ANNEXURE 6

Air Quality Impact Assessment

prepared by

GHD

22, 24, 171 and 220
Bolong Road, Bomaderry

Shoalhaven Starches Pty Ltd

Proposed modification application to 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

Air Quality Assessment

May 2018

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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 16). 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 and 13 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).

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 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 existing paper mill site.
Modification 15	Construction of the SupaGas CO_2 plant at the Argyle Meats site.

1.3 Current proposal: Modification 16

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 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.
- 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.

The modifications associated with the current proposal are shown in red in Figure 1.

1.4 Scope

The proposed changes (Mod 16) 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 assessment for the site (Mod 13)
- 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 year 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 13 model setup
- Presents the results of odour dispersion modelling for the Mod 13 and proposed (Mod 16) scenarios using CALPUFF
- Characterises non-odour sources at the plant
- Presents the results of air quality dispersion modelling for the proposed (Mod 16) scenarios 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 Shoalhaven Starches Pty Ltd and may only be used and relied on by Shoalhaven Starches Pty Ltd for the purpose agreed between GHD and the Shoalhaven Starches Pty Ltd as set out in section 1.6 of this report.

GHD otherwise disclaims responsibility to any person other than Shoalhaven Starches Pty Ltd 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.

The opinions, conclusions and any recommendations in this report are based on explicit assumptions made by GHD, described in section 1.3 and throughout the body of this document, and limitations of the modelling software CALPUFF. GHD disclaims liability arising from any of the assumptions being incorrect. GHD has prepared this report on the basis of information provided by Shoalhaven Starches Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

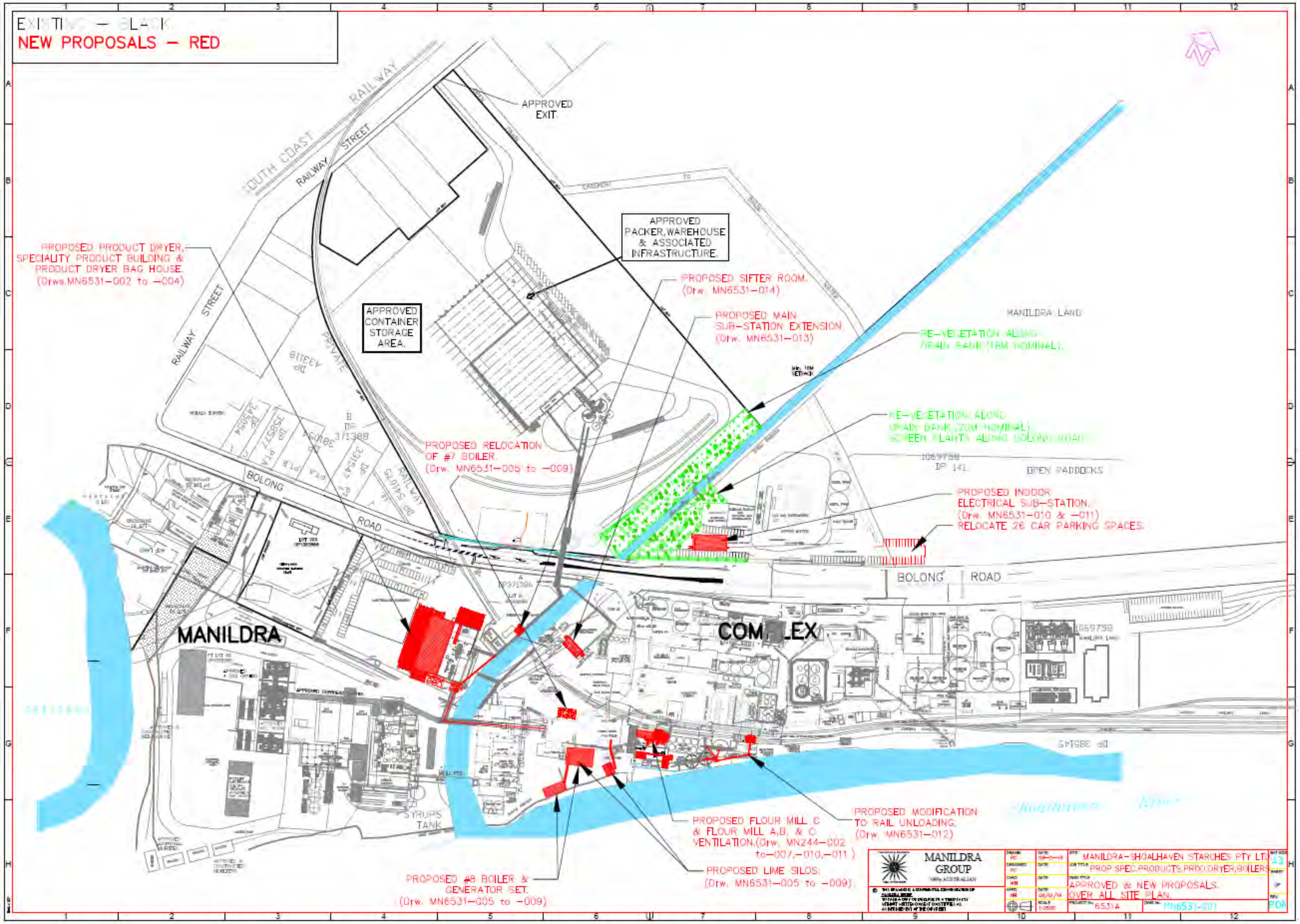

Figure 1 Proposed modification 16 changes (Source: Manildra)

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 Rural Residences

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. The nearest receptors to the factory, packing plant and environmental farm are identified in Figure 3, with the approximate distances and orientation of each residence from the plant listed in Table 2-1.

These receptors were selected to be consistent with previous odour assessments of the plant. These residences qualify as sensitive receptors, as defined in the Approved Methods as “a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area”.

Table 2-1 Location of identified sensitive receptors

Receptor	Range, m	To nearest odour source	Direction	Easting (m)	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

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

Shoalhaven Starches Factory

Packing plant (proposed)

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number	21-27188
Revision	A
Date	14 May 2018

Site location and layout

Figure 2

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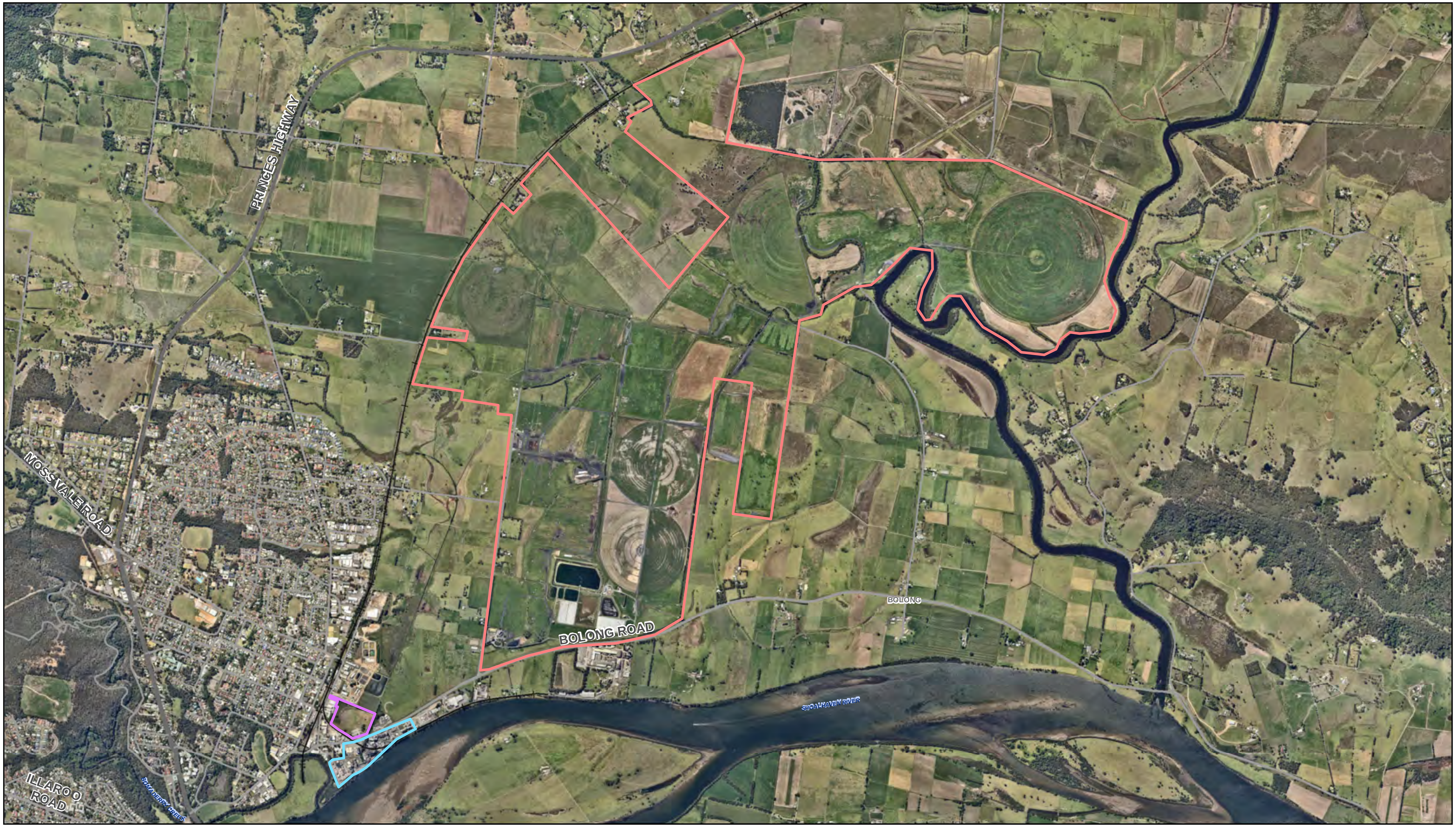
180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy



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0 125 250 500 750 1,000

Metres

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

N

LEGEND

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

GHD

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number 21-27188
Revision A
Date 18 May 2018

Site context

Figure 3

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180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

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 undergoing commissioning (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 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 boiler 4 is treated in a cyclone and those from boilers 5 and 6 are treated in a bag house prior to discharge to atmosphere.

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).

3.11.2 Mod 16

Modification 16 is discussed in Section 1.3. The main changes affecting odour and air quality impacts consist of:

- Reduction of modelled flour mill B exhausts from ten to six (only six exhausts were installed)
- Three additional flour mill C exhausts
- Conversion of gluten dryers 1 and 2 to starch
- New gluten dryer (proposed industrial building)
- New product silos outside the proposed industrial building
- Change in Boiler no 7's location
- New coal-fired boiler (Boiler no 8)
- Revision of odour and boiler emissions inventories based on measurements undertaken in the previous four quarters.

Further discussion of these changes in the context of the dispersion modelling is presented in Sections 6 and 8.

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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Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

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.

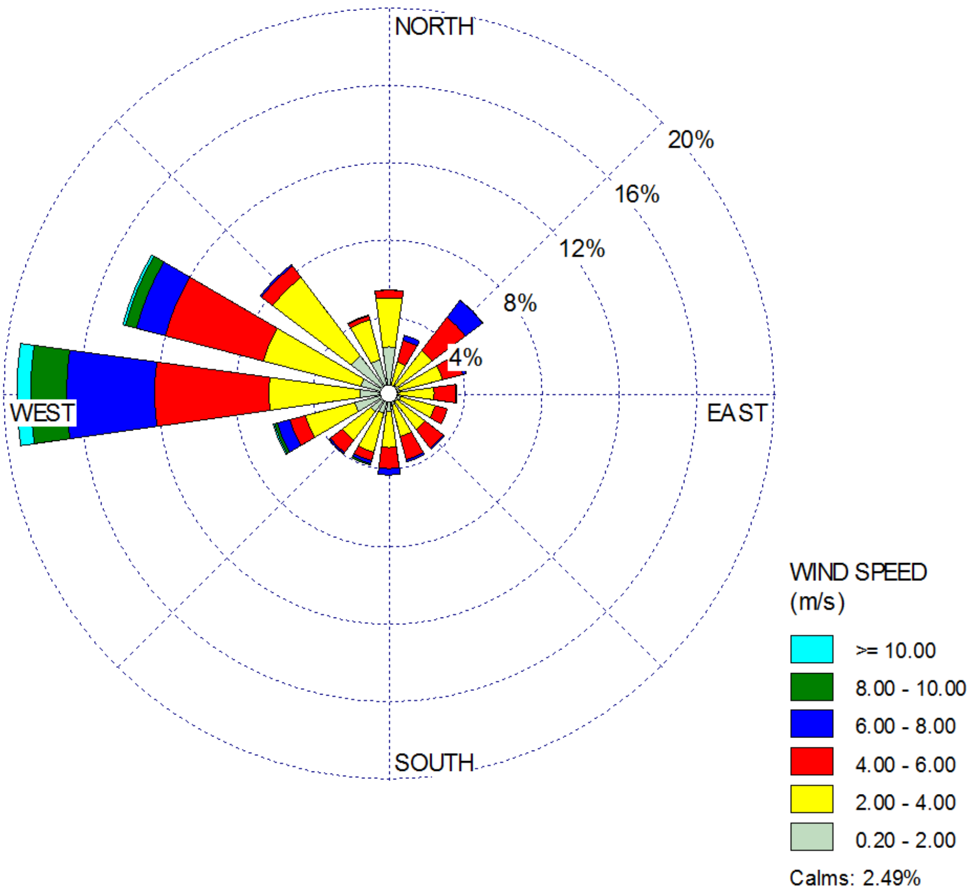

Figure 6 CALMET wind rose for the factory

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 70^{th} percentile for use in plotting general cumulative impacts. The 70^{th} 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 (100^{th} 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	1.6	
	Annual	15.7	
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/m^3

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/m^3
- NO_2 – 54.5 µg/m^3
- PM_{10} – 28.1 µg/m^3

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 13. The odour sources associated with these modifications have been discussed in depth in previous air quality assessments.

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

- Peak odour emission rates were taken from the odour monitoring conducted by SEMA in the previous four quarters (February 2017 to January 2018) 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 4 (February 2017)
- The exit velocities and temperatures for EPA ID sources were adjusted to the latest measurements. 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
- No. 1 and No. 2 gluten dryers were changed to starch dryers. The measurements from the existing starch dryer OER (5166 OUm^3/s) were assigned to these dryers
- Ten flour mill exhausts (FMBA to FMBM) were reduced to six. The six exhaust OERs were scaled based on flow rates of 243, 130, 233, 580, 580 and 200 m^3/min and the measurements provided by SEMA (October 2016) (total of 4621 OUm^3/s)
- Three additional flour mill C exhausts (FMC1 to FMC3) were added. The three exhaust OERs were scaled based on flow rates of 243, 130 and 233 m^3/min and the measurements provided by SEMA (October 2016) (additional 1657.6 OUm^3/s)

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

- Addition of a new gluten dryer (NGD). The gluten dryer was conservatively modelled with same OER as the existing gluten dryer No. 6 (additional 12568 OUm^3/s)
- Boiler 8 is not a source of odour, and this boiler will not treat odorous air from any sources onsite
- 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 16 scenario comprised the following sources:

- 67 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 12 (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 remain relatively constant between the mods, with a slight (3%) reduction in the total MOER.

The slight reduction in MOER is attributed to the use of more recent quarterly odour data.

[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.m^3/s (Mod 11 and Mod 12)	Modelled Mod 16 MOER OU.m^3/s	Mod 16 comments
Boilerhouse				
Boiler no 4	BOILR4	3,171	5,666	
Boiler no 5 & 6	BOILR5	38,463	43,711	
Sub total MOER		**41,634**	**49,377**	
% of total MOER		**15.0%**	**18.3%**	
DDG Plant				
Condenser drain	VCD	31	31	
DDG tent storage area	DDG36	1,929	1,929	
Product storage sheds	DDG34	1,023	1,023	
Light phase tank	DDG19	20	20	
Cooling towers	DDG46	172	172	
DDG Loadout Shed Awning	DDG35	923	923	
Pellet exhaust stack	PPES	38,240	31,544	
Pellet silo	S12	350	350	
Stillage surge tank	SST	149	149	
Pellet plant fugitives (non-DDG sources)	PPF	5,771	5,771	
Additional Cooling towers	CTP	172	172	
Sub total MOER		**48,780**	**42,084**	
% of total MOER		**17.5%**	**15.6%**	
Ethanol Plant				
Yeast Propagators -tanks 4 and 5	YP45	820	820	
Grain retention tank	GRT	3,250	3,250	
Ethanol recovery scrubber	ERESC	3,132	10,660	
Fermenters 10-16	FERM	2,668	3,298	
Jet cooker 1 retention tank	E13	1,067	1,067	
Jet cooker 2/4 grain retention	E7	567	567	

Source	Model Reference	MOER OU.m^3/s (Mod 11 and Mod 12)	Modelled Mod 16 MOER OU.m^3/s	Mod 16 comments
Feed to distillery	E22	83	83	
Sub total MOER		**11,587**	**19,745**	
% of total MOER		**4.2%**	**7.3%**	
Distillery				
Incondensable gases vent	D6	558	558	
Molec. sieve vacuum drum	D2	1,350	1,350	
Column Washing Vent	CWV	23	25	
Sub total MOER		**1,931**	**1,933**	
% of total MOER		**0.7%**	**0.7%**	
Starch and Glucose				
Cyclone and FF ID4	A4	679	679	
Cyclone and FF ID5	A5	96	96	
Cyclone and FF ID6	A6	449	449	
Cyclone and FF ID7	A7	932	932	
Drum vac receiver	C4	1,400	1,400	
Dry gluten roof bin	S07	4,500	4,500	
Enzyme tanks	B7	2,042	2,042	
Flash vessel jet cooker	C1	970	970	
Flour bin aspirator	S13A	500	500	
Flourbin aspirator	S13B	500	500	
Flourbin motor drive	S06	283	283	
Flour mill aspiration (Mod 8)	FMP1	266	205	
Flour mill aspiration (Mod 8)	FMP2	205	266	
High protein dust collector	S08	600	600	
Ion exchange effluent tank	C18	250	250	
No 1 gluten dryer baghouse	S02	5,925	5,166	
No 1 starch dryer	S01	5,193	5,193	
No 2 gluten/starch dryer	S04	2,354	5,166	

Source	Model Reference	MOER OU.m^3/s (Mod 11 and Mod 12)	Modelled Mod 16 MOER OU.m^3/s	Mod 16 comments
No 3 gluten dryer baghouse	S03	58,917	29,036	
No 3 starch dryer	S18	1,663	5,166	
No 4 gluten dryer baghouse	S05	31,222	22,433	
No 4 starch dryer	S19	1,824	4,008	
No 5 ring dryer gluten/starch	SDR5	4,817	4,817	
No 5 starch dryer	SD5	6,800	6,800	
No 6 gluten dryer	GD6	12,568	12,568	
No 7 gluten dryer	GD7	9,553	9,553	
Spray dryer	S20	738	738	
Starch factory rejects	E10	183	183	
Farm tank	F18	3,834	3,834	
Pellet mill silo	PMFS	173	173	
Flour Mill B Exhaust	FMBA to FMBM	5,637	4,621	10 exhausts reduced to 6 exhausts
Flour Mill C Exhaust	FMC1 to FMC3	n/a	1,658	3 additional exhausts
New gluten dryer	NGD	n/a	12,568	New gluten dryer
Sub total MOER		**165,073**	**147,353**	
% of total MOER		**59.3%**	**54.7%**	
Packing Plant (Not constructed)				
Starch silo 1	PPL1	86	86	Not constructed
Starch silo 2	PPL2	86	86	Not constructed
Gluten silo 1	PPM1	173	173	Not constructed
Gluten silo 2	PPM2	173	173	Not constructed
Gluten silo 3	PPM3	173	173	Not constructed
Small gluten silo	PPS1	92	92	Not constructed
Small starch silo	PPS2	35	35	Not constructed
Sub total MOER		**818**	**818**	
% of total MOER		**0.3%**	**0.3%**	
Area sources: Env farm after WWTP				

Source	Model Reference	MOER OU.m^3/s (Mod 11 and Mod 12)	Modelled Mod 16 MOER OU.m^3/s	Mod 16 comments
Biofilter A	BIO1	440	1,408	
Biofilter B	BIO2	330	803	
Biofilter C	BIO3	1,089	1,089	
Biofilter D	BIO4	1,280	1,280	
Storage dam 1	PO1	148	71	
Storage dam 2	PO2	1,656	248	
Storage dam 3	PO3	192	569	
Storage dam 5	PO5	515	971	
Storage dam 6	PO6	1,775	1,435	
Sulfur oxidisation basin	SOBAS	830	349	
Membrane bio-reactor	MBR	62	62	
Sub total MOER		**8,317**	**8,286**	
% of total MOER		**3.0%**	**3.1%**	
Total (Mod 11 and Mod 12)		278,140		
Total (Mod 16)			269,595	

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 minute, 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. Additional buildings and structures were added to represent the proposed speciality products building, product dryer and boiler 8.

7.3 Predicted odour impacts

Figure 7 shows the predicted 99th percentile odour impacts (one minute nose-response time) for the proposed Mod 16 operations and the previous mitigated Mod 13 results.

Table 7-2 shows the predicted odour levels for the proposal (Mod 16). Table 7-2 also shows the previous Mod 13 results.

The predicted odour levels show a slight (0.1 OU) increase at receptors R1 and R2 and a 0.6 OU increase at receptor R3. No increase is predicted at receptor R4. The increase is attributed to the new sources in the southern part of the site and the addition of new buildings.

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

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*
R1 Bomaderry	150	Packing Plant	W	6	3.3	3.5
R2 North Nowra	1300	Factory	SW	3	2.5	2.6
R3 Nowra	700	Factory	S	5	4	4.6
R4 Terara	1300	Factory	SE	5	3.7	3.7

Paper Size A4

0 110 220 440 660 880

Metres

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

N

LEGEND

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

GHD

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number 21-26310
Revision A
Date 11 May 2018

Odour impacts, 99th percentile,
one minute average- Modification 16, OU

Figure 7

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

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 odour sources at the Shoalhaven Starches plant up to Mod 13. The sources associated with these modifications have been discussed in the most recent cumulative air quality assessment undertaken in 2017 (*Shoalhaven Starches Mod 13 Air Quality Assessment Updated Cumulative Air Quality Assessment*, GHD 2017).

The following assumptions and changes were made to the baseline air quality model:

- Emissions from Boilers 2, 4, 5/6 and the proposed boiler 8 have been based on monitoring undertaken for boiler 5/6. The SO_2 emissions from boiler 5/6 was conservatively modelled at the EPA limit of 600 mg/m^3. The emissions have been scaled to proposed future coal consumption rates
- Measurements from Quarter 4 (2016-2017) have been used for NOx, SO_2 and particulates as the quarter has above average NOx, PM_{10} and TSP levels. The emissions report from SEMA for this quarter is attached in Appendix D
- Measurements from Quarter 1 (2017-2018) have been used for hydrogen chloride and metals as this is the most recent annual metals survey. The emissions report from SEMA is attached in Appendix E
- Ten flour mill exhausts (FMBA to FMBM) were reduced to six. The six exhaust PM_{10} and TSP levels were scaled based on flow rates of 243, 130, 233, 580, 580 and 200 m^3/min and the measurements provided by SEMA (October 2016)
- Three additional flour mill C exhausts (FMC1 to FMC3) were added. The three exhaust PM_{10} and TSP levels were scaled based on flow rates of 243, 130 and 233 m^3/min and the measurements provided by SEMA (October 2016)
- Addition of a new gluten dryer (NGD). The gluten dryer was conservatively modelled with same PM_{10} and TSP levels as the existing gluten dryer No. 6
- Addition of 17 silo exhausts (grouped into 4 emission points) outside the proposed new speciality products building. The silos were modelled at 0.0003 g/s per silo based on the older (now decommissioned) grain silo
- The addition of lime silos has not been included in the model as the discharges will occur for 1 hour every four days and are not expected to contribute significantly to the particulate levels
- Manildra advised that 236,520 MJ of biogas would be combusted in boiler 7. The emission factors for biogas combustion have been sourced from *National Pollutant Inventory Emission estimation technique manual For Combustion in boilers Version 3.6* (December 2011) Table 20
- Manildra advised that 500,000 MJ of natural gas would be directed to gluten dryers 6 and 7 and starch dryer 5. The dryers are similar to residential furnaces. The emission rates for residential furnaces have been sourced from US EPA *AP-42 Compilation of Air Emissions Factors Section 1.4 Natural Gas Combustion*

- Hydrogen fluoride emissions from boiler 8 will be controlled through the use of lime dosing systems. The control systems reduce the emissions by 99%. A conservative HF reduction of 90% has been assumed for modelling purposes
- PM_{10} and TSP levels were assumed to be unchanged for the other emission sources.

The emissions inventory for particulate matter is provided in Table 8-1.

Pollutants from combustion in the site boilers and turbines are presented in Table 8-2. The normalised and actual measured emission rates for boilers 5/6 are provided in Appendix C.

Table 8-1 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	0.03	0.03
Boiler No. 4	Cyclone and fabric filter	0.05	0.06
Boiler No. 5/6	Cyclone & Fabric filter	0.23	0.24
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	Cyclone	0.39	0.12
Spray dryer	Fabric filter	0.48	0.14
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 grinder	Fabric filter	0.02	0.02
Co-generator turbine No. 1 (proposed)	Gas-fired	0.1	0.1
Co-generator turbine No. 2 (proposed)	Gas-fired	0.1	0.1
Boiler No. 8 (including co-gen turbine)	Cyclone & Fabric filter	0.16	0.16
New gluten dryer	Fabric Filter	0.02	0.02
Silos associated with speciality products building	Fabric Filter	0.051	0.051

Table 8-2 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
Status	Existing	Existing	Existing	Existing	Proposed	Existing	Existing	Existing	Proposed
Fuel type	Natural gas	Coal	Coal	Coal	Coal	Natural gas	Natural gas	Natural gas	Natural gas
Stack height (m)	25	39	39	54	39	35	29	33.5	30
Exhaust temp. (°C)	180	138	138	150	150	73	68	56	160
Stack diameter (m)	0.9	0.63	1.16	2.05	0.65	1.7	1.7	2.4	0.5
Exhaust velocity (m/s)	25	19.9	5.8	16.8	16.8	18.9	22.4	15	25
Oxygen (%)	ND	ND	ND	8.7	ND	ND	ND	ND	ND
Moisture (%)	ND	ND	ND	5.2	ND	ND	ND	ND	ND
Exhaust Flow rate (Nm^3/s)	ND	4.5	8.4	27.9	ND	ND	ND	ND	ND
Emission rates (g/s)									
Carbon monoxide	8.78E-02	2.95E-01	5.71E-01	2.42E+00	1.65E+00	2.99E-01	2.27E-01	1.62E-01	0.3
Sulfur dioxide	4.03E-03	2.46E+00	4.76E+00	2.02E+01	1.38E+01	4.48E-03	3.40E-03	2.42E-03	0.012
Oxides of nitrogen	6.21E-01	1.84E+00	3.56E+00	1.51E+01	1.03E+01	7.02E-01	5.33E-01	3.80E-01	2.0
Total VOC	2.01E-02	1.80E-02	3.49E-02	1.48E-01	1.01E-01	ND	ND	ND	0.0042
Heavy metals (type 1)	7.52E-06	1.87E-04	3.61E-04	1.53E-03	1.05E-03	ND	ND	ND	ND
Heavy metals (type 2)	1.45E-05	2.34E-04	4.52E-04	1.92E-03	1.31E-03	ND	ND	ND	ND
HCL	-	2.92E-02	5.65E-02	2.40E-01	1.64E-01	ND	ND	ND	ND
PAH	2.33E-06	9.77E-06	1.89E-05	8.01E-05	5.47E-05	ND	ND	ND	4.4E-05
FL	-	7.72E-02	1.49E-01	6.33E-01	4.32E-02	ND	ND	ND	ND

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

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 8-3. The worst case predicted incremental PM_{10} level is at R1 with a level of 8.8 µg/m^3.

Table 8-3 Maximum Predicted Ground Level PM10, PM2.5 and TSP Concentrations

Pollutant	Averaging Period	Criteria µg/m^3	Predicted Incremental Ground Level Concentration (µg/m^3)			
			Bomaderry (R1)	**North Nowra (R2)**	**Nowra (R3)**	**Terara (R4)**
PM_{10}	24-hour	50	8.8	4.8	7.7	6.6
PM_{10}	annual	25	0.9	0.5	0.8	1.2
$PM_{2.5}$	24-hour	25	4.4	2.4	3.8	4.4
$PM_{2.5}$	annual	8	0.4	0.2	0.4	0.4
TSP	annual	90	1.8	0.9	1.6	2.3

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 receptor (R1) are presented in Table 8-4 and Table 8-5 below.

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

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 8-4 Summary of highest measured and predicted PM_{10} levels (R1)

Date	PM_{10} background	Date	PM_{10} increment	Date	PM_{10} cumulative
08/03/2004	49.0	22/03/2004	8.8	08/03/2004	49.3
27/11/2004	48.4	11/03/2004	8.1	27/11/2004	48.7
21/02/2004	47.0	20/10/2004	5.6	21/02/2004	47.0
26/03/2004	46.1	24/09/2004	5.1	26/03/2004	46.1
08/12/2004	43.7	18/08/2004	5.1	08/12/2004	44.5
10/01/2004	43.4	19/01/2004	4.6	10/01/2004	43.4
09/02/2004	43.1	18/01/2004	4.4	09/02/2004	43.1
06/02/2004	41.2	05/04/2004	4.2	20/02/2004	41.7
07/12/2004	40.8	02/03/2004	4.2	06/02/2004	41.3
20/02/2004	40.4	17/10/2004	4.2	07/12/2004	41.1

Table 8-5 Summary of highest measured and predicted $PM_{2.5}$ levels (R1)

Date	$PM_{2.5}$ background	Date	$PM_{2.5}$ increment	Date	$PM_{2.5}$ Total
10/01/2004	22.6	22/03/2004	4.4	10/01/2004	22.6
21/02/2004	22.3	11/03/2004	4.1	21/02/2004	22.3
26/03/2004	19.9	20/10/2004	2.8	26/03/2004	19.9
06/02/2004	19.0	24/09/2004	2.6	06/02/2004	19.0
09/02/2004	18.3	18/08/2004	2.6	11/02/2004	18.7
11/02/2004	17.9	19/01/2004	2.3	09/02/2004	18.3
09/03/2004	17.6	18/01/2004	2.2	27/11/2004	17.6
08/03/2004	17.5	05/04/2004	2.1	08/03/2004	17.6
27/11/2004	17.5	02/03/2004	2.1	09/03/2004	17.6
13/03/2004	17.0	17/10/2004	2.1	07/02/2004	17.1

Paper Size A4

0 110 220 440 660 880

Metres

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

N

LEGEND

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

PM10 24HR concentration contour (µg/m3)

- 5
- 10
- 20

Manildra Group Pty Ltd
Shoalhaven Starches

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

Figure 8

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180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

Paper Size A4

0 110 220 440 660 880

Metres

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

N

LEGEND

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

PM10 24HR concentration contour (µg/m3)

- 20
- 30
- 40

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Manildra Group Pty Ltd
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Revision	A
Date	11 May 2018

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

Figure 9

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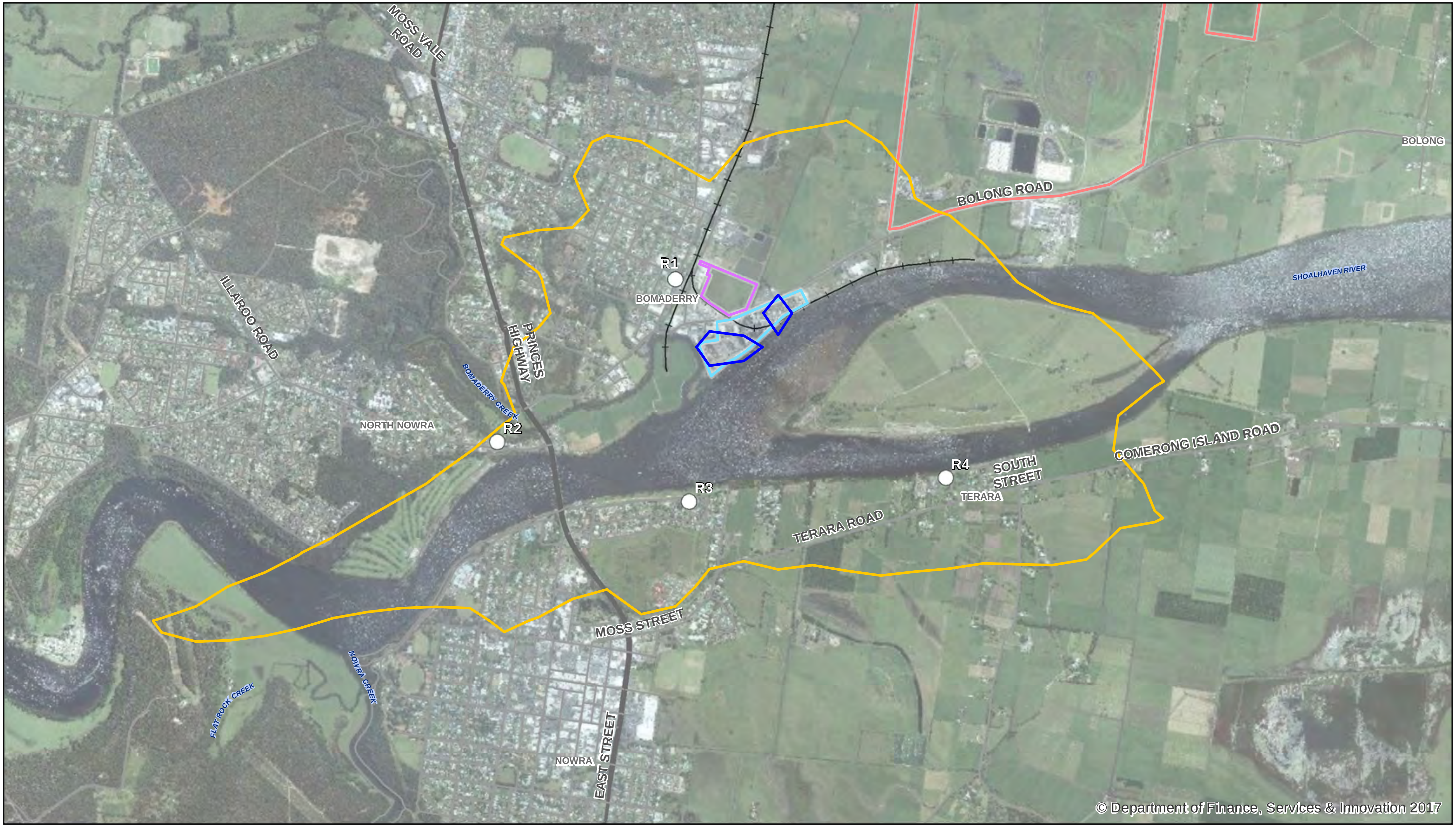
180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy



Paper Size A4

0 110 220 440 660 880

Metres

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

N

LEGEND

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

PM2.5 24HR concentration contour (µg/m3)

- 10
- 20

Manildra Group Pty Ltd
Shoalhaven Starches

Job Number	21-26310
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Maximum Predicted Cumulative Ground Level PM2.5 Concentrations (24-hour Average), µg/m3

Figure 10

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180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. 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 'worst case' 1 hour criteria from the Approved Methods as these were found to be closest to the criteria in the previous air quality assessments.

Predicted levels for SO_2 ,carbon monoxide, hydrogen fluoride and hydrogen chloride comply with the criteria.

The predicted levels for nitrogen dioxide exceed the criteria at sensitive receptor R3. 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 8-7. The NO_2 levels are predicted to comply with the criteria at all sensitive receptors.

Contour plots of cumulative NO_2 (Method 1) and SO_2 predictions are shown in Figure 11 and Figure 12.

Table 8-6 Maximum Predicted Ground Level Sulfur Dioxide concentrations

Receptor	Averaging Period	Incremental Impact (µg/m^3)	Background Concentration (µg/m^3)	Total Impact (µg/m^3)	Criteria (µg/m^3)
Bomaderry (R1)	1 hour	168.1	57.6	225.7	570
North Nowra (R2)	1 hour	203.3	57.6	260.9	570
Nowra (R3)	1 hour	338.6	57.6	396.2	570
Terara (R4)	1 hour	182.3	57.6	239.9	570

Table 8-7 Maximum predicted Ground Level Nitrogen Dioxide concentrations

Receptor	Averaging Period	Incremental Impact (µg/m^3)	Background Concentration (µg/m^3)	Method 1 total Impact (µg/m^3)	Method 2 total Impact (µg/m^3)*	Criteria (µg/m^3)
Bomaderry (R1)	1 hour	136.7	80.8	217.5	111.1	246
North Nowra (R2)	1 hour	156.7	80.8	237.5	103.1	246
Nowra (R3)	1 hour	263.2	80.8	**344**	155.7	246
Terara (R4)	1 hour	145.7	80.8	226.5	172.8	246

* Includes the background NO2 concentration as per Method 2 (Section 8.2.2) of the Approved Methods.

Table 8-8 Maximum Predicted Ground Level Carbon Monoxide concentrations

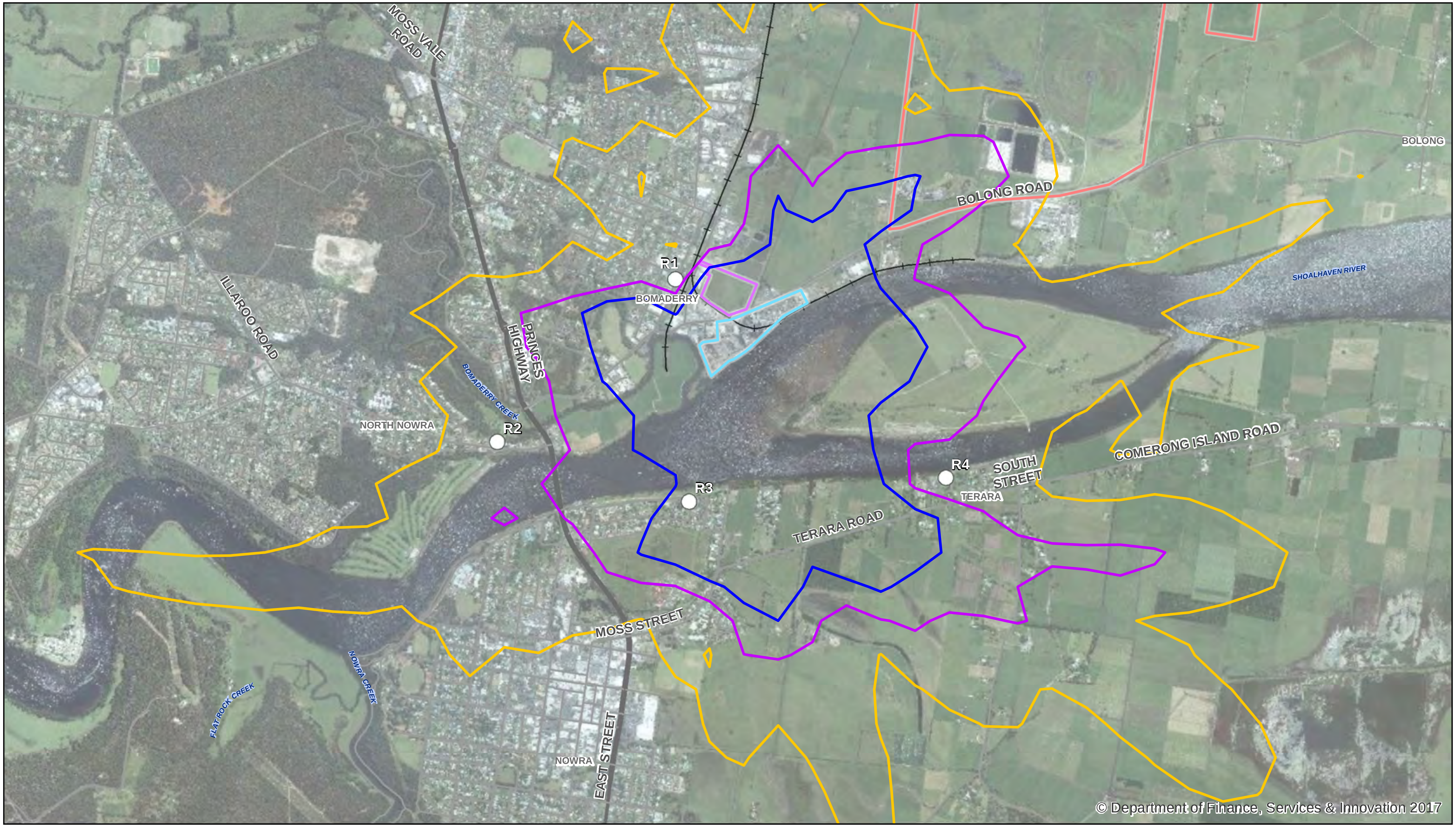
Receptor	Averaging Period	Incremental Impact (mg/m^3)	Background Concentration (mg/m^3)	Total Impact (mg/m^3)	Criteria (mg/m^3)
Bomaderry (R1)	1 hour	0.0243	1	1.0243	30
North Nowra (R2)	1 hour	0.0255	1	1.0255	30
Nowra (R3)	1 hour	0.0424	1	1.0424	30
Terara (R4)	1 hour	0.025	1	1.025	30

Table 8-9 Maximum Predicted Ground Level Hydrogen Fluoride concentrations

Receptor	Averaging Period	Incremental Impact (µg/m^3)	Background Concentration (µg/m^3)	Total Impact (µg/m^3)	Criteria (µg/m^3)
Bomaderry (R1)	24 hours	0.9	-	0.9	1.5
North Nowra (R2)	24 hours	0.8	-	0.8	1.5
Nowra (R3)	24 hours	0.8	-	0.8	1.5
Terara (R4)	24 hours	0.5	-	0.5	1.5

Table 8-10 Maximum Predicted Ground Level Hydrogen Chloride concentrations

Receptor	Averaging Period	Incremental Impact (mg/m^3)	Background Concentration (mg/m^3)	Total Impact (mg/m^3)	Criteria (mg/m^3)
Bomaderry (R1)	1 hour	0.0018	-	0.0018	0.14
North Nowra (R2)	1 hour	0.0018	-	0.0018	0.14
Nowra (R3)	1 hour	0.0027	-	0.0027	0.14
Terara (R4)	1 hour	0.0018	-	0.0018	0.14



Paper Size A4

0 110 220 440 660 880

Metres

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

N

LEGEND

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

N02 1HR concentration contour (µg/m3)

- 200
- 250
- 300

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Maximum Predicted Cumulative Ground Level NO2 concentrations (1 hour Average) , µg/m3

Figure 11

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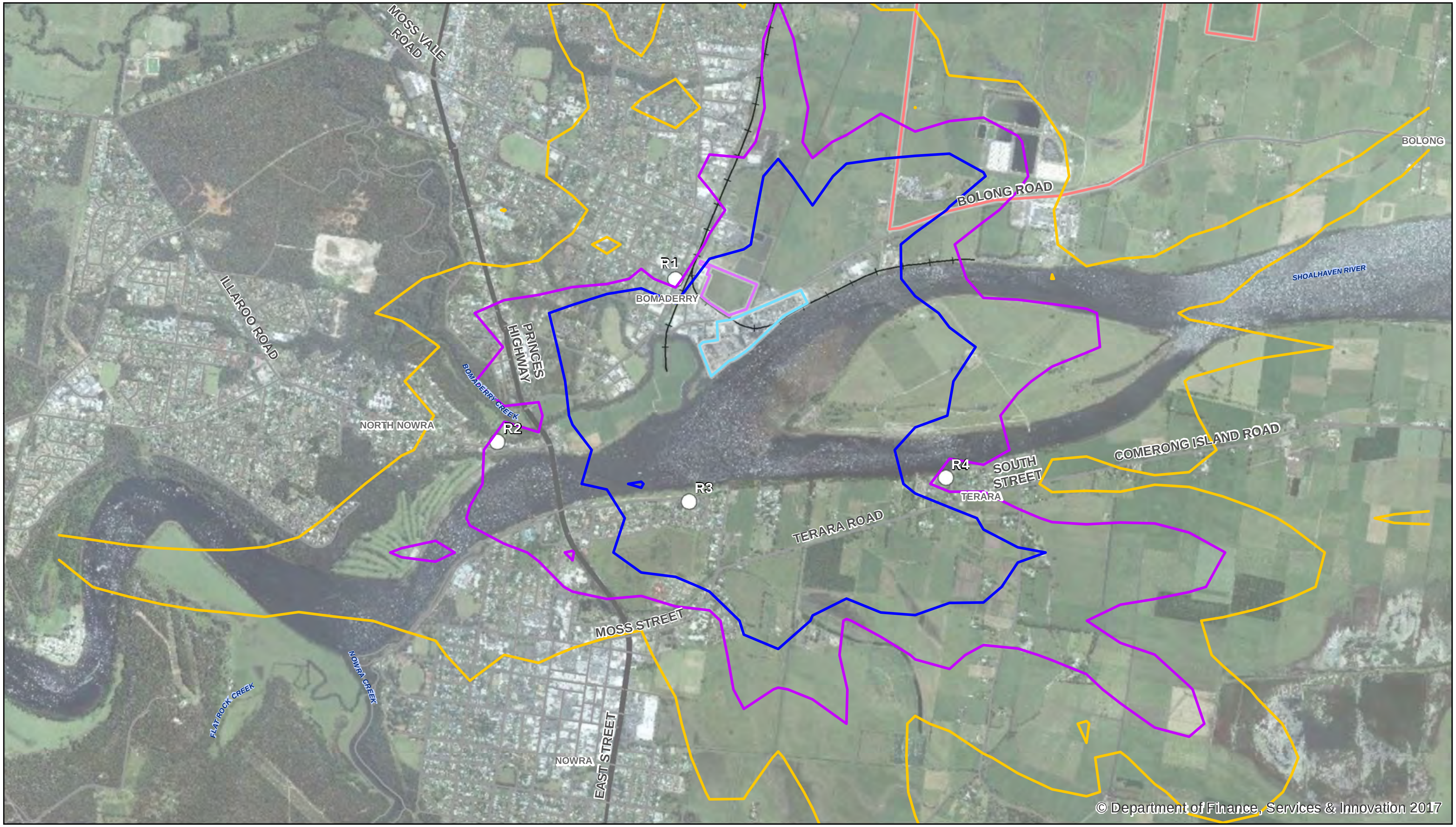
180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy



Paper Size A4

0 110 220 440 660 880

Metres

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

N

LEGEND

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

S02 1HR concentration contour (µg/m3)

- 200
- 250
- 300

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Shoalhaven Starches

Job Number 21-26310
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Date 11 May 2018

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

Figure 12

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180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

8.3.3 VOCs

The maximum predicted (99.9 percentile, 1-hour average) ground level aggregate VOC concentration, at and beyond the factory site boundary, was 0.0058 mg/m^3, which is lower than the respective EPA principal toxic air pollutant criteria for all the VOC compounds.

The maximum predicted (99.9 percentile, 1-hour average) ground level total VOC, at the most exposed sensitive receptor (R3), was 0.0018 mg/m^3, which is lower than the respective EPA principal toxic air pollutant criteria for all the VOC compounds.

8.3.4 PAH

The maximum predicted (99.9 percentile, 1-hour average) ground level total PAH concentration, at and beyond the factory site boundary, was 0.0000028 mg/m^3, which is lower than the EPA PAH criterion of 0.0004 mg/m^3.

The maximum predicted (99.9 percentile, 1-hour average) ground level total PAH, at the most exposed sensitive receptor (R3), was 0.00000093 mg/m^3, which is 0.2% of the criterion.

8.3.5 Metals

This maximum predicted ground level concentrations for type 1 and type 2 metals are shown in Table 8-11 and discussed below.

Type 1 metals

The maximum predicted (99.9 percentile, 1-hour average) ground level heavy metal type 1 concentration, at the most exposed sensitive receptor (R3), was 0.0000177 mg/m^3 which is lower than the respective air quality criteria for all constituents.

The EPA criteria also require consideration of the maximum predicted ground level concentration at and beyond the site boundary of the factory.

The maximum predicted level of type 1 metals at the site boundary is 0.000054 mg/m^3 which is also below the worst case criteria for all constituents, except for cadmium. The maximum predicted (99.9 percentile, 1-hour average) ground level cadmium concentration at the site boundary is 0.0000012 mg/m^3, which complies with the criterion.

Type 2 metals

The maximum predicted (99.9 percentile, 1-hour average) ground level heavy metal type 2 concentration, at the most exposed receptor (R3), was 0.000022 mg/m^3, which is lower than the respective air quality criteria for all constituents, except for beryllium at 0.000004 mg/m^3. The maximum predicted (99.9 percentile, 1-hour average) ground level beryllium concentration at the most exposed sensitive receptor (R3) was 2.36E-07 mg/m^3, which complies with the criterion.

The maximum predicted type 2 metals level at the site boundary is 0.000067 mg/m^3 which is also below the worst case criteria except for beryllium. The maximum predicted (99.9 percentile, 1-hour average) ground level beryllium concentration at the site boundary is 0.0000007 mg/m^3, which exceeds the criteria at the site boundary.

Table 8-11 Maximum Predicted Ground Level Metals Concentrations

Pollutant	Receptor	Averaging Period	Predicted Impact (mg/m^3)	Criteria (mg/m^3)
Total type 1 metals	Nowra (R3)	1 hour	0.00001765	Cadmium 0.000018
Total type 1 metals	Site boundary	1 hour	0.0000535	Cadmium 0.000018
Cadmium	Nowra (R3)	1 hour	3.8081E-07	Cadmium 0.000018
Cadmium	Site boundary	1 hour	0.0000012	Cadmium 0.000018
Total type 2 metals	Nowra (R3)	1 hour	0.00002213	Beryllium 0.000004
Total type 2 metals	Site boundary	1 hour	0.0000668	Beryllium 0.000004
Beryllium	Nowra (R3)	1 hour	2.3553E-07	Beryllium 0.000004
Beryllium	Site boundary	1 hour	0.000000713	Beryllium 0.000004

8.4 Mitigation measures

Specific mitigation measures are not recommended. However, the following mitigation measures will be implemented by Manildra on site and have been considered in the assessment methodology:

- Lime dosing systems to reduce SO_2 and hydrogen fluoride emissions from boiler 8. The addition of hydrated lime is to be applied at a rate which reduces SO_2 concentrations at the flue outlet to below 600 mg/m^3.

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 undertaking modifications to the flour mill B building, construction of a new industrial building, addition of a new boiler and gluten dryer, relocation of the existing boiler no. 7 and changes to existing dryers.

A marginal increase was observed in predicted odour impacts as a result of the modification. The odour criteria is met at all 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 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

Department of Environment and Conservation. (2006). *Technical Framework: Assessment and management of odour from stationary sources in NSW*. Sydney: NSW government

EPA. (2016). *Approved Methods for the Modelling and Assessment of Air Poluutants in New South Wales*. Sydney: NSW Government.

GHD. (2008). *Shoalhaven Starches- Report of Ethanol Upgrade Air Quality Assessment*. Melbourne VIC: GHD

Stephenson Environmental Management Australia. (2015). *Modifications to Existing Flour Mill. Newington NSW*: Stephenson Environmental Management Australia

Stephenson Environmental Management Australia. (2015). *Modifications to Packing Plant. Newington NSW*: Stephenson Environmental Management Australia

Stephenson Environmental Management Australia. (2017). *Emission Test Report No. 5805 Compliance stack emission survey – Quarter no. 4, 2016-2017*. Newington NSW: Stephenson Environmental Management Australia

Stephenson Environmental Management Australia. (2017). *Emission Test Report No. 5852/M Compliance stack emission survey – Quarter no. 1, 2017-2018*. Newington NSW: Stephenson Environmental Management Australia

The Odour Unit. (2010). *Ethanol Upgrade: DDG Biofilter Commissioning & Operating Manual . Eveleigh*, NSW: The Odour Unit

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).

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[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.

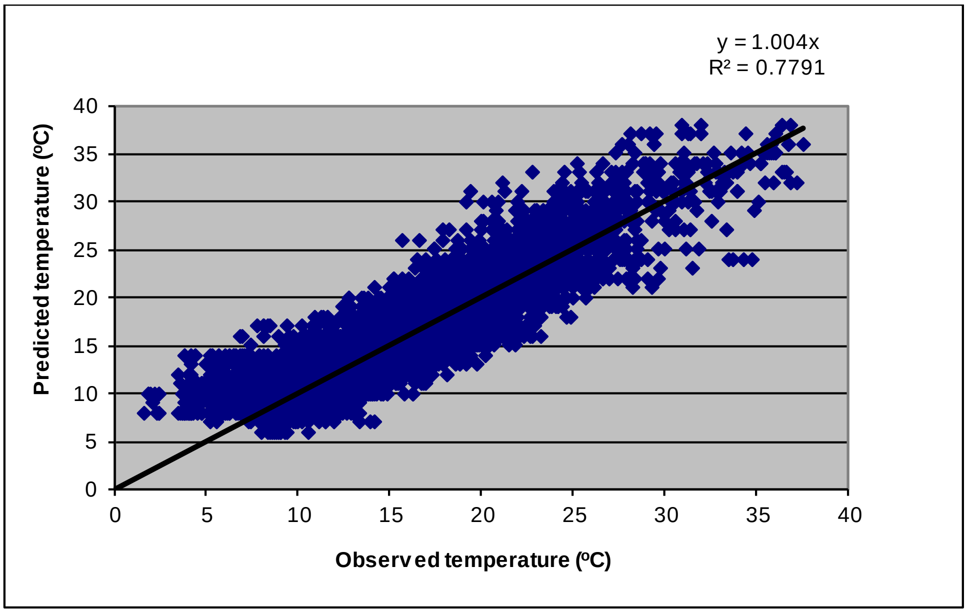


Figure A1 Scatter Plot of Observed and Predicted Ambient Temperature

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.

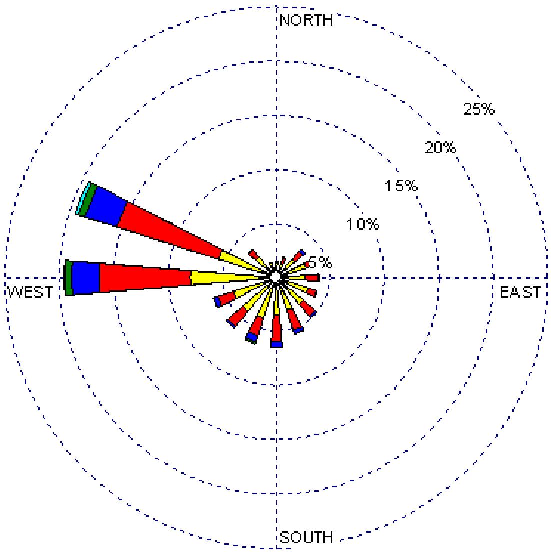
The wind speed and direction observations from the Farm AWS were assimilated into the prognostic model simulation to improve the ability of the model to capture the effects of local wind channelling and low wind speed conditions. The improvement to wind direction distributions in the model output is 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



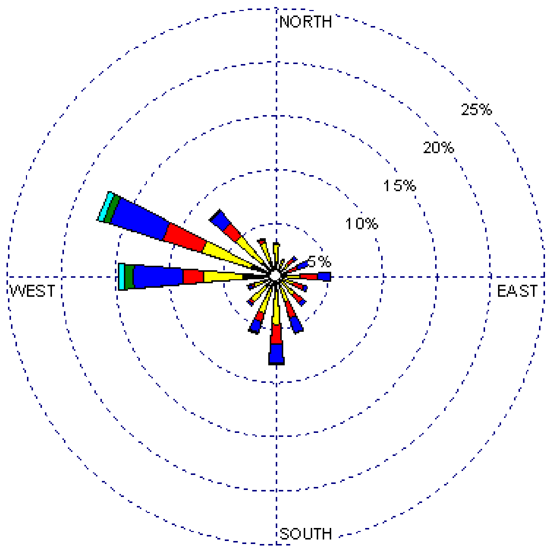


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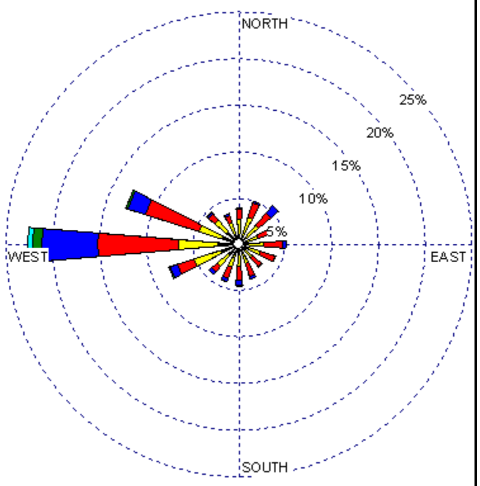
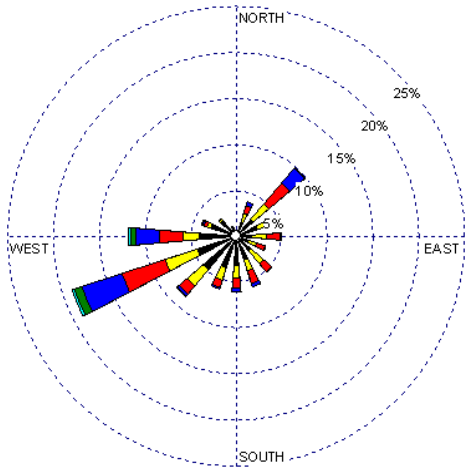
Figure A2 Nowra AWS - Annual Wind Roses (Year 2004)

a) TAPM output at Farm AWS



b) Recorded at Farm AWS



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

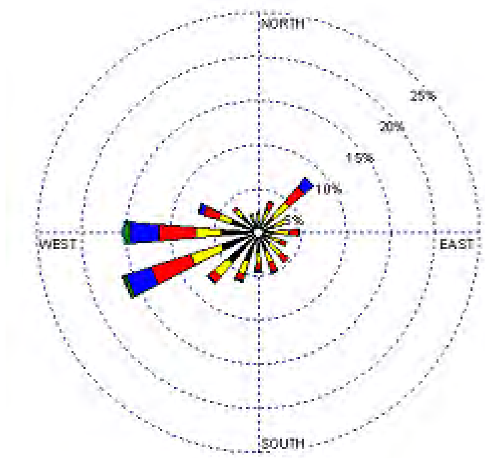


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Figure A3 Farm AWS - Annual Wind Roses (year 2004)

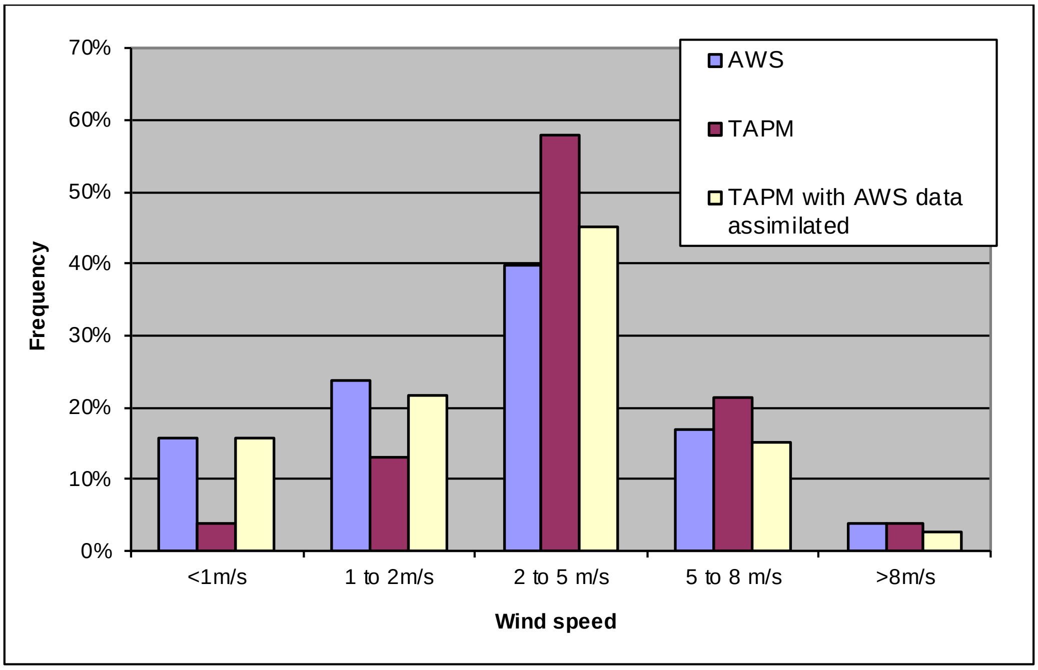


Figure A4 Wind Speed Distribution – TAPM and Farm AWS

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.

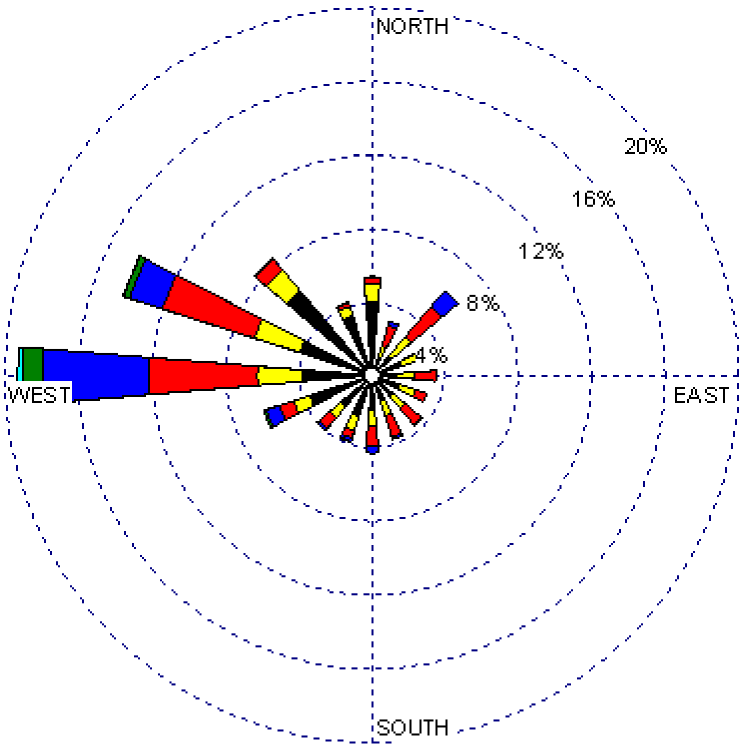
CALMET was used to produce hourly site-representative winds and micrometeorological information, which was used with the CALPUFF 3D puff-based dispersion model to assess the impacts of the air pollutants on the surrounding land uses.

[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

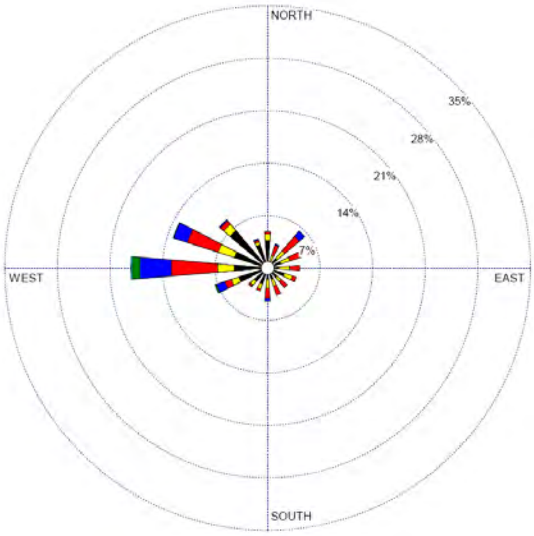
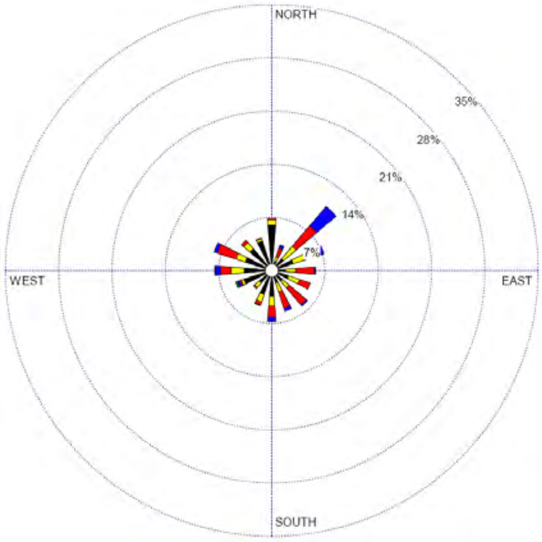
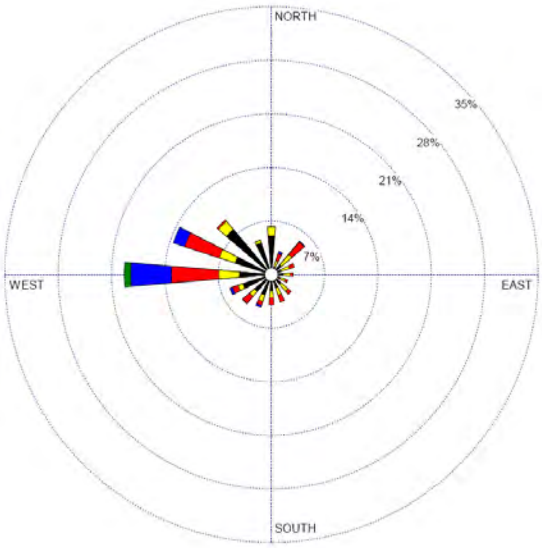
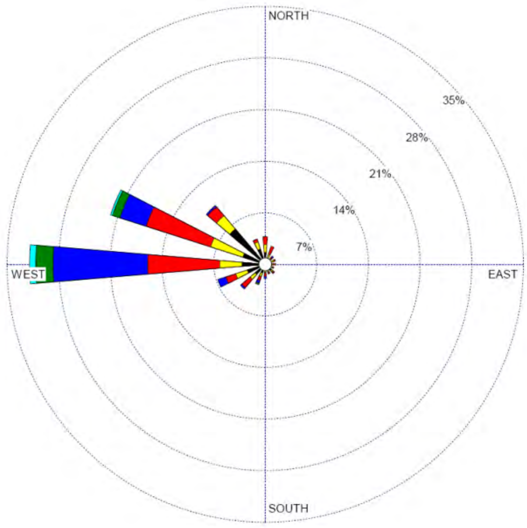
Figure A5 shows a wind rose that illustrates the distribution of wind speed and direction at the location of the Factory. On an annual basis the prevailing winds are from the west with winds also from the west-north-west, north-west, west-south-west and north-east. The mean wind speed is 3.2 m/s, with 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**	
	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

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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

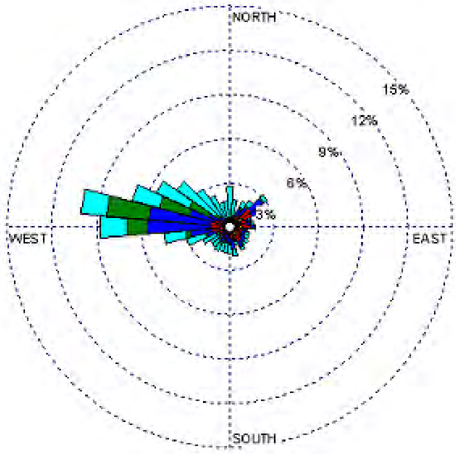
Potential off-site odour impact would tend to be maximised when winds are light and the atmosphere is stable, conditions that typically occur during the early evening and night-time. Table A1 shows that these conditions occurred for approximately 44% of the time.

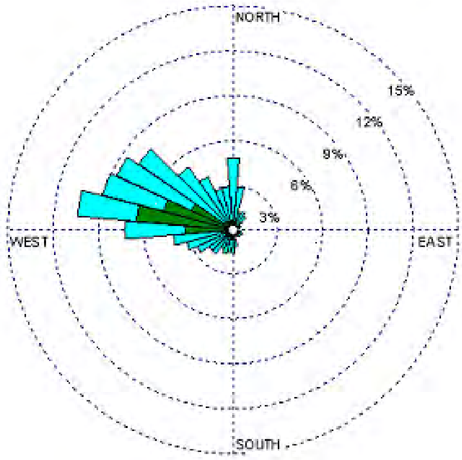
The occurrence of stable air flows is of significance as these generally provide the conditions for worst case dispersion of emissions to air from ground based (or near-ground based) sources, and hence potentially the highest impact to odour amenity. This is due to the limited mixing in the vertical 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**

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	7.3	477.2	5666.3	var
Combined Boiler Stack for No. 5 & 6 Boilers. Coal combustion odour	35	BOILR5	tall wake free	54	2.05	13.8	423.2	43710.5	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	12.5	326.4	31544.0	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	300.7	10660.0	24518.0
Fermenters (10-16)	44	FERM	tall wake free	21	0.28	2.6	304.7	3298.0	7585.4
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	7.2	315.5	5193.0	11943.9
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	10.5	348.1	29036.0	66782.8
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	16.9	352.9	22433.0	51595.9
No. 4 Starch Dryer	14	S19	wake affected	20	1.2	22	313.5	4008.0	9218.4
No. 5 Ring Dryer Starch		SDR5	wake affected	25	1.2	0.1	320	4817.0	11079.1
No. 5 Starch Dryer		SD5	wake affected	33.5	2.35	14.96	329.2	6800.0	15640.0
No. 6 Gluten Dryer		GD6	wake affected	35	1.7	22.4	346.2	12568.0	28906.4

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. 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					1408.0	var
Biofilter B	41	BIO2	area					803.0	var
Biofilter C		BIO3	area					1089.0	
Biofilter D		BIO4	area					1280.0	
Effluent storage dam 1	19	PO1	area					71.1	var
Effluent storage dam 2	20	PO2	area					248.0	var
Effluent storage dam 3	21	PO3	area					569.1	var
Effluent storage dam 5	23	PO5	area					970.8	var
Effluent storage dam 6	24	PO6	area					1435.2	var
Sulphur Oxidisation Basin	25	SOBAS	area					348.9	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
Pellet plant fugitives (discharged direct to atmosphere)		PPF	wake affected					5771.0	13273.3

Source	EPA ID	ID	Source type	Height, m	Diameter, m	Exit velocity, m/s	Exit temperature K	OER after control, OUm³/s	Peak to mean adjusted total OER OUm³/s
Farm tank		F18	volume					3834.0	8818.2
Column washing vent		CWV	wake affected	6.8	0.5	0.1	300	24.5	56.4
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
New gluten dryer		NGD	wake affected	29	1.9	22.4	346.2	12568.0	28906.4

Appendix C – Boiler 5/6 emission rates (mg/m^3)

Boiler 5/6 emission rates

Boiler 5/6 (at 91 tph)	Normalised mg/m^3	Actual mg/m^3	Actual g/s
Measurement details: Stack sampling plane diameter: 2 m Stack sampling plane velocity: 14.2 m/s Stack exit temperature: 142 C Stack moisture content: 5.2 % Ratio actual flow to normalised flow: 1.6			
PM10	6.9	4.3	0.192
TSP	7.1	4.4	0.198
CO	72	45.0	2.008
SO2	600	375.1	16.732
NO2	449	280.7	12.521
VOC	4.4	2.75	0.123
Type 1 metals	0.04558	0.02849	0.001
Type 2 metals	0.05705	0.03566	0.002
HCL	7.13	4.45718	0.199
PAH	-	-	6.65E-05[1]
FL	-	-	0.53[1]

Note 1: PAH and FL emission rates were sourced from the *National Pollutant Inventory Emission estimation technique manual For Combustion in boilers Version 3.6* (December 2011)

Appendix D – Quarter 4 (2016-2017) Boiler 5/6 emissions survey (SEMA, 2017)

Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526

52A Hampstead Road
Auburn NSW 2144 Australia
Tel: (02) 9737 9991
E-Mail: info@stephensonenv.com.au

EMISSION TEST REPORT NO. 5805

COMPLIANCE STACK EMISSION SURVEY – QUARTER NO. 4, 2016-2017

EMISSION POINT EPL ID 35 - (SERVING BOILERS NO. 5 & 6)

SHOALHAVEN STARCHES PTY LTD

BOMADERRY, NSW

PROJECT NO.: 5805/S24248/17

DATE OF SURVEY: 26 APRIL 2017

DATE OF ISSUE: 12 MAY 2017

1 EMISSION TEST REPORT NO. 5805

The sampling and analysis was commissioned by:

Client:	Shoalhaven Starches Pty Ltd
Contact:	John Studdert
Address:	Bolong Road, Bomaderry, NSW 2541
Telephone:	02 4423 8254
Email:	John.studdert@manildra.com.au
Project Number:	5805/S24248/17
Test Date:	26 April 2017
Production Conditions:	Normal operating conditions during emission testing.
Analysis Requested:	Dry gas density, flow, moisture, molecular weight of stack gases, temperature, carbon monoxide, carbon dioxide, oxygen, nitrogen oxides, particulate matter less than 10 microns, stack pressure, sulfur dioxide, total solid particulate matter and volatile organic compounds
Sample Locations:	EPL No.883; EPL ID No. 35 – Combined Stack Boilers No. 5 & 6
Sample ID Nos.:	See Attachment A

This report must not be reproduced except in full.

NATA accredited laboratory number 15043.

Accredited for Compliance with ISO/IEC 17025.

Identification	The samples are labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification) sampling date and time and whether further analysis is required.

Test	*Test Method Number for Sampling and Analysis*	*NATA Laboratory Analysis By: NATA Accreditation No. & Report No.*
Carbon Dioxide	NSW TM-24, USEPA M3A	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Carbon Monoxide	NSW TM-32, USEPA M10	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Dry Gas Density	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Flow	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Moisture	NSW TM-22, USEPA M4	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Molecular Weight of Stack Gases	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Oxides of Nitrogen	NSW TM-11, USEPA M7E	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Oxygen	NSW TM-25, USEPA M3A,	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Particulate Matter less than 10 microns	NSW OM-5, USEPA 201A	SEMA, Accreditation No. 15043, Particle Test Report No. 2039

Stack Pressure	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Stack Temperature	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Sulfur Dioxide	NSW TM-4, USEPA M6C	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Total Solid Particulates	NSW TM-15, AS4323.2	SEMA, Accreditation No. 15043, Particle Test Report No. 2039
Velocity	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5805
Volatile Organic Compounds	NSW TM-34, USEPA M18	TestSafe Australia, Accreditation No. 3726, Report No. 2017-1833

Deviations from Test Methods Nil

Sampling Times NSW - As per Test Method requirements or if not specified in the Test Method then as per Protection of the Environment Operations (Clean Air) Regulations Part 2.

Reference Conditions NSW – As per

(1) Environment Protection Licence conditions, or

(2) Schedule 4 and 5 of the Protection of the Environment Operations (Clean Air) Regulations

All associated NATA endorsed Test Reports/Certificates of Analysis are provided separately in Attachment A.

Issue Date
12 May 2017

Peter Stephenson
Managing Director

1.1 SUMMARY OF AVERAGE EMISSION RESULTS – TEST REPORT NO. 5805

Parameter	Unit	Location EPL ID 35 Boiler 5 & 6 / Date Tested: 26 April 2017 / Average Result	EPL 100 Percentile Emission Concentration Limit (mg/m³)
Temperature	°C	141	N/A
Pressure	kPa	103.2	N/A
Velocity	m/s	14.2	N/A
Volumetric Flow	m³/s	28.4	N/A
Moisture	%	5.2	N/A
Molecular Weight Dry Stack Gas	g/g mole	30	N/A
Dry Gas Density	kg/m³	1.34	N/A
Carbon Dioxide (CO_2)	%	10.3	N/A
Carbon Monoxide (1 hour average at 7% O_2)	mg/m³	72	N/A
Sulfur Dioxide (1 hour average at 7% O_2)	mg/m³	510	1,200
Nitrogen Oxides (1 hour average at 7% O_2)	mg/m³	449	500
Oxygen	%	8.7	> 5
Particulate Matter less than 10 microns (at 7% O_2)	mg/m³	6.9	N/A
Total Solid Particulates (at 7% O_2)	mg/m³	7.1	50
Volatile Organic Compounds (as n-propane equivalent at 7% O_2)	mg/m³	<4.2	40
Volatile Organic Compounds (uncorrected for n-propane at 7% O_2)	mg/m³	<4.4	N/A

Key:

°C	=	degrees Celsius
kPa	=	kilo Pascals
m/s	=	metres per second
m³/s	=	dry cubic metre per second 0°C and 101.3 kilopascals (kPa)
%	=	percentage
g/g mole	=	grams per gram mole
mg/m³	=	milligrams per cubic metre at 0°C and 101.3 kilopascals (kPa) @ Reference Conditions (where specified)
kg/m³	=	kilograms per cubic metre
>	=	greater than
<	=	less than
N/A	=	Not referenced in EPL

1.2 ESTIMATED UNCERTAINTY OF MEASUREMENT

Pollutant	Methods	Uncertainty
Moisture	AS4323.2, NSW TM-22, USEPA 4	25%
Nitrogen Oxides	NSW TM-11, USEPA 7E	15%
Oxygen and Carbon Dioxide	NSW TM-24, TM-25, USEPA 3A	1% actual
Carbon Monoxide	TM-32, USEPA 10	15%
Particulate > 20 mg/m³	NSW TM-15, AS4323.2,	15%
Particulate < 20 mg/m³	NSW TM-15, AS4323.2,	50%
Particulate matter less than 10 microns	NSW OM-5, USEPA M201A	50%
Sulfur Dioxide	NSW TM-4, USEPA M6C	15%
Velocity	AS4323.1, NSW TM-2, USEPA M2	5%
Volatile Organic Compounds (adsorption tube)	NSW TM-34, USEPA M18	25%

Key:

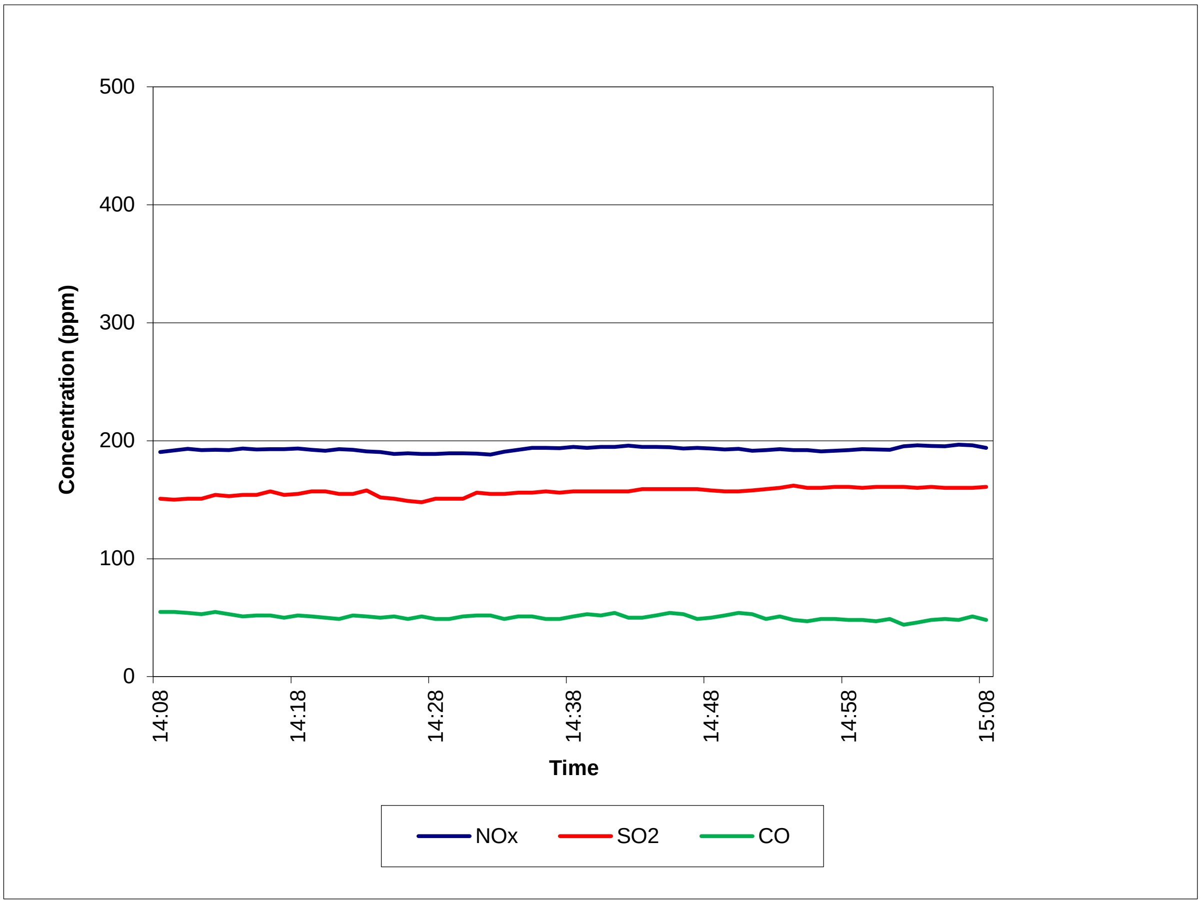
Unless otherwise indicated the uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source – Measurement Uncertainty)

Sources: *Measurement Uncertainty – implications for the enforcement of emission limits by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK*

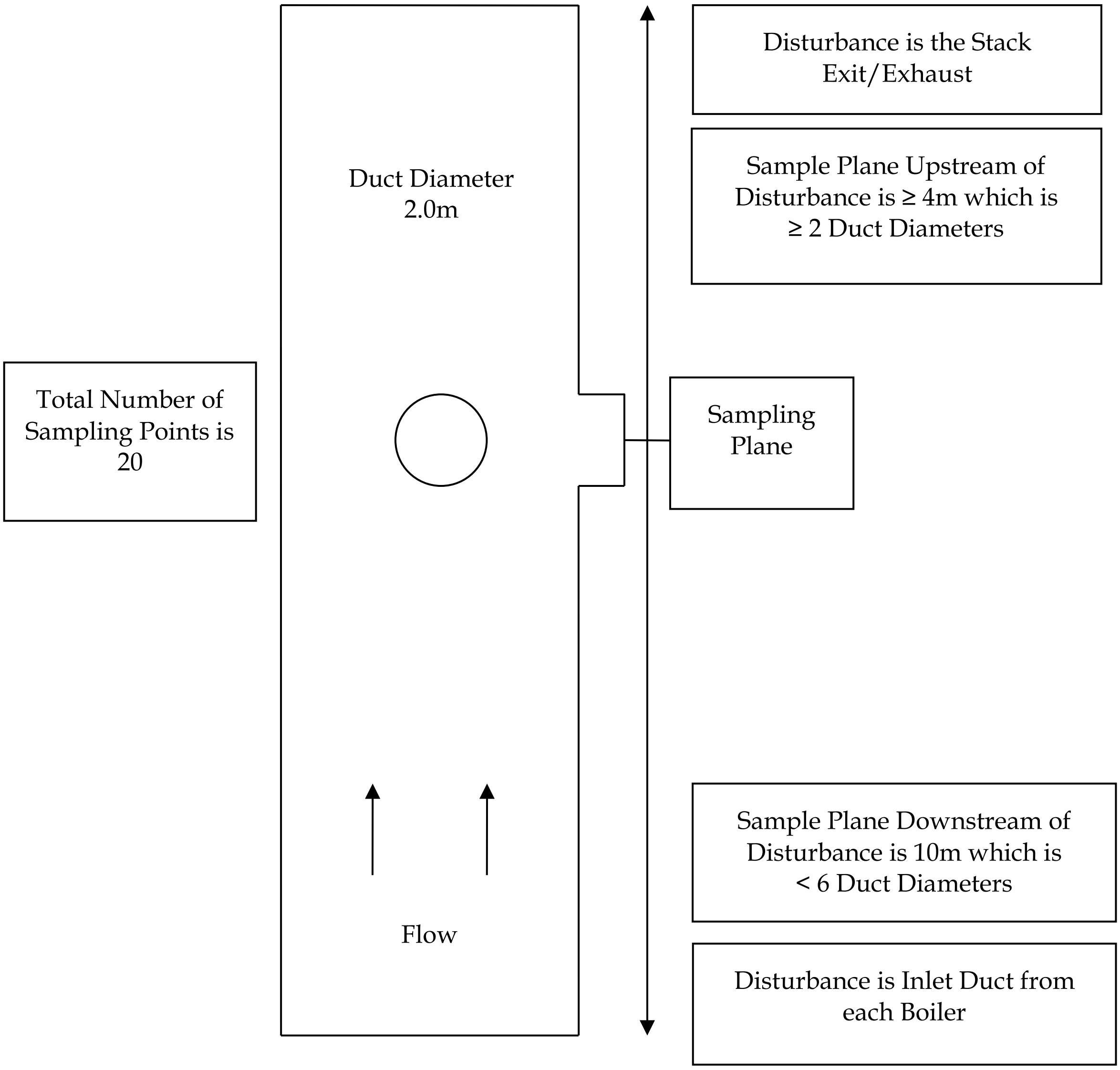
Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.

Note: ISO 9096 is for 20-1000 mg/m³- which AS4323.2 is based on. Note DSEN 13284-1 testing for < 5 mg/m³ correlates to 5 mg/m³ with most quoted uncertainties of ± 5.3 mg/m³ @ 6.4 mg/m³. From Clean Air Engineering in the United States the lowest practical limit of USEPA M5 is 5 mg/m³ under lab conditions.

1.3 CONTINUOUS LOGGED RECORD OF CO, SO_2 AND NO_x IN PPM– 26 APRIL 2017



1.4 SAMPLING LOCATION – EPL ID 35: BOILER NOS. 5 & 6



In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were used in compliance with AS4323.1 as the sampling plane was non-ideal.

The sample plane however does meet the minimum sampling plane conditions; sampling plane conditions will be found to exist at 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance.

The location of the sampling plane complies with AS4323.1 temperature, velocity and gas flow profile criteria for sampling.

1.5 INSTRUMENT CALIBRATION DETAILS

SEMA Asset No.	Equipment Description	Date Last Calibrated	Calibration Due Date
647	Stopwatch	18-Jan-17	18-Jul-17
904	Gas Meter	06-Jun-16	06-Jun-17
872	Gas Meter	21-Mar-17	21-Mar-18
858	Digital Temperature Reader	17-Jan-17	17-Jul-17
921	Thermocouple	17-Jan-17	17-Jul-17
426	Nozzle TSP Swagelok 1	09-Mar-17	09-Mar-18
916	Nozzle PM_{10} Head	18-Jan-17	18-Jan-18
885	Digital Manometer	23-Feb-17	23-Feb-18
613	Barometer	23-Feb-17	23-Feb-18
726	Pitot	03-Jun-16	03-Jun-2017 Visually inspected On-Site before use
929	Calibrated Site Mass	22-Mar-17	22-Mar-18
928	Balance		Response Check with SEMA Site Mass
946	Combustion analyzer	17-Feb-17	17-Aug-17
834	Personal Sampler	22-Mar-17	22-Mar-18
Gas Mixtures used for Analyser Span Response			
Conc.	**Mixture**	**Cylinder No.**	**Expiry Date**
902 ppm 9.8% 10.4%	Carbon Monoxide Carbon Dioxide Oxygen In Nitrogen	ALSB 4980	07-Feb-18
245 ppm 245 ppm 250 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen Sulfur Dioxide In Nitrogen	ALSB 1372	05-Jan-20
393 ppm 399 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen	ALSM1604	25-Oct-18
383 ppm	Sulfur Dioxide In Nitrogen	ALSD 3948	25-Oct-18

ATTACHMENT A – NATA CERTIFICATES OF ANALYSIS

SafeWork NSW

Test Safe AUSTRALIA

Jay Weber
Stephenson Environmental Management Australia
PO Box 6398
SILVERWATER NSW 1811

Lab. Reference: 2017-1833

SAMPLE ORIGIN: Project No. 5805

DATE OF INVESTIGATION: 26/04/2017 **DATE RECEIVED:** 28/04/17

ANALYSIS REQUIRED: Volatile Organic Compounds

REPORT OF ANALYSIS

See attached sheet(s) for sample description and test results.

The results of this report have been approved by the signatory whose signature appears below.

For all administrative or account details please contact the Laboratory.

Increment and total pagination can be seen on the following pages.

Martin Mazereeuw
Manager

Date: 8/05/17

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Accreditation No. 3726
Accredited for compliance with ISO/IEC 17025

NSW GOVERNMENT | SafeWork NSW

TestSafe AUSTRALIA

Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Jay Webber
Sample ID : 726211

Sample : 2017-1833-1

No	Compounds	CAS No	Front	Back	No	Compounds	CAS No	Front	Back
			µg/section					µg/section	
	Aliphatic hydrocarbons (LOD = 5µg/compound/section)					**Aromatic hydrocarbons** (LOD = 1µg/compound/section)			
1	2-Methylbutane	78-78-4	ND	ND	39	Benzene	71-43-2	ND	ND
2	n-Pentane	109-66-0	ND	ND	40	Ethylbenzene	100-41-4	ND	ND
3	2-Methylpentane	107-83-5	ND	ND	41	Isopropylbenzene	98-82-8	ND	ND
4	3-Methylpentane	96-14-0	ND	ND	42	1,2,3-Trimethylbenzene	526-73-8	ND	ND
5	Cyclopentane	287-92-3	ND	ND	43	1,2,4-Trimethylbenzene	95-63-6	ND	ND
6	Methylcyclopentane	96-37-7	ND	ND	44	1,3,5-Trimethylbenzene	108-67-8	ND	ND
7	2,3-Dimethylpentane	565-59-3	ND	ND	45	Styrene	100-42-5	ND	ND
8	n-Hexane	110-54-3	ND	ND	46	Toluene	108-88-3	ND	ND
9	3-Methylhexane	589-34-4	ND	ND	47	p-Xylene &/or m-Xylene	106-42-3 / 108-38-3	ND	ND
10	Cyclohexane	110-82-7	ND	ND	48	o-Xylene	95-47-6	ND	ND
11	Methylcyclohexane	108-87-2	ND	ND		**Ketones** (LOD #49, #54 & #55 =5µg/cm; #50, #51, #52 & #53 =25µg/cm)			
12	2,2,4-Trimethylpentane	540-84-1	ND	ND	49	Acetone	67-64-1	ND	ND
13	n-Heptane	142-82-5	ND	ND	50	Acetoin	513-86-0	ND	ND
14	n-Octane	111-65-9	ND	ND	51	Diacetone alcohol	123-42-2	ND	ND
15	n-Nonane	111-84-2	ND	ND	52	Cyclohexanone	108-94-1	ND	ND
16	n-Decane	124-18-5	ND	ND	53	Isophorone	78-59-1	ND	ND
17	n-Undecane	1120-21-4	ND	ND	54	Methyl ethyl ketone (MEK)	78-93-3	ND	ND
18	n-Dodecane	112-40-3	ND	ND	55	Methyl isobutyl ketone (MIBK)	108-10-1	ND	ND
19	n-Tridecane	629-50-5	ND	ND		**Alcohols** (LOD = 25µg/compound/section)			
20	n-Tetradecane	629-59-4	ND	ND	56	Ethyl alcohol	64-17-5	ND	ND
21	α-Pinene	80-56-8	ND	ND	57	n-Butyl alcohol	71-36-3	ND	ND
22	β-Pinene	127-91-3	ND	ND	58	Isobutyl alcohol	78-83-1	ND	ND
23	D-Limonene	138-86-3	ND	ND	59	Isopropyl alcohol	67-63-0	ND	ND
	Chlorinated hydrocarbons (LOD = 5µg/compound/section)				60	2-Ethyl hexanol	104-76-7	ND	ND
24	Dichloromethane	75-09-2	ND	ND	61	Cyclohexanol	108-93-0	ND	ND
25	1,1-Dichloroethane	75-34-3	ND	ND		**Acetates** (LOD = 25µg/compound/section)			
26	1,2-Dichloroethane	107-06-2	ND	ND	62	Ethyl acetate	141-78-6	ND	ND
27	Chloroform	67-66-3	ND	ND	63	n-Propyl acetate	109-60-4	ND	ND
28	1,1,1-Trichloroethane	71-55-6	ND	ND	64	n-Butyl acetate	123-86-4	ND	ND
29	1,1,2-Trichloroethane	79-00-5	ND	ND	65	Isobutyl acetate	110-19-0	ND	ND
30	Trichloroethylene	79-01-6	ND	ND		**Ethers** (LOD = 25µg/compound/section)			
31	Carbon tetrachloride	56-23-5	ND	ND	66	Ethyl ether	60-29-7	ND	ND
32	Perchloroethylene	127-18-4	ND	ND	67	tert-Butyl methyl ether (MTBE)	1634-04-4	ND	ND
33	1,1,2,2-Tetrachloroethane	79-34-5	ND	ND	68	Tetrahydrofuran (THF)	109-99-9	ND	ND
34	Chlorobenzene	108-90-7	ND	ND		**Glycols** (LOD = 25µg/compound/section)			
35	1,2-Dichlorobenzene	95-50-1	ND	ND	69	PGME	107-98-2	ND	ND
36	1,4-Dichlorobenzene	106-46-7	ND	ND	70	Ethylene glycol diethyl ether	629-14-1	ND	ND
	Miscellaneous (LOD #37= 5µg & #38=25µg/compound/section)				71	PGMEA	108-65-6	ND	ND
37	Acetonitrile	75-05-8	ND	ND	72	Cellosolve acetate	111-15-9	ND	ND
38	n-Vinyl-2-pyrrolidinone	88-12-0	ND	ND	73	DGMEA	112-15-2	ND	ND
	Total VOCs (LOD =50µg/compound/section)		ND	ND		Worksheet blank		YES	YES

2017/1833.xlsx

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TestSafe Australia - Chemical Analysis Branch
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ilac-MRA NATA

Accreditation No. 3726
Accredited for compliance with ISO/IEC 17025

NSW GOVERNMENT | SafeWork NSW

TestSafe AUSTRALIA

Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Jay Webber

Stephenson Environmental Management Australia

ND = Not Detected
VOC's = Volatile Organic Compounds
All compounds numbered 1-73 are included of this analysis in the scope of NATA accreditation. Any additional compounds annotated with * are not covered by NATA accreditation.

Method : Analysis of Volatile Organic Compounds in Workplace Air by Gas Chromatography/Mass Spectrometry
Method Number : WCA.207
Detection Limit : 5µg/section; 25µg/section for oxygenated hydrocarbons except acetone, MEK and MIBK at 5µg/section and aromatic hydrocarbon at 1µg/section.
Brief Description : Volatile organic compounds are trapped from the workplace air onto charcoal tubes by the use of a personal air monitoring pump. The volatile organic compounds are then desorbed from the charcoal in the laboratory with CS_2. An aliquot of the desorbant is analysed by capillary gas chromatography with mass spectrometry detection.

Total Volatile Organic Compounds (TVOC) test result in µg/section is calculated by comparison to the average mass detector response of the 73 quantified compounds. The response of a mass detector is dependent on the fragmentation of the molecule. Therefore, the TVOC test result should be interpreted as a semi-quantitative guide to the amount of VOCs present. If the TVOC test result is less than the addition of the total amount of the 73 quantified compounds then the TVOC result is of little value other than for comparative purposes. If the TVOC test result is greater than the addition of all the compounds quantified then this can indicate that there are additional compounds present other than the 73 quantified compounds reported.

PGME : Propylene Glycol Monomethyl Ether
PGMEA : Propylene Glycol Monomethyl Ether Acetate
DGMEA : Diethylene Glycol Monoethyl Ether Acetate

Measurement Uncertainty
The measurement uncertainty is an estimate that characterises the range of values within which the true value is asserted to lie. The uncertainty estimate is an expanded uncertainty using a coverage factor of 2, which gives a level of confidence of approximately 95%. The estimate is compliant with the "ISO Guide to the Expression of Uncertainty in Measurement" and is a full estimate based on in-house method validation and quality control data.

Quality Assurance
In order to ensure the highest degree of accuracy and precision in our analytical results, we undertake extensive intra- and inter-laboratory quality assurance (QA) activities. Within our own laboratory, we analyse laboratory and field blanks and perform duplicate and repeat analysis of samples. Spiked QA samples are also included routinely in each run to ensure the accuracy of the analyses. WorkCover Laboratory Services has participated for many years in several national and international inter-laboratory comparison programs listed below :-
- Workplace Analysis Scheme for Proficiency (WASP) conducted by the Health & Safety Executive UK;
- Quality Management in Occupational and Environmental Medicine QA Program, conducted by the Institute for Occupational, Social and Environmental Medicine, University of Erlangen – Nuremberg, Germany;
- Quality Control Technologies QA Program: Australia;
- Royal College of Pathologists QA Program: Australia

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TestSafe Australia – Chemical Analysis Branch
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ilac-MRA NATA
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Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526

52A Hampstead Road
Auburn NSW 2144 Australia
Tel: (02) 9737 9991
E-Mail: info@stephensonenv.com.au

Particle Test Report No. 2039

The analysis was commissioned by SEMA on behalf of:

Client	Organisation:	Shoalhaven Starches
	Contact:	John Studdert
	Address:	Bolong Road, Bomaderry, NSW 2541
	Telephone:	02 4423 8254
	Email:	John.studdert@manildra.com.au
	Project Number:	5805/S24248/17
	Analysis Requested:	TM-15, OM-5
	Chain of Custody Number	S24695
	Date Analysis Completed:	28 April 2017
	No. of Samples Tested:	2
	Sample Locations:	EPL ID No. 35 (Boiler 5 & 6)
	Sample ID Nos.:	726209, 726210
	Filter ID Nos.:	14848, 14847

This report cannot be reproduced except in full

NATA accredited laboratory number 15043
Accredited for Compliance with ISO/IEC 17025

Identification	The filters are labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification) sampling date and time and whether further analysis is required.

Test	*Analysis Test Method*
TSP	AS4323.2-1995 (R2014) (NSW TM-15)
PM_{10}	AS4323.2-1995 (R2014) (NSW OM-5)

Deviations from Test Methods	Nil

Issue Date
28 April 2017

Peter Stephenson
Managing Director

Gravimetric Results – Test Report No. 2039

Sample Location	Sample ID No.	Filter ID No	Sampling Date	Analysis Date (Completed)	Sample Mass (g)
Boiler 5 & 6	726209	14848	26/4/2017	28/4/2017	0.00582
Boiler 5 & 6	726210	14847	26/4/2017	28/4/2017	0.00670

Key:
g = grams

Appendix E – Annual metal survey (SEMA, 2017)

Stephenson
Environmental Management Australia

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ABN 75 002 600 526

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Tel: (02) 9737 9991

E-Mail: info@stephensonenv.com.au

EMISSION TEST REPORT NO. 5852/M

STACK EMISSION SURVEY – QUARTER NO. 1, 2017-2018

EMISSION POINT 35 SERVING BOILERS NO. 5 & 6

SHOALHAVEN STARCHES PTY LTD

BOMADERRY, NSW

PROJECT NO.:	**5854/M/S24804/17**
DATE OF SURVEY:	**21 JULY 2017**
DATE OF ISSUE:	**23 AUGUST 2017**

Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
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ABN 75 002 600 526

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Tel: (02) 9737 9991

E-Mail: info@stephensonenv.com.au

EMISSION TEST REPORT NO. 5852/M

HEXAVALENT CHROMIUM, HYDROGEN CHLORIDE AND METALS

The sampling and analysis was commissioned by:

Client	Organisation:	Shoalhaven Starches Pty Ltd
	Contact:	John Studdert
	Address:	Bolong Road, Bomaderry, NSW 2541
	Telephone:	02 4423 8254
	Email:	John.studdert@manildra.com.au
	Project Number:	5854/S24804/17
	Test Date:	21 July 2017
	Production Conditions:	Normal boiler operating conditions during testing of parameters
	Analysis Requested:	Metals, Hexavalent Chromium, Hydrogen Chloride, Dry Gas Density, Flow, Moisture, Molecular Weight of Stack Gases, Temperature, Oxygen, Stack Pressure
	Sample Locations:	EPL No. 833 EPL ID No. 35 – Combined Stack Boilers 5 & 6
	Sample ID Nos.:	See Attachment A

This report cannot be reproduced except in full.

NATA accredited laboratory number 15043.
Accredited for Compliance with ISO/IEC 17025.

Identification	The samples are labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification) sampling date and time and whether further analysis is required.

Test	*Test Method Number for Sampling and Analysis*	*NATA Laboratory Analysis By: NATA Accreditation No. & Report No.*
Hexavalent Chromium	NSW OM-4, Carb 425	SGS Environmental Services Accreditation No. 2562 Report No. SE168500 R0
Hydrogen Chloride	NSW TM-7 & 8, USEPA M26 & 26A	SGS Environmental Services Accreditation No. 2562 Report No. SE168500 R0
Metals	NSW TM-12, 13 & 14, USEPA M29	Envirolab Services Accreditation No. 2901 Report No. 172324
Flow	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5852/M
Moisture	NSW TM-22, USEPA M4	SEMA, Accreditation No. 15043, Emission Test Report No. 5852/M
Molecular Weight of Stack Gases	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report No. 5852/M
Oxygen	NSW TM-25, USEPA M3A,	SEMA, Accreditation No. 15043, Emission Test Report No. 5852/M
Stack Pressure	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5852/M

Stack Temperature	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5852/M
Velocity	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report No. 5852/M

Deviations from Test Methods A field blank for metals analysis, which is required under USEPA M29, was not analysed. This was requested by the client for commercial reasons.

Sampling Times NSW - As per Test Method requirements or if not specified in the Test Method then as per Protection of the Environment Operations (Clean Air) Regulations Part 2.

Reference Conditions NSW – As per

(1) Environment Protection Licence conditions, or

(2) Schedule 4 and 5 of the Protection of the Environment Operations (Clean Air) Regulations

All associated NATA endorsed Test Reports/Certificates of Analysis are provided separately in Attachment A.

Issue Date
23 August 2017

Peter Stephenson
Managing Director

1.1 SUMMARY OF THE AVERAGE EMISSION RESULTS – TEST REPORT NO. 5852/M

Parameter	**Unit**	**Location – Boiler 5 & 6 (EPA ID 35)**
		21 July 2017
		Average Result
Temperature	°C	147
Pressure	kPa	101.8
Velocity	m/s	14.9
Volumetric Flow	m^3/s	28.7
Moisture	%	6.2
Molecular Weight Dry Stack Gas	g/g mole	30.1
Dry Gas Density	kg/m^3	1.34
Oxygen	%	8.1
Hydrogen Chloride (Average)	mg/m^3	7.13
Hexavalent Chromium (Cr^{+6})	mg/m^3	<0.001
Metals - Type I & II Substances in Aggregate	mg/m^3	0.079
Antimony (Sb) Type I	mg/m^3	< 0.00406
Arsenic (As) Type I	mg/m^3	< 0.00406
Beryllium (Be) Type II	mg/m^3	0.00061
Cadmium (Cd) Type I	mg/m^3	0.00091
Chromium (Cr) Type II	mg/m^3	0.00416
Cobalt (Co) Type II	mg/m^3	0.00203
Lead (Pb) Type I	mg/m^3	0.0365
Manganese (Mn) Type II	mg/m^3	0.0223
Mercury (Hg) Type I	mg/m^3	< 0.00005
Nickel (Ni) Type II	mg/m^3	0.00862
Selenium (Se) Type II	mg/m^3	0.00406
Tin (Sn) Type II	mg/m^3	< 0.0102
Vanadium (V) Type II	mg/m^3	< 0.00507

Key:

°C	=	degrees Celsius
<	=	less than
%	=	percentage
kg/m^3	=	kilograms per cubic metre
kPa	=	kilo Pascals
g/g mole	=	grams per gram mole
m^3/s	=	dry cubic metre per second 0°C and 101.3 kilopascals (kPa)
m/s	=	metres per second
mg/m^3	=	milligrams per cubic metre at 0°C and 101.3 kilopascals (kPa)

ESTIMATED UNCERTAINTY OF MEASUREMENT

Pollutant	Methods	Uncertainty
Moisture	AS4323.2, NSW TM-M22, USEPA M4	25%
Hydrogen Chloride	NSW TM-7 & 8, USEPA M26 & M26A,	25%
Hexavalent Chromium (Cr^{+6})	NSW OM-4, Carb 425	200% ##
Metals - Type I & II Substances in Aggregate	NSW TM-12,13 & 14, USEPA M29	100%*(50-200%)**
Oxygen	NSW TM-24, USEPA M3A	1% actual
Velocity	AS4323.1, NSW TM-2, USEPA M2	5%

Key:

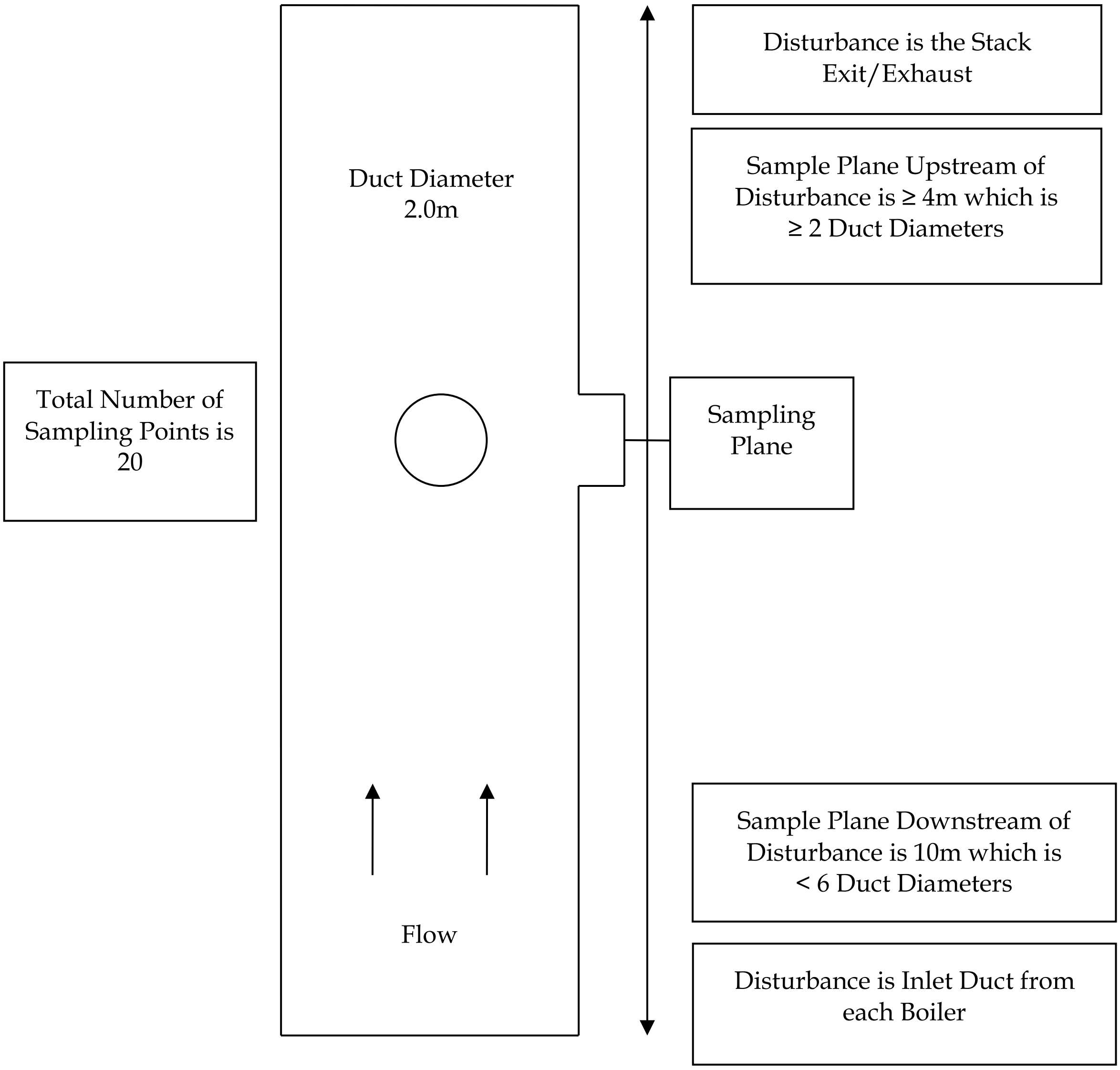
Unless otherwise indicated the uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source – Measurement Uncertainty)

Sources: *Measurement Uncertainty – implications for the enforcement of emission limits by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK*

Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.

Note: ISO 9096 is for 20-1000 mg/m^{3-} which AS4323.2 is based on. Note DSEN 13284-1 testing for < 5 mg/m^3 correlates to 5 mg/m^3 with most quoted uncertainties of $\pm$ 5.3 mg/m^3 @ 6.4 mg/m^3. From Clean Air Engineering in the United States the lowest practical limit of USEPA M5 is 5 mg/m^3 under lab conditions.

1.2 SAMPLING LOCATION – EPL ID 35: COMBINED STACK - BOILER NOS. 5 & 6



In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were used in compliance with AS4323.1 as the sampling plane was non-ideal.

The sample plane however does meet the minimum sampling plane conditions; sampling plane conditions will be found to exist at 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance.

The location of the sampling plane complies with AS4323.1 temperature, velocity and gas flow profile criteria for sampling.

1.3 INSTRUMENT CALIBRATION DETAILS

SEMA Asset No.	Equipment Description	Date Last Calibrated	Calibration Due Date
792	Gas Meter	28-Jul-16	28-Jul-17
708	Gas Meter	21-Mar-17	21-Mar-18
539	USEPA Meter Box (gas meter)	06-Mar-17	06-Mar-18
872	Gas Meter	21-Mar-17	21-Mar-18
858	Digital Temperature Reader	17-Jul-17	17-Jan-18
894	Thermocouple	17-Jul-17	17-Jan-18
815	Digital Manometer	23-Feb-17	23-Feb-18
613	Barometer	23-Feb-17	23-Feb-18
726	Pitot	03-Jun-17	03-Jun-2018 Visually inspected On-Site before use
428	Nozzle TSP Swagelok 3	09-Mar-17	09-Mar-18
916	Nozzle PM10 Head	18-Jan-17	18-Jan-18
407	Nozzle USEPA Metals Set Glass	18-Jan-17	18-Jan-18
408	Nozzle USEPA Metals Set Glass	18-Jan-17	18-Jan-18
946	combustion analyzer	17-Feb-17	17-Aug-17
927	Balance		Response Check with SEMA Site Mass
928	Balance		Response Check with SEMA Site Mass
929	Calibrated Site Mass	22-Mar-17	22-Mar-18

Gas Mixtures used for Analyser Span Response

Conc.	Mixture	Cylinder No.	Expiry Date
383 ppm	Sulphur Dioxide In Nitrogen	ALSD 3948	25-Oct-18
990 ppm 9.8% 10.1%	Carbon Monoxide Carbon Dioxide Oxygen In Nitrogen	ALWB5361	23-Jun-21
393 ppm 399 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen	ALSM1604	25-Oct-18
245 ppm 245 ppm 250 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen Sulphur Dioxide In Nitrogen	ALSB 1372	05-Jan-20

ATTACHMENT A – NATA CERTIFICATES OF ANALYSIS

SGS

ANALYTICAL REPORT

NATA Accreditation No. 2562

CLIENT DETAILS

Contact	Jay Weber
Client	Peter Stephenson & Associates Pty Ltd
Address	Po Box 6398 Silverwater NEWINGTON NSW 1811
Telephone	02 9737 9991
Facsimile	02 9737 9993
Email	jay@stephensonenv.com.au
Project	**5852 - Doc No S24816**
Order Number	**4780**
Samples	3

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE168500 R0**
Date Received	28 Jul 2017
Date Reported	07 Aug 2017

COMMENTS

Accredited for compliance with ISO/IEC 17025-Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong Liang
Metals/Inorganics Team Leader

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Member of the SGS Group

SGS

ANALYTICAL REPORT

SE168500 R0

Parameter	Units	LOR	SE168500.001	SE168500.002	SE168500.003
Sample Matrix			Impinger Solution	Impinger Solution	Impinger Solution
Sample Date			21 Jul 2017	21 Jul 2017	21 Jul 2017
Sample Name			726445	726446	726447

Hydrogen Halides and Halogen Emissions (USEPA Method 26A) Method: AN540 Tested: 7/8/2017

Parameter	Units	LOR	SE168500.001	SE168500.002	SE168500.003
Volume*	mL	1	-	360	346
Hydrogen Chloride as HCl	mg	0.08	-	6.7	6.9

Hexavalent Chromium analysis in Impinger/Filter Extract by Discrete Analyser Method: CEPA-ARB Method 425 Tested: 1/8/2017

Parameter	Units	LOR	SE168500.001	SE168500.002	SE168500.003
Hexavalent Chromium, Cr6+*	mg	0.001	<0.001	-	-

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SGS

QC SUMMARY

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MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Hexavalent Chromium analysis in Impinger/Filter Extract by Discrete Analyser   Method: CEPA-ARB Method 425

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Hexavalent Chromium, Cr6+*	LB129114	mg	0.001	<0.001	0%	NA

SGS

METHOD SUMMARY

SE168500 R0

METHOD	METHODOLOGY SUMMARY
AN540	A gas sample is extracted isokinetically from a stack. Hydrogen halides are solubilised in acidic solutions, forming chloride (Cl-), bromide (Br-) and fluoride (F-) ions. Halogens are passed through an alkaline solution where they are hydrolysed to form a proton (H+), a halide ion and a hypohalous acid molecule (HClO and HBrO). Sodium thiosulfate is added to the alkaline solution to assure reaction with hypohalous acid to form a second halide ion such that 2 halide ions are formed for each molecule of halogen gas.
CEPA-ARB Method 425	The received impinger solution and filter from the sampling process are combined and extracted by shaking for a minimum of 30 minutes followed by analysis of a portion of the extract for Chromium by ICP OES and Hexavalent Chromium by Discrete Analyser.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

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CERTIFICATE OF ANALYSIS 172324

Client Details

Client	Stephenson & Associates
Attention	Jay Weber
Address	PO Box 6398, Silverwater, NSW, 1811

Sample Details

Your Reference	**5852**
Number of Samples	m29 sample train
Date samples received	28/07/2017
Date completed instructions received	28/07/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	14/08/2017
Date of Issue	09/08/2017

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Report Comments

Please note that Magnesium, Vanadium and Tin are not covered under USEPA m29 methodology but are accredited under in house methodology.

Please note that impinger 5C was not provided and hence has no contribution to Analytical Fraction 3C (for run 726448).

Results Approved By
Simon Mills, Group R&D Manager

Authorised By
David Springer, General Manager

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Client Reference: 5852

Metals in Emissions USEPA m29						
Our Reference		172324-2	172324-3	172324-4	172324-5	172324-6
Your Reference	UNITS	726448-2	726448-3	726448-4	726448-5A	726448-5B
Type of sample		Acetone Rinse	Front half rinse - 0.1N HNO3	Back half - 5% HNO3 / 10% H2O2	4th impinger rinse - 0.1N HNO3	4% KMnO4 / 10% H2SO4
Date prepared	-	01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Date analysed	-	01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Volume	mL		87	317	58	275
Particle Matter	mg	16				

Metals in Emissions USEPA m29						
Our Reference		172324-8	172324-9	172324-10	172324-11	172324-12
Your Reference	UNITS	726448-run1-Analytical Fraction 1A	726448-run1-Analytical Fraction 2A	726448-run1-Analytical Fraction 1B	726448-run1-Analytical Fraction 2B	726448-run1-Analytical Fraction 3A
Type of sample		m29 Impinger	m29 Impinger	m29 Impinger	m29 Impinger	m29 Impinger
Date prepared	-	01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Date analysed	-	01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Antimony	μg	<4	<4			
Arsenic	μg	<4	<4			
Barium	μg	59	<3			
Beryllium	μg	0.6	<0.3			
Cadmium	μg	0.9	<0.1			
Chromium	μg	3.4	0.7			
Cobalt	μg	2	<0.3			
Copper	μg	4	<3			
Lead	μg	36	<1			
Magnesium	μg	<150	<150			
Manganese	μg	21	1			
Mercury	μg			<0.05	<0.05	<0.05
Nickel	μg	8.5	<0.3			
Phosphorus	μg	280	<150			
Selenium	μg	<4	4			
Silver	μg	<3	<3			
Thallium	μg	<15	<15			
Tin	μg	<10	<10			
Vanadium	μg	<5	<5			
Zinc	μg	120	<6			

Client Reference: 5852

Metals in Emissions USEPA m29			
Our Reference		172324-13	172324-14
Your Reference	UNITS	726448-run1-Analytical Fraction 3B	726448-run1-Analytical Fraction 3C
Type of sample		m29 Impinger	m29 Impinger
Date prepared	-	01/08/2017	01/08/2017
Date analysed	-	01/08/2017	01/08/2017
Mercury	µg	<0.05	<0.05

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Client Reference: 5852

Method ID	Methodology Summary
Metals-010	Determination of Metals in impingers and filters by ICP-OES/MS and Cold Vapour AAS using USEPA29 and in house methods METALS-010, 020, 021 and METALS-022.
Metals-029	Sample is evaporated to dryness at ambient temperature and pressure, dessicated and weighed back as per USEPA m29.

Client Reference: 5852

QUALITY CONTROL: Metals in Emissions USEPA m29					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			01/08/2017					01/08/2017	
Date analysed	-			01/08/2017					01/08/2017	
Particle Matter	mg	0.2	Metals-029	<0.2						
Antimony	µg	4	Metals-010	<4					103	
Arsenic	µg	4	Metals-010	<4					96	
Barium	µg	3	Metals-010	<3					94	
Beryllium	µg	0.3	Metals-010	<0.3					125	
Cadmium	µg	0.1	Metals-010	<0.1					100	
Chromium	µg	0.3	Metals-010	<0.3					87	
Cobalt	µg	0.3	Metals-010	<0.3					90	
Copper	µg	3	Metals-010	<3					88	
Lead	µg	1	Metals-010	<1					101	
Magnesium	µg	150	Metals-010	<150					100	
Manganese	µg	0.3	Metals-010	<0.3					97	
Mercury	µg	0.05	Metals-010	<0.05					92	
Nickel	µg	0.3	Metals-010	<0.3					89	
Phosphorus	µg	150	Metals-010	<150					113	
Selenium	µg	4	Metals-010	<4					96	
Silver	µg	3	Metals-010	<3					95	
Thallium	µg	15	Metals-010	<15					96	
Tin	µg	10	Metals-010	<10					109	
Vanadium	µg	5	Metals-010	<5					92	
Zinc	µg	6	Metals-010	<6					97	

Client Reference: 5852

Result Definitions	
NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions	
Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	

Client Reference: 5852

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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2127188-77163/https://projects.ghd.com/oc/Sydney1/airqualityassessment/Delivery/Documents/REP-0-Modification16_AQ_Assessment.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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