Manildra Group

Air Quality Assessment

Mod 17, 2019

December 2019

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

Table of contents

1. Introduction 1
   1.1 Introduction 1
   1.2 Background 1
   1.3 Current proposal: Modification 17 3
   1.4 Scope 3
   1.5 Assumptions 4
   1.6 Report structure 4
   1.7 Limitations 5
2. Site location and context 2
   2.1 Site description 2
3. Operation description 6
   3.1 General overview 6
   3.2 Flour mill 6
   3.3 Starch plant 6
   3.4 Glucose plant 7
   3.5 Ethanol and distillation plants 7
   3.6 DDG plant 7
   3.7 Steam production 8
   3.8 Environmental farm 8
   3.9 Packing plant (proposed) 8
   3.10 Other activities 8
   3.11 Proposed modifications 10
4. Criteria for assessment 12
   4.1 Odour 12
   4.2 Other air quality impacts 14
5. Meteorological data 16
6. Background air quality 18
7. Odour assessment 20
   7.1 Emissions inventory 20
   7.2 Dispersion modelling 26
   7.3 Predicted odour impacts 26
8. Air quality assessment 29
   8.1 Emissions inventory 29
   8.2 Dispersion modelling 35
   8.3 Predicted air quality impacts 35
9. Conclusions 49
10. References 50

Table index

Table 1-1 Summary of recent proposed modifications on site (2015-2017) 2

Table 2-1 Location of identified sensitive receptors 3

Table 4-1 Odour criterion for the assessment of odour 13

Table 4-2 Air quality impact assessment criteria - other pollutants 14

Table 6-1 Background Air Quality Data – Albion Park South (2016) 18

Table 6-2 Review of particulate monitoring at Albion Park South and Wollongong, $\mu g/m^3$ 19

Table 7-1 Comparison of odour emissions from previous mods to current mod 22

Table 7-2 Predicted peak (99th percentile, short term averaged) odour impact at nearby receptors 27

Table 8-1 Boiler 2: Measured operating with 100% woodchip and 100% coal 30

Table 8-2 Emission inventory – Particulate matter 31

Table 8-3 Emission inventory – Products of combustion 32

Table 8-4 Maximum predicted incremental ground level PM10, PM2.5 and TSP concentrations 35

Table 8-5 Summary of highest measured and predicted PM_{10} levels, $\mu g/m^3$ (R1) 37

Table 8-6 Summary of highest measured and predicted $PM_{2.5}$ levels, $\mu g/m^3$ (R1) 37

Table 8-7 Summary of highest measured and predicted PM_{10} levels, $\mu g/m^3$ (C1) 38

Table 8-8 Summary of highest measured and predicted $PM_{2.5}$ levels, $\mu g/m^3$ (C1) 38

Table 8-9 Maximum predicted ground level Sulfur Dioxide concentrations 43

Table 8-10 Maximum predicted ground level Nitrogen Dioxide concentrations 43

Table 8-11 Maximum predicted ground level Carbon Monoxide concentrations 44

Table 8-12 Maximum predicted ground level Hydrogen Fluoride concentrations 44

Table 8-13 Maximum predicted ground level Hydrogen Chloride concentrations 45

Table 8-14 Maximum predicted ground level PAH, VOC and metals concentrations 48

Figure index

Figure 1 Proposed modification 17 changes (Source: Manildra) 1

Figure 2 Site location and layout 4

Figure 3 Site context 5

Figure 4 Site layout and major odour sources 11

Figure 5 Extract from NSW Approved Methods 13

Figure 6 CALMET wind rose for the factory 17

Figure 7 Odour impacts, 99th percentile, short term averaged – Modification 17 28

Figure 8 Maximum Predicted Incremental Ground Level PM_{10} Concentrations (24-hour Average) 39

Figure 9 Maximum Predicted Cumulative Ground Level PM_{10} Concentrations (24-hour Average) 40

Figure 10 Maximum Predicted Cumulative Ground Level $PM_{2.5}$ Concentrations (24-hour Average) 41

Figure 11 Maximum Predicted Cumulative Ground Level SO2 Concentrations (1 hour Average) 46

Appendices

Appendix A – Meteorological analysis

Appendix B – Complete odour emission inventory

1. Introduction

1.1 Introduction

GHD was engaged by Shoalhaven Starches Pty Ltd (Manildra) to conduct an air quality impact assessment for a proposed modification to the approved Shoalhaven Starches Expansion Project (SSEP) (Modification 17). The existing Shoalhaven Starches factory is located at Bolong Road in Bomaderry, New South Wales.

This report describes the background and scope of the proposed modifications, the pollutant inventory for odorous and non-odorous emission sources and the predicted air quality impacts at identified sensitive receptors.

1.2 Background

Flour and grains are processed at the factory to produce ethanol, starch, gluten, glucose and distiller's dried grain (DDG). Shoalhaven Starches is the holder of Environment Protection Licence number 883 issued for the plant by the NSW EPA.

The Shoalhaven Starches Bomaderry plant currently produces around 225 million litres (ML) of ethanol per year. On 28 January 2009 the (then) Minister for Planning issued Project Approval MP 06_0228 for the Shoalhaven Starches Expansion Project. The Project Approval for the SSEP enabled Shoalhaven Starches, subject to certain conditions, to increase ethanol production in a staged manner at its Bomaderry Plant from the previous approved level of 126 million litres per year to 300 million litres per year. Following the Minister's determination Shoalhaven Starches have been implementing and commissioning works in accordance with this approval. Work on the change in operations has been completed, coupled to quarterly testing (independent audits) of emissions from licensed discharge points (a condition of the Licence), with the purpose to validate the predicted impacts against the original predictions in 2008 for the ethanol expansion.

The increase in ethanol production associated with the SSEP Project Approval was made in response to the NSW Government's ethanol mandate which increased the mandated ethanol content by volume in petrol in NSW from 2% to 6% in October 2011. The SSEP sought to increase ethanol production capacity at the Shoalhaven Starches site to meet the expected increase in demand for ethanol arising from this site. The increase in ethanol production required upgrades to the Stillage Recovery Plant including six additional Dried Distillers Grains Syrup (DDGS) dryers.

However, the anticipated increase in demand for ethanol has not occurred. In response, Manildra have undertaken a series of modifications to the site with a focus on exploring alternative options. These are summarised in Table 1-1.

Modifications 11, 12, 13 and 16 were assessed by GHD in the following documents:

- *Shoalhaven Starches expansion project – Modification 11 and 12 (Project approval MP_06_0228) Revised odour and air quality assessment* (GHD 2017)
- *Shoalhaven Starches Mod 13 Air Quality Assessment Cumulative odour assessment* (GHD 2017)
- *Shoalhaven Starches Mod 13 Air Quality Assessment Updated Cumulative Air Quality Assessment* (GHD 2017).
- *Shoalhaven Starches Proposed modification application MP 06_0228 Shoalhaven Starches Expansion Project, Proposed new speciality processing facility, new gluten dryer and other*

associated works at 22, 24 and 171 Bolong Rd, Bomaderry, NSW (Mod 16) (GHD, February 2019).

Modification 14 did not require an air quality assessment. Modification 15 was separately assessed by GHD for SupaGas in 2017.

Table 1-1 Summary of recent proposed modifications on site (2015-2017)

Modification	Summary of changes
Modification 11	Reducing the number of approved DDGS Dryers from six to four. A minor modification to the footprint of the four DDG dryers. Relocation of the cooling towers in the DDG Plant. A Mill Feed Silo and structure to feed DDG dryers. Expanded use of the existing coal and woodchip storage area within the SS Environmental farm. The addition of two biofilters to cope with the increased number of DDG Dryers. A forklift maintenance building adjacent to the relocated DDG dryers, along with a container preparation area adjacent to the relocated DDG Dryers.
Modification 12	Modifications to the existing Ethanol Distillery Plant to: • increase the proportion of 'beverage" grade ethanol that is able to be produced on the site. This modification will enable increased flexibility in terms of the range of types of ethanol produced at the site (i.e. between fuel, industrial and beverage grade ethanol) to meet market demands; and • modify the type and location of the Water Balance Recovery Evaporator that has been previously approved under MOD 2 adjacent to the Ethanol Plant.
Modification 13	Modification of boilers 2 and 4, with the conversion of boiler 4 from gas fired to coal fired. Installation of an additional baghouse on boiler 6.
Modification 14	Modifications to the former paper mill site.
Modification 15	Construction of the SupaGas CO_2 plant at the former Dairy Farmers factory site.
Modification 16	• Installation of a third flour mill C within the existing flour mill B building • Undertaking modifications to flour mills A and B • The construction of a new industrial building adjoining the Starch Dryer No. 5 building containing: – The new product dryer – Plant and equipment associated with the processing of specialised speciality products.

Modification	Summary of changes
	• Addition to Starch Dryer No 5 building to house a bag house for this dryer • Conversion of two existing gluten dryers (1 and 2) to starch dryers • Additional sifter for the interim packing plant • Construction of a coal-fired co-generation plant to the south of the existing boiler house complex. The co-generation plant will house a new boiler (No. 8) • Construction of lime silos: The lime injection system will consist of two storage silos and associated equipment for injecting powdered lime into each of the coal fired boilers • Relocation of the existing boiler no. 7 to the northern side of the overall boiler house complex • Construction of an indoor electrical substation on the northern side of Bolong Road • Construction of an additional rail intake pit for the unloading of rail wagons • Extension of the existing electrical substation located within the main factory area.

1.3 Current proposal: Modification 17

Manildra continue to explore alternative markets for products used in the manufacture of ethanol. In line with this, the following modifications are proposed to the site as part of the current modification (Mod 17):

- To modify the location of the baghouse for the No. 5 Starch Dryer. As part of this baghouse relocation, an additional stack will be added to starch dryer 5 (shown in Figure 1)
- Use of sawmilling residue (woodchips) for boiler fuel by blending woodchip with coal in Boilers 2 & 4
- To install a ‘services lift’ to the outside of the existing staircase adjacent to the No. 5 Starches Dryer Building to allow on-going access for personnel and customers to the floors within the building
- To modify the service conduit extending from the Shoalhaven Starches factory site on the southern side of Bolong Road to the proposed Packing Plant on the northern side of Bolong Road by elevating a section of the conduit above ground level.
- Amendment to design specifications for silencers to exhaust fans for Flour Mill B.

This Air Quality Impact Assessment addresses those components of the Modification 17 that have potential air quality impacts, namely the modification to the location of the approved baghouse and the use of sawmill residue for boiler fuel.

1.4 Scope

The proposed changes (Mod 17) require an application to the EPA assessing the associated off-site odour and air quality impacts.

In order to meet EPA NSW requirements, this report provides:

- A revised emissions inventory for odorous and non-odorous sources on site. A comparative analysis of the emissions inventory has been undertaken with the last major air quality assessments for the site (Mod 13 and Mod 16)
- A level 2 air quality assessment of odour and air quality in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016). Dispersion modelling was undertaken in CALPUFF v5
- A comparison of predicted odour and air quality results against the EPA criteria and against the previous modification results.

1.5 Assumptions

The major assumptions used in this assessment are as follows:

- Stack emission testing reports from the past measurements are accurate and representative of normal operations, and do not vary significantly
- The odour dispersion modelling using the NSW EPA and US EPA approved regulatory Gaussian puff dispersion model CALPUFF v5, which was considered appropriate for the location. Limitations with the predicted odour are inherent within the model and in its ability to handle multiple buildings and stacks in a complex setup, with wake effects included. As such, the layout of the plant was simplified in order for the model to handle the setup
- Odour emissions from the major sources of odour were modelled as both variable emission and fixed point, volume and area sources in CALPUFF with appropriate dispersion characteristics
- The site representative meteorological data was obtained from previous assessments of the plant, which have been approved by EPA NSW in the past. The meteorological data is discussed in Section 5
- Small silos in the Packing Plant are conservatively assumed to be filled 24 hours a day
- Odour sources with horizontal releases have conservatively been modelled with vertical velocities of 0.1 m/s
- The VOC concentration in the biofilter exhaust is not high enough to induce density flows of the exhaust plume in ambient air
- The emissions inventory, and therefore the dispersion modelling results, is largely based on estimates and on data measured on site by Stephenson Environmental Management Australia (SEMA). Actual measurements are dependent on site conditions at the time of measurement and these conditions may change. GHD does not accept any responsibility for updating the measurements or estimates made by SEMA.

1.6 Report structure

This report:

- Describes the operations of the plant
- Describes the site-representative meteorological and background air quality data
- Describes the proposed modifications
- Characterises odour sources at the plant, accounting for the required changes to the Mod 16 model setup

- Presents the results of odour dispersion modelling for the proposed (Mod 17) scenario using CALPUFF
- Characterises non-odour sources at the plant
- Presents the results of air quality dispersion modelling for the proposed (Mod 17) scenario using CALPUFF
- Presents a summary of the results and draws conclusions as to the off-site impacts (both odour and non-odour)
- Outlines the limitations of the analyses and conclusions presented.

1.7 Limitations

This report: has been prepared by GHD for Manildra Group and may only be used and relied on by Manildra Group for the purpose agreed between GHD and the Manildra Group as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Manildra Group arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has not been involved in the preparation of the planning submission and has had no contribution to, or review of the submission. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the submission.

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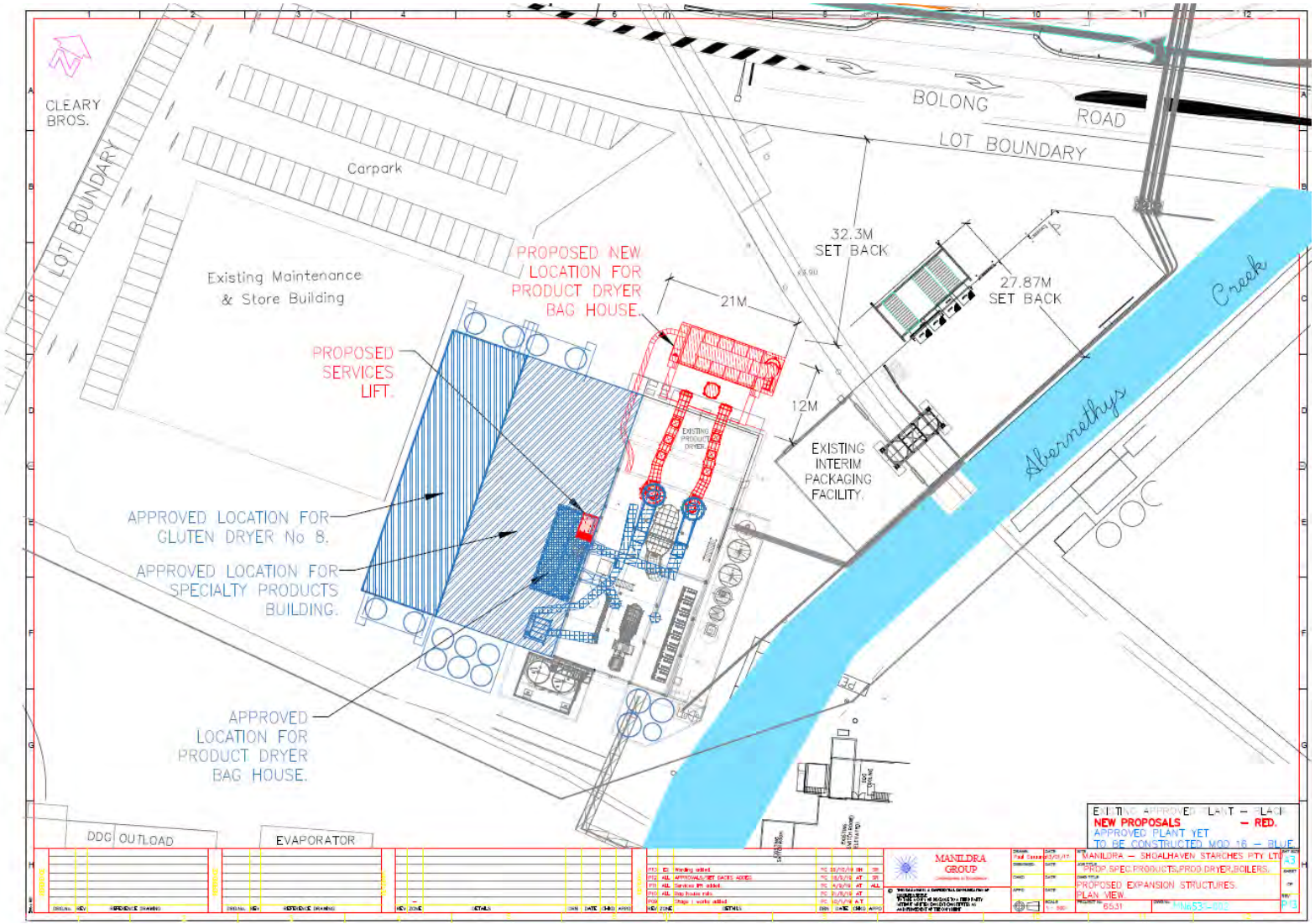

Figure 1 Proposed modification 17 changes to baghouse location (Source: Manildra)

2. Site location and context

2.1 Site description

Figure 2 shows the location and layout of the Shoalhaven Starches plant in Bomaderry, New South Wales. It is located between the Shoalhaven River and township of Bomaderry. The plant comprises a factory, a proposed (but not yet constructed) packing plant and environmental farm. The packing plant lies immediately to the north of the factory, while the environmental farm is situated approximately 400 m to the east.

2.1.1 Nearby sensitive receptors

The Approved Methods define a sensitive receptor as “a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area”.

The site is proximate to a number of sensitive receptors. The township of Bomaderry lies to the northwest of the factory and west of the packing plant. Nowra is situated south of the plant. Commercial and industrial sensitive receptors are located directly adjacent to the site and across from it along Bolong Road.

The nearest residential sensitive receptors are located between 150 to 1300 metres from the site. The nearest commercial/industrial and residential sensitive receptors to the site have been included in the modelling and are listed in Table 2-1, including the approximate distances and orientation of each receptor from the site. The commercial/industrial receptors also include the operating times in brackets.

The sensitive receptors are shown in Figure 3.

Table 2-1 Location of identified sensitive receptors

Receptor	Range, m	To nearest odour source	Direction	MGA56. Easting (m)	MGA56. Northing (m)
R1	150	Packing Plant	W	281,430	6,140,610
R2	1300	Factory	SW	280,400	6,139,650
R3	700	Factory	S	281,510	6,139,310
R4	1300	Factory	SE	283,000	6,139,450
C1 (7am to 5pm, weekdays)	45	Factory	N	281,977	6,140,501
C2 (8am to 5pm, weekdays)	20	Factory	N	281,685	6,140,373
C3 (8am to 5pm, weekdays)	30	Factory	N	281,663	6,140,373
C4 (7am to 4pm, weekdays)	75	Factory	NW	281,615	6,140,371
C5 (24 hours)	125	Factory	NW	281,563	6,140,372
C6 (7am to 5pm, weekdays 7am to 12pm, Saturday)	30	Factory	NW	281,655	6,140,320
C7 (8am to 5pm, weekdays, 8am to 12pm, Saturday)	55	Factory	NW	281,597	6,140,289

Paper Size A4

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Identified sensitive receptors
- Shoalhaven Starches Factory
- Packing plant (proposed)

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Shoalhaven Starches

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Revision	A
Date	12 Dec 2018

Site location and layout

Figure 2

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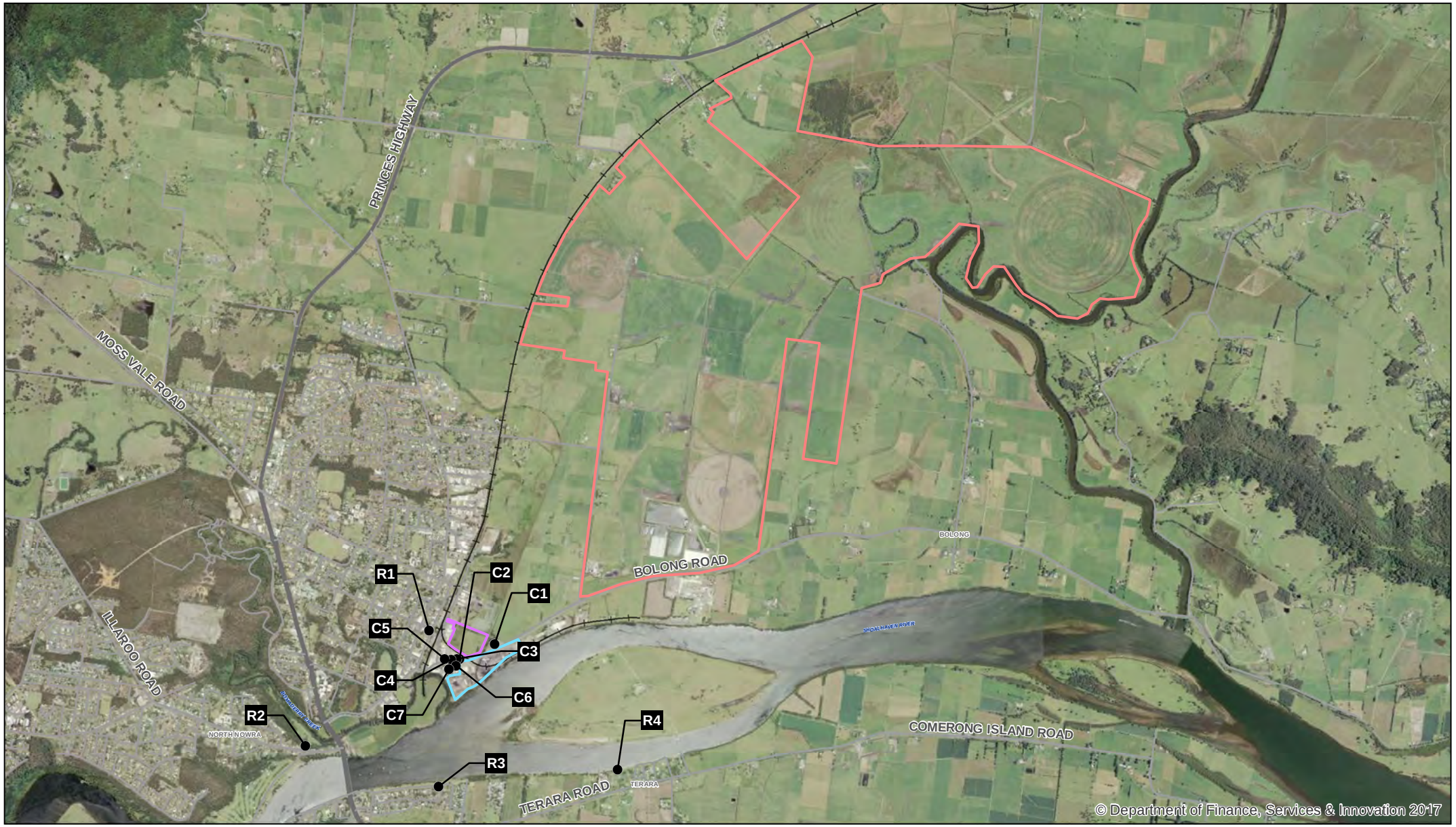

Paper Size A4

0 140280 560 840 1,120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Identified sensitive receptors
- Shoalhaven Starches Factory
- Packing plant (proposed)
- Environmental farm boundary

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Shoalhaven Starches

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Site context

Figure 3

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3. Operation description

3.1 General overview

Wheat flour and grains (wheat) are processed at the Shoalhaven Starches factory to produce ethanol, starch, gluten and glucose. Solid wastes are treated to produce distiller's dried grain (DDG), with liquid wastes being transferred to the environmental farm waste water treatment plant. Excess treated waste water is irrigated onto pasture. The main processing and materials treatment areas at Shoalhaven Starches comprise the:

- Flour mill
- Starch plant
- Glucose plant
- Ethanol and distillation plants
- DDG plant
- Packing plant
- Pellet Plant
- Environmental farm.

A brief description of the production process associated (including emission control) with each plant is given below. Figure 4 shows the layout of the plant in terms of its operational areas, along with the major odour sources of the plant, accounting for around 80% of total odour emissions (excluding the environmental farm).

3.2 Flour mill

Shoalhaven Starches commenced full operations at the flour mill in June 2011. The flour mill was originally approved by NSW Department of Planning and Environment in 2007 and was consolidated into the ethanol expansion project approval in 2008.

Proposed modifications to the flour mill were approved in March 2016, which enabled an increase in the total flour production capacity on the site from the previously approved limit of 265,000 tonnes per annum to 400,000 tonnes per annum.

The flour is used in the plant to produce starch, gluten, glucose and ethanol. All remaining mill feed and pollard (flour sieving rejects) is processed through the DDG dryers for sale as stock feed. Flours from the various grinding operations are collected and blended together before passing through final treatment and weighing operations to bulk storage bins. Flour is taken from these bins for use in existing site production processes.

All air extracted from the mill is passed through Buhler Airjet bag houses prior to being discharged to the atmosphere vertically via four individual stacks. Approval has previously been obtained for the installation of additional plant to increase production, along with two additional exhausts from the roof of the building.

3.3 Starch plant

Within the starch plant, flour is processed to separate the starch from gluten (the protein component of flour). The starch is graded, dried and packed for shipment. Different grades of starch are manufactured for food and paper making applications. Starch that is not used for these applications is used as a raw material for the ethanol plant. Gluten is dried and sold for use in the food industry.

Aqueous (water-based) wastes are reused within the plant or are transferred to the environmental farm waste water treatment plant.

Starch Dryer No.5 has been constructed and is currently operational (see Figure 4). No change to the production volume is predicted.

3.4 Glucose plant

The glucose plant (contained within the starch plant area) houses two lines; the 'confectioners' glucose line and the 'brewers' glucose line. Confectioner's glucose is distinguished by having been demineralised to remove latent odours and flavours that might be carried through to the final product by the glucose.

Both processes use starch as the raw material. The starch is broken down to its constituent glucose molecules using enzymatic and hydrolytic processes. Water is removed from the resulting solutions using evaporation to produce glucose and brewer's solutions of desired concentration. The glucose product is shipped to customers in bulk containers.

The glucose manufacturing process generates aqueous wastes, mostly condensate from the evaporators, which is reused during regeneration of the ion exchangers.

3.5 Ethanol and distillation plants

Waste starch from the starch plant is transferred to the ethanol plant and fermented to produce ethanol. Starch (described in section 3.3), which is in suspension, is heated in jet cookers before being fermented.

Fermentation is carried out in fermentation vessels using the treated substrate to which an ethanol-producing yeast inoculum has been added. The yeast inoculum is generated using yeast propagator vessels, these being seeded using commercial strains of yeast.

Wastes from the fermenters are transferred to the DDG plant (refer to section 3.2) for processing. Fermentation liquor from the ethanol plant is transferred to the distillation plant where water and other impurities are removed to produce various grades of ethanol.

3.6 DDG plant

Wastes from the ethanol and distillation plant are dewatered in decanter centrifuges and dried in steam dryers to produce granular DDG. Light phase from the DDG decanters is evaporated to recover soluble protein (syrup) and produce clear condensate (liquid line). The syrup is added to the dryer feed for recovery of the solids (solids line). DDG granular product is transferred to the DDG Pellet Plant for pelletising; the DDG pellets are stored in silos. Some of the granular DDG product is stored in a storage shed until it is loaded into trucks in the DDG load-out area.

Exhaust gases from the existing DDG dryers (three) are transferred to the boiler air intake in order to destroy odorous components of the gases by combustion.

3.7 Steam production

Steam is generated at Shoalhaven Starches by using a combination of three gas fired boilers (numbers 1, 3 and 7) and four coal fired boilers (numbers 2, 4, 5 and 6). The combustion gases from these boilers are discharged via stacks, with boilers 5 and 6 having a combined stack. Exhaust from boilers 2 and 4 is treated in a cyclone and baghouse prior to discharge to atmosphere. Exhaust from boilers 5 and 6 is treated in a baghouse prior to discharge to atmosphere.

The number of boilers operational at any given time depends on the operational and maintenance requirements of the plant. With boiler 8 installed and coal-fired boilers operating at full capacity, only one gas-fired boiler will be operational with the other two gas-fired boilers on standby. When coal-fired boilers are not at full capacity or offline for maintenance, steam requirements are met from the natural gas boilers.

3.8 Environmental farm

A number of wastewater streams are produced at the factory. These consist of five clear condensate streams (distillation plant condensate, evaporator condensate, DDG condensate, a small flow from the carbon dioxide plant and boiler blowdown) and a combined ‘dirty’ stream from the factory processes. The ‘dirty’ wastewater streams are combined in the farm tank (located at the factory) and pumped to the waste water treatment plant. Treated water is pumped back to the factory for re-use, while excess treated water is stored in dams for irrigation on the farm.

3.9 Packing plant (proposed)

It is proposed that dried gluten/starch will be pneumatically transferred from the existing site to the proposed new packing plant via underground pipes. This dried material is proposed to be stored in silos.

At present, the approved packing plant has not been constructed at the Shoalhaven Starches sites. The proposed packing plant was assessed by SEMA in 2015.

The packing plant will consist of seven silos that will store either gluten or starch product. The medium and large silos are to be filled 24 hours a day, seven days a week, while the small silos can be filled at any time of the day for eight hours.

3.10 Other activities

3.10.1 Product load-out areas

Starch, glucose and ethanol products are loaded into road tankers from bulk storage silos and tanks. Load out of starch and glucose does not have the potential to generate odours, as these products have a low inherent odour characteristic.

Given the flammable nature of ethanol, the load out process is strictly controlled for occupational health and safety purposes. These controls have the secondary effects of minimising the potential for vapour generation and spillage.

3.10.2 Cooling towers

Cooling towers operate as part of the cooling water circuit for the ethanol glucose and DDG plants. The recirculated cooling water has the potential to absorb odours and to disperse the odours to atmosphere during the evaporative cooling (aeration) process within the cooling towers. In addition, contamination of the cooling water by-product, process intermediates or wastes can introduce odorous materials direct to the cooling water, which can greatly increase

its odour generating potential. The aeration process readily strips the more volatile (and potentially odorous) compounds from the water, providing a high-volume potential source of odour that is released direct to atmosphere.

3.10.3 Biofilters

Exhaust air from odorous sources at the DDG plant is captured and ducted to two existing soilbed biofilters, each having a surface area of 110 m^2, located at the southwest corner of the factory (on the southern margin of the container storage area – placed to the left lower margin in Figure 4). The biofilters comprise a bed of organic bark and compost material (the matrix), with distribution of the odorous airstream through the floor of the biofilter via a manifold. Biological oxidation of odorous compounds takes place as the foul air percolates upward through the matrix. The oxidation is achieved by a population of microorganisms in the bed.

While the efficiency of biofilters destroying odorous components of the waste air varies according to a range of factors including soil moisture, composition and temperature, it is very high. Any odour in the exhaust air from the biofilter is due to the inherent odour of the matrix materials and typically has an ‘earthy’ characteristic. The odour level of the matrix is typically in the range of 250 to 500 OU, and it is this ‘background’ level that limits the efficiency of a soilbed biofilter.

The two biofilters at the site operate in parallel and are sized so that one biofilter can be taken offline during periodic replacement of the matrix of the sister filter.

As such, a soilbed biofilter operating as designed, with no malfunctions, will not vary significantly in its odour emissions; it will emit at the matrix background level independent of fluctuations in the input odour loading.

3.11 Proposed modifications

3.11.1 Mod 11, 12 and 13

Modifications 11, 12 and 13 focused on changing the configuration of the DDG plant (to the southwest of the factory), changes to the ethanol distillery and modification to boilers 2 and 4. These modifications have been discussed in Section 1.3. The resulting air quality impacts have been addressed in GHD's previous quality assessments (GHD 2017).

Mod 16 focused on changing the configuration of the flour mill exhausts, conversion of gluten dryers 1 and 2 to starch, change to boiler 7's location, a new gluten dryer (no. 8) and a new coal-fired boiler (boiler 8). The resulting air quality impacts from Mod 16 have been addressed in GHD's previous air quality assessment (GHD, February 2019).

3.11.2 Mod 17

Modification 17 is discussed in Section 1.3. The main changes affecting odour and air quality impacts consist of:

- Modifications to the location of the baghouse for starch dryer 5
- Installation of an additional stack to starch dryer 5
- Use of sawmilling residue (woodchips) for boiler fuel by blending woodchip with coal in Boilers 2 & 4

Further discussion of these changes in the context of the dispersion modelling is presented in Section 7.

Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Odour sources
- Shoalhaven Starches Factory
- Packing plant (proposed)
- Environmental farm boundary
- Boiler house
- DDG Plant
- Ethanol recovery and storage area
- Fermenters
- Flour Mill
- Starch plant

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number 21-27188
Revision A
Date 18 May 2018

Site layout and major odour sources

Figure 4

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4. Criteria for assessment

4.1 Odour

4.1.1 Odour Concentration

Odour 'strength' or concentration is measured in odour units (OU), where 1 OU represents the concentration of a sample that can just be detected by 50% of people in a controlled situation where there is no background ‘ambient ‘ odour.

4.1.2 Measurement of Odour

The most common method of measuring odour concentration is Dynamic Olfactometry using the ‘forced choice’ method. Dynamic olfactometry simply dilutes the odour sample in known ratios with odour free air. At each dilution, the diluted odour and a zero odour is presented in turn to six panellists via two ‘sniffing’ ports. Further, the selection of the port with the diluted odour sample is randomly reassigned at each presentation. Each panellist is required (forced) to nominate the port (left or right) from which the diluted odour emanates. Each panellist’s response (i.e. 'guess', 'likely' or 'certain') is recorded. The sequence of presentations generally follows a decreasing dilution ratio, and when half of the panellists have correctly returned a ‘certain’ response, that dilution ratio is numerically equal to the concentration of the original, undiluted odour sample. Hence, for example, if the dilution needed to get the 50% response was 250:1, then by definition the original sample had an odour concentration of 250 OU.

4.1.3 EPA Criterion for Odour

EPA has defined an odour criterion and the Odour Guideline specifies how it should be applied in dispersion modelling to assess the likelihood of nuisance impact arising from the emission of odour.

Odour impact is a subjective experience and has been found to depend on many factors, the most important of which are:

- The **F**requency of the exposure
- The **I**ntensity of the odour
- The **D**uration of the odour episodes
- The **O**ffensiveness of the odour
- The **L**ocation of the source

These factors are often referred to as the FIDOL factors.

DEC defined the odour criterion to take account of two of these factors (**F** is set at 99 percentile, **I** is set at from 2 to 7 OU). The choice of criterion odour level has also been made to be dependent on the population of the affected area, and to some extent it could be said that population is a surrogate for location – so that the **L** factor has also been considered. The relationship between the criterion odour level **C** to affected population **P** is given below.

$$C = [\log P\text{-}4.5] \div \text{-}0.6 \qquad \text{Equation 1}$$

Table 4-1 lists the values of C for various values of affected populations as obtained using equation 1.

Table 4-1 Odour criterion for the assessment of odour

Population of affected community	Odour performance criteria (nose response odour certainty units at 99th percentile)
Single Residence (≤ ~2)	7
~ 10	6
~ 30	5
~ 125	4
~ 150	3
Urban (~2,000)	2

The NSW Approved Methods specifies a criterion of two odour units at the 99th percentile over a short term averaging nose-response time of one second for a complex mixture of odorous air pollutants in an urban area (population greater than 2000 or with schools and hospitals). The criterion is applied at the location of the nearest sensitive receptor or likely future location of sensitive receptor.

5 OU is commonly taken as a conservative measure of the odour level which can be distinguished against the ambient background level of odour, and which if offensive, could result in complaint.

1 OU generally cannot be detected in a non-laboratory situation (i.e. where the ambient background odour levels reduce the detectability of a given odorant).

As the CALPUFF dispersion model (utilised in this assessment), when operating in micrometeorological mode can only predict concentrations over an averaging period of one hour, a ratio between the one second peak concentration and 60 minute average concentration has been applied to the source odour emission rates. In this manner, the predicted one hour odour levels predicted in CALPUFF represent the corresponding one second short-term levels required to be compared to the DEC criterion. The ratio is known as the peak to mean ratio (PM60). PM60 is a function of source type, stability category and range (i.e. near or far-field), and values are tabulated in the modelling Guideline[1]. This is reproduced below.

Table 6.1: Factors for estimating peak concentrations in flat terrain (Katestone Scientific 1995 and 1998)

Source type	Pasquill–Gifford stability class	Near-field P/M60*	Far-field P/M60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A–F	6	6
Surface wake-free point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A–F	2.3	2.3
Volume	A–F	2.3	2.3

* Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

Figure 5 Extract from NSW Approved Methods

[1] Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC, 2005).

4.2 Other air quality impacts

Potential non-odorous air quality impacts from the site include dust and products of combustion. The following pollutants have been assessed against relevant criteria:

- Total suspended particles (TSP)
- Fine particulate matter less than 10 micron equivalent aerodynamic diameter PM_{10}
- Fine particulate matter less than 2.5 micron equivalent aerodynamic diameter $PM_{2.5}$
- Products of combustion including carbon monoxide, oxides of nitrogen (NOx), sulfur dioxide (SO2), hydrogen chloride (HCL), heavy metals (Type I & II), total volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAHs) and hydrogen fluoride (HF).

The air quality impact assessment criteria for these pollutants has been sourced from the Approved Methods and is summarised in Table 4-2.

Table 4-2 Air quality impact assessment criteria - other pollutants

Pollutant	Averaging period	Criterion
Particulate Matter PM_{10}	24 hours	50 µg/m^3
	Annual	30 µg/m^3
Particulate Matter $PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
TSP	Annual	90 µg/m^3
Carbon monoxide (CO)	15 minutes	100 mg/m^3
	1 hour	30 mg/m^3
	8 hours	10 mg/m^3
Sulfur dioxide (SO_2)	10 minutes	712 µg/m^3
	1 hour	570 µg/m^3
	24 hours	228 µg/m^3
Nitrogen dioxide (NO_2)	1 hour	246 µg/m^3
	Annual	62 µg/m^3
Hydrogen fluoride (HF)	90 days	0.25 µg/m^3
	30 days	0.4 µg/m^3
	7 days	0.8 µg/m^3
	24 hours	1.5 µg/m^3
Hydrogen Chloride (HCL)	1 hour	0.14 mg/m^3
Polycyclic aromatic hydrocarbon (PAH)	1 hour	0.0004 mg/m^3
Type 1 metals		
Antimony	1 hour	0.009 mg/m^3
Arsenic	1 hour	0.00009 mg/m^3
Cadmium	1 hour	0.000018 mg/m^3
Lead	Annual	0.5 µg/m^3
Mercury	1 hour	0.0018 mg/m^3
Type 2 metals		
Beryllium	1 hour	0.000004 mg/m^3

Pollutant	Averaging period	Criterion
Chromium	1 hour	0.00009 mg/m^3
Manganese	1 hour	0.018 mg/ m^3
Nickel	1 hour	0.00018 mg/ m^3

5. Meteorological data

A 12-month dataset was constructed using the 3D prognostic modelling package, TAPM and the diagnostic 3D meteorological model, CALMET for the period from January to December 2004. This 12 month period was chosen to be consistent with previous modelling undertaken for the 2008 Air Quality Assessment, approved at the time by EPA and to allow to a direct comparison to previous modelling. Further detail is provided in Appendix A in regards to the selection and construction of the meteorological dataset used in the modelling.

The CALMET modelling can be summarised as follows:

- Prognostic models TAPM and CALMET were used for initial wind field 'guesses'
- Observations from both the environmental farm Automatic Weather Station (AWS) and Nowra AWS were used to optimise and check the prognostic model simulations
- Wind speeds and direction observations from the environmental farm AWS were assimilated into the prognostic model to make the data site-specific

The result of assimilating this data into the CALMET simulations makes the data site-specific (required for a Level 2 assessment), and inter-annual variability is not required to be accounted for, with the conditions of the Approved Methods met for using "*atleast one-year of site-specific meteorological data*".

An annual wind rose generated using CALMET is provided in Figure 6 to show the wind field at the factory. The following trends are evident from Figure 6:

- Annual average wind speed of 3.2 m/s
- Winds are most prevalent from the west and west northwest, accounting for around one third of all winds
- Winds are least prevalent along the north-south axis
- Light winds (shown in grey) are more prevalent from the northwest
- Drainage flows occurring during stable conditions at night time are dominated by the following distinct features (in order of scale):
  - Shoalhaven River running west to east through the site
  - Browns Mountains to the northwest of the site
  - Yalwal State Forest mountain range to the west.

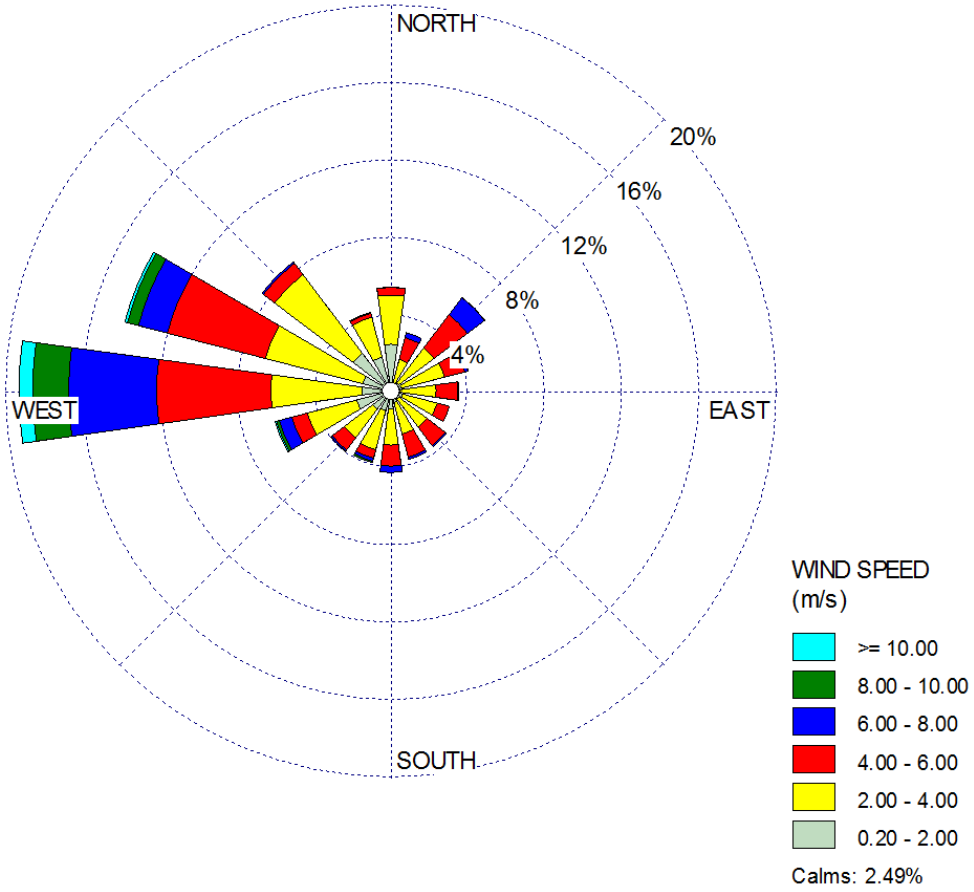


Figure 6 CALMET wind rose for the factory

6. Background air quality

The OEH runs a state wide air quality monitoring network, with the nearest monitoring site to Shoalhaven Starches being Albion Park South. Albion Park South commenced operation in 2006 meaning that daily background particulate levels ($PM_{2.5}$ and PM_{10}) cannot be directly compared to the GHD CALPUFF model of the site which uses meteorology from 2004.

Background levels of pollutants used in the assessment are provided in Table 6-1, with the exception of $PM_{2.5}$ and PM_{10}, which is based on 2004 data from Wollongong. This is because the nearest monitoring station that operated in 2004 with both $PM_{2.5}$ and PM_{10} data is the Wollongong site, approximately 20 km to the north of Albion Park. Wollongong generally experiences elevated particulate levels compared to Albion Park South due to the greater presence of emissions from urban and industrial sources (refer to Table 6-1).

Highest measured levels of particulate for the year 2004 at Wollongong are shown in the contemporaneous assessment in Section 8.

A reasonable representation of ambient $PM_{2.5}$ and PM_{10} (24-hour) concentration levels is the 70th percentile for use in plotting general cumulative impacts. The 70th percentile at Albion Park South in 2016 was 18.3 µg/m^3 for PM_{10} and 8.0 µg/m^3 for $PM_{2.5}$.

Table 6-1 Background Air Quality Data – Albion Park South (2016)

Pollutant	Averaging Period	Concentration (100th percentile)	Units
Nitrogen dioxide (NO_2)	1 hour	80.8	µg/m^3
	Annual	7.1	
Sulfur dioxide (SO_2)	1 hour	57.6	µg/m^3
	24 hour	15.7	
	Annual	1.6	
Carbon monoxide (CO)[1]	1 hour	1.0	mg/m^3
	8 hour	0.6	
PM_{10}	24 hours	43.2	µg/m^3
	Annual	14.9	
$PM_{2.5}$	24 hours	30.7	µg/m^3
	Annual	7.2	

[1] CO was sourced from the Wollongong monitoring station as this was not available at Albion Park South

The contemporaneous particulate assessment was undertaken using data from Wollongong in 2004. A review of particulate levels at Wollongong and Albion Park is provided in Table 6-2. Average particulate levels at Wollongong have reduced from 2004 to 2016. Levels at Albion Park South in 2016 are lower than the levels at Wollongong over the same period.

Table 6-2 Review of particulate monitoring at Albion Park South and Wollongong, µg/m³

Site and Year	Albion Park 2016	Wollongong 2016	Wollongong 2004
Average PM_{10}	14.9	17.3	25.5
70th percentile PM_{10}	18.3	20.7	28.8
90th percentile PM_{10}	25.6	29.7	37.8
Average $PM_{2.5}$	7.2	7.4	9.7
70th percentile $PM_{2.5}$	8.0	8.3	12.2
90th percentile $PM_{2.5}$	11.2	11.6	16.4

Shoalhaven Starches engaged Stephenson Environmental Management Australia to conduct targeted background ambient air quality monitoring at 26 Coomea Street, Bomaderry over four seasons. (AMBIENT AIR QUALITY MONITORING –SUMMARY REPORT 2015-2016, Stephenson Environmental Management Australia, April 2016). The maximum measured levels of pollutants measured over the monitoring periods with a 24 hour averaging period were:

- SO_2 – 10.2 µg/m³
- NO_2 – 54.5 µg/m³
- PM_{10} – 28.1 µg/m³

The results show all pollutants are significantly lower than the levels recorded at Albion Park South, and would include any emissions from the Shoalhaven Starches site. The maximum levels all readily comply with the relevant criteria. Using the background data from Albion Park South in this assessment allows for additional conservatism.

7. Odour assessment

7.1 Emissions inventory

7.1.1 Source identification

Odour emanating from Shoalhaven Starches is comprised of a complex mixture of primarily odorous volatile organic compounds (VOCs). VOC speciation data from a range of principal odour sources indicates that the individual VOCs within the mixture tend to be classified under odour-based air quality criteria rather than toxicity-based[2] criteria. Therefore, the identified sources of odour are modelled collectively as odour.

Consistent with the previous air quality assessments, the following sources contribute to the majority of the odour impacts from the Shoalhaven Starches sites, in order of significance:

- DDG Plant (including Pellet Plant exhaust stack and biofilters)
- Starch Plant (Gluten and Starch Dryers)
- Ethanol Plant (yeast propagators and retention tank).

A number of other minor odour sources contribute to the remainder of the plant's odour impact. These are detailed in Appendix B.

7.1.2 Changes to baseline odour model

The baseline odour model includes all existing and proposed odour sources at the Shoalhaven Starches plant, including EPA monitored sources and all minor sources, up to Mod 16. The odour sources associated with these modifications have been discussed in depth in previous air quality assessments.

The following assumptions and additional changes were made to the baseline odour model:

- Peak odour emission rates were sourced from the odour monitoring conducted by SEMA in the previous four quarters for EPA ID sources. The sources were scaled to a 300 ML per year production. The quarter with the maximum measured total OER was selected for use in the assessment and is consistent with guidance in the Approved Methods and the recommendation from EPA (16 February 2017) that peak emissions should be assessed. The peak period was found to be quarter 2, 2019 (August 2019)
- The exit velocities and temperatures for EPA ID sources were adjusted to the modelled quarter. These measurements include the mitigation modifications made to No. 3 and No. 4 gluten dryer exhausts as part of the Mod 11 and 12 air quality assessment recommendations
- As part of the current proposal, the starch dryer 5 (SD5) emissions will be split to two stacks- 16% of the flow will pass through the existing SD5 stack (now relabelled to SD5C) while 84% of the flow will pass through a new stack (labelled as SD5N). The modelling proportionately splits the odour emissions to account for this flow split. The new stack (SD5N) is located south of the proposed baghouse (refer to Figure 1)
- No. 1 and No. 2 gluten dryers were proposed to be modified to starch dryers as part of Mod 16 assessment. Therefore, the emission rates assigned to these dryers remains unchanged from the Mod 16 assessment as the dryers have not been modified yet
- Mod 16 assessed the addition of a new gluten dryer (NGD). The model ID corresponding to this dryer has been changed to GD8 from NGD to be consistent with the naming

[2] Based on VOC speciation data for selected sources in the DDG plant: DDG dryers, palmer cooler and condensate tanks.

conventions used by Shoalhaven Starches. The emission rates assumed in Mod 16 remain unchanged as the dryer has not been constructed yet.

- Odour emission rates were assumed to be unchanged for the other emission sources.

7.1.3 Source summary and comparison

Modelling for the proposed Mod 17 scenario comprised the following sources:

- 68 point sources (each assumed at constant OER) throughout the site
- Three point sources with variable emissions within the site
- 11 area sources (consisting of two biofilters and the effluent treatment ponds)
- Five volume sources within the factory area.

These sources are detailed in Table 7-1 and Appendix B.

A comparison of the sources between Mod 13, Mod 16 (the last major air quality assessment[3]) and the current modification is also provided in Table 7-1. This shows that the total odour levels increase of approximately 40% between the previous and current modifications.

This increase is primarily due to the highest quarterly results displaying a significantly higher source emissions for the following three sources (compared to Mod 16):

- Boiler no 4: Increase from an MOER of 5,666 to 22,077. This increase is likely due to switch in the fuel source from gas-fired to coal fired.
- Boiler no 5 & 6: Increase from an MOER of 43,711 to 68,610
- Pellet exhaust stack: Increase from an MOER of 31,544 to 88,073. The cause of this increase is unknown.

[3] The changes associated with Mod 13 were not significant- only the MOER associated with Boiler no 4 was revised in Mod 13.

Table 7-1 Comparison of odour emissions from previous mods to current mod

Source	Model Reference	MOER OU.m³/s (Mod 13)	MOER OU.m³/s (Mod 16)	Modelled Mod 17 MOER OU.m³/s
Boilerhouse				
Boiler no 4	BOILR4	3,171	5,666	22,077
Boiler no 5 & 6	BOILR5	38,463	43,711	68,610
Sub total MOER		**41,634**	**49,377**	**90,687**
% of total MOER		**15.0%**	**18.3%**	**24.1%**
DDG Plant				
Condenser drain	VCD	31	31	31
DDG tent storage area	DDG36	1,929	1,929	1,929
Product storage sheds	DDG34	1,023	1,023	1,023
Light phase tank	DDG19	20	20	20
Cooling towers	DDG46	172	172	172
DDG Loadout Shed Awning	DDG35	923	923	923
Pellet exhaust stack	PPES	38,240	31,544	88,073
Pellet silo	S12	350	350	350
Stillage surge tank	SST	149	149	149
Pellet plant fugitives (non-DDG sources)	PPF	5,771	5,771	5,771
Additional Cooling towers	CTP	172	172	172
Sub total MOER		**48,780**	**42,084**	**98,613**
% of total MOER		**17.5%**	**15.6%**	**26.2%**
Ethanol Plant				
Yeast Propagators -tanks 4 and 5	YP45	820	820	820
Grain retention tank	GRT	3,250	3,250	3,250
Ethanol recovery scrubber	ERESC	3,132	10,660	15,405
Fermenters 10-16	FERM	2,668	3,298	795
Jet cooker 1 retention tank	E13	1,067	1,067	1,067
Jet cooker 2/4 grain retention	E7	567	567	567

Source	Model Reference	MOER OU.m³/s (Mod 13)	MOER OU.m³/s (Mod 16)	Modelled Mod 17 MOER OU.m³/s
Feed to distillery	E22	83	83	83
Sub total MOER		**11,587**	**19,745**	**21,987**
% of total MOER		**4.2%**	**7.3%**	**5.8%**
Distillery				
Incondensable gases vent	D6	558	558	558
Molec. sieve vacuum drum	D2	1,350	1,350	1,350
Column Washing Vent	CWV	23	25	27
Sub total MOER		**1,931**	**1,933**	**1,935**
% of total MOER		**0.7%**	**0.7%**	**0.5%**
Starch and Glucose				
Cyclone and FF ID4	A4	679	679	679
Cyclone and FF ID5	A5	96	96	96
Cyclone and FF ID6	A6	449	449	449
Cyclone and FF ID7	A7	932	932	932
Drum vac receiver	C4	1,400	1,400	1,400
Dry gluten roof bin	S07	4,500	4,500	4,500
Enzyme tanks	B7	2,042	2,042	2,042
Flash vessel jet cooker	C1	970	970	970
Flour bin aspirator	S13A	500	500	500
Flourbin aspirator	S13B	500	500	500
Flourbin motor drive	S06	283	283	283
Flour mill aspiration (Mod 8)	FMP1	266	205	205
Flour mill aspiration (Mod 8)	FMP2	205	266	266
High protein dust collector	S08	600	600	600
Ion exchange effluent tank	C18	250	250	250
No 1 gluten dryer baghouse	S02	5,925	5,166	5,166
No 1 starch dryer	S01	5,193	5,193	11,316
No 2 gluten/starch dryer	S04	2,354	5,166	5,166

Source	Model Reference	MOER OU.m³/s (Mod 13)	MOER OU.m³/s (Mod 16)	Modelled Mod 17 MOER OU.m³/s
No 3 gluten dryer baghouse	S03	58,917	29,036	21,696
No 3 starch dryer	S18	1,663	5,166	5,166
No 4 gluten dryer baghouse	S05	31,222	22,433	13,693
No 4 starch dryer	S19	1,824	4,008	5,020
No 5 ring dryer gluten/starch	SDR5	4,817	4,817	4,817
No 5 starch dryer (existing)	SD5 ►SD5C	6,800	6,800	3,393
No 5 starch dryer (new stack)	SD5N			17,387
No 6 gluten dryer	GD6	12,568	12,568	12,568
No 7 gluten dryer	GD7	9,553	9,553	9,553
Spray dryer	S20	738	738	738
Starch factory rejects	E10	183	183	183
Farm tank	F18	3,834	3,834	3,834
Pellet mill silo	PMFS	173	173	173
Flour Mill B Exhaust	FMBA to FMBM	5,637	4,621	4,621
Flour Mill C Exhaust	FMC1 to FMC3	n/a	1,658	1,658
New gluten dryer	NGD ►GD8	n/a	12,568	12,568
Sub total MOER		**165,073**	**147,353**	**152,387**
% of total MOER		**59.3%**	**54.7%**	**40.5%**
Packing Plant (Not constructed)				
Starch silo 1	PPL1	86	86	86
Starch silo 2	PPL2	86	86	86
Gluten silo 1	PPM1	173	173	173
Gluten silo 2	PPM2	173	173	173
Gluten silo 3	PPM3	173	173	173
Small gluten silo	PPS1	92	92	92
Small starch silo	PPS2	35	35	35
Sub total MOER		**818**	**818**	**818**
% of total MOER		**0.3%**	**0.3%**	**0.2%**

Source	Model Reference	MOER OU.m³/s (Mod 13)	MOER OU.m³/s (Mod 16)	Modelled Mod 17 MOER OU.m³/s
Area sources: Env farm after WWTP				
Biofilter A	BIO1	440	1,408	1,386
Biofilter B	BIO2	330	803	1,111
Biofilter C	BIO3	1,089	1,089	1,089
Biofilter D	BIO4	1,280	1,280	1,280
Storage dam 1	PO1	148	71	119
Storage dam 2	PO2	1,656	248	143
Storage dam 3	PO3	192	569	1,231
Storage dam 5	PO5	515	971	1,922
Storage dam 6	PO6	1,775	1,435	793
Sulfur oxidisation basin	SOBAS	830	349	535
Membrane bio-reactor	MBR	62	62	62
Sub total MOER		**8,317**	**8,286**	**9,671**
% of total MOER		**3.0%**	**3.1%**	**2.6%**
Total (Mod 11 and Mod 12)		278,140		
Total (Mod 16)			269,595	
Total (Mod 17)				376,099

7.2 Dispersion modelling

The odour dispersion modelling was conducted using the US EPA regulatory Gaussian puff model CALPUFF Version 5.8. This model is also a recognised regulatory model in NSW. Where the modelling of odour dispersion is in complex terrain (as is the case at the Shoalhaven site), CALPUFF is recommended for use under NSW Guidelines. CALPUFF is especially suited for modelling light to calm wind conditions.

The following settings were used in the simulations:

- Model: CALPUFF Version 5.8
- The receptor grid was 25 km x 25 km, with a 200 m grid resolution
- The nearest receptors from the townships of Bomaderry (to the west) and Nowra (to the south) were used as sensitive receptors, along with a few isolated residences around the factory and environmental farm
- Ground level receptor heights have been modelled using the same terrain data as the original 2008 GHD assessment. This terrain data was used in the CALMET 2004 model which is used for CALPUFF modelling
- Emissions were scaled based on a nose-response time for odour of one second, applying a peak-to-mean ratio to the one hour average concentration of 2.3 for wake affected point sources and volume sources, and variable scaling for non-wake affected sources and area sources
- Meteorology was taken from the CALMET 2004 synthesised dataset, approved for use in previous studies
- Building wake effects were modelled to the extent practicable.

7.3 Predicted odour impacts

Figure 7 shows the predicted 99th percentile odour impacts (one minute nose-response time) for the proposed Mod 17 operations and the previous modifications.

Table 7-2 shows the predicted odour levels for the proposal (Mod 17). Table 7-2 also shows the previous modification results.

The predicted odour levels show an increase at all sensitive receptors. The increase is attributed to the higher quarterly results in the last four quarters, particularly the pellet plant stack (PPES). The increase is not a result of the proposed modifications.

The results show that the impact assessment odour criteria are achieved at all residential sensitive receptors.

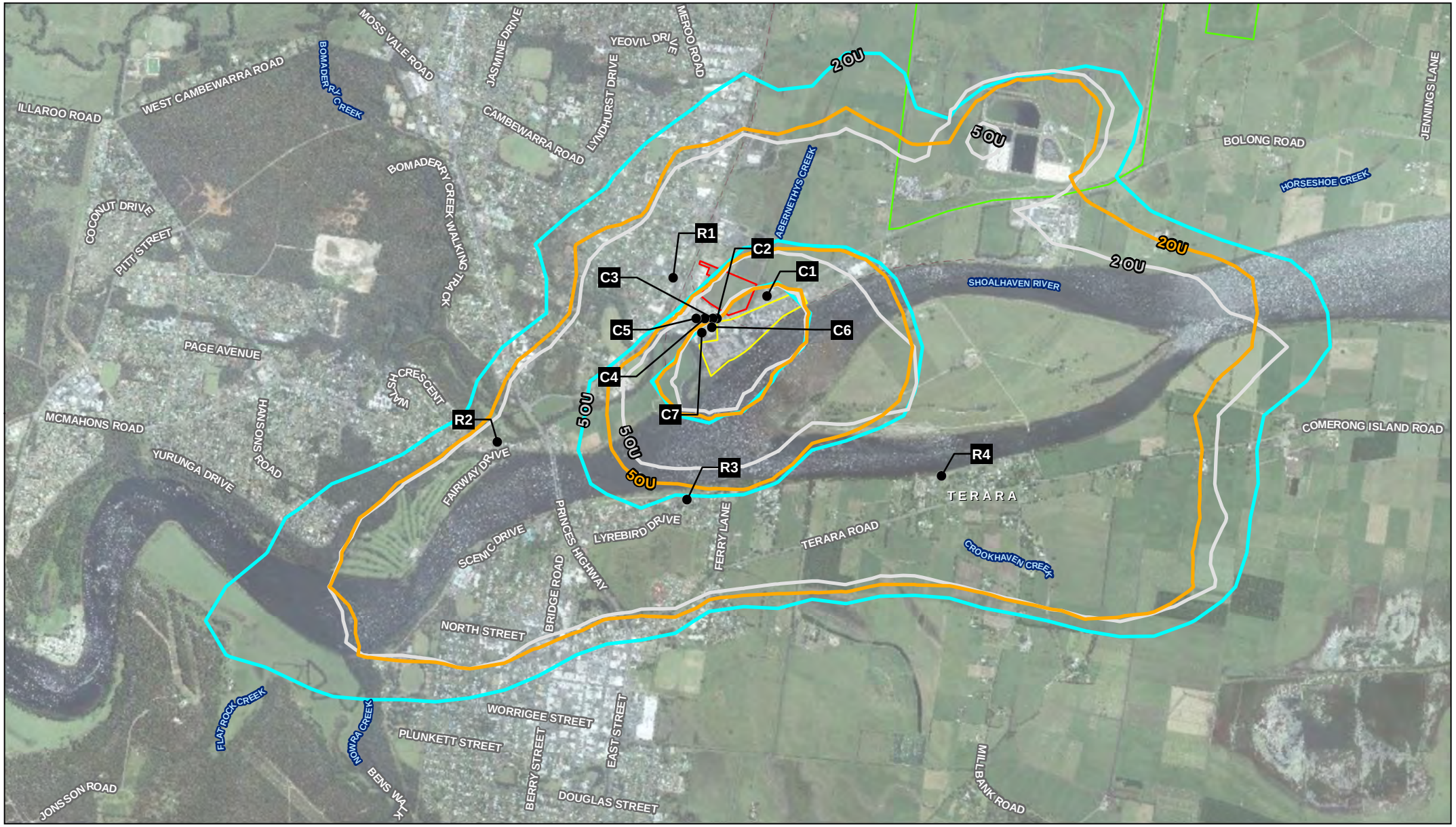
Seven commercial/industrial receptors are included in the assessment. These are all located within approximately 125 m of the site. One hour, 99th percentile odour impacts have been predicted based on the hours of operation of the receptors as per Section 2.1.1 (i.e. predicted odour impacts when the sites are not operational have been excluded from the assessment). Commercial/industrial receptors C2, C3, C4, C5, C6 and C7 marginally exceed the criteria of 6 OU (assumed the same criteria as R1) due to the higher quarterly results.

Commercial receptor C1 is located approximately 45 m from the site and is the BOC CO2 Plant. Given the industrial nature of C1, and its existing proximity to the site no significant odour impacts are anticipated from the proposal.

No odour complaints attributed to the Shoalhaven Starches plant were made in the previous four quarters.

Table 7-2 Predicted peak (99th percentile, short term averaged) odour impact at nearby receptors

Receptor	Range, m	To nearest odour source	Direction	2009 EA approved 'base case' Odour criterion	Odour impact, OU, 99th percentile, nose-response time			
					Mod 13	*Mod 16*	*Mod 17*	*Mod 17 (rounded as per EPA advice)*
R1 Bomaderry	150	Packing Plant	W	6	3.3	3.5	4.1	4
R2 North Nowra	1300	Factory	SW	3	2.5	2.6	3.3	3
R3 Nowra	700	Factory	S	5	4	4.6	4.8	5
R4 Terara	1300	Factory	SE	5	3.7	3.7	3.9	4
C1	45	Factory	N	n/a	n/a	10.3	12.1	12
C2	20	Factory	N	n/a	n/a	5.8	7.5	8
C3	30	Factory	N	n/a	n/a	5.3	6.9	7
C4	75	Factory	NW	n/a	n/a	4.4	6.1	6
C5	125	Factory	NW	n/a	n/a	6.1	6.6	7
C6	30	Factory	NW	n/a	n/a	5.4	7.2	7
C7	55	Factory	NW	n/a	n/a	4.8	6.8	7



Paper Size A4

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Identified sensitive receptors
- Mod 16 odour unit contour
- Mod 13 odour unit contour (with mitigation)
- Mod 17 odour unit contour
- Shoalhaven Starches Factory
- Environmental farm boundary
- Packing plant (proposed)

Manildra Ground Pty Ltd
Shoalhaven Starches

Job Number 2126310
Revision A
Date 29 Nov 2019

Odour impacts, 99th percentile,
one-second average, Modification 17, OU

Figure 7

\\ghdnet\ghd\AU\Sydney\Projects\21\27188\GIS\Maps\Deliverables\21_27188_Odour_Mod17.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

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Data source: Aerial Imagery: SIXMAPS, 2018. General Topo: NSW LPI DTDB 2012. Created by:ppandey

8. Air quality assessment

8.1 Emissions inventory

In addition to odour emissions, the operation of the Shoalhaven Starches plant also has the potential to generate emissions of particulate matter and products of combustion.

The baseline air quality model includes all existing and proposed air emissions sources at the Shoalhaven Starches plant up to Mod 16. The sources associated with these modifications have been discussed in the most recent cumulative air quality assessment undertaken in February 2019.

Assumptions and changes made to the baseline air quality model as part of this assessment are discussed in detail below for each of the individual source types.

8.1.1 Coal fired boiler emission sources

Emissions modelling undertaken as part of the Mod 16 air quality assessment assumed that Boilers 2, 4, 5, 6 and 8 would all operate on coal.

Boiler emissions were based on stack emission surveys, the National Pollutant Inventory and measurements undertaken by SEMA. SO_2 emissions from all boilers were conservatively modelled at the EPA limit. Appropriate mitigation measures, such as a lime dosing system for boiler 8, were assumed as part of the modelling.

As part of the current (Mod 17) approvals process, Manildra seek to operate Boilers 2 and 4 on a mix of woodchip and coal:

- Boiler 2 is planned to operate on 25% woodchip and 75% coal
- Boiler 4 is planned to operate on 16% woodchip and 84% coal.

Overall, a total of 7000 tonnes per annum (tpa) of woodchip is planned to be used, displacing 4,400 tpa of coal.

Prior to the Mod 12/13, Boiler 2 used to operate on 100% woodchip. Therefore, past measurement data has been compared with recent data (assuming 100% coal) in Table 8-1. The measurement data shows that emissions for key pollutants such as sulphur dioxide and nitrogen dioxides are significantly lower when the boiler was operating on 100% woodchip.

Emissions for particulates and metals were higher as the emission surveys were undertaken prior to the addition of a baghouse. A review of the *National Pollutant Inventory Emission estimation technique manual for Combustion in boilers Version 3.6* (December, 2011) provides the following emission factors:

- For black coal (spreader stoker, corresponding to the combustion mechanisms in Boilers 2 and 4), the NPI (uncontrolled) emission factors are 6.6 kg/t for PM_{10} and 2.3 kg/t for $PM_{2.5}$.
- For wood/bark fired boilers, the NPI (uncontrolled) emission factors are 3.24 kg/t for PM_{10} and 2.74 kg/t for $PM_{2.5}$.

The emissions factors with coal are higher for PM_{10} and comparable for $PM_{2.5}$. Therefore, the capture efficiencies of the existing baghouse are expected to remain high with a small proportion of woodchip used as fuel, and particulates and metals will remain below the EPL emission limits.

In lieu of the above, no changes have been made to the emissions inventory as the Mod 16 modelled emissions (refer to Mod 16 assessment and Table 8-3) are based on 100% coal and

considered to be conservative. Minor additions of woodchip (as proposed) are likely to reduce these emissions slightly.

The remaining boiler emission sources remain unchanged from Mod 16.

Table 8-1 Boiler 2: Measured operating with 100% woodchip and 100% coal

Parameter/Pollutant	Boiler 2 at 100% woodchip[1]			Boiler 2 at 100% coal, 2019
	2015	2016	2017	
Oxygen (%)	9.4	13.3	12.4	10.7
Carbon dioxide (at 7% O_2) (%)	11.9	7.1	8.5	8.8
Sulphur dioxide (at 7% O_2), mg/m^3	<2	<3	<3	443
Nitrogen oxides (at 7% O_2), mg/m^3	125	179	165	344
TSP (at 7% O_2), mg/m^3	49.3	54.7	96	4.3
PM10 (at 7% O_2), mg/m^3	-	-	-	2.8
Metals – Type I and II substances in aggregate (at 7% O_2), mg/m^3	0.004	0.98	0.77	0.037

Note 1: Particulate and metal emissions are higher as the measurements were undertaken prior to the installation of a baghouse.

8.1.2 Other emission sources

Other emissions sources, including the two gas turbines, would remain unchanged from previous assessments.

It should be noted that the gas turbines were assessed as part of the 2008 air quality assessment (GHD, 2008) and have been approved by EPA. However, the gas turbines have not yet been constructed.

The gas turbines would be installed as part of a gas-fired co-generation plant, which would be used to supply electricity and steam to the factory.

The turbines have been included as part of the cumulative assessment. The modelled emission rates from turbines is summarised in Table 8-2 and Table 8-3.

Table 8-2 Emission inventory – Particulate matter

Discharge Point	Emission Control	TSP, g/s	PM_{10}, g/s
Boiler No. 1	Gas-fired	0.027	0.027
Boiler No. 2	Cyclone and fabric filter	0.042	0.043
Boiler No. 4	Cyclone and fabric filter	0.078	0.080
Boiler No. 5/6	Fabric filter	0.23	0.24
Boiler No. 8 (including co-gen turbine)	Cyclone & Fabric filter	0.16	0.16
Gluten dryer No. 1	Fabric filter	0.015	0.0003
Gluten dryer No. 2	Fabric filter	0.015	0.001
Gluten dryer No. 3	Fabric filter	0.02	0.02
Gluten dryer No. 4	Fabric filter	0.02	0.02
Starch dryer No. 1	Wet-scrubber	0.59	0.18
Starch dryer No. 3	Wet-scrubber	0.04	0.013
Starch dryer No. 4	Wet-scrubber	1.2	0.31
Starch dryer No. 5 (combined)	Cyclone	0.39	0.12
Spray dryer	Fabric filter	0.48	0.14
Ring dryer no. 5	Fabric filter	0.01	0.01
Flour Mill	Fabric filter	0.03	0.009
DDG Pellet Plant	Fabric Filter	0.25	0.25
Packing Plant (proposed)	Fabric Filter	0.016	0.016
Flour Mill B	Fabric Filter	0.004	0.004
Flour Mill C (proposed)	Fabric Filter	0.001	0.001
Gluten dryer No. 6	Fabric filter	0.02	0.02
Gluten dryer No. 7	Fabric filter	0.03	0.03
Gluten grinder	Fabric filter	0.02	0.02
Co-generator turbine No. 1 (approved, not yet constructed)	Gas-fired	0.1	0.1
Co-generator turbine No. 2 (approved, not yet constructed)	Gas-fired	0.1	0.1
New gluten dryer	Fabric Filter	0.02	0.02
Silos associated with speciality products building	Fabric Filter	0.051	0.051

Table 8-3 Emission inventory – Products of combustion

Discharge Point	Boiler No. 1	Boiler No. 2	Boiler No. 4	Boiler No. 5/6	Boiler No. 8	GD6	GD7	SD5	Turbine No. 1 & 2
Fuel type	Natural gas and biogas	Coal and woodchip	Coal and woodchip	Coal	Coal	Natural gas	Natural gas	Natural gas	Natural gas
Status/ details	Existing, No change	Existing, changing from gas to coal-fired	Existing, changing from gas to coal-fired	Existing, coal consumption increasing	New proposed boiler	Natural gas is fed through to the dryers for combustion. The majority of the gas is fed to gluten dryers 6 and 7 and starch dryer 5.			Approved, yet to be constructed
Stack height (m)	25	40	41	54	54	35	29	33.5	30
Exhaust temp. (°C)	180	162	162	141	141	73	68	56	160
Stack diameter (m)	0.9	0.675	0.9	2	2	1.7	1.7	2.4	0.5
Exhaust velocity (m/s)	25	28.3	29.6	17.0	11.6	18.9	22.4	15	25
Oxygen (%)	ND	ND	11.2	8.7	ND	ND	ND	ND	ND
Moisture (%)	ND	ND	4.0	5.2	ND	ND	ND	ND	ND
Exhaust Flow rate, actual (m^3/s)	ND	10.1	18.8	53.5	36.4	ND	ND	ND	ND
Ratio (Actual to normalised flow)	ND	1.7	1.7	1.6	1.6	ND	ND	ND	ND
Emission rates (g/s)									
CO	8.77500E-02	9.76439E-02	1.81339E-01	2.40598E+00	1.64044E+00	2.98513E-01	2.26901E-01	1.61512E-01	3.00000E-01
SO2	4.02570E-03	3.66165E+00	6.80020E+00	2.00498E+01	1.36703E+01	4.47769E-03	3.40352E-03	2.42269E-03	1.20000E-02
NO2	6.21000E-01	2.86219E+00	5.31549E+00	1.50039E+01	1.02300E+01	7.01505E-01	5.33218E-01	3.79554E-01	2.00000E+00
VOC	2.01000E-02	2.31904E-02	4.30679E-02	1.47032E-01	1.00249E-01	-	-	-	4.20000E-03
Antimony (Sb) Type I	-	5.85863E-05	1.08803E-04	1.35670E-04	9.25025E-05	-	-	-	-

Discharge Point	Boiler No. 1	Boiler No. 2	Boiler No. 4	Boiler No. 5/6	Boiler No. 8	GD6	GD7	SD5	Turbine No. 1 & 2
Arsenic (As) Type I	7.30500E-07	8.54384E-05	1.58671E-04	1.35670E-04	9.25025E-05	-	-	-	-
Cadmium (Cd) Type I	4.02000E-06	2.50213E-06	4.64680E-06	3.04089E-05	2.07333E-05	-	-	-	-
Lead (Pb) Type I	1.82250E-06	7.32329E-04	1.36004E-03	1.21970E-03	8.31611E-04	-	-	-	-
Mercury (Hg) Type I	9.45000E-07	1.83082E-04	3.40010E-04	1.67082E-06	1.13919E-06	-	-	-	-
Beryllium (Be) Type II	4.38750E-09	1.70877E-05	3.17343E-05	2.03840E-05	1.38982E-05	-	-	-	-
Chromium (Cr) Type II	5.11500E-06	6.71302E-05	1.24670E-04	1.39012E-04	9.47809E-05	-	-	-	-
Cobalt (Co) Type II	2.97000E-07	6.71302E-05	1.24670E-04	6.78352E-05	4.62513E-05	-	-	-	-
Manganese (Mn) Type II	1.38750E-06	4.08884E-04	7.59356E-04	7.45184E-04	5.08080E-04	-	-	-	-
Nickel (Ni) Type II	7.65000E-06	2.99034E-04	5.55350E-04	2.88049E-04	1.96397E-04	-	-	-	-
Selenium (Se) Type II	8.62500E-08	1.64774E-04	3.06009E-04	1.35670E-04	9.25025E-05	-	-	-	-
Tin (Sn) Type II	-	8.54384E-05	1.58671E-04	3.40847E-04	2.32395E-04	-	-	-	-
Vanadium (V) Type II	-	4.21089E-05	7.82023E-05	1.69421E-04	1.15514E-04	-	-	-	-
HCL	-	4.35126E-02	8.08091E-02	2.38258E-01	1.62449E-01	-	-	-	-
PAH	2.33250E-06	4.10062E-06	7.61543E-06	3.22191E-05	2.19676E-05	-	-	-	4.40000E-05
FL	-	3.24074E-02	6.01852E-02	2.54630E-01	1.73611E-02	-	-	-	-
Emission rates, normalised (mg/m^3)									
CO	9	16	16	72	72	-	-	-	-
SO2	0	600	600	600	600	-	-	-	-
NO2	65	469	469	449	449	-	-	-	-
TSP	2.8	7.1	7.1	7.1	7.1	-	-	-	-

Discharge Point	Boiler No. 1	Boiler No. 2	Boiler No. 4	Boiler No. 5/6	Boiler No. 8	GD6	GD7	SD5	Turbine No. 1 & 2
Type 1 and 2 metals (combined)	0.0	0.4	0.4	0.1	0.1	-	-	-	-
Cadmium	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Mercury	0.0	0.0	0.0	0.0	0.0	-	-	-	-
VOC	2.1	3.8	3.8	4.4	4.4	-	-	-	-
HCL	-	7.1	7.1	7.1	7.1	-	-	-	-
FL	-	5.3	5.3	7.6	0.8	-	-	-	-

The emission rate limits are as follows:

Protection of the Environment Operations (Clean Air) Regulation (2010): CO: 125 mg/m^3, SO2: 1000 mg/m^3, NO2: 500 mg/m^3, TSP: 50 mg/m^3, Type 1 and 2 metals (combined): 1 mg/m^3, Cadmium: 0.2 mg/m^3, Mercury: 0.2 mg/m^3, VOC: 40 mg/m^3, HCL: 100 mg/m^3, FL: 50 mg/m^3

EPA: SO2: 600 mg/m^3, NO2: 500 mg/m^3, TSP: 30 mg/m^3, Type 1 and 2 metals (combined): 1 mg/m^3, Cadmium: 0.2 mg/m^3, Mercury: 0.2 mg/m^3, VOC: 40 mg/m^3.

8.2 Dispersion modelling

The air quality dispersion modelling was conducted using the US EPA regulatory Gaussian puff model CALPUFF Version 5.8. The model settings were as described in Section 7.2.

8.3 Predicted air quality impacts

The predicted air quality impacts are reproduced below and remain unchanged from Mod 16.

8.3.1 Particulates

The impact of dust emissions principally relates to the potential effect on human health of inhalation of particles in the air column, and it is the finer fraction that have the greater potential to cause respiratory health effects. EPA have advised to assess $PM_{2.5}$, if PM_{10} impacts are significant. The $PM_{2.5}$ emissions from some sources on site are not known, however guidance is available for estimates of $PM_{2.5}$ from boilers in the NPI. NPI emission factors for coal boilers with a baghouse states that $PM_{2.5}$ emissions are half of PM_{10} emissions and the ratio of $PM_{2.5}$ to PM_{10} in gas fired boilers is the same.

A summary of the maximum incremental predicted levels at each receptor site is presented in Table 8-4. The worst case predicted incremental PM_{10} level is at R1 with a level of 8.5 µg/m^3.

Table 8-4 Maximum predicted incremental ground level PM10, PM2.5 and TSP concentrations

Receiver	Pollutant				
	PM_{10} (24 hour)	PM_{10} (Annual)	$PM_{2.5}$ (24 hour)	$PM_{2.5}$ (Annual)	TSP (Annual)
Criteria µg/m^3	50	25	25	8	90
R1	8.5	0.8	4.3	0.4	1.8
R2	4.6	0.4	2.3	0.2	0.9
R3	8.1	0.8	4.1	0.4	1.6
R4	6.4	1.2	3.2	0.6	2.3
C1	27.4	3.1	13.7	1.6	8.8
C2	17.0	3.1	8.5	1.5	7.3
C3	15.0	2.8	7.5	1.4	6.5
C4	15.0	2.4	7.5	1.2	5.2
C5	12.5	2.0	6.2	1.0	4.1
C6	17.8	3.2	8.9	1.6	7.0
C7	17.3	2.8	8.6	1.4	5.5

A contemporaneous assessment has been undertaken for the year 2004 in accordance with the Approved Methods. Predicted 24 hour $PM_{2.5}$ and PM_{10} values from the site in 2004 have been added to the 24 hour measured values at Wollongong for every day in the year.

The top predicted, measured and total concentrations at the most impacted residential receptor (R1) and commercial receptor (C1) are presented in Table 8-5 to Table 8-8 below. The background and incremental contributions for the highest cumulative concentrations are also included.

Results of the assessment show full compliance with the $PM_{2.5}$ and PM_{10} 24 hour criteria at sensitive receptor R1.

Results of the assessment show full compliance with the $PM_{2.5}$ 24 hour criteria at sensitive receptor C1. An exceedance of the PM_{10} 24 hour criteria is predicted for one day of the year at sensitive receptor C1. This exceedance is bolded in Table 8-7 and includes a background contribution of 49 µg/m^3 and a site contribution of 13.5 µg/m^3.

The site contributions at receptor C1 for the exceedance day are dominated by the following top four sources:

- S19 (Starch dryer no. 4): 3.6 µg/m^3
- S20 (Spray dryer): 3.2 µg/m^3
- S01 (Starch dryer no. 1): 2.9 µg/m^3
- PPF (DDG Pellet Plant): 1.5 µg/m^3.

In total, these sources account for 82% of the site contribution on the day. The contributions from the boilers are as follows:

- Boiler 1: 0.1 µg/m^3
- Boiler 2: 0.2 µg/m^3
- Boiler 4: 0.3 µg/m^3
- Boiler 5/6: 0.3 µg/m^3
- Boiler 8: 0.1 µg/m^3.

The contributions from all boilers account for 8% of the total concentration on the day, with boiler 8 accounting for less than 1% of the total contribution. Therefore, the proposal is not anticipated to increase levels PM_{10} significantly.

Plots of the predicted 24 hour maximum PM_{10} levels are provided in Figure 8 (incremental impact) and in Figure 9 (cumulative impact with 70th percentile PM_{10} levels at Albion Park South 2016 for comparative purposes).

Plots of the predicted 24 hour maximum $PM_{2.5}$ levels are provided in Figure 10 (cumulative impact with 70th percentile $PM_{2.5}$ levels at Albion Park South 2016 for comparative purposes).

Table 8-5 Summary of highest measured and predicted PM_{10} levels, µg/m^3 (R1)

Top 10 PM_{10} background		Top 10 PM_{10} incremental		Top 10 PM_{10} cumulative			
Date	PM_{10} background	Date	PM_{10} increment	Date	PM_{10} cumulative	Background contribution	Site contribution
08/03/2004	49.0	23/03/2004	8.5	08/03/2004	49.3	49.0	0.3
27/11/2004	48.4	11/03/2004	8.0	27/11/2004	48.7	48.4	0.3
21/02/2004	47.0	20/10/2004	5.6	21/02/2004	47.0	47.0	0.0
26/03/2004	46.1	24/09/2004	5.0	26/03/2004	46.1	46.1	0.0
08/12/2004	43.7	18/08/2004	5.0	08/12/2004	44.5	43.7	0.8
10/01/2004	43.4	19/01/2004	4.5	10/01/2004	43.4	43.4	0.0
09/02/2004	43.1	18/01/2004	4.3	09/02/2004	43.1	43.1	0.0
06/02/2004	41.2	02/03/2004	4.1	20/02/2004	41.7	40.4	1.3
07/12/2004	40.8	17/10/2004	4.1	06/02/2004	41.3	41.2	0.1
20/02/2004	40.4	05/04/2004	4.1	07/12/2004	41.1	40.8	0.3

Table 8-6 Summary of highest measured and predicted $PM_{2.5}$ levels, µg/m^3 (R1)

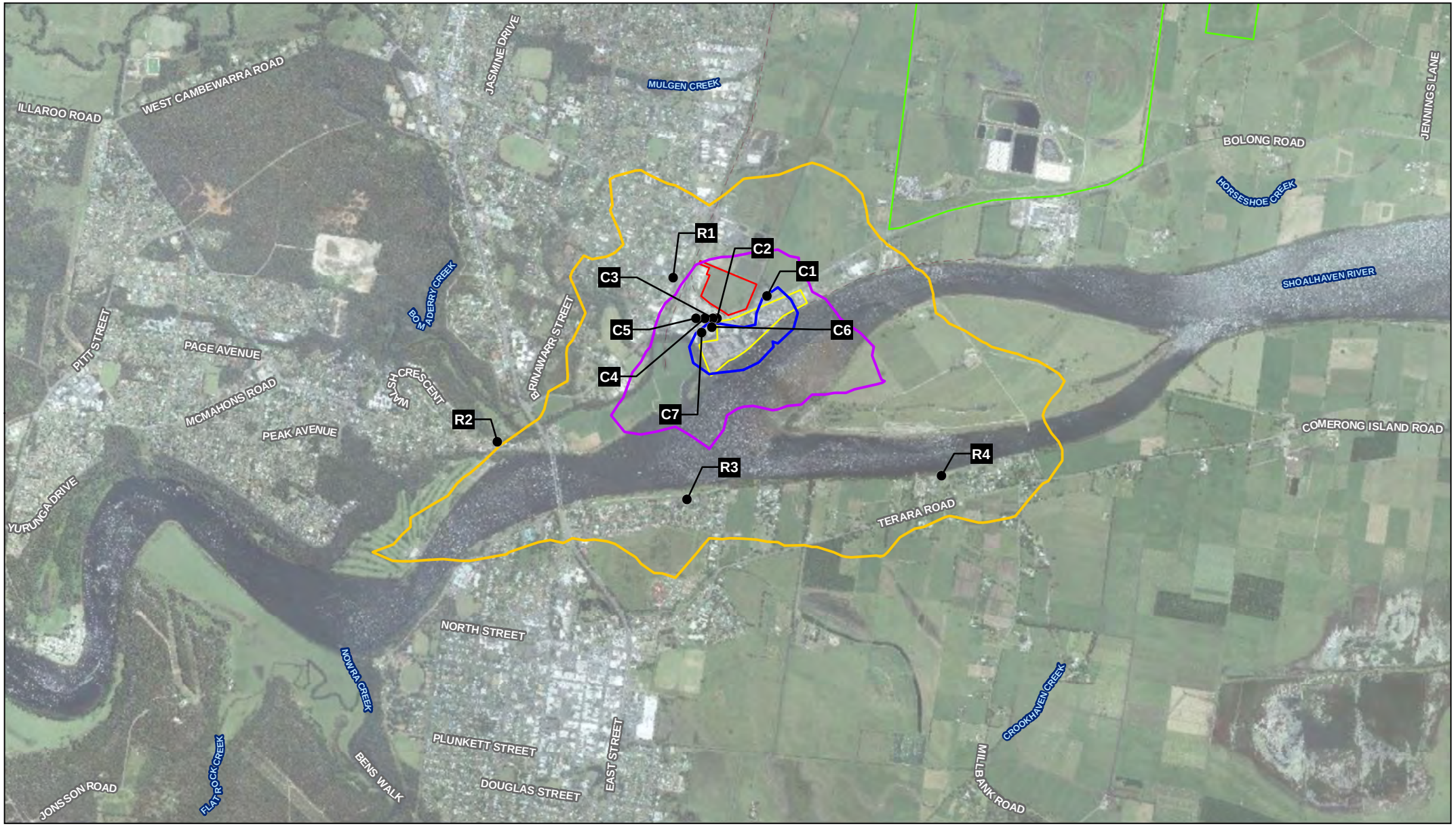
Top 10 PM_{10} background		Top 10 PM_{10} incremental		Top 10 PM_{10} cumulative			
Date	$PM_{2.5}$ background	Date	PM_{10} increment	Date	$PM_{2.5}$ cumulative	Background contribution	Site contribution
10/01/2004	22.6	23/03/2004	4.3	10/01/2004	22.6	22.6	0.0
21/02/2004	22.3	11/03/2004	4.0	21/02/2004	22.3	22.3	0.0
26/03/2004	19.9	20/10/2004	2.8	26/03/2004	19.9	19.9	0.0
06/02/2004	19.0	24/09/2004	2.5	06/02/2004	19.0	19	0.0
09/02/2004	18.3	18/08/2004	2.5	11/02/2004	18.6	17.9	0.7
11/02/2004	17.9	19/01/2004	2.3	09/02/2004	18.3	18.3	0.0
09/03/2004	17.6	18/01/2004	2.2	08/03/2004	17.6	17.5	0.1
08/03/2004	17.5	02/03/2004	2.1	27/11/2004	17.6	17.5	0.1
27/11/2004	17.5	17/10/2004	2.1	09/03/2004	17.6	17.6	0.0
13/03/2004	17.0	05/04/2004	2.1	07/02/2004	17.1	16.2	0.8

Table 8-7 Summary of highest measured and predicted PM_{10} levels, µg/m^3 (C1)

Top 10 PM_{10} background		Top 10 PM_{10} incremental		Top 10 PM_{10} cumulative			
Date	PM_{10} background	Date	PM_{10} increment	Date	PM_{10} cumulative	Background contribution	Site contribution
08/03/2004	49.0	10/05/2004	27.4	**08/03/2004**	**62.5**	**49**	**13.5**
27/11/2004	48.4	26/01/2004	26.6	10/01/2004	49.1	48.4	0.7
21/02/2004	47.0	5/04/2004	21.6	21/02/2004	47.2	47	0.2
26/03/2004	46.1	27/01/2004	19.8	26/03/2004	46.4	46.1	0.3
08/12/2004	43.7	20/07/2004	19.3	06/02/2004	44.4	43.1	1.3
10/01/2004	43.4	3/10/2004	19.0	09/02/2004	43.6	43.4	0.2
09/02/2004	43.1	16/08/2004	16.0	11/02/2004	41.3	41.2	0.1
06/02/2004	41.2	19/08/2004	15.9	07/02/2004	39.7	37.7	2.0
07/12/2004	40.8	19/07/2004	15.8	27/11/2004	39.1	38.9	0.2
20/02/2004	40.4	4/02/2004	15.6	09/03/2004	37.2	33.4	3.8

Table 8-8 Summary of highest measured and predicted $PM_{2.5}$ levels, µg/m^3 (C1)

Top 10 PM_{10} background		Top 10 PM_{10} incremental		Top 10 PM_{10} cumulative			
Date	$PM_{2.5}$ background	Date	PM_{10} increment	Date	$PM_{2.5}$ cumulative	Background contribution	Site contribution
10/01/2004	22.6	10/05/2004	13.7	08/03/2004	24.3	17.5	6.8
21/02/2004	22.3	26/01/2004	13.3	10/01/2004	22.7	22.6	0.1
26/03/2004	19.9	5/04/2004	10.8	21/02/2004	22.4	22.3	0.1
06/02/2004	19.0	27/01/2004	9.9	26/03/2004	20.1	19.9	0.2
09/02/2004	18.3	20/07/2004	9.7	06/02/2004	19.0	19.0	0.0
11/02/2004	17.9	3/10/2004	9.5	09/02/2004	19.0	18.3	0.7
09/03/2004	17.6	16/08/2004	8.0	11/02/2004	18.9	17.9	1.0
08/03/2004	17.5	19/08/2004	8.0	07/02/2004	18.1	16.2	1.9
27/11/2004	17.5	19/07/2004	7.9	27/11/2004	17.8	17.5	0.3
13/03/2004	17.0	4/02/2004	7.8	09/03/2004	17.7	17.6	0.1



Paper Size A4

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Identified sensitive receptors
- **PM10 24HR concentration contour (µg/m3)**
  - 5
  - 10
  - 20
- Shoalhaven Starches Factory
- Environmental farm boundary
- Packing plant (proposed)

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number	21-26310
Revision	A
Date	18 Feb 2019

Maximum Predicted Incremental Ground Level PM10 Concentrations (24-hour Average), µg/m3

Figure 8

G:\21\27188\GIS\Maps\Deliverables\21_27188_SMA.mxd (SMA record: 2)

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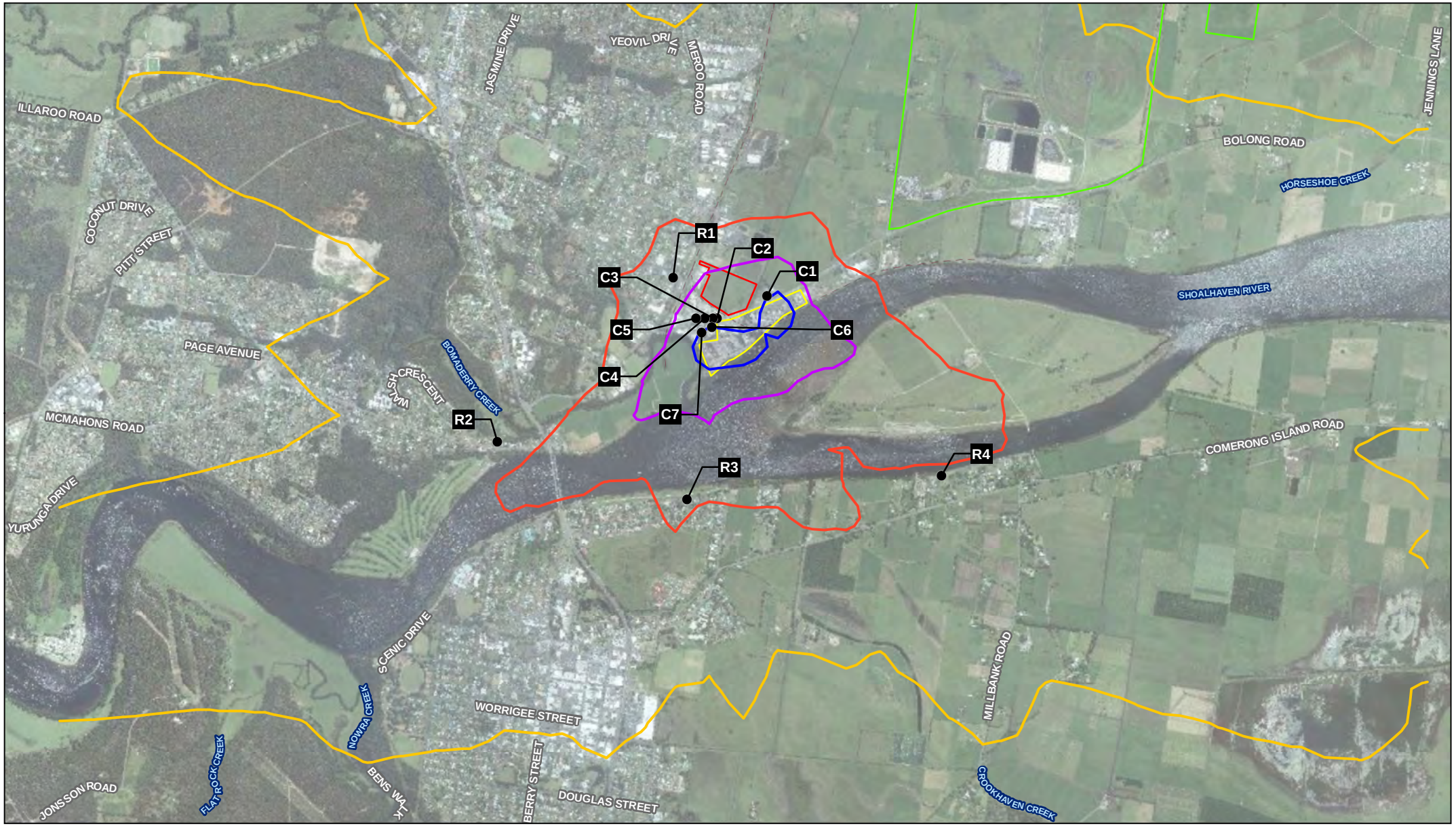
Data source: Aerial Imagery: SIXMAPS, 2018. General Topo: NSW LPI DTDB 2012. Created by:afoddy



Paper Size A4

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Identified sensitive receptors

PM10 24HR concentration contour (µg/m3)

- 20
- 25
- 30
- 40
- Shoalhaven Starches Factory
- Environmental farm boundary
- Packing plant (proposed)

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number	21-26310
Revision	A
Date	18 Feb 2019

Maximum Predicted Cumulative Ground Level PM10 Concentrations (24-hour Average), µg/m3

Figure 9

G:\21\27188\GIS\Maps\Deliverables\21_27188_SMA.mxd (SMA record: 3)

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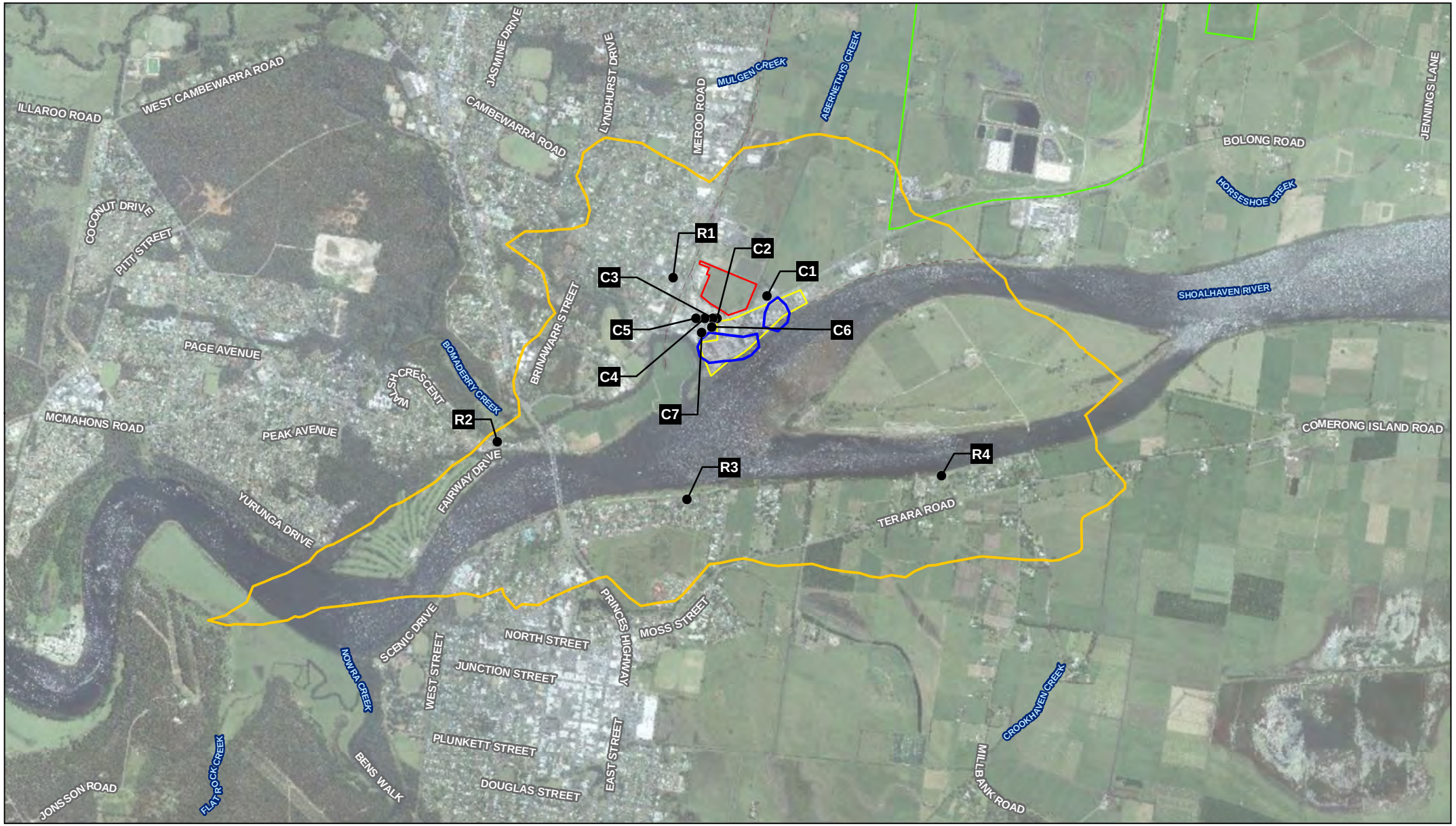
Data source: Aerial Imagery: SIXMAPS, 2018. General Topo: NSW LPI DTDB 2012. Created by:afoddy



Paper Size A4

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Identified sensitive receptors
- **PM2.5 24HR concentration contour (µg/m3)**
  - 10
  - 20
  - Shoalhaven Starches Factory
- Environmental farm boundary
- Packing plant (proposed)

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number	21-26310
Revision	A
Date	18 Feb 2019

Maximum Predicted Cumulative Ground Level PM2.5 Concentrations (24-hour Average), µg/m3

Figure 10

G:\21\27188\GIS\Maps\Deliverables\21_27188_SMA.mxd (SMA record: 4)

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Data source: Aerial Imagery: SIXMAPS, 2018. General Topo: NSW LPI DTDB 2012. Created by:afoddy

8.3.2 Products of combustion

The primary pollutants in coal and gas fired boiler emissions are oxides of nitrogen (NO_x), formed by the high temperatures in the combustors, sulfur dioxide (SO_2), formed from the sulfur content of the fuel, VOCs, hydrogen chloride, polycyclic aromatic hydrocarbons (PAH), carbon monoxide (CO) and hydrogen fluoride (HF) all formed by incomplete combustion of the fuel.

All pollutants have all been assessed against their relevant criteria from the Approved Methods.

Predicted levels for SO_2, NO_2, carbon monoxide, hydrogen fluoride and hydrogen chloride are provided in Table 8-9 to Table 8-13. The predicted levels comply at all receivers for SO_2, CO, HF and HCL.

The predicted levels for nitrogen dioxide exceed the criteria at all commercial/industrial sensitive receptors. However, the predicted levels assume that 100% of NO will be converted to NO_2 as per Method 1 (Section 8.1.1) of the Approved Methods. This is considered extremely conservative as in reality, only a fraction of the NO will be converted to NO_2.

Therefore, a more detailed assessment has been undertaken for all receptors using Method 2 (Section 8.2.2) of the Approved Methods. Method 2 is based on NO reacting with ozone in the atmosphere to form NO_2. Background ozone data was sourced from Kembla Grange for the year 2004. The calculated NO_2 levels using Method 2 are provided in Table 8-10.

The NO_2 levels are predicted to comply with the criteria at all sensitive receptors using method 2 of the Approved Methods.

Contour plots of cumulative SO_2 predictions are shown in Figure 11.

Table 8-9 Maximum predicted ground level Sulfur Dioxide concentrations

Receptor	Total impact (Incremental plus background) (µg/m³)			
Criteria, µg/m³	712 (10 min[1])	570 (1 hour)	228 (24 hour)	60 (Annual)
Background, µg/m³	No data[2]	57.6	15.7	1.6
Bomaderry (R1)	255.6	195.9	51.7	5.5
North Nowra	198.3	155.9	45.5	3.9
Nowra (R3)	269.7	205.8	42.8	2.8
Terara (R4)	174.3	139.1	26.3	2.3
C1	546.2	399.0	111.4	10.6
C2	636.5	462.2	85.7	11.3
C3	578.1	421.4	81.8	10.9
C4	477.3	350.9	85.6	10.0
C5	404.8	300.3	83.1	9.0
C6	527.9	386.3	99.7	12.2
C7	456.9	336.7	102.5	11.3

Note 1: The 10 minute concentrations were calculated from the hourly values by applying a peak to mean factor of $(60/10)^{0.2}$.

Note 2: The 10 minute background levels were assumed to be the same as the 1 hour background levels in the absence of monitoring data.

Table 8-10 Maximum predicted ground level Nitrogen Dioxide concentrations

Receptor	Total impact (Incremental plus background) (µg/m³)		
Criteria, µg/m³	246 (1 hour, Method 1)	246 (1 hour, Method 2)	62 (Annual)
Background, µg/m³	80.8	n/a	7.1
Bomaderry (R1)	197.1	115.2	10.5
North Nowra	164.4	98.6	9.1
Nowra (R3)	203.0	116	8.2
Terara (R4)	153.8	123.8	7.8
C1	373.5	184.4	15.3
C2	419.7	153.2	16.8
C3	385.4	150.9	16.2
C4	326.1	147.3	15.2
C5	282.6	143.4	13.9
C6	364.1	149.7	17.6

Receptor	Total impact (Incremental plus background) (µg/m³)		
Criteria, µg/m³	246 (1 hour, Method 1)	246 (1 hour, Method 2)	62 (Annual)
Background, µg/m³	80.8	n/a	7.1
C7	325.2	142.7	16.3

Table 8-11 Maximum predicted ground level Carbon Monoxide concentrations

Receptor	Total impact (Incremental plus background) (mg/m³)		
Criteria, mg/m³	100 (15 min[1])	30 (1 hour)	10 (8 hour)
Background, mg/m³	No data[2]	1	0.6
Bomaderry (R1)	1.15	1.12	0.61
North Nowra	1.11	1.08	0.61
Nowra (R3)	1.16	1.12	0.61
Terara (R4)	1.10	1.07	0.60
C1	1.39	1.29	0.62
C2	1.45	1.34	0.62
C3	1.40	1.30	0.62
C4	1.32	1.25	0.62
C5	1.27	1.20	0.61
C6	1.37	1.28	0.62
C7	1.32	1.24	0.62

Note 1: The 15 minute concentrations were calculated from the hourly values by applying a peak to mean factor of $(60/15)^{0.2}$.

Note 2: The 15 minute background levels were assumed to be the same as the 1 hour background levels in the absence of monitoring data.

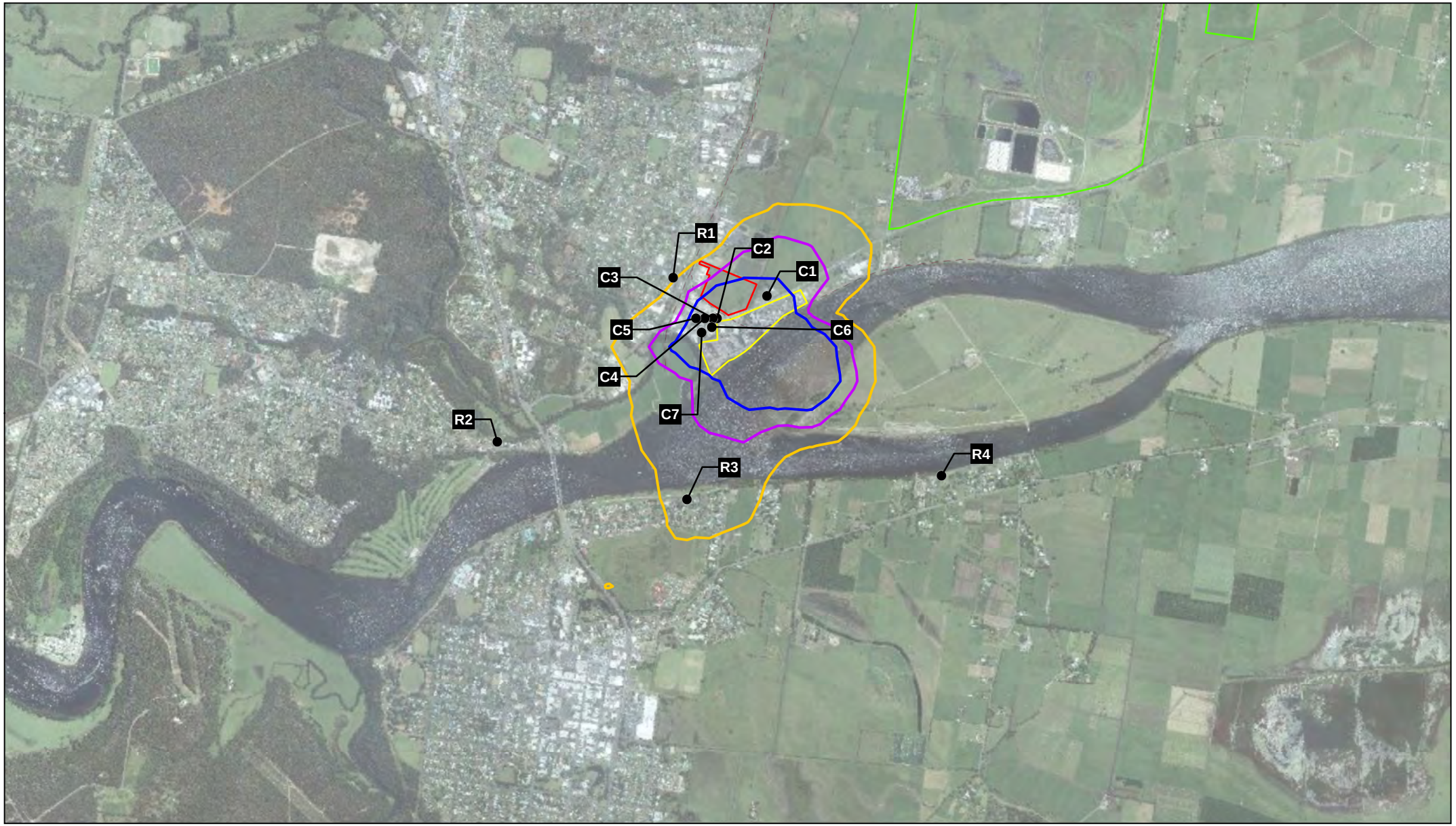
Table 8-12 Maximum predicted ground level Hydrogen Fluoride concentrations

Receptor	Total impact (Incremental plus background) (µg/m³)			
Criteria, µg/m³	1.5 (24 hour)	0.8 (7 day)	0.4 (30 day)	0.5 (90 day)
Background, µg/m³	No data	No data	No data	No data
Bomaderry (R1)	0.3	0.1	0.1	0.05
North Nowra	0.2	0.1	0.1	0.03
Nowra (R3)	0.2	0.0	0.0	0.02
Terara (R4)	0.1	0.0	0.0	0.01
C1	0.9	0.3	0.1	0.09
C2	0.6	0.2	0.1	0.12

Receptor	Total impact (Incremental plus background) (µg/m³)			
Criteria, µg/m³	1.5 (24 hour)	0.8 (7 day)	0.4 (30 day)	0.5 (90 day)
Background, µg/m³	No data	No data	No data	No data
C3	0.5	0.2	0.1	0.11
C4	0.6	0.2	0.1	0.11
C5	0.6	0.2	0.1	0.10
C6	0.7	0.3	0.2	0.14
C7	0.7	0.3	0.2	0.13

Table 8-13 Maximum predicted ground level Hydrogen Chloride concentrations

Receptor	Averaging Period	Incremental Impact (mg/m³)	Background Concentration (mg/m³)	Total Impact (mg/m³)	Criteria (mg/m³)
Bomaderry (R1)	1 hour	0.0012	-	0.0012	0.14
North Nowra (R2)	1 hour	0.0011	-	0.0011	0.14
Nowra (R3)	1 hour	0.0014	-	0.0014	0.14
Terara (R4)	1 hour	0.0007	-	0.0007	0.14
C1	1 hour	0.0036		0.0036	0.14
C2	1 hour	0.0030		0.0030	0.14
C3	1 hour	0.0029		0.0029	0.14
C4	1 hour	0.0025		0.0025	0.14
C5	1 hour	0.0022		0.0022	0.14
C6	1 hour	0.0030		0.0030	0.14
C7	1 hour	0.0025		0.0025	0.14



Paper Size A4

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Identified sensitive receptors

S02 1HR concentration contour (µg/m3)

- 200
- 250
- 300

- Shoalhaven Starches Factory
- Environmental farm boundary
- Packing plant (proposed)

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number	21-26310
Revision	A
Date	18 Feb 2019

Maximum Predicted Cumulative Ground Level SO2 Concentrations (1 hour Average) , µg/m3

Figure 11

G:\21\27188\GIS\Maps\Deliverables\21_27188_SMA.mxd (SMA record: 6)

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Data source: Aerial Imagery: SIXMAPS, 2018. General Topo: NSW LPI DTDB 2012. Created by:afoddy

8.3.3 PAH, VOCs and metals

The maximum predicted (99.9 percentile, 1-hour average) ground level incremental PAH, VOC and metal concentrations, within and beyond the factory site boundary are provided in Table 8-14. The predicted levels are significantly lower than the respective EPA principal toxic air pollutant criteria for all substances both within and beyond the site boundary.

Table 8-14 Maximum predicted ground level PAH, VOC and metals concentrations

Receptor	Incremental Impact (mg/m^3)										
Pollutant	PAH	VOC	Antimony	Arsenic	Cadmium	Mercury	Beryllium	Chromium	Manganese	Nickel	Lead
Criteria	0.0004 mg/m^3 (1 hour)	Individual VOCs (1 hour)	9.00E-03 mg/m^3 (1 hour)	9.00E-05 mg/m^3 (1 hour)	1.80E-05 mg/m^3 (1 hour)	1.80E-03 mg/m^3 (1 hour)	4.00E-06 mg/m^3 (1 hour)	9.00E-05 mg/m^3 (1 hour)	1.80E-02 mg/m^3 (1 hour)	1.80E-04 mg/m^3 (1 hour)	0.5 µg/m^3 (Annual)
Bomaderry (R1)	1.54E-07	7.91E-04	1.08E-06	1.39E-06	1.39E-07	2.44E-06	2.61E-07	1.22E-06	6.95E-06	4.47E-06	4.90E-04
North Nowra (R2)	1.33E-07	7.03E-04	1.05E-06	1.37E-06	1.17E-07	2.43E-06	2.64E-07	1.17E-06	6.77E-06	4.51E-06	3.02E-04
Nowra (R3)	1.68E-07	8.77E-04	1.37E-06	1.94E-06	1.47E-07	3.62E-06	3.77E-07	1.60E-06	9.34E-06	6.50E-06	1.91E-04
Terara (R4)	8.42E-08	4.81E-04	7.16E-07	9.52E-07	7.34E-08	1.69E-06	1.80E-07	8.16E-07	4.70E-06	3.07E-06	1.21E-04
C1	4.53E-07	2.40E-03	3.62E-06	4.87E-06	3.99E-07	8.81E-06	9.32E-07	4.13E-06	2.40E-05	1.60E-05	1.33E-03
C2	3.93E-07	2.18E-03	3.05E-06	4.13E-06	3.57E-07	7.64E-06	7.88E-07	3.51E-06	2.02E-05	1.37E-05	1.42E-03
C3	3.69E-07	2.00E-03	2.81E-06	3.81E-06	3.33E-07	6.93E-06	7.25E-07	3.24E-06	1.87E-05	1.25E-05	1.33E-03
C4	3.26E-07	1.75E-03	2.43E-06	3.25E-06	2.94E-07	5.97E-06	6.19E-07	2.79E-06	1.60E-05	1.07E-05	1.19E-03
C5	2.82E-07	1.49E-03	2.00E-06	2.69E-06	2.58E-07	5.14E-06	5.14E-07	2.29E-06	1.32E-05	8.87E-06	1.01E-03
C6	3.98E-07	2.11E-03	2.90E-06	3.91E-06	3.66E-07	7.11E-06	7.44E-07	3.34E-06	1.92E-05	1.28E-05	1.59E-03
C7	3.22E-07	1.71E-03	2.34E-06	3.10E-06	2.91E-07	5.69E-06	5.85E-07	2.67E-06	1.53E-05	1.01E-05	1.40E-03
Maximum level (on site)	6.02E-07	3.61E-03	6.13E-06	8.74E-06	6.46E-07	1.74E-05	1.71E-06	7.19E-06	4.25E-05	2.97E-05	Not applicable

9. Conclusions

GHD was engaged by Manildra to conduct an air quality and odour impact assessment for a proposed modification to the approved SSEP.

The proposed changes include minor modifications to boiler operations and the addition of a new starch dryer stack.

A marginal increase was observed in predicted odour impacts as a result of the modification. The odour criteria is met at all residential sensitive receptors and it is considered highly unlikely that the increase in odour would be detected at sensitive receptors.

Air quality impacts are predicted to comply with the criteria at all residential sensitive receptors. Manildra have implemented reasonable and feasible mitigation measures on site to reduce the potential air quality impacts from the new boiler.

Overall, the proposal should be acceptable from an air quality perspective.

10. References

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Appendices

Appendix A – Meteorological analysis

The following section is taken from the Shoalhaven Starches Report on Ethanol Upgrade: Air Quality Assessment (GHD, 2008), and describes the meteorology of the area and how the dataset was compiled.

A1 Meteorology

The three-dimensional meteorological data for a CALPUFF model simulation are provided by CALMET[4], its meteorological pre-processor. CALMET requires meteorological input from surface weather station networks and upper air stations.

The following sub-sections describe the available meteorological data, how the data was applied and the features of the dispersion meteorological data used to run CALPUFF.

A1.1 Data Available

Wind data were collected at three locations within the Shoalhaven Starches facility. Of these three stations, only one station, the automated weather station (AWS) located near the storage ponds at the environmental farm (hereafter referred to as Farm AWS), is compliant with the Australian Standard for the measurement of horizontal wind for air quality applications (AS 2923:1987). The other two stations, in particular the weather station located at the factory, are compromised by building and equipment infrastructure. Wind data have been collected at the Farm AWS since 2003, with the most complete data set collected in 2004.

The nearest source of additional surface meteorological data was the Bureau of Meteorology (BoM) Nowra AWS located approximately 12 km to the west at the Royal Australian Navy base at Nowra (HMAS ALBATROSS). This data source was considered to be too far from the subject area to be site-representative.

The nearest source of upper air meteorological data was also the HMAS ALBATROSS site, which does irregular upper air soundings based on operational requirements. However, the time gap between these vertical atmospheric soundings is too large to be suitable for use as model input.

A1.2 Data Application

To take full advantage of the CALPUFF features, described in Section 7.1, and make use of the available meteorological data described above, a combined prognostic/diagnostic meteorological modelling approach was used to synthesise the three-dimensional meteorological data input required by CALPUFF.

The regional-scale prognostic meteorological model, TAPM[5], was used to simulate the meteorology over the subject site with consideration to the DECC *Approved Methods*. TAPM is an approved model for specialist applications and its use, as part of this assessment, is described in the next section.

The observations from the Farm AWS and Nowra AWS were first used for optimising and checking the performance of the prognostic model simulation.

Wind speed and wind direction data from the Farm AWS were then assimilated into the prognostic model.

The subsequent TAPM output (with assimilated Farm AWS data) was then passed to meteorological pre-processor model CALMET (version 5.5).

[4] Scire J.S., E.M. Insley, R.J. Yamartino, and M.E. Fernau, 1995: A User's Guide for the CALMET Meteorological Model. Report prepared for the USDA Forest Service by EARTH TECH, Concord, MA. See: http://www.src.com/calpuff/calpuff1.htm
[5] Hurley, P. The Air Pollution Model (TAPM) version 3. CSIRO Atmospheric Research Paper No. 31, 2005

A2 Prognostic Meteorological Modelling

TAPM (version 3.0.7) was developed at CSIRO Division of Atmospheric Research as a PC-based prognostic modelling system that can predict regional scale three-dimensional meteorology. TAPM accesses databases of synoptic weather analyses from the Bureau of Meteorology. The model then provides the link between the synoptic large-scale flows and local climatology, which includes characterising such factors as local land use and topography, and their influence on atmospheric stability and mixing height.

TAPM was initially configured with a nested model grid coverage designed to capture:

- Broad scale synoptic flows
- Regional to local scale wind channelling
- The influence of local land use

The nested grids were then configured with surface characteristics, such as terrain elevation, surface type (land use and vegetation type), soil type and deep soil moisture content.

Specific model settings were:

- Four nested grids at 1 000 m, 3 000 m, 10 000 m and 25 000 m resolution, with 55 x 55 grid points. The grid was set to ensure the locations of the Farm AWS and Nowra AWS were within the inner nested grid
- Surface vegetation and precipitation processes were included, whereas, non-hydrostatic processes were not included

Following an initial model run, the model output from the grid point nearest to the Farm AWS was compared with data recorded at that station. Specifically, the predicted hourly ambient temperatures and the annual wind rose (wind speed and direction distributions) were compared with corresponding recordings. Model output from the model grid point nearest to the Nowra AWS was also compared with an annual wind rose derived from data recorded at that station.

Figure A1 shows the scatter plot of observed and predicted ambient temperature at the Farm AWS. The determined optimal model configuration produced a correlation coefficient of 0.88 for predicted temperature. The strong correlation between predicted and recorded temperature indicates that the model is accurately calculating the surface energy balance, which, in turn, adds confidence to the hourly varying predictions made for atmospheric stability and the height of the mixed layer.

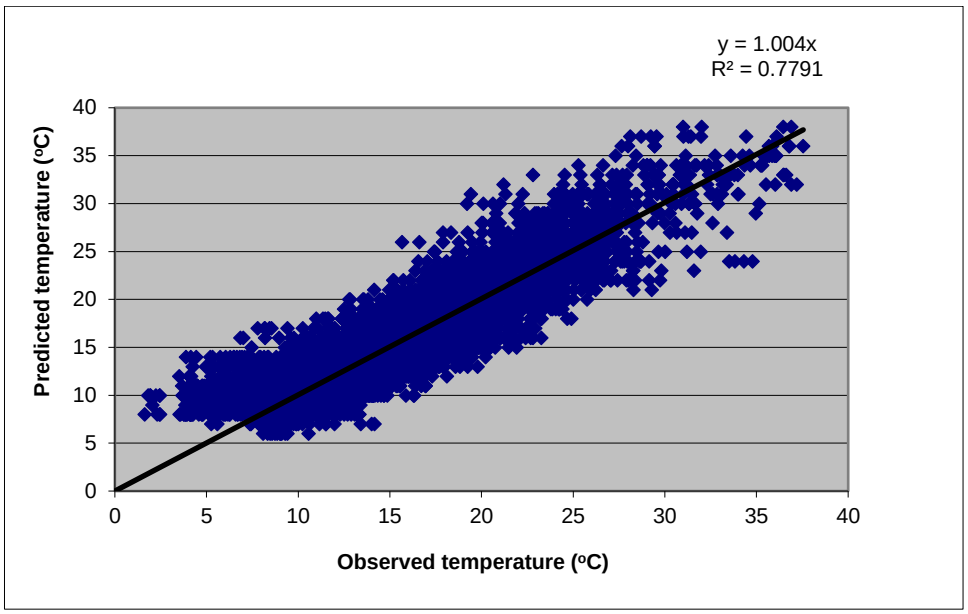


Figure A1 Scatter Plot of Observed and Predicted Ambient Temperature

A2.1 Wind Distribution

Figure A2 shows the predicted (a) and observed (b) wind roses for the location of the Nowra AWS. The directional distribution of winds predicted by TAPM shows reasonable agreement with the recorded observations and with the wind patterns expected for this region.

Figure A3 shows the predicted (a) and observed (b) wind roses for the location of the Farm AWS after the initial TAPM simulation. The directional distribution of winds predicted by TAPM shows reasonable agreement with the recorded wind patterns expected for this region.

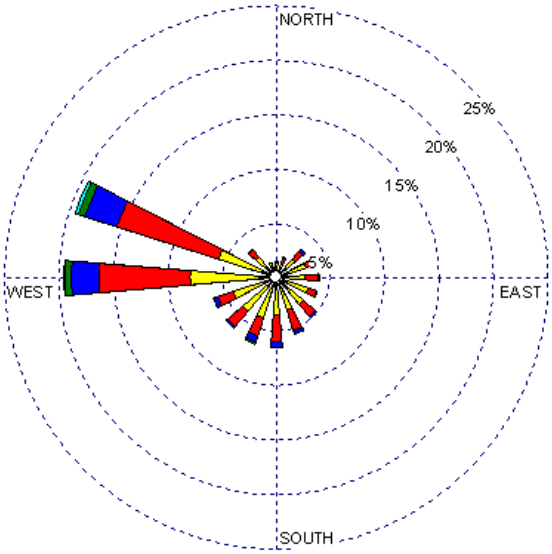
The wind speed and direction observations from the Farm AWS were assimilated into the prognostic model simulation to improve the ability of the model to capture the effects of local wind channelling and low wind speed conditions. The improvement to wind direction distributions in the model output is clearly evident in Figure A3(c). The marked improvement in the capture of low wind events is examined below.

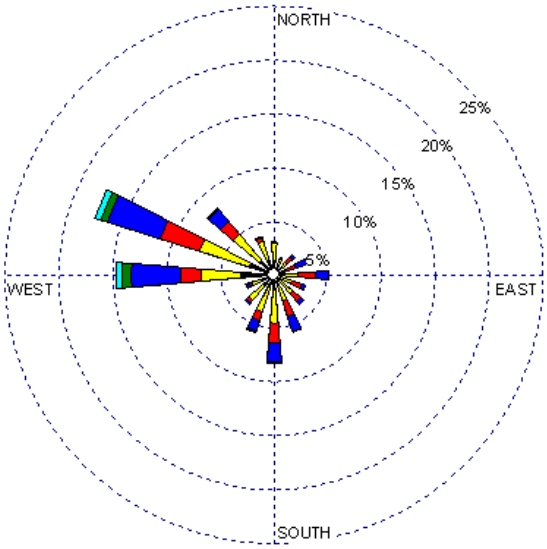
It is understood that TAPM performs reasonably well at simulating low wind speeds when the atmosphere is unstable but is known to perform relatively poorly during stable atmospheric conditions[6]. This is a critical factor in this assessment given that odour emissions occur 24-hours per day, resulting in predictions of maximum odour impact dominating during these conditions.

Figure A4 shows a histogram of wind speed distribution for observations at the Farm AWS, predictions from TAPM and predictions from TAPM after wind speed and direction data from the Farm AWS were assimilated into TAPM. It is clear from this figure that TAPM did reasonably well at originally predicting moderate to high wind speeds but did relatively poorly predicting low wind speeds. However, Figure A4 also shows that the representation of low winds in the TAPM output was significantly improved once the Farm AWS data were assimilated into the model.

[6] Luhar, A., Hurley, P. and Rayner, K. Improving Land Surface Processes in TAPM. Part 2: Low Wind Stable Conditions. 14th IUAPPA World Congress 2007

TAPM output at Nowra AWS grid point	Recorded at Nowra AWS





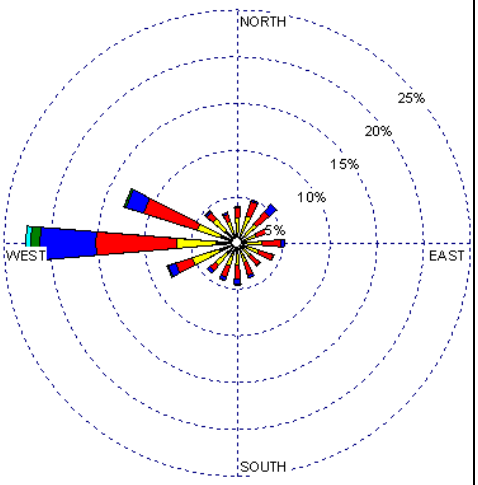
Legend

Project No.:

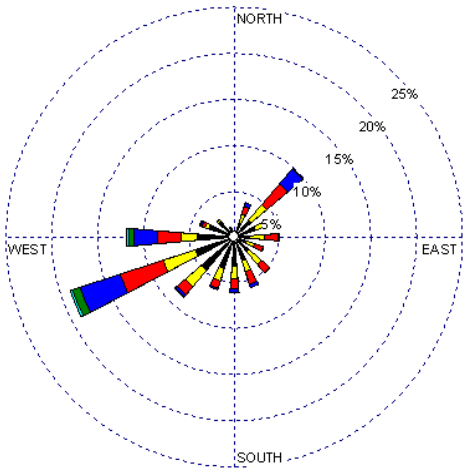
22/13594

Figure A2 Nowra AWS - Annual Wind Roses (Year 2004)

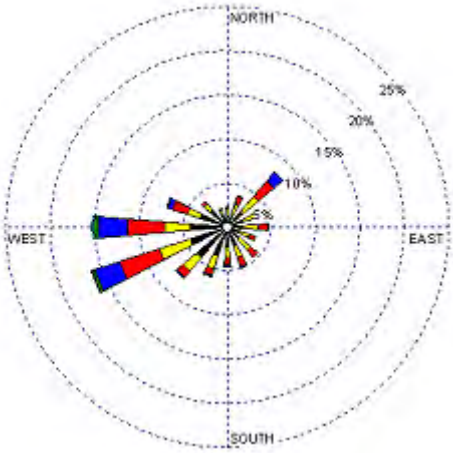
a) TAPM output at Farm AWS



b) Recorded at Farm AWS



c) TAPM output at Farm AWS grid point after Farm AWS data assimilated



Legend

Project No.:

22/13594

Figure A3 Farm AWS - Annual Wind Roses (year 2004)

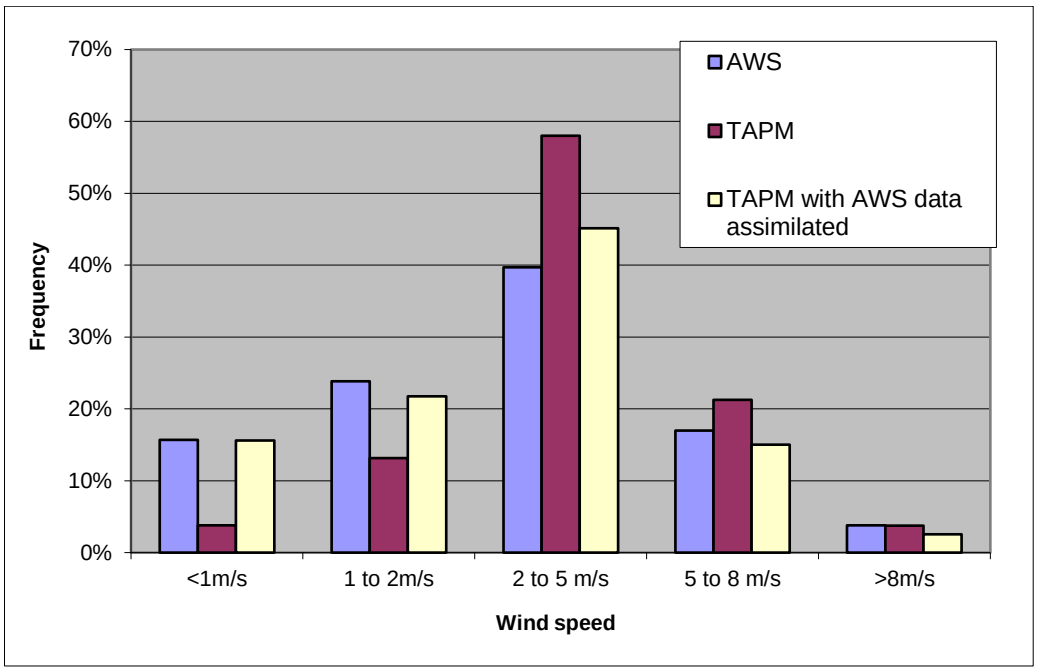


Figure A4 Wind Speed Distribution – TAPM and Farm AWS

To further investigate the effect of data assimilation on model output, a sensitivity analysis was conducted to compare the subsequent CALPUFF model predictions using meteorological input derived with and without the assimilation of observed wind speed and wind direction data from the Farm AWS into TAPM. Good agreement was found in the general pattern of dispersion (i.e. similar directions of poor dispersion), however, the highest ground level odour concentrations were predicted when the assimilated meteorological data file was used, which was expected given the higher frequency of light winds.

A3 Diagnostic Meteorological Model - CALMET

The TAPM output (with assimilated data) was then passed to model CALMET (version 5.5)[7], which is the 3D meteorological diagnostic model pre-processor to the CALPUFF 3D puff based dispersion model.

Hourly varying 3D meteorological data, at a 1000 m resolution, were extracted from the TAPM inner nested grid and passed to CALMET in their entirety as initial guess fields. Surface meteorological parameters and vertical profile data were also extracted from TAPM at a grid point near the factory, and used as if they were observations in the diagnostic model (i.e. pseudo-data).

CALMET was configured with a 15 km by 15 km grid at 200 m resolution and with local scale surface characteristics, such as terrain elevation and land use (e.g. forest or sparse growth, water or residential). The land use and terrain elevation information was derived from US Geological Survey and AusLig data, respectively, with adjustments based upon inspection of aerial photographs, topographical and land uses maps, and a site inspection.

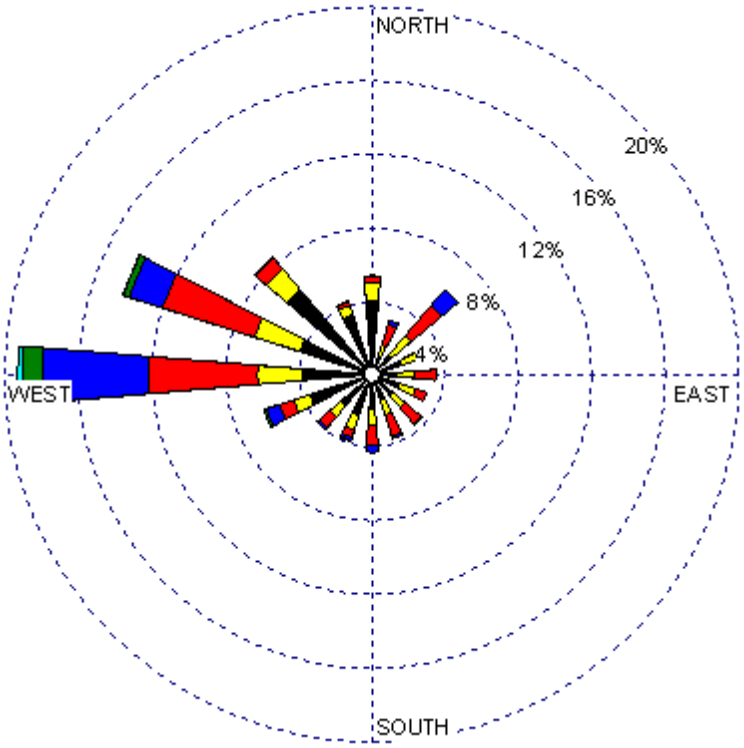
CALMET was used to produce hourly site-representative winds and micrometeorological information, which was used with the CALPUFF 3D puff-based dispersion model to assess the impacts of the air pollutants on the surrounding land uses.

[7] Scire J.S., E.M. Insley, R.J. Yamartino, and M.E. Fernau, 1995: A User's Guide for the CALMET Meteorological Model. Report prepared for the USDA Forest Service by EARTH TECH, Concord, MA. See: http://www.src.com/calpuff/calpuff1.htm

A3.1 Site-specific meteorology

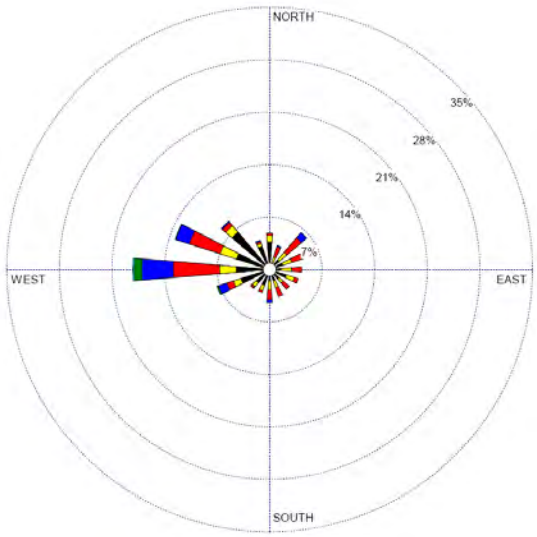
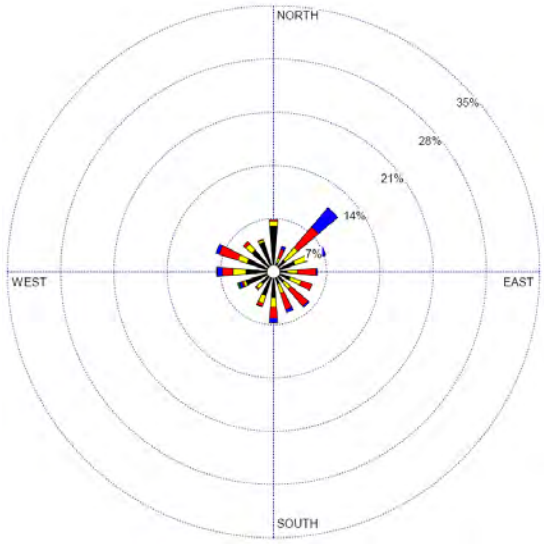
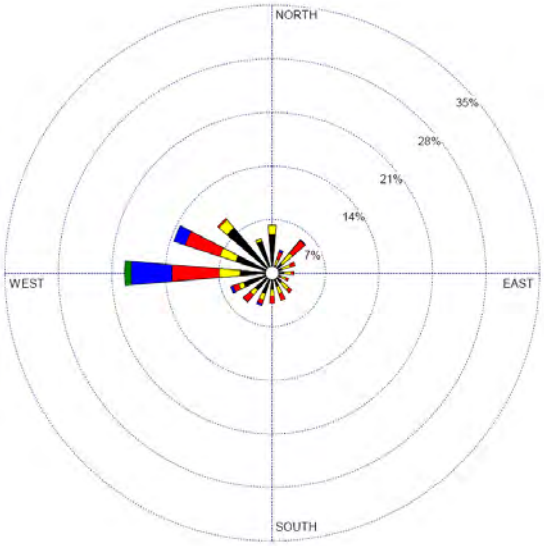
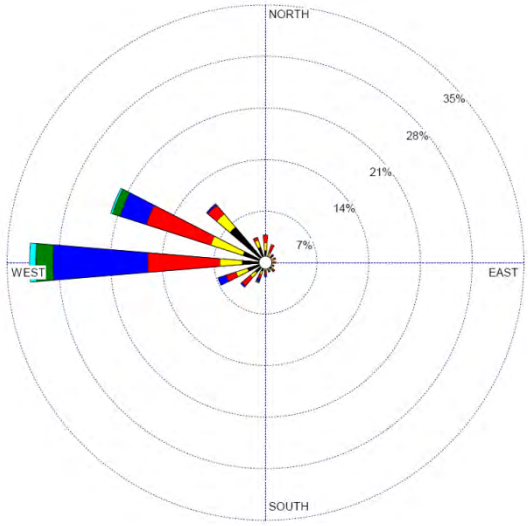
Figure A5 shows a wind rose that illustrates the distribution of wind speed and direction at the location of the Factory. On an annual basis the prevailing winds are from the west with winds also from the west-north-west, north-west, west-south-west and north-east. The mean wind speed is 3.2 m/s, with higher speed winds associated with westerly winds with speeds up to 11 m/s; such speeds are not reached from other directions. The highest frequency of light winds occurs from the south-west, west and north.

Figure A6 provides a seasonal breakdown of the predicted wind distribution at the Factory, this figure reveals a north-easterly predominance during summer (sea-breeze) and a westerly predominance during the other seasons, in particular during winter.



Legend	Comments: **Average wind speed = 3.2 m/s**	
WIND SPEED (m/s) > 11.1 8.8 - 11.1 5.7 - 8.8 3.6 - 5.7 2.1 - 3.6 0.5 - 2.1	Project No.: **22/13594**	GHD CLIENTS | PEOPLE | PERFORMANCE

Figure A5 Factory Annual Wind Rose - Year 2004

Spring (average wind speed = 3.1 m/s)	Summer (average wind speed = 2.8 m/s)
	
Autumn (average wind speed = 2.8 m/s)	**Winter (average wind speed = 4.1 m/s)**
	

Legend

Project No.:

22/13594

Figure A6 Factory Seasonal Wind Roses - Year 2004

A categorised measure of atmospheric stability is also output from the model. These can be broadly defined as listed in Table A1.

Table A1 Atmospheric Stability Classes and Distribution

Stability Class	Description	Frequency of Occurrence [1]
A	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud.	2%
B	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud.	14%
C	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud.	17%
D	Neutral atmospheric conditions. Occur during the day or night with stronger winds. Or during periods of total cloud cover, or during twilight (transition) period.	22%
E	Slightly stable atmospheric conditions occurring during the night-time with some cloud and/or light-moderate winds.	12%
F	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds.	32%

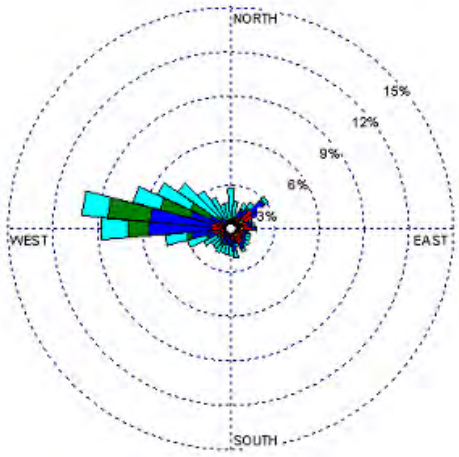
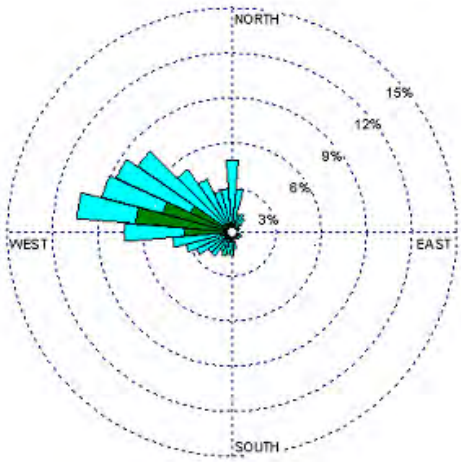
1. Stability data in this table extracted from Factory meteorological data

Potential off-site odour impact would tend to be maximised when winds are light and the atmosphere is stable, conditions that typically occur during the early evening and night-time. Table A1 shows that these conditions occurred for approximately 44% of the time.

The occurrence of stable air flows is of significance as these generally provide the conditions for worst case dispersion of emissions to air from ground based (or near-ground based) sources, and hence potentially the highest impact to odour amenity. This is due to the limited mixing in the vertical plane of these light wind airflows, and hence less dilution of the emissions from the majority of odour sources, which are either at ground level or wake affected short stacks. Therefore, the distribution of light wind stable flows can define the directions of “poor odour dispersion” from the factory and environmental farm.

Vertical mixing of airflows can be brought about by two mechanisms. The first is mechanical mixing caused by the shear stresses as air moves over rough terrain. The second is via thermal convective mixing, which has the potential to occur significantly only during daytime. The occurrence of unstable and strong-wind neutral air flows generally provide the conditions for the highest ground level concentrations due to emissions to air from elevated stack sources, such as the coal-fired boiler exhaust stacks found at the factory.

A rose that illustrates the directional distribution of the predicted atmospheric stability is shown in Figure A7. During these stable periods, the regional scale cool air drainage flows down the river valley from the west to dominate the transport and dispersion of emissions to air from the factory and environmental farm. To a lesser extent, local slope drainage flows from the elevated terrain located to the north, west-north-west and west-south-west of the site would also generate these conditions for poor dispersion.

All stability classes	E & F Stability classes (stable conditions only)
	

Legend	Comments: Location of Factory	
Stability Class F E D C B A	Project No.: **22/13594**	GHD CLIENTS | PEOPLE | PERFORMANCE

Figure A7 Factory Annual Stability Rose - Year 2008

Appendix B – Complete odour emission inventory

The following Table details all sources modelled for both the existing and proposed modifications

Source	EPA ID	ID	Source type	Height, m	Diameter, m	Exit velocity, m/s	Exit temperature K	OER after control, OUm^3/s	Peak to mean adjusted total OER OUm^3/s
Boiler No. 4	42	BOILR4	tall wake free	39	1.1	17.6	429	22077.2	var
Combined Boiler Stack for No. 5 & 6 Boilers. Coal combustion odour	35	BOILR5	tall wake free	54	2.05	15	413	68609.7	var
Additional cooling towers to the west		CTP	wake affected	10	4.5	6	295	172.0	395.6
Cooling towers		DDG46	wake affected	10	4.5	6	295	172.0	395.6
Light phase recovery tank		DDG19	wake affected	11	0.1	3.3	362	20.0	46.0
Pellet Mill Silo (proposed)		PMFS	wake affected	23	0	0	0	173.0	397.9
Pellet Plant exhaust stack	46	PPES	tall wake free	49.2	1.5	15.5	318	88073.3	var
Pellet silo (mill feed silo)		S12	wake affected	2	0.3	0.1	304	350.0	805.0
Stillage surge tank		SST	wake affected	2	0.2	3.3	360	149.0	342.7
Vent condensor drain		VCD	wake affected	24.1	0.3	0.3	300	31.0	71.3
Ethanol Recovery Scrubber Discharge	16	ERESC	wake affected	28	0.3	7.9	299.6	15405.4	35432.4
Fermenters (10-16)	44	FERM	tall wake free	21	0.28	2.4	301	795.0	1828.5
Yeast propagators - tanks 4 & 5		YP45	wake affected	17	0.4	3	310.4	820.0	1886.0
Cyclone and fabric filter		A4	wake affected	33	1.6	6	313	679.0	1561.7
Cyclone and fabric filter		A5	wake affected	33	1.6	6	313	96.0	220.8
Cyclone and fabric filter		A6	wake affected	33	1.6	6	311	449.0	1032.7
Cyclone and fabric filter		A7	wake affected	33	0.8	9	297	932.0	2143.6
Drum vacuum receiver		C4	wake affected	21	0.2	11	319.5	1400.0	3220.0
Dry gluten roof bin		S07	wake affected	25	0.7	0.1	328	4500.0	10350.0
Enzyme Tanks		B7	wake affected	6	0.5	0.3	327	2042.0	4696.6
Feed transfer to distillery		E22	wake affected	15	0.3	0.1	300	83.0	190.9
Flash Vessel Jet Cooker		C1	wake affected	21	0.1	0.1	350	970.0	2231.0
Flour bin aspirator		S13A	wake affected	2.5	0.4	0.1	306	500.0	1150.0
Flour bin aspirator		S13B	wake affected	2.5	0.4	0.1	306	500.0	1150.0

Source	EPA ID	ID	Source type	Height, m	Diameter, m	Exit velocity, m/s	Exit temperature K	OER after control, OUm^3/s	Peak to mean adjusted total OER OUm^3/s
Flour bin motor drive		S06	wake affected	24	0.3	0.1	307	283.0	650.9
Flour mill stack propsed and approved 1		FMP2	wake affected	31.8	0.68	4.4	320	266.0	611.8
Flour mill stack propsed and approved 2		FMP1	wake affected	33.4	0.9	4.2	300	205.0	471.5
Retention - tank 2 (now located in adjacent tank)		GRT	wake affected	21	0.25	0.1	293	3250.0	7475.0
High protein dust collector		S08	wake affected	24.5	0.4	0.1	316	600.0	1380.0
Incondensible gases vent		D6	wake affected	13	0.2	0.6	309	558.0	1283.4
Ion exchange effluent tank		C18	wake affected	2.5	0.32	0.1	307	250.0	575.0
Jet cooker 1 - retention tank		E13	wake affected	10	0.2	0.1	362	1067.0	2454.1
Jet cooker 2 & 4 - Retention		E7	wake affected	9	0.1	2.2	373	567.0	1304.1
Molecular Sieve - Vacuum drum		D2	wake affected	10	0.1	13	337	1350.0	3105.0
No. 1 Gluten Dryer baghouse	8	S02	wake affected	25.5	3.2	0.1	345.5	5166.0	11881.8
No. 1 Starch Dryer	12	S01	wake affected	26	1.3	8.4	317.6	11316.0	26026.8
No. 2 Gluten Dryer baghouse (aka. No 2 Starch Dryer)	9	S04	wake affected	27	3.2	0.1	342.2	5166.0	11881.8
No. 3 Gluten Dryer baghouse	10	S03	wake affected	21	2.5	9.7	353.8	21696.0	49900.8
No. 3 Starch Dryer	13	S18	wake affected	20	1.2	21.2	318.3	5166.0	11881.8
No. 4 Gluten Dryer baghouse	11	S05	wake affected	30	2.7	17.1	348.8	13692.7	31493.1
No. 4 Starch Dryer	14	S19	wake affected	20	1.2	20.8	315.8	5020.0	11546.0
No. 5 Ring Dryer Starch		SDR5	wake affected	25	1.2	0.1	320	4817.0	11079.1
No. 5 Starch Dryer (existing)	47	SD5C	wake affected	33.5	2.35	15.4	341.4	3392.9	7803.7
No. 5 Starch Dryer (new)		SD5N	wake affected	30	2.35	15.4	341.4	17387.1	39990.3

Source	EPA ID	ID	Source type	Height, m	Diameter, m	Exit velocity, m/s	Exit temperature K	OER after control, OUm^3/s	Peak to mean adjusted total OER OUm^3/s
No. 6 Gluten Dryer		GD6	wake affected	35	1.7	22.4	346.2	12568.0	28906.4
No. 7 Gluten Dryer		GD7	wake affected	29	1.7	18.9	341.2	9553.0	21971.9
Spray dryer		S20	wake affected	19	1.4	0.1	335	738.0	1697.4
Starch factory rejects collection tank		E10	wake affected	8	0.1	0.1	308	183.0	420.9
Large Starch Silo 1		PPL1	wake affected	26.5	0.16	6.8	323.2	86.4	198.8
Large Starch Silo 2		PPL2	wake affected	26.5	0.16	6.8	323.2	86.4	198.8
Medium Gluten Silo 1		PPM1	wake affected	20.7	0.16	6.8	323.2	173.0	397.9
Medium Gluten Silo 2		PPM2	wake affected	20.7	0.16	6.8	323.2	173.0	397.9
Medium Gluten Silo 3		PPM3	wake affected	20.7	0.16	6.8	323.2	173.0	397.9
Small Gluten Silo		PPS1	wake affected	34.3	0.2	18.6	323.2	91.6	210.6
Small Starch Silo		PPS2	wake affected	34.3	0.2	18.6	323.2	35.0	80.5
Biofilter A	40	BIO1	area					1386.0	var
Biofilter B	41	BIO2	area					1111.0	var
Biofilter C		BIO3	area					1089.0	
Biofilter D		BIO4	area					1280.0	
Effluent storage dam 1	19	PO1	area					118.5	var
Effluent storage dam 2	20	PO2	area					143.1	var
Effluent storage dam 3	21	PO3	area					1231.2	var
Effluent storage dam 5	23	PO5	area					1921.8	var
Effluent storage dam 6	24	PO6	area					793.1	var
Sulphur Oxidisation Basin	25	SOBAS	area					535.0	var
Membrane bio-reactor		MBR	wake affected					62.4	
DDG load out shed - awning		DDG35	volume					923.0	2122.9
DDG product storage sheds		DDG34	volume					1023.0	2352.9
DDG tent storage area		DDG36	volume					1929.0	4436.7

Source	EPA ID	ID	Source type	Height, m	Diameter, m	Exit velocity, m/s	Exit temperature K	OER after control, OUm^3/s	Peak to mean adjusted total OER OUm^3/s
Pellet plant fugitives (discharged direct to atmosphere)		PPF	wake affected					5771.0	13273.3
Farm tank		F18	volume					3834.0	8818.2
Column washing vent		CWV	wake affected	6.8	0.5	0.1	300	27.0	62.1
Flour Mill B		FMBA	wake affected	39.5	0.65	10.1	322	560.0	1288.0
Flour Mill B		FMBB	wake affected	39.5	0.65	6.53	294	1260.0	2898.0
Flour Mill B		FMBC	wake affected	39.5	0.65	10.1	322	1260.0	2898.0
Flour Mill B		FMBD	wake affected	39.5	1.1	8.77	300	257.0	591.1
Flour Mill B		FMBE	wake affected	39.5	1.1	8.77	300	642.0	1476.6
Flour Mill B		FMBF	wake affected	39.5	0.65	10.1	322	642.0	1476.6
Flour Mill C		FMC1	wake affected	37.6	0.65	10.1	322	678.8	1561.2
Flour Mill C		FMC2	wake affected	37.6	0.65	6.53	294	300.0	690.0
Flour Mill C		FMC3	wake affected	37.6	0.65	10.1	322	678.8	1561.2
Gluten dryer no. 8		GD8	wake affected	29	1.9	22.4	346.2	12568.0	28906.4

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