per day
Capacity per heavy vehicle	30 tonnes
Number of heavy vehicles	**approx. 11 heavy vehicles per direction per day** (including daily trucking to Rice Growers siding)
Liquid Fertilizer (Sludge)	
Annual output	7,854 kl (7.854 ML)
Operational days per year	330 days per year
Operational hours per day	24 hours per day
Daily output	23.8 kl
Capacity per heavy vehicle	20 litres
Number of heavy vehicles	**1 heavy vehicle per direction per day**
Syrup	
Annual output	178,571 kl (178 ML)
Operational days per year	330 days per year

Annual Inputs / Outputs	Quantity
Operational hours per day	24 hours per day
Daily output	541.1 kl
Capacity per heavy vehicle	40,000 litres
Number of heavy vehicles	**14 heavy vehicles per direction per day**

There are other input materials that are required for the ethanol production which would be transported monthly such as Ammonium Phosphate (1 heavy vehicle movement per month), Urea pills or pellets (1 heavy vehicle movement per month), Antifoam Liquid (1 heavy vehicle movement per month), Caustic Soda (1 heavy vehicle movement per month), Hydrochloric Acid Solution (1 heavy vehicle movement per month), and Sodium Hypochlorite (1 heavy vehicle movement per month).

As the number of vehicle movements are relatively small (6 two-way trips per month), for the purpose of the traffic assessment, they have not been considered as part of the typical traffic movement related to the daily operation of the plant.

4.2.4 Daily traffic generation

Light vehicles

The number of light vehicle daily traffic movements during the operations phase would be made up from eight office staff (standard working hours), eight technical staff and four R&D staff per shift (three 8-hr shifts per day).

Allowing for shift changes (7:00 am to 3:00 pm, 3:00 pm to 11:00 pm and 11:00 pm to 7:00 am), the worst case scenario in terms of identifying the number of vehicle trips per hour would be to assume two shifts coming in and out within the same hour (i.e. 12 light vehicles inbound and 12 light vehicles outbound within the same hour). For the office staff, the worst case would be all eight staff arriving or departing within the same hour in the morning and in the afternoon peak periods.

Therefore, taking into account the shift changes for the technical and R&D staff, the number of light vehicles accessing the plant in the morning peak would be 20 inbound and 12 outbound vehicles. For the afternoon peak, the number would be 12 inbound and 20 outbound vehicles. The remaining trips would be during the remaining shift change for the technical staff (i.e. around 11:00 pm at night).

The workforce traffic generation, in terms of light vehicles is summarised in Table 9.

Table 9 Workforce traffic generation (light vehicles)

Periods	Inbound	Outbound
AM peak hour, around shift change (vehicle/hr)	20	12
PM peak hour, around shift change (vehicle/hr)	12	20
Non-peak period, around shift change (vehicle/hr)	12	12
Overall daily (vehicle/day)	44	44

Heavy vehicles

Based on the transportation of raw materials required for the ethanol production and the products from the process, the number of heavy vehicle movements per day are summarised in Table 10 below.

Table 10 Daily heavy vehicle movements

	Vehicles per day per direction	Total Trips (inbound and outbound)
Inputs		
Grain	30	60
Total	***30***	***60***
Outputs		

	Vehicles per day per direction	Total Trips (inbound and outbound)
Ethanol	9	18
DDGS	11	22
Liquid Fertilizer	1	2
Syrup	14	28
Total	***35***	***70***
Overall Total	**65**	**130**

The daily traffic volumes for the operations phase are presented in Plate 5.

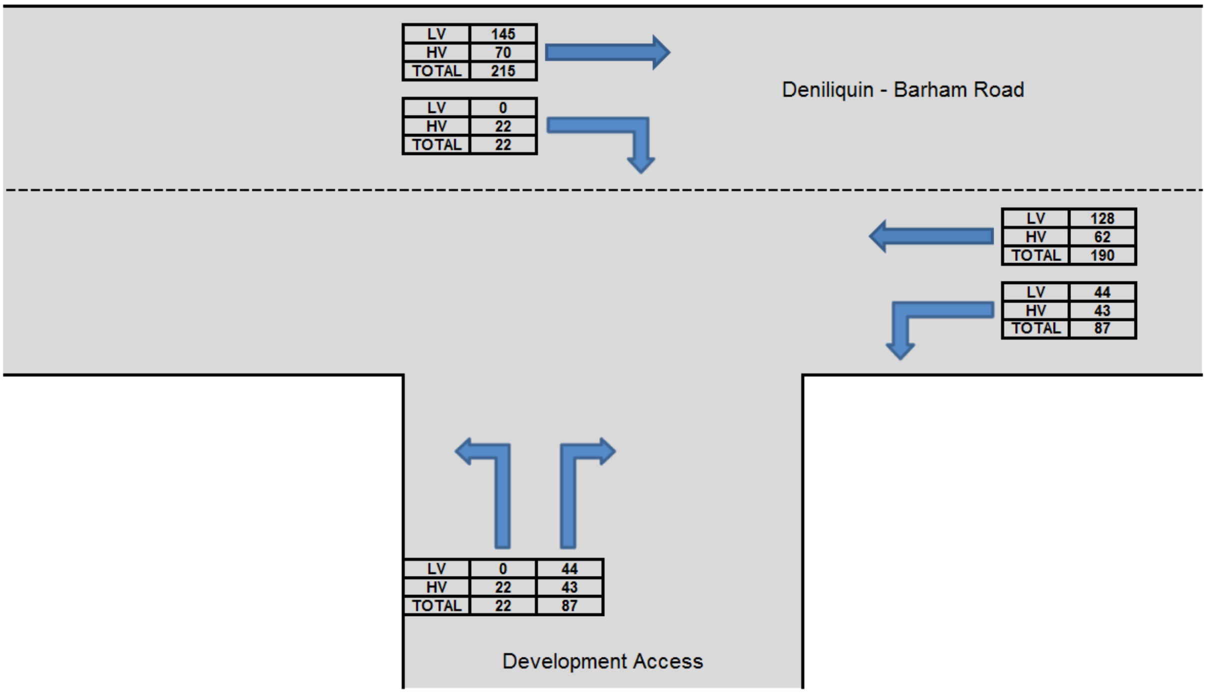


Plate 5 Operations phase daily traffic generation

Note: Background traffic volumes are based on observed traffic counts conducted by Dongmun Greentec Pty Ltd in January 2014 for Deniliquin Barham Road and pro rata to AADT data (405 AADT) provided by Deniliquin Council in June 2015 for Deniliquin Barham Road

4.2.5 Distribution

Light vehicles

For the workforce-related traffic generation, it is assumed that the inbound and outbound trips would be from and to Deniliquin respectively.

Heavy vehicles

As the supply arrangements for the raw materials and distribution of the output products has yet to be finalised based on available suppliers and markets for product, for the purpose of the traffic assessment, it has been assumed that the heavy vehicle movements are split evenly along Deniliquin Barham Road, the Cobb Highway and the Riverina Highway. More detailed assessments including the movement of ethanol products would be carried out in the next design phase once the volume of heavy vehicles and destinations have been confirmed.

4.2.6 Daily and average hourly movements

Input material trips

The daily heavy vehicle turning movements at the site access intersection is 60 heavy vehicles per day. 20 vehicles per day (10 inbound and 10 outbound) would be accessing to/from the west along Deniliquin Barham Road and 40 vehicles (20 inbound and 20 outbound) would be accessing to/from the east along Deniliquin Barham Road (linking to the Cobb Highway and Riverina Highway at Deniliquin).

Output product trips

The daily heavy vehicle turning movements at the site access intersection (for heavy vehicles) is 70 heavy vehicles per day. 24 vehicles per day (12 inbound and 12 outbound) would be accessing to/from the west along Deniliquin Barham Road and 46 vehicles (23 inbound and 23 outbound) would be accessing to/from the east along Deniliquin Barham Road (linking to the Cobb Highway and Riverina Highway at Deniliquin).

Average hourly movements

The number of workforce related light vehicles accessing the plant in the morning peak, taking into account the shift changes for the technical and R&D staff, would be 20 inbound and 12 outbound vehicles. For the afternoon peak, the number would be 12 inbound and 20 outbound vehicles. The remaining trips would be during the remaining shift change for the technical staff (i.e. around 11:00 pm at night).

Assuming the movement of materials by heavy vehicles occurs over a 10-hour period per day, the overall hourly movement is around 13 vehicles per hour with six to seven vehicles per hour per direction. In terms of distribution, on average, five vehicles per hour (two to three inbound and two to three outbound) would be accessing to/from the west along Deniliquin Barham Road and eight vehicles (four inbound and four outbound) would be accessing to/from the east along Deniliquin Barham Road (linking to the Cobb Highway and Riverina Highway at Deniliquin).

4.3 Summary of impacts

The potential traffic impacts related to the construction and operations phases of the proposed ethanol plant have been considered to identify the potential level of impact from the Project on the transport system.

- Construction phase – the assessment included identifying the transport impact from the movement of materials, workforce and equipment/components required for the establishment of the facility and supporting infrastructure. The assessment included identifying the movement of construction related vehicles (light vehicles and heavy vehicles) during the construction period (daily and peak periods).
- Operations phase – the traffic generation from the movement of the workforce, required raw materials as well as products from the ethanol production process.

4.3.1 Construction phase

The construction activities would be carried out between 7:00 am and 6:00 pm on weekdays and from 8:00 am to 1:00 pm on Saturdays. The overall traffic volume related to the construction phase is around 300 vehicles per day (two-ways) during periods of peak construction activities. This is mainly due to the movement of the workforce during the start and end of shift with 122 worker related vehicle trips accessing the site around 7:00 am and 122 worker related vehicle trips exiting the site around 6:00 pm. However, this could be further reduced by providing shuttle bus services (assume 40-seater shuttle bus) for the construction workforce travelling between the site and Deniliquin. The use of the buses to shuttle workforce between the site and Deniliquin would be further considered in the next design phase.

The average number of daily construction-related heavy vehicle movements is up to 56 heavy vehicle movements (two-way) during periods of peak construction activities. This relates to approximately up to six heavy vehicles per hour (two-way) during period of peak construction activities. Overall, based on construction activities to be carried out between 7:00 am to 6:00 pm during the weekdays, this is equivalent to around one heavy vehicle every ten minutes during periods of peak construction activities.

The existing traffic volume along Deniliquin Barham Road is around 405 vehicles per day (with 32.6 percent heavy vehicles). Due to its low background traffic volume, the estimated daily construction related traffic (300 vehicles per day) during peak construction activities is around 74 percent of the current daily traffic volumes. However, if the traffic volume of 1,696 vehicles per day (with 10.6 percent heavy vehicles) along Deniliquin

Barham Road (west of Calimo Street) is to be adopted as the background traffic volume, the Project generated construction traffic would be reduced to around 18 percent of the current background traffic.

Furthermore, apart from comparing the percentage of development traffic against the existing background traffic, the overall breakdown in terms of vehicle types and frequency of vehicles accessing the site should also be considered with one heavy vehicle every ten minutes during periods of peak construction activities.

For a two-lane rural road on level terrain with a design speed of 100 km/hr and with heavy vehicles exceeding 15 percent; the estimated capacity would be around 2,290 vehicles per hour (based on peak hour flow for Level of service E[3]). For the weekday peak hour, the performance standard for a two-lane rural road, as recommended in RTA's *Guide to Traffic Generating Developments,* would be Level of Service C (LoS C), which equates to around 870 vehicles per hour.

Assuming the peak hour traffic volumes for a rural road are around 15 percent of the daily traffic volume (for the purpose of this assessment); the estimated peak hour traffic volume would be around 61 vehicles per hour (based on 405 vehicles per day). The additional traffic volume generated by the construction activities during the peak hour would be around 128 vehicles per hour. Therefore the peak hour traffic volume along Deniliquin Barham Road would only be around 189 vehicles per hour which is relatively low compared to the peak hour volume of 870 vehicles per hour for a two-lane rural road with LoS C.

Furthermore, even if the traffic volume of 1,696 vehicles per day at the eastern end of Deniliquin Barham Road is to be adopted (or around 255 vehicles per hour at 15 percent of the daily traffic volume), the additional peak hour volume would still be below 870 vehicles per hour for LoS C (overall around 383 vehicles per hour). Hence the peak hour traffic generated during the construction phase is unlikely to have an adverse impact on the performance of the surrounding road network.

Moreover, with the average number of heavy vehicles generated during the construction phase, being one heavy vehicle every ten minutes, it is considered to be relatively low in comparison to the existing traffic volumes[4] on the key road connections (namely Cobb and Riverina Highways accessed by the construction vehicles) and hence unlikely to have a significant impact on the operational efficiency of these key road links.

Council is upgrading a 2 km section of Deniliquin Barham Road from the Ochtertyre Street roundabout with Cobb Highway approximately 2.6 km to the east of the Project Site. The road is being widened, strengthened and resurfaced for the use of road trains and the upgrade would assist in maintaining a safer road network for Deniliquin and hence the upgrade would be a benefit to the Project.

In terms of pavement impact, the magnitude of heavy vehicles generated by the Project during the construction phase at 56 vehicles per day is between 31 to 42 percent of the heavy vehicle volumes for the existing background traffic along Deniliquin Barham Road (405 * 32.6% = 132 and 1,696 * 10.6% = 180). Hence, the magnitude of ESA for the Project generated construction heavy vehicles would be between 31 and 42 percent of the background ESA value for Deniliquin Barham Road.

Therefore, the section of Deniliquin Barham Road, between the Project Site and the end of Council's upgrade work, is likely to experience some pavement impact by the Project during the construction phase (14 to 16 months) and would be the subject of further discussions with Deniliquin Council to identify how to best ameliorate the impact.

Of the 56 heavy vehicles per direction per day accessing the site during the period of peak construction activities, 28 heavy vehicles per direction per day would be accessing to and from the west and 28 heavy vehicles per direction per day would be accessing to and from the east. Hence, the number of heavy vehicles accessing the Cobb and Riverina Highways is likely to be around four heavy vehicles per direction per hour and hence unlikely to cause adverse impacts on these highways.

4.3.2 Operations phase

During the operations phase, the number of light vehicle movements is about 32 vehicles per hour (two-way) for the AM and PM peak periods (which equates to one vehicle every three minutes in the peak direction and one vehicle every five minutes in the non-peak direction during the morning and afternoon peaks). The remaining 24 light vehicles would be from the shift change around 11:00 pm.

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[3] RTA *Guide to Traffic Generating Developments*, Table 4.5 - peak hour flows on two-lane rural roads (vehicles/hr), (Design speed of 100km/hr)
[4] Existing daily traffic volumes for Cobb and Riverina Highways as presented in Table 1

The heavy vehicle two-way movement is around 13 vehicles per hour (six to seven vehicles per hour per direction) which is equivalent to one vehicle ever four to five minutes.

The current traffic volume along Deniliquin Barham Road is around 405 vehicles per day (June 2015). Due to its low background traffic volume, the estimated daily operation Project related traffic (218 vehicles per day) is around 54 percent of the current daily traffic volumes. However, if the traffic volume of 1,696 vehicles per day along Deniliquin Barham Road west of Calimo Street is to be adopted as the background traffic volume, the Project operations generated traffic would be reduced to around 13 percent of the current background traffic.

Furthermore, apart from comparing the percentage of development traffic against the existing background traffic, the overall breakdown in terms of vehicle types and frequency of vehicles accessing the site should also be considered with one heavy vehicle every four to five minutes during the operations phase.

For a two-lane rural road on level terrain with a design speed of 100 km/hr and with heavy vehicle exceeded 15 percent; the estimated capacity would be around 2,290 vehicles per hour (based on peak hour flow for Level of Service E[5]). For the weekday peak hour, the performance standard for both major and minor rural roads, as recommended in RTA's *Guide to Traffic Generating Developments,* would be Level of Service C (LoS C), which equates to around 870 vehicles per hour.

Assuming the peak hour traffic volume for a rural road is around 15 percent of the daily traffic volume (for the purpose of this assessment); the estimated peak hour background traffic volume would be around 61 vehicles per hour. The additional peak hour traffic volume generated by the operations phase would be around 45 vehicles per hour (with approximately 32 light vehicle workforce trips and 13 heavy vehicle trips). Therefore the peak hour traffic volume along Deniliquin Barham Road would be around 103 vehicles per hour which is relatively low compared to the peak hour volume of 870 vehicles per hour for a two-lane rural road with LoS C.

Furthermore, even if the traffic volume of 1,696 vehicles per day at the eastern end of Deniliquin Barham Road is to be adopted (or around 255 vehicles per hour at 15 percent of the daily traffic volume), the additional peak hour volume would still be below 870 vehicles per hour for Los C (overall around 300 vehicles per hour). Hence the peak hour traffic generated during the operations phase is unlikely to have an adverse impact on the performance of the surrounding road network.

Moreover, with the average number of heavy vehicles generated during the operations phase being one heavy vehicle every four to five minutes, it's impact on the surrounding road network is considered to be relatively low and hence unlikely to have a significant impact on the operational efficiency of other key road connections (namely Cobb and Riverina Highways accessed by the vehicles from the operations phase).

Council is upgrading a 2 km section of Deniliquin Barham Road from the Ochtertyre Street roundabout with Cobb Highway approximately 2.6 km to the east of the Project Site. The road is being widened, strengthened and resurfaced for the use of road trains and the upgrade would assist in maintaining a safer road network for Deniliquin and hence the upgrade would be a benefit to the Project.

In terms of pavement impact, the magnitude of heavy vehicles generated by the Project during the operations phase at 130 vehicles per day is of similar magnitude to the heavy vehicle volumes of the existing background traffic along Deniliquin Barham Road (405 * 32.6% = 132 and 1,696 * 10.6% = 180). Hence, the magnitude of ESA for the Project related heavy vehicles on Deniliquin Barham Road would be similar to the existing background ESA.

Therefore, the section of Deniliquin Barham Road, between the Project Site and the end of Council's upgrade work, is likely to be impacted by the Project and would be the subject of further discussions with Deniliquin Council to identify how to best ameliorate the pavement impact.

Of the 65 heavy vehicles per direction accessing the site per day, 22 heavy vehicles per direction per day would be accessing to and from the west and 43 heavy vehicles per direction per day would be accessing to and from the east. Hence, with majority of the heavy vehicles travelling between the site and Deniliquin Rice Growers Siding east of the site (say around 29 heavy vehicles per direction per day transporting grains and ethanol); the number of heavy vehicles accessing the Cobb and Riverina Highways is likely to be relatively small and unlikely to cause any adverse impacts on these highways.

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[5] RTA *Guide to Traffic Generating Developments*, Table 4.5 - peak hour flows on two-lane rural roads (vehicles/hr), (Design speed of 100km/hr)

4.3.3 Rail transport

The proposal is to transport 70 percent of the raw materials and output products from the ethanol production using the rail network. For the longer term, the plan is to provide a rail siding on the western boundary of the site which connects to the Deniliquin Railway line immediately to the east of the site. However, for the proposed Project, the raw materials and products would be trucked to/from the Rice Grower's siding approximately 3 km to the north east. This assumption has been adopted for the traffic assessments included in this report.

Qube Logistics, the sole operator of the rail line into Deniliquin has been consulted and confirmed that there is available capacity on this line for all the proposal's rail freight needs. Details around the specific requirements for transporting the ethanol product would be defined at the next stage of Project development.

5.0 Mitigation and management measures

The following environmental management measures would be implemented during the detailed design, construction and operations phases.

For the detailed design phase:

- For any works on road corridors during construction, a detailed Road Use Management Plan (RMP) (to include details on the number, type and duration of the vehicle movements, traffic management and controls, and consideration of public transport) would be prepared by the construction contractor for the Project further to discussions with RMS and Deniliquin Council including any detailed traffic control plans.
- A Transport Management Plan (TMP) for the operations phase would be provided to RMS and Deniliquin Council for review prior to Project works or Project related works occurring. Where appropriate, the TMP would also provide details on the number, type and duration of the vehicle movements, description of intended access locations, consideration of public transport, and transportation of hazardous materials.
- Intersections to enter and exit the site during operations phase be designed during the detailed design phase to meet the Road Design Guide (RTA) and Austroads Guide to Road Design, including provision of acceleration and deceleration lanes where required. To be discussed with Deniliquin Council.
- The condition of the public roads to be used for the delivery of raw and fabricated materials should be established prior to commencement of works and then regularly monitored during the period of the works. The road and intersection conditions should be established by the use of field surveys and regular site inspections. When required, rehabilitation of the pavement and/or edges of seal, shoulders and verges would be carried out. At the completion of the construction works, the access roads should be in the same or be of superior condition than at the commencement of the works.
- The measures required to ensure safety and structural integrity of the section of Deniliquin Barham Road between the development site and the end of Council's upgrade (during construction and operations phases) would be the subject of further discussions with Deniliquin Council. Once more detail is known around the exact construction vehicles and routing, then more detailed vehicle swept path analysis should be undertaken along the heavy vehicle route (if required). The outcomes would be included within the RMP.
- Large oversize materials (if required) should be transported outside of peak traffic times to reduce impacts on road network (subject to RMS approval) and the police should be contacted for any of these movements.

For the construction phase:

- For safety reasons, the Deniliquin Barham Road entry and exit should have traffic control in place during the construction phase. Adequate signage should be displayed to inform motorists of the approach to the intersection for construction traffic turning. This should form part of a Traffic Control Plan (governed by Australian Standard AS 1742.3 – 2009) for the construction phase of works.
- Once more detail is known around the exact vehicles to be used and the actual routing, detailed vehicle swept path analysis (to demonstrate the manoeuvring paths of the heavy vehicle to be used) should be undertaken along the heavy vehicle routes if required.

For the operations phase:

- Transportation of hazardous materials would be carried out in consultation with the consent authorities and in accordance with NSW Government's *Hazardous Industry Planning Advisory Paper No 11 on Route Selection, January 2011*. The TMP would include the following:
  - Hours of operation.
  - Routes to be used through the affected local government area(s).
  - The quantity of hazardous goods (i.e. ethanol product) to be transported.
- With the available capacity at the existing Rice Grower's siding, no additional rail siding would be required for the ethanol plant in the short term.
- In terms of fatigue and drivers' behaviour, site induction are to be provided for all staff (both construction and operations phase) on traffic and site access requirements, including the use of the Project identified transport routes (to be detailed within the RMP and TMP).

6.0 Conclusion

This traffic impact assessment has concluded that the impact of the Project on the local and wider road network is likely to be minimal, for both the construction and operations phases.

In view of the relatively low heavy vehicle volumes (56 vehicles per direction per day during peak construction activities and 65 heavy vehicles per direction per day during daily operations) the overall traffic impact from the heavy vehicles on the surrounding road network is not considered to be significant. Furthermore, the light vehicle movements would be readily accommodated on the local road network.

For the operations phase, of the 65 heavy vehicles per direction accessing the site, 34 heavy vehicles per direction would be accessing to and from the east. Hence, with 29 heavy vehicles per direction (transport of grains and ethanol) travelling between the site and Deniliquin Rice Growers Siding east of the site, the number of heavy vehicles accessing the Cobb and Riverina Highways is likely to be relatively small and unlikely to cause adverse impacts on these highways.

Council is upgrading a 2 km section of Deniliquin Barham Road from the Ochtertyre Street roundabout with Cobb Highway approximately 2.6 km to the east of the Project Site. The road is being widened, strengthened and resurfaced for the use of road trains and the upgrade would assist in maintaining a safer road network for Deniliquin and hence the upgrade would be a benefit to the Project.

The impact from the heavy vehicles during the construction phase is less than the operations phase in terms of timeframe (14 to 16 months construction period) and heavy vehicle volume (with 56 heavy vehicles per day for construction phase and 130 heavy vehicles per day for the operations phase). The magnitude of the Project related heavy vehicle volumes calculates ESA is to be around 31 to 42 percent of the existing heavy vehicle background traffic on Deniliquin Barham Road (depending on the background traffic volume used). The magnitude of heavy vehicles generated by the Project during the operations phase at 130 vehicles per day is of a similar magnitude to the heavy vehicle volumes of the existing background traffic along Deniliquin Barham Road. Hence, the ESA for the Project operations generated heavy vehicles would be of a similar magnitude to the existing ESA.

Therefore, the section of Deniliquin Barham Road, between the Project Site and the end of Council's upgrade work, is likely to be impacted by the Project and would be the subject of further discussions with Deniliquin Council to identify how to best ameliorate potential impacts for the construction and operations phases.

The impact of the additional traffic on the existing intersections (namely the proposed site accesses along Deniliquin Barham Road and at the intersection between Deniliquin Barham Road and Line Road) is expected to be minimal; however, there would be potential safety impacts due to large construction vehicles turning across the Deniliquin Barham Road at the site entrance and exit intersections. Traffic management measures would be in force to ensure vehicles could access and depart the site safely.

Site access is provided for light vehicles accessing the main office area with separate heavy vehicle access for the delivery of raw materials and empty heavy vehicles for picking up ethanol and other co-products. The access driveways are located along the straight sections of road with available sight distances (in both directions) that more than satisfy the requirement for a 100 km/hr road.

The detailed design of the site access configurations would be carried out as part of the next design phase. The access driveways would be designed in accordance with Australian Standards AS 2890 for the vehicular access to the car park as well as the heavy vehicle access points to and from the proposed ethanol plant allowing access for heavy rigid and articulated vehicles.

The hourly traffic generation during the operations phase is relatively low with around 42 vehicles per hour during the morning and afternoon peaks (with 32 light vehicles and 13 heavy vehicles accessing the site at each peak). For the remaining operational hours of the day (excluding the change of shift at 11:00 pm), there would be 10 heavy vehicles per hour (with six to seven heavy vehicles per direction) generated by the Project. Therefore, the additional traffic, associated with the operations phase, is unlikely to have an adverse traffic impact on the surrounding road network.

Appendix N

Preliminary Hazard Analysis Technical Report

Deniliquin Ethanol Plant EIS
Dongmun Greentec
02-Oct-2015

Deniliquin Ethanol Plant

Technical Report - Preliminary Hazard Analysis (PHA)

Deniliquin Ethanol Plant

Technical Report - Preliminary Hazard Analysis (PHA)

Client: Dongmun Greentec

ABN: 11158522000

Prepared by

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Quality Information

Document Deniliquin Ethanol Plant

Ref 60344248

Date 02-Oct-2015

Prepared by Lauren Bowden and Delene Kock

Reviewed by Kevin Blackie

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	10-June-2015	Draft for Review	James MacDermott Practice Leader Approvals	J. MacDermott
B	12-Jun-2015	For Submission	James MacDermott Practice Leader Approvals	J. MacDermott
C	21-Aug-2015	Partial Quantitative Risk Assessment	James MacDermott Practice Leader Approvals	J. MacDermott
0	28-Aug-2015	Issued for Adequacy	James MacDermott Practice Leader Approvals	J. MacDermott
1	02-Oct-2015	Final	James MacDermott Practice Leader Approvals	J. MacDermott

Table of Contents

Executive summary

Dongmun Greentec Pty Ltd. is seeking approval for the development of an Ethanol Production Plant with the capacity to produce 115 ML of ethanol per annum at Deniliquin, New South Wales (NSW).

AECOM Australia Pty Ltd (hereinafter referred to as AECOM) were engaged by Dongmun to undertake a Preliminary Hazard Analysis (PHA) for the proposed Deniliquin Ethanol Production Plant (the Project).

In accordance with the Director General's Requirements, the key issues for consideration for Hazard and Risk include:

- *A Preliminary Hazard Analysis (PHA) in accordance with Hazardous Industry Advisory Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis and Multi-Level Risk Assessment*
- *Details of fire/ emergency measures and procedures*
- *Detail contingency plans for potential incidents or equipment failure during the operation of the Project.*

The Project proposes to store, handle and produce hazardous chemicals including Class 3 PGII flammable liquid (i.e. Fuel Grade Ethanol 99.5 percent v/v) and therefore *State Environmental Planning Policy No.33, Hazardous and Offensive Developments* (SEPP33), could apply to the site. As hazardous chemicals would be stored and handled at the Project Site it is necessary to review the hazards associated with the storage and handling of these materials, the proposed safeguards and their effectiveness in managing the hazards and risks.

The hazard and risk analysis was carried out in accordance with the requirements of *Applying SEPP 33 Guideline* and the applicable Department of Planning and Infrastructure's (DP&I) Hazardous Industry Planning Advisory Papers. All hazardous chemicals were identified, assessed and preliminarily screened. Although no hazardous chemicals definitively exceeded the screening assessment requirements, four hazardous chemicals were identified to have possible potentially significant offsite effects namely ethanol, grain dust, corrosive Class 8 chemicals and compressed natural gas (CNG). The study further followed the DP&I Multilevel Risk Assessment approach and identified the following levels of assessment to be adopted:

- Level 1 – Qualitative Analysis, primarily based on the hazard identification techniques and qualitative risk assessment of consequences, frequency and risk. Grain dust and corrosive Class 8 chemicals were assessed against Level 1 criteria.
- Level 2 – Partially Quantitative Analysis, using hazard identification and the focused quantification of key potential offsite risks. Ethanol and CNG were assessed against Level 2 criteria demonstrating the risks are acceptable. The Level 2 criteria included Level 1 criteria as well as the following:
    - Detailed qualification of consequences with appropriate modelling tools
    - Demonstration that the more likely events consequences are contained within the Project Footprint
    - Societal risks are negligible
    - The necessary technical and management safeguards are well understood and readily implemented
    - There are no sensitive surrounding land uses impacted by the Project.

The Preliminary Hazard Analysis Technical Report found that the hazards associated with the facility are not significant with respect to land use safety planning criteria and that appropriate safeguards have been proposed to prevent and mitigate the hazards and risks associated with the storage and handling of hazardous chemicals.

1.0 Introduction

1.1 Background

Dongmun Greentec Pty Ltd. proposes to construct and operate an ethanol production facility at Deniliquin (Deniliquin Ethanol Plant, hereafter referred to as the Project), New South Wales (NSW).

In accordance with the Director General's Requirements the key issues for consideration for Hazard and Risk include:

- *A Preliminary Hazard Analysis (PHA) in accordance with Hazardous Industry Advisory Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis and Multi-Level Risk Assessment*
- *Details of fire/ emergency measures and procedures*
- *Detail contingency plans for potential incidents or equipment failure during the operation of the Project.*

As the Project proposes to store, handle and produce hazardous chemicals including Class 3 PGII flammable liquid (i.e. Fuel Grade Ethanol 99.5 percent v/v) there is the potential that *State Environmental Planning Policy No.33, Hazardous and Offensive Developments* (SEPP33) could apply to the Project Site. As hazardous chemicals would be stored and handled at the Project Site, it is necessary to review the hazards associated with the storage and handling of these materials, the proposed safeguards and their effectiveness in managing the hazards and risks. This report details the hazard analysis conducted for the Project.

1.2 Proponent

Dongmun IRS Co. Ltd was established in 1996 in Korea. The company specialises in the construction and installation of anaerobic fermentation facilities. To obtain approval and operate the proposed ethanol plant in Deniliquin, Dongmun IRS has established Dongmun Greentec Pty. Ltd. in Australia (hereafter referred to as 'Dongmun').

1.3 Objective

The objective of the study is to identify hazards associated with the Project and assess and quantify the off-site effects to people, property and the environment. The study aims to determine the effectiveness of safeguards at the Project Site in maintaining these hazards in the as low as reasonably practicable (ALARP) or acceptable range.

1.4 Scope of the assessment

The hazard analysis of the Project used a multi-level risk assessment approach (NSW DP&I, 2011) as recommended in the *Applying SEPP33 Hazardous and Offensive Development Guidelines* (NSW DP&I, 2011). This is further discussed in Section 2.0. As hazardous chemicals would be stored and handled at the Project Site it is necessary to review the hazards associated with the storage and handling of these materials, the proposed safeguards and their effectiveness in managing the hazards and risks through appropriate assessment.

1.5 Structure of the report

An outline of the sections in this hazard analysis report is as follows:

- a description of the Project, its operations and its location
- processes employed and hazardous chemicals handled and stored
- identification of credible hazard scenarios associated with the storage and handling of hazardous chemicals
- screening assessment, risk prioritization and assessment including:
    - assessment of the potential consequences and impacts on the surrounding communities or environment
    - a review of the proposed safeguards for the Project and their effectiveness in managing the hazards and risks

- an assessment of the acceptability of the level of off-site risks and impacts on the surrounding communities or environment

- a presentation of the findings of the preliminary hazard analysis.

2.0 Methodology

This hazard analysis was based on a desktop assessment of the existing environment and the Project. Referenced information includes:

- information provided by Dongmun
- publicly available information from relevant agencies
- outcomes from an AECOM workshop with Dongmun on 7-May-2015
- NSW Planning and Environment Letter (SSD 13_6281) dated 8-July-2015 and teleconference with Ms L. Donkova on 16 July 2015.

No field work, surveying or consultation with stakeholders was undertaken to prepare this technical report.

2.1 Preliminary risk screening (*Applying SEPP 33)*

A risk screening has been carried out as per *Applying SEPP 33 Application Guidelines* (NSW DP&I, 2011) to determine whether or not SEPP 33 applies.

The following information was used in the risk screening process:

- Details of dangerous goods and otherwise hazardous chemicals involved in the Project - including raw materials, intermediates, and products.
- Dangerous Goods classifications (including subsidiary classes) for the dangerous goods held on site.
- Quantities of dangerous goods and otherwise hazardous chemicals involved in the Project.
- Distance from the boundary for each hazardous chemical.
- Weekly and annual number of deliveries (and the quantities) of dangerous goods and otherwise hazardous chemicals to and from the Project Site.
- The Project Site layout plan. There is no existing development on site.
- Locality plan showing immediate neighbours including residential properties and their land use.

In order to identify hazards outside of the scope of the risk screening method, the following additional information was considered:

- incompatible materials (hazardous and non-hazardous chemicals)
- wastes that could be hazardous
- the possible existence of combustible dusts within confined areas
- types of activities the dangerous goods and otherwise hazardous chemicals are associated with (storage, processing, reaction, etc.)
- incompatible, reactive or unstable chemicals and process conditions that could lead to uncontrolled reaction or decomposition
- storage or processing operations involving high (or extremely low) temperatures and/or pressures.

The dangerous goods which are likely to be stored, handled and produced at the Deniliquin Ethanol Plant are outlined in Section 4.0, Table 3.

2.2 Assessment approach

To determine if the Project is potentially hazardous, a preliminary hazard and risk screening was carried out in accordance with the requirements of *Applying SEPP 33 Guidelines* (NSW DP&I, 2011).

For hazardous scenarios that were identified to have potential significant offsite effects, the study further followed a multilevel risk assessment approach as outlined in the *Multi-Level Risk Assessment Guideline* (NSW DP&I, 2011). The assessment also included the (DP&I) *Hazardous Industry Planning Advisory Papers No. 6, "Hazard Analysis"* (NSW DP&I, 2011)**,** and *No. 4, "Risk Criteria for Land Use Safety Planning*" (NSW DP&I, 2011).

The Multi-Level Risk Assessment approach is summarised in Figure 1 below. There are three levels of assessment, depending on the outcome of preliminary screening. These are:

- **Level 1** – **Qualitative Analysis**, primarily based on the hazard identification techniques and qualitative risk assessment of consequences, frequency and risk.
- **Level 2** – **Partially Quantitative Analysis**, using hazard identification and the focused quantification of key potential offsite risks.
- **Level 3** – **Quantitative Risk Analysis (QRA)**, based on the full detailed quantification of risks, consistent with Hazardous Industry Planning Advisory Paper (HIPAP) No.6 – Guidelines for Hazard Analysis.

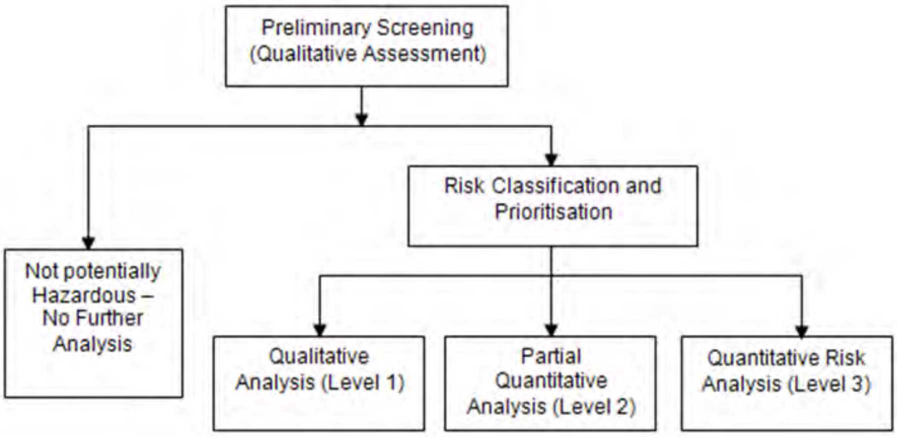


Figure 1 Multilevel risk assessment approach

Generally, qualitative assessments (Level 1) are sufficient in the following circumstances:

- where materials are relatively non-hazardous (for example corrosive substances and hazardous chemicals (non-dangerous goods))
- where the quantity of materials used are relatively small
- where the technical and management safeguards are self-evident and readily implemented
- where the surrounding land uses are relatively non-sensitive.

In these cases, it may be appropriate for a PHA to be relatively simple. Such a PHA should:

- identify the types and quantities of all dangerous goods to be stored and used
- describe the storage/processing activities that would involve these materials
- identify accident scenarios and hazardous incidents that could occur (in some cases, it would also be appropriate to include consequence distances for hazardous events)
- consider surrounding land uses (identify any nearby uses of particular sensitivity)
- identify safeguards that can be adopted (including technical, operational and organisational), and assess their adequacy (having regards to the above matters).

A partially quantitative assessment (Level 2) should address the elements as described in a Level 1 assessment as well as provide sufficient quantification of risk contributors to demonstrate the following:

- consequences of events using appropriate modelling tools
- an estimate of the likelihood for each event confirmed to have significant off-site effects
- an indicative estimate of the off-site risk
- demonstration in principle that no individual event would have a fatality or injury frequency greater than that appropriate for the exposed land use
- demonstration in principle that no combination of events would cumulatively cause individual risk criteria to be exceeded.

A full quantitative risk assessment (Level 3) is required where the societal risk from a proposed development is plotted in the intolerable zone or where a Level 2 assessment is unable to demonstrate that the significant offsite risk criteria can be met.

2.3 Application of the risk management standard

In line with risk management principles described in AS/NZS ISO 31000, the objective of a risk assessment is to identify all hazards, assess the risks, identify controls, and implement controls to monitor and review the effectiveness of the controls, to ensure that risks arising from the operation or maintenance of the installations are managed to an acceptable level. When selecting control methods to manage risk, the hierarchy of risk treatment methods shall be as follows:

- **Elimination**: hazard is eliminated and associated risk is removed.
- **Substitution**: if hazard cannot be eliminated, minimise the risk through substitution of a substance or process that has less potential to cause injury.
- **Isolation**: engineering, design, structural changes to the work environment, plant or equipment which shall isolate persons from the potential risk.
- **Administration**: risk may be reduced through the provision of training, procedures, and other methods.
- **Personal protective equipment**: this control should be used in conjunction with other controls and should not be relied upon in isolation.

The risk management process follows a continuous improvement process and the risks should continue to be assessed throughout the lifecycle of The Project, including when the design of the processes and plant has been further developed. Specific risk minimisation opportunities at various phases in the Project life cycle are further outlined in Section 10.0, Opportunities for risk reduction**.**

3.0 Project description

3.1 Project site location

The Project is located 5.5 kilometres (km) south west of the township of Deniliquin, NSW. The Project Site in its entirety covers an area of approximately 120 ha of land off Deniliquin Barham Road, in the Deniliquin Local Government Area (LGA). The Project Footprint is 25.6 ha. The Project Site is bounded by Deniliquin Barham Road to the north and Line Road to the east as shown in Figure 2.

3.2 Surrounding land use

The current dominant land use in the Project locality is agriculture, including cropping and grazing. Most remnant vegetation within the area has previously been cleared for agricultural development.

The land uses surrounding the Project Site include:

- a council reservoir on the eastern boundary of the Project Site
- the Deniliquin railway line, approximately 300 m east of the Project Site
- residential properties (refer to Table 1)
- Deniliquin aerodrome, approximately 2.7 km east of the Project Site
- Cobb Highway, approximately 3.5 km east of the Project Site
- an industrial precinct including rice mill, approximately 2 km north east of the Project Site.

Figure 2 shows the approximate location of the Project Site relative to the local area.

3.3 Sensitive receptors

The Project Site is surrounded by rural farmland and the council reservoir on the eastern boundary. Further afield there are the saleyards, abattoir and the rice mill to the north east, and Deniliquin airport and cemetery to the east. The closest residential zone that makes up part of Deniliquin township is located approximately 4.2 km to the north east. In closer proximity are scattered rural residences to the north and south of the Project Site.

Five receptors representative of the surrounding land uses were included in the study based on a desktop review of the Project (Table 1). Receptors 1 to 5 represent the nearest residential properties.

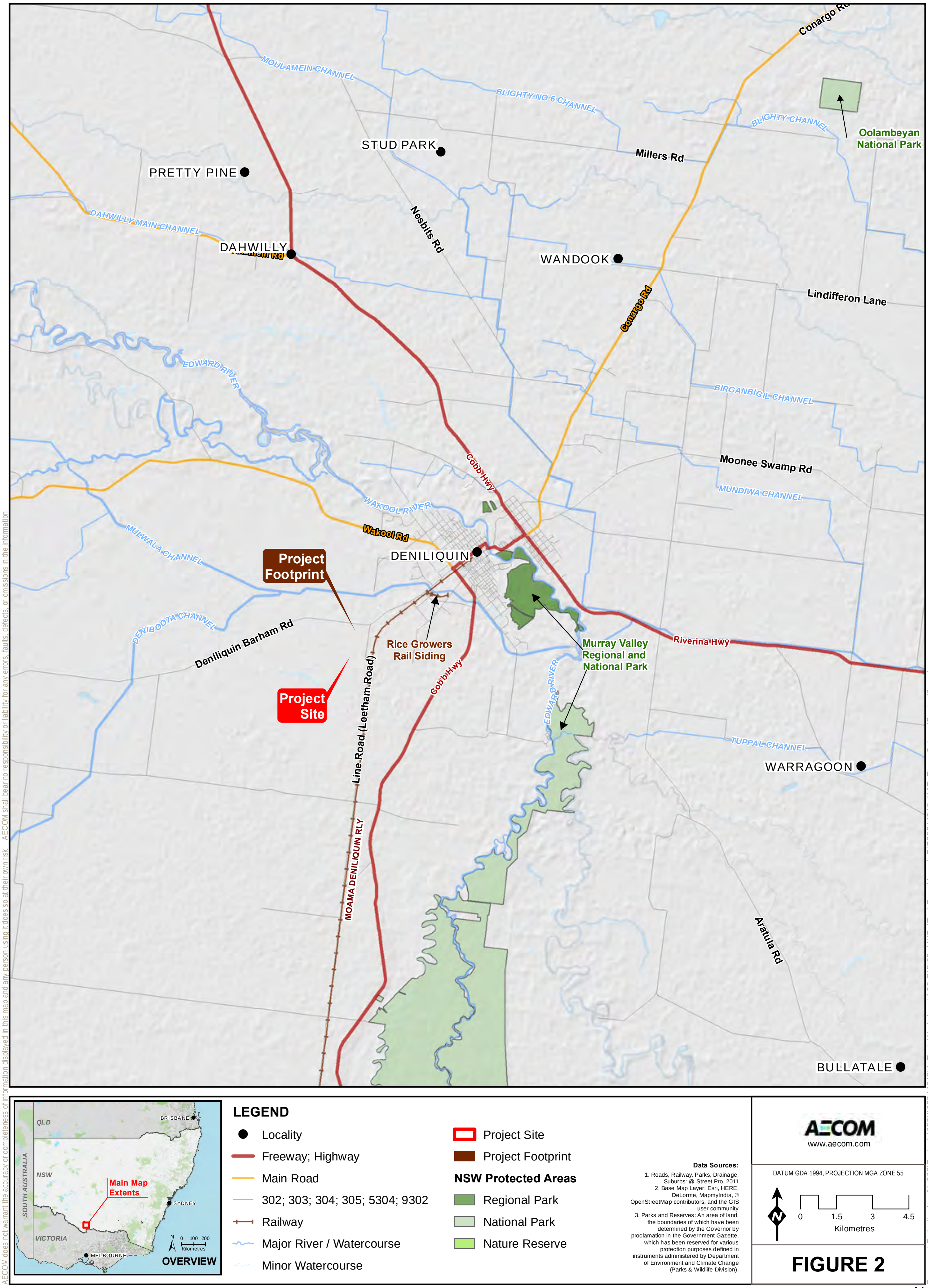
A map indicating the location of the nearest sensitive receivers to the Project, being rural dwellings, is shown in Figure 3.

Table 1 List of surrounding sensitive receptors

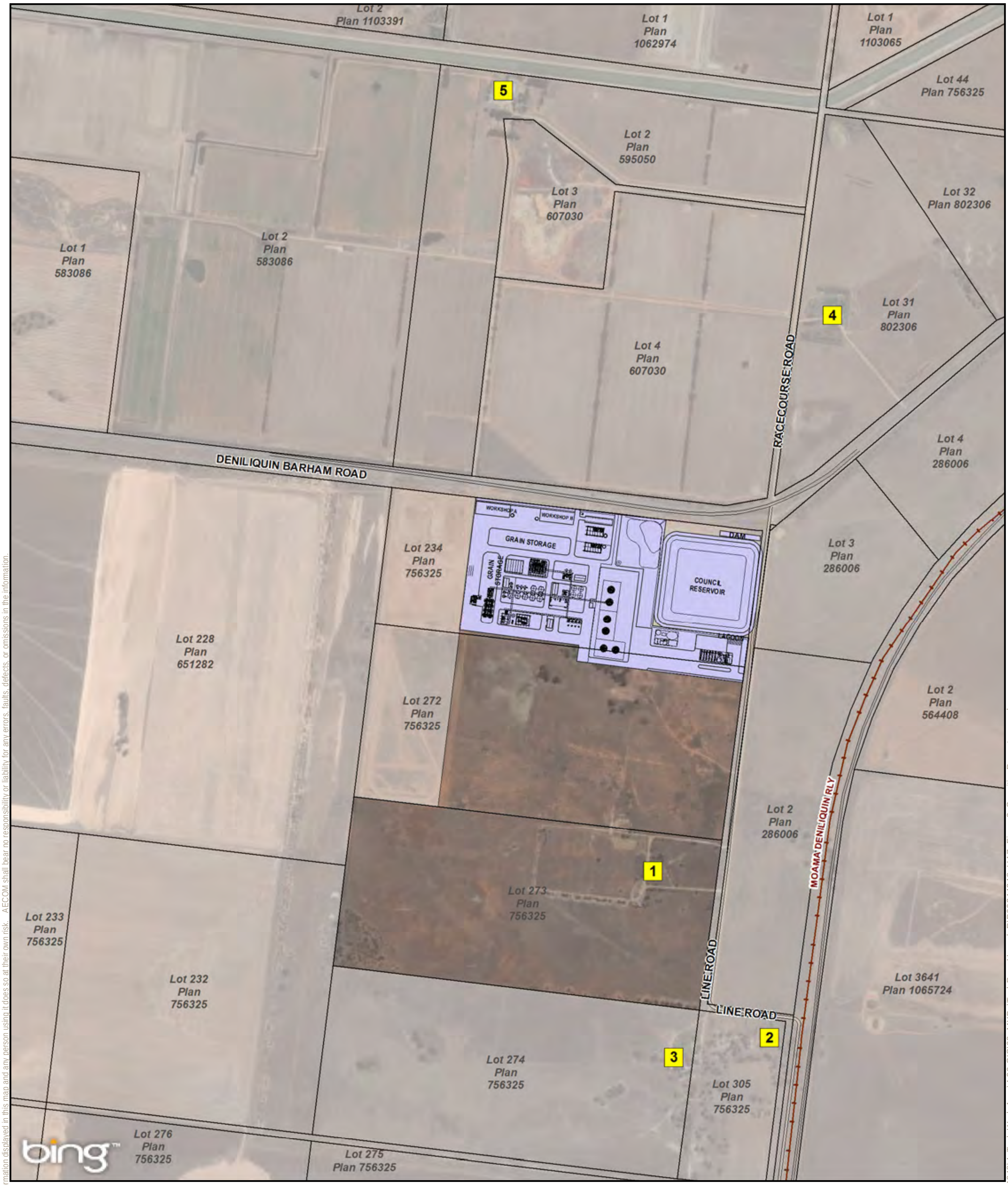
Receptor ID	Easting	Northing	Type	Approximate Distance from Project Site (m) / Direction (degree true)
1	310235	6062318	Rural Residential	500 m S [1]
2	310569	6061841	Rural Residential	850 m SE
3	310295	6061784	Rural Residential	880 m S
4	310749	6063912	Rural Residential	550 m N
5	309806	6064557	Rural Residential	1100 m N

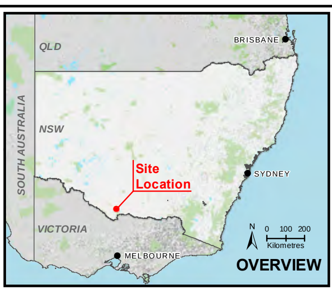
Notes: [1] Measured from Project Footprint to property boundary of the sensitive receptor

Local Context



Location of Sensitive Receptors





LEGEND

- Sensitive Receptors
- Railway
- Site Features
- SITE_SiteLayoutPolyg
- Cadastral Boundaries

Data Sources:
1.Imagery: © 2015 DigitalGlobe © 2015 GeoEye Earthstar Geographics SIO © 2015 Microsoft Corporation
2. Roads, Railway, Drainage, Suburbs, Parks, Localities: @ Street Pro, 2011
3. Key Map Base Layer: ESRI Online
4. Site Layout: based on CAD Drawingd prepared by DONGMUN I.R.S. Co. Ltd.

Disclaimer:
Site Layout is indicative only. To be used for information only. For detailed design reffer to CAD Drawings

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FIGURE 3

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3.4 Meteorological and topographical considerations

The proposed Project Site is situated in an area which is predominantly flat farm land and grass land.

The predominant predicted wind conditions on an annual basis are from the western and southern quadrants. The wind roses which detail the direction and speed of the local wind conditions were taken from the Deniliquin Airport situated approximately 3 km from the Project Site.

Temperatures are usually relatively mild with significant seasonal or day / night variation. Humidity levels are also variable all year around.

The following data was taken from Bureau of Meteorology (BOM) website (BOM, n.d.):

Table 2 Deniliquin BOM data

Bureau of Meteorology Data	Value
Mean Maximum Daily temperature (1997-2015)	23.6^{o}C
Mean Minimum Daily temperature (1997-2015)	9.5^{o}C
Mean Daily Temperature	17^{o}C
Mean 9am relative humidity (1997-2010)	67%
Mean 3pm relative humidity (1997-2010)	39%

Dispersion of gas clouds and impacts of thermal radiation is governed by the prevalent weather conditions including, wind speed and direction (essentially horizontal mixing) and stability of the atmosphere (essentially vertical mixing).The latter is essentially the extent to which wind turbulence, which is responsible for the dispersion, is suppressed or assisted. On cold windless nights, cold air is trapped close to the surface of the earth and any gas release would not be easily dispersed. On the contrary, on a hot summer's day there is generally a lot of turbulence in the air due to heating of the earth's surface and the air in contact with it. This aids dispersion of gases. These conditions had been labelled weather stability classes with the letters A to F. Using the wind and weather information presented in BOM, the following two broad dominant weather categories relate to the Project Site;

- F1.5 (stable and low wind speed 1.5 m/s, typical night time)
- D6 (unstable and low to moderate high wind speed, typical day time).

These represent both low and high wind speed conditions as well as day and night conditions at the Project Site.

3.5 Project description

The Deniliquin Ethanol Plant would produce up to 115 mega litres (ML) of ethanol annually and would include several grain storage silos, the ethanol production plant and a wastewater treatment facility.

The plant would be capable of processing a range of locally grown grain or wheat. Utilizing only the carbohydrate (starch) in the wheat, the primary output from the production is fuel grade ethanol to be sold to the major petroleum companies as additive to regular ULP to produce E10, or to be exported.

The Project aims to process 300,000 tonnes per annum of locally grown wheat to produce fuel grade ethanol. The wheat would be transported to the site and stored on-site prior to processing. The production of ethanol involves the milling of the wheat to flour followed by a cooking, fermentation and distillation process. This process converts starch, which comprises up to 75 percent of the wheat to ethanol. The process would also produce 102,000 tonnes per annum of dried distillers grain with solubles (DDGS) as a process co-product, which would be sold as stock feed. Compressed Natural Gas (CNG) would be piped to the site via a proposed Elgas facility located between the Project Site and the airport (to the east). The ethanol production process and ancillary processes are detailed below.

The proposed site layout for the Project is provided in the layout diagram in Figure 4.

3.5.1 Operation and staff

To meet the processing requirements, the Project will need to operate 24 hours a day, seven days a week with a scheduled four week annual shutdown to allow for plant maintenance.

It is anticipated that the on-site ethanol plant workforce will comprise 50 full-time staff when fully operational. This includes six to eight administration staff and up to six to eight research and development staff that will be present only during standard working hours. There will typically be three shifts per day for technical staff. Shifts will nominally be 7:00 am to 3:00 pm, 3:00 pm to 11:00 pm and 11:00 pm to 7:00 am and operate on a rotational roster.

3.6 Process description

The production of ethanol involves the milling of wheat to flour followed by a cooking, fermentation and distillation process. This process converts starch, which comprises up to 75 percent of the wheat to ethanol. An overview of the proposed ethanol plant processes is further detailed below.

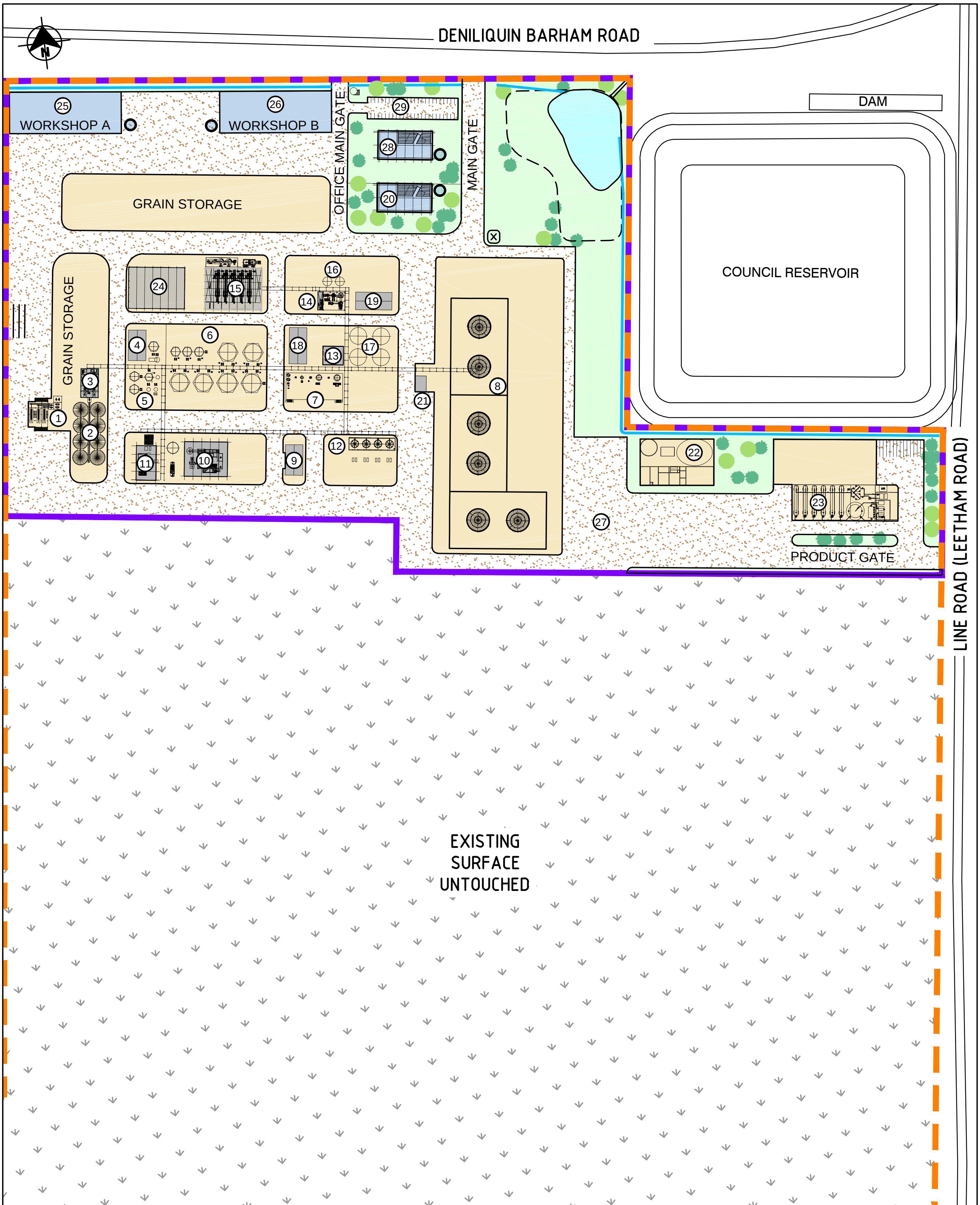
Process stage 1 - Grain intake and processing

1) Heavy vehicles delivering grain will enter and exit the site in a forward direction and travel along internal roads with appropriate signage.
2) Grain Reception and Storage: Grain delivered by heavy vehicles will be transferred to storage silos. This system will be a closed-system to prevent any dust emissions. The dust generated inside the intake hopper during unloading will be filtered by bag-filters.
3) Pre-cleaning: A drum screen will be used to separate foreign material, other than ferrous material, from the grain. The dust generated from this process will be filtered by bag-filters.
4) Magnetic Separator: A magnetic separator will be used to remove ferrous materials from the wheat. The ferrous materials will be collected for recycling.
5) De-branning: Bran is then removed from the grain. The dust generated from this process will be filtered by bag-filters.
6) Flour milling – Hammer milling equipment will be used to mill the de-branned grain into flour. The dust generated from this process will be collected by a bag-filter system.

Process stage 2 - Fermentation

1) Mixing - Flour, process water and enzymes will be mixed firstly in the screw mixer and then in the mixing tank. Within the mixing tank, an agitator will ensure a uniform mixture and caustic soda will be added to adjust the pH to 6.2. The dust generated from the flour will be collected in bag-filters.

Site Layout



CAD REF:P:\603X\60344248\5. CAD\25-SKETCHES\60344248-FIGURE-4.DWG

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LEGEND

- ROADWAY
- SITE BOUNDARY
- PROJECT BOUNDARY
- LANDSCAPING
- RAIN HARVESTING TANK
- PAVEMENT AREA
- HARDSTAND AREA
- ROOFWATER CATCHMENT
- BIO-RETENTION & FLOOD DETENTION BASIN
- VEGETATED SWALE
- STORMWATER HOLDING TANK
- PARKING

1. Grain Intake
2. Grain Storage
3. Grain Preparation & Milling
4. Enzyme Storage
5. Gelatinization & Liquefaction
6. Fermentation
7. Distillation (Mash Tower, Rectifier Tower, Sieve Column & Dehydration)
8. Product Storage
9. Substation
10. Boiler & Air compressor
11. Water Treatment
12. Cooling Tower
13. Decanter
14. Evaporator
15. Dryer
16. Syrup Tank
17. Stillage Storage Tank
18. Control Room
19. Maintenance Room
20. Office
21. Ethanol Loading
22. Waste Water Treatment
23. Anaerobic Digestion
24. DDGS Storage & Loading Area
25. Workshop A
26. Workshop B
27. Impermeable Pavement
28. Training & Development Centre
29. Staff & Visitor Car Park

AECOM

0 100m

FIGURE 4

2) Liquefaction – The slurry made from the mixing process would be pumped to the liquefaction tank. Steam is pumped into the tank where it reacts with the starch in the slurry and becomes gelatinized. The slurry is stirred in the tank to obtain a uniform mixture.

3) Saccharification – The liquefaction slurry would then be pumped to the saccharification tank where an enzyme is added. The slurry is mixed by an agitator to assist the enzyme to convert the starch in the slurry to glucose through hydrolysis. The pH of the slurry is adjusted to 6.2 using hydrochloric acid.

4) Pre-Fermentation – The hydrolysed slurry would then be pumped to the pre-fermentation tank where yeast is added and mixed using an agitator. In this process, the glucose is decomposed and CO_2 ethanol vapour generated would be passed through a vent scrubber, which is absorbed and recovered for future use.

5) Fermentation – The slurry is then pumped to the fermentation tank where it is allowed to ferment. This process produces ethanol and CO_2. The CO_2 would be treated by a vent scrubber for release to the atmosphere.

Process stage 3 – Distillation process

1) Mash Tower – Mash will be fed to a Mash Tower through a feed pump. The Mash will be isolated to ethanol vapour and ethanol whole stillage by steam temperature. Ethanol vapour and inert gas will be exhausted by a ventilation system. Through the process, ethanol vapour will be collected in a vent scrubber. This distillate ethanol will then be sent to the rectification process. Whole stillage will be transferred to the centrifuge and treated in process Stage 5.

2) Rectification – The ethanol isolated in the Mash Tower will be fed to the Rectifier Tower passing through a feed pump and rectified as 95.5 percent of ethanol by differential temperature (steam) and then sent to the Dehydration process. Wastewater which is generated in this process will be treated in the wastewater treatment system via a pipeline.

3) Dehydration – The ethanol (95.5 percent) that is isolated in the Rectifier Tower will be supplied to the Sieve Column through a feed pump and again dehydrated to more than 99.5percent of ethanol and water. Ethanol vapour will be vented in the exhaust system and then collected in the Vent Scrubber. Wastewater will be treated in the wastewater treatment system.

Process stage 4 – Production (Bio Ethanol)

1) Storage tank – More than 99.5 percent of ethanol which is generated in the dehydration system would be stored in the on-site storage tanks. Ethanol vapour which is generated in the tank would be collected by a vent scrubber when vented through the exhaust system. When loading ethanol via a pipe network from the production plant, a breather valve on the top of tank will capture ethanol vapour and send it to the vent scrubber.

2) Loading system – The loading system will use a feed pump to load ethanol products from the storage tanks to a tank truck. At this time, ethanol vapour will be generated but these vapours will be collected safely by a vapour collection system.

Process stage 5 – Dried distillers grain drying process

1) Stillage Centrifuging – Whole stillage would be centrifuged to separate thin stillage (167.95 tonnes per hour) and wet distiller's grain (WDG) (35.32 tonnes per hour).

2) Evaporation – The thin stillage would then be evaporated to produce a syrup (32.2 tonnes per hour) recovered partially for re-use and the rest for wastewater treatment (120 tonnes per hour).

3) Mixing – To produce a higher quality of dried distiller's grain (DDG) WDG will be mixed with syrup (produced from the evaporation of thin stillage) and bran (produced from initial grain processing). There will be no dust produced from this process given the water content of the WDG. Odour generation is likely from this process; however odours will be eliminated using thermal oxidation methods by re-directing exhaust gas into the gas furnace.

4) Drying for DDGS – Compressed natural gas would dry the DDGs. Dust generated by this process would be collected by dust filters located at the rear of the drying equipment. Odours generated by this process would be combusted using thermal oxidation methods by re-directing exhaust gas into gas furnace.

5) Cooling for DDGS – The DDGS would be cooled by mechanical fans. The cooling process would be a closed system process. Dust generated by this process would be collected by bag dust filters.

6) Packing and Transportation – Cooling, transporting, storing and packing process of DDGS would be a closed system process. Any dust generated by this process would be collected by bag dust filters.

Wastewater production

Sources of wastewater from the ethanol processing and utilities are:

1) Wastewater from stillage evaporation (condensate of evaporation). The wastewater generated from stillage evaporation is condensed in the condenser (approximately 1,350 m3 per day, with a design of 1,400 m3 per day). Approximately 1,350 m3 of the daily condensate will be pumped to the on-site wastewater treatment system while approximately 640 m3 per day pumped to a liquefaction process to be reused. The quality of this water will have the BOD of approximately 2,500 mg/L and SS of approximately 200 mg/L.

2) Wastewater from cleaning water. Wastewater generated from floor cleaning in the plant, including scrubber cleaning water, backwash of the ion exchange, cooling tower blow down, and the vacuum pump sealing water will be pumped to the collection basin. This water will have a BOD of approximately 1,500 mg/L and SS of approximately 100 mg/L.

Wastewater Treatment

The wastewater treatment process comprises a neutralisation/equalisation process, a sealed anaerobic digestion process and a subsequent aerobic and membrane bio-reactor process summarised below.

1) Neutralisation/equalisation. The pH of the wastewater is adjusted to 6.0 to support the subsequent anaerobic digester. The water is retained for a period of approximately 15 minutes. The wastewater also requires cooling. The temperature of condensate scrubbing wastewater will be approximately 42 to 45ºC. This water must be allowed to cool to a temperature of 35 to 38ºC to support the mesophilic microorganisms in the anaerobic digester.

2) Anaerobic filter (digestion). This system consists of two anaerobic fermenters with a gas holder on top. The digester is operated at a temperature of approximately 35 - 38ºC, with a retention time of about 1.5 days. The digestion process begins with bacterial hydrolysis of the input materials in order to break down insoluble organic polymers such as carbohydrates and make them available for other bacteria. Acidogenic bacteria then convert the sugars and organic acids into intermediate products carbon dioxide, hydrogen, ammonia and organic acids. Acetogeric bacteria then convert these resulting organic acids into the intermediate products of acetic acid along with additional ammonia, hydrogen, and carbon dioxide. Methanogens then immediately convert these products to methane and carbon dioxide. The overall process can be described by the chemical reaction of biochemically converting glucose (input material) into carbon dioxide and methane (output material) through the use of anaerobic microorganisms. Gas from anaerobic digestion contains about 65-70 percent methane by volume, 25-30 percent Carbon Dioxide (CO_2), and small amounts of nitrogen, hydrogen and hydrogen sulphide, water vapour and other gases.

3) Aerobic biological system.

Anoxic basin

A small amount of the nitrogen components found in the wastewater is nitrified in the aerobic system. This nitrified wastewater is transferred and recycled and denitrified by organic carbon resources. This process removes the nitrogen gas.

Aeration basin

The wastewater treated in the anaerobic filter has a BOD of between 500 and 600 mg/L. To reduce BOD to 30 mg/L and total Nitrogen to 10 mg/L, the waste water is aerated in the aeration basin. The retention time is approximately 1.5 days. The amount of Oxygen required for the Aeration Basin (T-303) with capacity of 2 ML would be 0.1 kg-O2/hr. The water aerator can supply 15.4 kg-O2/hr to the basin that would be more than the required oxygen.

Membrane bio-reactor (MBR)

The membrane bioreactor (MBR) is a combination of a membrane process like microfiltration or ultrafiltration with a suspended growth bioreactor. Membrane bioreactor processes are widely used for municipal and industrial wastewater treatment applications and can produce effluent of high quality and will maintain a very low concentration of organic matter and nitrogen. The membrane bioreactor process produces two separate streams, treated effluent and sludge. The concentration of the sludge generated from the intermediate basin is approximately 8000 ppm (0.8 percent).

Advanced treatment

Water from the MBR is treated by an activated carbon filter to reduce COD by about 85 percent and recycled for reuse in the ethanol production process.

Sludge digestion

Organic waste generated in the production process and final sludge generated from the wastewater treatment facilities will be aerobically digested to generate liquid fertiliser. This will be stored in holding tanks located next to the digester solid waste. Biogas will be transferred to the boiler to be reused.

4.0 Hazard analysis and risk assessment

This hazard analysis focuses on key issues and considerations for land use safety planning in in accordance with *Hazardous Industry Advisory Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis* (NSW DP&I, 2011) and *Multi-Level Risk Assessment* (NSW DP&I, 2011).

This technical study does not specifically focus on the risks to the health and safety of employees on site. Onsite related hazards would be addressed through site based risk assessments in accordance with the *NSW WHS Regulation 2011*.

This hazards analysis and risk assessment includes:

- identification of credible hazard scenarios associated with loss of containment events associated with the various storage and transport facilities
- an assessment of the consequences and impacts on the surrounding communities, property or environment
- a review of the proposed safeguards for the Project and their effectiveness in managing the hazards and risks
- an assessment of the acceptability of the level of off-site risks and impacts on the surrounding communities, property or environment.

4.1 Types and quantities of dangerous goods

The dangerous goods which are likely to be stored, handled and produced at the Project Site are outlined in Table 3 and Table 4.

Any construction or industrial site requires minor quantities of hazardous chemicals such as paints and solvents. The correct storage and separation of such goods is governed by Australian Standards and the appropriate safety management systems of the Project. The minor storage of dangerous goods is not considered to be significant contributor to the overall risk profile of the facility from a land use safety planning perspective; therefore such hazardous chemicals have been excluded from the tables below.

Table 3 Project hazardous materials

Hazardous materials	Maximum quantity stored on site	Dangerous goods class including subsidiary class(es)	Packing Group	UN No.	Chemical abstract Number (CAS No.)	Physical and Chemical Properties	Type of storage	On-site Location	Average number of road movements
Fuel Grade Ethanol 99.5% v/v	18,000m^3 (14,500 tonne equivalent to 50 days storage)	Class 3 Flammable Liquid	PG II	1170	64-17-5	Extremely flammable liquid.	Bulk storage tanks	Designated Ethanol storage area located in the east of The Project Footprint (Area 8 as per site layout Figure 4)	30% transport by road 70% transport by rail 9 x 32 tonne capacity heavy vehicles road tankers per day used to transport product to customers and rail
Compressed Natural Gas (CNG)	N/A	Class 2.1 Flammable Gas	N/A	1972	74-82-8	Odourless colourless Flammable Gas.	Pipeline	Pipeline to steam Boiler, DDGS dryer and Waste Heat Boiler (Area 10 and 15 as per site layout Figure 4)	N/A
Biogas (70% CH4 and 30% CO_2)	Co-product of the anaerobic digester process, collected in gas holder (600m^3)	Class 2.1 Flammable Gas	N/A	1954	98615-67-9	Flammable Gas	Gas holder	The gas holder is located within the anaerobic digester process (Area 23 as per site layout Figure 4)	N/A
Carbon Dioxide	By product of ethanol process (95,100 tonne/a)	Class 2.2 — non-flammable, non-toxic gases	N/A	1013	124-38-9	Asphixiant	N/A	N/A	N/A

Hazardous materials	Maximum quantity stored on site	Dangerous goods class including subsidiary class(es)	Packing Group	UN No.	Chemical abstract Number (CAS No.)	Physical and Chemical Properties	Type of storage	On-site Location	Average number of road movements
Caustic Soda	8 tonne	Class 8 - Corrosive	PG II	1824	1310-73-2	May cause severe skin burns, eye damage and respiratory irritation.	Bags (pillets) Chemical is dissolved to 20% v/v in 1m^3 tanks prior to use.	Storage: Designated chemical storage area. Use: Grain liquefaction and wastewater treatment plant areas (Area 5 and 22 as per site layout Figure 4)	1 x 8 tonne capacity heavy vehicles per month used to deliver caustic soda to the site
Hydrochloric Acid (HCl) Solution	17.5 tonne	Class 8 - Corrosive	PG II	1789	7647-01-0	May cause severe skin burns, eye damage and respiratory irritation	Bulk Storage Tanks	Fermentation (Area 6 as per site layout Figure 4)	1 x 10 m^3 delivery per month
Sodium Hypochlorite (NaOCl)	13 tonne	Class 8 - Corrosive	PG III	1791	7681-52-9	May cause severe skin burns, eye damage and respiratory irritation	Bulk Storage Tanks	Waste Water (Area 5 as per site layout Figure 4)	1 x 10 m^3 delivery per month

Chemical substances which are not subject to SEPP 33, which are also likely to be stored and handled at the Deniliquin Ethanol Plant are presented in Table 4 below.

Table 4 Other chemical substances not subject to SEPP 33 requirements

Chemicals Substances	Maximum storage quantity on-site	Dangerous goods class	Type of storage	On-site location	Average number of road movements
Organic Liquid Fertilizer	1,500 tonne	Not considered a dangerous good: No UN Number allocated	In-ground concrete tank (Organic Liquid fertiliser is a product of the anaerobic digestion process)	Stored: Anaerobic digestion section	1 x 20 tonne tank lorry per day used to distribute organic liquid fertiliser to local growers
Liquefaction Enzyme (Alpha Amylase, ENL)	0.210 tonne	Not considered a dangerous good	50L jars Chemical is dissolved in 1 m^3 capacity tank prior to use.	Stored: Enzyme storage area Used: Grain liquefaction and saccharification section	N/A
Saccharification Enzyme (Alpha Gluco-amylase, ENS)	0.210 tonne	Not considered a dangerous good	50L jars Chemical is dissolved in 1 m^3 capacity tank prior to use.	Stored: Enzyme storage area Used: Grain liquefaction and saccharification section	N/A
Antifoam Liquid	8 tonne	Not considered a dangerous good	200L plastic drums Chemical is dissolved in 1 m^3 capacity tank prior to use.	Stored: Chemical storage area Used: Fermentation section	1 x 8 tonne capacity heavy vehicles per month used to deliver to the site
Ammonium Phosphate	15 tonne	Not considered a dangerous good	50kg bags (powder) Chemical is dissolved in 1 m^3 capacity tank prior to use.	Stored: Chemical storage area Used: Fermentation section	1 x 15 tonne capacity hevy vehicles per month used to deliver to the site
Urea Pills or pellets with total nitrogen not less than 46% w/w	15 tonne	Not considered a dangerous good	50kg bags (solid) Chemical is dissolved to in 1m^3 capacity tank prior to use.	Stored: Chemical storage area Used: Fermentation section	1 x 15 tonne capacity heavy vehicles per month used to deliver to the site
Water Treatment Polymer	1 m^3	Not considered a dangerous good	200L plastic Drums Chemical is dissolved in 1 m^3 capacity tank prior to use	Stored: Chemical storage area Used: Waste Water Treatment	Delivered with Anti-foam

Chemicals Substances	Maximum storage quantity on-site	Dangerous goods class	Type of storage	On-site location	Average number of road movements
Syrup	3000 tonne	Not considered a dangerous good	Storage vats	Stored: Syrup storage area	14 heavy vehicles per day used to deliver product
Grain and DDGS	-	Not considered a dangerous good	Storage silos and packages	Stored: Grain storage and DDGS storage area	30 heavy vehicles per day of grain delivered and 11 heavy vehicles of DDGS to distribute

4.2 Hazard identification

The first step in any hazard assessment process is to identify *all hazardous chemicals* and the *type of associated hazard* they potentially pose. It is important that the large inventories of hazardous chemicals or the very hazardous small quantities, which have the potential to create a major hazard, if released, are identified. Hazardous materials can be defined in terms of their dangerous goods class code. A summary of key hazards and a qualitative assessment of the consequences is provided below.

4.2.1 Ethanol 99.5 percent

Fuel Grade Ethanol 99.5 percent v/v is a Class 3.2 Flammable Liquid. Ethanol is a flammable liquid whose vapours can form ignitable and explosive mixtures with air at normal room temperatures. Thus, an aqueous mixture containing 30 percent ethanol can produce a flammable mixture of vapour and air at 29°C, and even one containing only 5 percent alcohol can produce a flammable mixture at 62°C. There are a number of substances that are incompatible with ethanol e.g. ethanol reacts vigorously with a wide range of oxidizing materials and other chemicals.

Approximately 70 percent of the ethanol production (243,600 L/day) would be transported by rail from the existing siding at the rice mill, while the remaining 30 percent (104,400 L/day) would be transported by road to market. Heavy vehicles of 32 tonne capacity would be used, equating to approximately nine movements per day to deliver ethanol to market and the rail siding.

Ethanol vapours generated in the distillation processes are recovered within vent scrubbers. The vapours are returned to the waste heat boiler in a closed system.

The ethanol storage facility has been designed preliminarily in accordance with AS 1940:2004 (Standards Association of Australia, 2004) in relation to bund sizing and appropriate separation distances. The worst case scenario of six tanks (capacity 3,000,000 L each) storing a total of 14,000 tonne was taken as the basis for the risk assessment. The total volume is approximately 50 days storage capacity.

4.2.2 Compressed natural gas (CNG)

Natural gas (methane) is a buoyant Class 2.1 Flammable Gas and would burn if ignited upon release. Low temperature methane would rise into the air from a release site and may form a gas cloud in favourable weather conditions (i.e. no wind). At high pressure, the gas would be subjected to the Joule-Thomson effect and rapidly cool, causing methane to be slightly denser than air. This may cause the gas to temporarily fall to the ground. However, as the gas picks up the sensible heat from its surrounds, it would rise and dissipate in the air. Under these circumstances a gas cloud may form at ground level, however, this would be limited by the quantity of gas released, the ambient temperature and the direction of the release (i.e. vertical releases would tend to dissipate the gas more readily than horizontal or downward releases). It should be noted that natural gas is a low potential explosive gas. It has a propensity to cause a flash fire rather than an explosion. A flash fire would be the more likely, however, given enough confinement there is a potential for confined vapour cloud explosions.

CNG would be piped to the site via a proposed Elgas facility located between the Project Site and the airport to the east. The natural gas is proposed to be used at three different appliances at the Project Site, namely the steam boiler, the waste heat boiler and the DDGS dryer. It is anticipated that a high pressure pipeline would run underground to a reducing station aboveground at the Project Site, where the compressed gas pressure would be reduced to meet the low pressure gas requirements for the appliances.

4.2.3 Biogas gas

Biogas is generated in the anaerobic fermentation process. Biogas contains 70 percent methane which is a Class 2.1 Flammable Gas and 30 percent carbon dioxide. Biogas is stored in a gas holder at atmospheric pressure as part of the anaerobic digester. The methane would burn if ignited upon release. Hazards associated with stored flammable gasses include the risk of explosion if heated under confinement.

4.2.4 Carbon dioxide (CO_2)

Carbon Dioxide is produced as a co-product of the ethanol process. Carbon dioxide is colourless. At low concentrations it is odourless but has a sharp, acidic odour at higher concentrations. CO_2 is an asphyxiate gas and would be vented in well-ventilated areas away from access platforms.

4.2.5 Caustic soda (NaOH)

Sodium Hydroxide is commonly known as Caustic Soda. It is a white, highly caustic base and alkali salt. Caustic Soda is corrosive and can cause severe burns on contact. It is highly soluble in water.

4.2.6 Hydrochloric acid (HCl) solution

Hydrochloric acid is a clear, colourless corrosive acid. It is used for pH control and neutralisation. HCl is not flammable. The greatest risk associated with the chemical is severe burns on contact and environmental effects if spilled.

4.2.7 Sodium hypochlorite (NaOCl) solution

Sodium Hypochlorite is commonly known as bleach. It is use in water treatment as a biocide to control slime and bacteria formation. It is a strong oxidizer and corrosive. The greatest risk associated with the chemical is severe burns on contact and environmental effects if spilled.

4.2.8 Grain dust

Grains are not considered to be dangerous goods, but it is important to note that there are also risks associated with combustible dust associated with the grain milling and storage and silos that must be identified, assessed and appropriately managed.

Approximately 909 tonne/day of grain would be delivered to site and stored in silos. Possible areas of the plant that could produce dust emissions include:

- grain intake and processing – dust generated in the hopper truck unloading, storage and pre-cleaning, de-branning and milling of grain would be collected in a bag filter
- fermentation process - dust generated from the mixing, liquefaction, saccharification, pre-fermentation and fermentation processes would be filtered by bag filter and returned to the process
- DDGS Drying - dust generated by the drying process would be collected by dust filters located at the rear of the drying equipment.

5.0 Hazardous event screening and risk prioritisation

5.1 Screening assessment

Applying SEPP33 Guideline ((NSW DP&I, 2011), Section 7 and Appendix 4) provides a series of tables and graphs which can be used to determine screening thresholds for various types of dangerous goods for which, quantities below which it can be assumed there is unlikely to be a significant off-site risk.

The preliminary screening assessment for dangerous goods detailed in Section 4.0, Table 3 is summarised in Table 5 and discussed in Sections 5.1.1 to 5.1.8 below:

Table 5 Preliminary screening assessment

Material	Type	Max Quantity on site	Distance to Site Boundary [m]	Distance to Sensitive Receptor	Screening Threshold or minimum separation distance (Other Land Uses)	Screening Threshold or minimum separation distance (Sensitive Receptors)	Notes
Ethanol	Class 3 PGII Flammable Liquid	14,500 tonne	105 (from bund)	>550 m	80 m (Note 1: Figure 9)	115 m (Note 1, Figure 9)	Below the threshold
CNG (Methane)	Class 2.1 Flammable Gas	60 kg @ 1070 kPa	0 to 300 m	>550 m	100 kg (Note 1, Table 1)	100 kg (Note 1, Table 1)	Below the threshold
Biogas (Methane)	Class 2.1 Flammable Gas	295 kg (600 m^3 @ 70% CH_4)	50 m	>600 m	20 m (Note 1, Figure 6)	26 m (Note 1, Figure 6)	Below the threshold
Carbon Dioxide	Class 2.2 Non Flammable, Non Toxic Gas	Vented	>100 m	>600 m	N/A	N/A	N/A
Caustic Soda	Class 8 PG II Corrosive	8 tonne	N/A		25 tonne	25 tonne	Above the threshold
HCl Acid	Class 8 PG II Corrosive	17.5 tonne	N/A				
NaOCl	Class 8 PG III Corrosive	13 tonne	N/A		50 tonne	50 tonne	Below the threshold
Grain Dust	N/A						

Note: 1: *Applying SEPP 33 Guideline* (NSW DP&I, 2011)

5.1.1 Class 3 PGII flammable liquid (Ethanol 99.5 percent)

With reference to *Applying SEPP33*, ((NSW DP&I, 2011), Figure 9), the storage of class 3 PGII flammable liquids in quantities 14,500 tonnes at distances less than 80 m to the site boundary or 115 m to sensitive receptors, has the potential to result in off-site risk. The distance to the site boundary from the proposed ethanol Tank Farm bund is 105 m. Given the quantity, site layout and distance from the site boundary, the ethanol 99.5 percent storage is unlikely to result in a significant off-site risk to the current land uses.

Further to the screening assessment, ethanol is stored in relatively large quantities, is produced at high temperatures and pressures and is a flammable liquid. As a result, risk scenarios associated with the storage of ethanol have been carried forward as a special case for further analysis and risk prioritisation based on the risks associated with the ethanol properties and possible changes to future land use.

5.1.2 Class 2.1 pressurised flammable gas (CNG)

With reference to *Applying SEPP33*, (NSW DP&I, 2011) (, Table 1) the aggregated quantity of class 2.1 flammable gases in quantities up to 100 kg, is assumed to be unlikely to result in significant off-site risk. It is noted that the methane/CNG would not be stored on site, but supplied by a gas pipeline. The quantity of methane is limited to the size and length of the gas pipeline. Even though the screening limit suggests that The Project is unlikely to be potentially hazardous in terms of the CNG on site, the risks associated with a high pressure flammable gas have been considered and evaluated as a special case that does not fall within the screening assessment.

5.1.3 Class 2.1 flammable gas mixture (Biogas)

With reference to *Applying SEPP33*, ((NSW DP&I, 2011), Figure 6) the storage of class 2.1 flammable gases in quantities up to 1 tonne which is at least 35 meters from the nearest site boundary, is assumed to be unlikely to result in significant off-site risk. The biogas has not been grouped with the CNG as the gas is at atmospheric pressure and stored in a separate area away from the Ethanol Production facility. The biogas present on site is a co-product of the anaerobic digestion process which is collected in a gas holder and used within the anaerobic digestion process. Due to the quantity, process conditions and location relative to the site boundary for the biogas handled on site, it is unlikely to result in a significant off-site risk.

5.1.4 Class 2.2 Non-flammable, non-toxic gas (carbon dioxide)

No screening limit is applicable to Class 2.2 gases. Carbon Dioxide is not stored on site. It is vented as a gas so does not pose significant off-site risk.

5.1.5 Class 8 PGII corrosives (caustic soda and hydrochloric acid),

With reference to *Applying SEPP33* ((NSW DP&I, 2011), Table 3), the threshold for class 8 PGII corrosive substances is 25 tonne. One 8 tonne delivery of caustic soda and 17.5 tonne of HCl would be delivered and consumed monthly. Substances of the same class that are stored in the same area are required to be grouped for screening. Caustic Soda is a solid and would be stored in a designated store, while HCl is a liquid and would be stored in tanks. The two chemicals are not likely to be used in the same area of the facility so can be assessed individually. However, for the assessment they have been grouped to ensure a conservative approach has been considered. Therefore, the quantity of Class 8 PG II on site is 25.5 tonne which exceeds the threshold quantity and it can be assumed that there is the potential for off-site risk. Risks associated with the storage of Class 8 PGII have been carried forward for further analysis.

5.1.6 Class 8 PGIII corrosives (sodium hypochlorite),

With reference to *Applying SEPP33*, ((NSW DP&I, 2011), Table 3) the threshold for class 8 PGIII corrosive substances is 50 tonne. The quantity of Class 8 PG III on site is less than 15 tonne which does not exceed the threshold quantity. It can be assumed that sodium hypochlorite does not pose significant off-site risk.

5.1.7 Grain dust

No screening limit is applicable to grains. The risks associate with the storage of grains and in particular confined dust leading to explosions are required to be evaluated as part of a PHA as a special case that does not fall within the screening assessment.

5.1.8 Potentially hazardous industries in relation to transport of dangerous goods

In addition to storage quantities, a development may be potentially hazardous if the number of generated traffic movements is for significant quantities of hazardous chemicals entering or leaving the site. Table 6 lists all the hazardous chemicals that are transported to or from site.

Table 6 Transport assessment

Material	No. of Traffic Movements	Evaluation criteria (Table 2 of Apply SEPP33 (NSW DP&I, 2011))	Potentially Hazardous
Class 3 (PG II): Ethanol	45/ week or 2900 /year	>45 /week or > 750 /year	Yes
Class 8 Chemicals	0.5/ week or 24 / year	>30 /week	No

The proposed Project is found to be potentially hazardous with respect to transportation and a route evaluation study would be required to be completed in accordance with *HIPAP No. 11: Route Selection* (NSW DP&I, 2011).

5.2 Schedule 15 notification requirements

In accordance with, Schedule 15, of the *NSW WHS Regulations 2011* the Class 3 flammable liquid packaging group II threshold quantity is 50,000 tonnes. It should be noted that the ethanol storage on site is greater than 10 percent of the Major Hazardous Facility threshold quantity. The Project is required to notify Work Cover NSW that the quantity of ethanol in relation to the Schedule 15 chemicals is likely to exceed 10 percent of the threshold quantity.

6.0 Hazardous events risk prioritisation

Based on the initially screening review of *Applying SEPP33*, the Project could be considered to be a potentially hazardous development with respect to ethanol production, storage and transport, CNG usage, Class 8 Corrosive chemicals and grain dust. A preliminary hazard analysis (PHA) is required to be conducted to assess the hazards associated with the storage and handling of materials, the proposed safeguards and their effectiveness in managing the hazards and risks. A detailed hazard identification table has been developed for these identified goods to be stored, handled and produced at the Project and is presented in Table 7. This table identified a number of hazards, hazard causes, hazard consequences and safeguards which would be implemented for the Project Site.

The Project is considered to be a potentially hazardous development with respect to ethanol transportation. A route evaluation study would be completed in accordance with *HIPAP No. 11: Route Selection* (NSW DP&I, 2011) as a separate study.

6.1 PHA risk prioritisation

Applying SEPP 33 Guidelines (NSW DP&I, 2011) was used to assist in the selection of the appropriate level of hazard analysis and risk assessment for the materials identified to have the potential for significant injury, fatality, property damage or harm to the environment in the absence of controls. The assessment approach for the PHA is outlined in Section 2.2.

The risk prioritisation into Level 1, 2 or 3 is not a measure of acceptability of an activity in terms of risk, but only a pointer to one of the types of risk analysis that is required in accordance with *HIPAP No. 6 — Hazard Analysis* (NSW DP&I, 2011).

Generally, qualitative assessments (Level 1) are sufficient where materials are relatively non-hazardous (for example corrosive substances and non-dangerous goods) and where the quantity of materials used is relatively small.

Grain combustible dusts are not classified dangerous goods. Grain dust can cause explosions if there is a combination of a dust concentration within the explosive range and the presence of an ignition source. Static electricity is the most common source of ignition due to the dry conditions typically prevailing within a dusty atmosphere. A Level 1 qualitative assessment is appropriate for grain dust.

Caustic soda and hydrochloric acid solution are corrosive substances and the quantity of material on site is relatively small. A Level 1 qualitative assessment is appropriate.

Ethanol is flammable and is stored in relatively large quantities, however, it is stored some distance from the boundary on site. CNG is flammable, but is not stored on site. Both materials fall outside the Level 1 assessment criteria due to the materials being classified as having a medium potential for harm due to the hazardous nature of the materials. A Level 2 or semi-quantitative analysis is deemed appropriate in accordance with the multi-level approach to risk assessment, provided the following conditions can be demonstrated:

- detailed qualification of consequences with appropriate modelling tools
- demonstration that the more likely events consequences are contained within the site
- societal risks are negligible
- the necessary technical and management safeguards are well understood and readily implemented
- there are no sensitive surrounding land uses impacted by the proposed development.

Table 7 Hazard identification

Plant Area	Hazard Scenario	Cause	Consequences	Mitigation measures (Prevention/Detection Protection)
Bunds containing flammable liquids tanks	Leak from storage tank or pipework filling bund with ignition	- Impact damage - Tank overfill - Tank failure - Pipework failure	- Pool fire or full bund fire - Possible propagation to other tanks/bunds - Ground contamination - Possible evolution of toxic fumes - Watercourse pollution via bund drainage system. - Pollution via firefighting water - Damage to environment due to accidental release to sewers, surface water, storm water	- Regular inspection and maintenance of tanks and pipework - Loss detection systems - High level alarms/overfill protection - Remote isolation systems - Appropriate fire protection measure in accordance with the findings of the fire safety study e.g. foam monitors - Water cooling of tanks - Control of ignition sources - Adequate bunding - Impermeable bund floors/walls - Separator pits - If leak or spill has not ignited, incident response procedures would include the following: ventilate area and use water spray to disperse gas or vapour and to protect personnel attempting to stop a leak
Rail or road tanker loading bays for flammable liquids	A loss of containment of ethanol or ethanol vapour.	- Tanker overfill - Flexible hose failure - Driver uncouples hose before isolating - Driver fails to disconnect before driving off.	- Spillage of fuel with pool fire if ignited - Possible propagation to involve entire tanker contents or other tankers - Ground contamination - Watercourse pollution via drainage system - Pollution via firefighting water	- Tanker overfill protection - Regular inspection/maintenance of hoses - Drive away protection through brake interlocks or boom gates - Control of ignition sources - Remote isolation systems - Adequate bunding/drainage systems - Foam monitors/deluges - Adequate emergency egress routes - A Fire Safety Study would be conducted to ensure appropriate fire suppression is in place and appropriate fire management plans are developed and implemented. - Emergency Response Procedures.

Plant Area	Hazard Scenario	Cause	Consequences	Mitigation measures (Prevention/Detection Protection)
Process equipment containing flammable liquid ethanol 99.5 percent	Leak Ignition during maintenance Lightning Ignition by static electricity	- Ethanol vapours can form flammable or explosive mixtures - Ethanol vapours may spread to distant ignition sources and flash back - Vapours may concentrate in confined areas - High temperature liquid release	- Explosion of vapours in equipment - Pollution via firefighting water - A loss of containment of ethanol vapour or gas may spread to distant ignition sources and flash back	- Regular maintenance - Flame arresters on vents - Earthing straps - Control of ignition sources - Adequate pigging prior to maintenance - Adequate bunding - Appropriate storage and handling in accordance with AS1940 - Appropriate fire protection measure in accordance with the findings of the fire safety study e.g. foam injection systems, external water cooling systems (Note: Water may be ineffective but should be used to cool fire)
CNG Pipeline	CNG pipe failure (high and low pressure)	- Mechanical impact - Corrosion	- Gas disperses. If ignited may result in flash fire. - Impact local	- Regular maintenance - Control of ignition sources - Boundary isolation valve.
Grain Storage and Processing areas	Combustible Dust Explosion	- Accumulation of Combustible dust – poor housekeeping - Sufficient oxygen concentration (air) - Confinement within an enclosure - An ignition source	- Combustible dust explosion	- Process equipment would be kept clean to prevent combustible dust accumulating within a building on equipment and structures - Design of equipment for the storage and processing of grain would be in accordance with Australian standards and industry codes of practise. - Explosions suppression / venting systems where required
Corrosive chemical storage area	Loss of containment	- Unsafe storage of pallets - Tank Overfill - Corrosion	- Ground contamination - Watercourse pollution via drainage system	- All products segregated by class. - Regular inspection and maintenance of tanks and pipework - High level alarms/overfill protection - Remote isolation systems - Adequate bunding - Impermeable bund floors/walls

7.0 Level 1 qualitative risk assessment

7.1 Grain dust (Level 1)

There are risks associated with combustible dust associated with the grain milling and storage and silos that have been identified.

Possible areas of the plant that could produce grain dust emissions include:

- grain intake and processing – dust generated in the hopper truck unloading, storage and pre-cleaning, de-branning and milling of grain would be collected in a bag filter
- fermentation process - dust generated from the mixing, liquefaction, saccharification, pre-fermentation and fermentation processes would be filtered by bag filter and returned to the process
- DDGS Drying - dust generated by the drying process would be collected by dust filters located at the rear of the drying equipment.

A Hazardous Area Classification would be conducted for combustible dust atmospheres in accordance with AS/NZS 60079.10.2. Grain dust explosion risks would be managed through engineering controls such as suitably rated electrical appliances and installations, explosion suppression and venting systems for areas storing and handling grain dust. Management practises such as good housekeeping and additional controls such as the addition of syrup to increase the moisture content would be implemented. Further mitigation measures include awareness training of the hazards associated with grain dusts and their potential to result in dust explosions. Confined dust explosions accidents can occur which normally result in effects to the immediate area such as the grain silo or conveying systems. Off-site effects are unlikely and the proposed measures are appropriate and sufficient for the risk identified. The risk associated with grain dust has been qualitatively assessed to be an activity that does not pose a significant risk with appropriate controls in place.

7.2 Class 8 corrosives (Level 1)

The main hazard associated with Class 8 Corrosive chemicals as detailed in Table 7 is loss of containment which poses a risk to the biophysical environment. Appropriate controls would be implemented on site to prevent the loss of containment of chemicals namely maintenance, overfill protection and safe segregation of chemicals. Additional mitigation measures to ensure that chemicals do not reach a water course or contaminate the ground include adequate bunding (in accordance with AS 3780-2008, *The storage and handling of corrosive substances*) and impermeable bund floor and walls. The total aggregated quantity of corrosives stored on site is relatively small. Effects from a Class 8 chemical release is an acute impact. Accidental emission would not threaten the long-term viability of the surround ecosystems. The risk associated with Class 8 corrosives has been qualitatively assessed to be an activity that does not pose a significant risk with appropriate controls in place

8.0 Level 2 semi-quantitative risk assessment

8.1 Ethanol and CNG (Level 2)

Table 7 identified a number of potential scenarios that can possibly result in significant off site effects and can be summarised as follows:

- Ethanol storage tank -Tank leak or failure, tank overfilling
- Ethanol pipework/ Equipment leak – Storage/ Loading area – Liquid leak
- Ethanol road tanker filling – Hose failure, tanker overfilling
- Ethanol pipework / equipment leak – Processing Area – Liquid or vapour release
- CNG high pressure gas release – main supply line
- CNG low pressure gas release – appliance gas supply line

Hazardous scenarios relating to the event are discussed below.

8.2 Hazardous scenarios

The physical consequence of a release is based on the loss of containment of a potentially hazardous material (e.g. toxic gas, flammable gas, flammable liquid etc. from a pipe, vessel, etc.). The effect of the consequence is generally dependent on the quantity released, the rate of release and for fire and explosion events, when ignition occurs. The quantity of release depends on the inventory, size of release and duration of the release (how soon can the release be detected and isolated).

A release of liquid onto the ground may form a pool and / or accumulate in a bund / sump.

If the liquid is volatile, then a vapour cloud may form and disperse in the air. Similarly, a release of gas (from pressurised equipment) may form a gas cloud and disperse in the air. The vapour / gas dispersion rate depends on the wind speed and atmospheric stability conditions. If the vapour / gas is toxic, or an asphyxiate, then the potential may exist for injury or fatality if exposed (typically via inhalation).

If the flammable gas-air mixture is ignited, then a flash fire or a vapour cloud explosion (VCE) may occur. A VCE is more likely to occur in a partially confined and / or congested plant areas.

If the release is a flammable gas / vapour under pressure, ignition would produce a jet fire. A jet fire generates heat radiation, which can lead to subsequent damage or injury to persons. Fires impinging on adjacent equipment may cause structural failures and incident escalation.

The Project is at the preliminary design phase. A desk top review of the potential hazardous scenarios has therefore assumed worse case spill sizes to identify possible hazardous scenarios with potential off site impacts. The worst case scenarios for the Project were evaluated based on a desktop review of the potential scenarios in **Section 8.1**, to include the following

- Ethanol Event 1 (E1): Catastrophic failure of ethanol storage tank. Liquid release of ethanol into one of three compartments in the storage bund, ignition and resulting pool fire. This event is the largest pool fire event associated with any leak at the storage area or within the Project Footprint.
- Ethanol Event 2 (E2): Failure of the filling hose (most likely worst case scenario during filling operation) with the loading pump operating. Liquid release of ethanol into the loading bund, ignition and resulting pool fire.
- Ethanol Event 3/4 (E3/4): Failure of equipment or piping at the distillation plant. High temperature (greater than boiling point), liquid/vapour release, ignition and resulting jet fire or late explosion.
- CNG Gas Event 1 (G1): Failure of CNG pipeline. High pressure, gas release, ignition and resulting jet fire or late explosion.
- CNG Gas Event 2 (G2): Failure of CNG pipeline at appliance. Low pressure, gas release, ignition and resulting jet fire or late explosion. Gas is piped to three appliances namely the steam boiler, waste heater boiler and the DDGS dryer. The steam boiler appliance location was chosen as a representative location.

8.3 Risk demonstration

8.3.1 Qualification of consequences with appropriate modelling tools

To assess the consequence of each hazard scenario DNV's Phast Risk Modelling Program, version 6.7 was used. The program requires a number of inputs to model the consequence effects associated with different hazards. The meteorological data used as input to the program is discussed in Section 3.4. Process condition assumptions were based on a typical ethanol production facility and details provided by the Proponent as defined in Appendix A. The overall inputs are tabulated below.

Table 8 Modelling program inputs

Event ID	Description	Spill size	Operating conditions	Consequence[1]
E1	Single failure of Ethanol Storage tank. Tank fills one of three compartmentalized bund areas 50m x 80m	One storage tank: 2370 tons	Temp 17oC Pressure: atm	Pool fire (Area 8)
E2	Hose failure, ethanol loading. Pump operating Bund size 12m x 8m	Isolation for remote operable isolation by operator at loading: 10 mins Volume: 7000 L	Temperature: 17^{o}C Pressure: 450 kPa	Pool fire (Area 21)
E3/4	Distillation – High temperature liquid/vapour ethanol release (100mm hole)	Production rate: 390 000 L/ day Manual isolation time: 30 mins Volume: 8125 L	Temperature: 160^{o}C Pressure 600kPa	Jet fire, Delayed ignition Vapour cloud explosion VCE (Area 7)
G1	Gas piping proposed to be installed below ground from metering station outside of Project Site above ground reducing station 50mm hole	Manual isolation: 30 mins	Temperature 17^{o}C Pressure 1070 kPa	Jet fire, Delayed ignition VCE (Area 10)
G2	Gas release at gas appliance 25mm hole	Manual isolation: 30 mins	Temperature 17^{o}C Pressure 37 kPa	Jet fire, Delayed ignition VCE (Area 10)

The consequences of flammable hazardous events are fire, blast and shock wave damage and possible damage due to missiles (i.e. fragments becoming projectiles). In general, every flammable release has the potential for heat radiation and explosive effects.

The consequences of fires are damage to equipment and heat radiation burns to people. In terms of burns there are two aspects that are important, the intensity of the heat radiation and the duration of exposure. In quantifying the magnitude of a fire the information is presented in the form of radiation intensities (measured in kW/m^2) for simplified specific exposure times and are defined in Table 6 of HIPAP No. 4 *Risk Criteria for Land Use Safety Planning* (NSW DP&I, 2011) and summarized in Table 9

The major consequence of an explosion is the shock wave effect due to over pressure. The shock wave shatters glass; damages equipment and can cause fatalities either directly or indirectly through structures collapsing onto people. The over pressures (measured in kPa) and associated effects are considered in a quantitative risk assessment as defined in Table 7 of HIPAP No. 4 *Risk Criteria for Land Use Safety Planning* (NSW DP&I, 2011)**,** and are summarized in Table 10.

[1] Area defined by location number on Site Layout Figure 4

Table 9 Consequences of heat radiation

Heat Radiation (kW/m^2)	Effect
4.7	- Would cause pain in 15-20 seconds and injury after 30 seconds' of exposure (at least second degree burns would occur)
12.6	- Significant chance of fatality for extended exposure. High chance of injury. - Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure - Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure
35	- Cellulosic material would pilot ignite within one minutes exposure - Significant chance of fatality for people exposed instantaneously

Table 10 Consequences of explosion overpressure

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

8.3.2 Demonstration of events consequences

The results of the event consequence modelling are tabulated in Appendix B Table 11. The consequence effects of the events for all weather conditions are contained within the site boundary except for the worst case weather condition for the catastrophic failure of a single storage tank, resulting in a pool fire (Event 1, Weather D6). During this event and worst case weather condition, the 4.7 kW/m^2 (injury) radiation contour extends a few meters over the boundary to the east onto the council reservoir, but the 12.6 kW/m^2 (fatality) radiation contour is within The Project Footprint boundary. The worst case consequence distances for the modelled events are shown in Figures Figure 5 to Figure 14 in Appendix B.

Facilities that are considered to be potentially hazardous are classified as such due to the fact that the worst case consequence scenarios associated with the facility would impact beyond the site boundary. The risk associated with these events occurring is related to the consequence as well as the likelihood of the event.

Catastrophic tank ruptures are not likely events and the likelihood of this this occurring at the same time as worst weather conditions, is even lower.

For all events the heat radiation levels of 12.6 kW/m^2, 50% Lower Flammability Limits and the explosion over pressures of 7 kPa are contained within the site boundary so the risk to property damage for possible future installations adjacent to The Project Footprint is negligible. It was also confirmed that a vapour release gas cloud was limited to within the site footprint.

Even if all combination of events would cumulatively occur, the consequences are contained within The Project Footprint such that in principle no combination of events would result in individual risk criteria to be exceeded.

Through this quantitative consequence assessment it has been concluded that the consequences associated with the more likely events are contained within the Project Footprint.

8.3.3 Societal risks

The impact of societal risk is based on the consequence and likelihood of all events associated with a facility in relation to the number of people that may be affected.

The risk takes into account the population density and the percentage of time that a person is associated with the area. There are no residential areas within the vicinity of the Project Footprint. The area bordering the Project Footprint is sparsely, if at all occupied. The frequency of fatalities associated with the Project in relation to the number of fatalities for the community is deemed to be an acceptable risk level. The societal risks for the outside community are expected to be negligible.

8.3.4 Technical and management safeguards

The following detail on the preliminary design of the Project demonstrates that the technical and management safeguards associated with the preliminary design stage of the Project are well understood and readily implementable.

Ethanol product tank storage area

The storage tanks would be designed to AS1692 (Standards Association of Australia, 2006) and operated in accordance with the requirements of AS1940-2004, “The storage and handling of flammable and combustible liquids” (Standards Association of Australia, 2004). As part of this, the following safety features would be installed:

- tank level instruments (high and low) with independent high/high alarms
- tank vents with anti-flash gauze to prevent potential for sparking and ignition from external sources
- multi-level temperature measurements
- water draining/pump away facilities for bunds to prevent water build up in the tank bund area and potential corrosion in the tank base
- appropriate separation distances between the tanks and on site protected places
- appropriate bund sizing in accordance with AS1940-2004 (Standards Association of Australia, 2004).

Ethanol loading facilities (including pipeline transfer)

The ethanol loading areas would be fitted with the following safety systems in accordance with AS1940 (Standards Association of Australia, 2004):

- Project Site security measures eliminating unauthorised access to the loading facilities and site in general.
- Overfill protection for the tankers and static connections to prevent the potential for electrostatic build-up and spark/ignition source.
- A dead-man button requiring regular activation by the vehicle driver, integrated into the gantry emergency shutdown system.
- Automatic/remote isolation valves at the loading arm feed point to provide loading emergency shut down in the event of incident at the loading bay.
- Appropriate fixed detection and fire suppression systems.

Fire safety systems

The following fire safety systems and services would be provided for The Project:

- Fire water pumps to cool surrounding areas in accordance with the requirements of AS2419.1 (Standards Association of Australia, 2005) and AS1940 (Standards Association of Australia, 2004).
- Fire water tank to provide a minimum of 90 minutes fire water on site (exact storage capacity of tanks to be determined by a Fire Safety Study in accordance with the requirements of AS1940).
- Fire ring main, with hydrants, monitors and foam generating facilities at selected locations around the Project Site.
- An access fire road to provide fire tender access as required.
- Hose reels and fire extinguishers located throughout the Project Site (installed in accordance with the applicable Australian Standards).

- Fire protection facilities at the hazardous chemicals loading and unloading facilities.
- The Project Site would be staffed at all times during road tanker deliveries, transfers and product loading.

8.3.5 Sensitive surrounding land uses

Detailed technical and management safeguards are proposed for the Project to minimise the hazards and risks associated with the storage and handling of hazardous chemicals.

Based on the site location, surrounding land uses, distances to sensitive uses and proposed safeguards, there are no sensitive surrounding land uses impacted by the Project.

9.0 Risk evaluation

The risk assessment (Level 1) for grain dust and corrosive chemicals qualitatively assessed that these activities do not pose a significant risk with appropriate controls in place.

The partially quantitative assessment (Level 2) for ethanol and CNG has addressed the elements as described in a Level 1 assessment and provided sufficient quantification of risk contributors to demonstrate the following:

- consequences of events using appropriate modelling tools
- an estimate of the likelihood for each event confirmed to have significant off-site effects
- an indicative estimate of the societal risk as negligible
- demonstration in principle that no individual event would have a fatality or injury frequency greater than that appropriate for the exposed land use based on *(HIPAP) No. 4, "Risk Criteria for Land Use Safety Planning*
- demonstration in principle that no combination of events would cumulatively cause individual risk criteria to be exceeded.

Land use safety planning is the principal driver for assessment of risks in the context of statutory development assessment and regulation. Given the size of the Project, distances to site boundaries and surrounding receivers, the PHA has appropriately detailed the hazards associated with the Project and demonstrated through risk assessment that the hazards do not pose a significant risk to surrounding land uses.

10.0 Opportunities for risk reduction

10.1 Current risk minimisation opportunities

In line with risk management principles described in AS/NZS ISO 31000, the objective of a risk assessment is to identify all hazards, assess the risks, identify controls, and implement controls and review the effectiveness of the controls to ensure that risks arising from the operation or maintenance of the installations are managed to an acceptable level. When selecting control methods to manage risk, the hierarchy of risk treatment methods shall be as follows:

- **Elimination**: hazard is eliminated and associated risk is removed.
- **Substitution**: if hazard cannot be eliminated, minimise the risk through substitution of a substance or process that has less potential to cause injury.
- **Isolation**: engineering, design, structural changes to the work environment, plant or equipment which shall isolate persons from the potential risk.
- **Administration**: risk may be reduced through the provision of training, procedures, and other methods.
- **Personal protective equipment**: this control should be used in conjunction with other controls and should not be relied upon in isolation.

These principles have already been followed in the preliminary design of the Project namely through the elimination of the largest significant off site risk with the storage and handling of LNG (Liquefied Natural Gas) which had previously been considered. This risk has been removed by substituting the storage and transport of large quantities of LNG with a gas pipeline supplying CNG to the Project Site.

10.1.1 Summary of safeguards

Based on the qualitative risk analysis presented in **Section 6.0**, key risk control, minimisation and management opportunities have been identified. A number of safeguards have been proposed that limit the consequences of major incidents including:

- layout of storage and process vessels
- design of vessels and ancillary equipment
- mitigating systems such as fire protection and adequate bunding.

A number of safeguards have been proposed that limit the likelihood of hazardous events including:

- process control systems
- operating practices
- safety management procedures including fire, incident and emergency management.

Risk management is a continuous improvement process. Safeguards would continually be monitored and reviewed as the project matures and through the entire project lifecycle, including detailed design, construction, operation, maintenance and eventual decommissioning.

10.2 Future risk minimisation opportunities

Potential control measures/environmental safeguards have been considered in identifying credible hazards scenarios (refer to Table 7) and qualitatively analysing potential risks posed by those scenarios. Below is a summary of key control measures that are considered of importance in minimising and managing risks posed during the design, construction and operation of the Project.

10.2.1 Design phase opportunities

To control, minimise and manage risks during all phases of the Project, through safety in design, the following measures would be implemented:

- In detailed design, locate product storage tanks at separation distances with specific reference to the applicable Australian Standards AS 1940:2004 The storage and handling of flammable and combustible liquids.
- Conduct a fire safety study for the Project to determine appropriate fixed and portable fire protection systems for the Project Site to ensure the consequences of major fire incidents are adequately mitigated.
- Conduct a Hazard and Operability (HAZOP) study for the processes and plant items within the Project Site to identify potential hazards and operational problems in terms of plant design and human error. HAZOPs seek to minimise the effect of an atypical situation in the operation/process by ensuring that control and other safety systems such as functional safety (e.g. emergency safe shutdown) are in place and operate with a high level of reliability to achieve a safe outcomes.
- Conduct a Hazardous Area Classification Study in accordance with AS/NZS 60079 series which considers explosive dust atmospheres and explosive gas atmospheres and develop comprehensive ignition source control measures for the Project Site.
- Develop an emergency response plan in accordance with HIPAP No.1 – Emergency planning for the site including scenario based emergency response plans developed for the range of incident scenarios that have been identified as having significant consequences.
- In addition to this Preliminary Hazard Analysis, conduct a Final Hazard Analysis prior to construction.
- Develop a Traffic Risk Assessment and a detailed Route Selection study for the dangerous goods transport activities particularly for the transport of ethanol from the Project Site.
- Develop a detailed Safety Management System prior to the commencement of operation in accordance with the requirements of the NSW Work Health and Safety Regulation 2011.
- The results of the PHA would be used as inputs into other safety studies required to be developed as a part of the design, construction / commissioning and operations phases of The Project.

- Identify and implement Safety Instrumented Systems in line with AS IEC 61511.1 -2004, *Functional safety – Safety instrumented systems for the process industry sector*
- Carry out safety in Design Reviews in accordance with *WHS Regulations and Code of Practice – Safe Design of Structures*.

10.2.2 Construction phase opportunities

To control, minimise and manage risks during the construction phase of The Project, the following measures would be envisaged:

- Develop and implement an appropriate Safety Management Plan. This should include access by workers to a risk register for all construction activities.
- Develop an Emergency Response Plan, including actions to be taken in the event of an emergency.
- Ensure a permit to work system is implemented, in particular where workers may be exposed to high risk activities.
- Undertake audits on construction activities, and address and communicate any findings to the relevant workers.
- Ensure the workers have appropriate training and the necessary competencies.
- Implement actions / risk reduction strategies as identified through Safety in Design reviews.

10.2.3 Operations phase opportunities

To control, minimise and manage risks during the operations phase of The Project, the following measures would be envisaged:

- Develop an appropriate Safety Management Plan. This should include access by workers to a risk register for all operational activities.
- Develop an Emergency Response Plan to ensure a co-ordinated response to the hazard scenarios identified in this assessment.
- Develop an Operational Environmental Management Plan.
- Undertake audits on operational activities, and address and communicate any findings to the relevant workers.
- Ensure the workers have appropriate training and necessary competencies.
- Implement appropriate preventive maintenance programs.
- Notify Work Cover NSW that the quantity of ethanol in relation to the Schedule 15 chemicals is likely to exceed 10 percent of the threshold quantity.

10.2.4 Post-closure phase opportunities

To control, minimise and manage risks during the post-closure phase of the Project, the following measures would be envisaged:

- Develop a decommissioning plan. This should include a project risk register that is available to all workers, including any risk items added during the construction and operations phases.
- Keep records of all workplace health and safety related information relating to the Project post closure phase.

11.0 Findings and conclusions

The hazard and risk analysis was carried out in accordance with the requirements of, *Applying SEPP 33 Guideline* and the applicable Department of Planning and Infrastructure's (DP&I) Hazardous Industry Planning Advisory Papers. Hazardous chemicals were identified, assessed and preliminarily screened. Although no hazardous chemicals definitively exceeded the screening assessment requirements under *Applying SEPP 33,* four hazardous chemicals were identified to have possible potentially offsite effects, namely ethanol, grain dust, corrosive Class 8 chemicals and compressed natural gas (CNG). The study further followed the DP&I Multilevel Risk Assessment approach.

The Preliminary Hazard Analysis Technical Report found that the hazards associated with the facility are not significant with respect to land use safety planning criteria and that appropriate safeguards have been proposed to prevent and mitigate the hazards and risks associated with the storage and handling of all hazardous chemicals within the Project Site.

12.0 References

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13.0 Definitions

The following definitions are used throughout this study:

ADG Code	The Australian Code for the Transport of Dangerous Goods by Road and Rail.
Class	The classification number assigned to a dangerous good to indicate its most significant type of risk.
Hazardous materials	Substances falling within the classification of the Australian Code for Transportation of Dangerous Goods by Road and Rail (Dangerous Goods Code).
Intermediate	A partly processed substance formed during a manufacturing process which is neither unconverted raw material nor a finished product.
UN Number	United Nations Number, a four digit number assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods Petroleum and Gas Legislation / Queensland: 2004.
LFL	Lower flammability limit, the lower end of the concentration range over which a flammable mixture in air can be ignited

Appendix A

Assumptions register

Appendix A Assumptions register

This Appendix provides a summary of the key assumptions used in the preparation of this preliminary hazard analysis.

The workshop meeting on 7 May 2015 discussed daily CNG gas requirement for the ethanol plant and other dangerous goods storage and handling requirements. Based on the information provided by Dongmun in the workshop held and subsequent communications in terms of the supply of CNG, the following assumptions were made for the :

1) The total ethanol 99.5 percent product stored on site would be 18,000m^3. The storage quantity is in excess of 50 days production capacity. Allowance has been made for ethanol storage tanks with a diameter up to 20 m or a height up to 15 m.
2) Ethanol tank bund requirements are based on a 100 percent tank contents of 3,000m^3, a bund height of 1 m and 90mins fire water. Three bunds of 50 m by 80 m per two ethanol storage tanks were modelled.
3) A bund size covering two loading bays was assumed for the ethanol loading covering 12 m by 8 m.
4) Ethanol liquid leaks modelled as a pool fire. Vapour release modelled as a vapour cloud explosion.
5) The ethanol transfer pump is assumed to operate at a pressure of 450 kPa. Isolation of a hose failure by an operator within 10 mins.
6) Natural gas is assumed to be 100 percent methane.
7) The supply pressure of the CNG is assumed to be 1070 kPa with pressure reduction at the appliances to 37 kPa.
8) Supply of CNG to The Project Site is 112 tonne/day.
9) The length of high pressure CNG pipeline @ 100 mm within The Project Site is assumed to be no more than 1km.
10) Isolation of the CNG boundary isolation valve is assumed to be manual isolation with 30 mins.
11) Methane release modelled as a jet fire and delayed vapour cloud explosion.
12) Biogas generated in the anaerobic digestion process would be collected in a gas holder with a capacity of 600m^3 and used to supplement the CNG supply.
13) Material Properties used in the PHAST Modelling:

Material	Boiling Point [^{o}C]	Specific Gravity	Vapour pressure [kPa]	Flash Point [^{O}C]	LEL [ppm]	UEL [ppm]	Melting Point [^{O}C]	Auto Ignition Temp [^{O}C]
Ethanol	78.29	0.79	4.86 @ 17^{O}C 1246.26 @ 160 ^{O}C	12.85	4.30E+04	1.90E+05	-114.1	365
Methane	-161.5	0.55	51438 @ 17^{O}C	-188	4.40E+04	1.65E+05	-182.5	537

14) Operating days is assumed to be 330 days.

Appendix B

Modelling results

Appendix B Modelling results

The worst case consequence distances for events are shown in the figures.

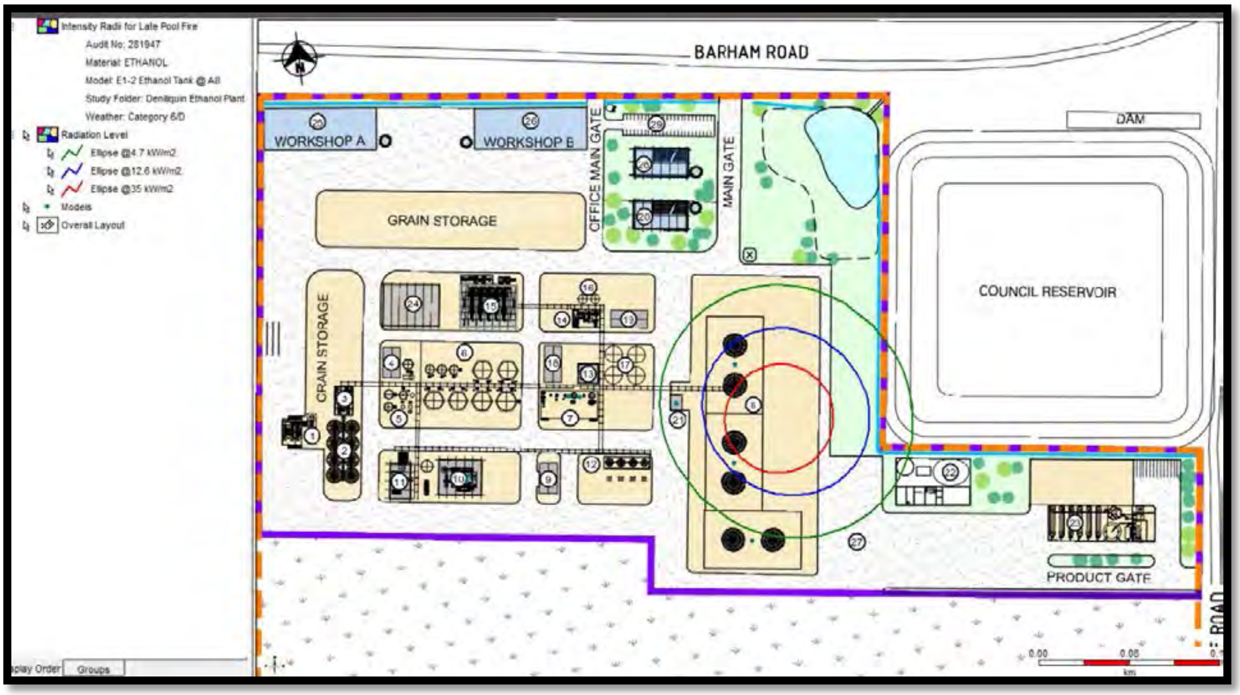

Figure 5 **Ethanol Event 1 (E1): Catastrophic failure of ethanol storage tank middle bund D6 Weather conditions Thermal Radiation**

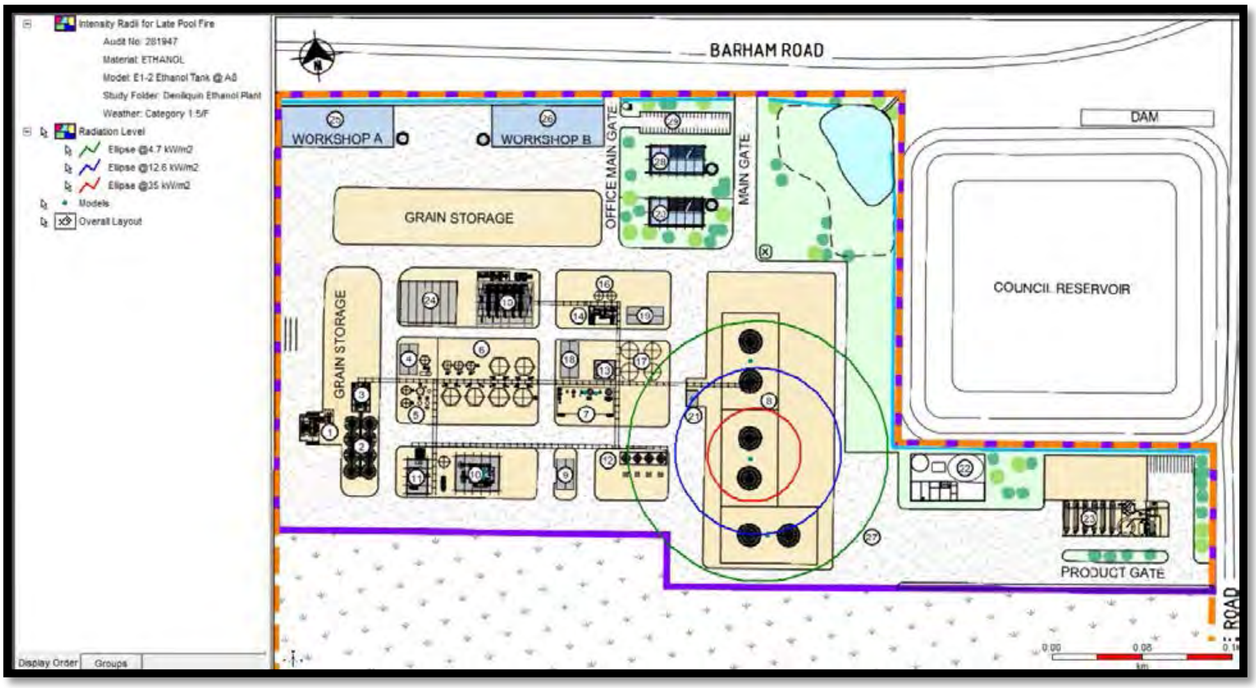

Figure 6 **Ethanol Event 1 (E1): Catastrophic failure of ethanol storage tank middle bund F1.5 Weather conditions Thermal Radiation**

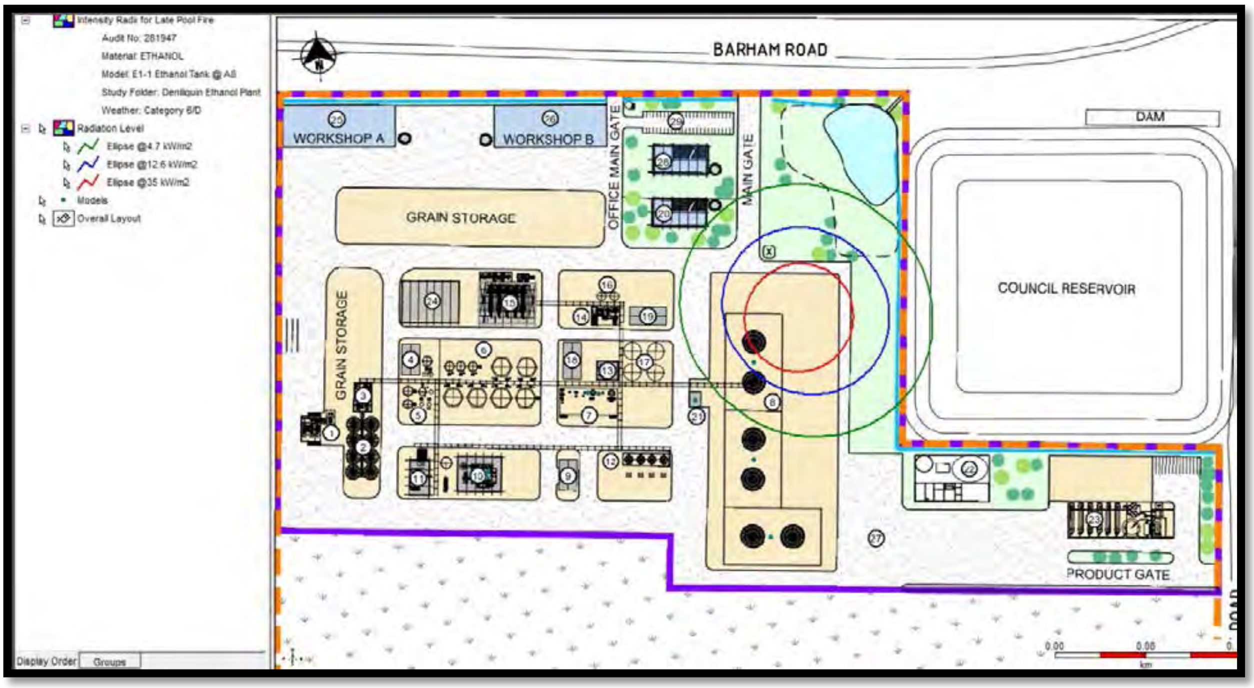

Figure 7 Ethanol Event 1 (E1): Catastrophic failure of ethanol storage tank first bund D6 Weather conditions Thermal Radiation

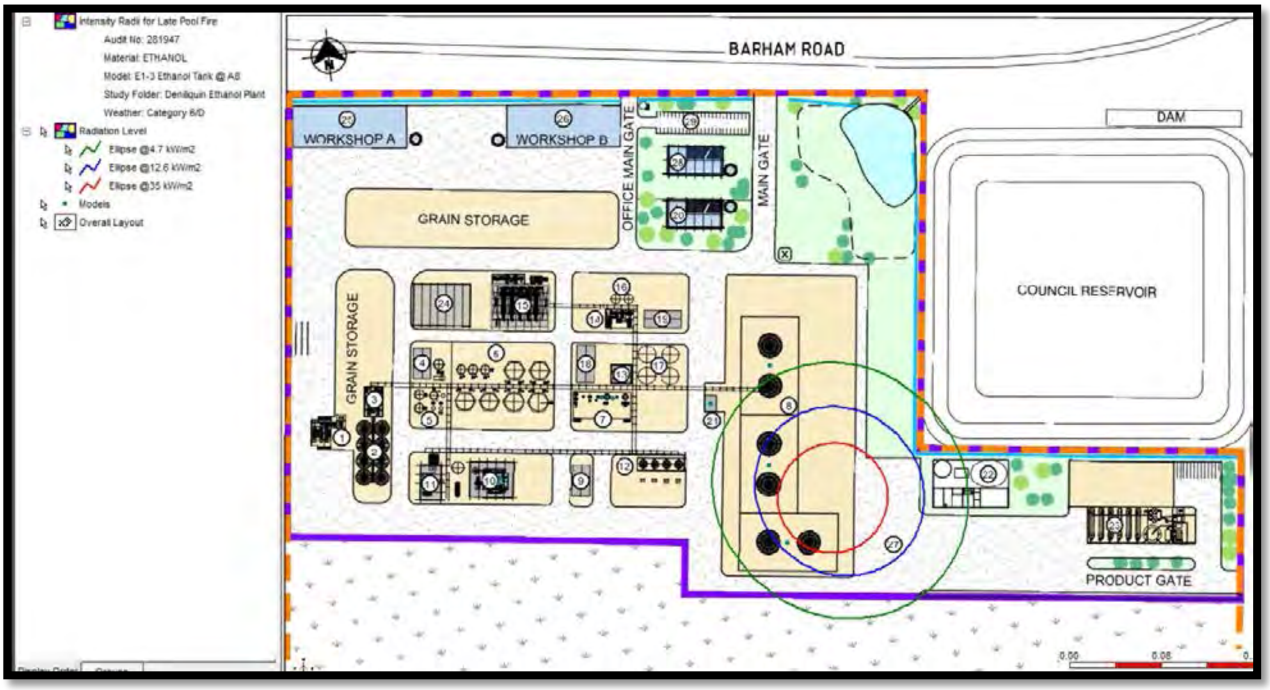

Figure 8 Ethanol Event 1 (E1): Catastrophic failure of ethanol storage tank third bund D6 Weather conditions Thermal Radiation

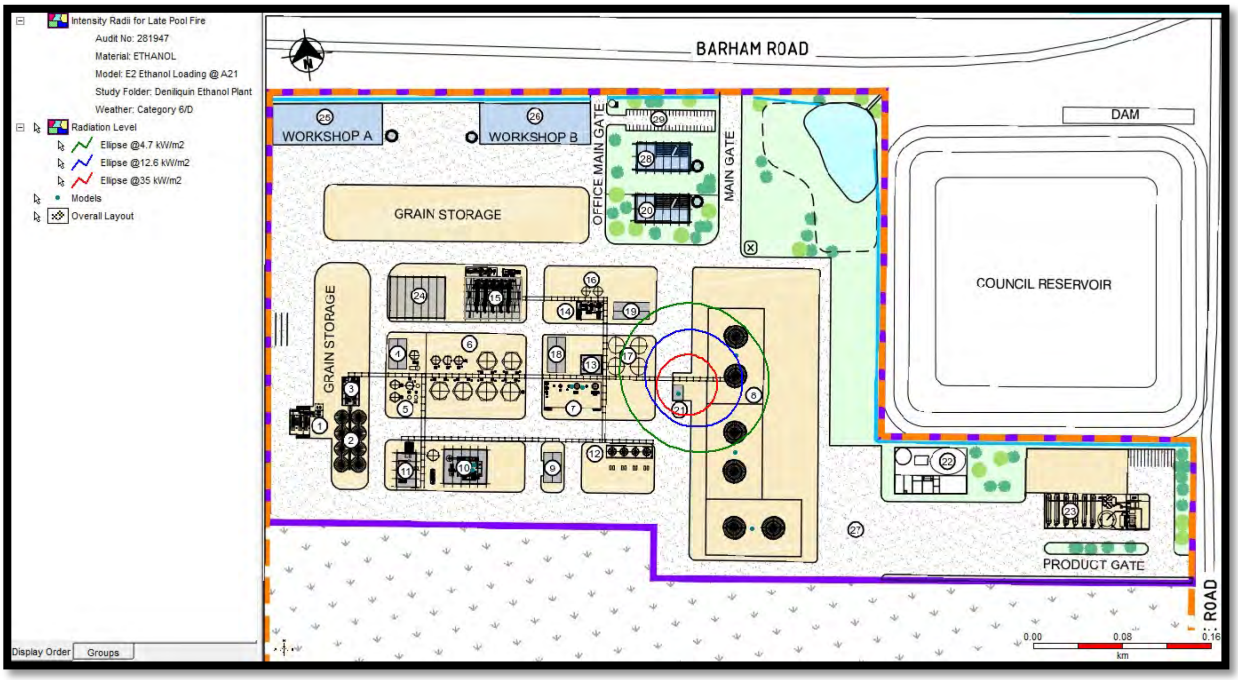

Figure 9 Ethanol Event 2 (E2): Failure of the filling hose D6 Weather conditions Thermal Radiation

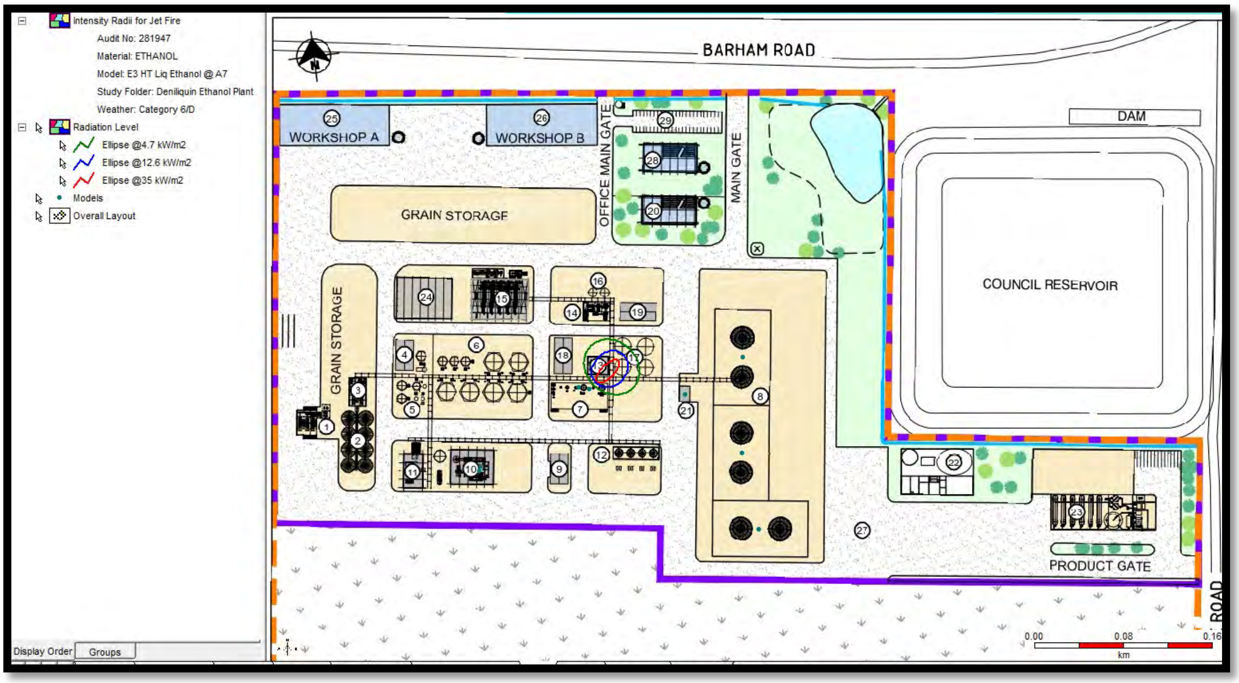

Figure 10 Ethanol Event 3 (E3): Failure at Distillation Plant D6 Weather conditions Thermal Radiation

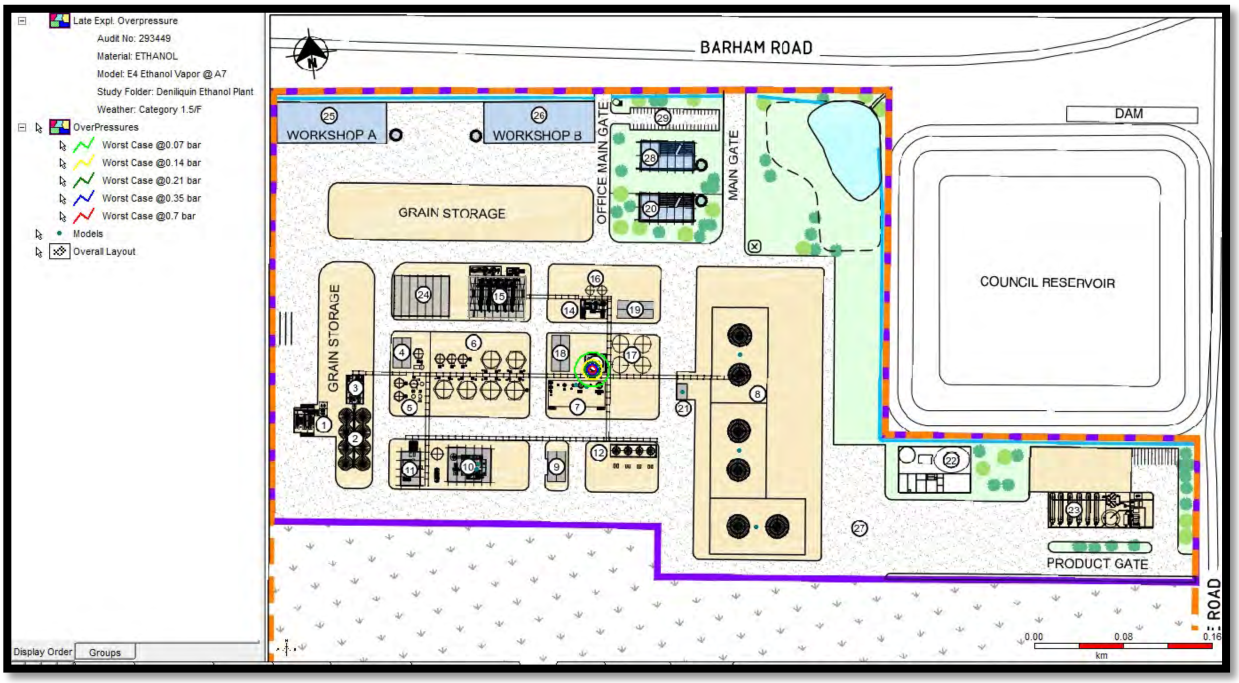

Figure 11 Ethanol Event 4 (E4): Failure at Distillation Plant F1.5 Weather conditions Explosion Overpressure

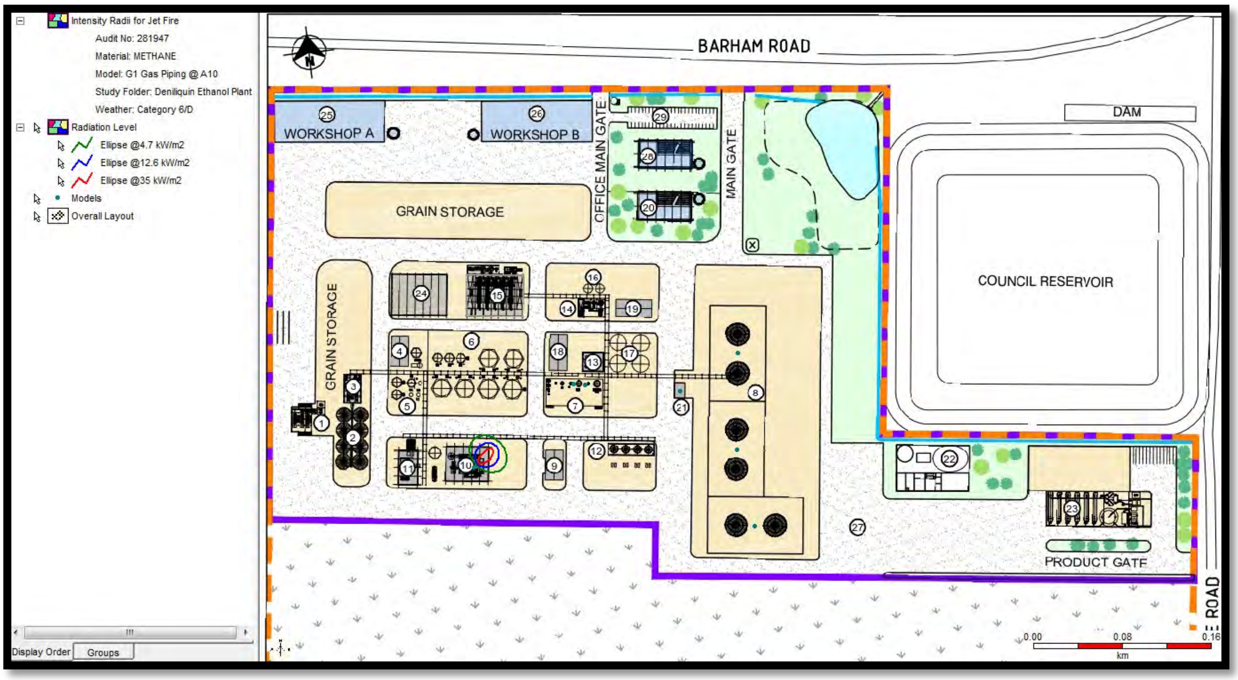

Figure 12 Gas Event 1 (G1): Failure at High Pressure CNG Pipeline D6 Weather conditions Thermal Radiation

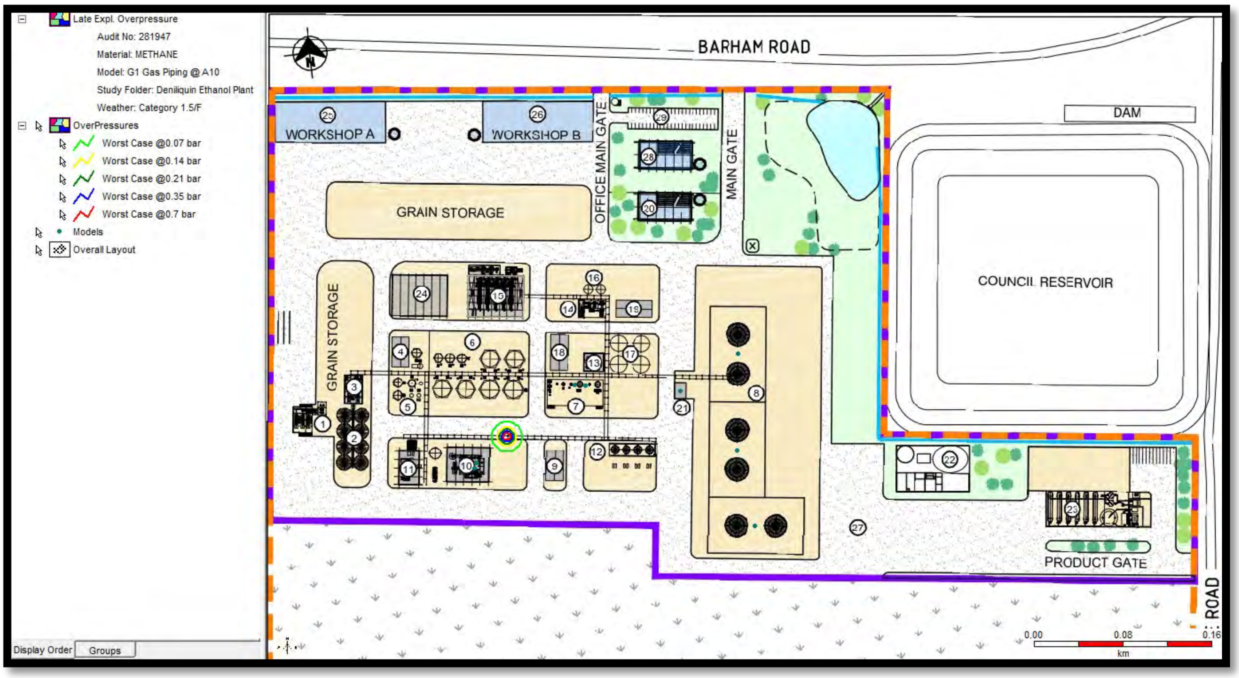

Figure 13 Gas Event 1 (G1): Failure at High Pressure CNG Pipeline F1.5 Weather conditions Explosion Overpressure

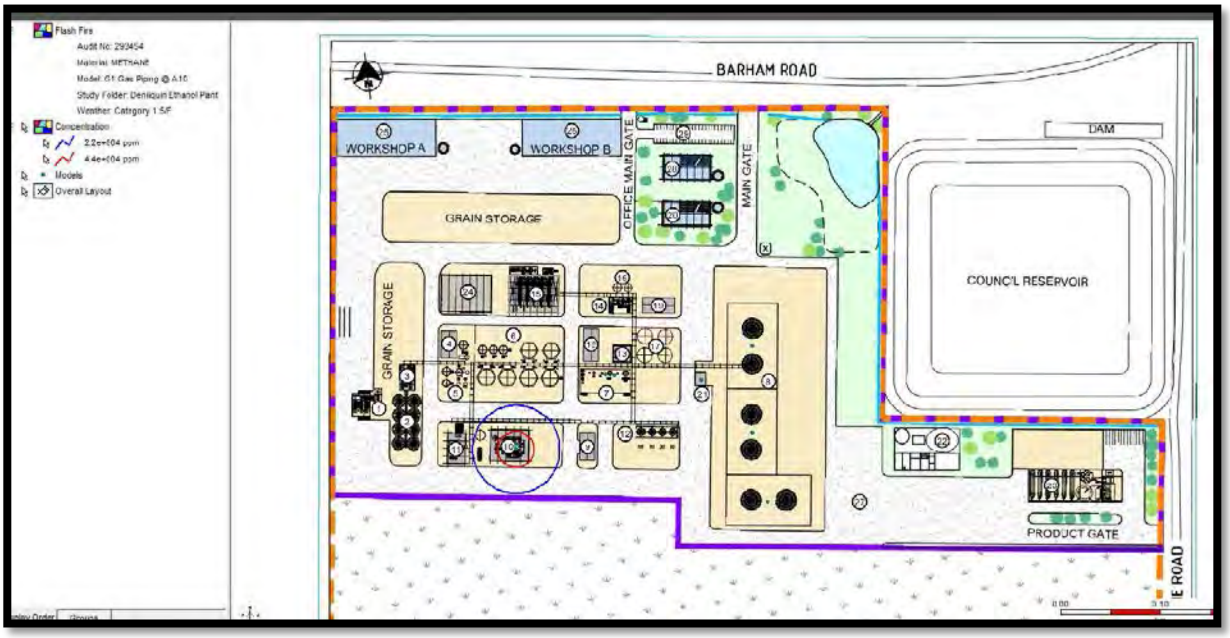

Figure 14 Gas Event 1 (G1): Failure at High Pressure CNG Pipeline F1.5 Weather conditions Flash Fire

The modelling results are detailed in Table 11.

Table 11 Modelling results

Ethanol Scenarios	Weather Category	Pool Fire Thermal Radiation Effect Distance (m)			Jet Fire Thermal Radiation Effect Distance (m)			VCE Overpressure Effect Distance (m)				
		4.7 kW/m^2	12.6 kW/m^2	35 kW/m^2	4.7 kW/m^2	12.6 kW/m^2	35 kW/m^2	7 kPa	14 kPa	21 kPa	35 kPa	70 kPa
E1: Single failure of Ethanol storage tank	**1.5F**	122.949	82.426	46.780								
	6D	170.409	133.497	103.248								
E2: Hose failure, ethanol loading	**1.5F**	75.355	49.993	26.227								
	6D	83.418	60.736	38.002								
E3: Distillation – high temperature liquid ethanol release	**1.5F**				48.612	39.204	31.604	30.324	26.511	25.039	23.693	22.469
	6D				50.154	42.605	36.002	29.451	25.960	24.613	23.381	22.261
E4: Distillation –ethanol vapour release	**1.5F**							35.110	28.654	26.497	24.717	23.250
	6D							33.832	27.922	25.947	24.318	22.975
Gas Scenarios	Weather Category	Flash Fire Envelope Effect Distance (m)			Jet Fire Thermal Radiation Effect Distance (m)			VCE Overpressure Effect Distance (m)				
			50% LFL	LFL	4.7 kW/m^2	12.6 kW/m^2	35 kW/m^2	7 kPa	14 kPa	21 kPa	35 kPa	70 kPa
G1: Gas release –high pressure	**1.5F**		43.6	17.7	31.774	25.962	20.951	53.370	48.432	46.526	44.783	43.198
	6D		38.8	14.5	32.117	27.351	22.938	41.362	37.166	35.546	34.065	32.718
G2: Gas release at appliance – low pressure	**1.5F**				No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect
	6D				No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect

Appendix O

LVIA Assessment Methodology

Landscape and Visual Impact Assessment Methodology

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AECOM in Australia and New Zealand is certified to the latest version of ISO9001, ISO14001, AS/NZS4801 and OHSAS18001.

Quality Information

Document Landscape and Visual Impact Assessment Methodology

Ref \\aubne1fp003\projects\603x\60344248\6. draft docs\6.1 reports\draft eis\3. final draft - post adequacy\appendices\appendix o - lvia methodology\appendix o landscape and visual impact assessment methodology_final draft.docx

Date 02-Oct-2015

Prepared by Jemma Purandare

Reviewed by Mark Herod

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	28-Aug-2015	Draft Issued for Adequacy	James MacDermott Practice Lead- Approvals	J. MacDermott
0	02-Oct-2015	Final	James MacDermott Practice Leader - Approvals	J. MacDermott

Table of Contents

List of Tables

1.0 Landscape character and visual amenity methodology

1.1 Judgement of landscape sensitivity

The sensitivity of a landscape is judged on the extent to which it can accept change of a particular type and scale without adverse effects on existing landscape character. Levels of sensitivity, shown in Table 1, vary according to the type of development and the nature of the landscape. Key aspects that have been considered when identifying the level of sensitivity associated with each landscape character type include:

- The landscape's inherent values (e.g. perceptual qualities, cultural importance, and any specific values that may apply such as landscape planning designations)
- The landscape's ability to absorb changes associated with the Project (e.g. the extent to which the Project may fit or be absorbed into the landform, land use, pattern, scale or texture of the existing landscape).

Table 1 Defining landscape sensitivity

Sensitivity of landscape	Attributes of Landscape Sensitivity Categories
High	A landscape protected by national designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.
Medium	A moderately valued landscape, perhaps a regionally important landscape and / or protected by regional/state designation, or where its character, land use, pattern and scale may have some capacity to accommodate a degree of the type of change envisaged.
Low	A landscape valued to a limited extent, perhaps a locally important landscape or where its character, land use, pattern and scale is likely to have the capacity to accommodate the type of change envisaged.
Negligible	A landscape which is not valued for its scenic quality or where its character, existing land use, pattern and scale are tolerant of the type of change envisaged, and the landscape has capacity to accommodate change.

1.2 Magnitude of change to landscape character

The magnitude of change to landscape character depends on the nature, scale and duration of the change that is expected to occur. The magnitude of change also depends on the loss, change or addition of any feature to the existing landscape and is based upon that part of the landscape character type which is likely to be impacted to the greatest extent by the Project (i.e. worst case scenario) before the application of any mitigation.

Magnitude of change is described as being barely perceptible, noticeable, considerable or dominant, as illustrated in Table 2. The descriptions of magnitude and sensitivity are illustrative as there is no defined boundary between levels of impacts.

Table 2 Defining magnitude of change to landscape character

Magnitude of Change	Typical Examples
High	Dominant change: A clearly evident and frequent/continuous change in landscape characteristics affecting an extensive area, which is likely to fundamentally change the character of the landscape.
Medium	Considerable change: A considerable change in landscape characteristics, frequent or continuous and over a wide area or a clearly evident change, but over a restricted area.
Low	Noticeable change: A noticeable change in landscape characteristics over a wide area or a considerable change over a restricted area, but will not fundamentally change the character of the landscape.
Negligible	Barely perceptible change: An imperceptible, barely or rarely perceptible change in landscape characteristics.

1.3 Level of effect on landscape character

An evaluation of overall potential impacts on landscape character is based on the sensitivity of the existing landscape to change and the magnitude of change that is likely to occur. No prescribed methods for assessment of significance of landscape impacts exist; therefore professional judgement and experience are applied in order to identify the level of significance. Each landscape character type is assessed on its own merits, as factors unique to each circumstance need to be considered. However, there are general principles which can be used as a guide to this process; which provide transparency about how judgements have been made. The overall significance of change to landscape character is determined by using Table 3.

Table 3 Determining level of effect on landscape character

Significance of Impact		Magnitude of change in landscape: High (Dominant change)	Medium (Considerable change)	Low (Noticeable change)	Negligible (Barely perceptible change)
Sensitivity of landscape	High	**Major**	**Moderate to Major**	Moderate	Moderate to Minor
	Medium	**Moderate to Major**	Moderate	Moderate to Minor	Minor
	Low	Moderate	Moderate to Minor	Minor	Minor to Negligible
	Negligible	Moderate to Minor	Minor	Minor to Negligible	Negligible

Denotes a 'Significant' impact.

Denotes a 'Not Significant' impact.

2.0 Visual amenity assessment

2.1 Identification and description of visual receptor audiences and viewpoints

Visual receptor audiences are assessed and described in terms of the views which can be obtained from selected representative viewpoints within a certain radius of the Project. Representative viewpoints have been identified and described as part of the LVIA. Visual receptors have been identified based on a number of parameters, including:

- Proximity of the receptor, i.e. that the most effected visual receptors are anticipated to be located within a 5 km radius of the Project unless located at an elevated vantage point.
- Type of visual receptor, i.e. that the visual receptor is a permanent resident of a residential dwelling or homestead.
- A driver or passenger of vehicles passing alongside, or in the vicinity of, the Project.
- A member of the public accessing marked recreational areas (e.g. National Parks, cycle ways and footpaths).
- An industrial or commercial worker.

2.2 Judgement of visual sensitivity

The sensitivity of each viewpoint, and the visual receptor audiences which it represents, is considered to be dependent upon:

- The importance of the view, its existing scenic qualities and the presence of other existing manmade elements in the view.
- The type of the visual receptor audience and their likely interest in the view (e.g. residents, visitors to important/valued landscapes or visitors to non-designated areas, motorists).
- The volume of visual receptors and the duration of time that receptors spend experiencing the view.

Levels of sensitivity, shown in Table 4, vary according to the type of development and the visual receptor audience.

Table 4 Defining viewpoint sensitivity

Sensitivity of Viewpoint	Attributes of viewpoint sensitivity categories
High	Large numbers of viewers, particularly those with proprietary interest and prolonged viewing opportunities such as residents and users of attractive and/ or well-used recreational facilities. Views from a regionally important location such as a scenic lookout whose interest is specifically focussed on the landscape.
Medium	Medium numbers of residents and moderate numbers of visitors with an interest in their environment e.g., visitors to State Forests, including bush walkers, horse riders, trail bikers. Larger numbers of travellers with an interest in their surroundings.
Low	Small numbers of people with a passing interest in their surroundings e.g., those travelling along principal roads. Viewers whose interest is not specifically focussed on the landscape e.g., workers, commuters.
Negligible	Very occasional numbers of viewers with a passing interest in their surroundings e.g., those travelling along minor roads, views from the air

2.2.1 Magnitude of change to visual amenity from representative viewpoints

The magnitude of change to views and visual amenity depends on the nature, scale and duration of the change that is expected to occur. The magnitude of change also depends on the loss, change or addition of any feature in the field of view of the receptor; or any change to the backdrop to, or outlook from, a viewpoint. The assessment assumes a worst case scenario without mitigation. The level of effects on a view depend on the extent of visibility, degree of obstruction of existing features, degree of contrast with the existing view, angle of view, duration of view and distance from the Project.

Magnitude of change is described as being barely perceptible, noticeable, considerable or dominant, as illustrated in Table 5.

Table 5 Defining magnitude of change to visual amenity

Magnitude of change	Typical examples
High	Dominant change: Major changes in view at close distances (typically <100 m), affecting a substantial part of the view, continuously visible for a long duration, or obstructing a substantial part or important elements of view.
Medium	Considerable change: Clearly perceptible changes in views at intermediate distances (typically 100 – 500 m), resulting in either a distinct new element in a significant part of the view, or a wider ranging, less concentrated change across a wider area.
Low	Noticeable change: Minor changes in views, at long distances (typically 500 m – 1 km) or visible for a short duration, and/or are expected to blend in with the existing view to a moderate extent.
Negligible	Barely perceptible change: Change which is barely visible, at a very long distance (typically >1 km), or visible for a very short duration, and/or are expected to blend with the existing view.

2.3 Overall significance of impact on visual amenity from representative viewpoints

The evaluation of overall potential impacts on visual amenity is based on the sensitivity of existing views to change and the magnitude of change that is likely to occur. No prescribed methods for assessment of significance of impacts exist; therefore professional judgement and experience are applied in order to identify the level of significance. Each viewpoint is assessed on its own merits, as factors unique to each circumstance need to be considered. However, there are general principles which can be used as a guide to this process; which provides transparency about how judgements have been made. The overall significance of change to visual amenity and individual viewpoints is determined by using Table 6.

Table 6 Determining level of effect on visual amenity

Significance of Impact		Magnitude of change in landscape: High (Dominant change)	Medium (Considerable change)	Low (Noticeable change)	Negligible (Barely perceptible change)
Sensitivity of landscape	High	**Major**	**Moderate to Major**	Moderate	Moderate to Minor
	Medium	**Moderate to Major**	Moderate	Moderate to Minor	Minor
	Low	Moderate	Moderate to Minor	Minor	Minor to Negligible
	Negligible	Moderate to Minor	Minor	Minor to Negligible	Negligible

Denotes a 'Significant' impact.

Denotes a 'Not Significant' impact.

3.0 Lighting assessment on visual amenity

3.1 Definition and description of the lighting assessment

A qualitative assessment of the impacts of lighting on visual amenity has been undertaken based upon determination of the current level of lighting within the area and any potential changes to lighting levels that may be associated with the Project. As there is no prescribed assessment method for the impacts of lighting on visual amenity, guidance and terminology has been taken from the *Guidance Notes for Reduction of Obstructive Lighting* (2005), prepared by The Institution of Lighting Engineers UK, and *Australian Standard 4282 – Control of Obtrusive Effects of Outdoor Lighting* (1997). This information has then been combined with the standard method of assessment for impacts on visual amenity.

Visual receptor audiences are assumed to be the same as those identified in the Visual Amenity Assessment. A further refinement of the representative viewpoints has been undertaken to ensure efficiency of the assessment as well as for logistical and health and safety reasons. The refined group of three representative viewpoints have been selected based on their ability to best represent a range of scenic viewpoint locations or those viewpoints which best capture any potential changes to lighting levels. Judgements on magnitude of change and visual sensitivity will not therefore directly assess impacts on residents of individual dwellings.

3.2 Judgement of visual sensitivity

The sensitivity of each representative viewpoint to changes in after-dark lighting conditions as a result of the Project has been based upon elements illustrated in Table 7, including:

- The proximity of the viewpoint to the greatest lighting source that is associated with the Project (specifically defined for every project and the type of impacts that may be associated with that project's specific infrastructure).
- The public and private accessibility of the representative viewpoint location and the likely number of viewers who will visit the viewpoint.

Table 7 Visual sensitivity to Project lighting

LIGHTING SENSITIVITY		Proximity of the viewpoint to the Project			
		Typically <100 m	**Typically 100 m – 500 m**	**Typically 500 m – 1 km**	**Typically >1 km**
Accessibility of viewpoint location	**Easily accessible at night** (e.g. frequently visited by residents/workers for long durations or visited by large numbers of viewers)	High	Medium	Low	Negligible
	Relatively accessible at night (e.g. frequently visited for short durations or by a moderate number of viewers)	Medium	Low	Negligible	Negligible
	Typically not accessed at night (e.g. infrequently visited for short durations or by a small number of viewers)	Low	Negligible	Negligible	Negligible
	Rarely accessed at night (e.g. commonly viewed by passers-by for very short durations or visited by a very small number of viewers)	Negligible	Negligible	Negligible	Negligible

3.3 Magnitude of change to visual amenity from representative viewpoints

The magnitude of change to views and visual amenity, as a result of lighting conditions, depends on the nature, scale and duration of the change to lighting that is expected to occur. The magnitude of change also considers any change to the backdrop to, or outlook from, the representative viewpoint. The assessment assumes a worst case scenario without mitigation. The level of effect on a view depends on the extent of visibility, degree of obstruction of existing features, degree of contrast with the existing view, and angle of view.

To enable the judgement of the magnitude of changes in lighting, Table 8 considers the existing condition against the potential condition. These conditions include very dark, predominantly dark, predominantly lit, or brightly lit landscapes as a measure of change in visual conditions. The outcome of this judgement will result in either a dominant, considerable, noticeable or imperceptible change to lighting conditions from the representative viewpoint.

Intrinsically Dark– Inherently remote rural landscapes with minimal artificial lighting other than that which is localised lighting of a dwelling. Typically no street lighting and no industrial lighting.

Predominantly Dark – Commonly rural residential landscapes where dwellings are still largely isolated from one another, creating a relatively dark atmosphere with intermittent sources of lighting (such as street lighting). Industrial lighting may occur in predominantly dark landscapes; however lengthy distances between these sites and residential dwellings result in minimal lighting spill onto private property.

Predominantly Lit – Commonly small towns with standard elements of lighting such as street lighting and lighting from residential dwellings, commercial businesses and some industrial lighting.

Brightly Lit – Town/city centres or large scale industrial landscapes with high levels of lighting.

Table 8 Defining magnitude of change to visual amenity

Magnitude of change	Typical examples
High	Dominant change: Occurs when an intrinsically dark landscape becomes brightly lit.
Medium	Considerable change: Occurs when an intrinsically dark landscape becomes predominantly lit or a predominantly dark landscape becomes brightly lit.
Low	Noticeable change: Occurs when an intrinsically dark landscape become predominantly dark, a predominantly dark landscape becomes predominantly lit or a predominantly lit landscape becomes brightly lit.
Negligible	Barely perceptible change: Occurs when a landscape experiences negligible changes from the existing lighting conditions to the proposed lighting conditions.

3.4 Overall significance of impact on visual amenity from representative viewpoints

This evaluation considers sensitivity of each representative night time viewpoint and the magnitude of change that is likely to occur. Professional judgement and experience have been applied in order to identify the visual sensitivity to lighting and the potential magnitude of change. Each viewpoint is assessed on its own merits, as factors unique to each circumstance need to be considered. However, there are general principles which can be used as a guide to this process and provide transparency about how judgements have been made. The overall significance of change to visual amenity and individual viewpoints is determined using Table 9.

Table 9 Determining level of effect on lighting

Significance of Impact		Magnitude of change in landscape			
		High (Dominant change)	Medium (Considerable change)	Low (Noticeable change)	Negligible (Barely perceptible change)
Sensitivity of landscape	High	**Major**	**Moderate to Major**	Moderate	Moderate to Minor
	Medium	**Moderate to Major**	Moderate	Moderate to Minor	Minor
	Low	Moderate	Moderate to Minor	Minor	Minor to Negligible
	Negligible	Moderate to Minor	Minor	Minor to Negligible	Negligible

Denotes a 'Significant' impact.

Denotes a 'Not Significant' impact.

3.4.1 Cumulative landscape and visual impact assessment

The aim of the cumulative LVIA is to describe and assess the ways in which the Project could have additional impacts when considered in combination with other proposed and built developments in the area.

Information to inform the cumulative LVIA is based on descriptions of other similar scale projects to the extent that such data was publicly available at the time of this assessment. The cumulative situation may change as applications are made or withdrawn. Therefore, the cumulative assessment is current as of May 2015.

The cumulative impact assessment methodology follows a qualitative method similar to the main LVIA assessment; including a three step process, as follows:

- **Step One:** Identification and description of existing projects within the Project area.

The projects included in the cumulative assessment are those that have been approved by the Minister or have sufficient information in the public domain (e.g. an EIS) to enable an assessment of the potential impacts. Projects included for consideration in the cumulative impact assessment also need to be located sufficiently close to the Project for cumulative landscape and visual effects to be possible.

- **Step Two:** Project screening i.e. exclusion of projects anticipated to generate a negligible cumulative impact on landscape and visual amenity.

  A provisional review has been conducted to streamline the assessment process to eliminate, or scope out projects, which are anticipated to generate negligible landscape and visual impacts. The inclusion of a site is based on a judgement of whether views of the Project and the development are anticipated at the same time (which is for example related to distance).

- **Step Three:** Assessment of cumulative landscape and visual impacts.

  This step determines the nature and extent of potential impacts in relation to landscape and visual values of the region, as determined through the assessment criteria in the main LVIA. The assessment considers if the cumulative impact would be “combined” (two or more projects visible from one viewpoint), “successive” (two or more projects visible from one location and with the same viewfield), or “sequential” (developments viewed at different times e.g. passing along a road).

Appendix P

Air Quality

Appendix P.1

Addendum to Air Quality Technical Report

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2 October 2015

Addendum to SLR, June 2015 Air Quality Technical Report

The below points contain important additional information and clarification with regards to Appendix P2 - Air Quality Impact Assessment dated 11 June 2015.

1. Table 2 of Appendix P2 - Air Quality technical report identifies all potential sources of significant air pollutant emissions associated with the Project. As discussed in the comments section of Table 2 the majority of potential emissions are captured in closed systems and returned to the process rather than vented to the atmosphere. An example of captured emissions being returned to the process is the fabric filter systems during the grain intake and processing stage.

   Several potential sources of odorous emissions along with nominated control systems are identified within Table 2 of Appendix P2 - Air Quality technical report. Section 2.2.6 of the report discusses the closed system wastewater treatment process and highlights that within the treatment system the aeration basin is the only significant potential odour source exposed to the air. Accordingly as nominated in Section 7.5 of Appendix P2 the odour emissions quantified for dispersion modelling were the aerated basin along with the steam boiler and waste heat boiler. A summary of the odour emission rates are provided in Table 24 of Appendix P2 - Air Quality technical report.

2. The NSW Environment Protection Authority (EPA) has published an Energy from Waste Policy Statement that requires any facility proposing to recover energy from waste to meet current international best practice. The policy sets out eligible waste fuels that may be thermally treated using a range of technologies. Any proposed control technology must represent the most efficient reuse of the resource with no increased risk to human health or the environment. The policy also requires that emissions must, as a minimum, meet current emission limits prescribed by the *Protection of the Environment Operations (Clean Air) Regulation 2002* (POEO (Clean Air)).

   Biogas waste fuel generated in the wastewater treatment process is proposed to be reused by the Project. The biogas will primarily be methane and is considered an eligible waste fuel by the NSW Energy from Waste Policy Statement. Thermal oxidisation of the biogas within the DDGS process and the waste heat boiler is based on the best available control technology approach used in a similar ethanol manufacturing facility in Nebraska, USA[1]. Appendix P2 - Air Quality technical report provides further information on how the project emissions are not anticipated to increase risk to human health or the environment. Section 7.5.1 specifically addresses how the Project emissions comply with the current emission limits prescribed by the POEO (Clean Air).

3. Appendix P2 - Air Quality technical report refers to speciated VOC emissions data. The supplied VOC data as used in the dispersion modelling was based on stack test data from a similar ethanol manufacturing facility in Nebraska, USA. The VOC stack test emissions data is provided in Table G1 of the Prevention of Significant Deterioration (PSD) construction permit for Abengoa Bioenergy Corporation Ethanol Manufacturing Facility at 1414 Road O, York, York County, Nebraska. The emissions factors in Table G1 are provided in lbs/ton of DDGS for each of the assessed VOC's. Table 1 below provides an example of the conversion from Table G1 in the PSD to the modelled emission rates in Appendix P2.

[1] State of Nebraska (2004) "*Prevention of Significant Deterioration (PSD) construction permit for Abengoa Bioenergy Corporation Ethanol Manufacturing Facility at 1414 Road O, York, York County, Nebraska*"

Table 1 **VOC Emission data Example Conversion - Formaldehyde**

	Units	Formaldehyde
PSD emission rate in Table G1	(lbs/ton)	0.34
Annual emission rate at the nominated DDGS production rate of 102,000 ton/yr	(lbs/yr)	34,680
Daily Formaldehyde emission rate at nominated 330 production days per year	(lbs/day)	105.1
Modelled Steam Boiler emission rate in Appendix P2	mg/min	35,728
PSD Best Available Control Technology (BACT) nominated control efficiency for thermal oxidisation applied to the waste heat boiler emissions	%	98
Modelled Waste Heat Boiler emission rate in Appendix P2	mg/min	715

4. Appendix B of the EIS provides process flow diagrams with the air emissions controls discussed in Appendix P2 - Air Quality technical report. The process flow diagrams include detail on process location of fabric filter and thermal oxidisation control technologies.

5. Two main types of emissions controls are proposed for the Project's air emissions: fabric filters; and thermal oxidisation. Fabric filters have been proposed in numerous parts of the process to control particulate emissions. Fabric filters generally attain greater than 99% efficient[2] and allow lost product to be collected and returned to the process. The other main emission control proposed is the thermal oxidisation of odorous emission associated with the DDGS process and the waste heat boiler. A 98% control efficiency is applied to the waste heat boiler emissions based on the best available control technology approach used in the PSD.

6. The Project will operate 24 hours per day, seven days a week for 330 days per year with a scheduled one-month shut down period. During the scheduled shut down period there may be instances when the natural gas fired boilers incur some incomplete combustion due to non-optimal combustion conditions. Typically for a natural gas fired boiler during periods of incomplete combustion the CO emission may increase and NOx emissions decrease[3]. Appendix P2 - Air Quality technical report predicted minimal CO impact on the surrounding environment with a maximum project increment of 0.01 mg/m³ 8 hour CO average compared to a criterion of 10 mg/m³ and 0.013 mg/m³ 15 minute hour average compared to a criterion of 100 mg/m³. During the infrequent periods where the waste heat boiler is non-operational and the wastewater treatment process is still generating biogas the excess methane will be control released via a flare. The approach to flare excess methane when the waste heat boiler is non-operational is based on the BACT approach used in the PSD for the Abengoa Bioenergy Corporation Ethanol Manufacturing Facility. Further information regarding the wastewater treatment process is provided in Appendix L - Surface Water and Groundwater Technical Report.

Yours faithfully

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[3] United States Environmental Protection Agency (USEPA) (1995). *AP-42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I, Chapter 1.4:Natural Gas Combustion*.

Appendix P.2

Air Quality Technical Report

global environmental solutions

Deniliquin Ethanol Plant

Construction and Operation Air Quality Impact Assessment

Report Number 640.10923-R2R0

11 June 2015

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Deniliquin Ethanol Plant

Construction and Operation Air Quality Impact Assessment

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Executive Summary

SLR Consulting Australia Pty Ltd (SLR) was commissioned by NGH Environmental Pty Ltd on behalf of Dongmun I.R.S Ltd to perform an Air Quality Impact Assessment (including odour) on the construction and operation of the proposed Ethanol Plant located on Barham Road, Deniliquin.

This study will inform the overall Environmental Impact Statement required to be submitted to the NSW Department of Planning and Environment. The specific requirements of this study are clearly outlined within the Director General's Requirements as issued for State Significant Development 13_5917.

The objective of this Air Quality Impact Assessment was to defined the sources of emissions from the proposed construction and operation of the Deniliquin Ethanol Plant and assess the impacts against applicable air quality criteria to determine the requirement for further mitigation and control, and to identify any residual impacts.

The potential impacts on local air quality from construction activities were assessed qualitatively, using the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management.

In order to quantitatively assess the potential impacts on local air quality of the Deniliquin Ethanol Plant, emissions estimation and dispersion modelling were performed for the operational phase. The assessment methodology included meteorological and dispersion modelling using established and recognised modelling techniques. The emission rates and source parameters defined for the modelling scenarios were based on site specific information and recognised emission estimation factors.

The qualitative assessment of construction impacts considered the sensitivity of the receiving environment and the magnitude of the likely dust emissions from the construction of the Project. Overall, the risk of air quality impacts from earthworks, construction of infrastructure, and trackout of dust were determined to be *low* or *negligible* across the Project Site. In addition to the low risk of air quality impacts from construction activities, mitigation and management measures will be applied to further reduce the impact, and therefore it is considered that there will be no significant impact from generated dust emissions at the Project Site.

The quantitative assessment addressed the impacts to air quality of emissions from the operation of the Project, including nitrogen dioxide, carbon monoxide, particulates (as PM_{10}, $PM_{2.5}$), speciated volatile organic compounds and odour. The predicted ground level concentrations of the pollutants assessed met their respective guidelines for the appropriate averaging periods. The predicted maximum 24-hour average particulates (as PM_{10}) ground level concentrations did not comply with the respective guideline when background air quality concentrations from Albury were included. However, further analysis of the contemporaneous impact and background concentrations showed that no additional exceedances of the 24-hour average impact assessment criterion are likely. Provided the ethanol plant is well managed it is reasonable to conclude that minimal adverse impacts would be anticipated.

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) was commissioned by NGH Environmental Pty Ltd (NGH Environmental) on behalf of Dongmun I.R.S Ltd (Dongmun) to perform an Air Quality Impact Assessment (AQIA) (including odour) in relation to the potential impacts of the construction and operation of the proposed Ethanol Plant located on Barham Road, Deniliquin, NSW (the Project Site).

This study will inform the overall Environmental Impact Statement (EIS) required to be submitted to the NSW Department of Planning and Environment (DP&E). The specific requirements of this study are clearly outlined within the Director General's Requirements (DGR's) as issued for State Significant Development 13_5917 as described in detail in **Section 1.1**.

1.1 Director General's Requirements for State Significant Development 6393

The DGR's for the development as they relate to air quality and odour are presented below:

***Air Quality and Odour** - including:*

- *description of all potential odour sources and predicted odour emissions from the construction and operation of the abattoir and its wastewater treatment system;*
- *a comprehensive air quality assessment of all potential air quality and odour impacts from the development, including details of air quality and odour impacts on private properties, in accordance with relevant Environment Protection Authority guidelines;*
- *details of mitigation, management and monitoring measures for preventing and/or minimising both point and fugitive emissions; and*
- *an assessment of the effectiveness of the proposed air quality and odour mitigation measures.*

A description of how these requirements have been met is presented in **Section 1.2**.

1.2 Study Scope

1.2.1 Construction Phase Impacts

Construction phase impacts are required to be assessed by the DGR's. Following consultation with the client and a review of the likely magnitude of impacts, the scope of the construction phase component of the AQIA is a focussed risk-based (qualitative) assessment, the purposes of which are to (i) identify potential impacts associated with the construction of the development with respect to air quality, (ii) identify any constraints from existing and proposed sources of emissions to air from local industry and commerce proximate to the Project Site and (iii) propose suitable mitigation and control measures.

Recommendations provided in this report focus on air quality control and mitigation strategies that may be applied to the construction phase of the development, to ensure that the proposed development does not result in a significant and adverse impact upon air quality in the local area.

1.2.2 Operation Phase Impacts

Impacts on air quality resulting from the operation of the ethanol plant have been examined. Key emissions to air associated with the operation of the proposed development are likely to comprise:

- Odour generation due to the operation of the wastewater management system and ethanol production process.
- Particulate matter (as PM_{10} and $PM_{2.5}$), from combustion sources.

- Oxides of nitrogen (NO_X) and carbon monoxide (CO), from combustion sources.
- Volatile Organic Compounds (VOCs), including acetaldehyde, acrolein, formaldehyde, ethanol and methanol.
- Traffic-related exhaust emissions due to increased vehicle movements (i.e. road truck transport of stock/product).

1.3 Broad Methodology

1.3.1 Construction Phase (Qualitative) Air Quality Impact Assessment

The methodology performed for the Construction Phase AQIA is as follows:

- Gather available and relevant information as made available by the client including, but not limited to: hours of operation; construction scenarios and timing; the number of truck movements per day; equipment inventory (both fixed and mobile); emission control equipment and management strategies currently proposed; and locations of general air pollution generating activities.
- Using the collated data, determine the area of land being worked, and the scale and nature of equipment and processes on site, the potential traffic routes resulting in fugitive emissions, the location of controlled emission points (i.e. exhausts).
- Perform a desktop study to identify separation distances between the facility and existing receptors/nearby sensitive land uses. Determine the sensitivity of the identified receptors.
- Obtain data from nearby, representative Office of Environment and Heritage (OEH) air quality monitoring stations to characterise the background ambient air environment and to determine whether local air quality objectives are likely to be exceeded as a result of construction activities.
- Characterise the local meteorological environment to determine the potential for dust impacts, particularly in relation to the amount of rainfall typically received by the area. Generate annual and seasonal wind rose/s (plots of wind speed and direction) for the local area using data obtained from the nearest and/or most representative Bureau of Meteorology (BoM) Automatic Weather Station (AWS) to determine the potential for winds to transport pollutants in the direction of sensitive receptor locations during construction works.
- Determine the potential for cumulative impacts at receptor locations by undertaking a desk-based study to identify surrounding sources of emissions to air and perform a review of publicly available (Environmental Impact Statement) EIS documentation, National Pollutant Inventory (NPI) and Environmental Protection Licence (EPL) database information to examine existing potential sources of air pollution.
- Perform a qualitative risk-based assessment of identified activities to determine the risk of air quality impacts with no mitigation applied and taking into account prevailing weather conditions.
- Based on the results of the assessment, prescribe appropriate air quality control measures and proactive/response management procedures (i.e. complaints handling, monitoring etc.) as necessary for ensuring that adverse air quality impacts do not occur at off-site sensitive receptor locations. All recommendations for monitoring are based on the NSW Environment Protection Authority's (EPA) document, *Approved Methods for Sampling and Analysis of Air Pollutants in NSW* (DEC 2007).

1.3.2 Operational Phase (Quantitative) Air Quality Impact Assessment

The methodology performed for the Operational Phase AQIA is as follows:

- Identify the relevant air quality and odour criteria applicable to the Project.
- Identify all potential sources of emissions through review of existing plans, documentation and discussion with the Client.

- Obtain meteorological data from the closest or most representative Bureau of Meteorology (BoM) site/s and use this dataset to analyse and describe the prevailing climatic conditions and provide input into the atmospheric dispersion modelling.
- Derive appropriate odour and other air pollutant emission rates to adequately describe the emissions from the nominated sources. This information will include the scale and nature of operations and emissions to air, air quality and odour controls proposed for implementation and other relevant information that may materially affect the conclusions of the Level 2/3 odour study. Emission inventories will be supplemented as necessary with published and publicly available emissions data.
- Develop a modelling scenario to address the continuous operation of the plant, the effectiveness of the proposed air quality and odour mitigation measures, and the potential for cumulative impacts.
- Use TAPM/CALMET/CALPUFF dispersion modelling suite to infer predicted concentrations of air quality pollutants and odour arising as a result of the operations.
- Undertake consultation with the relevant regulatory bodies (including Council and the EPA) to ensure that they agree with the model chosen and the assumptions made.
- Assess predicted air quality and odour impacts at the identified receptor locations and produce air quality contours to predict the extent of impact beyond the site boundary. All dispersion modelling to be undertaken in accordance with the EPA's documents, *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005) and odour policy documents, *Assessment and Management of Odour from Stationary Source in NSW, Technical Framework* (DEC 2005) and *Technical Notes* (DEC 2006).
- Make recommendations for appropriate air quality / odour control and management given the above considerations.

Refer to **Section 6** for the Construction Phase AQIA and **Section 7** for the Operational Phase AQIA.

2 PROJECT OVERVIEW

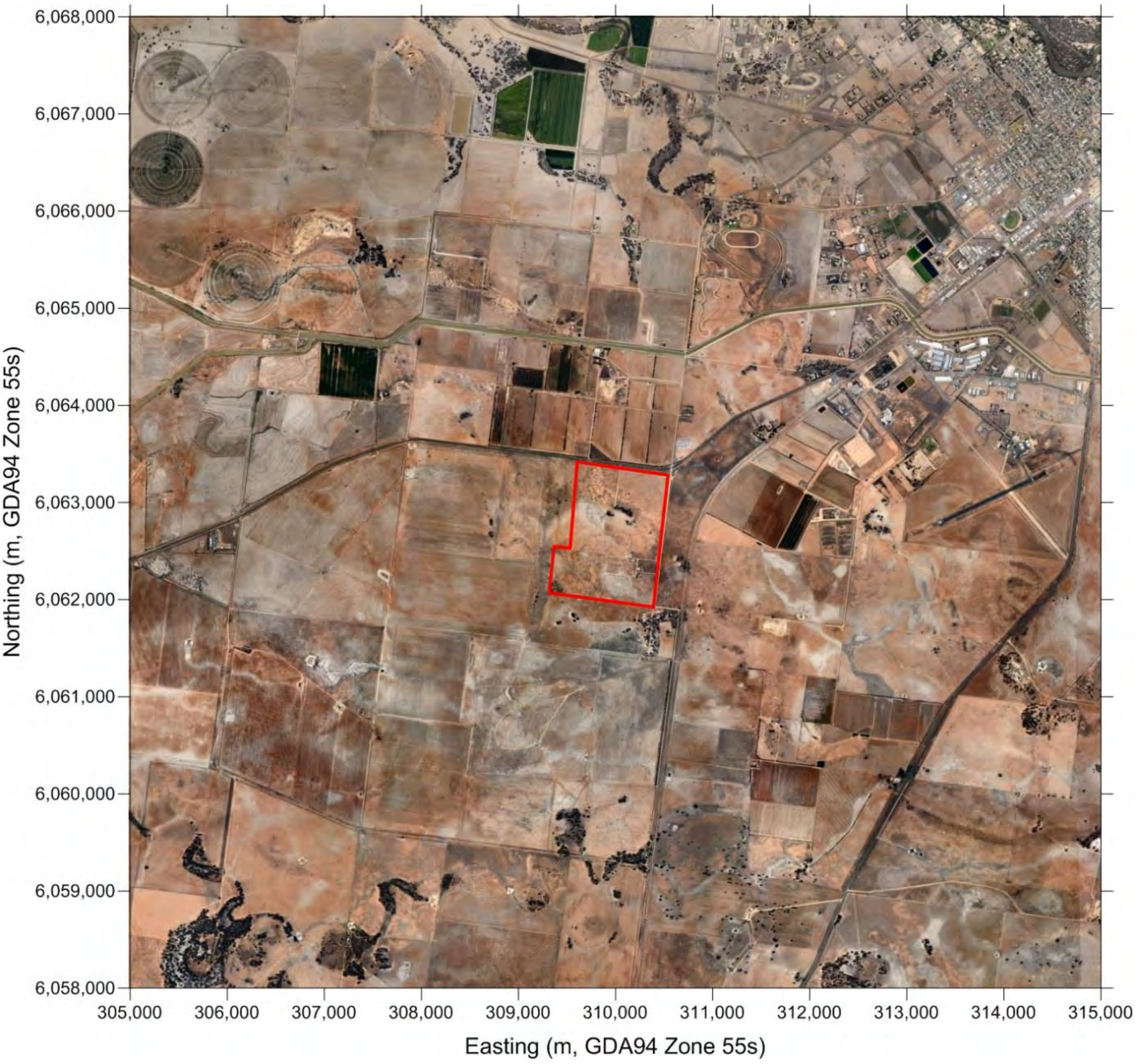
2.1 Study Area and Surrounds

The proposed ethanol plant site is located 4.5 kilometres (km) south-west of the township of Deniliquin, NSW. The plant is bounded by Deniliquin Barham Road to the north and Leetham Road to the east. An overview of the site area is shown in **Figure 1**.

The local area contains several other industrial and commercial type operations, with farming and rural living located further afield. The main saleyards are located approximately 2.0 km north-west of the proposed ethanol plant. The Rice Mill is situated 3.1 km to the north-east of the ethanol plant, and Deniliquin Airport terminal building is 2.8 km to the east.

Figure 1 shows the approximate location of the Project Site relative to the local area.

Figure 1 Site Locality



2.2 Project Description

The proposed ethanol plant aims to process 300,000 tonnes per annum of locally grown wheat to produce 115,000 kilolitres (kL) of fuel grade ethanol. The wheat will be transported to the site and stored on-site prior to processing. The production of ethanol involves the milling of the wheat to flour followed by a cooking, fermentation and distillation process. This process converts starch, which comprises up to 75% of the wheat to ethanol. The process will also produce 102,000 tonnes of dried distillers grain (DDGS) as a process by-product, which will be sold as stock feed. The process is described below.

2.2.1 Grain Intake & Processing

- Grain reception and storage – Grain delivered by truck will be transferred to storage silos. The intake hopper used to receive the grain will be fitted with a fabric filter and the dust collected and returned to the process. The air flow through this filter will be returned to the process. The receipt and storage of grain is within a closed-system and no dust emissions will be released to atmosphere from this process during normal operations.
- Pre-cleaning – A drum screen will be used to separate foreign material, other than ferrous material, from the grain. The dust generated from this process will be filtered by fabric filters and the subsequent air returned to the process, and therefore the pre-cleaning process does not emit any dust to the atmosphere during normal operations.
- Magnetic separator – A magnetic separator will be used to remove ferrous materials from the wheat. The ferrous materials will be collected for recycling.
- De-branning – Firstly the bran is removed from the grain. The dust generated from this process will be filtered by fabric filters in a completely closed system. No dust will be emitted to atmosphere from the de-branning process during normal operations as it is returned to the process.
- Flour milling – Hammer milling equipment will be used to mill the de-branned grain into flour. The dust generated from this process will be collected by a fabric filter system and recycled into the process. Once again, the hammer mill is a closed system with no dust emissions released into the atmosphere during normal operations.

2.2.2 Fermentation Process

- Mixing - Flour, process water and enzyme will be mixed firstly in the screw mixer and then in the mixing tank. Within the mixing tank an agitator will ensure a uniform mixture and caustic soda will be added to adjust the pH to 6.2. The dust generated from the flour will be filtered by fabric filter and returned to the process.
- Liquefaction – The slurry made from the mixing process will be pumped to the liquefaction tank. Steam generated from the steam boiler (which uses compressed natural gas as a fuel) is pumped into the tank where it reacts with the starch in the slurry and becomes gelatinized. The slurry is stirred in the tank to obtain a uniform mixture. The emissions from the steam boiler, notably products of combustion of the fuel gas, will be vented to atmosphere through a dedicated emission stack.
- Saccharification – The liquefaction slurry will then be pumped to the saccharification tank where an enzyme is added. The slurry is mixed by an agitator to assist the enzyme to convert the starch in the slurry to glucose through hydrolysis. The pH of the slurry is adjusted to 6.2 using hydrochloric acid.
- Pre-fermentation – The hydrolysed slurry will then be pumped to the pre-fermentation tank where yeast is added and mixed using an agitator. In this process the glucose is decomposed, and carbon dioxide (CO_2) and the ethanol vapour generated will be passed through a vent scrubber, and at this time these will be absorbed and recovered. There are no emissions to atmosphere from this process during normal operations as the air from the scrubber is returned to the process.

- Fermentation – The slurry is then pumped to the fermentation tank where it is allowed to ferment. This process produces ethanol and CO_2. The CO_2 will either be absorbed and on-sold or be released to the atmosphere.

2.2.3 Distillation Process

- Mash tower - Mash will be fed to the Mash Tower through feed pump. In the Mash Tower the mash will be isolated to ethanol vapour and ethanol whole stillage by steam temperature. Through the process, ethanol vapour will be collected in the vent scrubber again. This distillate ethanol will be sent to rectification process.
- Rectification - The ethanol isolated in Mash Tower will be fed to Rectifier Tower passing through feed pump and rectified as 95.5% of ethanol by differential temperature (steam) and sent to the Dehydration process. Wastewater generated in this process will be treated in the wastewater treatment system (see **Section 2.2.6**). Steam for this process is also generated by the Waste Heat Boiler (W H Boiler), which is powered by organic waste and (potentially) compressed natural gas. Process air from other parts of the process will also be directed and burnt in the W H Boiler prior to release to atmosphere.
- Dehydration - The ethanol (95.5%) isolated in Rectifier Tower will be supplied to Sieve Column through a feed pump and again dehydrated to more than 99.5% of ethanol and water. Ethanol vapour will be vented in the exhaust system and then collected in the Vent Scrubber. Wastewater will be treated in the wastewater treatment system.

2.2.4 Production (Bio Ethanol)

- Storage tank - More than 99.5% of ethanol (generated in the dehydration system) will be stored in a series of storage tanks (2,000m^3 x 4 set). Ethanol vapour generated in the tank during loading will be collected by a vent scrubber and vented to the exhaust system. When loading ethanol, a breather valve in the top of tank will absorb ethanol vapour and direct it to the vent scrubber.
- Loading system - The Loading system is used to load ethanol products from storage tank to tank lorry through a feed pump. Ethanol vapour generated during this process will be collected by a vapour collection system.

2.2.5 DDGS Drying Process

- Stillage Centrifuging - Whole stillage will be centrifuged to separate thin stillage (167.95 ton per hour) and wet distiller's grain (WDG) (35.32 ton per hour).
- Evaporation – The thin stillage will then be evaporated to produce a syrup (32.2 ton per hour) and a condensate (120 ton per hour).
- Mixing – To produce a higher quality of dried distiller's grain (DDG), WDG will be mixed with syrup (produced from the evaporation of thin stillage) and bran (produced from initial grain processing). There will be no dust produced from this process given the water content of the mix. Odour generation is likely from this process however of odours will be destroyed using the Thermal Oxidiser on the exhaust gas.
- Drying for DDGs – Compressed natural gas will be combusted to generate hot air used to dry the DDGs. Dust generated by this process will be collected by fabric filters located at the rear of the drying equipment. Odours generated by this process will be combusted by the thermal oxidiser by re-directing exhaust gas into a gas furnace.
- Cooling for DDGs – The DDGs will be cooled by mechanical fans. The cooling process will be a closed system process. Dust generated by this process will be collected by fabric filters and returned to the process.
- Packing & Transportation - Cooling, transporting, storing and packing process of DDGs will be a closed system process. Any dust generated by this process will be collected by fabric filters and returned to the process.

2.2.6 Wastewater Production and Treatment

- Wastewater from Stillage Evaporation (Condensate of Evaporation) - The wastewater generated from stillage evaporation is condensed in the condenser. Approximately 1,980 cubic metres (m^3) of the daily condensate will be pumped to the on-site wastewater treatment system with the remaining 660 m^3 per day pumped to a dam for storage for 12 hours minimum. The quality of this water will have a biological oxygen demand (BOD) of approximately 2,500 milligrams per litre (mg/L) and suspended solids (SS) of approximately 200 mg/L.
- Wastewater from Cleaning Water - The wastewater generated from floor cleaning in the plant, including scrubber cleaning water, backwash of the ion exchange, cooling tower blow down, vacuum pump sealing water and the like will be pumped to a storage dam. This water will have a BOD of approximately 1,500 mg/L and SS of approximately 100 mg/L.
- Wastewater Cooling - The temperature of condensate scrubbing wastewater will be approximately 42-45 degrees centigrade (°C). This water must be allowed to cool to a temperature of 35-38°C to support the mesophilic microorganisms in the anaerobic digester.
- Neutralization - The pH of the wastewater is adjusted to 6.0 to support the anaerobic digestor. The water is retained for a period of approximately 15 minutes.
- Anaerobic Filter (Digestion) - This system consists of two anaerobic fermenters with gas holder on the top as the form of filter filled with media. The digester is operated at a temperature of approximately 35-38°C, with a retention time of about 1.5 days. The digestion process begins with bacterial hydrolysis of the input materials in order to break down insoluble organic polymers such as carbohydrates and make them available for other bacteria. Acidogenic bacteria then convert the sugars and organic acids into carbon dioxide, hydrogen, ammonia and organic acids. Acetogeric bacteria then convert these resulting organic acids into acetic acid along with additional ammonia, hydrogen, and carbon dioxide. Methanogens finally are able to convert these products methane and carbon dioxide.
- Aerobic Biological System
  - Anoxic Basin - A small amount of the nitrogen components found in the wastewater is nitrified in the aerobic system. This nitrified wastewater is transferred and recycled and denitrified by organic carbon resources. This process removes nitrogen gas.
  - Aeration Basin - The wastewater treated in the anaerobic filter has a BOD of between 500 mg/L and 600 mg/L. To reduce BOD to 30 mg/L and total nitrogen to 10 mg/L, aeration would occur within the aeration basin. The retention time is expected to be around 1.5 days. This is the only process within the wastewater treatment system that is exposed to the air and may generate odorous emissions.
  - MBR (Membrane Bio-Reactor) - Wastewater will be processed by the Micro Bio-Filter (MBR) which is a facility that will maintain a very low concentration of organic matter and nitrogen. The concentration of the sludge generated from the sedimentation basin is approximated 8000 ppm (0.8%).
  - Advanced Treatment - Water from the MBR is treated by activated carbon filter to reduce the chemical oxygen demand (COD) by about 85%. All wastewater is to be treated and recycled on site through an aerated reservoir. Wet weather storage will be around 30 days for wettest month in an average year rainfall.
  - Sludge Digestion - Organic waste generated in the production process and final sludge generated from wastewater treatment facilities is aerobically digested to generate compost. Biogas is transferred to the boiler to be reused.

2.3 Key Air Quality Issues from the Construction Phase

The potential for a construction site to generate air quality impacts is related to the activities being undertaken (e.g. demolition, earthworks, construction, dirt trackout etc.), the duration of these activities and the size of the site. The building type (i.e. construction materials used) and the staging and/or timing of construction activities during the year (i.e. seasonality) will also influence the potential for air quality impacts.

Emissions to air may be categorised as either controlled emission sources or uncontrolled ("fugitive") emissions. Controlled emission sources are typically directed into a vent or stack and emitted into the atmosphere. Fugitive emissions are uncontrolled releases and may be due to accidental spillage, leakage, materials handling, transfer or storage.

Key air quality impacts associated with the redevelopment works will include:

- Nuisance dust and particulate matter emitted from the proposed redevelopment works, particularly where earthworks, site preparatory and demolition works are required.
- The emission of products of combustion, including oxides of nitrogen (NO_X), carbon monoxide (CO), carbon dioxide (CO_2), sulphur dioxide (SO_2), volatile organic compounds (VOCs) and particulate matter (PM) from construction equipment (i.e. trucks, excavators, bulldozers, generators, etc.) and worker transport (i.e. light vehicles).
- Fugitive release of VOC emissions from the storage and transfer of diesel and other fuels.
- Emissions of dust and fumes from workshops (e.g. from sanding, welding and the use of solvents for cleaning equipment parts).
- Potential fugitive release of odorous emissions during demolition of old facilities or earthworks.

Section 3 provides an overview of the nuisance-related impacts and health issues associated with key pollutants noted above.

Information on proposed development activities are presented in **Table 1** below. Details associated with construction works (see **Section 2.2**) and construction traffic numbers have been provided by NGH Environmental. Details on earthwork areas have been estimated through a review of the architectural drawings provided and Google Earth aerial photography.

Table 1 Construction Activity Details

Activity	Description	Detail
Construction of Ethanol Plant	Earthworks area for construction of lagoons etc.	4,100 m^2
	Building area	~18,880 m^2
	Building volume	~169,920 m^3
	Trucks transporting building materials and concrete to the site	255 vehicles during the 14-16 month period
	Trade utes/vans and workers cars travelling to/from the site	45 vehicles during the 14-16 month period

Notes:
1. Height of existing buildings assumed to be 9 m (3 storeys).

Trucks travelling to/from the site will enter and exit the site via Barham Road. Barham Road is sealed road and all other internal access routes will be sealed.

2.4 Key Air Quality Issues from the Operational Phase

There are multiple sources that release air pollutants into the atmosphere from ethanol production operations (i.e. the operational phase). Key air quality impacts associated with the operation of the ethanol plant include:

- Odour generation due to the operation of the wastewater management system and ethanol production process.
- Particulate matter (PM_{10} and $PM_{2.5}$), from combustion sources.
- Oxides of nitrogen (NO_X) and carbon monoxide (CO), from combustion sources.
- Volatile Organic Compounds (VOCs), including acetaldehyde, acrolein, formaldehyde, ethanol and methanol.
- Traffic-related exhaust emissions due to increased vehicle movements (i.e. road truck transport of stock/product).

The operations which have the potential to cause emissions to air, and the pollutants likely to be emitted are outlined in **Table 2**.

Table 2 Air Pollutant Emissions from the Ethanol Plant

Operation	Type of Emission	Pollutants Emitted	Comments
Ethanol Plant			
Grain Intake & Processing	Fugitive	Particulate matter	The receival, storage, pre-cleaning, de-branning and milling of grain are in a closed-system and no dust emissions will be released to atmosphere from this process.
Fermentation Process	Fugitive	Particulate matter	The dust generated from the mixing, liquefaction, saccharification, pre-fermentation and fermentation processes will be filtered by bag filter and returned to the process. There are no emissions to atmosphere from this process.
Distillation Process	Fugitive	Speciated VOCs, odour	Any emissions generated in the Mash Tower, Rectification, and Distillation processes are exhausted to the vent scrubbers once the ethanol vapour has been recovered. The vapours are returned to the WH boiler in a closed system. There are no emissions to atmosphere from this process.
Boilers for generation of steam (Steam boiler and WH boiler)	Point	Products of combustion, particulate matter, speciated VOCs, odour	The boiler will ultimately be fuelled by gas and by combustion of organic waste. It will operate 24 hours a day.
Ethanol Storage	Fugitive	Speciated VOCs	Ethanol vapour generated in the tank during loading will be collected by a vent scrubber and vented to the exhaust system. When loading ethanol, a breather valve in the top of tank will absorb ethanol vapour and direct it to the vent scrubber. There are no emissions to atmosphere from this process.
DDGS Drying	Point	Speciated VOCs, odour	VOCs and odour generation is likely from the mixing and drying of DDGS however of odours will be destroyed using the Thermal Oxidation method on the exhaust gas.

Operation	Type of Emission	Pollutants Emitted	Comments
		Particulate Matter	Dust generated by the drying process will be collected by dust filters located at the rear of the drying equipment.
Wastewater treatment	Fugitive	Odour	The aeration basin contains pre-treated wastewater, is exposed to the air and may generate odorous emissions.
Ancillary Sources			
Onsite traffic			
exhaust	Fugitive	Products of combustion	Due to traffic numbers to site, exhaust emissions will be minimal in context of the surrounding environment. It is assumed these emissions are adequately captured in background data.
wheel generated dust		Particulate matter	All internal roads on site are sealed, therefore wheel generated dust will be minimal.
transfer points and loading/unloading		Particulate matter	Minimal dust will be emitted from unloading/ loading of trucks.

3 OVERVIEW OF KEY POLLUTANTS

A general overview of key pollutants associated with the proposed Project and the key air quality issues identified in **Section 2.3** and **Section 2.4** is provided below.

3.1 Particulate Matter

The term "particulate matter" refers to a category of airborne particles (including solid particles, liquid droplets and aggregates of particles and liquids) that range from 0.1 micrometres (µm) to 50 µm in aerodynamic diameter and represents a complex mixture of organic and inorganic substances. Typical particle sizes are detailed in **Table 3**.

Table 3 Typical Particle Sizes for Particulate Matter

Pollutant	Example of Particle Sizes[1]
Dust	> 30 - 50 microns
Total Suspended Particulates (TSP)	< 30 - 50 microns
PM_{10}	< 10 microns
$PM_{2.5}$	<2.5 microns

Notes:

1. A micron (µm) is one-millionth of a metre ($1x10^{-6}$m).

Sources of particulate matter can be attributed to anthropogenic and natural sources (i.e. bush fires and dust storms).

3.1.1 Particulate Matter (as PM_{10} and $PM_{2.5}$)

Particles less than 10 µm and 2.5 µm in diameter are referred to as PM_{10} and $PM_{2.5}$. Emissions of PM_{10} and $PM_{2.5}$ are considered important pollutants in terms of impact due to their ability to penetrate into the human respiratory system as this can lead to a variety of health effects including heart or lung disease. Smaller particles can remain suspended in the air for days or weeks until removed by rain.

Sources of these particles include combustion sources (i.e. residential wood burning, motor vehicles, agricultural burning, and some industrial processes), coal mining, crushing and grinding, and materials handling and transfer.

3.1.2 Nuisance Dust and Total Suspended Particulate (TSP)

Amenity impacts from dust are usually associated with coarse particles and particles larger than PM_{10}. Amenity concerns can relate to "visibility" of dust plumes and dust sources while amenity impacts include dust depositing on fabrics (i.e. washing), balconies, and the transport of dust from roofs to water tanks.

TSP refers to all particulates suspended in the air and is a good indicator of nuisance dust impacts. The measurement of deposited dust is also a measure of nuisance dust impacts. Sources of nuisance dust include combustion sources (i.e. residential wood burning, motor vehicles from the wear of tyres and brakes, agricultural burning etc.) coal mining and wind-blown dust.

3.2 Oxides of Nitrogen (NO_X)

The term, oxides of nitrogen (NO_X), is used to describe any mixture of nitrogen oxides formed during combustion. In atmospheric chemistry NO_X generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide (NO_2).

NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to form NO_2 which can have significant health effects including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. Long term exposure to NO_2 can lead to lung disease.

NO will be converted to NO_2 soon after being emitted to atmosphere. The goals specified within the Approved Methods for NO_2 are provided in **Table 6**.

3.3 Carbon Monoxide (CO)

Carbon monoxide (CO) is an odourless, colourless gas formed from the incomplete burning of fuels in motor vehicles. CO bonds to the haemoglobin in the blood and reduces the oxygen carrying capacity of red blood cells, thus decreasing the oxygen supply to the tissues and organs, in particular the heart and the brain.

It can be a common pollutant at the roadside and highest concentrations are found at the kerbside with concentrations decreasing rapidly with increasing distance from the road. CO in urban areas results almost entirely from vehicle emissions and its spatial distribution follows that of traffic flow.

The goals specified within the Approved Methods for CO are provided in **Table 6.**

3.4 Volatile Organic Compounds (VOC)

Volatile Organic Compounds (VOCs) are organic compounds (i.e. contain carbon) that have high vapour pressure at normal room-temperature conditions. Their high vapour pressure leads to evaporation from liquid or solid form and emission release to the atmosphere. Impacts due to emissions of VOCs can be health or nuisance (odour) related.

VOCs are emitted by a variety of sources, including motor vehicles, chemical plants, and meat rendering plants. VOCs that are often released from an ethanol plant include acetaldehyde, acrolein, formaldehyde, ethanol and methanol. These VOCs will be assessed individually against their air quality design criteria (**Table 6**).

VOCs will also be assessed according to their odorous properties given that the concentration required to trigger odour thresholds are at least an order of magnitude higher than those needed to cause adverse health impacts on human receptors. The odour detection thresholds of these VOCs have also been used to calculate the correlated odour concentration of the mix of compounds. This has been assessed separately against the relevant odour criterion (**Section 3.5**).

3.5 Odour

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance goals guide decisions on odour management, but are generally not intended to achieve “no odour”.

The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the *odour threshold* and defines 1 odour unit (OU). An odour goal of less than 1 OU would theoretically result in no odour impact being experienced.

In practice, the character of a particular odour can only be judged by the receiver’s reaction to it, and preferably only compared to another odour under similar social and regional conditions. Based on the literature available, the level at which an odour is perceived to be a nuisance can range from 2 OU to 10 OU depending on a combination factors including population sensitivity, background level, public expectation (considered offensive or easily tolerated), source characteristics (i.e. emitted from a stack or general area) and health effects.

Odour performance goals need to be designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours, using a statistical approach which depends on the size of the affected population.

It is often not possible or practical to determine and assess the cumulative odour impacts of all odour sources that may impact on a receptor in an urban environment. Therefore, the proposed odour performance goals allow for population density, cumulative impacts, anticipated odour levels during adverse meteorological conditions, and community expectations of amenity.

A summary of the impact assessment criteria given for various population densities, as drawn from the Approved Methods, is given in **Table 4**. The Approved Methods states that the impact assessment criteria for complex mixtures of odorous air pollutants must be applied at the nearest existing or likely future off-site sensitive receptor(s).

Section 5.1 details the sensitive receptors identified in the local environment. There are five (5) defined sensitive receptors (residential dwellings) within approximately 1 km of the site. Therefore, the population of the affected community has been conservatively approximated to be 5 residences (i.e. 10 people) and the corresponding impact assessment criterion of 6 OU has been applied to this assessment.

Table 4 Impact Assessment Criteria – Complex Mixtures of Odorous Air Pollutants (nose-response-time average, 99th percentile)

Population of Affected Community	Impact Assessment Criteria for Complex Mixtures of Odours (OU)
Urban area (≥ 2000)	2
~500	3
~125	4
~30	5
~10	6
Single residence (≤ 2)	7

Source: Approved Methods 2005

3.5.1 Peak to Mean Ratios

It is a common practice to use dispersion models to determine compliance with odour goals. This introduces a complication because dispersion models are only able to directly predict concentrations over an averaging period of 1-hour or greater. The human nose, however, can respond to odours over periods of the order of one second. During longer periods, odour concentrations can fluctuate significantly above and below the mean depending on the nature of the source.

To determine the ratio between the one-second peak concentrations and longer period average concentrations (referred to as the peak to mean ratio) that might be predicted by a dispersion model, the EPA commissioned a study by Katestone Scientific Pty Ltd (1995, 1998). This study recommended peak to mean ratios for a range of circumstances (**Section 7.5**). Properly defined peak-to-mean ratios depend upon the type of source, atmospheric stability and distance downwind. The peak-to-mean ratios are applied to the emission rates, dependant on the source type, stability class and receptor locations, and entered into the dispersion model. The peak to mean ratios for area, volume and point sources are presented in **Table 5.**

Table 5 Peak to Mean Ratio for Area and Volume Sources

Source Type	Pasquill-Gifford stability class	Near field P/M60[1]
Area	A, B, C,D	2.5
	E, F	2.3

Source Type	Pasquill-Gifford stability class	Near field P/M60[1]
Volume	A-F	2.3
Point (wake affected)	A-F	2.3

Note:
1. Ratio of peak 1-second average concentrations to mean 1-hour average concentrations.

The Approved Methods take account of this factor and the goals shown in **Table 4** are based on the nose-response time.

3.6 Summary of Air Quality Impact Assessment Criteria

The EPA has established ground level air quality impact assessment criteria for key air pollutants to achieve appropriate environmental outcomes and to minimise associated risks to human health as published in the EPA's document, *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* (NSW OEH, 2005). A summary of the impact assessment criteria for the pollutants identified above is given in **Table 6**.

These criteria and guideline reporting goals for key air quality pollutants noted above have been sourced from the National Environmental Protection Council (NEPC); their published National Environment Protection Measure for Ambient Air Quality (Air NEPM) and Variation to Air NEPM, which outline agreed national objectives for protecting air quality for these criteria pollutants.

Table 6 Summary of Air Quality Impact Assessment Criteria

Pollutant	Averaging Period	Concentration (µg/m^3)	Source
PM_{10}	24 hours	50	NEPC (1998)
	Annual	30	EPA (1998)
$PM_{2.5}$	24 hours	25	NEPM (2003)
Total Suspended Particulate (TSP)	Annual	90	NHMRC (1996)
NO_2	1-hour	246	NEPC (1998)
	Annual	62	NEPC (1998)
Pollutant	**Averaging Period**	**Concentration (mg/m^3)**	**Source**
CO	15-min	100	WHO (2000)
	1-hour	30	WHO (2000)
	8-hour	10	NEPC (1998)
Acetaldehyde	1-hour	0.042	VIC EPA (2001)
Acrolein	1-hour	0.00042	VIC EPA (2001)
Formaldehyde	1-hour	0.02	VIC EPA (2001)
Ethanol	1-hour	2.1	VIC EPA (2001)
Methanol	1-hour	3.0	VIC EPA (2001)
Pollutant	**Averaging Period**	**Incremental Increase / Total (g/m^2/month)**	**Source**
Deposited Dust	Annual	2 / 4	NERDDC (1988)
Pollutant		**Impact Assessment Criteria for Complex Mixtures of Odours (OU)**	**Source**
Nuisance Odour	-	6	EPA (2001)

Source: Approved Methods 2005 (NSW OEH, 2005)

4 RELEVANT AIR QUALITY LEGISLATION AND GUIDANCE

4.1 Protection of the Environment Operations Act 1997 & Amendment Act 2011

The Protection of the Environment Operations (POEO) Act 1997 and Amendment Act 2011 are a key piece of environment protection legislation administered by the EPA which enables the Government to establish instruments for setting environmental standards, goals, protocols and guidelines.

The following sections of the POEO Act are of general relevance to the Project.

- Section 117 of the POEO Act states that the wilful or negligent release of ozone depleting substances such as chlorofluorocarbons (CFCs) to the atmosphere carries the highest of all penalties under NSW environmental law.
- Section 124 and 125 of the POEO Act state that any plant located at a premise should be maintained in an efficient condition and operated in a proper and efficient manner to reduce the potential for air pollution.
- Section 126 of the POEO Act requires that materials are managed in a proper and efficient manner to prevent air pollution.
- Section 128 of the POEO Act states:
  - The occupier of a premises must not carry on any activity or operate any plant in or on the premises in such a manner to cause or permit the emission at any point specified in or determined in accordance with the regulation of air impurities in excess of [the standard of concentration and/or the rate] prescribed by the regulations in respect of any such activity or any such plant.
  - Where neither such a standard nor rate has been so prescribed, the occupier of any premises must carry on activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution.
- Section 129 of the POEO Act states that odours generated by operational activities should not be detectable beyond the site boundary.
- Section 133 of the POEO Act states that the EPA may prohibit the burning of fires in the open or burning of waste in an incinerator. These activities are illegal in most local Council areas.

Changes under the POEO Amendment Act 2011 include that the owner of a premises, the employer or any person carrying on the activity which causes a pollution incident is to *immediately* notify the relevant authorities when material harm to the environment is caused or threatened.

4.1.1 Protection of the Environment Operations (Clean Air) Regulation 2010

The POEO (Clean Air) Regulation 2010 (the Regulation) is the core regulatory instrument for air quality issues in NSW. In relation to industry, the Regulation:

- sets maximum limits on emissions from activities and plant for a number of substances.
- deals with the transport and storage of volatile organic liquids.
- restricts the use of high sulphur liquid fuel.
- imposes operational requirements for certain afterburners, flares, vapour recovery units and other treatment plant.

Part 5 (Division 3) of the Regulation deals with the emissions of air impurities from activities and plant and sets maximum limits on emissions for a number of substances (including solid particles and visible smoke). The standards of concentrations prescribed by Part 5, Division 3 do not apply to or in relation to any plant during start-up and shutdown periods, however are still subject to requirements of Section 128 (2) of the POEO Act in relation to the prevention and minimisation of air pollution.

The Regulation notes that the EPA may grant an exemption in relation to smoke emitted in the course of activities such as research to improve safety in relation to the flammability of materials and smoke reduction or testing undertaken to certify that manufactured or imported products comply with Australian Standards, International Standards or meet any legislative requirements place on them.

Part 6 of the Regulation outlines the control of VOCs and the requirement for any fuel burning equipment or industrial plant to be fitted with control equipment. Exemptions exist where approved by the EPA.

4.2 Approved Methods

The EPA's Approved Methods publication lists the statutory methods for modelling and assessing air pollutants from stationary sources and specifies criteria which reflect the environmental outcomes adopted by the EPA. The Approved Methods are referred to in the POEO (Clean Air) Regulation 2002 for assessment of impacts of air pollutants.

4.3 Odour Technical Framework and Notes

The EPA's Odour Policy publications provide a policy framework for assessing and managing activities that emit odour and offers guidance on dealing with odour issues.

4.4 Preliminary Assessment of Buffer Distances

In situations where the specifics of a development are unknown (i.e. the potential locations of residential developments, or the nature, scale and potential impact of industrial or commercial land uses), the application of buffer distances provide a valuable 'screening' tool to judge whether a detailed assessment is required to evaluate the potential risk of conflicting land uses.

Reference has been made to Victoria Environment Protection Authority (VIC EPA) documentation for relevant referenced buffer distances.

4.4.1 Recommended Buffer Distances for Industrial Residual Air Emissions

In accordance with Clause 13.04-2 (Air Quality) of Victoria's State Planning Policy Framework, all planning must consider the VIC EPA's "*Recommended Separation Distances for Industrial Residual Air Emissions*" (2013). In their document, the VIC EPA makes recommendations for assessing appropriate separation distances where amenity may be reduced for sensitive or incompatible land uses. Sensitive land uses which warrant protection from amenity-reducing off-site effects of industry by maintenance of a buffer distance include residential areas and zones, hospitals and schools.

A summary of the industrial residual air emissions (IRAE) buffer distances that relate to the chemical production industry are provided below in **Table 7**. These values have been provided for context only and are not regulatory guideline values.

Table 7 Recommended Buffer Distances for Industrial Residual Air Emissions[1]

Industry Type	Recommended Buffer Distance (m)[2]
Grain and stockfeed mill and handling facility (>20,000 tonnes per year)	250
Other hydrocarbon production and refining (>2,000 tonnes per year)	500
Other organic or inorganic chemical production (>2,000 tonnes per year)	2,000

Notes:

1. IRAEs are defined by the VIC EPA as unintended or accidental emissions (i.e. due to equipment failure, abnormal weather conditions etc) which are often episodic in occurrence and may originate near ground level.
2. Buffer distances are recommended for large scale operations. The NSW EPA should be consulted in relation to recommended buffer distances for smaller scale operations.

5 THE EXISTING ENVIRONMENT

5.1 Sensitive Receptor Locations

The site is surrounded by rural farmland. Further afield there is the saleyards, proposed abattoir and the rice mill to the north-east, and Deniliquin airport and cemetery to the east. In closer proximity are scattered rural residences to the north and south of the Project site. The closest residential zone that makes up part of Deniliquin township is located approximately 4.2 km to the north-east.

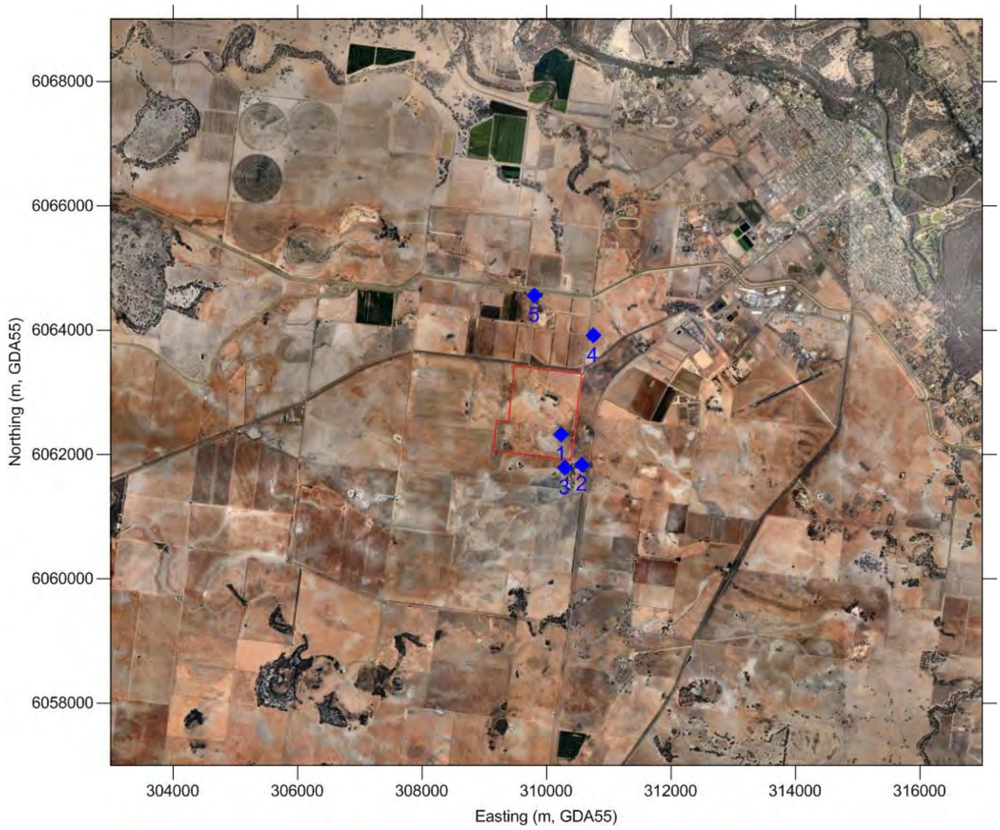
Five receptors representative of the surrounding land uses were included in the modelling study based on a desktop review of the Project area (**Table 8**). Receptors 1 to 5 represent the nearest residential properties. Receptor 1 is located within the Project site and is presented in the assessment but is exempt from complying with the assessment criteria (**Figure 2**).

Table 8 List of Surrounding Representative Receptors

Receptor ID	Easting (m, UTM)	Northing (m, UTM)	Type	Approximate Distance from Site (m) / Direction (degree true)[1]
1	310235	6062318	On-site Residential	NA
2	310569	6061841	Rural Residential	850 m SE
3	310295	6061784	Rural Residential	880 m S
4	310749	6063912	Rural Residential	550 m N
5	309806	6064557	Rural Residential	1100 m N

Notes: 1 Measured from activity zone boundary to property boundary of the sensitive use area

Figure 2 Identified Sensitive Receptor Locations



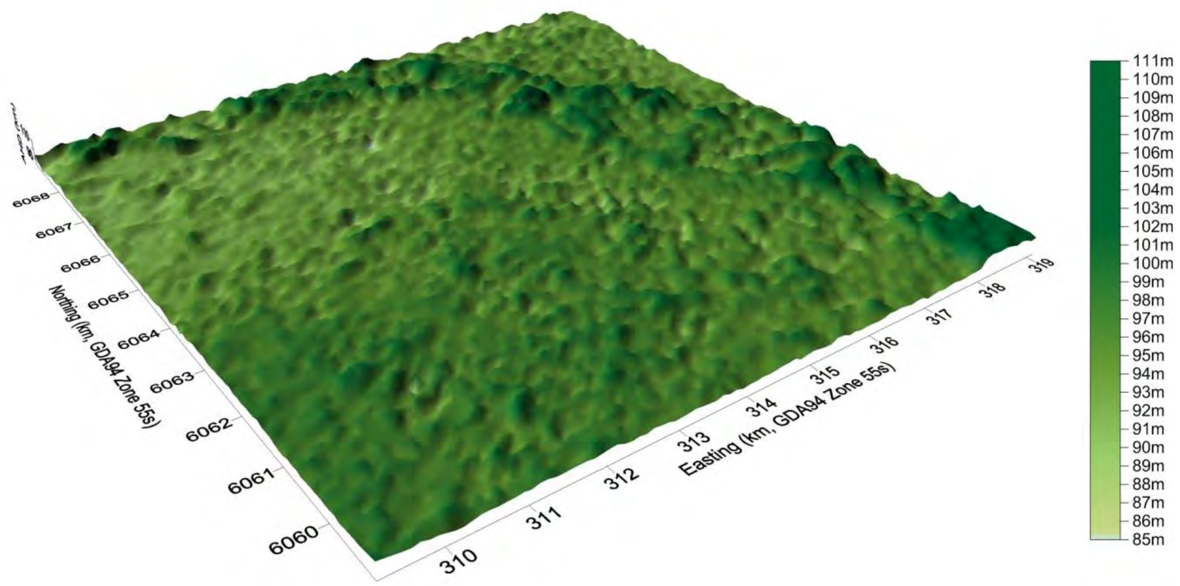
5.2 Local Topography

Topography is important in air quality studies as local atmospheric dispersion could be influenced by night-time katabatic (downhill) drainage flows from elevated terrain or channelling effects in valleys or gullies around the Project site.

A three dimensional representation of the area is given in **Figure 3**. The Project site is situated at an approximate elevation of 96 m Australian Height Datum (AHD).

The surrounding area is characterised by primarily flat terrain with some hilly areas. No downhill drainage flows or significant features exist that would influence the local dispersion.

Figure 3 Topography of the Local Area



5.3 Local Meteorological Conditions

Local wind speed and direction influence the dispersion of air pollutants. Wind speed determines both the distance of downwind transport and the rate of dilution as a result of 'plume' stretching. Wind direction, and the variability in wind direction, determines the general path pollutants will follow and the extent of crosswind spreading.

Surface roughness (characterised by features such as the topography of the land and the presence of buildings, structures and trees) will also influence dispersion.

5.3.1 Wind Speed and Wind Direction

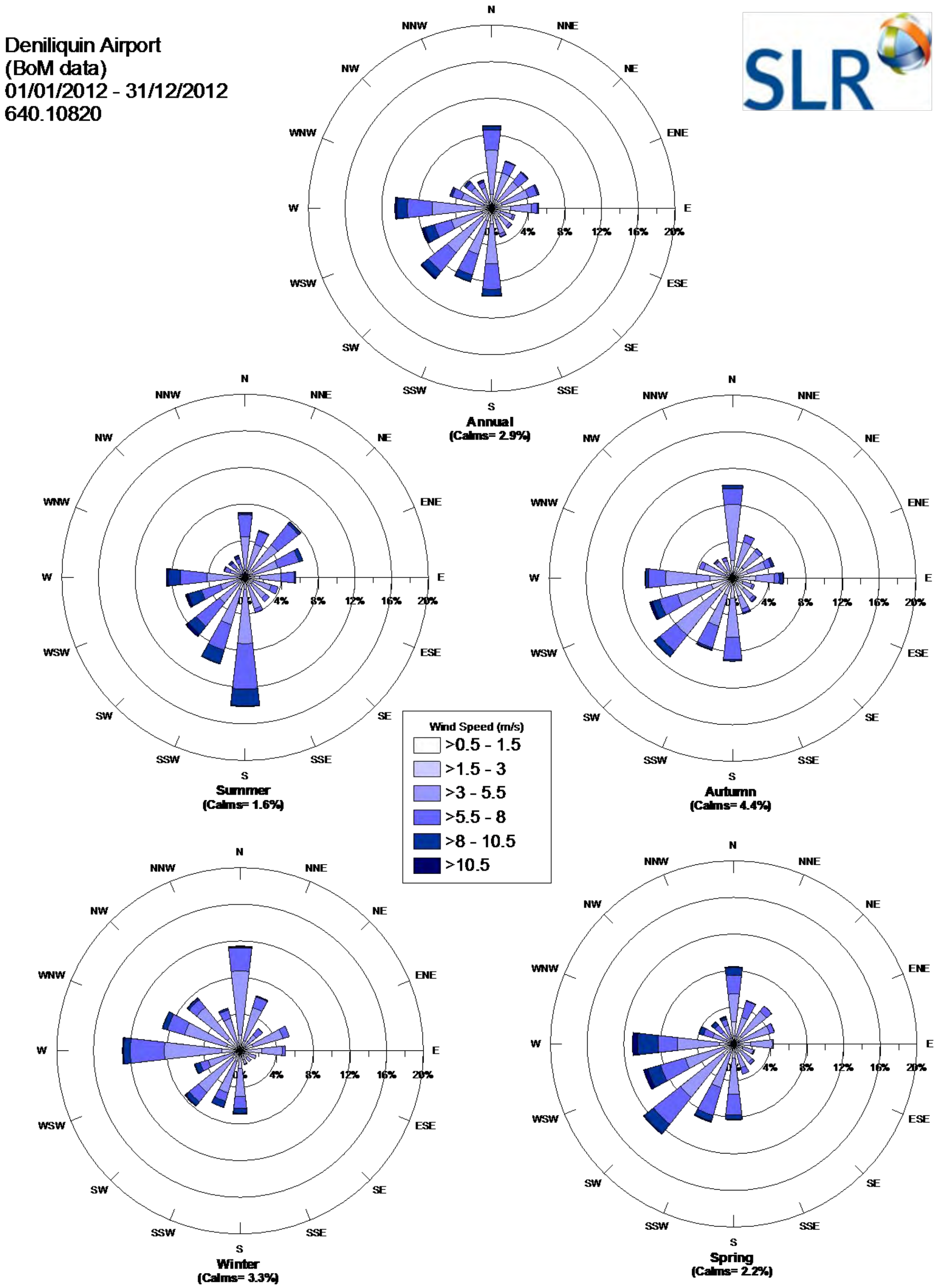
Annual and seasonal wind roses for the year 2012 are presented in **Figure 4**. The meteorological data was obtained from the Australian Government Bureau of Meteorology (BoM) automatic weather station (AWS) located at Deniliquin Airport.

On an annual basis, the dominant wind direction is quite scattered between northerly, southerly, south-westerly and westerly winds. Annually, 2.9% of wind speeds were recorded as calms (≤0.5 m/s).

During summer, winds from the south predominate. By autumn, the southerly winds are less frequent compared with northerly and south-westerly winds. Winds in winter are predominantly westerly or northerly, reflecting the frequent passage of cold fronts and general westerly flow, while in spring a transition occurs again with a more uniform wind direction distribution but with westerly to south-westerly flow most frequent.

The representativeness of 2012 as the modelled year of meteorology is discussed in **Section 7.1**.

Figure 4 Annual and Seasonal Wind Roses in 2012 at Deniliquin Airport



5.4 Surrounding Industrial Sources of Airborne Pollutants

The following sources have been identified from a desktop mapping study of sites regulated by the EPA and those that are required to report under the POEO with information stored in the National Pollutant Inventory (NPI).

Environment Protection Licences (EPL) are issued under the Protection of the Environment Operations Act 1997 (POEO Act) and are regulated by the EPA. EPLs stipulate emission limits to water, land and/or air and provide operational protocols to ensure emissions/operations comply with relevant standards. General requirements of EPLs relating to air quality include:

- Plant and equipment to be maintained and operated in a proper and efficient manner.
- Emissions of dust and odour are to be minimised/prevented from the premises.

The NPI database provides details on industrial emissions of over 4,000 facilities across Australia. The requirement to return emissions estimates to the NPI is determined by the activities/processes being undertaken at the facility, and also whether those processes exceed process-specific thresholds in terms of activity rates (i.e. throughput and/or consumption). It is not intended to make a statement that impacts associated with those activities will be significant in terms of their potential for impact, generation of complaint, or constraint to the development of the Project site.

A search of the EPA public register and NPI database for the Deniliquin Local Government Area (LGA) and postcode "2710" returned the following information for existing industries in the vicinity of the subject land, applying an arbitrary cut off distance of 2 km. **Table 9** provides an overview of those industries regulated by the EPA. The NPI data search returned no results.

Table 9 Surrounding Industrial Sources

Facility Name	Sector	Address	EPL/NPI Requirements
Charlie Carp Fertiliser	Livestock processing activities - Rendering or fat extraction	Lot 2 Saleyards Road	EPL 12173 Scale: 0 – 4000 T rendering or fat extraction produced. No monitoring for discharges to air, water and applications to land. General conditions applicable only.
Deniliquin Council Sewage Treatment System	Sewage treatment processing by small plants	Calimo Street	EPL 1694 Scale: > 219-1,000 ML discharged. Discharge monitoring. General conditions apply with respect to dust and odour.
Deniliquin Council Saleyards	Livestock intensive activities - Animal accommodation	Saleyards Road	EPL 11506 Scale: 0 – 25000 T accommodated. Water and land monitoring. General conditions apply with respect to dust and odour.
Famicorp Pty Ltd	Livestock processing activities - Slaughtering or processing animals	Abattoir Road	EPL 11614 Scale: 0 – 30,000 T processed. Groundwater and soil monitoring. Effluent application to land controls. General conditions apply with respect to dust and odour.
Murray Irrigation Limited	Irrigated agriculture	Deniliquin	EPL 5014 Scale: > 100,000 ha of existing area of operations (over multiple shires). Discharge monitoring. Process and management controls.
Ricegrowers Limited, Deniliquin Rice Mill	General agricultural processing	Saleyards Road	EPL 1833 Scale: > 250,000 T processed. Subject to Methyl Bromide container fumigation air quality monitoring program from 24/01/2014. General conditions apply with respect to dust and odour.

Additional industries existing in the local area may operate below the activity threshold specified for the industry, and hence do not need to report under the NPI program. Sources that potentially fall under this category may still constitute a constraint to the development of surrounding incompatible land uses, but on a smaller scale than those required to report under the NPI program.

In addition to the above EPA regulated industries, the Project site is also located near to Deniliquin Airport (situated to the east of the Project site on approximately 230 ha of land). Air carriers and ground-based maintenance vehicles, stationary and mobile plant will generate emissions to air as a result of the combustion of fossil fuels.

The above findings demonstrate the predominantly industrial and agricultural nature of the area.

5.5 Background Air Quality

Background air quality data for PM_{10} has been obtained for Albury, Wagga Wagga, Wagga Wagga North, Bargo, and Liverpool air quality monitoring stations (AQMS):

- Albury AQMS: located approximately 190 km to the ESE of the Project Site;
- Wagga Wagga AQMS: located approximately 225 km to the ENE of the Project Site;
- Wagga Wagga North AQMS: located approximately 225 km to the ENE of the Project Site;
- Bargo AQMS: located approximately 540 km to the ENE of the Project Site; and
- Liverpool AQMS: located approximately 580 km to the ENE of the Project Site.

The first three AQMS measure particulate concentrations however other pollutants such as CO, SO_2 or NO_2 are not measured and hence in lieu of more proximate AQMS, ambient concentrations of NO_2 have been sourced from Bargo AQMS and the CO ambient concentrations from Liverpool.

The Office of Environment and Heritage (OEH) note on their website[1] that monitoring data from Sydney and Newcastle regions allows screening of SO_2 and NO_2 and therefore monitoring of these parameters is not required in the South West Slopes region (encompassing Deniliquin). The requirement to monitor for CO is currently under review however monitoring data from Sydney CBD demonstrates that CO arising from motor vehicles will be low. There are no significant industrial sources of air pollution in the region and therefore emissions of SO_2 and CO are expected to be negligible in the area surrounding the Project Site.

The Albury AQMS was commissioned in June 2000 and is located approximately 190 km east south-east of the site. The Wagga Wagga AQMS was decommissioned and replaced by the Wagga Wagga North AQMS in October 2011 which is located approximately 225 km east north-east of the site. The existing stations at Albury and Wagga Wagga North are located within predominantly rural residential areas at an approximate elevation of 180 m. Given Albury and Wagga Wagga townships have populations of greater than 45,600 people and the population of Deniliquin sits around 7,500 people, air quality data obtained for the region is considered conservative for the purposes of the air quality assessment. Albury was selected as it has the most representative population and hence, the emissions from vehicles will be more representative of Deniliquin air quality levels but still conservative.

The Bargo AQMS was commissioned in January 1996. It is in a rural area on the far south-west edge of the Sydney basin and is at an elevation of 365 m. It is approximately 100 km south west of Sydney and approximately 540 km north east of Deniliquin. Bargo has a population of approximately 4,000 people.

[1] http://www.environment.nsw.gov.au/air/nepm/306wagga.htm

The Liverpool AQMS is located in the Council depot, off Rose Street, Liverpool. It is situated in the centre of the Sydney basin in a mixed residential and commercial area and is at an elevation of 22 m. It is situated in the South-west Sydney region. The Liverpool site was commissioned in 1990. As a suburb of Sydney, Liverpool has a much higher population that Deniliquin and therefore provides a conservative estimate of background CO concentrations.

5.5.1 NO_2 Background Concentrations

The annual average and maximum 1-hour average NO_2 concentrations recorded in Bargo from 2010 to 2013 are presented in **Table 10**. For air quality impact assessment purposes, it is standard practice to use background monitoring datasets taken from the same year as the meteorological dataset chosen for use in the dispersion modelling assessment, in this case 2012.

Table 10 NO_2 Background Concentrations

Year	Annual Average (µg/m^3)	Maximum 1-hour Average (µg/m^3)
2010	9.4	110.9
2011	9.4	86.5
2012	9.4	82.7
2013	9.4	127.8

5.5.2 CO Background Concentrations

The maximum 8-hour average CO concentrations recorded in Liverpool are presented in **Table 11**. Turner's power law was used to convert the maximum 8-hour average CO concentration to an equivalent 1-hour and 15-min average. For air quality impact assessment purposes, it is standard practice to use background monitoring datasets taken from the same year as the meteorological dataset chosen for use in the dispersion modelling assessment, in this case 2012.

Table 11 CO Background Concentrations

Year	Maximum 8-hour Average (mg/m^3)	Maximum 1-hour Average[1] (mg/m^3)	Maximum 15-min Average[1] (mg/m^3)
2010	2.41	3.65	4.81
2011	2.75	4.17	5.50
2012	2.18	3.30	4.35
2013	2.41	3.65	4.81

Note:

1. Turner's power law has been used to convert between the maximum 8-hour average and the maximum 1-hour average; likewise with the conversion from maximum 1-hour average to maximum 15-min average.

5.5.3 Particulate Matter Background Concentrations

Figure 5 below shows PM_{10} concentrations measured at the Albury, Wagga Wagga and Wagga Wagga North AQMS for the years 2010 to 2013. These data indicates that the 24-hour average PM_{10} concentrations in the region typically range between 13.7 µg/m^3 to 19.8 µg/m^3, however a number of exceedances of the NSW EPA 24-hour average guideline of 50 µg/m^3 were measured across all sites during this time with maximum 24-hour concentrations between 2010 and 2013 of 60.8 µg/m^3 for Albury, 64.9 µg/m^3 for Wagga and 110.7 µg/m^3 for Wagga Wagga North (see **Table 12**).

Table 12 Maximum 24-hour PM_{10} Concentrations (µg/m^3)

Year	Albury	Wagga Wagga	Wagga Wagga North
2010	60.8	64.9	N/A
2011	28.0	36.0	56.3

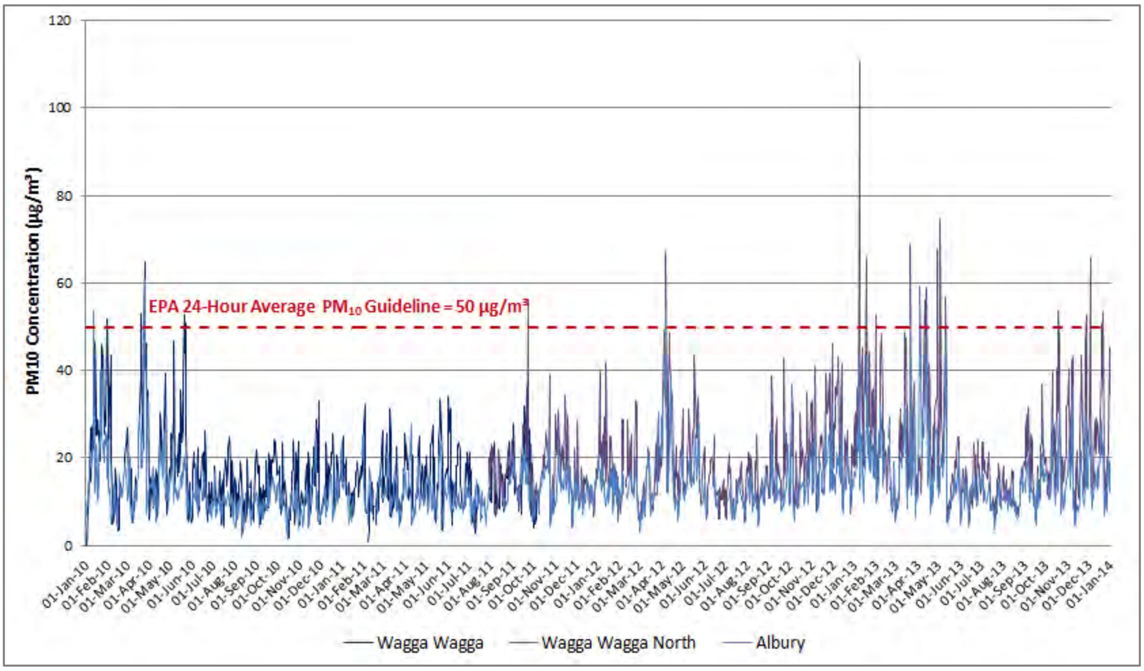
Year	Albury	Wagga Wagga	Wagga Wagga North
2012	54.4	N/A	67.2
2013	59.2	N/A	110.7

The number of exceedances measured at Wagga Wagga North AQMS was 15 during 2013 (see **Table 13**). Poor air quality in the Wagga Wagga area during 2013 has largely been attributed to seasonal activities including agricultural and hazard reduction burning during the Autumn, dust storms and bushfires experienced primarily in the warmer months of the year, and domestic wood heating in the cooler months of the year. Two exceedances of the 24-hour average guideline were measured at the Albury AQMS during the corresponding year.

Table 13 Exceedances of the 24-hour Average PM_{10} Criteria (µg/m^3)

Year	Albury	Wagga Wagga	Wagga Wagga North
2010	2	6	N/A
2011	0	N/A	1
2012	1	N/A	1
2013	2	N/A	15

Figure 5 24-Hour Average PM_{10} Concentrations for the Region, 2010 – 2013



The annual average PM_{10} concentrations are shown below in **Table 14**. The annual average PM_{10} concentrations measured at Albury represent 41% to 52% of the NSW EPA guideline of 30 µg/m^3, while the annual average PM_{10} concentrations measured at Wagga Wagga represent 50% to 74% of the NSW EPA guideline.

Table 14 Annual Average PM_{10} Concentration (µg/m^3)

Year	Albury	Wagga Wagga	Wagga Wagga North
2010	12.6	17.5	N/A
2011	12.3	15.0	16.5
2012	14.3	N/A	18.8
2013	15.8	N/A	22.1

Of the above three AQMS, $PM_{2.5}$ concentrations were measured at the Wagga Wagga North AQMS from August 2011. The maximum 24-hour average $PM_{2.5}$ concentration in 2012 at Wagga Wagga North AQMS was 23.2 µg/m$^{3.}$ No exceedances of the 24-hour average guideline of 25 µg/m^3 were measured at Wagga Wagga North during 2012, however the maximum 24-hour average $PM_{2.5}$ concentration was exceeded in 2013 (see **Table 15**).

Table 15 Maximum 24-hour $PM_{2.5}$ Concentration (µg/m^3)

Year	Wagga Wagga North
2012	23.2
2013	29.9

For air quality impact assessment purposes, it is standard practice to use background monitoring datasets taken from the same year as the meteorological dataset chosen for use in the dispersion modelling assessment (refer to **Section 7.1**). The meteorological dataset for 2012 has been used in this assessment. The background monitoring data measured at Bargo, Albury and Wagga Wagga North was used in the calculation of cumulative impacts (i.e. the increase over background levels due to the operation of the proposed development). Albury was selected to be the representative location for PM_{10} concentrations as it has the most representative population and hence, the emissions from vehicles will be more representative of Deniliquin air quality levels but still conservative. The background levels of pollutants assessed for this project were selected as follows:

- The maximum 1-hour average NO_2 concentration adopted as background for the purposes of this study is 82.7 µg/m^3.
- The annual average NO_2 concentration adopted as background for the purposes of this study is 9.4 µg/m^3.
- The maximum 8-hour average CO concentration adopted as background for the purposes of this study is 2.18 µg/m^3.
- The maximum 1-hour average CO concentration adopted as background for the purposes of this study is 3.30 µg/m^3.
- The maximum 15-min average CO concentration adopted as background for the purposes of this study is 4.35 µg/m^3.
- The 24-hour average PM_{10} concentration adopted as background for the purposes of this study is 54.4 µg/m^3.
- The annual average PM_{10} concentration adopted as background for the purposes of this study is 14.3 µg/m^3.
- The 24-hour average $PM_{2.5}$ concentration adopted as background for the purposes of this study is 23.2 µg/m^3.

Given the lack of significant appropriate industries in the local area it can be assumed that there are no background sources of the VOCS (acetaldehyde, acrolein, formaldehyde, ethanol and methanol).

5.5.4 Existing Odour Environment

The area around the Project site includes land uses that are agricultural in nature, which may emit odours of a similar character to those released from the aerated basin. The other contributing source to the background odour of the local environment is the saleyards which is approximately 2 km to the north-east of Project site. It is understood that the saleyards operate once a week, alternating between cattle sales on a Friday and sheep sales on a Tuesday. The saleyards have the capacity to hold 2,000 cattle or 100,000 sheep.

Deniliquin local council were contacted regarding the number and frequency of odour complaints from the receptors close to the saleyards. Council indicated that no odour complaints have been received in the area in the last two to three years. Therefore, it can be assumed that the saleyards, and other sources of odour in the local area, are unlikely to add to the existing odour environment at the Project site.

In accordance with NSW OEH odour Framework and Technical Notes, only odour with similar characteristics may be assessed cumulatively, and given the lack of similar processes in the immediate environment, for the purposes of this AQIA the background odour is assumed to be negligible.

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6 CONSTRUCTION PHASE AIR QUALITY IMPACTS

The following *qualitative* risk-based assessment has been carried out to address the potential air quality impacts from the construction phase.

The full risk assessment methodology is detailed in **Appendix B**. The overall approach is described below.

6.1 Overview

Predictions of air quality impacts are necessary when appraising potential future impacts on potentially sensitive land uses. Sensitive receptors (e.g. residences) have been identified through site-based investigations and are outlined in **Table 8**. Construction activities proposed as having the potential to generate air pollution have been confirmed in consultation with NGH Environmental and are outlined in **Section 1.2.1** and **Section 0**.

Using the above information and taking into consideration local weather characteristics (local wind behaviour is discussed in **Section 5.3**) and natural shelters (e.g. vegetated buffers and terrain), a *qualitative* risk-based impact assessment has been undertaken of potential air quality impacts on surrounding receptors to identify a range of suitable control measures available to mitigate those impacts. The methodology adopted for this risk-based assessment (see **Appendix B**) has been adapted from UK guidance presented in the Institute of Air Quality Management (IAQM) document, *Guidance on the assessment of dust from demolition and construction* (February 2014) (IAQM, 2014).

The IAQM method uses a four step process for assessing dust impacts from construction activities:

- Step 1: Screening based on distance to nearest receptor.
- Step 2: Assess risk of dust effects from activities based on:
    - the scale and nature of the works, which determines the potential dust emission magnitude; and
    - the sensitivity of the area.
- Step 3: Determine site-specific mitigation for remaining activities with greater than negligible effects.
- Step 4: Assess significance of remaining activities after mitigation has been considered.

It is noted that the adopted methodology is designed to provide an overall impact risk, and is not the defining determination for the requirement for mitigation and control. Impacts with a lower determined risk should also be minimised wherever possible. The approach may also underestimate the impact risk in environments which are assessed as having low sensitivity to impacts of a high magnitude, and therefore a pragmatic approach to the assessment should be applied. Any impacts identified as having a high risk should receive detailed appraisal of mitigation options.

Refer to the following section for a preliminary risk assessment and **Section 6.4** for a reappraisal of the potential impacts (i.e. residual impacts) associated with each site where mitigation measures are applied.

6.2 Risk Assessment

6.2.1 Screening Assessment

The Step 1 screening criteria provided by the IAQM guidance suggests screening out the requirement for any assessment of impacts from construction activities where sensitive receptors are located more than:

- 350 m from the boundary of the site.
- 50 m from the route used by construction vehicles on public roads more than 500 m from the site entrance.

Table 16 Step 1 Screening Criteria

Receptor	Distance from the Boundary of the Site[1] (m)	Distance from the Route used by Construction Vehicles (m)	Distance from the Site Entrance (m)
1	NA	NA	NA
2	225	450	450
3	135	360	360
4	630	540	990
5	>1000	>1000	>1000

Note:
1. Measured from the boundary of the site to the residence.

All receptors are located more than 50 m from the route used by construction vehicles. However, Receptor 2 and 3 are located within 350 m of the site boundary and within 500 m of the site entrance and in accordance with the methodology must be included in the assessment. Given Receptor 4 and Receptor 5 are outside the range of the step 1 screening criteria, they have not been included in the assessment.

6.2.2 Impact Magnitude

The activity levels for the construction phase are outlined below and have been categorised based on **Appendix B**, Table A.

Table 17 Assessed Scale of Activity

Activities	Discussion	Scale of Activity
Demolition	No significant demolition works are proposed given it's a greenfield site.	Negligible
Earthworks	Total site area will be > 10,000 m^2, < 5 heavy earth moving vehicles active at any one time	Medium
Construction	Building volume to be construction is > 100,000 m^3 and no significant dust generating activities (such as concrete batching, sandblasting) are proposed	Large
Trackout	Unpaved road length within the site likely > 100 m long, < 10 HRV outward movements of trucks per day carrying primarily concrete and building materials, review of publicly available data suggests high clay content for the Deniliquin area	Medium

It is not known if ground contamination is present at the site however earthworks involved in constructing to the wastewater treatment ponds may have the potential to lead to emissions of odorous compounds. Appropriate remediation works and specific mitigation measures are therefore necessary to ensure that nuisance odour impacts are not realised during earthworks. Refer to **Section 6.3** for potential mitigation measures.

6.2.3 Receptor Sensitivity

Receptors may be classified as having high, medium or low sensitivity to dust deposition, nuisance odour and human health impacts (ecological receptors have not been addressed in this assessment).

The sensitivity of people and their property can be identified based on a few general principles (see Table B of **Appendix B**). In this case, all receptors within 350 m of the construction site have been categorised as *low sensitivity* receptors as this most adequately reflects the nature of these receptors. Two receptors located at distances greater than 350 m from the construction site have also been included in the risk assessment and are also categorised as *low sensitivity* receptors. Justification is provided in **Table 18**.

Table 18 Receptor Sensitivities

<table>
<tr><th>Receptor</th><th>Justification</th><th>Sensitivity</th></tr>
<tr><td>2</td><td rowspan="2">Receptors such as Receptor 2 and 3 can be classified as receptors with medium sensitivity to air pollution as they are included in the following list: farms, outdoor storage, light and heavy industry, parks, places of work.
When these receptors are located >20 m away from the source their sensitivity reduces to low.</td><td>low sensitivity</td></tr>
<tr><td>3</td><td>low sensitivity</td></tr>
</table>

Given the assessed sensitivity of the area, the identified receptors associated with each of the construction activities (i.e. demolition, earthworks, construction, trackout) are likely to have low sensitivity to dust deposition and to impact to human health. The potential for adverse air quality impacts at these locations is determined in the proceeding section.

6.2.4 Preliminary Impacts

A preliminary risk assessment (i.e. no application of mitigation measures) has been undertaken for each stage of the redevelopment works using Matrices 1 to 4 of **Appendix B** and applying the scaled activities and receptor sensitivities determined from the previous sections. The resultant risk ratings are presented below in **Table 19**.

In terms of human health impacts (relating to PM_{10}), Table D of **Appendix B** uses the annual mean 24-hour PM_{10} concentration as a criteria for determining the likely sensitivity of a receptor area. Analysis of monitoring data from the region suggests an annual mean 24-hour background concentration of 14.3 µg/m^3 should be adopted for the local area.

Table 19 Preliminary Impacts – Nuisance Dust / Impacts to Health

Potential Impact to Low Sensitivity Receptors	Preliminary Risk			
	Demolition	Earthworks	Construction	Trackout
Construction Phase	Negligible	Low Risk	Low Risk	Low Risk

The results indicate that there is a low risk of adverse air quality impacts occurring at offsite receptor locations where no mitigation is applied during the redevelopment works.

A low level risk rating does not preclude the requirement for suitable mitigation measures to be implemented during the construction phase. The following section provides a range of appropriate mitigation measures that should be applied during construction to ensure that all risks are minimised where ever practicable.

6.3 Mitigation Measures

6.3.1 Nuisance Dust Control Measures

Ambient dust emissions from wheel-generated dust, excavation and rehabilitation, demolition, clearing and grading, truck loading and unloading, and wind erosion areas will be the primary focus of dust control during construction works at the redevelopment site. Typically, emissions from these processes can be minimised through the implementation of water spraying, particularly during periods of heavy on-site activity.

Dust mitigation measures that may be implemented during the construction phase include:

- Silt and other material be removed from around erosion and sediment control structures to ensure deposits do not become a dust source.
- Soft strip inside buildings before demolition (i.e. retaining walls and windows in the rest of the building where possible, to provide a screen against dust).
- Amending of dust-generating construction activities during adverse wind conditions blowing in the direction of sensitive receptors. A wind sock should be made available and be visible to all areas of an active construction site to assist in reactive response procedures (i.e. to determine when construction activities should be postponed, minimised or relocated in windy conditions).
- Minimising the use of material stockpiles and ensuring sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
- Erecting solid screens or barriers around dusty activities or the site boundary to prevent windblown dust being transported offsite.
- Ensuring fine powder materials are delivered in enclosed tankers and stored in silos to prevent escape of material during delivery.
- Ensuring smaller bags of powder materials are sealed after use and stored appropriately.
- Minimising drop heights from loading shovels and other loading / unloading equipment and using fine water sprays on such equipment where appropriate.
- Ensuring vehicles entering/exit the site are covered to prevent escape of materials during transport.
- Reducing the truck speeds on site will reduce wheel generated dust.
- If dirt track out is causing problems, avoiding dry sweeping of large areas. Manual brushing of the truck’s flanks and wheels could be implemented as a further precaution.

6.3.2 Plant and Machinery

Control measures relating to plant and machinery that may be implemented during the construction phase include:

- Ensuring vehicles and machinery are maintained in accordance with manufacturer’s specifications.
- Minimising truck queuing and unnecessary trips through logistical planning of materials delivery and work practices.
- Ensure all vehicles switch off engines when stationary so that there are no idling vehicles.

- Fixed plant should be located as far from local receptors as practicable.

6.3.3 Fuel Storage Areas

The storage of fuels will be performed in accordance with the relevant Australian Standards. The Australian Institute of Petroleum's document, *Guidance for the Safe Above Ground Fuel Storage on Farms and Industrial Sites* (AIP GL12-2003), provides a succinct summary of the above requirements and a checklist to appraise whether the fuel storage facility is deigned and operated in compliance with the relevant Australian Standards. The Australian Capital Territory (ACT) Government has also produced a guidance document entitled *Environmental guidelines for service station sites and hydrocarbon storage* (2011), which provides further clarification and advice concerning environmental monitoring around fuel storage facilities.

Control measures that may be implemented during the construction phase will be referenced from the above AS, and will:

- Storage areas for all liquids should be appropriately bunded.
- Spill kits including absorbing materials should be provided nearby handling and storage areas.
- Where possible, the delivery of liquid fuels should utilise reciprocal feeds, so that tank vapours are displaced into the delivery vehicle rather than being emitted to the atmosphere as a fugitive emission.
- Empty containers should be managed and disposed of in appropriate manner.

6.3.4 Contaminated Soils

Where there is the potential for invasive ground works to cause the emission of odorous ground vapour or contaminated dust particles, these impacts would need to be specifically addressed in the Construction Environmental Management Plan (CEMP), and an odour assessment and management procedure developed to manage the risks of off-site odour impacts and/or health impacts from the volatilisation of ground contaminants.

General odour mitigation measures and controls that may be implemented during the construction phase include:

- Restricting ground invasive works to the hours of 7am and 6pm, Monday to Friday, and between the hours of 8am and 1pm on Saturdays.
- Keeping excavation surfaces moist.
- Using appropriate covering techniques to cover excavation faces or stockpiles.
- Use of soil vapour extraction systems and regular monitoring of discharges.

6.3.5 Site Management

Air emissions associated with all construction activities should also be managed through compliance with the Construction Environmental Management Plan (CEMP). The CEMP would be implemented so that:

- The works are conducted in a manner that minimises the generation of air emissions.
- The effectiveness of the controls being implemented is monitored.
- Additional measures are implemented where required.

Construction contractors should also undertake daily environmental inspections of their works and worksite. The daily environmental inspection reports should include the below observations, with remedial or corrective actions noted (as appropriate).

Any remedial or corrective actions should be reported to the Site Manager as soon as is practicable. Inspections may include, but not be limited to:

- Visual inspection of dust generation.
- Ensure roads leaving the site are free of soil, and prevention of soil tracking onto the road network.
- Inspection of the erosion and sediment controls.
- Inspection of the waste storage areas.
- Inspection of any rehabilitated areas (where relevant).
- Ensure all hazardous goods, including fuel and oil, are adequately stored or bunded.
- Ensure spill kits are appropriately located and stocked.

6.3.6 Complaints Handling

An effective complaints logging system should be maintained to monitor complaints, to effectively manage any requests for information or respond to any public concerns in relation to the proposed redevelopment activities throughout the construction phase, and to ensure identified incidents are dealt with through investigation and implementation of corrective treatments.

6.4 Residual Impacts

A reappraisal of the predicted unmitigated air quality impacts on sensitive receptors has been performed to demonstrate the opportunity for minimising risks associated with the use of mitigation strategies. These are termed “residual impacts”.

The results of the reappraisal are presented below in **Table 20**.

Table 20 Residual Impacts – Nuisance Dust / Impacts to Health

Potential Impact to Low Sensitivity Receptors	Preliminary Risk			
	Demolition	Earthworks	Construction	Trackout
Construction Phase	Negligible	Negligible	Negligible	Negligible

7 OPERATIONAL PHASE AIR QUALITY IMPACTS

The following approach was used for the quantitative dispersion modelling assessment:

- Selection of representative meteorological data;
- Selection of an appropriate dispersion model;
- Development of the meteorological dataset for dispersion modelling;
- Verification of the meteorological dataset;
- Emissions estimation;
- Dispersion modelling; and
- Post-processing.

7.1 Selection of Representative Meteorological Data

In dispersion modelling, one of the key considerations is the representativeness of the meteorological data used. Once emitted to atmosphere, emissions will:

- rise according to the velocity and temperature at the point of emission;
- be advected from the source according to the strength and direction of the wind at the height which the plume has risen in the atmosphere;
- be diluted due to mixing with the ambient air, according to the intensity of turbulence, and
- possibly be chemically transformed and/or depleted by deposition processes.

Dispersion is the combined effect of these processes.

Dispersion modelling is used as a tool to simulate the air quality effects of specific emission sources, given the meteorology typical for a local area together with the expected emissions. Selection of a year when the meteorological data is atypical means that the resultant predictions may not appropriately represent air quality.

The year of meteorological data used for the dispersion modelling was selected by reviewing the most recent five years of historical surface observations at the Deniliquin AWS (2009 to 2013 inclusive) to determine the most representative year. Wind speed, ambient temperature and relative humidity were compared to long term averages for the region to determine the most representative year.

Data collected from 2009 to 2013 is summarised in **Figure 6** to **Figure 11**. Examination of the data indicates the following:

- **Figure 6** and **Figure 7** show that wind speeds in 2009 were above average.
- **Figure 8** and **Figure 9** show a 9 am and 3 pm temperature in November 2009 slightly above the climate mean.
- In the first 6 months of 2011, relative humidity at 9 am and 3 pm was above the climate mean. In addition, in the last 6 months of 2010 relative humidity at 9 am and 3 pm was above the climate mean (**Figure 10** and **Figure 11**).
- On average, 2012 wind speeds at 9 am and 3 pm are slightly lower than those in 2013. Using 2012 as the representative year would be a conservative approach because low wind speeds are associated with less effective plume dispersion. Consequently, 2012 was selected as a suitably representative year of meteorology.

Figure 6 Wind Speed at 9 am at Deniliquin Airport (2009-2013)

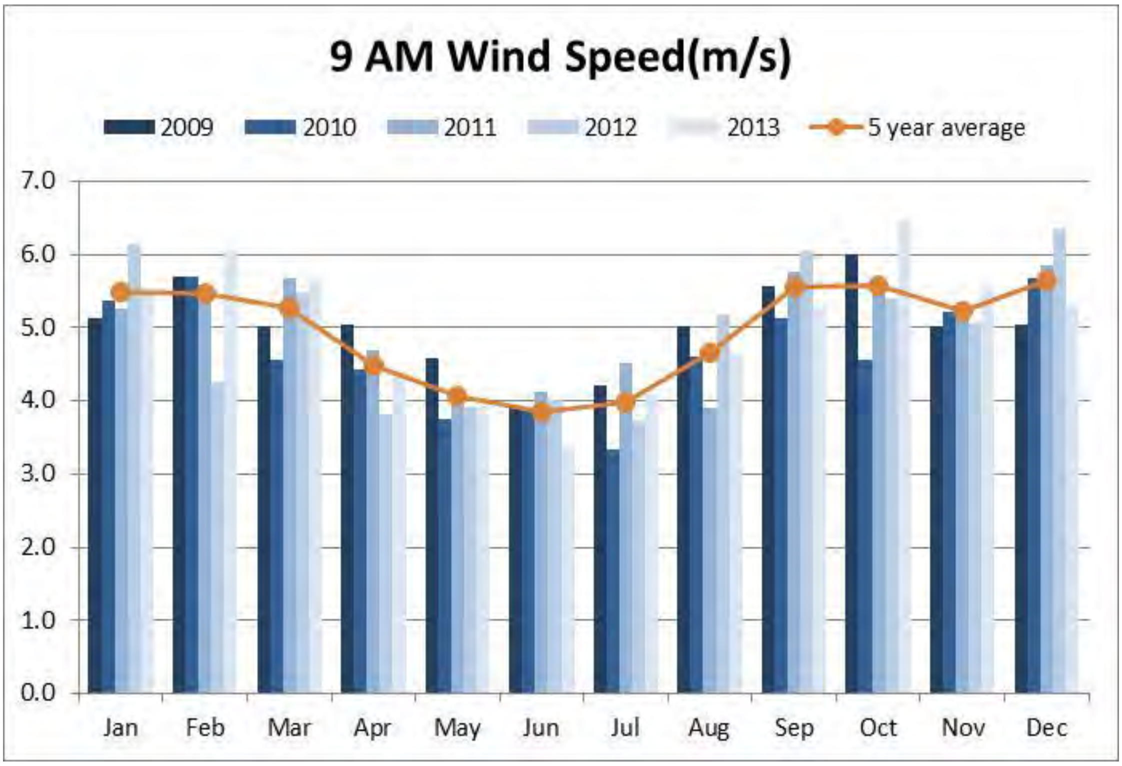


Figure 7 Wind Speed at 3 pm at Deniliquin Airport (2009-2013)

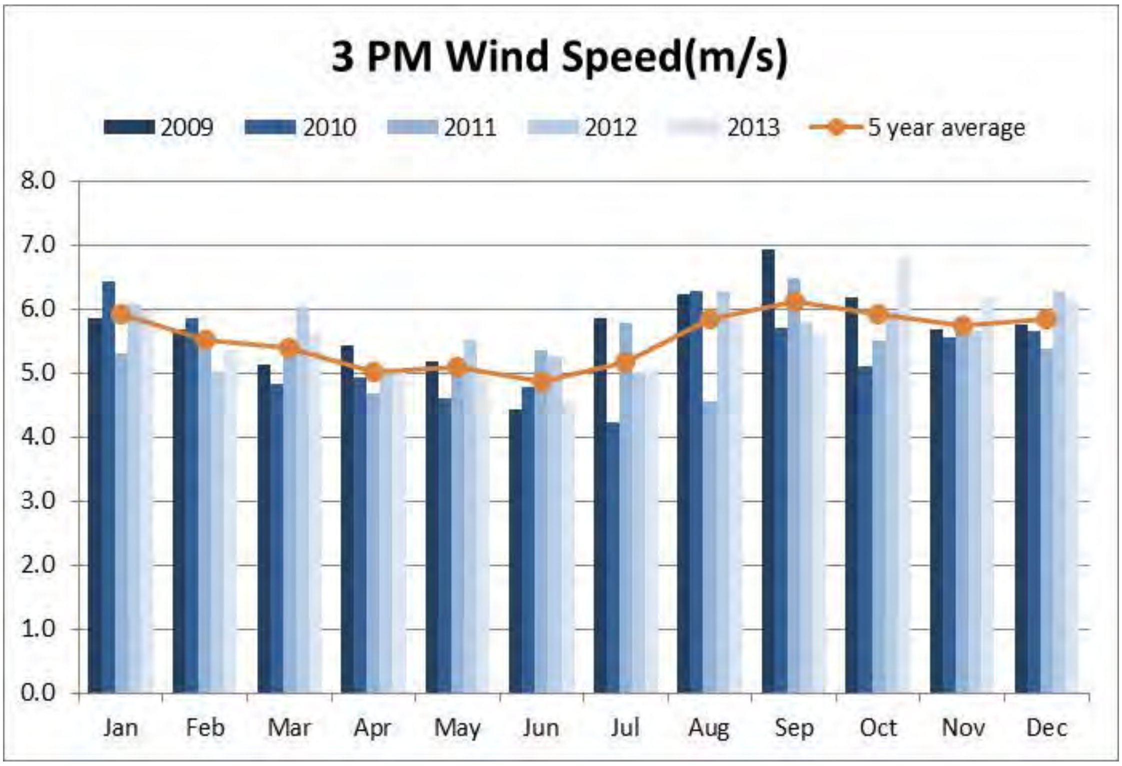


Figure 8 Temperature at 9 am at Deniliquin Airport (2009-2013)

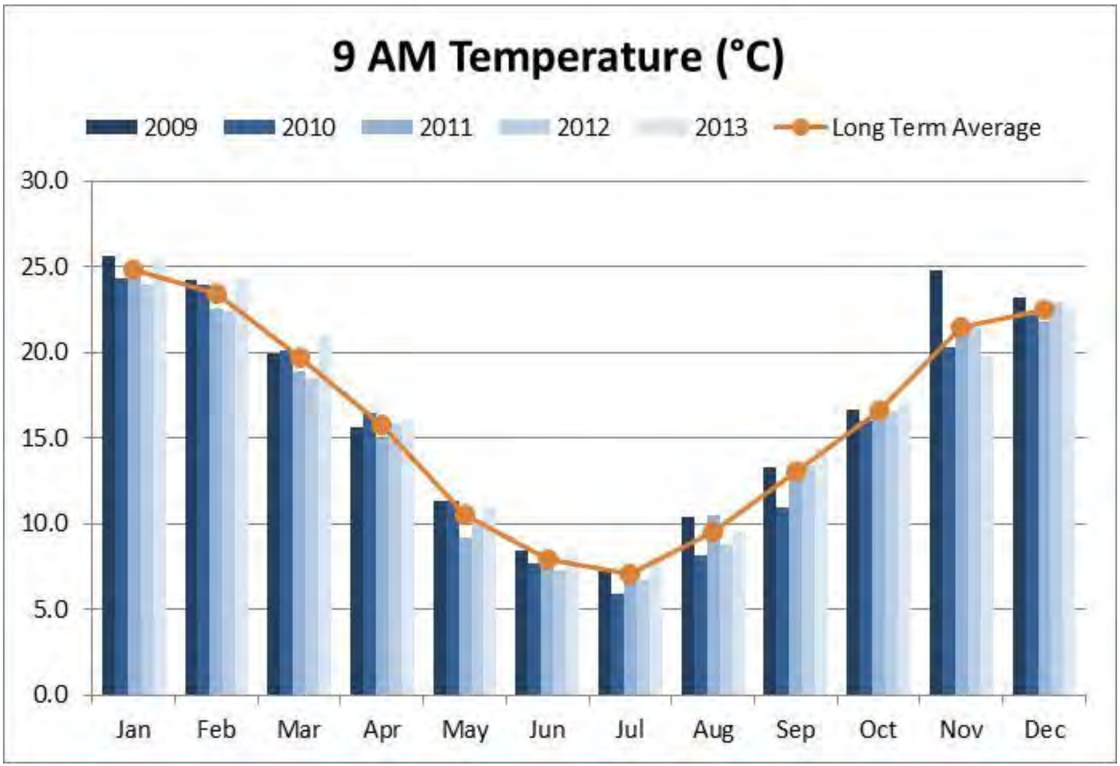


Figure 9 Temperature at 3 pm at Deniliquin Airport (2009-2013)

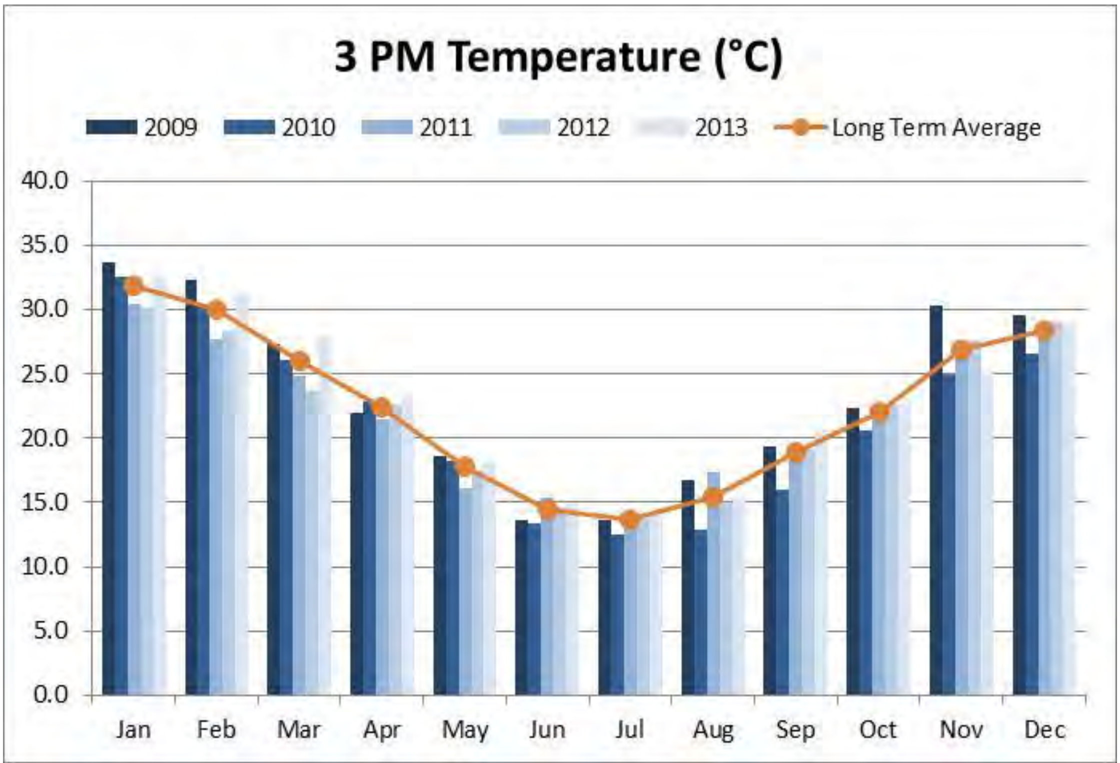


Figure 10 Relative Humidity at 9 am at Deniliquin Airport (2009-2013)

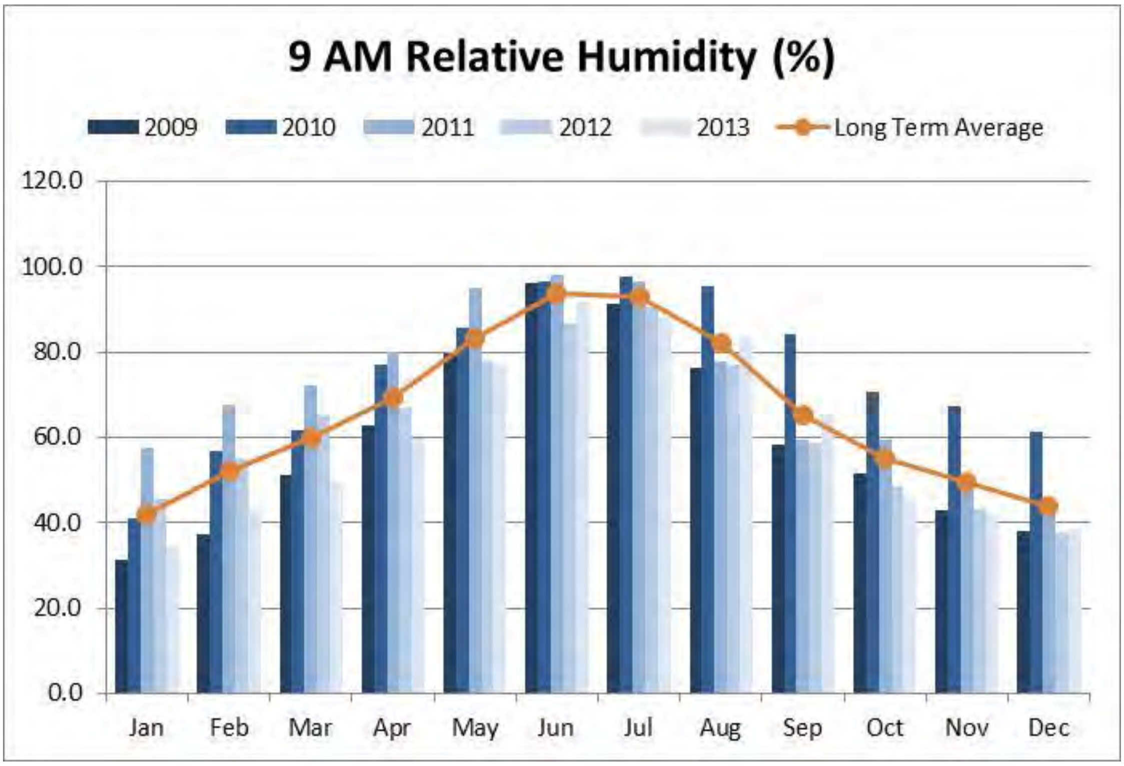
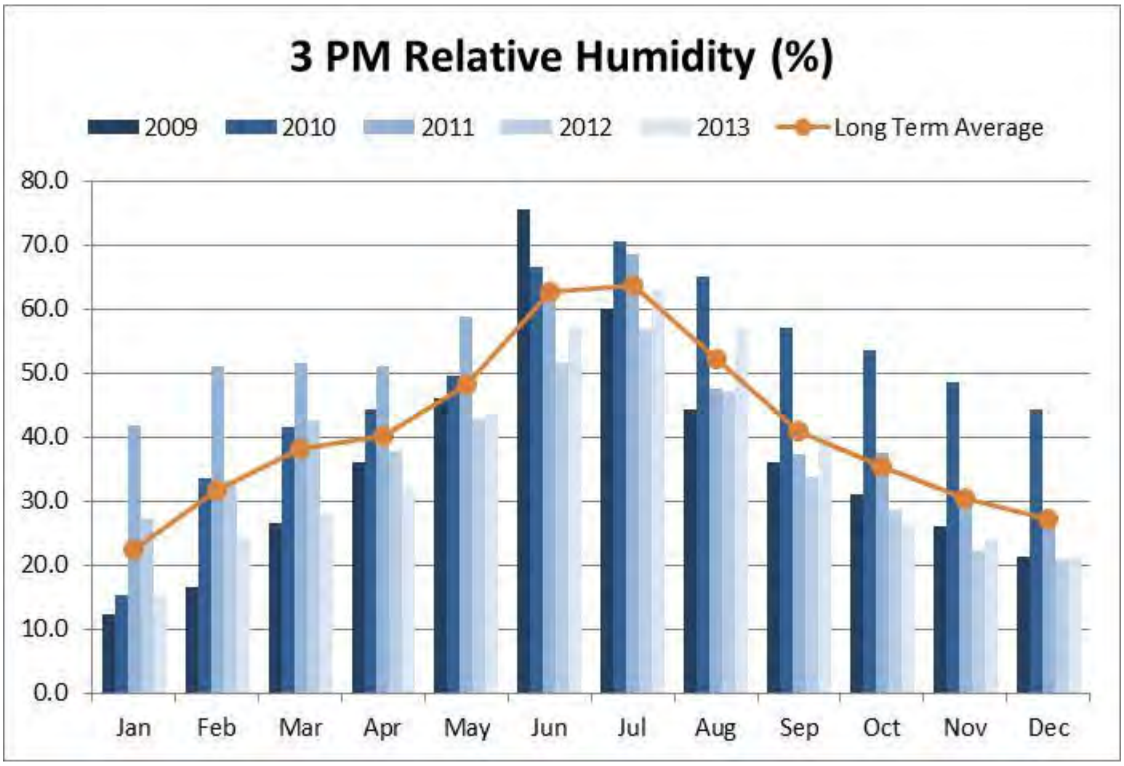


Figure 11 Relative Humidity at 3 pm at Deniliquin Airport (2009-2013)



7.2 Model Selection

There are several notable dispersion model options available for use in NSW. They include:

- AUSPLUME;
- AERMOD; and
- CALPUFF.

7.2.1 AUSPLUME

AUSPLUME (Lorimer, 1986) is a steady state Gaussian plume dispersion model, whose mathematical basis derives from the ISC model (Bowers, et al., 1979), which is capable of simulating the effects of multiple sources, including stacks, volume sources and area sources. These effects can be integrated over a long time period (>1 year), or evaluated for short-term maximum impacts. Gravitational effects (settling) can be accounted for in particle emissions by including information on particle characteristics. The terrain and gravitational options are not highly sophisticated, but for general purposes are considered to be useful and adequate.

Most State regulatory authorities in Australia recognise AUSPLUME Version 6.0 (v6.0) or later as an acceptable dispersion model for general use (EPA Victoria, 2001) (NSW OEH, 2005) (SA EPA, 2006). In January 2014, the EPA Victoria phased out AUSPLUME as the regulatory model in favour of AERMOD. AUSPLUME is not normally recommended for use in the following applications, noting that this is not an exhaustive list:

- Complex terrain where the height of any receptor exceeds the lowest release height (NSW OEH, 2005).
- Dispersion modelling beyond a distance of 10 km.
- Where sensitive receptors are located at a distance from the source that is greater than the minimum distance travelled by the plume in one hour (under conditions critical to compliance).

AUSPLUME, like all Gaussian models, is limited as a dispersion model in the manner in which it operates, which is to:

- predict ensemble-average concentrations but not the transient peaks caused by downdrafts in thermal convection eddies.
- ignore or only partly account for horizontal and vertical variation in turbulence, wind speed and wind direction within the boundary layer.
- assume quasi-steady state conditions. This precludes simulation of events such as inversion breakup fumigation.
- ignore longitudinal diffusion (parallel to the plume axis), which restricts applications to wind speeds above about 0.5 m/s.
- use empirical dispersion parameters sigma y and sigma z that are difficult to determine experimentally beyond about 10 km from a source and become meaningless at distances sufficiently large for advection effects to dominate over diffusion (which may be only a kilometre in complex terrain).
- be unsuccessful in its ability to precisely parameterise the complex flow in the wake of buildings or other obstacles.

7.2.2 AERMOD

AERMOD stands for the AERMIC Dispersion Model. It was designed by the AERMIC Committee (the American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee) to treat elevated and surface emission sources in terrain that is simple or complex (Perry & Cimorelli, 2005).

AERMOD has been built on the framework of the Industrial Source Complex (ISC3) model and retains the steady-state limitation of ISC3. However, its treatment of dispersion in the presence of complex terrain improves on that used in ISC3 and it contains advanced algorithms to describe turbulent mixing processes in both convective and stably stratified conditions. AERMOD also offers new and potentially improved algorithms for plume rise and buoyancy, as well as the computation of vertical profiles of wind, turbulence and temperature.

In November 2006 AERMOD replaced ISC3 model as the USEPA's regulatory model for near-field applications (less than 50 km) for simple and complex terrain (US EPA, 2008). Compared to ISC and AUSPLUME, AERMOD represents an advanced new-generation model which requires additional meteorological and land-use inputs to provide more refined predictions. However, given that AERMOD is essentially a more refined version of the ISC dispersion model the same limitations listed for AUSPLUME are likely to apply to AERMOD.

7.2.3 CALPUFF

CALPUFF (California Puff model) is a multi-layer, multi-species non-steady state puff dispersion model that can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation and removal (Scire, et al., 2000). CALPUFF is a highly versatile and widely-used model which can be run in three-dimensional or two-dimensional mode with respect to meteorology. The three-dimensional mode allows spatially varying wind fields, for example, to be incorporated: this can be important in coastal regions with seabreeze effects. CALPUFF also allows plumes to be tracked through time as they are transported by regional winds: in coastal regions recirculation of pollutants due to seabreeze and landbreeze cycles can also be important.

CALPUFF contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as effects such as pollutant removal, chemical transformation, vertical wind shear, a Probability Distribution Function for dispersion in the convective boundary layer and coastal interaction effects (e.g. sea-breeze recirculation and fumigation within the Thermal Internal Boundary Layer).

Meteorological data used to drive CALPUFF are processed by the CALMET meteorological pre-processor (Scire, et al., 2000). CALMET includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the three-dimensional meteorological fields that are used in CALPUFF. CALMET uses measured and/or modelled meteorological inputs in combination with land use and geophysical information for the modelling domain to predict gridded meteorological fields for the region of interest.

CALPUFF is an USEPA regulatory model (US EPA, 2008) and is widely used in Australia.

7.2.4 Site Specific Factors affecting Model Selection

The dispersion algorithms used by the dispersion models determines how the model simulates the dispersion of a plume. The Gaussian models assume that the average concentration distribution of the plume is based on a Gaussian distribution. However, at any particular instant, the actual concentration may be very different. In addition, the steady state nature implies that these models cannot simulate the effects of time- and space-varying meteorological conditions. Non-steady state models can simulate the effects of time- and space-varying meteorological conditions on pollutant transport. AUSPLUME and AERMOD are steady-state Gaussian models whereas CALPUFF is a non-steady state puff model.

Another key modelling consideration is the specification of the Gaussian dispersion coefficients (σy and σz). These describe the horizontal and vertical dispersion parameters used to define the rate of turbulent diffusion of contaminants in the plume in the horizontal and vertical directions. AUSPLUME uses Pasquill-Gifford stability categories, whereas AERMOD and CALPUFF favour the more complex, Monin-Obukhov similarity theory.

An accurate characterisation of the sources of emission and their effective emission rates is crucial for adequate quantification of the pollutant concentrations. Sources described as volume sources have an initial horizontal and vertical spread. Area sources have an emission rate applied across the surface of the area (in $g/m^2/s$). The Project Site has a few sources described as either area or volume sources. AUSPLUME does not adequately describe emissions from area sources and it is recommended that a volume source approximation be used to model area sources. Plume meander has not been implemented for area sources in AERMOD. As a result, concentration predictions for area sources may be overestimated under very light wind conditions. It is recommended that a volume source approximation be used to model area sources in AERMOD. However, CALPUFF uses a specialised algorithm to simulate concentrations within and downwind of area sources.

The dispersion algorithms, the treatment of turbulent diffusion, and the characterisation of sources inherent to CALPUFF are more sophisticated and more accurately simulate the real world dispersion of plumes. With regard to odour dispersion modelling in particular, AUSPLUME has pronounced limitations under the conditions often most critical for the prediction of maximum impacts, i.e., very light wind, stable conditions. Therefore, the CALPUFF dispersion model was selected for use in this assessment, as it is most critically able to better account for the behaviour of plumes under light wind, stable conditions.

7.3 Meteorological Modelling

Dispersion modelling conducted for this assessment included TAPM, CALMET and CALPUFF.

7.3.1 TAPM

Meteorological data was prepared for the dispersion modelling using The Air Pollution Model (TAPM) developed by CSIRO. TAPM v4 solves the fundamental fluid dynamics and scalar transport equations to predict meteorology and (optionally) pollutant concentrations. It consists of coupled prognostic meteorological and air pollution concentration components. The model predicts airflow important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analyses. Detailed description of the TAPM model and its performance is provided elsewhere. A Technical Paper by Hurley (2008a) describes technical details of the model equations, parameterisations, and numerical methods. A summary of some verification studies using TAPM is also given in Hurley (2008b).

A meteorological dataset for 2012 was created using meteorological information and terrain data inherent to TAPM. TAPM v4 has a tendency to overpredict the incidence of light winds in some situations. However, this tendency is considered to lend a conservative bias as low wind speeds are conducive to higher ground level concentrations. TAPM v4 was run without observations at the Deniliquin Airport.

CALTAPM

CALTAPM was developed to provide users of the TAPM model the ability to create an hourly, 3-dimensional data file of gridded meteorological parameters of the type 3D.DAT for direct use in the CALMET diagnostic meteorological model. When used this way the TAPM data can be used in CALMET to determine the initial guess wind field, prior to the weighting of true observations or even to run CALMET in no-observation mode. The TAPM output file was converted to a 3D.DAT file using CALTAPM for input into CALMET as an initial guess wind field.

7.3.2 CALMET

CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the three-dimensional meteorological fields that are used in the CALPUFF dispersion model.

CALMET requires several datasets in order to resolve the surface and upper air meteorology occurring for each hour of the year:

- Surface observations:
    - Wind speed;
    - Temperature;
    - Cloud cover amount;
    - Precipitation amount and type; and
    - Base cloud height.
- Upper air observations:
    - Height of observation;
    - Wind speed and direction at each height;
    - Temperature at each height; and
    - Barometric pressure at each height.
- Land Use data; and
- Topographical data.

CALMET was run without observations at the Deniliquin Airport so the model predictions could be verified against actual observations. CALTAPM provided a 3D.DAT file containing surface and upper air observations at every grid point in the model domain.

7.4 Meteorological Model Verification

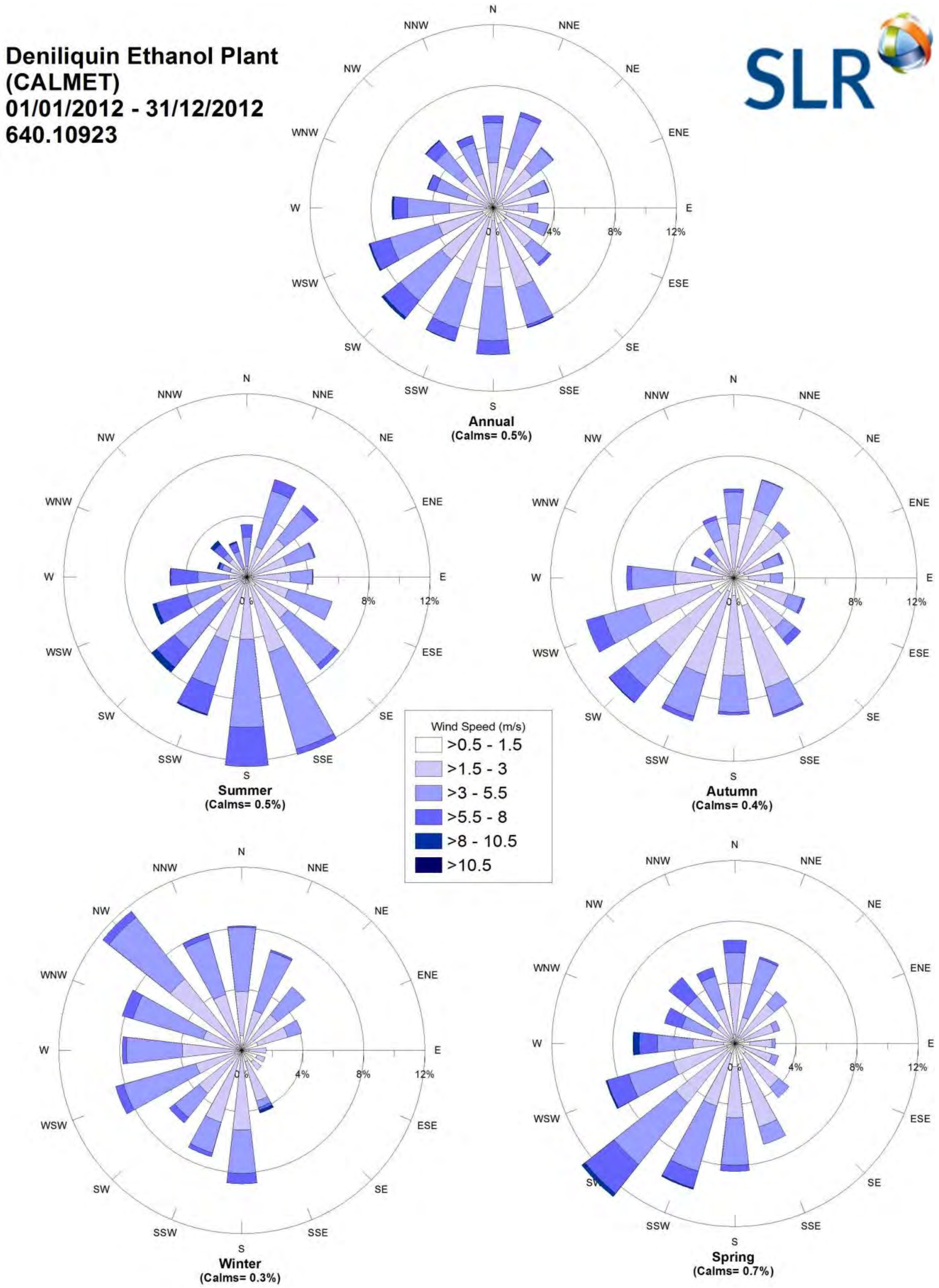
7.4.1 Wind Speed and Direction

Figure 12 shows the annual and seasonal wind roses extracted (from the CALMET generated data) for the area. The predominant predicted wind directions at Deniliquin Airport on an annual basis are in the western and southern quadrants. As with the observed data at Deniliquin Airport, southerly winds dominate in summer and south-westerly winds in autumn (**Figure 4**). The cooler months show a significant percentage of winds from the north-west. Dominant spring winds were predicted to originate from the south-west. The CALMET generated data showed calm conditions occurring approximately 0.5% of the time.

The model under-predicts the frequency of westerly winds in the winter and northerly winds in autumn and winter. Depending on other factors affecting dispersion, this may mean that ground level concentrations may be under-predicted at receptors in the south.

The model predictions of wind speed indicate the model is predicting a lower frequency of higher wind speeds (>8 m/s) than those observed at Deniliquin Airport. This would lead the model to predict more conservative estimations of pollutant ground level concentrations as high winds facilitate dispersion. In addition, the model is adequately predicting the percentage of calm conditions, with CALMET predicting calm conditions 0.5% of the time compared with 0.5% observed at Deniliquin Airport in 2012. Calm conditions often precipitate the highest ground level concentrations, especially of odour, as there is minimal wind present to aid dispersion. Therefore, the model is likely to be adequately addressing the conditions under which the worst ground level concentrations will occur.

Figure 12 CALMET Generated Wind Roses at Deniliquin Airport



7.4.2 Stability Class

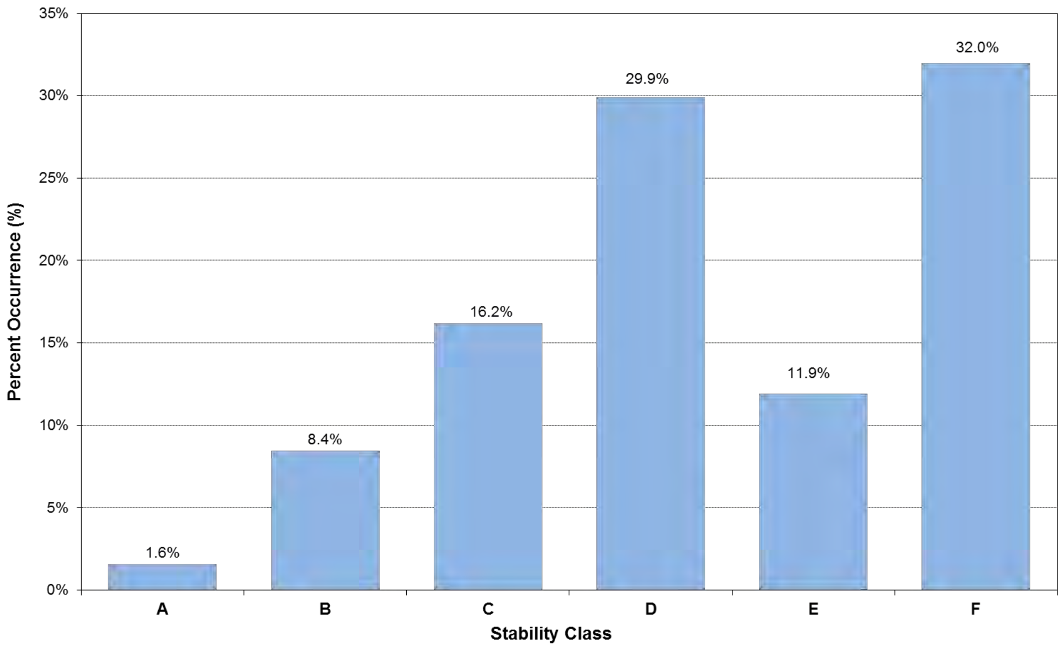
An important aspect of emissions dispersion is the level of turbulence in the atmosphere near the ground. Turbulence acts to dilute or diffuse a plume by increasing the cross-sectional area of the plume due to random motion. As turbulence increases, the rate of plume dilution or diffusion increases. Weak turbulence limits diffusion and is a critical factor in causing high plume concentrations downwind of a source. Turbulence is related to the vertical temperature gradient, the condition of which determines what is known as stability, or thermal stability. For traditional dispersion modelling using Gaussian plume models, categories of atmospheric stability are used in conjunction with other meteorological data to describe the dispersion conditions in the atmosphere.

The best known stability classification is the Pasquill-Gifford (P-G) scheme, which denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution. At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, such as those that commonly occur under clear skies at night and in the early morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind. Intermediate stability classes grade from moderately unstable (B class), slightly unstable (C class), to neutral (D class) and then slightly stable (E class). Whilst classes A and F are closely associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is low.

The CALMET-generated meteorological data can be used to estimate stability classes and the frequency distribution of estimated stability classes is presented in **Figure 13**. The data show a high proportion of neutral conditions (class D) and night time stable conditions (class F), due to the high number of hours a day where these conditions dominate (starting at sunset, progressing throughout the night and concluding after sunrise). The amount of turbulence in the atmosphere has a major effect on the dispersion because turbulence increases the entrainment and mixing. This high precedence of stable and neutral conditions represents the worst case for pollution dispersion and allows for a conservative assessment.

It is noted that a turbulence based scheme within CALPUFF was used in the modelling and the P-G stability class frequency is shown for information only.

Figure 13 Frequency Distribution of Stability Classes



7.4.3 Mixing Height

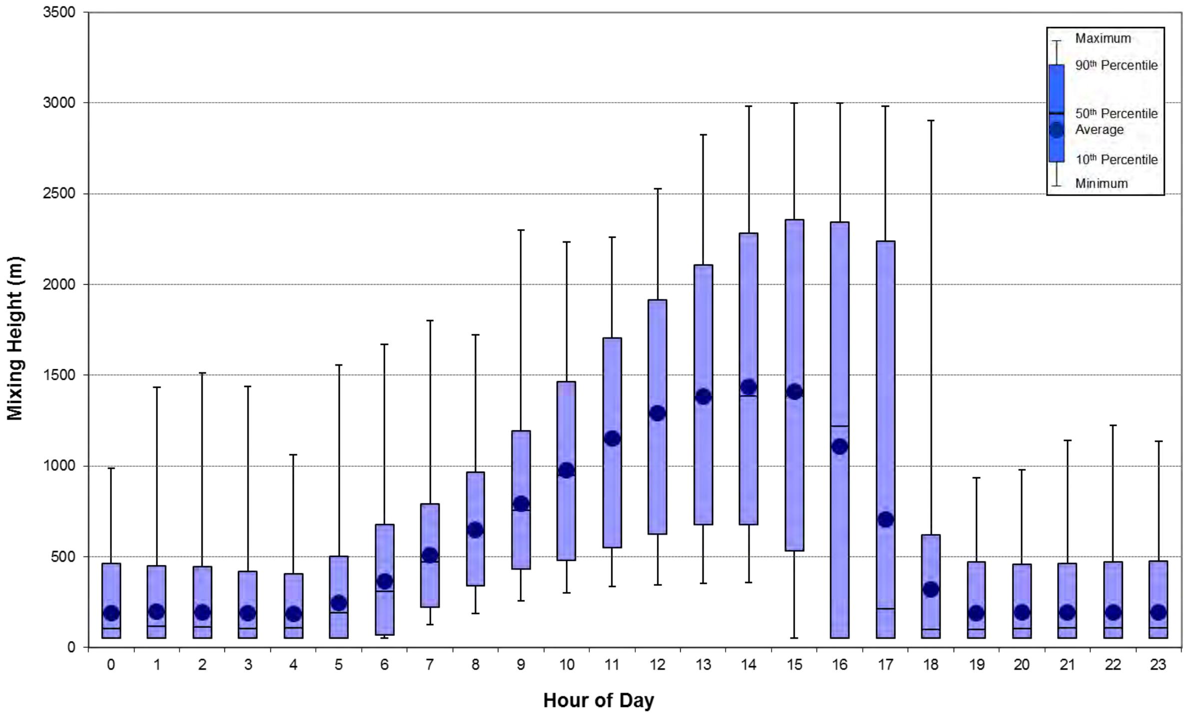
Mixing height is defined as the height above ground of a temperature inversion or statically stable layer of air capping the atmospheric boundary layer.

It is an important parameter within air pollution meteorology as vertical diffusion or mixing of a plume is generally considered to be limited by the mixing height, as the air above this layer tends to be stable, with restricted vertical motion.

It is often associated with, or measured by, a sharp increase of temperature with height, a sharp decrease of water-vapour, a sharp decrease in turbulence intensity and a sharp decrease in pollutant concentration. Mixing height is variable in space and time, and typically increases during fair-weather daytime over land from tens to hundreds of metres around sunrise up to 1-3 km in the mid-afternoon, depending on the location, season and day-to-day weather conditions.

Mixing heights show diurnal variation and can change rapidly after sunrise and at sunset. Diurnal variations in the minimum, maximum and average mixing depths, based on the CALMET-generated meteorological data close to Deniliquin Airport, are shown in **Figure 14**. As expected, mixing heights begin to increase following sunrise with the onset of vertical convective mixing with maximum heights reached in mid to late afternoon. The median, highest and lowest mixing heights for each hour are represented by the horizontal lines. The vertical bars represent the lower quartile and upper quartile of mixing heights. The dark blue points represent the average.

Figure 14 Mixing Heights at Deniliquin Airport



7.5 Emissions Estimation

The major activities giving rise to emissions of odour or dust to the atmosphere associated with the operation of the ethanol plant are outlined in **Section 2.4**. The potential emission sources associated with the ethanol plant are discussed in detail in **Section 2.2.1** to **Section 2.2.6**. The discussion includes which sources were deemed significant to include in the dispersion modelling.

7.5.1 Process Emissions

The sources that were modelled included two point sources (Steam Boiler, Waste Heat Boiler) and an area source (aerated basin). The pollutants emitted from these sources include:

- Products of Combustion (PM_{10}, $PM_{2.5}$, NO_X, CO);
- Speciated VOCs (Acetaldehyde, acrolein, formaldehyde, ethanol, methanol); and
- Odour.

The stack characteristics used in the modelling are outlined in **Table 21**. The corresponding emission rates for the pollutants released from the Steam Boiler and Waste Heat Boiler (W H Boiler) are supplied in **Table 22**. The odour emission rates calculated from the in-stack VOC concentrations and the odour emission rate from the aerated basin are outlined in **Table 24**.

Table 21 Stack Characteristics

	Location (km)		Height	Diameter	Temperature	Volumetric Flow Rate	Exit Velocity
Stack ID	**X**	**Y**	**m**	**m**	**Kelvin**	**m^3/min**	**m/s**
Steam Boiler	309.777	6063.002	30	1.5	393	1484	14
WH Boiler	309.818	6063.189	30	1.5	423	1590	15

Table 22 Emission Estimation for the Boilers

Emission Parameter	Units	Steam Boiler	W H Boiler
Fuel Rate[1,2]	m^3/hr	2,100	3,906
	tonnes/hr	1.62	3.00
Emission Factor[3] (kg/tonne)	PM_{10}	0.16	0.16
	$PM_{2.5}$	0.16	0.16
	NO_X	5.95	5.95
	CO	1.82	1.82
Emission Rate[4] (mg/min)	Acetaldehyde	78,812	1,576
	Acrolein	1,030	21
	Formaldehyde	35,728	715
	Ethanol	18,915	378
	Methanol	1,081	22
Emission Rate (g/sec)	PM_{10}	0.07	0.13
	$PM_{2.5}$	0.07	0.13
	NO_X	2.67	4.97
	CO	0.82	1.52
	Acetaldehyde	1.31	0.026
	Acrolein	0.017	0.00034
	Formaldehyde	0.60	0.012
	Ethanol	0.32	0.0063
	Methanol	0.018	0.00036

Notes:
1. Amount of Compressed Natural Gas burnt, provided by Dongnum
2. A density of natural gas of 1300 m^3/tonne has been assumed
3. Emission Factors sourced from the NPI Emission estimation manual for combustion in boilers.
4. Speciated VOC emission rates provided by Dongnum

VOCs will also be assessed according to their odorous properties given that the concentration required to trigger odour thresholds are (typically) at least an order of magnitude higher than those needed to cause adverse health impacts on human receptors. The odour detection thresholds of these VOCs have been used to calculate the correlated odour concentration of the mix of compounds. These calculations and the resulting odour emission rates are provided in **Table 24**.

The in-stack concentrations of pollutants from the boilers must also show compliance with the *Protection of the Environment Operations (Clean Air) Regulation 2002*. **Table 23** compares the in-stack concentrations of each pollutant with the corresponding Regulation emission concentration limit. The W H Boiler has been compared to the Schedule 2 Group 6 emission limits for sources with an afterburner. The steam boiler has been compared Schedule 4 Group 6 emission limits for general activities. The steam boiler and W H Boiler meet the required in-stack concentration limits.

Table 23 Regulation Emission Concentration Limits

Pollutant	In-Stack Concentration mg/m^3	Regulation Emission Concentration Limit Schedule 4 General Activities Group 6 mg/m^3
Steam Boiler		
PM_{10}	2.9	
$PM_{2.5}$	2.9	
Total PM	5.8	50
NO_2	108	350
CO	33	125
Acetaldehyde	53	
Acrolein	0.69	
Formaldehyde	24	
Ethanol	13	
Methanol	0.73	
Total VOCs[1]	91	40
Pollutant	**In-Stack Concentration mg/m^3**	**Regulation Emission Concentration Limit Schedule 2 Afterburners for Group 6 mg/m^3**
W H Boiler		
PM_{10}	5	
$PM_{2.5}$	5	
Total PM	10	50
NO_2	187	350
CO	57	125
Acetaldehyde	0.99	
Acrolein	0.013	
Formaldehyde	0.45	
Ethanol	0.24	
Methanol	0.014	
Total VOCs	1.7	20

Notes:

1. The Schedule 4 Group 6 emission limit for VOCs is a limit of 40 mg/m^3 for VOCs or 125 mg/m^3 CO. As the concentration of CO is below 125 mg/m^3, the steam boiler complies with the in-stack emission limit requirements.

Table 24 Odour Emission Estimation

	Emission Rate[1]	Concentration[2]	Odour Detection Threshold[4]	Correlated Odour Concentration	Odour Emission Rate (OER)
Speciated VOCs	**mg/min**	**g/m³**	**g/m³**	**OU**	**OU.m³/sec**
Steam Boiler					
Acetaldehyde[5]	78811.7	0.050	0.00009	550.1	14,581
Acrolein[6]	1029.8	0.00065	0.0041	0.16	4.2
Formaldehyde[7]	35728.0	0.022	0.0010	22.0	584
Ethanol[8]	18914.8	0.012	0.00026	46.4	1,230
Methanol[5]	1080.9	0.00068	0.21	0.0032	0.086
Total OER					**16,399**
W H Boiler[3]					
Acetaldehyde[5]	1576.2	0.0011	0.00009	11.8	292
Acrolein[6]	20.6	0.000014	0.0041	0.0034	0.083
Formaldehyde[7]	714.6	0.00048	0.0010	0.47	11.7
Ethanol[8]	378.3	0.00025	0.00026	0.99	24.6
Methanol[5]	21.6	0.000015	0.21	0.000069	0.0017
Total OER					**328**
Aerated Basin[9]					
Odour					0.05

Notes:
1. The data was supplied as is by Dongmun and has not been verified by SLR Consulting.
2. The volumetric flow rate in the stack of the steam boiler is 26.51 m3/sec and 24.74 m3/sec in the Waste Heat Boiler
3. The thermal oxidation efficiency associated with the W H Boiler was assumed to be 98%. The 98% efficiency was assumed for the thermal oxidiser as a conservative assumption.
4. The odour detection threshold is equivalent to the concentration of each compound that is equal to 1 OU
5. sipcotcuddalore.com; last accessed Monday 17th November 2014
6. hazmap.nlm.nih.gov; last accessed Monday 17th November 2014
7. epa.gov/ttnatw01/hlthef/formalde.html; last accessed Monday 17th November 2014
8. iaquk.org.uk; last accessed Monday 17th November 2014
9. The aerated reservoir holds processed wastewater. An odour emission rate from an aerated wastewater pond has been taken from the meat processing industry.

7.5.2 Traffic Emissions

Exhaust emissions from trucks making deliveries or travelling off-site have been considered in this assessment. Details of the number of off-site truck movements are outlined in **Section 2.3**.

Given the low level of current vehicle traffic in the area, the local air quality is not heavily impacted by emissions of products of combustion from vehicle exhaust. The exhaust emissions from the types of vehicles travelling on-site are therefore not considered significant as the impacts of the additional emissions associated with vehicles on-site will be short term in nature (i.e. there are small numbers of vehicles making deliveries and pick-ups throughout the day and any vehicles loading or unloading on-site will not be left to idle). Exhaust emissions from these vehicles are unlikely to significantly impact on local air quality and therefore have not been included as sources in the dispersion modelling.

The number of external vehicles making deliveries to site and taking product off-site will be minimal in context of the surrounding environment. The background air quality has been sourced from Albury AQMS, which is the nearest representative location where monitoring is undertaken by NSW Office of Environment and Heritage (OEH). These locations are likely to have a higher number of vehicles in the vicinity of the monitoring location. Therefore, it can be reasonably assumed that the impact from the increase in traffic emissions from the Project is captured in the use of conservative background air quality data.

Wheel generated dust from these on-site and off-site traffic movements will also be minimal as the internal roads will be sealed. Therefore it has be assumed that wheel generated dust will be adequately managed with appropriate on-site management practices.

7.6 Dispersion Modelling

7.6.1 CALPUFF

CALPUFF (Scire, et al., 2000) is a multi-layer, multi-species, non-steady state puff dispersion model that can simulate the effects of time and space varying meteorological conditions on emissions transport, transformation and removal. The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer-range effects such as substance removal, chemical transformation, vertical wind shear and coastal interaction effects. The model uses dispersion equations based on a Gaussian distribution of substances across the puff and takes into account the complex arrangement of emissions from point, area, volume, and line sources.

As with any air dispersion model, CALPUFF requires inputs in three major areas:

- Emission rates and source details;
- Meteorology; and
- Terrain and surface details, as well as specification of specific receptor locations.

7.6.2 Model Domain

The model domain encompassed a 10 km x 10 km grid with 0.1 km resolution and was referenced to a south-west corner of 305.016 km E, 6057.834 km S. The 3D.DAT file generated by CALTAPM was used as an initial guess wind field for the meteorological modelling of the grid. The model was setup in accordance with the procedure outlined in Approved Methods (NSW OEH, 2005).

The following settings were used in the CALPUFF setup:

- Grid of 100 x 100 grid points at resolution of 100 m, with the south-west corner at 305.016 km E, 6057.834 km S (MGA UTM Zone 55);

- Partial plume adjustment for terrain effects;
- Chemical transformation was not included; and
- Deposition was not included.

7.6.3 Post-Processing

The primary output files from CALPUFF contain hourly concentrations evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

7.7 Modelling Results

7.7.1 Nitrogen Dioxide

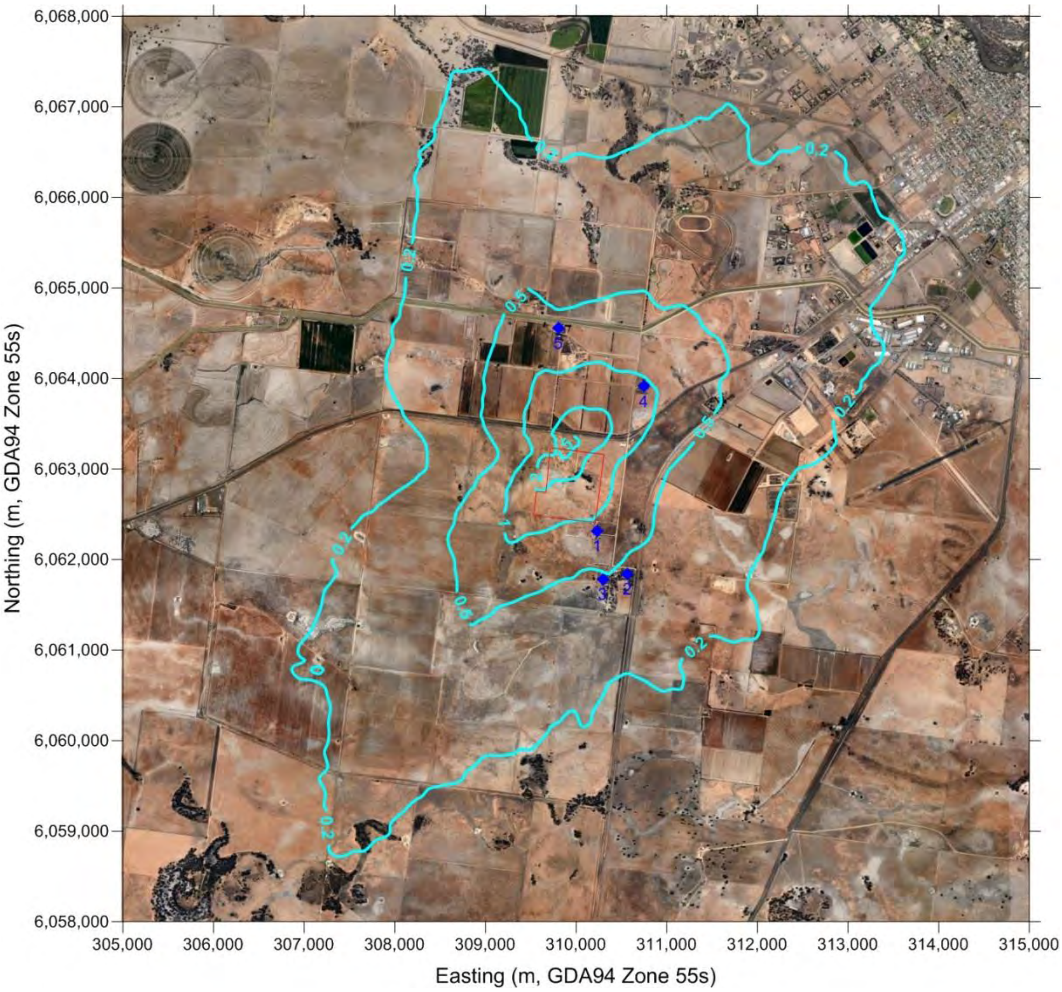
Table 25 shows the predicted annual average and maximum 1-hour NO_2 concentrations, respectively, due to emissions from the boilers. It has been assumed that there is full oxidation of the NO_x to NO_2. Generally, the oxidation of NO to NO_2 takes time to occur, during which time dispersion should have also occurred so that NO_2:NOx ratios should not be too high (i.e. less than 10%) (NZMfE, 2004). These predictions, assuming full oxidation, are therefore considered to be highly conservative.

The concentration contours of the predicted model results are presented in **Figure 15** and **Figure 16**. The predicted cumulative annual average NO_2 concentrations reach a maximum at Receptor 4 of 10.5 µg/m^3, which is below the 62 µg/m^3 criterion. The cumulative maximum 1-hour average NO_2 concentration of 114.6 µg/m^3 was predicted at Receptor 2 and is below the 246 µg/m^3 criterion.

Table 25 Predicted Incremental NO_2 Concentrations at Sensitive Receptors

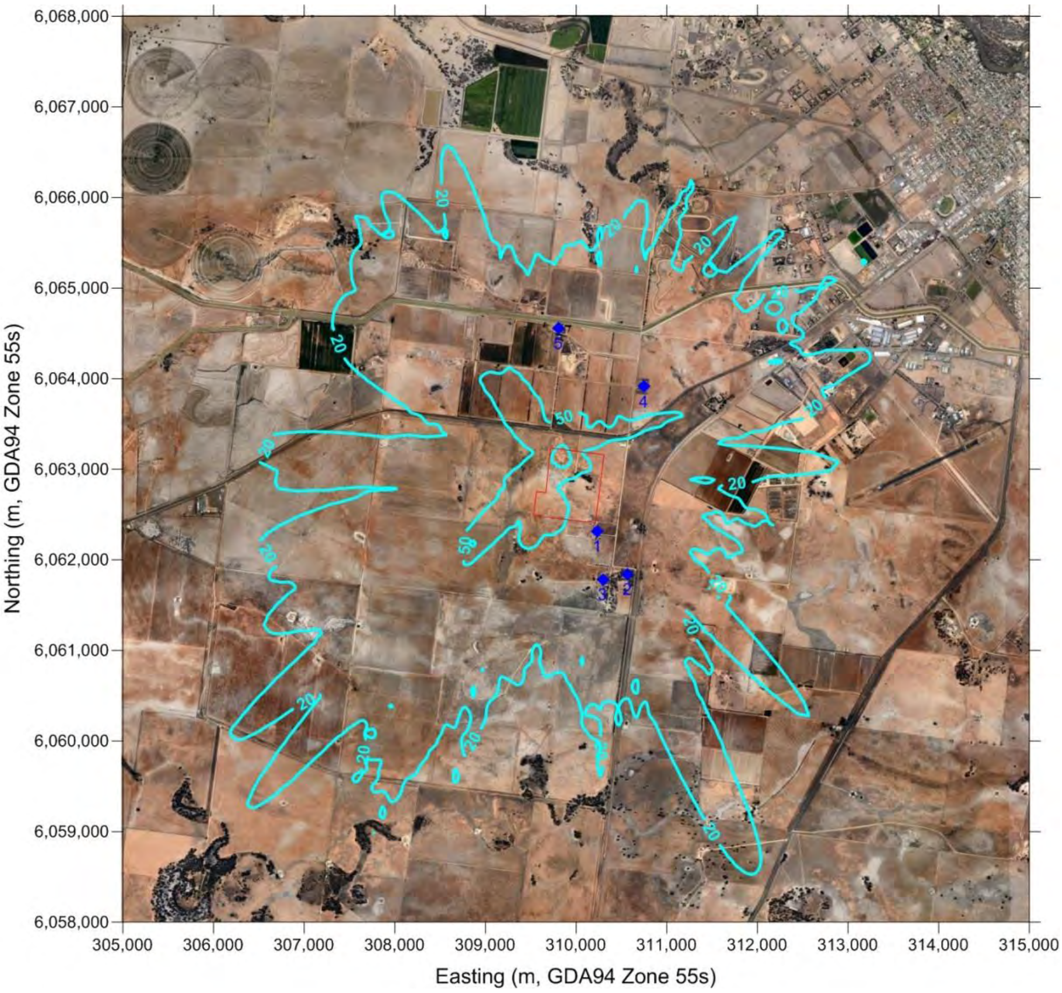
Receptor ID	NO_X as NO_2 Annual Average (µg/m^3)			NO_X as NO_2 Maximum 1-hour Average (µg/m^3)		
	Background	Increment	Total	Background	Increment	Total
R1	9.4	0.8	10.2	82.7	31.4	114.1
R2	9.4	0.4	9.8	82.7	31.9	114.6
R3	9.4	0.5	9.9	82.7	27.5	110.2
R4	9.4	1.1	10.5	82.7	30.1	112.8
R5	9.4	0.6	10.0	82.7	25.9	108.6
Criterion (µg/m^3)			**62**			**246**

Figure 15 Predicted Maximum Incremental Annual Average NO_X as NO_2 Ground Level Concentrations (µg/m^3)



Criterion: 62 µg/m^3

Figure 16 Predicted Maximum Incremental 1-hour Average NO_X as NO_2 Ground Level Concentrations (µg/m^3)



Criterion: 246 µg/m^3

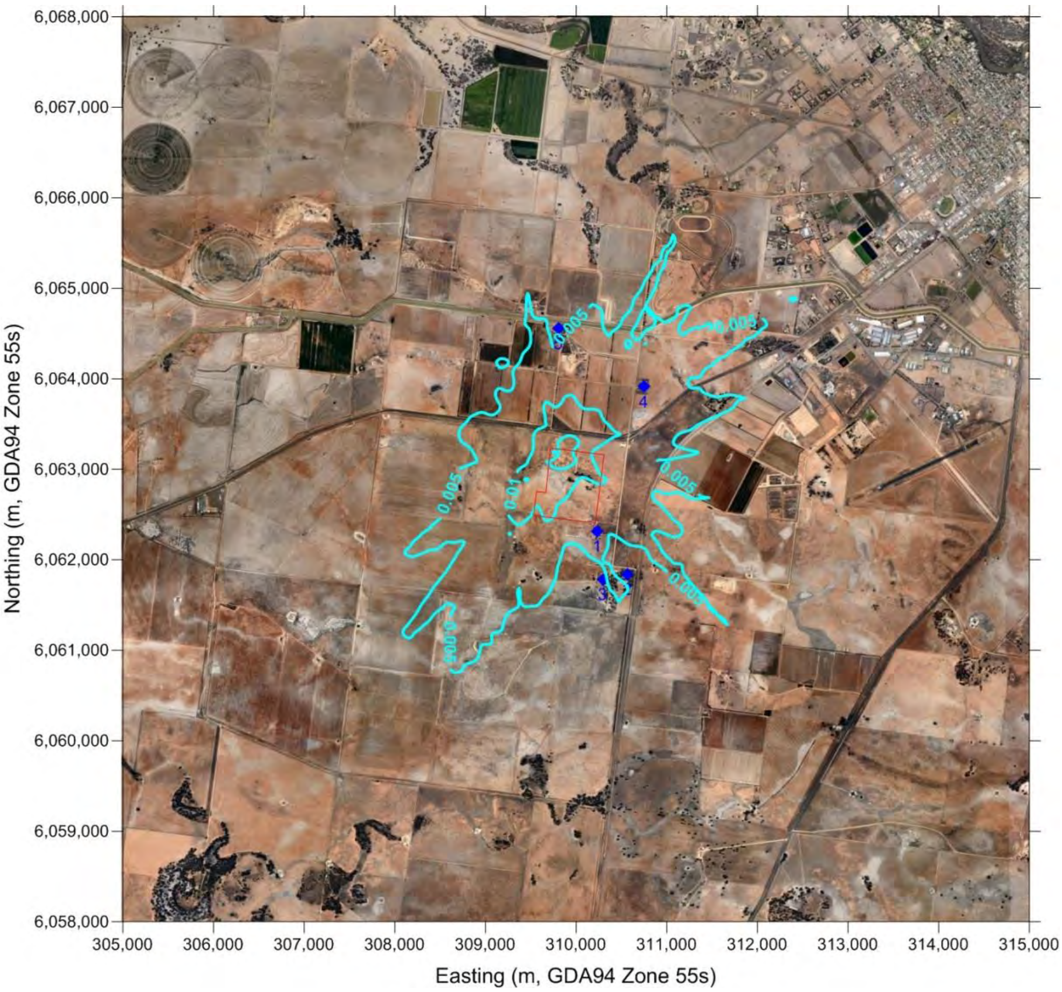
7.7.2 Carbon Monoxide (CO)

Table 26 and **Table 27** show the predicted maximum 8-hour average, maximum 1-hour average and maximum 15-min average CO concentrations, respectively, due to emissions from the boilers. The concentration contours of the predicted model results are presented in **Figure 17**, **Figure 18** and **Figure 19**. The predicted cumulative Maximum 8-hour average CO concentrations reach a maximum at Receptor 4 of 2.19 µg/m^3, which is below the 10 µg/m^3 criterion. The cumulative maximum 1-hour average CO concentration of 3.31 µg/m^3 was predicted at Receptor 1 and Receptor 2 and is below the 30 µg/m^3 criterion. The cumulative maximum 15-min average CO concentration of 4.36 µg/m^3 was predicted at Receptor 1 and Receptor 2 and is below the 100 µg/m^3 criterion.

Table 26 Predicted Incremental CO Concentrations at Sensitive Receptors

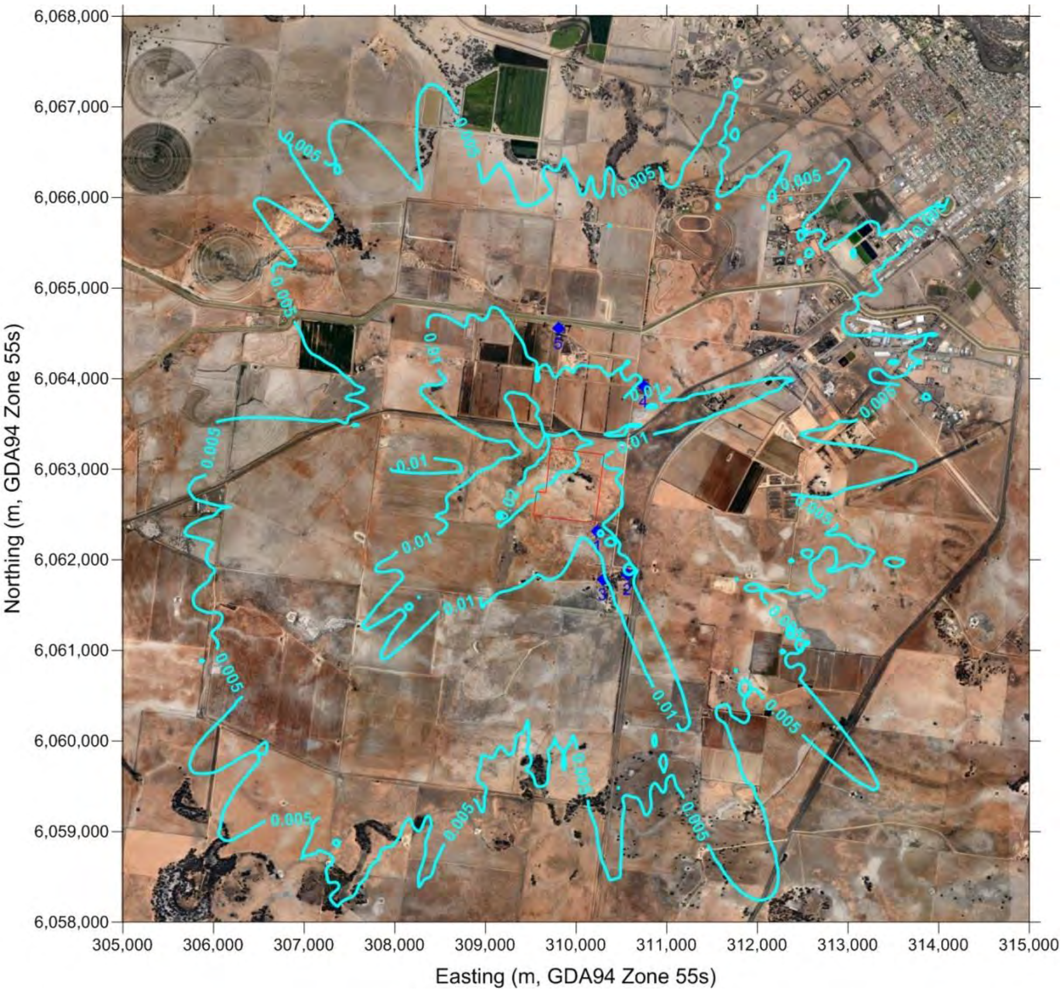
Receptor ID	CO 8-hour average (mg/m^3)			CO Maximum 1-hour Average (mg/m^3)		
	Background	**Increment**	**Total**	**Background**	**Increment**	**Total**
R1	2.18	0.006	2.19	3.30	0.010	3.31
R2	2.18	0.004	2.18	3.30	0.010	3.31
R3	2.18	0.004	2.18	3.30	0.008	3.31
R4	2.18	0.007	2.19	3.30	0.009	3.31
R5	2.18	0.004	2.18	3.30	0.008	3.31
Criterion (mg/m^3)			**10**			**30**

Figure 17 Predicted Incremental Maximum 8-hour Average CO Ground Level Concentrations (mg/m^3)



Criterion = 10 mg/m^3

Figure 18 Predicted Incremental Maximum 1-hour Average CO Ground Level Concentrations (mg/m^3)

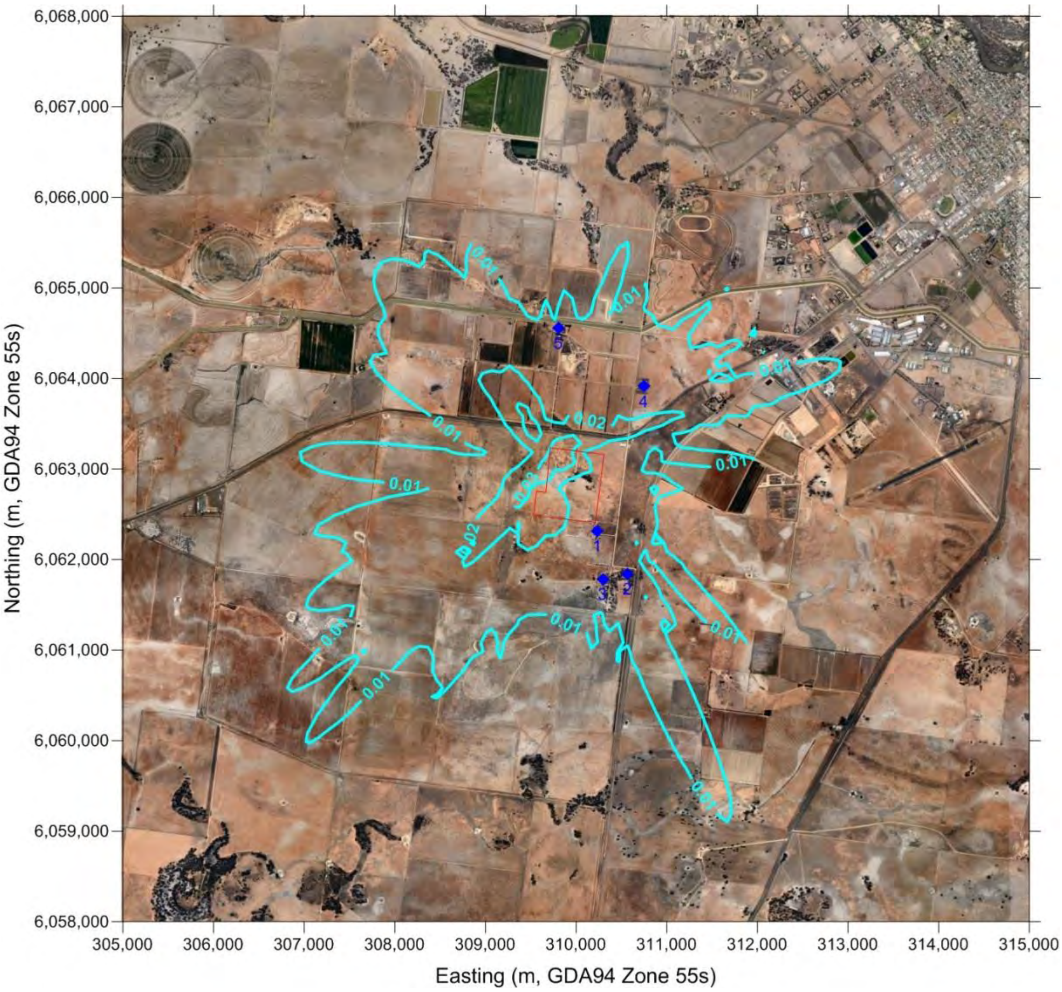


Criterion = 30 mg/m^3

Table 27 Predicted Incremental CO Concentrations at Sensitive Receptors

Receptor ID	CO 15-min Average (mg/m^3)		
	Background	Increment	Total
R1	4.35	0.013	4.36
R2	4.35	0.013	4.36
R3	4.35	0.011	4.36
R4	4.35	0.012	4.36
R5	4.35	0.011	4.36
Criterion (mg/m^3)			**100**

Figure 19 Predicted Incremental Maximum 15-min Average CO Ground Level Concentrations (mg/m^3)



Criterion = 100 mg/m^3

7.7.3 Particulate Matter (PM_{10})

Emissions of particulate matter as PM_{10} from the boilers were modelled. The background air quality contribution was sourced from the Albury air quality monitoring station (**Section 5.5**).

The predicted annual average at the sensitive receptors is presented in **Table 28**. The concentration contours of the predicted model results are presented in **Figure 20**. The predicted incremental annual average PM_{10} concentrations reach a maximum at Receptor 4 of 0.03 µg/m^3, which is below the 30 µg/m^3 criterion. Inclusive of background air quality contributions of 14.3 µg/m^3, the criterion is still achieved.

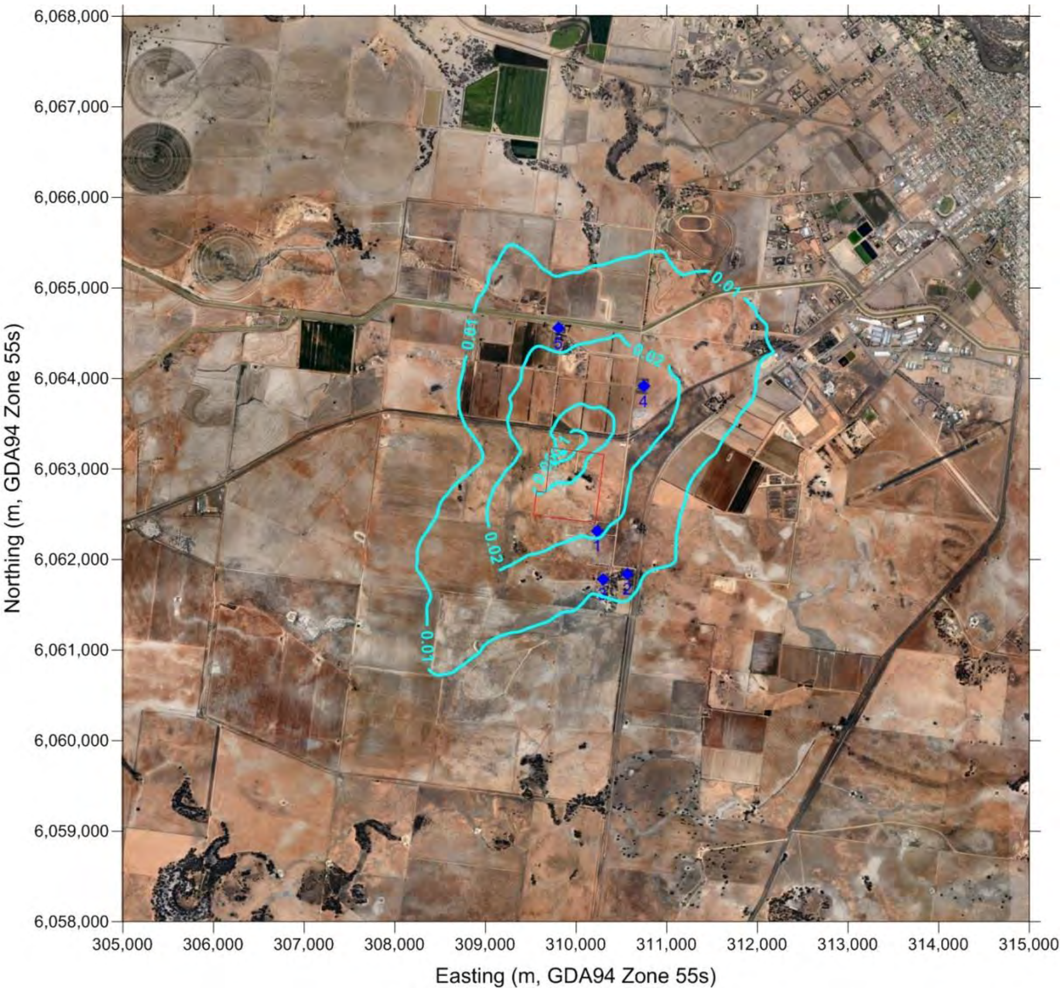
Table 28 Predicted PM_{10} Annual Average Concentrations at Receptors

Receptor ID	PM_{10} Annual Average (µg/m^3)		
	Background[1]	Increment	Total
R1	14.3	0.02	14.32
R2	14.3	0.01	14.31
R3	14.3	0.01	14.31
R4	14.3	0.03	14.33

Receptor ID	PM_{10} Annual Average (µg/m^3)		
	Background[1]	Increment	Total
R5	14.3	0.02	14.32
Criterion (µg/m^3)			**30**

Notes:
1. Albury air quality monitoring station (**Section 5.5**).

Figure 20 Predicted Incremental Annual Average PM_{10} Ground Level Concentrations (µg/m^3)



Criterion = 30 µg/m^3

The predicted maximum 24-hour average PM_{10} concentration at each of the sensitive receptors is presented in **Table 29**. The concentration contours of the predicted model results are presented in **Figure 21**. The predicted incremental maximum 24-hour average PM_{10} concentration of 0.31 µg/m^3 was predicted at Receptor 4 and was predicted to be below the 50 µg/m^3 guideline.

In situations where the maximum 24-hour average ambient PM_{10} concentration exceeds the impact assessment criteria, Approved Methods allows the licensee to demonstrate that no additional exceedance of the impact assessment criteria will occur as a result of the proposed activity (NSW OEH, 2005). It is important to note that in the absence of local ambient PM_{10} concentrations, data from Albury has been used as a conservative estimate.

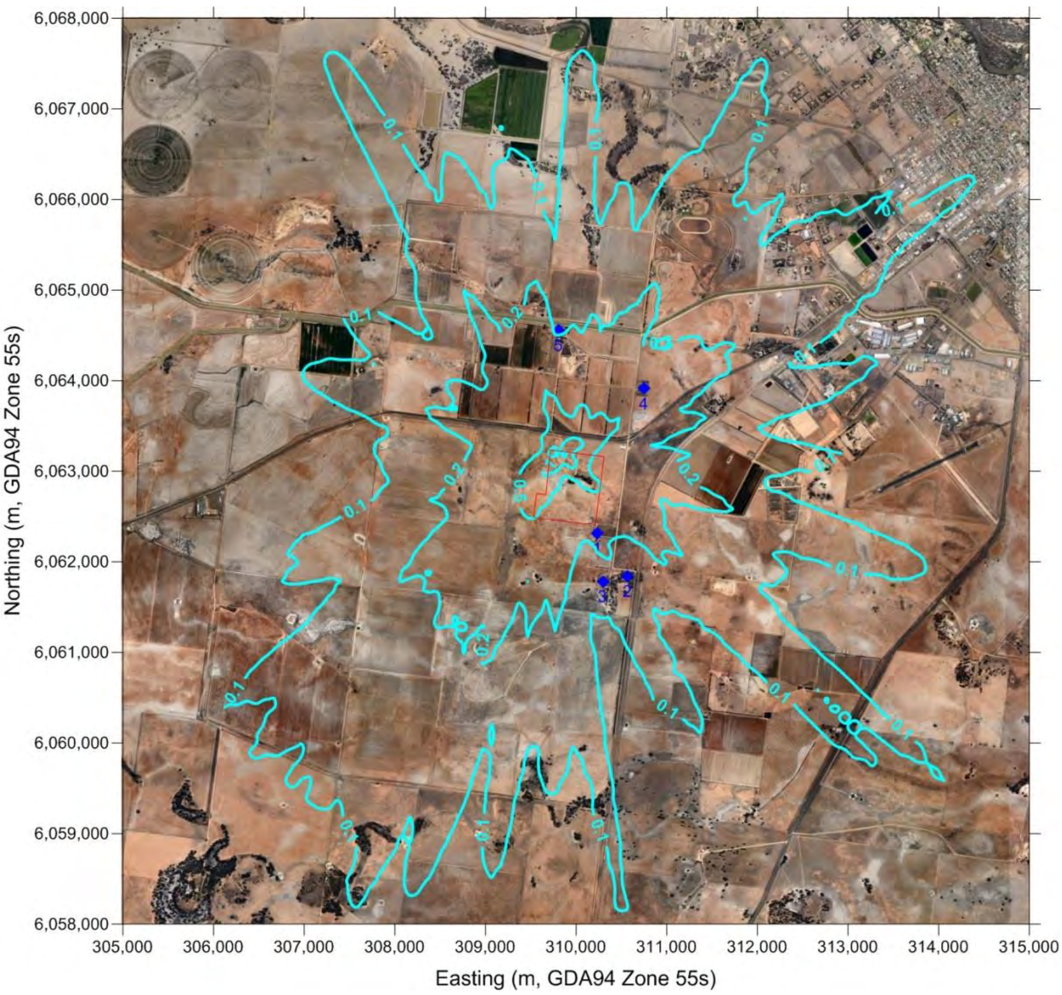
Table 29 shows the total predicted concentration on days with the highest background and the total predicted concentration on days with the highest predicted incremental ground level concentrations. From this refined analysis it is evident that no additional exceedances of the 24-hour average impact assessment criterion are likely. The single exceedance of the impact criteria on 6 April 2012 shows there is very minor contribution from proposed facility the receptors during this 24-hour period.

Table 29 PM_{10} Maximum 24-hour Average Contemporaneous Impact and Background at Receptors

Receptor ID	PM_{10} Maximum 24-hour Average (µg/m^3)							
	Assessment of Maximum Cumulative Impact				Assessment of Maximum Incremental Impact			
	Date	Background	Increment	Total	Date	Background[1]	Increment	Total
R1	6/04/2012	54.4	0.038	54.44	22/05/2012	20.7	0.26	20.96
R2	6/04/2012	54.4	0.016	54.42	22/05/2012	20.7	0.14	20.84
R3	6/04/2012	54.4	0.018	54.42	09/05/2012	16.8	0.13	16.93
R4	6/04/2012	54.4	0.023	54.42	13/09/2012	10.5	0.31	10.81
R5	6/04/2012	54.4	<0.001	54.40	06/03/2012	11.2	0.17	11.37
Criterion (µg/m^3)				50				50

Notes: Albury air quality monitoring station (**Section 5.5**).

Figure 21 Predicted Maximum Incremental 24-hour Average PM_{10} Ground Level Concentrations (µg/m^3)



Criterion = 50 µg/m^3

7.7.4 Particulate Matter ($PM_{2.5}$)

Emissions of particulate matter as $PM_{2.5}$ from the boilers were modelled. The background air quality contribution was sourced from the Albury air quality monitoring station (**Section 5.5**).

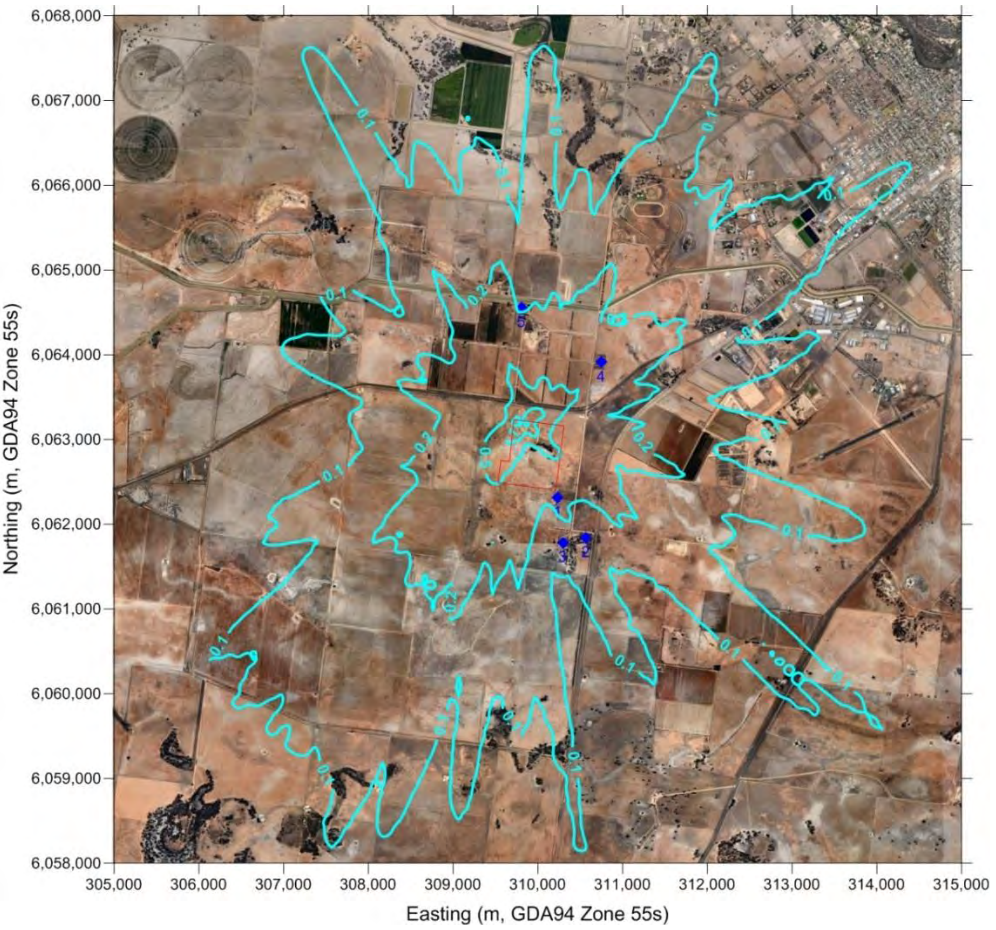
The predicted maximum 24-hour average at the sensitive receptors is presented in **Table 30**. The concentration contours of the predicted model results are presented in **Figure 22**. The predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations reach a maximum at Receptor 4 of 0.03 µg/m^3, which is below the 25 µg/m^3 criterion. Inclusive of background air quality contributions of 23.2 µg/m^3, the criterion is still achieved.

Table 30 Predicted Maximum 24-hour Average $PM_{2.5}$ Concentrations at Receptors

Receptor ID	PM_{10} Annual Average (µg/m^3)		
	Background	Increment	Total
R1	23.2	0.02	23.22
R2	23.2	0.01	23.21
R3	23.2	0.01	23.21
R4	23.2	0.03	23.23
R5	23.2	0.02	23.22
Criterion (µg/m^3)			**25**

Notes: Albury air quality monitoring station (**Section 5.5**).

Figure 22 Predicted Incremental Maximum 24-hour Average $PM_{2.5}$ Ground Level Concentrations (µg/m^3)



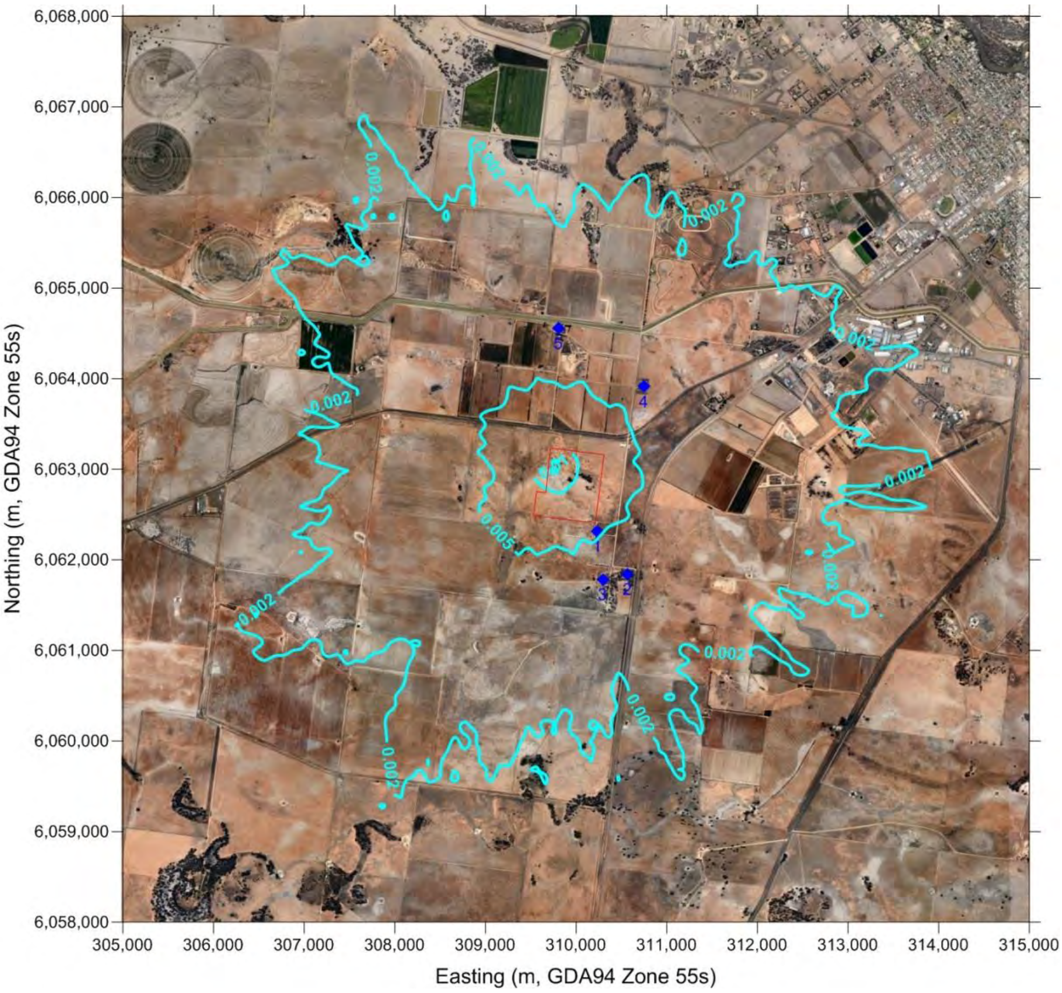
7.7.5 Speciated VOCs

The VOCs listed in **Table 31** were emitted from the boilers. The predicted 99.9th percentile 1-hour average ground level concentrations of each of the VOCs at the sensitive receptors are presented in **Table 28**. The concentration contours of the predicted model results are presented in **Figure** 23 to **Figure** 27. The predicted incremental 99.9th percentile 1-hour average concentrations for each VOC reached a maximum at Receptor 1. All the predicted ground level concentrations were below their respective criterion.

Table 31 99.9th Percentile 1-hour Average Ground Level Concentrations of Speciated VOCs

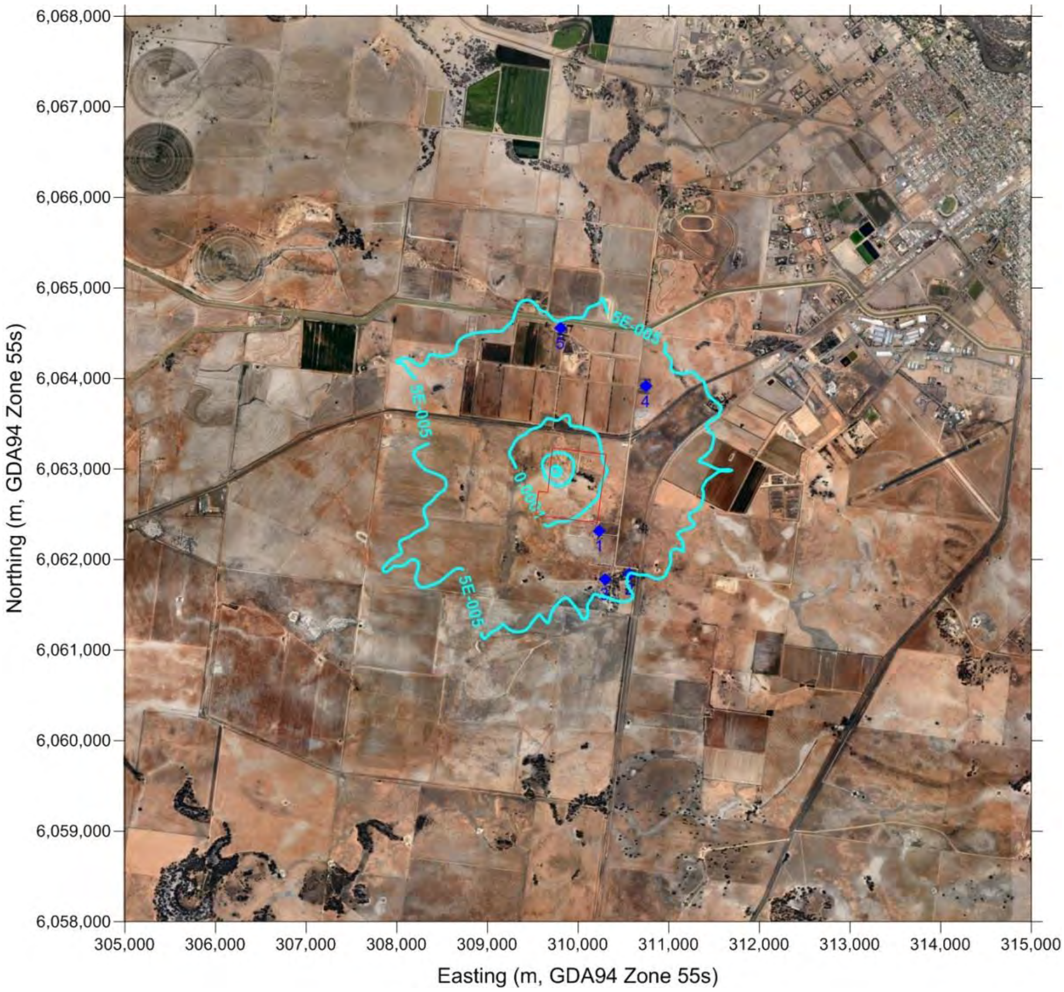
Receptor ID	99.9th Percentile 1-hour Average (mg/m^3)				
	Acetaldehyde	**Acrolein**	**Formaldehyde**	**Ethanol**	**Methanol**
R1	0.005	0.00008	0.0024	0.0013	0.00008
R2	0.003	0.00005	0.0016	0.0008	0.00005
R3	0.004	0.00006	0.0017	0.0009	0.00006
R4	0.004	0.00006	0.0019	0.0010	0.00006
R5	0.004	0.00005	0.0016	0.0009	0.00005
Criterion (mg/m^3)	**0.042**	**0.00042**	**0.02**	**2.1**	**3.0**

Figure 23 Predicted 99.9th Percentile Incremental 1-hour Average Acetaldehyde Ground Level Concentrations (mg/m^3)



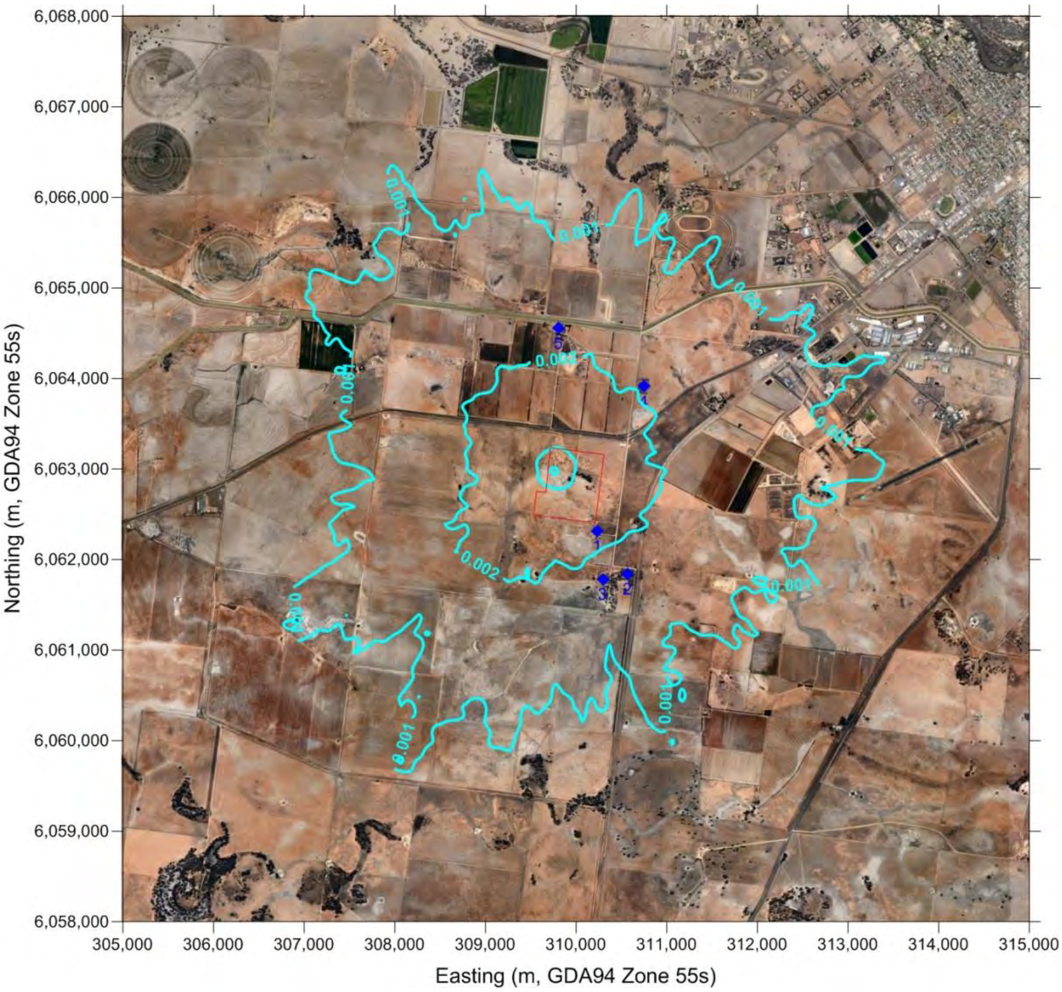
Criterion = 0.042 mg/m^3

Figure 24 Predicted 99.9th Percentile Incremental 1-hour Average Acrolein Ground Level Concentrations (mg/m³)



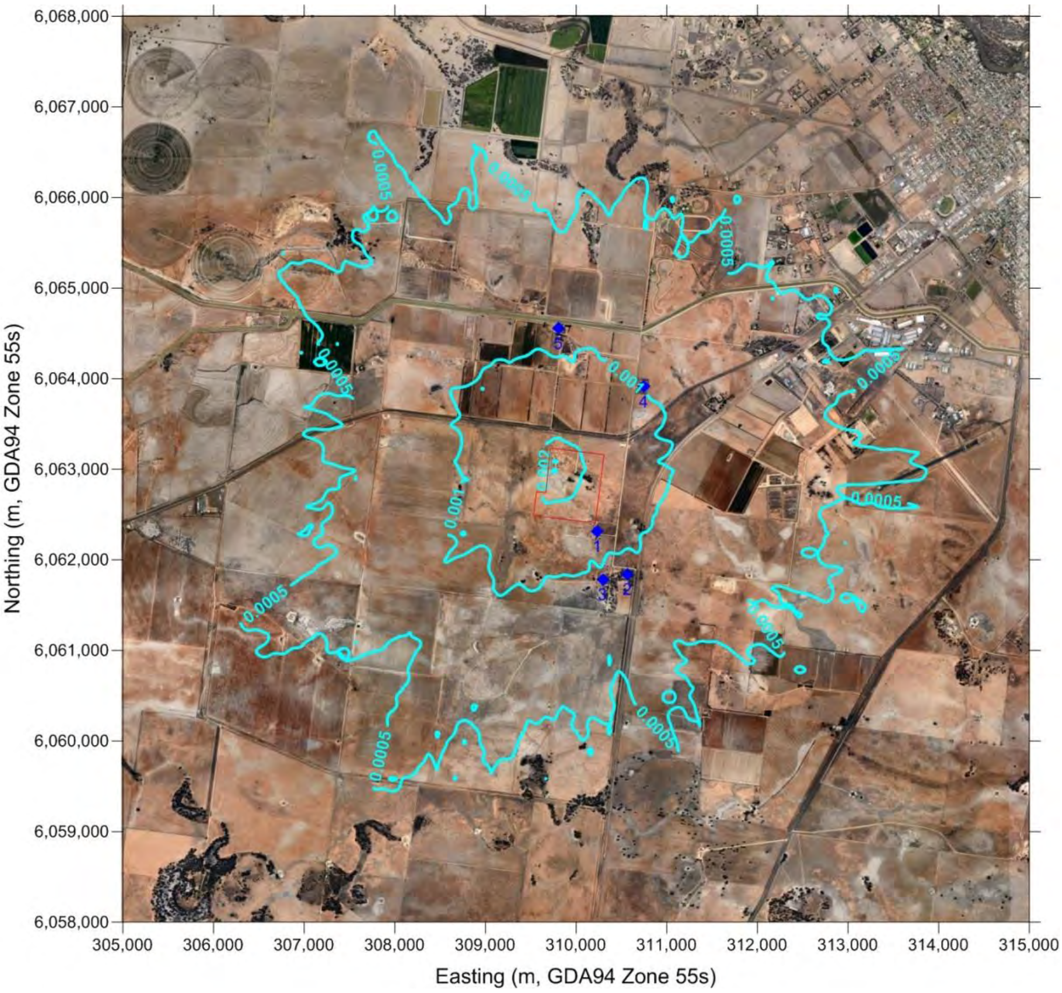
Criterion = 0.00042 mg/m³

Figure 25 Predicted 99.9th Percentile Incremental 1-hour Average Formaldehyde Ground Level Concentrations (mg/m³)



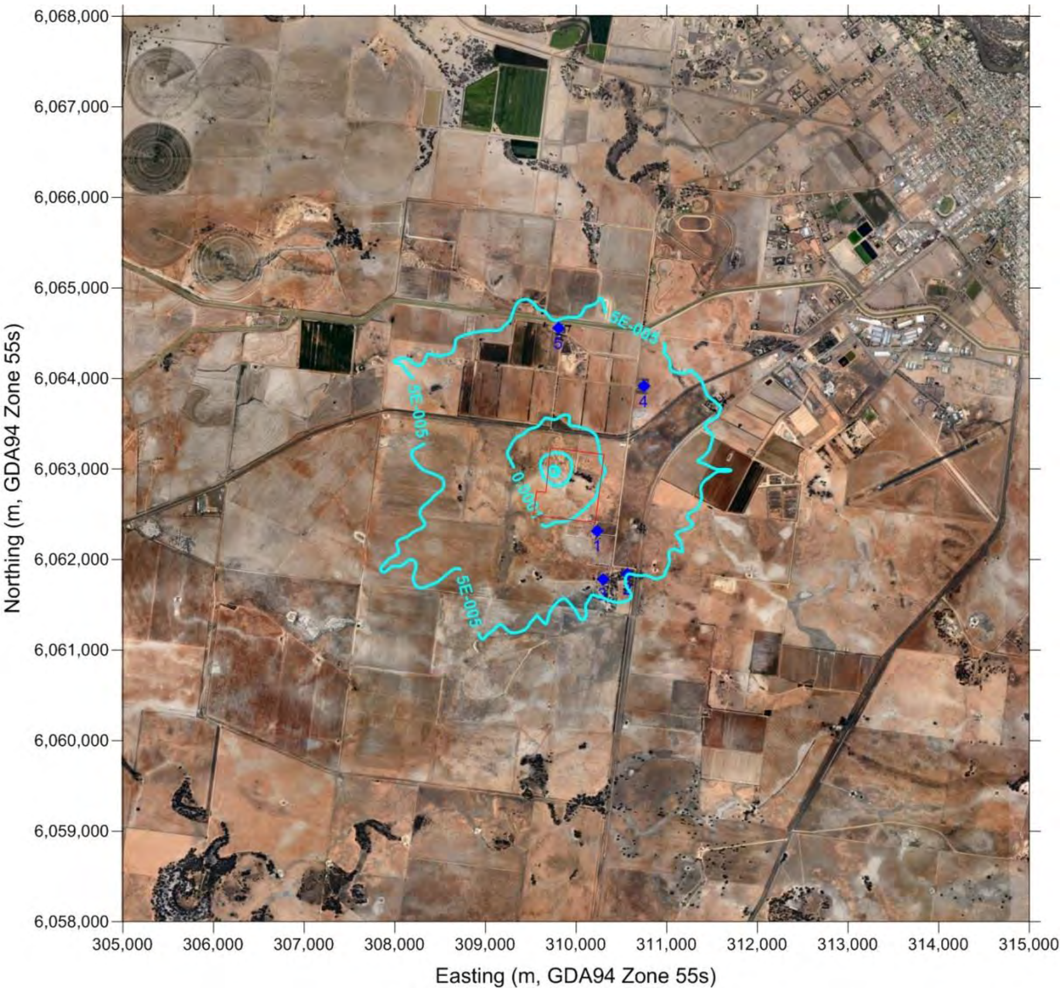
Criterion = 0.02 mg/m³

Figure 26 Predicted 99.9th Percentile Incremental 1-hour Average Ethanol Ground Level Concentrations (mg/m^3)



Criterion = 2.1 mg/m^3

Figure 27 Predicted 99.9th Percentile Incremental 1-hour Average Methanol Ground Level Concentrations (mg/m^3)



Criterion = 3.0 mg/m^3

7.7.6 Odour

The predicted ground level concentrations of odour at the nearest receptors are summarised in **Table 32**. The sources contributing to these odour concentrations are detailed in **Section 7.5**.

Table 32 Predicted Peak 1-Second Average (99th percentile) Odour Concentrations

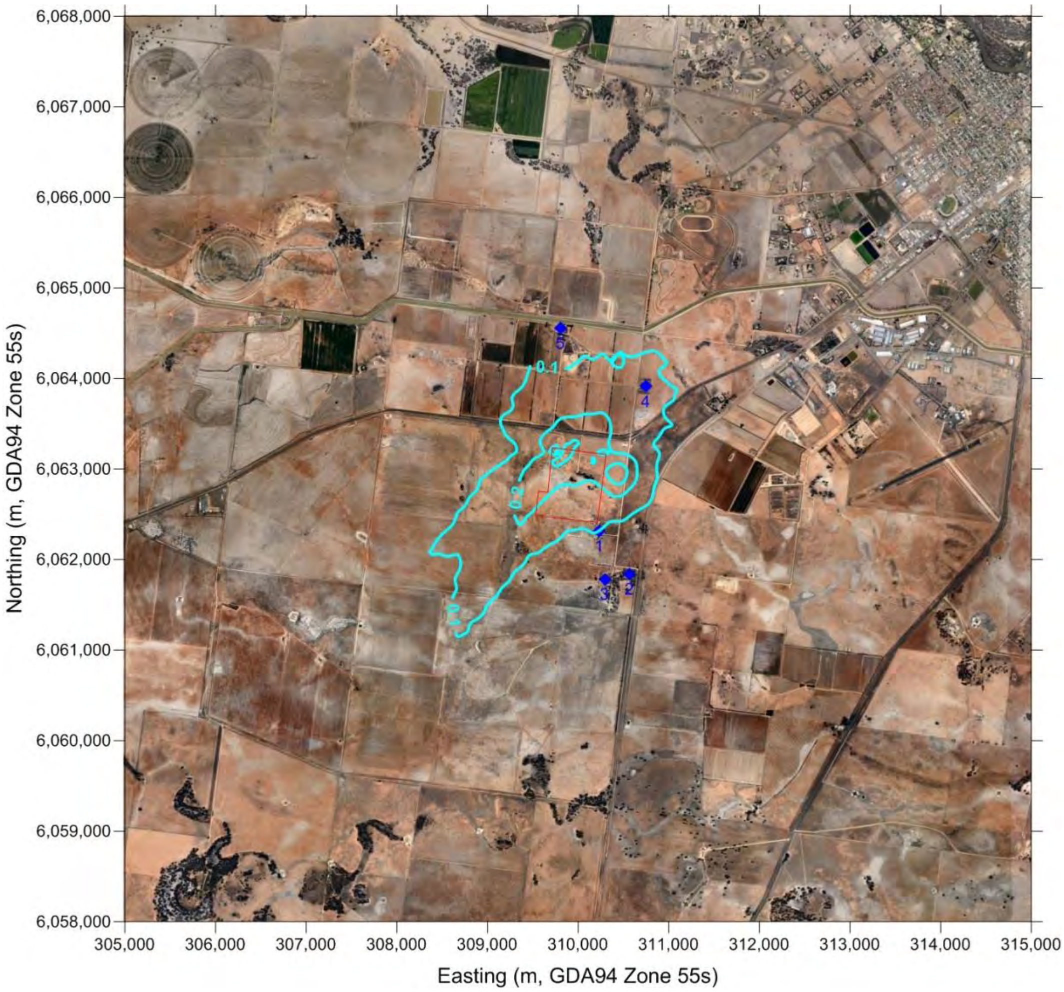
Receptor ID	Odour Concentration (99th percentile, nose response time) (OU)
R1	0.10
R2	0.06
R3	0.06
R4	0.12
R5	0.07
Criterion (OU)	**6.0**

Table 32 shows the predicted 99th percentile peak 1-second average odour concentrations for the proposed facility only. All the receptors are predicted to be impacted by odour concentrations less than 1 OU. 1 OU is considered the theoretical minimum concentration that produces an olfactory

response or sensation in 50% of the population under laboratory conditions. The character of an odour usually cannot be determined at this concentration. This is also below the detection limit for odours and it is unlikely any odours will be perceived at locations with predicted odour concentrations below 1 OU.

Predicted peak 1-second average ground level odour concentrations (99th percentile) are presented as a contour plot in **Figure 28** across the modelling domain.

Figure 28 Predicted 99.9th Percentile Incremental 1-second Average Odour Ground Level Concentrations (OU)



Criterion = 6.0 OU

8 CONCLUSION

SLR Consulting Australia Pty Ltd (SLR) was commissioned by NGH Environmental Pty Ltd (NGH Environmental) on behalf of Dongmun I.R.S Ltd (Dongmun) to perform an Air Quality Impact Assessment (AQIA) (including odour) on the construction and operation of the proposed Ethanol Plant located on Barham Road, Deniliquin (the Project Site).

This study will inform the overall Environmental Impact Statement (EIS) required to be submitted to the NSW Department of Planning and Environment (DP&E). The specific requirements of this study are clearly outlined within the Director General's Requirements (DGR's) as issued for State Significant Development 13_5917.

The objective of this AQIA was to defined the sources of emissions from the proposed construction and operation of the Deniliquin Ethanol Plant (the Project) and assess the impacts against applicable air quality criteria to determine the requirement for further mitigation and control, and to identify any residual impacts.

In lieu of Australian guidance on risk assessment from construction sites, the potential impacts on local air quality from construction activities were assessed qualitatively, using a methodology adapted from the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management.

In order to quantitatively assess the potential impacts on local air quality of the Project, emissions estimation and dispersion modelling were performed for the operational phase. The assessment methodology included meteorological and dispersion modelling using established and recognised modelling techniques. The emission rates and source parameters defined for the modelling scenarios were based on site specific information and recognised emission estimation factors.

The qualitative assessment of construction impacts considered the sensitivity of the receiving environment and the magnitude of the likely dust emissions from the construction of the Project. Overall, the risk of air quality impacts from earthworks, construction of infrastructure, and trackout of dust were determined to be *low* or *negligible* across the Project Site. In addition to the low risk of air quality impacts from construction activities, mitigation and management measures will be applied to further reduce the impact, and therefore it is considered that there will be no significant impact from generated dust emissions at the Project site.

The quantitative assessment addressed the impacts to air quality of emissions from the operation of the Project, including nitrogen dioxide, carbon monoxide, PM_{10}, $PM_{2.5}$, speciated VOCs and odour. The predicted ground level concentrations of the pollutants assessed met their respective guidelines for the appropriate averaging periods. The predicted maximum 24-hour average PM_{10} ground level concentrations did not comply with the respective guideline when background air quality concentrations from Albury were included. However, further analysis of the contemporaneous impact and background concentrations showed that no additional exceedances of the 24-hour average impact assessment criterion are likely. Provided the ethanol plant is well managed it is reasonable to conclude that minimal adverse impacts would be anticipated.

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Abbreviations and Acronyms

%	percent
°C	degrees Celsius
µg	microgram (g x 10^{-6})
µg/m^3	microgram per cubic metre
µg/Nm^3	microgram per normalised cubic metre (273K, 101.3kPa)
µm	micrometre or micron (metre x 10^{-6})
AHD	Australian Height Datum
AQMS	air quality monitoring station
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
CASANZ	Clean Air Society of Australia and New Zealand
CO	carbon monoxide
CSIRO	Australian Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Conservation (now EPA)
DECC	Department of Environment and Climate Change (now EPA)
DECCW	Department of Environment, Climate Change and Water (now EPA)
DP&E	Department of Planning and Environment
DGRs	Director-General's Requirements
EETM	Emission Estimation Technique Manual
EPA	NSW Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
g	gram
km	kilometre
km E	kilometres east
km N	kilometres north
LGA	Local Government Area
m/s	metre per second
m^3	cubic metre
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
NO	nitrous oxide
OEH	NSW Office of Environment and Heritage
OU	odour unit
PAH	polycyclic aromatic hydrocarbon
PCDD/DF	polychlorinated dibenzo-*p*-dioxins and furans
PM_{10}	particular matter with an equivalent aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particular matter with an equivalent aerodynamic diameter of 2.5 microns or less
SO_2	sulphur dioxide
T	tonnes
TAPM	The Air Pollution Model
TSP	total suspended particulate matter
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VIC EPA	Victoria Environment Protection Authority
VKT	vehicle kilometres travelled
VOC	volatile organic compounds
WHO	World Health Organization

Commonly Used Terminology

air dispersion model	A computer-based software program that provides a mathematical prediction of how pollutants from a source will be distributed in the surrounding area under specific conditions of wind, temperature, humidity and other environmental factors.
airshed	The geographical area associated with a given air supply
ambient	Pertaining to the surrounding environment or prevailing conditions
anemometer	An instrument for measuring wind force and velocity
AUSPLUME	A steady state Gaussian dispersion model
atmosphere	A gaseous mass surrounding the planet Earth that is retained by Earth's gravity. It is divided into five layers. Most of the weather and clouds are found in the first layer
atmospheric stability	The tendency of the atmosphere to resist or enhance vertical motion
atmospheric pressure	The force per unit area exerted against a surface by the weight of air above that surface in the Earth's atmosphere
background air quality	The existing air quality in the project area excluding the impacts from the proposed development
baseline monitoring program	A monitoring program designed to measure the ambient concentration levels which currently exist prior to the proposed development
CALMET	A meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain.
CALPOST	A post-processor used to process CALPUFF files, producing tabulations that summarise results for user-selected averaging periods.
CALPUFF	A transport and dispersion model that advects “puffs” of material emitted from modelled sources, simulating dispersion and transformation processes.
calms	Refers to calm wind speeds of less than 0.5 m/s.
climatological	The science that deals with climate and climatic phenomena
combustion	The process of burning. A chemical change, especially oxidation, accompanied by the production of heat and light
crushers	A machine designed to reduce large rocks into smaller rocks, gravel, or rock dust
dust deposition	Settling of particulate matter out of the air through gravitational effects (dry deposition) and scavenging by rain and snow (wet deposition)
dispersion	The spreading and dilution of substances emitted in a medium (e.g. air or water) through turbulence and mixing effects
diurnal	Relating to or occurring in a 24-hour period; daily
downwind	The direction from which the wind is blowing
emission factor	A measure of the average amount of a specific pollutant or material emitted by a specific process, fuel, equipment, or source based on activity data such as the quantity of fuel burnt, hours of operation or quantity of raw material consumed.
emissions inventory	A database that lists, by source, the amount of air pollutants discharged into the atmosphere from a facility over a set period of time (e.g. per annum, per hour)
fugitive emissions	Pollutants which escape from an industrial process due to leakage, materials handling, transfer, or storage
greenhouse gas	A gas that contributes to the greenhouse effect by absorbing infrared radiation, e.g., carbon dioxide.
guideline	A general rule, principle, or piece of advice. A statement or other indication of policy or procedure by which to determine a course of action.

meteorological	The science that deals with the phenomena of the atmosphere, especially weather and weather conditions
mitigate	To moderate (a, quality or condition) in force or intensity; alleviate
mixing height	The height to which the lower atmosphere will undergo mechanical or turbulent mixing, producing a nearly homogeneous air mass.
modelling domain	The area over which the model is making predictions.
odour units	Concentration of odorous mixtures. The number of odour units is the concentration of a sample divided by the odour threshold or the number of dilutions required for the sample to reach the threshold. This threshold is equivalent to when 50% of a testing panel correctly detect an odour
particulate	Of, relating to, or formed of minute separate particles. A minute separate particle, as of a granular substance or powder
plume	A space in air, water, or soil containing pollutants released from a point source
point source	A pollution source that is fixed and/or uniquely identifiable, such as a stack, chimney, outlet pipe or vent
pollutant	A substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource
prognostic	A prediction of the value of variables for some time in the future on the basis of the values at the current or previous times.
qualitative assessment	An assessment of impacts based on a subjective, non-statistical oriented analysis
quantitative assessment	An assessment of impacts based on estimates of emission rates and air dispersion modelling techniques to provide estimate values of ground level pollutant concentrations.
receptor	Coordinate locations specified in an air dispersion model where ground level pollutant concentrations are calculated by the model
sensitive receptor	Locations such as residential dwellings, hospitals, churches, schools, recreation areas etc where people (particularly the young and elderly) may often be present, or locations with sensitive vegetation and crops.
spatial variation	Pertaining to variations across an area.
standard	The prescribed level of a pollutant in the outside air that should not be exceeded during a specific time period to protect public health
synoptic meteorology	A branch of meteorology analysing data collected simultaneously over a wide region, for the purpose of weather forecasting.
topography	Detailed mapping or charting of the features of a relatively small area, district, or locality
volatile organic compounds	All organic compounds (substances made up of predominantly carbon and hydrogen) with boiling temperatures in the range of 50-260°C, excluding pesticides. This means that they are likely to be present as a vapour or gas in normal ambient temperatures.
wind direction	The direction from which the wind is blowing
wind erosion	Detachment and transportation of loose topsoil or sand due to action by the wind
wind rose	A meteorological diagram depicting the distribution of wind direction and speed at a location over a period of time

Risk Assessment Methodology

Overview

The methodology adopted for this risk-based assessment has been adapted from UK guidance presented in the Institute of Air Quality Management (IAQM) document, *Guidance on the assessment of dust from demolition and construction* (February 2014).

The IAQM method uses a four step process for assessing dust impacts and impacts to human health from PM_{10} concentrations from construction activities:

Step 1: Screening based on distance to nearest receptor.

Step 2: Assess risk of effects from activities based on:

- the scale and nature of the works, which determines the potential emission magnitude; and
- the sensitivity of the area.

Step 3: Determine site-specific mitigation for remaining activities with greater than negligible effects.

Step 4: Assess significance of remaining activities after mitigation has been considered.

The assessor should apply a pragmatic approach to the assessment. There may be occasions where the examples provided are subject to exclusions.

Methodology

Step 1

The Step 1 screening criteria provided by the IAQM guidance suggests screening out the requirement for any assessment of impacts from construction activities where sensitive receptors are located more than:

- 350 m from the boundary of the site.
- 50 m from the route used by construction vehicles on public roads more than 500 m from the site entrance.

This step is noted as having deliberately been chosen to be conservative, and will require assessment for applicability in all cases.

Step 2a

Step 2a of the assessment procedure provides “emission magnitudes” for four activities; demolition, earthworks, construction, and trackout. “Magnitude” describes the anticipated scale of proposed works and consequently, the potential scale of the predicted environmental change and the likelihood of the impact resulting in a change to existing (baseline) conditions. The magnitudes are: Large; Medium; or Small. Suggested definitions for each category provided in **Table A** for each activity.

Table A Scale of Activity Considerations

Scale of Activity	Demolition	Earthworks	Construction	Trackout[1, 2]
Large	Total building volume of >50,000 m^3	Total site area > 10,000 m^2	Total building volume > 100,000 m^3	Unpaved road length > 100 m
	Demolition activities > 20 m above ground	>10 heavy earth moving vehicles active at any one time		> 50 HRV outward movements (maximum one-way movements in one day)
	On-site crushing and screening	Total material moved >100,000 tonnes	On-site concrete batching or sandblasting.	
	Potentially dusty construction materials.	Potentially dusty soil type (e.g. clay)		Potentially dusty surface material (e.g. high clay content)
		Earthworks carried out during seasons typically associated with high wind speed components.		
Medium	Total building volume between 20,000 m^3 and 50,000 m^3	Total site area 2,500 m^2 - 10,000 m^2	Total building volume 25,000 m^3 – 100,000 m^3	Unpaved road length 50 m -100 m
	Demolition activities 10 - 20 m above ground	5 – 10 heavy earth moving vehicles active at any one time	On-site concrete batching	10 – 50 HRV outward movements (maximum one-way movements in one day)
	Potentially dusty construction materials.	Total material moved 20,000 T – 100,000 T	Potentially dusty construction materials used.	Moderately dusty surface material (e.g. medium clay content)
Small	Total building volume < 20,000 m^3	Total site area < 2,500 m^2	Total building volume < 25,000 m^3	Unpaved road length < 50 m
	Demolition activities < 10 m above ground	< 5 heavy earth moving vehicles active at any one time		< 10 HRV outward movements (maximum one-way movements in one day)
	Demolition performed during wetter months	Total material moved < 20,000 T		
	Construction material with low potential for dust release (e.g. primarily metal cladding or timber).	Soil type with large grain size (e.g. sand)	Construction material with low potential for dust release (e.g. metal cladding or timber).	Surface material with low potential for dust release (e.g. sand)
		Earthworks carried out during wetter months.		

Source: IAQM 2014

Notes:

1. For vehicles that leave the site after moving over unpaved ground, where they will accumulate mud and dirt that can be tracked out onto public roads / highway. HRV = Heavy Rigid Vehicle greater than 3.5 T truck.
2. Scale of trackout activities should be considered as negligible if receptor is located > 50 m from the road.

Step 2b

Step 2b of the assessment allows the sensitivity of the area to be defined and addresses different potential effects on the population and property, and human health. The sensitivity of the area takes into account:

- The specific sensitivities of receptors in the area.
- The proximity and number of those receptors.
- Site specific factors, such as whether there are natural shelters, such as trees, to reduce the risk of wind-blown dust.
- In the case of impacts to human health, the local background concentration of PM_{10} is considered.

Receptors may be classified as having high, medium or low sensitivity to dust deposition or PM_{10} concentrations. Exposure to dust deposition may lead to nuisance impacts and exposure to PM_{10} has the potential to have impacts on human health.

Table B and **Table C** show how the sensitivity of an area may be may be determined considering the number of receptors and the distance of those receptors from the construction site for nuisance dust and human health impacts. When using these tables it should be noted that distances are to the source and so a different area may be affected by trackout than by on-site works.

Site specific circumstances should be taken into account in all cases so that the sensitivity that most adequately reflects the nature of the receptors is applied. Additional factors to consider when determining the sensitivity of the area include:

- Any history of dust generating activities in the area.
- The likelihood of concurrent dust generating activities on nearby sites.
- Any pre-existing screening between the source and the receptors.
- Any conclusions drawn from analysing local meteorological data, and, if relevant, the season during which the works will take place.
- Any conclusions drawn from local topography.
- Duration of the potential impact, as a receptor may become more sensitive over time.

Table B Sensitivity of the Area to Dust Deposition Impacts

Receptor Sensitivity		**No. of Receptors**	**Distance from Source (m)**			
			<20	**<50**	**<100**	**<350**
High	Receptors with high sensitivity to air pollution include: hospitals, retirement homes, painting and furnishing, hi-tech industries, food processing, schools, high density residential areas, food retailers, glasshouses and nurseries, horticultural land and offices, museums, car showrooms. Users would reasonably be expected to be present continuously (or at least regularly) for extended periods at the property. Users can reasonably expect a high level of amenity. The appearance, aesthetics or value of a receptor would be diminished by soiling. There is substantial risk that the impacts will generate nuisance complaints, resulting in regulatory action.	>100	High	High	Medium	Low
		10–100	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
Medium	Receptors with medium sensitivity to air pollution include: farms, outdoor storage, light and heavy industry, parks, places of work. Users wouldn't reasonably be expected to be present at the property continuously or regularly for extended periods as part of the normal pattern of use of the land. Users would expect to enjoy a reasonable level of amenity, but would not expect to enjoy the same level of amenity as in their home. The appearance, aesthetics or value of a receptor could be diminished by dust deposition. There is moderate to slight risk that the impacts will generate nuisance complaints, resulting in regulatory action.	>1	Medium	Low	Low	Low
Low	All other air quality sensitive receptors not identified above There is transient exposure where the receptors would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. The population is accustomed to transient changes in dust deposition due to natural occurrences and does not have high expectations regarding dust deposition in the area. Property would not reasonably be expected to be diminished in appearance, aesthetics or value by dust deposition. Negligible risk that the impacts will generate nuisance complaints resulting in regulatory action.	>1	Low	Low	Low	Low

Source: IAQM 2014

Notes:

1. Estimate the total number of receptors within the stated distance. Only the highest level of area sensitivity from the table needs to be considered. For example, if there are 7 high sensitivity receptors <20 m of the source and 95 high sensitivity receptors between 20 and 50 m, then the total number of receptors <50 m is 102. The sensitivity in this case would be high.
2. See **Table A** for 'Trackout' activities.

Table C Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity		Annual Mean 24-hour PM_{10} Concentration	No. of Receptors	Distance from Source (m)				
				<20	<50	<100	<200	<350
High	Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (i.e. where individuals may be exposed for eight hours or more) Indicative examples include residential properties, hospitals, schools and retirement homes.	>90% of criterion (>27 µg/m^3)	>100	High	High	High	Medium	Low
			10-100	High	High	Medium	Low	Low
			1-10	High	Medium	Low	Low	Low
		75 – 90% of criterion (22.5 µg/m^3 to 27 µg/m^3)	>100	High	High	Low	Low	Low
			10-100	High	Medium	Low	Low	Low
			1-10	High	Medium	Low	Low	Low
		50 – 75% of criterion (15 µg/m^3 to 22.5 µg/m^3)	>100	High	Medium	Low	Low	Low
			10-100	High	Medium	Low	Low	Low
			1-10	Medium	Low	Low	Low	Low
		<50% of criterion (<15 µg/m^3)	>100	Medium	Low	Low	Low	Low
			10-100	Low	Low	Low	Low	Low
			1-10	Low	Low	Low	Low	Low
Medium	Locations where the exposed population are workers and exposure is over a time period relevant to the air quality objective for PM_{10} (i.e. where individuals may be exposed for eight hours or more) Indicative examples include offices and shops but don't include workers.	-	>10	High	Medium	Low	Low	Low
		-	1-10	Medium	Low	Low	Low	Low
Low	Locations where human exposure is transient. Indicative examples include public footpaths, playing fields, parks and shopping streets.	-	>1	Low	Low	Low	Low	Low

Source: IAQM 2014

Notes:

1. Estimate the total number of receptors within the stated distance. Only the highest level of area sensitivity from the table needs to be considered. For example, if there are 7 high sensitivity receptors <20 m of the source and 95 high sensitivity receptors between 20 and 50 m, then the total number of receptors <50 m is 102. If the annual mean 24-hour PM_{10} objective is between 75% and 90% of the criterion value, the sensitivity in this case would be high.
2. In the case of high sensitivity receptors with high occupancy (i.e. schools, hospitals) approximate the number of people likely to be present or assume > 100 people. In the case of residential dwellings, just include the number of properties.
3. See **Table A** for 'Trackout' related definitions and receptor distances.

Step 2c

The dust emission magnitude from Step 2a and the receptor sensitivity from Step 2b are then applied to the matrices shown below (Matrix 1 – 4) to determine the risk category with no mitigation applied.

Matrix 1 Risk of Impacts - Demolition

Sensitivity of Area	Scale of Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Matrix 2 Risk of Impacts - Earthworks

Sensitivity of Area	Scale of Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Matrix 3 Risk of Impacts - Construction

Sensitivity of Area	Scale of Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Matrix 4 Risk of Impacts - Trackout

Sensitivity of Area	Scale of Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 3

Once the risk categories are determined for each of the relevant activities, site-specific mitigation measures are identified based on whether the site is a low, medium or high risk site.

Step 4

The residual impact can be determined after mitigation has been considered.

Matrix 5 Example Preliminary Risk Rating

Potential Impact	Preliminary Risk			
	Demolition	Earthworks	Construction	Trackout
Dust Deposition	High	Medium	Low	Low
Human Health	Medium	Medium	Low	Low

Matrix 6 Example Residual Risk Rating

Potential Impact	Residual Risk			
	Demolition	Earthworks	Construction	Trackout
Dust Deposition	Medium	Low	Negligible	Negligible
Human Health	Low	Low	Negligible	Negligible