Report

Proposed Knauf Insulation Glass Wool Manufacturing Facility, Steel River Newcastle- Air Quality Impact Assessment

2 JULY 2009

Prepared for

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Abbreviations

Abbreviation	Description
CO	Carbon monoxide
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
Dry EP	Dry Electrostatic Precipitator
HAP	Hazardous Air Pollutants
HF	Hydrogen fluoride
OU	Odour Unit
NO_2	Nitrogen dioxide
PM_{10}	Particulate matter 10 microns or less in aerodynamic diameter
SO_2	Sulfur dioxide
Wet EP	Wet Electrostatic Precipitator

Executive Summary

An air quality impact assessment was performed on the proposed Knauf Insulation (KI) glass wool fibre manufacturing plant to be located in the Steel River Estate in Newcastle, NSW. The stack emissions were compared against regulatory limits and found to be below regulatory limits specified in *The Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005*. The assessment also estimated ground level concentrations of air pollutants from the plant and has used a conservative approach applied in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) (Approved Methods). The assessment of the impacts against regulatory criteria has used, where applicable, the aggregate of the worst case predicted plant concentrations and peak background concentrations from DECC (formerly NSW EPA) and other relevant monitoring stations.

The ground level pollutant concentrations as a result of the proposed plant were predicted using the Ausplume dispersion model. The modelled species included oxides of nitrogen (NO_x), particulate matter (PM_{10}), carbon monoxide (CO), sulphur dioxide (SO_2), lead, hydrogen fluoride (HF), Hazardous Air Pollutants (HAPs) and odour.

The air dispersion modelling assessment has concluded that the predicted impacts on ground level concentrations of NO_2, PM_{10}, CO, SO_2, lead and HF when added to background concentrations, are within the DECC regulatory criteria. As per the Approved Methods, HAPs and odour were assessed for incremental impact and were found to be below regulatory criteria.

Given the generally conservative nature of the air quality assessment, it is considered that the potential for adverse air quality impacts of the proposed KI plant will be low and within regulatory limits.

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Introduction

Knauf Insulation (KI) proposes to build a glass wool fibre manufacturing plant (the Plant) at the Steel River Industrial Estate, located in Newcastle, NSW, as shown in Figure 1-1. Depending on market conditions the Plant will produce between 100 and 200 tonnes per day. For the purpose of the air quality impact assessment, the output of the plant is assumed to operate at a maximum capacity of 200 tonnes per day, and up to 80,000 tonnes per year of glass wool products. The glass wool fibre will primarily be used to as insulation material for use in Australian homes.

1.1 Scope of Assessment

As with all major developments in NSW, the air emissions were assessed against *The Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005* and the local air quality impact assessment was undertaken in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005). In addition, the air quality impact was also compared to air quality guidelines provided in the Strategic Impact Assessment Study (SIAS), which provides a range of environmental guidelines for industries located within the Steel River Envelope.

Generally, emissions from proposed developments are assessed during construction and operation. A quantitative assessment of odour, volatile and semi volatile organic compounds and dust during construction has not been included in this assessment however, mitigation measures to minimise adverse air quality impacts during the construction process have been included. The assessment of air quality during construction is to be addressed in the Construction Environmental Management Plan.

For the operational phase of the project, a quantitative review of air quality impacts was undertaken using dispersion modelling. The modelling investigated a range of air pollutants likely to be emitted from the plant including oxides of nitrogen (NO_x), particulate matter (PM_{10}), carbon monoxide (CO), sulphur dioxide (SO_2), lead, hydrogen fluoride (HF), Hazardous Air Pollutants (HAPs) and odour. This assessment includes the methods used to undertake the air quality assessment of the plant and a discussion of the local air quality impact of the proposed development.

Project Overview

2.1 Project Description

2.1.1 Construction

Construction of the Project is expected to take 15 months. Construction of the plant will require earthworks and site preparation, construction of foundations and construction of plant components.

2.1.2 Operation

Operating Equipment

The process involves the following major steps, as shown in Figure 2-1.

1. The first stage of the process involves the mixing of the raw materials, comprising primarily sand and Cullet (recycled plate glass and bottles). The use of Cullet allows for a decrease in energy consumption and decrease of greenhouse gases attributed to energy use. After the materials are mixed, they are fed into a glass furnace at 1200^0C which forms molten glass. The glass furnace is heated through the use of the combustion of natural gas and electrically boosted electrodes. It should be noted that the type and concentration of air emissions from the furnace is dependent on the Cullet quality. The emissions from the glass furnace are directed to a Dry Electrostatic Precipitator (Dry EP) which primarily acts to reduce particulate matter. In addition to the continuously running furnace stack, an emergency (bypass) stack exists, which is anticipated to be used up to 6 days per year in the case that the Dry EP requires maintenance or plant failure necessitates the bypass of the Dry EP;

2. The molten glass is then fed through glass fiberisers which form ‘wool fibers’ which is then made into either ‘white wool’ or ‘glass wool’;

3. For the production of white wool, the glass fibers are sprayed with silicone, crushed, and sprayed with oil and antistatic materials. The air emissions from this process are primarily associated with the forming process. The air emissions are passed through a water scrubber and mist eliminator (cyclone), which is shown as the emission abatement system in Figure 2-1, after which they are vented to the blowing wool stack;

4. For the production of glass wool, the wool fibers are sprayed with a binder and then fed through a moving production line to form a blanket of glass wool. KI are investigating the use of a new binder to replace the current binder. The new binder is understood to have reduced formaldehyde and phenol emissions compared with the current binder, however for the purpose of this assessment, emissions associated with the current binder have been used. The blankets of glasswool are fed into a (oxy-gas) curing oven after which they are cut to size and compressed as a roll or batt. The air emissions from the forming hood, curing oven and cooling section after the cooling oven are directed to the Wet Electrostatic Precipitator (Wet EP), after which the emissions after vented to the down stream stack. Offcuts from the glass wool production line are recycled and processed separately to produce yellow wool;

5. One of the final processes resulting in air emissions is the facing pit. Products requiring a coating of glass fibres are faced or coated with a foil backing before final cutting and packaging;

6. The products are packaged and stored outdoors on-site, ready for transport to the market.

Operating Hours

The plant is anticipated to operate continuously i.e. 24 hours, 7 days / week.

2.2 Emission Inventory

Based on the processes to be undertaken and the emission rates supplied from KI or other relevant sources such as the *Emissions Estimation Manual* (Department of Environment and Heritage 2004), an emissions inventory was prepared and is presented in Appendix A. Key air pollutants likely to be emitted are further discussed in Sections 2.2.1 to 2.2.7.

2.2.1 Oxides of Nitrogen

Oxides of nitrogen (NO_X) are the sum of nitric oxide (NO) and nitrogen dioxide (NO_2). In gas combustion, the primary mechanism for NO_X formation is termed “thermal NO_X”. This occurs when the high temperatures allow the dissociation of atmospheric nitrogen (N_2), after which the nitrogen may combine with excess oxygen. Generally the NO_x emissions from gas combustion would comprise approximately 90% NO and 10% NO_2. The primary source of NOx is the combustion of fossil fuels, which is also the case for this development. It should be noted that KI propose to use the oxy-gas process which assists in limiting NO_x formation.

2.2.2 Particulate Matter

Emissions of particulate matter from this type of process are attributed to emissions derived from the melting of the raw materials, glass particulate matter entrained into the waste air stream from processing, and incomplete combustion of the fuel. It is anticipated that the majority of the particles generated from the processes at this plant will be controlled using electrostatic precipitators (EPs) and comprise particulate matter less than 10 microns in diameter (PM_{10}).

Given the potentially elevated emissions associated with the use of the emergency stack, background concentrations of particulate matter were investigated as part of this assessment. Major natural sources of background particulate levels include forest fires, pollen and wind-blown dust from exposed areas. Anthropogenic sources include stationary and mobile combustion sources, road dust, agriculture, mining, major fires and emissions from industrial processes. Background levels vary widely depending on location, meteorology and proximity of major point or area sources.

2.2.3 Sulfur dioxide

Sources of sulfur dioxide in glass manufacture are derived from the melting of raw materials and combustion of fossil fuels containing high concentrations of sulfur (NEPC 1998). It is proposed that natural gas will be the principal fuel used on site and the natural gas supply to the site is regulated by the Australian Standard AS4564-2005 (Standards Australia 2005), which specifies a concentration of less than 50 mg/m^3 (at 1atm, 15°C). This will limit the amount of sulfur dioxide produced.

2.2.4 Carbon monoxide

Carbon monoxide (CO) is produced due to the incomplete combustion of any fuel containing carbon. Carbon monoxide is not expected to be a significant concern in this type of plant, as the health-related air quality standard is high for this pollutant relative to its emissions.

2.2.5 Lead

Lead pollution was historically related to the combustion of distillate fuels containing lead and has declined significantly in recent years, due to the complete ban of lead in petrol. Since this time, the DECC has ceased all monitoring for ambient lead. Small concentrations of lead are emitted during the melting of the raw materials, and the impact of lead has been assessed in accordance with regulatory criteria.

2.2.6 Hazardous Air Pollutants

For this assessment, Hazardous Air Pollutants (HAPs) emissions comprise a range of metals and other Volatile Organic Compounds (VOCs) primarily from the raw materials being melted. Generally, HAPs from glass production include metallic HAPs such as lead and cadmium and other organic HAP such as ammonia and benzene. Whilst HAP may be formed from combustion of fuel, they are generally present in trace concentrations and for this type of plant are more related to raw material use and other processes on site such as glass fibre binding. The type and concentration of HAP are also heavily dependent on cullet quality.

2.2.7 Odour

Odour is not generally considered an air quality issue in currently operating KI plants. Process operations have suggested that odour is generated from: 1) the blast furnace stack; 2) VOCs used in the current binder; 3) emitted from the down stream stack and 4) blowing wool stack. However KI have advised URS[1] that the use of a new binder will reduce the ammonia and phenol generated from this process, consequently it is anticipated that odour impact from the binding process will be low.

In addition, boundary odour monitoring at four locations was performed at KI's Krupka plant (located in the Czech Republic) and showed that odour concentrations[2] were below the detection limit when measured using olfactometry. This suggests that fugitive odour emissions (from buildings) are unlikely to result in adverse impacts and do not require assessment, however odour emissions from the stack (using the current binder) were investigated as part of the assessment.

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[1] Information provided to URS from KI dated 26 May 2009.

[2] Information provided to Nick Ballard of URS from Brodie McHutichison of Crown Project Services titled *Odour –operations* and dated 19 May 2009

Air Quality Criteria

3.1 Overview

There are three main types of air quality criteria relevant to the project.

- ***Emission Standards*** – which are maximum allowable pollutant emission concentrations (stack concentrations) specified for particular types of equipment;
- ***Air Impact Assessment Criteria*** – which are designed for use in air dispersion modelling studies and air quality impact assessments for new or modified emission sources; and
- ***Ambient Air Quality Standards*** – which set standards against which ambient air quality monitoring results may be assessed.

In general, Emission Standards and Air Impact Assessment Criteria are used to evaluate the expected impact of air emissions on air quality and the effectiveness of plant design and any associated mitigation measures. The main objective of these criteria is to ensure that the resulting local and regional ambient air quality meets the relevant Ambient Air Quality Standards.

In addition, the SIAS outlines an environmental envelope around the Steel River Industrial Area which provides maximum ground level concentrations allowed by industrial development. This, in effect, is another type of Air Impact Assessment Criteria within the Industrial Estate, as opposed to DECC criteria, which are designed for use at the closest affected sensitive receptors which would generally be located outside of the Industrial Estate. Both the DECC criteria and SIAS guidelines are further discussed below.

3.1.1 Emission Standards

The NSW *Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005* (Clean Air Regulation) sets emission limits (as in-stack concentrations) for air impurities from stationary plant and equipment. The current standards, taken from Schedule 3 (Glass Production) of the Clean Air Regulation, relevant to the KI plant are presented in Table 3-1.

3 Air Quality Criteria

Table 3-1 Emission Standards for Glass Production (from Schedule 3, Protection of the Environment Operation (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005)

Pollutant	Applicability	Reference Conditions	Limit (Group 6 sources)
Solid Particulates (Total)	Any melting furnace	Dry, 273 K, 101.3 kPa, 3 % O_2	50 mg/m^3
	Any crushing, grinding, separating or materials handling activity	Dry, 273 K, 101.3 kPa	20 mg/m^3
NO_2 or NO or both as NO_2 equivalent	Any melting furnace except manufacture of glass using sodium nitrate ($NaNO_3$)	Dry, 273 K, 101.3 kPa, 3 % O_2	700 mg/m^3 as NO_2
Type 1 and Type 2 substances ^{A}	Any melting furnace	Dry, 273 K, 101.3 kPa, 3 % O_2	1 mg/m^3
Cadmium (Cd) or mercury (Hg) individually	Any melting furnace	Dry, 273 K, 101.3 kPa, 3 % O_2	0.2 mg/m^3
Smoke	Any melting furnace	Gas stream temperature above dew point. Path length corrected to stack exit diameter as per CEM-1	Ringelmann 1 or 20% opacity

Notes:

Reference conditions taken from Schedule 5 Part 3 of the Clean Air Regulation (2005)

An activity is designated to "Group 6"if it commenced to be carried on, or to operate, on or after 1 September 2005, as a result of an environment protection licence granted under the Protection of the Environment Operations Act 1997 pursuant to an application made on or after 1 September 2005.

^{A}: Type 1 substances include antimony, arsenic, cadmium, lead or mercury. Type 2 substances include beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium.

3.1.2 DECC Air Quality Impact Assessment Criteria

The air quality impact assessment criteria are provided in *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). This document specifies a range of impact assessment criteria for toxic and odorous air pollutants. The impact assessment criteria for those pollutants associated with the proposed plant are shown in Table 3-2.

Table 3-2 DECC Impact Assessment Criteria for Modelled Pollutants (DEC 2005)

Pollutant	Averaging Period	Frequency	Cumulative / Incremental impact ^{A}	Concentration	
Criteria Pollutants				(ppm)	(µg/m^3)
NO_2	1 hour	100%	cumulative	0.12	246
	Annual	100%	cumulative	0.03	62
PM_{10}	24 hour	100%	cumulative	-	50
	Annual	100%	cumulative	-	30
SO_2	10 minutes	100%	cumulative	0.25	712
	1 hour	100%	cumulative	0.20	570
	24 hours	100%	cumulative	0.08	228
	Annual	100%	cumulative	0.02	60
CO	15 minutes	100%	cumulative	87	100,000

Pollutant	Averaging Period	Frequency	Cumulative / Incremental impact [A]	Concentration	
	1 hour	100%	cumulative	25	30,000
	8 hours	100%	cumulative	9	10,000
Lead (Pb)	Annual	100%	cumulative	-	0.5
Hydrogen Fluoride (HF) [B]	24 hours	100%	cumulative	-	1.5
	7 days	100%	cumulative	-	0.8
	30 days	100%	cumulative	-	0.4
	90 days	100%	cumulative	-	0.25
Hazardous Air Pollutants				(ppm)	(µg/m^3)
Ammonia	1 hour	99.9%	incremental	0.46	330
Antimony	1 hour	99.9%	incremental	-	9
Arsenic	1 hour	99.9%	incremental	-	0.09
Cadmium	1 hour	99.9%	incremental	-	0.018
Chromium [C]	1 hour	99.9%	incremental	-	9
Chromium VI	1 hour	99.9%	incremental	-	0.09
Copper	1 hour	99.9%	incremental	-	3.7
Formaldehyde	1 hour	99.9%	incremental	0.018	20
Hydrogen Chloride	1 hour	99.9%	incremental	0.09	140
Manganese	1 hour	99.9%	incremental	-	18
Nickel	1 hour	99.9%	incremental	0.00009	0.18
Phenol	1 hour	99.9%	incremental	0.0052	20
Odour				Odour Units	
Odour	1 second	99.0%	incremental	2 – 7 OU [D]	

Notes:

- = not applicable

Gas volumes expressed at 25^{0}C and 101.3 kPa (DEC 2005);

[A]: Cumulative impact refers to the addition of an ambient air background concentration when assessing plant impact, whilst incremental refers only to predicted concentration derived from the plant.

[B]: hydrogen fluoride concentrations provided are for general land use (DEC 2005);

[C]: assumed to be chromium III;

[D]: The impact assessment criteria for odour is dependant on the population and ranges from 2 OU for an affected community of > 2000 people to 7 OU for a single residence.

3.1.3 Strategic Impact Assessment Study Air Quality Guidelines

In addition to the DECC criteria, other ambient air criteria are presented in the SIAS prepared for the Steel River Estate. One of the objectives of the SIAS was to establish an environmental envelope comprising environmental standards with which future development should comply. This SIAS states that the Newcastle City Council will likely be the consent and regulatory authority, however, for larger (scheduled) premises, such as the Knauf Plant, the DECC (EPA) would be the regulatory authority in relation to air emissions.

The SIAS provides ambient air criteria (within the Steel River envelope) for a range of pollutants which are presented in Table 3-3. These criteria are designed to be met at the estate boundary and the most affected receiving location outside the estate.

Table 3-3 SIAS Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Averaging Period	Concentration	Concentration
Criteria Pollutants		(pphm)	(µg/m^3)
NO$_2$	1 hour Annual	16 5	328 102.5
PM$_{10}$	24 hour Annual	- -	150 50
SO$_2$	10 minutes 1 hour Annual	25 20 2	715 572 57.2
Lead	3 months	-	1.5

Notes:

For the purposes of this report, it is understood the criteria is cumulative.

TSP has been excluded, as particulate matter are anticipated to comprise PM$_{10}$.

The SIAS Ambient Air Quality Standards provide units of Lead and PM$_{10}$ in g/m^3, however it is believed this is an error and the units of µg/m^3 should actually be used.

Concentrations of (NO$_2$ and SO$_2$) pollutants converted from pphm to µg/m^3 at 0^{0}C and 1 atm.

The SIAS also provide design ground level concentrations for a range of odorous and toxic air pollutants, as provided in Table 3-4. These criteria are designed to be met within the estate.

Table 3-4 SIAS Design Ground Level Concentration Criteria for Air Toxics

Pollutant	Averaging Period	Concentration	Concentration
Criteria Pollutants		(ppm)	(mg/m^3)
Ammonia	1 hour	0.83	0.6
Formaldehyde	1 hour	0.033	0.05
Hydrogen chloride	1 hour	0.2	0.3
Phenol	1 hour	0.0094	0.036

Notes:

For the purposes of this report, it is understood the criteria is incremental.

Hydrogen chloride concentration was reported as 0.2 mg/m^3. This is inconsistent with a concentration of 0.2 ppm, consequently the concentration (in mg/m^3) was amended.

In addition, the SIAS has also developed a model which is designed to limit adverse air quality impact based on development size and also provides ambient air criteria. The purpose of the modelling is described in the following excerpt:

> *"The function of the model is to ensure the orderly allocation of environmental emissions entitlements to projects on the Steel River Project site in a manner which allows the cumulative aggregation of emissions within the site. This will enable BHP to be sure that emissions entitlements are not distributed in a manner which "fills up" the envelope prematurely and results in later development not being able to make any emissions. It further allows an ongoing cumulative assessment of current and future impacts from industry at the*

> *site. As the site develops, so too does the model to reflect the changing status quo.”* (Woodward Clyde 2000 p.2)

Hence, the model provides additional ambient air guidelines referred to as the Steel River Environmental Envelope Air Emission Allocation. These Steel River Environmental Envelope Air Emission Allocation concentrations are provided in Table 3-5.

Table 3-5 Environmental Envelope Air Emission Allocation (Mirvac 2009)

Pollutant	Averaging Period	Frequency	Concentration
Criteria Pollutants			(µg/m^3)
NO_2	1 hour Annual	100% 100%	73.83 19.688
PM_{10}	24 hour Annual	100% 100%	7.383 3.6915
SO_2	10 minutes 1 hour Annual	100% 100% 100%	159.985 123.05 9.844
Lead	3 months	100%	0.2481

Notes:

TSP has been excluded, as particulate matter are anticipated to comprise PM_{10}.

For the purposes of this report, it is understood the criteria is cumulative.

3.1.4 Ambient Air Quality Criteria

The ambient air quality criteria adopted by NSW are provided by the *National Environment Protection Measure (NEPM) for Ambient Air Quality* (referred to herein as ‘NEPM for Ambient Air Quality’), published by the National Environment Protection Council (NEPC) (1998). The NEPM for Ambient Air Quality, sets out national standards and goals for six common ambient air pollutants (NEPC, 1998), namely nitrogen dioxide (NO_2), carbon monoxide (CO), photochemical oxidants (as ozone), sulphur dioxide (SO_2), lead and particulates as PM_{10} and an advisory standard for $PM_{2.5}$ is also included. When reviewing the standards and goals set out in the NEPM for Ambient Air Quality, it should be noted that they are designed for use in assessing regional air quality and are not intended for use as site boundary or atmospheric dispersion modelling criteria. Consequently, proposed facility emissions have not been assessed directly against NEPM guidelines, however it should be noted that the NEPM guidelines for NO_2, PM_{10}, SO_2 and CO are identical to the DEC (2005) criteria, as shown in Table 3-2**.**

In 2004 the NEPC released the *Air Toxics NEPM* (NEPC, 2004) that presented a number of monitoring investigation levels for some key VOCs. The air investigation levels were derived on the basis of the long term protection of human health within regional areas. The purpose of the Air Toxics NEPM (NEPC, 2004) is the collection ambient air concentration of VOC “…*at locations where elevated levels are expected to occur and there is a likelihood that significant population exposure could occur*.” (NEPC, 2004 p 2). Similarly to the Ambient Air Quality NEPM, the Air Toxics NEPM is designed for use in assessing regional air quality and not intended for use as site boundary or atmospheric dispersion modelling criteria. Thus, the predicted concentrations of HAP will be compared against the (DEC 2005) criteria.

Existing Environment

4.1 Climate

URS understands that the Nobby's Head Automatic Weather Station (AWS) is the closest currently operating AWS suitable for use in a climate discussion. The Nobby's Head AWS is located approximately 9km to the south east of the site and a summary of climatological data collected at Nobby's Head by the Bureau of Meteorology (BoM) is provided in Table 4-1. Table 4-1 indicates the region experiences hot summers and mild winters. The records indicate that mean maximum daily temperatures for summer are approximately 24-25^{0}C and temperatures can exceed 40°C between November and February, whilst winter periods can have temperatures as low as 1.8^{0}C. The area has a moderate rainfall, with a mean annual rainfall of 1139.6 mm reported over an average of 132.4 raindays per year.

4.2 Meteorology

The meteorology for the site was prepared using site representative meteorology from Steel River for 2004 and incorporated into a meteorological program (TAPM) which was used to estimate other atmospheric parameters. An assessment of the meteorological data generated is provided in Appendix B and it is considered that the data incorporated into the dispersion modelling is suitable for use.

4.3 Ambient Air Quality

Background concentrations of air pollutants in this area may be derived from a range of sources. Short-term elevated concentrations of PM_{10}, NO_x, CO and other products of combustion may occur in the event of bush-fires or fuel reduction burns. The *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) requires the use of the maximum measured ambient concentration, measured over at least a 12 month period, to be used as the background concentration within the modelling assessment. The 12 month period allows for seasonal variation in background concentrations as well as range of atmospheric conditions to be assessed. This method is considered very conservative and where more refined methods exist to assess pollutant impacts, such as for PM_{10}, these methods were used. As the meteorology used was for 2004, URS also obtained, where possible, background concentrations for 2004 from DECC or other relevant background stations. Specific issues relating to key criteria pollutants are discussed in the following sections.

Particulate Matter

It should be noted that particulate matter emitted from the plant will comprise PM_{10}, consequently, TSP and deposited dust will not be assessed. PM_{10} comprises particulate matter less than 10 µm in aerodynamic equivalent diameter, while TSP generally refers to PM_{30} (particulate matter less than 30 µm in aerodynamic diameter). PM_{10} is more easily entrained within local winds and less likely to deposit in local surrounds, thus not requiring a deposition assessment.

To enable a complete set of background data to be used, the background data has been taken as the average of the Wallsend, Newcastle and Beresfield monitoring stations, as data gaps existed at each of the monitoring stations. In addition, occurrences of high PM_{10} were frequent throughout the year meaning that a cumulative PM_{10} impact (background PM_{10} plus PM_{10} derived from the plant) may have approached or exceeded the criteria of 50 µg/m^3. Consequently, a more thorough (contemporaneous) investigation of PM_{10} was needed and this assessment has been undertaken in Section 7.

Table 4-1 Climate Data from Nobbys Head Automatic Weather Station 061055 (Bureau of Meteorology 2009)

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean maximum temperature (Degrees C)	25.5	25.4	24.7	22.8	20	17.5	16.7	18	20.2	22.1	23.5	24.9	21.8
Highest temperature (Degrees C)	41.4	40.9	39	36.8	28.5	26.1	26.3	29.9	34.4	36.7	41	42	42
Lowest maximum temperature (Degrees C)	18.4	18.1	17.8	15.6	12.8	10.6	8.9	11.2	11.7	14	15.6	17.2	8.9
Mean minimum temperature (Degrees C)	19.2	19.3	18.2	15.3	12	9.7	8.4	9.2	11.4	14	16.1	18	14.2
Lowest temperature (Degrees C)	12	10.3	11.1	7.4	4.7	3	1.8	3.3	5	6.5	7.2	11	1.8
Highest minimum temperature (Degrees C)	25.5	24	23.9	21.9	19.5	17.6	15.7	17.2	19.8	21	22.4	24	25.5
Mean number of days <= 0 Degrees C	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean rainfall (mm)	89	108.4	120.3	116.9	117.4	117.4	94.9	74.8	73.5	73.3	70.4	81.5	1139.6
Highest rainfall (mm)	404	559.2	544.4	546.4	441.3	495.8	351.1	545.3	283.1	277.5	203.9	326.5	1919.4
Lowest rainfall (mm)	2	0.5	2.8	0	2.1	0.8	0	0	0.8	4.6	2.4	4.6	596.9
Highest daily rainfall (mm)	144.8	252.7	283.7	231.1	181.9	209.8	118.6	168.9	157.5	96.5	103.7	177.5	283.7
Mean number of days of rain	11	11.1	12.1	11.9	12	11.7	10.7	10.2	9.9	10.7	10.6	10.5	132.4
Maximum wind gust speed (km/h)	121	141	137	115	171	152	139	135	131	141	145	130	171
Mean daily solar exposure (MJ/(m*m))	24.4	22	19.1	14.8	10.8	9	10.1	13.9	17.5	20.8	23	24.8	17.5
Mean number of clear days	6.3	5.3	6.4	7.4	6.9	7.5	9.7	10.8	9.3	7.4	5.5	6.3	88.8
Mean number of cloudy days	12.4	11.9	11.7	10.7	11.9	11.7	9.5	8.3	9	12.1	12.2	11.7	133.1
Mean 9am temperature (Degrees C)	21.9	21.8	20.8	18	14.6	12	10.9	12.1	15	17.9	19.5	21.1	17.1
Mean 9am wet bulb temperature (Degrees C)	19.3	19.5	18.4	15.7	12.7	10.3	8.9	9.8	12.1	14.6	16.4	18.2	14.7
Mean 9am dew point temperature (Degrees C)	17.6	18.2	16.9	14.1	10.9	8.5	6.6	7.1	9.2	11.6	14	16.2	12.6
Mean 9am relative humidity (%)	77	80	79	78	79	79	77	73	70	68	72	75	75
Mean 9am cloud cover (okas)	4.6	4.6	4.4	4.1	4.2	4.2	3.5	3.3	3.6	4.1	4.5	4.5	4.1
Mean 9am wind speed (km/h) for years 1957 to 2009	20.9	20.9	20.8	21.5	23.6	26.6	26.5	25.8	25.2	23.8	23.3	21.7	23.4
Mean 3pm temperature (Degrees C)	23.3	23.4	22.9	21.3	18.8	16.5	15.9	16.9	18.5	19.8	20.9	22.4	20
Mean 3pm wet bulb temperature (Degrees C)	19.9	20.3	19.5	17.3	14.9	12.7	11.7	12.3	14	15.7	17.2	18.9	16.2
Mean 3pm dew point temperature (Degrees C)	17.9	18.5	17.2	14.3	11.6	9.4	7.3	7.5	9.4	12.2	14.4	16.3	13
Mean 3pm relative humidity (%)	72	74	72	66	64	64	59	56	59	64	68	71	66
Mean 3pm cloud cover (oktas)	4.1	4.2	4.3	4.3	4.5	4.5	4.1	3.7	3.8	4.2	4.4	4.3	4.2
Mean 3pm wind speed (km/h) for years 1957 to 2009	33.4	32.7	30.6	28.1	26.2	28.4	29.1	30.6	34.2	34.4	35.4	35.3	31.5

Lead

Annual background concentrations of lead were taken from DEC (2005a) which measured ambient air concentrations of lead at Wallsend. The Wallsend monitoring site was the only monitoring station in relatively proximity to the site and data from 2002, 2003 and 2004 were assessed. The annual average measurements ranged in concentration from 0.02 to 0.09 µg/m^3. To remain conservative, the highest annual average background value of 0.09 µg/m^3 recorded in 2003, was adopted in this assessment.

Hydrogen Fluoride

Measurements of hydrogen fluoride are not available from the DECC's monitoring sites in the Newcastle region. For this assessment, background data were sourced from a recent study by HLA for Dora Creek site (2007). The primary background value (7 day) for hydrogen fluoride was taken as the maximum 7 day average for 2005, as presented in HLA (HLA, 2007). This gives a background concentration of 0.17µg/m^3, or 21% of the ambient air quality criteria. For the 24 hour average background concentration, no direct measurements are available so the background concentration was assumed to be also 21% of the criteria, or a concentration of 0.32 µg/m^3. For the 30 day and 90 day background concentration, the maximum 7 day value was conservatively left unchanged. The background values for 30 days and 90 days are considered conservative as longer averaging periods give rise to lower background concentrations due to changes in exposure at the monitoring location.

4.4 Summary of Ambient Air Quality Monitoring Data

Table 4-2 provides a summary of the background data used in the air quality modelling. The data was preferentially taken from the DECC Newcastle monitoring stations as it was located closer to the site, however, where monitoring instruments were not established or data had not been collected, data from the DECC Wallsend and DECC Beresfield site were used. The datum from HLA (2007) from Dora Creek were used for hydrogen fluoride.

Table 4-2 Summary of Background data used in Air Quality Modelling

Species	Averaging Time	Monitoring Station	Maximum Background Concentration (µg/m^3) A	Air Quality Criteria (µg/m^3)
NO_2	1 hour	Newcastle	90.2	246
	Annual	Newcastle	18.5	62
PM_{10}	24 hour	Average of Wallsend, Newcastle and Beresfield	50.5	50
	Annual	Wallsend	21.9	30
Lead	Annual	Wallsend	0.09	0.5
SO_2	10 minutes	Wallsend	274	712
	1 hour	Wallsend	192	570
	24 hour	Wallsend	40	228
	Annual	Wallsend	6	60
CO	15 minute	Newcastle	4800	100,000

Species	Averaging Time	Monitoring Station	Maximum Background Concentration ($\mu g/m^3$) ^{A}	Air Quality Criteria ($\mu g/m^3$)
	1 hour	Newcastle	3600	30,000
	8 hour	Newcastle	3000	10,000
Hydrogen fluoride	24 hours	Dora Creek	0.32	1.5
	7 days	Dora Creek	0.17	0.8
	30 days	Dora Creek	0.17	0.4
	90 days	Dora Creek	0.17	0.25

Notes:

[A]: Values taken from DEC (2005);

[B]: Due to missing PM_{10} data from each of the monitoring stations, the average value was taken when conducting contemporaneous assessments.

Dora Creek data taken from HLA (2007)

All data taken from 2004 with the exception of lead, which was taken during 2003 and hydrogen fluoride which was taken during 2005

4.4.1 Estimation of pollutant concentrations for averaging periods less than one hour

Where pollutant concentrations were required to be assessed for averaging times less than one hour, namely for SO_2 and CO, as presented in Table 3-2, Equation 1 was used (Victoria EPA, 2005).

$$C_t = C_{60}\left[\frac{60}{t}\right]^{0.2} \quad \text{…[Equation 1]}$$

Where:

C_t = concentration of pollutant at time t

C_{60} = concentration of pollutant based on averaging time of 60 minutes;
t = time (in minutes)

Dispersion Modelling

5.1 Approach to Modelling

Given the relatively flat terrain, proximity of residential receptors and that the source was situated approximately 8 km inland from the coast, AUSPLUME V6.0 was considered an appropriate model to use. Other parameters used in the modelling are discussed in the remainder of this section.

5.2 Meteorology

The meteorology for the site was generated using meteorological data collected from Steel River in 2004 (originally collected by Connell Wagner at a location adjacent to the proposed development) and incorporated into TAPM (v4). The meteorological data used in the assessment is discussed in Appendix B.

5.3 Terrain, Gridded and Sensitive Receptors

A 3km by 3km grid domain (378864 – 381895 by 6360148 - 6362998 MGA) was used and terrain data sourced from Department of Lands were used over the model grid and to represent the base elevation of gridded receptors. The terrain required a relatively fine resolution in order to capture the potential for building downwash effects and residential areas immediately to the south of the plant, therefore a 30m model grid spacing was used.

Nine discrete (sensitive) receptors that were represented in the modelling are the residential locations to the south of the site, which were considered to be the closest sensitive receptors to the site. The locations of the sensitive receptors are shown in Figure 2-3.

5.4 Emission Sources

The emissions inventory for the following sources is presented in Appendix A.

5.4.1 Modelled Sources

The following sources were included in the modelling scenarios and relevant building information was added to the model to incorporate building downwash effects.

Furnace Stack

The source comprises the outlet of the Dry EP and was modelled during normal operation (Scenario 1 – refer Section 5.5). Again, it should be noted that the emissions data, specifically, metals and VOCs are dependant on cullet quality.

Additionally, the VOCs were conservatively assumed to comprise 100% formaldehyde. The Department of Environment and Heritage (2004) shows that formaldehyde, benzene, cyclohexane, n-hexane and toluene comprise approximately 8.6% (by weight) of Total VOCs emitted from glass production facilities. The composition of the remainder of the 91.4% (by weight) of VOCs is not known, however, given the presence of formaldehyde as a significant VOC and the relatively low criteria of formaldehyde (compared with the other VOCs known to be generated from this process), it was considered a conservative approach to assume all VOCs as formaldehyde.

Blowing Wool Stack

This source was modelled for all hours of the year.

Facing Pit Extraction Stack

This source was modelled for all hours of the year.

Down Stream Stack

This source comprises the outlet of the Wet EP and was modelled for all hours of the year. Similarly to the Dry EP, Total VOCs were conservatively assumed to comprise all formaldehyde.

Emergency Stack

The emergency stack will be operating approximately 6 days per year during maintenance of the Dry EP, resulting in elevated PM_{10} emissions during this time. As such, the modelling included a scenario to run the Emergency Stack for a full year with the operation of the other process sources, excluding the Furnace Stack, which would not be operating due to the shut down and maintenance of the Dry EP. This represents a worst-case assessment of PM_{10} emissions from the operation of the furnace as the control methods would be off-line.

5.4.2 Sources Excluded from Modelling

The following sources have been omitted from modelling:

Furnace Stack

The source comprises the outlet of the Dry EP and was not modelled during Emergency Stack operation (Scenario 2 – refer Section 5.5) as the emissions from the Emergency Stack (inlet to the Dry EP) replace the emissions from the Furnace stack during this period.

Raw materials

The raw materials will be stored appropriately (covered) and comprise the following:

- Sand
- Soda ash
- Borax
- Nepheline
- Dolomite
- Limestone
- Plate or Bottle Cullet (broken waste / recyclable glass)

Given the inertness of the materials, air emissions, specifically odour and dust are considered to be insignificant from these sources, consequently, were excluded from the assessment.

Oxygen plant

The oxygen plant involves the extraction of oxygen from ambient air. Compressed air has ‘impurities’ comprising primarily nitrogen, carbon dioxide and water vapour which are removed into the ‘waste gas’ stream, leaving the oxygen available for purification. Consequently, the ‘waste gas’ has, for all intents and purposes, the same composition as ambient air, excluding the oxygen, and therefore does not warrant further assessment.

On-site Vehicles

On-site vehicles such as trucks containing raw materials have been excluded from the assessment as the site roads will be sealed, thus minimising dust generation. Combustion products from the vehicle exhausts are considered negligible and does not warrant further assessment.

5.5 Scenarios Assessed

The plant is proposed to operate continuously, even though the plant will have the emergency stack operating (Dry EP off line for maintenance) for up to 6 days per year. Consequently, two scenarios were assessed, namely, Scenario 1 – Normal Operation and Scenario 2 - Emergency Stack operation. It should noted that Scenario 2 assumes all other sources (Downstream Stack, Facing Pit Extraction Stack and Blowing Wool Stack) are running normally. The emergency stack scenario is to be operational during the Dry EP maintenance, which is expected to occur for on average 6 days per year, hence the modelling (particularly for particulate matter) is considered conservative.

The modelling assessed ground level concentrations at the nine sensitive receptors on the southern side of Industrial Drive, which are shown are the closest residential areas to the plant.

5.6 Odour

When assessing ground level concentrations of odour, DEC (2005) require the use of peak to mean ratios be incorporated into the ground level concentrations. The peak to mean ratio is defined by DEC (2005 p 58) as "*a conversion factor that adjusts mean dispersion model predictions to the peak concentrations perceived by the human nose*". For example, where a 1-hour averaging time has been used for modelling and an odour concentration at a receptor is predicted to be 0.5 OU, a peak to mean ratio of 3 would increase the predicted odour concentration to 1.5 OU. During that hour, the dispersion model predicts an average concentration of 0.5 OU at the receptor, however, the instantaneous odour concentration may rise to 1.5 OU and fall to 0.1 OU, but the fluctuations may only last for a matter of seconds. As the human nose has a relatively quick response time, namely in the order of seconds, the peak to mean ratio (in this case, a factor of 3) incorporates the quicker response time of the human nose when perceiving natural variations (increases) in odour concentration throughout that hour period.

For this assessment, a uniform peak to mean ratio of 2.3 was incorporated into the odour results, consistent with guidelines for wake affected stacks (DEC, 2005).

Results

6.1 Dispersion Modelling Results

The results of the modelling compared against DECC criteria are presented Table 6-1 and Table 6-2 for Scenarios 1 and 2 respectively showing the maximum concentration at any one of the sensitive receptors. The results of the modelling compared against SIAS criteria are presented Table 6-3 and Table 6-4 for Scenarios 1 and 2 respectively showing the maximum concentration within or immediately adjacent to the Estate. The Ausplume model output files, which provide a summary of the modelling parameters, are provided in Appendix C. Selected figures of the modelling results are provided in the Figures section.

The results have been compared against DECC and SIAS criteria and found to comply with the stated criteria, with the exception of NO_2, PM_{10} , SO_2 and lead for the SIAS Emission Envelope Allocation Data criteria and lead for the SIAS ambient air guidelines.

For Tables 6-1 and 6-2, it should be noted that PM_{10} results have been provided as inclusive of background.

6 Results

Table 6-1 Predicted ground level concentrations using dispersion modelling for Scenario 1 – Normal Operation (highest concentration at sensitive receptors) compared against DECC criteria

Pollutant	Averaging Time	Maximum Concentration		Background	Cumulative	Criteria		Exceedence
		mg/m^3	ug/m^3	ug/m^3	ug/m^3	mg/m^3	ug/m^3	
SOx	10 minutes	-	172.00	274.00	446.00	-	712	NO
	1 hour	-	120.20	192.00	312.20	-	570	NO
	24 hours	-	26.36	40.00	66.36	-	228	NO
	Annual	-	1.10	6.00	7.10	-	60	NO
NO$_x$	1 hour	-	85.08	90.20	175.28	-	246	NO
	Annual	-	1.19	18.50	19.69	-	62	NO
CO	15 minutes	-	8.1	4800	4808	-	100,000	NO
	1 hour	-	6.1	3600	3606	-	30,000	NO
	8 hours	-	3.5	3000	3003	-	10,000	NO
PM$_{10}$	24 Hour	-	49.7	Included	49.7	-	50	NO
	Annual	-	20.5	Included	20.5	-	30	NO
Lead	Annual	-	3.90E-04	0.09	9.04E-02	-	0.5	NO
HF	90 day	-	1.22E-02	0.17	0.18	-	0.25	NO
	30 day	-	6.16E-02	0.17	0.23	-	0.4	NO
	7 day	-	6.16E-02	0.17	0.23	-	0.8	NO
	24 hour	-	1.83E-01	0.32	0.50	-	1.5	NO
Pollutant	**Averaging Time**	**99.9% Concentration**		**Background**	**Cumulative**	**Criteria**		**Exceedence**
		mg/m^3	**ug/m^3**	**g/m^3**	**mg/m^3**	**mg/m^3**	**ug/m^3**	
VOC's as Formaldehyde	1 hour	1.42E-02	-	-	1.42E-02	0.029	-	NO
Hydrogen Chloride	1 hour	1.19E-03	-	-	1.19E-03	0.14	-	NO
Cobalt	1 hour	3.96E-06	-	-	3.96E-06	-	-	-
Cadmium	1 hour	1.78E-05	-	-	1.78E-05	0.000018	-	NO
Chromium	1 hour	5.55E-05	-	-	5.55E-05	0.00009	-	NO
Nickel	1 hour	3.76E-05	-	-	3.76E-05	0.00018	-	NO
Arsenic	1 hour	2.97E-05	-	-	2.97E-05	0.00009	-	NO
Selenium	1 hour	1.78E-05	-	-	1.78E-05	-	-	-
Antimony	1 hour	2.97E-05	-	-	2.97E-05	0.009	-	NO
Vanadium	1 hour	1.19E-05	-	-	1.19E-05	-	-	-
Ammonia	1 hour	1.68E-02	-	-	1.68E-02	0.33	-	NO
Phenol	1 hour	5.02E-03	-	-	5.02E-03	0.02	-	NO
Pollutant	**Averaging Time**	**99% Concentration**		**Background**	**Cumulative**	**Criteria**		**Exceedence**
		OU/m^3				**OU/m^3**	**ug/m^3**	
Odour (99%)	1 hour	3.3E+00	-	-	3.3	4	-	NO

Table 6-2 Predicted ground level concentrations using dispersion modelling for Scenario 2 – Operation Using Emergency Stack (highest concentration at sensitive receptors) compared against DECC criteria

Pollutant	Averaging Time	Emission Rate (g/s)	Maximum Concentration		Background	Cumulative	Criteria		Exceedence
			mg/m^3	ug/m^3	ug/m^3	ug/m^3	mg/m^3	ug/m^3	
SOx	10 minutes	-	-	171.29	274.00	445.29	-	712	NO
	1 hour	-	-	119.70	192.00	311.70	-	570	NO
	24 hours	-	-	26.28	40.00	66.28	-	228	NO
	Annual		-	1.08	6.00	7.08	-	60	NO
NO$_x$	1 hour	-	-	68.55	90.20	158.75	-	246	NO
	Annual	-	-	1.19	18.50	19.69	-	62	NO
CO	15 minutes	-	-	6.51	4800	4807	-	100,000	NO
	1 hour	-	-	4.93	3600	3605	-	30,000	NO
	8 hours	-	-	3.16	3000	3003	-	10,000	NO
PM$_{10}$	24 Hour	-	-	49.8	Included	49.8	-	50	NO
	Annual	-	-	22.1	Included	22.1	-	30	NO
Lead	Annual	0.00007	-	5.84E-05	0.09	9.01E-02	-	0.5	NO
HF	90 day	-	-	1.96E-02	0.17	0.19	-	0.25	NO
	30 day	-	-	7.49E-02	0.17	0.24	-	0.4	NO
	7 day	-	-	7.49E-02	0.17	0.24	-	0.8	NO
	24 hour	-	-	1.84E-01	0.32	0.50	-	1.5	NO
Pollutant	**Averaging Time**	**Emission Rate (g/s)**	**99.9% Concentration**		**Background**	**Cumulative**	**Criteria**		**Exceedence**
			mg/m^3	**ug/m^3**	**mg/m3**	**mg/m3**	**mg/m^3**	**ug/m^3**	
VOC's as Formaldehyde	1 hour	-	1.42E-02	-	-	1.42E-02	0.029	-	NO
Hydrogen Chloride	1 hour	0.03	1.38E-03	-	-	1.38E-03	0.14	-	NO
Cobalt	1 hour	0.00007	3.22E-06	-	-	3.22E-06	-	-	-
Cadmium	1 hour	0.00006	2.76E-06	-	-	2.76E-06	0.000018	-	NO
Chromium	1 hour	0.00083	3.82E-05	-	-	3.82E-05	0.00009	-	NO
Nickel	1 hour	0.00056	2.58E-05	-	-	2.58E-05	0.00018	-	NO
Arsenic	1 hour	0.00006	2.76E-06	-	-	2.76E-06	0.00009	-	NO
Selenium	1 hour	0.00028	1.29E-05	-	-	1.29E-05	-	-	-
Antimony	1 hour	0.00006	2.76E-06	-	-	2.76E-06	0.009	-	NO
Vanadium	1 hour	0.00017	7.83E-06	-	-	7.83E-06	-	-	-
Ammonia	1 hour	7.4	1.68E-02	-	-	1.68E-02	0.33	-	NO
Phenol	1 hour	2.21	5.02E-03	-	-	5.02E-03	0.02	-	NO
Pollutant	**Averaging Time**	**Peak To Mean**	**99% Concentration**		**Background**	**Cumulative**	**Criteria**		**Exceedence**
			OU/m^3				**OU/m^3**	**ug/m^3**	
Odour (99%)	1 hour	2.3	3.6E+00	-	-	3.6	4	-	NO

6 Results

Table 6-3 Predicted ground level concentrations using dispersion modelling for Scenario 1 – Normal Operation compared against SIAS criteria

Pollutant	Averaging Period	Frequency	SIAS Guideline Concentration	Predicted Ground Level Concentration	Exceedance
Ambient Air Guidelines			(µg/m^3)	(µg/m^3)	
NO_2	1 hour	100%	328	107	NO
	Annual	100%	102.5	2.3	NO
PM_{10}	24 hour	100%	150	25.4	NO
	Annual	100%	50	8.4	NO
SO_2	10 minutes	100%	715	497	NO
	1 hour	100%	572	347	NO
	Annual	100%	57.2	3.5	NO
Lead	3 months	100%	1.5	2.2	YES
Design Ground Level Concentration (Air Toxics) Criteria			(mg/m^3)	(mg/m^3)	
Ammonia	1 hour	99.9%	0.6	0.018	NO
Formaldehyde	1 hour	99.9%	0.05	0.05	NO
Hydrogen chloride	1 hour	99.9%	0.3	0.0015	NO
Phenol	1 hour	99.9%	0.036	0.005	NO
Environmental Envelope Air Emission Allocation			(µg/m^3)	(µg/m^3)	
NO_2	1 hour	100%	73.83	107	YES
	Annual	100%	19.688	2.3	NO
PM_{10}	24 hour	100%	7.383	25.4	YES
	Annual	100%	3.6915	8.4	YES
SO_2	10 minutes	100%	159.985	497	YES
	1 hour	100%	123.05	347	YES
	Annual	100%	9.844	3.5	NO
Lead	3 months	100%	0.2481	2.2	YES

Notes:

All VOC from stack have been assumed to be formaldehyde consequently, the actual concentration will be lower.

Where peak concentrations exist within 0.5 km of the Steel River Estate boundary, those values have been taken in preference to lower values on site.

Table 6-4 Predicted ground level concentrations using dispersion modelling for Scenario 2 – Operation Using Emergency Stack compared against SIAS criteria

Pollutant	Averaging Period	Frequency	SIAS Guideline Concentration	Maximum Predicted Ground Level Concentration	Exceedance
Ambient Air Guidelines			(µg/m^3)	(µg/m^3)	
NO_2	1 hour	100%	328	136	NO
	Annual	100%	102.5	19	NO
PM_{10}	24 hour	100%	150	146	NO
	Annual	100%	50	30	NO
SO_2	10 minutes	100%	715	497	NO
	1 hour	100%	572	347	NO
	Annual	100%	57.2	3.5	NO
Lead	3 months	100%	1.5	1.6	YES
Design Ground Level Concentration (Air Toxics) Criteria			(mg/m^3)	(mg/m^3)	
Ammonia	1 hour	99.9%	0.6	0.02	NO
Formaldehyde	1 hour	99.9%	0.05	0.05	NO
Hydrogen chloride	1 hour	99.9%	0.3	0.003	NO
Phenol	1 hour	99.9%	0.036	0.005	NO
Environmental Envelope Air Emission Allocation			(µg/m^3)	(µg/m^3)	
NO_2	1 hour	100%	73.83	136	YES
	Annual	100%	19.688	19	NO
PM_{10}	24 hour	100%	7.383	146	YES
	Annual	100%	3.6915	30	YES
SO_2	10 minutes	100%	159.985	497	YES
	1 hour	100%	123.05	347	YES
	Annual	100%	9.844	3.5	NO
Lead	3 months	100%	0.2481	1.6	YES

Notes:

All VOC from stack have been assumed to be formaldehyde consequently, the actual concentration will be lower.

Where peak concentrations exist within 0.5 km of the Steel River Estate boundary, those values have been taken in preference to lower values on site.

7

Discussion

7.1 Comparison to Emissions Standard

Table 7-1 presents a comparison of the emission sources to the Clean Air Regulation and shows that the stated stack emissions are compliant with regulatory criteria.

Table 7-1 Comparison of source emissions from a KI Stack Emissions to Standards of Concentrations for Glass Production (Clean Air Regulation 2005)

Pollutant	Applicability	Stack	Reference Conditions	Clean Air Regulation Limit	Estimated emission concentration	Conformance to Clean Air Regulation
Solid Particulates (Total)	Any melting furnace	Dry EP	Dry, 273 K, 101.3 kPa, 3 % O_2	50 mg/m^3	20 mg/m^3	Yes
	Any crushing, grinding, separating or materials handling activity	Blowing Wool, Facing Pit [B]	Dry, 273 K, 101.3 kPa, 3 % O_2	20 mg/m^3	20 mg/m^3	Yes
NO_2 or NO or both as NO_2 equivalent	Any melting furnace except manufacture of glass using sodium nitrate ($NaNO_3$)	Dry EP	Dry, 273 K, 101.3 kPa, 3 % O_2	700 mg/m^3 as NO_2	500 mg/m^3	Yes
Type 1 and Type 2 substances	Any melting furnace	Dry EP	Dry, 273 K, 101.3 kPa, 3 % O_2	1 mg/m^3	1mg/m^3	Yes
Cadmium (Cd) or mercury (Hg) individually	Any melting furnace	Dry EP	Dry, 273 K, 101.3 kPa, 3 % O_2	0.2 mg/m^3	0.02 mg/m^3 Cd	Yes
Smoke	Any melting furnace	Dry EP	Gas stream temperature above dew point. Path length corrected to stack exit diameter as per CEM-1	Ringelmann 1 or 20% opacity	< 20% opacity [A]	Yes

Note:
The Clean Air Regulation Limit concentrations are reported at reference conditions stated in Schedule 5 Part 3 of the Clean Air Regulation (2005). The plant O_2 reference conditions specified in an Environment Protection Limit will be based on technology type and operation of the plant in a proper and efficient manner. Consequently the reference oxygen concentration may vary from the 3% specified.

[A]: Opacity of the emissions has not been provided, however, emissions from the Dry EP emissions are expected to meet regulatory criteria.

[B]: For the purposes of modelling, a higher concentration of 30 mg/m^3 was assumed.

7.2 Comparison to DECC Air Impact Assessment Criteria

As presented in Table 6-1 and Table 6-2, the modelled pollutants from the plant do not exceed criteria at the sensitive receptors. Whilst the pollutants were below the criteria, PM_{10} and odour were shown to be approaching criteria thus warranting further investigation. These species are further discussed below in Sections 7.2.1 to 7.2.3.

7.2.1 Particulate Matter (PM_{10})

Further assessment of the particulate matter involved a more detailed assessment of the highest background concentrations and peak plant impacts. The highest background concentration investigated during this assessment was shown to be 50.5 µg/m^3 and it occurred on 1 December 2004. As the background concentration was already over regulatory criteria, this day may be excluded, as the *Approved Methods* only require the number of times additional exceedances occur (DEC 2005). It should also be noted that bushfires occurred near Parkes and Kempsey in NSW on that day (BoM 2009a), which may have elevated the background PM_{10} concentration.

A contemporaneous PM_{10} assessment where background PM_{10} data were incorporated into the dispersion model showed no instances of additional exceedances of the 50 µg/m^3 criteria, however, cumulative concentrations were shown to be at 49.8 µg/m^3 (incorporating an average background concentration of 48.5 µg/m^3). Consequently, PM_{10} is shown to have complied with regulatory criteria.

Further investigation of incremental PM_{10} shows that the highest concentration from the plant during normal operation is approximately 6 µg/m^3 and 32.6 µg/m^3 during Emergency Stack operation. The incremental and associated cumulative values are presented in Table 7-2, which suggests that peak incremental impact during normal plant operation is relatively low.

Table 7-2 Contemporaneous assessment of PM_{10} for the top two days at any one of the sensitive receptor

Peak Concentrations Based on Top 2 Total Concentrations Scenario 1 – Normal Operation				Peak Concentrations Based on Top 2 Total Concentrations Scenario 2 - Emergency			
Date	Background (µg/m^3)	Predicted increment (µg/m^3)	Total (µg/m^3)	Date	Background (µg/m^3)	Predicted increment (µg/m^3)	Total (µg/m^3)
12/3/2004	26.6	6.05	32.65	7/12/2004	16.4	32.6	49.0
5/12/2004	16.5	5.65	22.15	5/12/2004	16.5	24.2	40.7

To ensure the 2004 PM_{10} data was representative, the most recent full year (2007) of PM_{10} measurements from Wallsend were also assessed (DECC 2007). The measurements showed only one exceedance during the year at a concentration of 51 µg/m^3, namely in May 2007. On this basis, it is considered that the PM_{10} measurement data used in this assessment are likely to be representative of current conditions.

7.2.2 Odour

Odour impact is dependent on the population likely to be affected and odour performance criteria range from 7 OU for a single residence to 2 OU for a large population of > 2000 people, therefore an understanding of the likely impacted population is necessary.

The predicted 3.3 OU (under operating conditions) contour covers several houses to the south of Industrial Drive and a small component of the industrial area to the north of the Industrial Drive suggesting a potentially affected community of approximately 50 to 100 people. Consequently, an odour criteria between 4 and 5 OU would be an appropriate impact assessment criteria. On this basis, the odour impact is considered to be within regulatory criteria.

7.3 Comparison to SIAS Air Impact Assessment Criteria

As shown in Tables 6-3 and 6-4, the SIAS Air Impact Assessment Criteria are mostly met with the exception of NO_2, PM_{10} SO_2 and lead for the Environmental Air Emission Allocation Data criteria, and lead for the Ambient Air Guidelines.

It should be noted that the Environmental Air Emission Allocation Data may not be appropriate for application to this project, as stated in Woodward Clyde (2000, p3):

> *"Development that wishes to locate within the Steel River Project site that exceeds its environmental emissions entitlements of the envelope may still take place subject to demonstration through a full and detailed EIS, using statewide criteria and methodologies specified by the relevant government agencies, that its impacts are acceptable."*

Whilst the assessment has shown that exceedances of the Environmental Air Emission Allocation Data criteria may occur, the criteria are considered too conservative for application to an industrial development. In addition, the (higher) DECC criteria have been met, which are protective of adverse impact at relatively more sensitive receptors. The original intent of the model set up for the Environmental Air Emission Allocation Data acknowledges the preference of other appropriate (DECC) criteria, which this assessment has shown to meet.

The marginal exceedance (maximum of 2.2 $\mu g/m^3$ compared to a criteria of 1.5 $\mu g/m^3$) of the Ambient Air Guidelines of lead, which occurs on site, is not considered significant, as higher criteria would generally be applicable to workplace exposures. The Australian Safety and Compensation Council suggests a 8 hour Time Weighted Average value for lead fumes or dust of 150 $\mu g/m^3$ which is significantly higher than the maximum predicted concentration from the stack emissions.

Whilst SIAS criteria would generally be considered suitable for assessing medium size developments in this area in the absence of a detailed assessment, this air quality impact assessment has undertaken a broader assessment, investigating adverse impacts at local sensitive receptors using regulatory (DECC) criteria and found impacts to be below criteria. It is considered that the DECC assessment methods and criteria provide a more robust assessment and should be viewed in preference of the SIAS criteria.

Mitigation Measures

A brief discussion of key mitigation measures to be employed during construction are provided below, however, a more detailed assessment of air pollutants and discussion of mitigation measures is to be provided in the Construction Environment Management Plan (CEMP).

8.1 Particulate Matter

Environmental safeguards that would be implemented during the construction phases of the development are listed below. Any emissions of particulates matter would be specifically controlled through the implementation of these mitigation measures, which would be incorporated into a CEMP for the works.

- Before works begin, a CEMP will be prepared which addresses air monitoring and management issues;
- In dry, windy conditions, water sprays would be used to dampen down soils prior to excavation and handling. Exposed surfaces and stockpiles would also be watered, sprayed or covered where required;
- Vehicles would only be loaded to less than the height of the side and tailboards and loads of fill would be covered during transport. Any soil adhering to the undercarriage and wheels of trucks would be removed prior to departure from the site;
- Any long-term stockpiles would be stabilised using fast-seeding grass or synthetic cover spray; and
- All major access roads are sealed and vehicle speeds on unsealed site areas would be controlled to minimise dust.

Other dust control mitigation measures may be included in the CEMP in order to meet regulatory requirements.

8.2 Odour

During the construction phase, there is the potential for odour to be generated due to the excavation and handling of site soils. A quantitative odour assessment during the construction phase has not been included as part of this assessment and odour issues shall be addressed in the CEMP.

Should it be necessary, there are several mitigation measures available to control odour, which include:

- Enclosures or tents;
- Soil vapour extraction;
- In situ oxidation;
- Foams;
- Wind breaks;
- Odour suppressants; and
- Management and operational controls.

Proposed odour mitigation will be addressed in the CEMP in order to meet regulatory requirements.

Conclusion

An air quality assessment was undertaken for the proposed KI plant, to be located in the Steel River Estate in Newcastle, NSW. The assessment comprised two primary components, namely a comparison of in stack concentrations to the limits specified in the Clean Air Regulation 2005 and a comparison of ground level concentrations against criteria contained in the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The stack emissions were also compared against regulatory limits and found to be below regulatory limits specified in the Clean Air Regulation 2005.

The ground level concentrations were assessed using the Ausplume dispersion model, incorporating meteorological data from the Steel River weather station. The modelled species included oxides of nitrogen (NO_x), particulate matter (PM_{10}), carbon monoxide (CO), sulphur dioxide (SO_2), lead, hydrogen fluoride (HF), Hazardous Air Pollutants (HAPs) and odour.

The assessment has used a conservative approach applied in accordance with the *Approved Methods* (DEC, 2005). Where appropriate, the assessment of the cumulative impacts against regulatory criteria has used the aggregate of the worst case predicted plant impacts and peak background concentrations from DECC and other relevant monitoring stations.

The air dispersion modelling assessment has concluded that the predicted impacts on ground level concentrations of NO_2, PM_{10}, CO, SO_2, lead and HF when added to background concentrations, are within the DECC regulatory criteria. As per the *Approved Methods*, HAPs and odour were assessed for incremental impact and were below regulatory criteria.

Given the generally conservative nature of the air quality assessment, it is considered that the potential for adverse air quality impacts of the proposed KI plant will be low and within regulatory limits.

References

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Woodward Clyde 2000 *Agreement regarding Air Model for the Steel River Project Site*. Letter from Michael England and Louise Wickham of Woodward Clyde to Alan Norton BHP dated 25 May 2000.

11

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Knauf Insulation Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 8th April 2009.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between April and 2nd July 2009 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

Figures

Client

CROWN PROJECT SERVICES PTY LTD

URS

Project

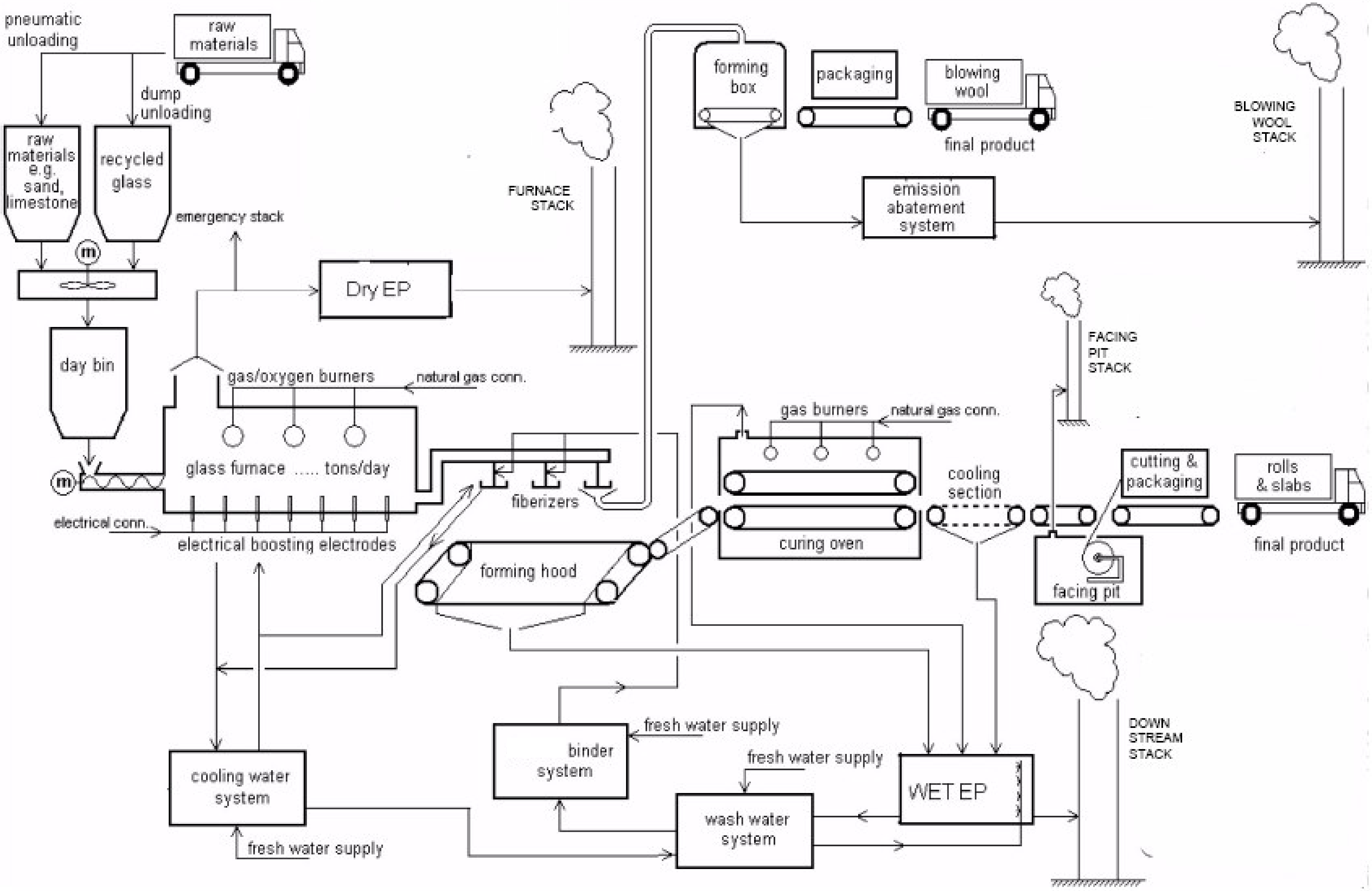
KNAUF INSULATION WOOL MANUFACTURING PLANT,
TRANSPORT AND ACCESSIBILITY ASSESSMENT

Drawn: AO
Approved: NV
Date: 18/06/2009
Job No: **43177672**
File No: 43177672.004.wor

Title

SITE LOCALITY

Figure: **1-1**



Source: Knauf Insulation

Client
CROWN PROJECT SERVICES PTY LTD

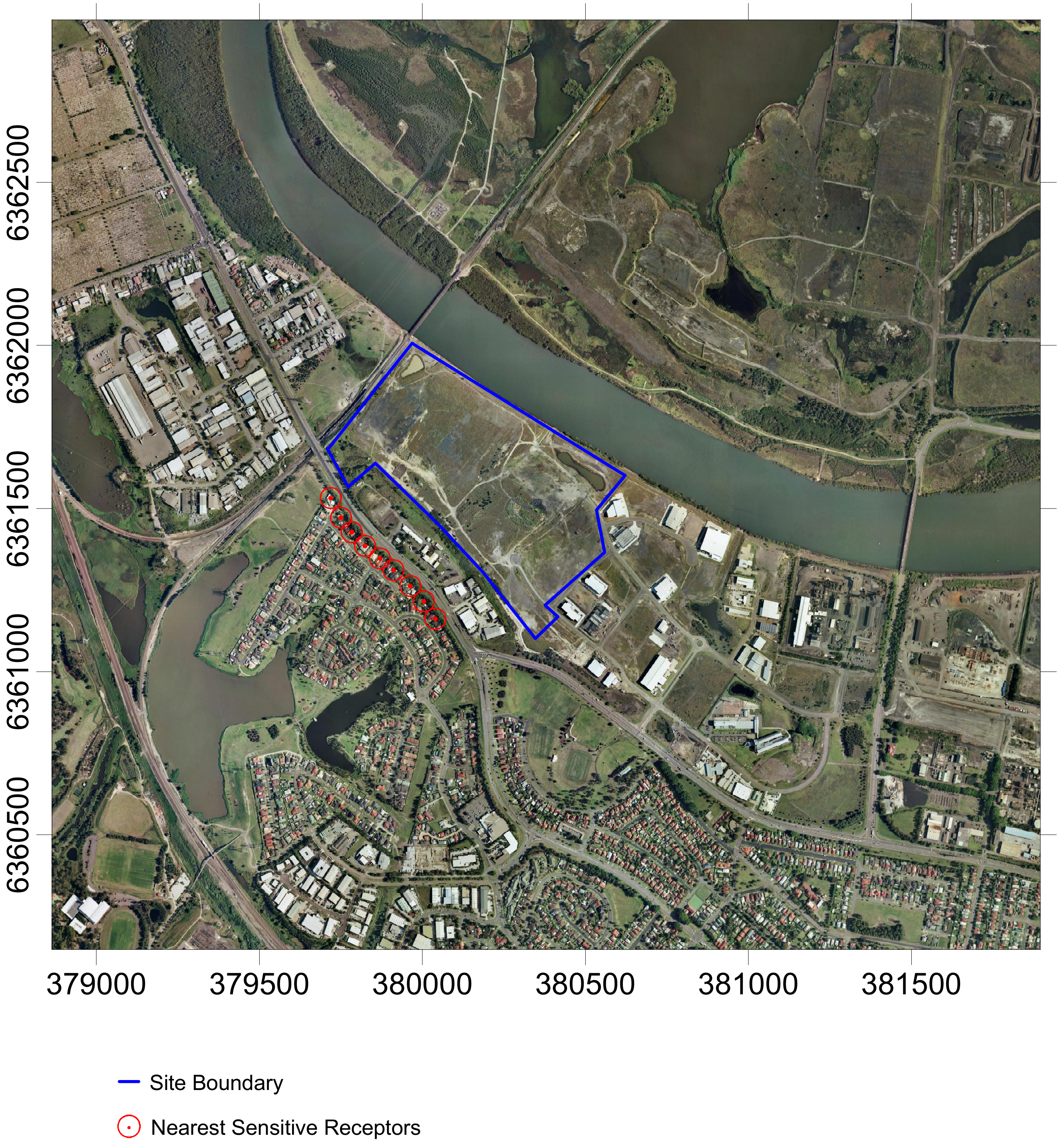
URS

Project
PROPOSED KNAUF INSULATION GLASS WOOL MANUFACTURING PLANT
STEEL RIVER, NSW

Drawn: AJW
Approved: SB
Date: 26/05/2009
Job No: 43177672
File No: 43177672.001.wor

Title
OVERVIEW OF KNAUF INSULATION PROCESS

Figure: **2-1**



MGA Coordinates (m), image sourced from Google Earth

Client: **CROWN PROJECT SERVICES PTY LTD**

URS

Project: **PROPOSED KNAUF INSULATION**
GLASS WOOL MANUFACTURING FACILITY
STEEL RIVER NEWCASTLE
AIR QUALITY IMPACT ASSESSMENT

Title: **Aerial Photo Showing Discrete Receptor Locations**

Drawn: SWB	Approved: FINAL	Date: June 2009
Job No: 43177672	File: 43177672 Figure 1.srf	

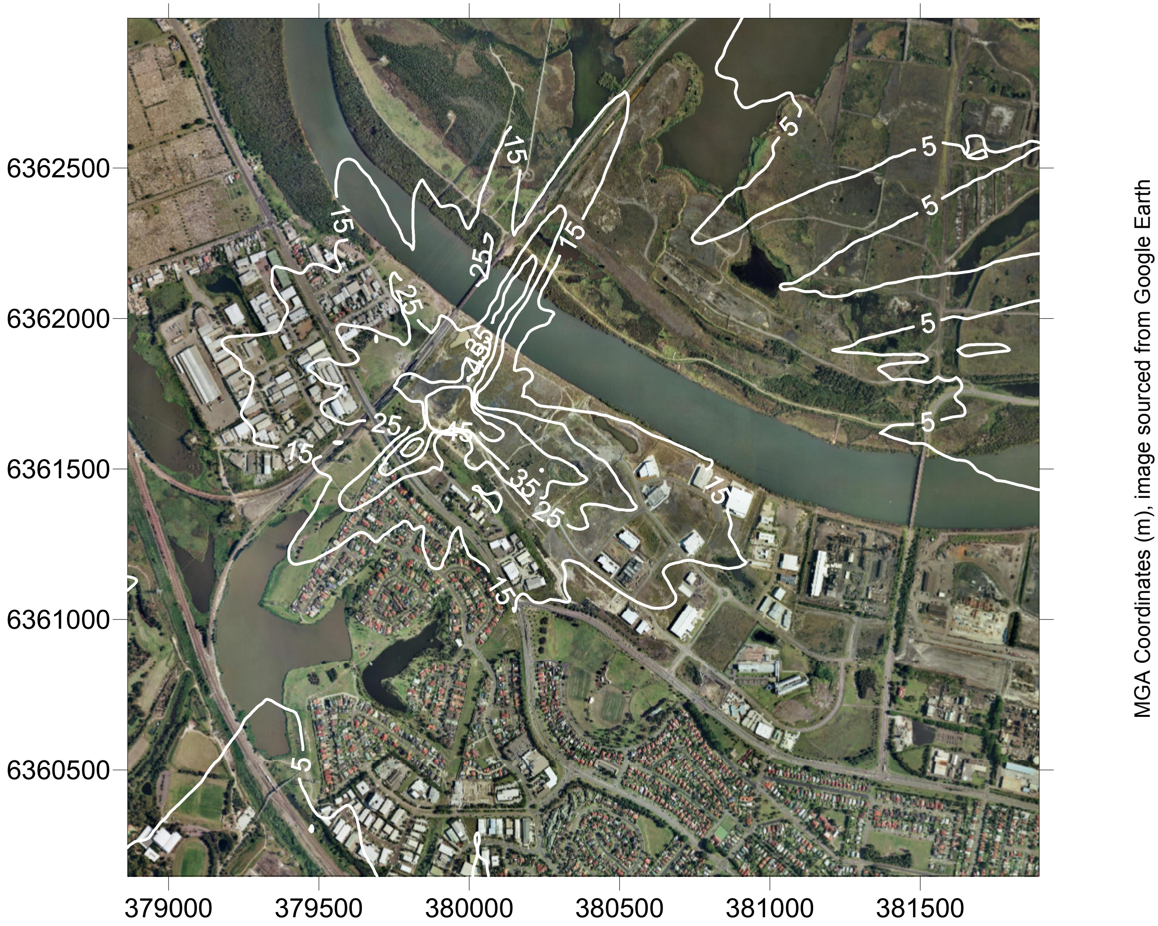
Figure: 2-2

Rev: A

A4

Scenario 1

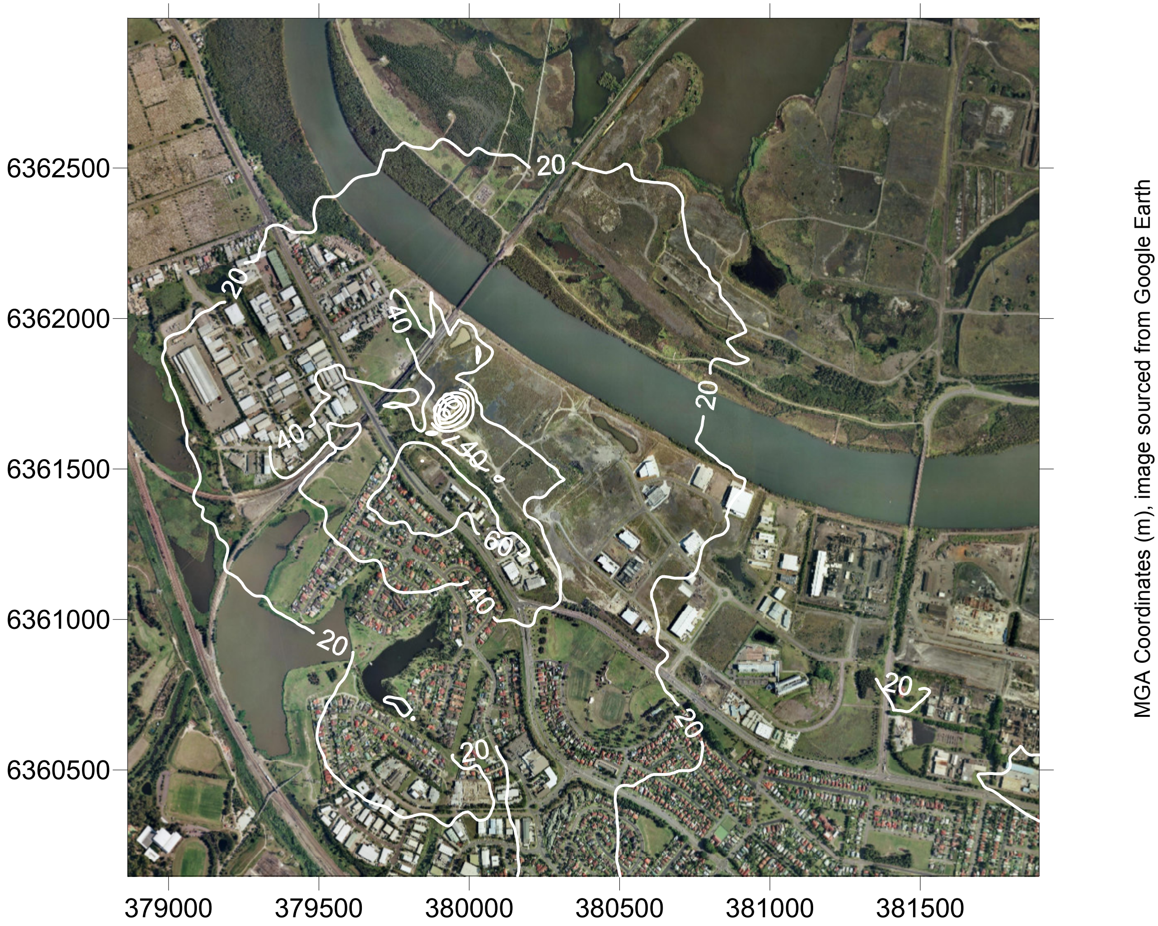
Scenario 2



Client: **CROWN PROJECT SERVICES PTY LTD**	Project: **PROPOSED KNAUF INSULATION GLASS WOOL MANUFACTURING FACILITY STEEL RIVER NEWCASTLE AIR QUALITY IMPACT ASSESSMENT**	Title: **Substance: PM10 Averaging Period: 24 Hour**
URS	Drawn: SWB | Approved: FINAL | Date: June 2009	Figure: 2-3 | Rev: A
	Job No: 43177672 | File: 43177672 Figure 2-7.srf	A4

Scenario 1

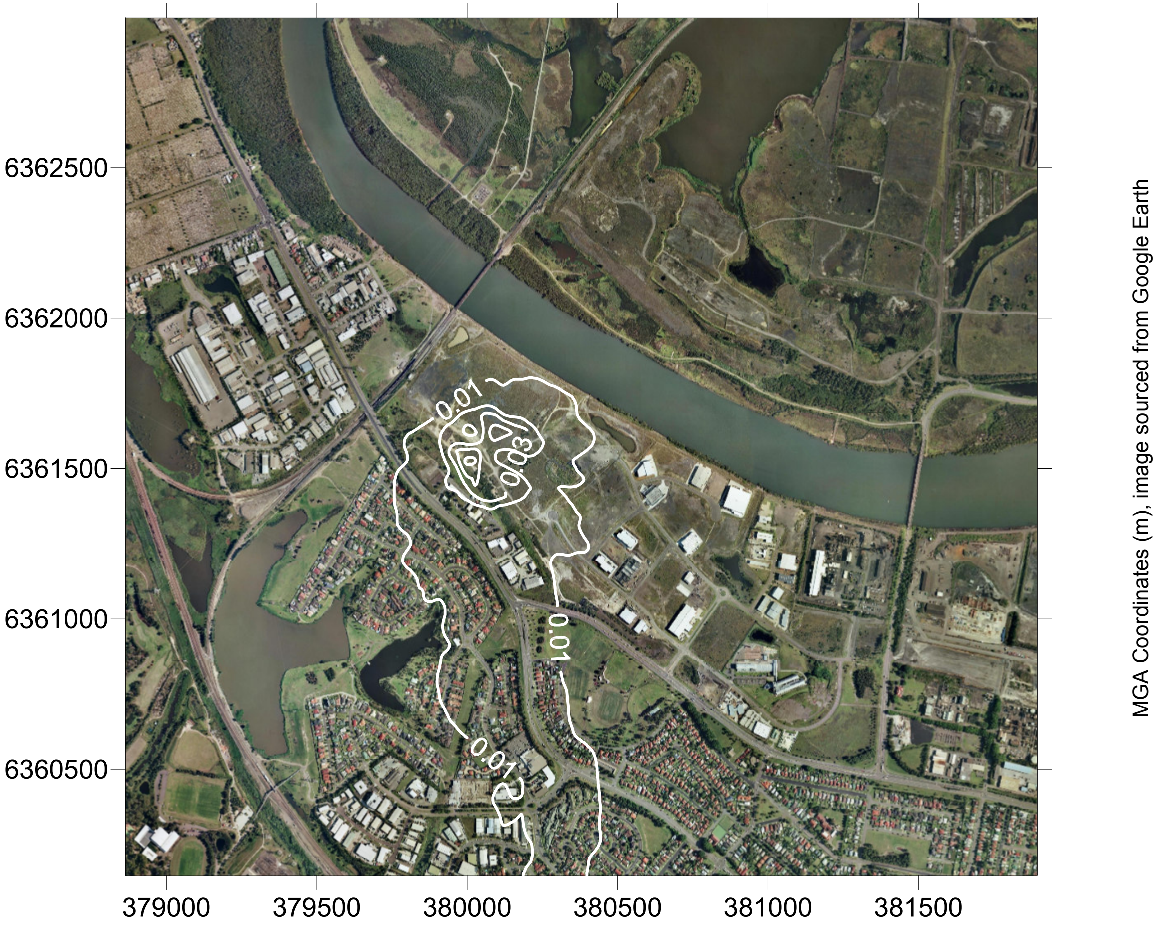
Scenario 2



Client: **CROWN PROJECT SERVICES PTY LTD**	Project: **PROPOSED KNAUF INSULATION GLASS WOOL MANUFACTURING FACILITY STEEL RIVER NEWCASTLE AIR QUALITY IMPACT ASSESSMENT**		Title: **Substance: NOx as Nitrogen Dioxide Averaging Period: 1 Hour**
URS	Drawn: SWB	Approved: FINAL	Date: June 2009
	Job No: 43177672	File: 43177672 Figure 2-7.srf	Figure: 2-4 Rev: A A4

Scenario 1

Scenario 2



Client:
CROWN PROJECT SERVICES PTY LTD

URS

Project:
PROPOSED KNAUF INSULATION
GLASS WOOL MANUFACTURING FACILITY
STEEL RIVER NEWCASTLE
AIR QUALITY IMPACT ASSESSMENT

Drawn: SWB
Approved: FINAL
Date: June 2009
Job No: 43177672
File: 43177672 Figure 2-7.srf

Title:
Substance: VOCs as Formaldehyde
Averaging Period: 1 Hour

Figure: 2-5
Rev: A
A4

Scenario 1

Scenario 2

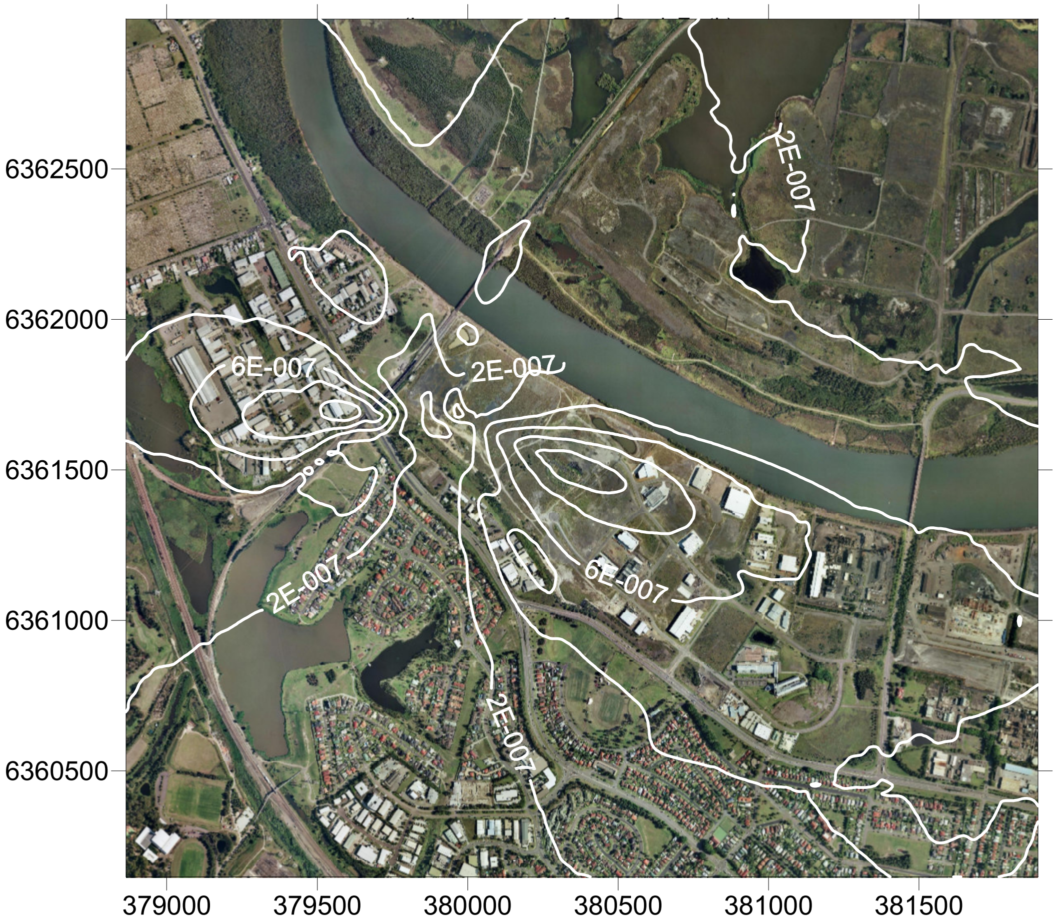
Client: **CROWN PROJECT SERVICES PTY LTD**	Project: **PROPOSED KNAUF INSULATION GLASS WOOL MANUFACTURING FACILITY STEEL RIVER NEWCASTLE AIR QUALITY IMPACT ASSESSMENT**		Title: **Substance: Odour Averaging Period: 1 Hour**
URS	Drawn: SWB	Approved: FINAL	Date: June 2009
	Job No: 43177672	File: 43177672 Figure 2-7.srf	Figure: 2-6
			Rev: A
			A4

Scenario 1

Scenario 2

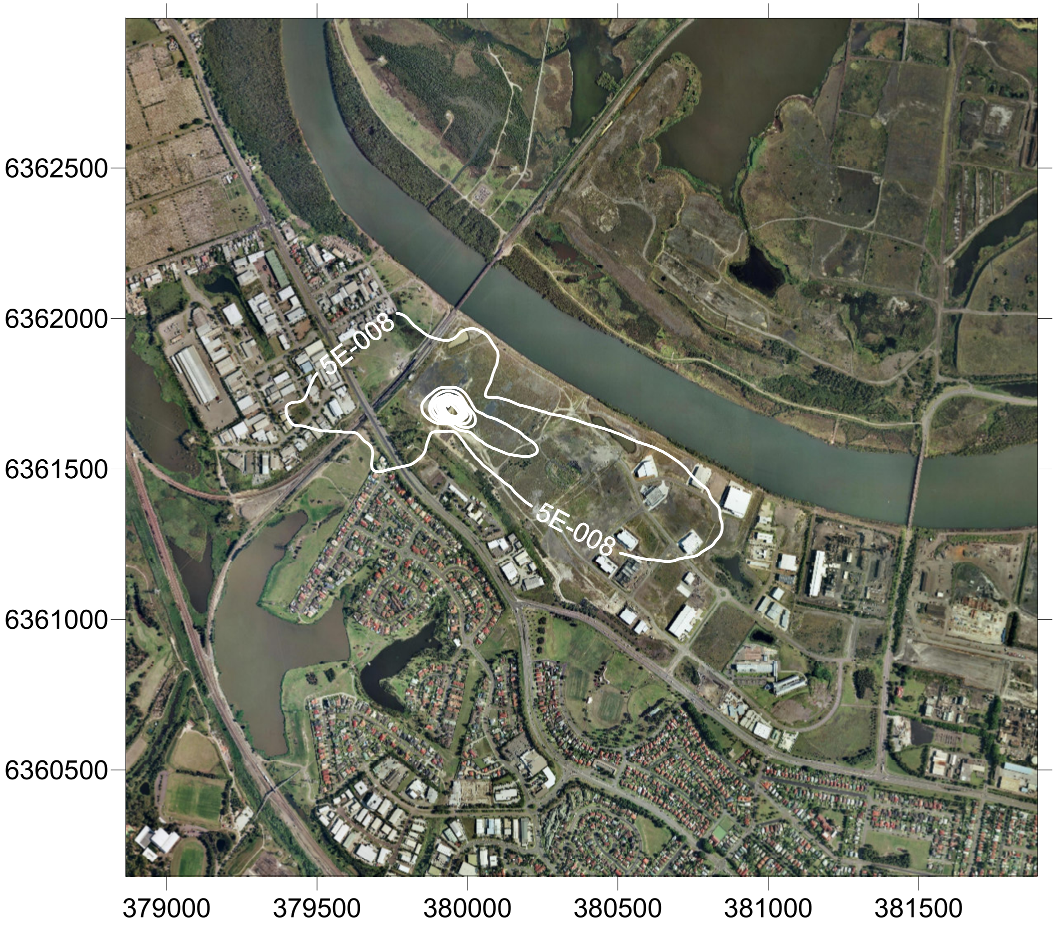
Client: **CROWN PROJECT SERVICES PTY LTD**	Project: **PROPOSED KNAUF INSULATION GLASS WOOL MANUFACTURING FACILITY STEEL RIVER NEWCASTLE AIR QUALITY IMPACT ASSESSMENT**	Title: **Substance: Sulfur Dioxide Averaging Period: 1 Hour**
URS	Drawn: SWB Job No: 43177672	Approved: FINAL File: 43177672 Figure 2-7.srf
Date: June 2009	Figure: 2-7	Rev: A A4

Scenario 1



MGA Coordinates (m), image sourced from Google Earth

Scenario 2



MGA Coordinates (m), image sourced from Google Earth

Client: **CROWN PROJECT SERVICES PTY LTD**	Project: **PROPOSED KNAUF INSULATION GLASS WOOL MANUFACTURING FACILITY STEEL RIVER NEWCASTLE AIR QUALITY IMPACT ASSESSMENT**	Title: **Substance: Lead Averaging Period: Annual**
URS	Drawn: SWB Job No: 43177672	Approved: FINAL File: 43177672 Figure 2-7.srf
	Date: June 2009	Figure: 2-8
		Rev: A A4

Appendix A Emissions Inventory

Appendix A

1 Melting Furnace / Dry EP

Source	Melting Furnace / Dry EP	Reference
Operating Time	> 98.4%	R9
Height (m)	40	R1
Diameter (m)	0.8	R1
Flowrate (Nm^3 dry/hr)	23000	R1,R4
Velocity (m/s)	24	CALC
Flowrate (Am^3/s)	12.29	CALC
Flowrate (Am^3/hr)	44238	CALC
Flowrate (Nm^3/hr, wet)	25539	CALC
Temperature (deg C)	200	R4
Pollutant Concentrations (mg/Nm^3 dry)		
Oxides of Sulphur (SO_x)	75	R4
Oxides of Nitrogen (NO_x)	500	R4
Dust (PM_{10})	20	R4
VOC	20	R4
Hydrogen Chloride (HCl)	10	R4
Hydrogen Fluoride (HF)	5	R4
Cadmium (Cd)	0.14	R9
Mercury (Hg)	NA	NA
Type 1 (Sb, As, Cd, Pb, Hg)	1	R6
Type 2 (Be, Cr, Co, Mn, Ni, Se, Sn, V)	1	R6
Odour (OU/m3)	1460	R7
Pollutant Emission Rates (g/s)		
Oxides of Sulphur (SO_x)	0.48	CALC
Carbon Monoxide (CO)	0.23	CALC
Oxides of Nitrogen (NO_x)	3.19	CALC
Dust (PM_{10})	0.13	CALC
VOC	0.13	CALC
Hydrogen Chloride (HCl)	0.06	CALC
Hydrogen Fluoride (HF)	0.03	CALC
Cadmium (Cd)	0.0013	CALC
Mercury (Hg)	NA	NA
Type 1 (Sb, As, Cd, Pb, Hg)	0.0064	CALC
Type 2 (Be, Cr, Co, Mn, Ni, Se, Sn, V)	0.0064	CALC
Odour (OU/s inc. P2M)	26002	CALC
Sb	0.0015	CALC
As	0.0015	CALC
Cd	0.0009	CALC
Pb	0.0019	CALC
Hg	NA	NA
Be	NA	CALC
Cr	0.0028	CALC
Co	0.0002	CALC
Mn	NA	CALC
Ni	0.0019	CALC
Se	0.0009	CALC
Sn	NA	CALC
V	0.0006	CALC

Notes:
R1 = CPS to URS, titled Split: FW: Process information: oxygen plant, stacks, Dated 19 May 2009
R2 = CPS to URS, titled Tyumen Tank - Exhaust Stack, no date.
R3 = KI 2009 New Glasswool Plant Australia Process Description, Rev 0, Dated 25 March 2009
R4 = Emissions expected for the future australian plant (1st version), no date
R5 = Emissions expected for the future australian plant (2nd version) including Australia emergency stack, no date
R6 = Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities) and Plant) Regulation 2005
R7 = CPS to URS, titled Odour - Operations. Dated 27 May 2009
R8 = URS (N Ballard to URS (J Grieve), titled Knauf - Conference Call Confirmation. Dated 26 June 2009
R9 = Coune, P (KI), pers.comm 1 July 2009
R10 = KI 2009 New Glass Wool Plant Australia Scope fo Work Rev 3 29 May 2009

1a Melting Furnace / Emergency Stack (bypass of dry EP)

Source	Melting Furnace / Dry EP	Reference
Operating Time	< 1.6%	R9
Height (m)	35	R1
Diameter (m)	0.75	R1
Flowrate (Nm^3 dry/hr)	10000	R5
Moisture (%)	58.20%	R2
Velocity (m/s)	30	CALC
Flowrate (Am^3/s)	13.46	CALC
Flowrate (Am^3/hr)	48447	CALC
Flowrate (Nm^3/hr, wet)	23923	CALC
Temperature (deg C)	280	R4
Pollutant Concentrations (mg/Nm^3 dry)		
Carbon Monoxide	37.33	R4
Oxides of Nitrogen (NO_x)	500	R4
Oxides of Sulphur (SO_x)	75	R4
Total Hydrocarbons	10	R4
HF	5	R4
HCl	10	R4
Dust (PM10)	750	R6
Total Metals	1.3	R6
Odour (OU/m3)	1460	CALC
Sb	0.02	CALC
As	0.02	CALC
Cd	0.02	CALC
Pb	0.025	CALC
Hg	NA	CALC
Be	NA	CALC
Cr	0.3	CALC
Co	0.025	CALC
Mn	NA	CALC
Ni	0.2	CALC
Se	0.1	CALC
Sn	NA	CALC
V	0.06	CALC
Pollutant Emission Rates	*(g/s)*	
Carbon Monoxide	0.10	CALC
Oxides of Nitrogen (NO_x)	1.39	CALC
Oxides of Sulphur (SO_x)	0.21	CALC
Total Hydrocarbons	0.03	CALC
HF	0.01	CALC
HCl	0.03	CALC
Dust (PM10)	2.08	CALC
Total Metals	0.00	CALC
Odour (OU/s)	24358	CALC
Sb	0.00006	CALC
As	0.00006	CALC
Cd	0.00006	CALC
Pb	0.00007	CALC
Hg	NA	NA
Be	NA	NA
Cr	0.00083	CALC
Co	0.00007	CALC
Mn	NA	NA
Ni	0.00056	CALC
Se	0.00028	CALC
Sn	NA	NA
V	0.00017	CALC

Notes:
R1 = CPS to URS, titled Split: FW: Process information: oxygen plant, stacks, …. Dated 19 May 2009
R2 = CPS to URS, titled Tyumen Tank - Exhaust Stack, no date.
R3 = KI 2009 New Glasswool Plant Australia Process Description, Rev 0, Dated 25 March 2009
R4 = Emissions expected for the future australian plant (1st version), no date.
R5 = Emissions expected for the future australian plant (2nd version) including Australia emergency stack, no date.
R6 = Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities) and Plant) Regulation 2005.
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R8 = URS (N Ballard to URS (J Grieve), titled Knauf - Conference Call Confirmation. Dated 26 June 2009
R9 = Coune, P (KI), pers.comm 1 July 2009
R10 = KI 2009 New Glass Wool Plant Australia Scope fo Work Rev 3 29 May 2009

2 Downstream Stack / Wet EP

Source	Downstream / Wet EP	Reference
Operating Time	100%	R10
Height (m)	60	CALC
Diameter (m)	3.9	R1
Flowrate (Nm^3 dry/hr)	530000	R1,R4
Velocity (m/s)	14	R4
Flowrate (Am^3/s)	171.32	CALC
Flowrate (Am^3/hr)	616761	CALC
Flowrate (Nm^3/hr, wet)	552083	CALC
Temperature (deg C)	32	R4
Pollutant Concentrations (mg/Nm^3 dry)		
Oxides of Sulphur (SO_x)	300	R4
Carbon Monoxide (CO)	10	CALC
Oxides of Nitrogen (NO_x)	20	R8
VOC	30	R4
Dust (PM10)	30	R4
NH3	50	R4
Formaldehyde	5	R4
Phenol	15	R4
Amine	3	R4
Odour (OU/m3)	479	R7
Pollutant Emission Rates (g/s)		
Oxides of Sulphur (SO_x)	44.2	CALC
Oxides of Nitrogen (NO_x)	2.9	CALC
VOC	4.4	CALC
Dust (PM10)	4.4	CALC
NH3	7.4	CALC
Formaldehyde	0.7	CALC
Phenol	2.21	CALC
Amine	0.44	CALC
Odour (OU/s) inc. P2M-2.3	184000	CALC

Notes:
R1 = CPS to URS, titled Split: FW: Process information: oxygen plant, stacks, …. Dated 19 May 2009
R2 = CPS to URS, titled Tyumen Tank - Exhaust Stack, no date.
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R8 = URS (N Ballard to URS (J Grieve), titled Knauf - Conference Call Confirmation. Dated 26 June 2009
R9 = Coune, P (KI), pers.comm 1 July 2009
R10 = KI 2009 New Glass Wool Plant Australia Scope fo Work Rev 3 29 May 2009

3 Facing Pit

Source	Facing Pit	Reference
Operating Time	100%	R10
Height (m)	10	R1
Diameter (m)	1.13	R1
Flowrate (Nm^3 dry/hr)	7000	R1,R4
Velocity (m/s)	2.12	R4
Flowrate (Am^3/s)	2.12	CALC
Flowrate (Am^3/hr)	7641	CALC
Flowrate (Nm^3/hr, wet)	7000	CALC
Temperature (deg C)	25	R4
Pollutant Concentrations (mg/Nm^3 dry)		
VOC	20	R4
Dust (PM10)	30	R4
Pollutant Emission Rates (g/s)		
VOC	0.04	CALC
Dust (PM10)	0.06	CALC

Notes:
R1 = CPS to URS, titled Split: FW: Process information: oxygen plant, stacks, …. Dated 19 May 2009
R2 = CPS to URS, titled Tyumen Tank - Exhaust Stack, no date.
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R5 = Emissions expected for the future australian plant (2nd version) including Australia emergency stack, no date
R6 = Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities) and
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R8 = URS (N Ballard to URS (J Grieve), titled Knauf - Conference Call Confirmation. Dated 26 June 2009
R9 = Coune, P (KI), pers.comm 1 July 2009
R10 = KI 2009 New Glass Wool Plant Australia Scope fo Work Rev 3 29 May 2009

4 Blowing Wool

Source	White Wool Stack	Reference
Operating Time	1	R10
Height (m)	40	R1
Diameter (m)	1.7	R1
Stack Area (m2)	2.27	CALC
Flowrate (Nm^3 dry/hr)	60000	R3
Velocity (m/s)	7	CALC
Flowrate (Am^3/s)	17	CALC
Flowrate (Am^3 dry/hr)	65495	CALC
Flowrate (Nm^3 dry/hr wet)	60003	CALC
Temperature (deg C)	25	R4
Pollutant Concentrations (mg/Nm^3 dry)		
Dust (PM$_{10}$)	20	R6
Odour (OUe/m3)	2944	CALC
Pollutant Emission Rates (g/s)		
Dust	0.33	CALC
Odour (OU/s) inc. P2M-2.3	123188	CALC

Notes:
R1 = CPS to URS, titled Split: FW: Process information: oxygen plant, stacks, …. Dated 19 May 2009
R2 = CPS to URS, titled Tyumen Tank - Exhaust Stack, no date.
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R6 = Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities) and P
R7 = CPS to URS, titled Odour - Operations. Dated 27 May 2009
R8 = URS (N Ballard to URS (J Grieve), titled Knauf - Conference Call Confirmation. Dated 26 June 2009
R9 = Coune, P (KI), pers.comm 1 July 2009
R10 = KI 2009 New Glass Wool Plant Australia Scope fo Work Rev 3 29 May 2009

Appendix B Meteorological Data Discussion

Appendix B

B.1 Assessment of Meteorological Data – 2000 - 2005

The meteorological data needed for dispersion modelling is required to be site representative. The closest weather station was found to be located at Steel River, located adjacent to the site, and operated by Connell Wagner. The year for 2004 was chosen as it was considered relatively recent i.e. within the last 5 years and significant industrial development had not occurred at that time, as has done in the most recent few years. The recent development of the industrial estate is likely to have altered the measured atmospheric parameters, such as wind flow, hence representative data may not have been collected in recent years.

In order to ensure local meteorological conditions were represented in the dispersion modelling and given the lack of strong terrain features in the area, the Steel River meteorological data for 2004 was assimilated into TAPM to generate local wind fields. The method is further discussed in the following sections.

B.2 Meteorological modelling

TAPM (v4) was run to calculate meteorological fields for the modelling domain. Through a number of verification studies (e.g. CSIRO 2005), TAPM has been identified as a suitable model to simulate meteorological fields in a number of situations[3].

TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical co-ordinate for three-dimensional simulations. It includes parameterisations for cloud/rain micro-physical processes, turbulence closure, urban/vegetative canopy and soil, and radiative fluxes.

TAPM, with the use of the input databases provided by CSIRO, was used to generate a meteorological dataset for the year 2004 based on actual synoptic data. The following TAPM settings and input files were used to generate the meteorological file for the site for the year 2004.

Default options were selected, except where noted otherwise below:

- Grid centre coordinates –32°53’30’’ latitude, 151°45’30’’ longitude (MGA94: 383863mE, 6360039mN);
- Meteorological grid consisting of four nests of 25 x 25 grid points at 30, 10, 3 and 1 km and 300 m spacing, with 25 vertical grid levels from 10 to 8000 m;
- Terrain at 9 arc-second (approximately 270m) resolution from the Geoscience Australia terrain database. Land characterisation data at approximately 1km resolution, sourced from the US geological Survey, Earth Resources Observation System (EROS) Data Centre Distributed Active Archive Centre (EDC DAAC). Sea surface temperature data at 100 km grid intervals from the US National Centre for Atmospheric Research (NCAR);
- Six hourly synoptic scale meteorology from the BoM on a 75 to 100 km grid. This data is derived from the BoM LAPS (Limited Area Prediction System) output; and
- Steel River meteorological data for the year 2004 was assimilated into the model predictions on a radius of influence of 20km.

The annual and seasonal windroses for the TAPM generated meteorological data are provided in Figure B.1. These wind roses show the dominance of winds from the north west. Summer shows

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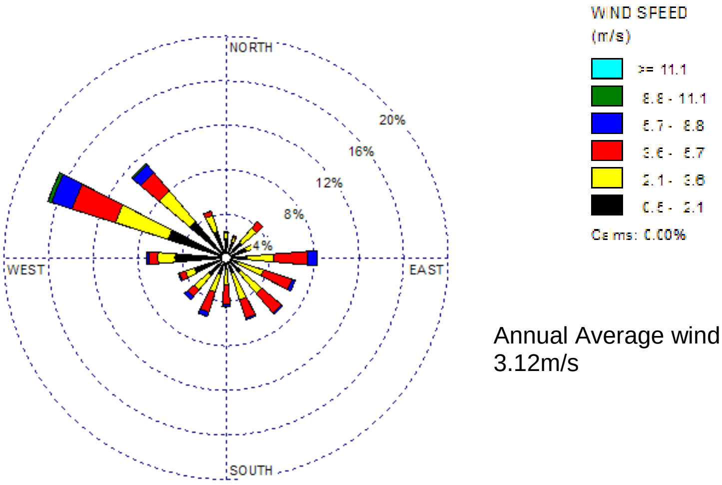
[3] CSIRO, 2005. The Air Pollution Model (TAPM) Version 3. Part 2: Summary of Some Verification Studies. CSIRO Atmospheric Research Technical Paper 72, 2005.

winds to be primarily from the east, with autumn showing a distinct north westerly component. Similarly, Winter shows the presence of a high proportion of winds from the north west with Spring showing a more uniformly spread of winds with a slight dominance of winds from the north west and south west quadrants.

It should be noted that the meteorological file generated by TAPM for use in Ausplume excludes wind speeds less than 0.5 m/s due to a limitation within Ausplume. Consequently, no percentages of calm conditions are provided in Figure B.1, however, interrogation of the original TAPM file shows approximately 1.9% of the year is predicted to have calm periods of less than 0.5 m/s. Calm atmospheric conditions are of most concern when associated with fugitive ground level sources. Given the absence of fugitive ground level sources the exclusion of winds less than 0.5 m/s was considered acceptable.

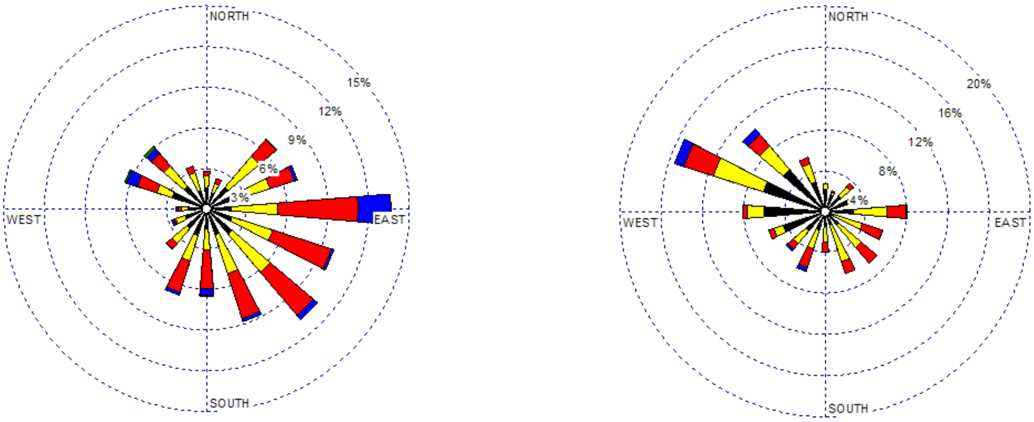
The methodology for assessing representativeness of the meteorological contained in DEC (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* requires the comparison of the generated meteorological file within recent years. As the development of the industrial facilities in the Steel River area may have affected the meteorological data recorded, it was considered appropriate as a simple validation check, to compare the generated meteorological data to that recorded at the Automatic Weather Station operated by the Bureau of Meteorology at Nobbys Head (Station 061055). The data at Nobbys Head has been recorded between 1957 through 2008. As can be seen in Figure B.2, similarities exist in the wind roses with a strong north westerly (off shore) wind exhibited in the 9am periods and a strong easterly / south easterly (on shore) shown in the 3pm periods as expected with coastal locations. This comparison further suggests that the TAPM generated meteorology is representative of the site.

Appendix B



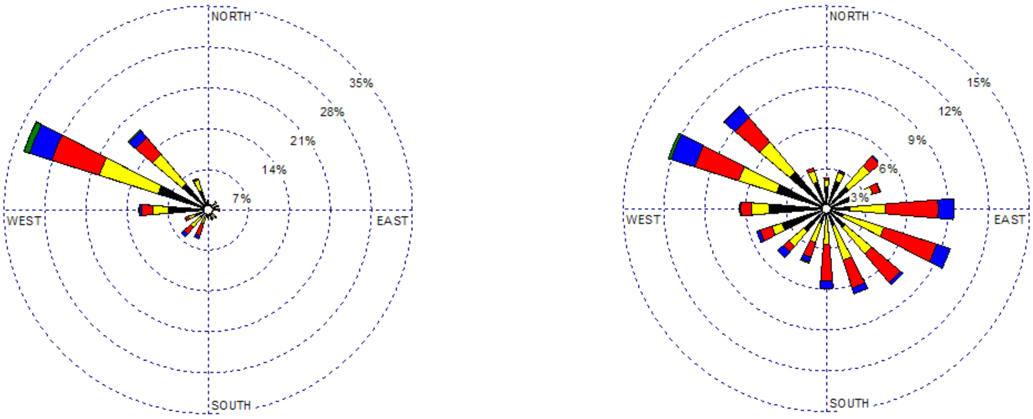
Annual Average wind speed:
3.12m/s

Annual Wind Rose



Summer

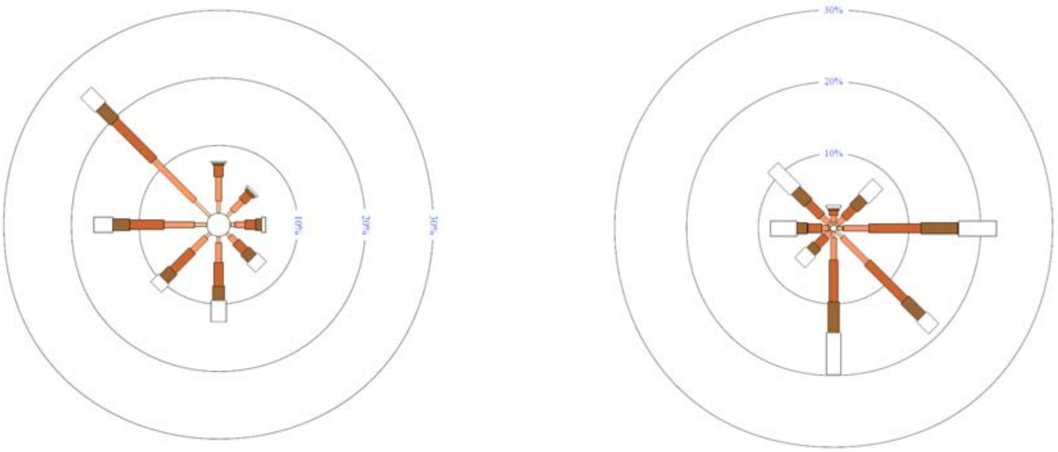
Autumn



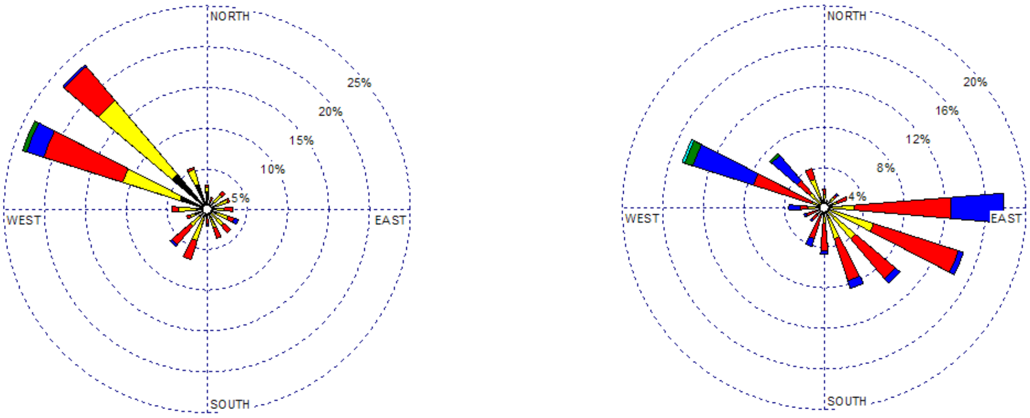
Winter

Spring

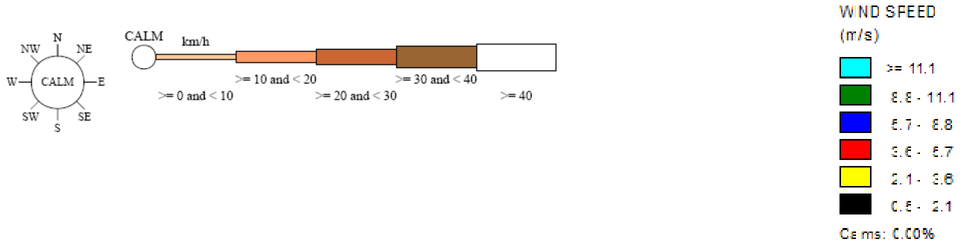
Figure B.1: Seasonal TAPM generated wind roses for the proposed development site



Nobbys Head 9am All Years (BoM 2009) Nobbys Head 3pm All Years (BoM 2009)



Steel River 9am Steel River 3pm



BoM Legend (Bom 2009) Steel River Legend

Figure B.2: Comparison of 9am and 3pm wind roses between Nobbys Head (BoM) and that generated by TAPM at the Steel River site

B.3 Mixing Height

Figure B.3 shows the Mixing Height (m) vs Time of Day (Hour) generated from TAPM data at the development site for 2004. The figure shows that the TAPM predicted mixing height increases with increasing solar radiation as a function of time of day. This is consistent with general atmospheric processes that show increased vertical mixing during the daytime associated with the increasing thermal radiation. Nightime conditions are cooler, more stable and, as expected, winds are generally lighter thus vertical mixing is reduced leading to a lower mixing height.

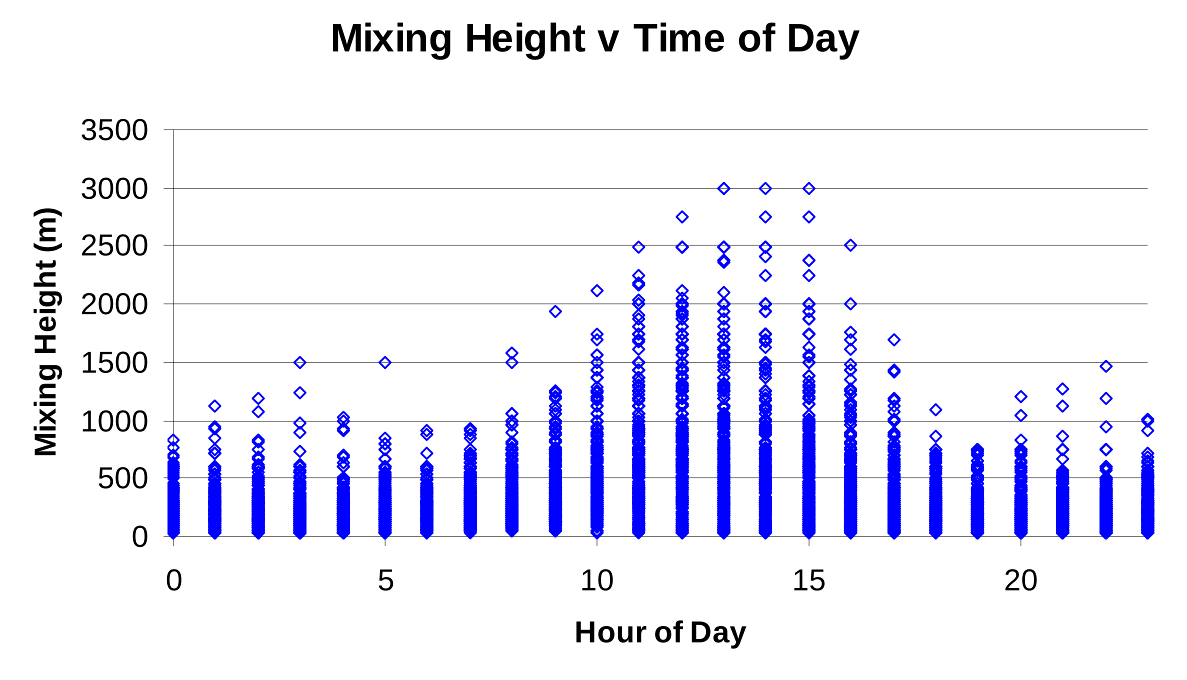


Figure B.3 Mixing Height (m) vs Time of Day (Hour of Day) – TAPM predicted, Steel River Site 2004

B.4 Atmospheric Stability

Stability class is used as an indicator of atmospheric turbulence for use in meteorological models. The class of atmospheric stability generally used in these types of assessments is based on the Pasquill-Gifford-Turner scheme where six categories are used (A to F) which represent atmospheric stability from extremely unstable to moderately stable conditions. The stability class of the atmosphere is based on three main characteristics, these being:

- Static stability (vertical temperature profile/structure);
- Convective turbulence (caused by radiative heating of the ground); and
- Mechanical turbulence (caused by surface roughness).

The Pasquill Gifford Stability classes are provided in **Table B.1**.

The stability classes for the site have been extracted from a TAPM generated meteorological file and are shown in **Table B.2**.

Table B.1: Modified Pasquill-Gifford Stability Classes (adapted from Turner, 1994[4])

Surface Wind Speed at 10m (m/s)	Insolation			Night-time cloud (Oktas)	
	Strong	Moderate	Slight	Thinly overcast of > 4/8 low cloud	< 3/8 Cloud
≤ 2	A	A-B	B	-	-
2 - 3	A-B	B	C	E	F
3 - 5	B	B-C	C	D	E
5 - 6	C	C-D	D	D	D
> 6	C	D	D	D	D

Notes:

- : Generally referred to as strongly stable conditions.

The Pasquill Gifford Stability Classes, shown in **Table B.2** shows neutral atmospheric conditions (Stability Class D) is the most prevalent Stability Class of the area, with the extreme stability classes, namely Extremely Unstable (Stability Class A) being the least prevalent.

Table B.2: Site Representative Pasquill-Gifford Stability Classes

Stability Class	% of year
A (Extremely Unstable)	0.6%
B (Moderately Unstable)	4.7%
C (Slightly Unstable)	14.6%
D (neutral)	48.0%
E (Slightly Stable)	10.0%
F (Moderately Stable)	22.1%

In addition to their composition, Stability Classes were also predicted by TAPM for the site as a function of time of day, as shown in **Figure B.4**. As expected, the Stability Classes show a tendency for the unstable classes (Stability Classes A, B and C) to occur during daytime, whilst the more stable conditions (Stability Classes D, E and F) are shown to occur primarily during night time. This is consistent with the values contained in **Table B.1**.

---

[4] Turner B 1994 *Workbook of Atmospheric Dispersion Estimates: An Introduction to Dispersion Modelling*. 2nd Edition. CRC Press Inc

Appendix B

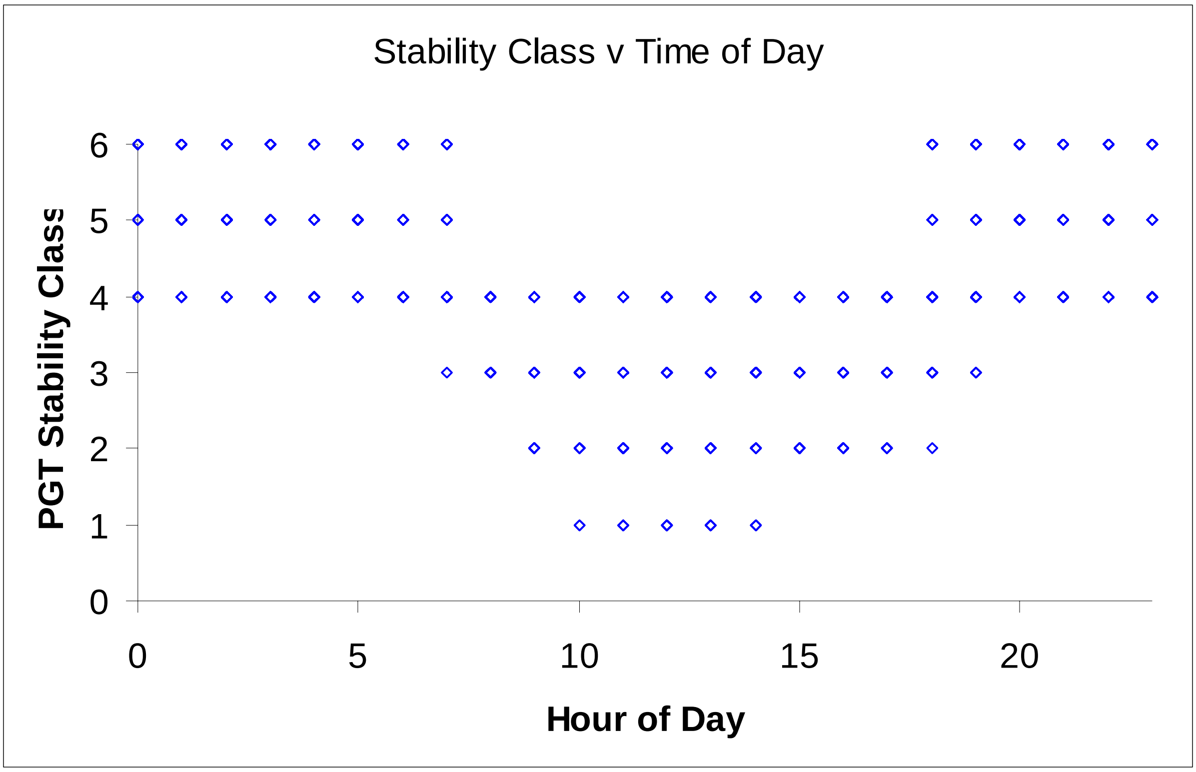


Figure B.4: Stability Class vs Time of Day – TAPM predicted, Steel River Site 2004 (Pasquill Gifford Turner Stability Classes 1 – 6 refer to A to F respectively)

Stability Classes were also measured against wind speed, as shown in **Figure B.5**. As expected, the highest wind speeds are associated with Stability Classes C and D. The more unstable conditions (Stability Classes A and B) are associated with lower wind speeds, as it is under low winds (coupled with stronger solar insolation) where thermal turbulence is able to dominate. The more stable conditions (Stability Classes E and F) are also associated with low wind speeds. These data are consistent with the values contained in **Table B.1.**

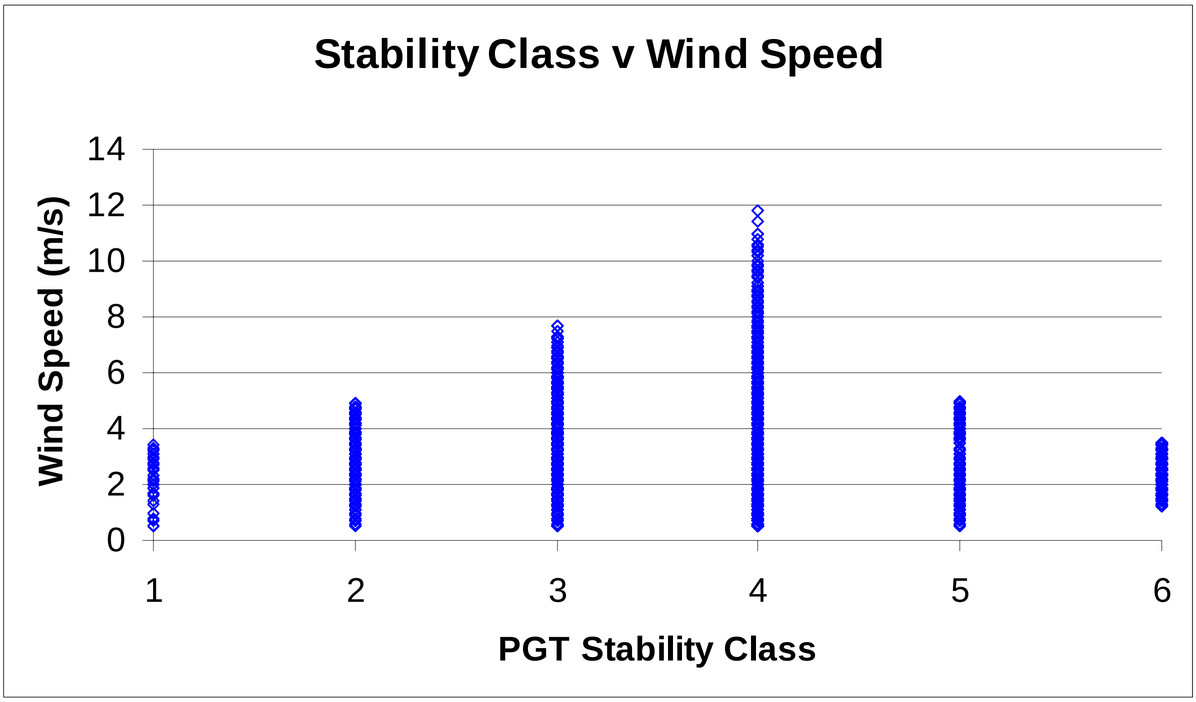


Figure B.6: Stability Class vs Wind Speed – TAPM predicted, Steel River Site 2004 (Pasquill Gifford Turner Stability Classes 1 – 6 refer to A to F respectively)

B.5 Conclusion

Where site specific dispersion meteorological data may not be site representative, as is the case for the proposed Steel River development site, the predicted meteorological data used in the dispersion modelling is required to be representative of the surrounding area. It is accepted standard Australian practice, that in situations where adequate site-specific meteorological data does not exist, TAPM is used to synthetically generate meteorological data. TAPM is a sophisticated, 3D meteorological model that has been extensively validated. In order to better represent the meteorology of the proposed development site, Steel River meteorological data was incorporated into the predicted TAPM meteorology.

The assessment of the predicted meteorology at the proposed Steel River development site was discussed and was shown to be consistent with general atmospheric parameters and long-term measurements available from Nobbys Head. It is therefore considered that the meteorological data used in dispersion modelling is appropriate.

Appendix C Ausplume Output file

Appendix C

Example Scenario 1 Ausplume Output file

```
1              _______________________________________________

                 Knauf Model Run - NOx - 30 m Terrain Spacing

               _______________________________________________

 Concentration or deposition                          Concentration
 Emission rate units                                  grams/second
 Concentration units                                  microgram/m3
 Units conversion factor                              1.00E+06
 Constant background concentration                             0.00E+00
 Terrain effects                                      Egan method
 Smooth stability class changes?                      No
 Other stability class adjustments ("urban modes")    None
 Ignore building wake effects?                        No
 Decay coefficient (unless overridden by met. file)   0.000
 Anemometer height                                    10 m
 Roughness height at the wind vane site               0.300 m
 Use the convective PDF algorithm?                    No

                    DISPERSION CURVES
 Horizontal dispersion curves for sources <100m high  Pasquill-Gifford
 Vertical  dispersion  curves for sources <100m high  Pasquill-Gifford
 Horizontal dispersion curves for sources >100m high  Briggs Rural
 Vertical  dispersion  curves for sources >100m high  Briggs Rural
 Enhance horizontal plume spreads for buoyancy?       Yes
 Enhance  vertical  plume spreads for buoyancy?       Yes
 Adjust horizontal P-G formulae for roughness height? Yes
 Adjust  vertical  P-G formulae for roughness height? Yes
 Roughness height                                     0.400m
 Adjustment for wind directional shear                None

                     PLUME RISE OPTIONS
 Gradual plume rise?                                  Yes
 Stack-tip downwash included?                         Yes
 Building downwash algorithm:                        PRIME method.
 Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
 Partial penetration of elevated inversions?          No
 Disregard temp. gradients in the hourly met. file?   No

 and in the absence of boundary-layer potential temperature gradients
 given by the hourly met. file, a value from the following table
 (in K/m) is used:

    Wind Speed                Stability Class
     Category       A      B      C      D      E      F
   _______________________________________________________
        1         0.000  0.000  0.000  0.000  0.020  0.035
        2         0.000  0.000  0.000  0.000  0.020  0.035
        3         0.000  0.000  0.000  0.000  0.020  0.035
        4         0.000  0.000  0.000  0.000  0.020  0.035
        5         0.000  0.000  0.000  0.000  0.020  0.035
        6         0.000  0.000  0.000  0.000  0.020  0.035

 WIND SPEED CATEGORIES
 Boundaries between categories (in m/s) are:  1.54,  3.09,  5.14,  8.23, 10.80

 WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

 AVERAGING TIMES
  1 hour
  average over all hours

 ____________________________________________________________________________

1              _______________________________________________

                 Knauf Model Run - NOx - 30 m Terrain Spacing
```

```
                              SOURCE CHARACTERISTICS
                   ________________________________________________

                      STACK SOURCE: MF-NOX

   X(m)     Y(m)   Ground Elev.  Stack Height  Diameter Temperature  Speed
  379906  6361682       11m          40m        0.80m      200C    24.0m/s

            ______ Effective building dimensions (in metres) ______
 Flow direction                   10°  20°  30°  40°  50°  60°  70°  80°  90°
 100° 110° 120°
 Effective building width          41   39   36   32   34   37   40   41   40
 39   36   32
 Effective building height         35   35   35   35   35   35   35   35   35
 35   35   35
 Along-flow building length        39   36   32   28   31   35   38   40   41
 41   39   36
 Along-flow distance from stack     3    9   15   21   21   20   19   17   14
 11    8    4
 Across-flow distance from stack  -31  -27  -22  -17  -10   -3    3   10   16
 22   27   31

 Flow direction                  130° 140° 150° 160° 170° 180° 190° 200° 210°
 220° 230° 240°
 Effective building width          37   39   40   40   40   41   41   39   36
 32   34   37
 Effective building height         29   29   29   29   35   35   35   35   35
 35   35   35
 Along-flow building length        17   20   26   31   40   40   39   36   32
 28   31   35
 Along-flow distance from stack   -29  -35  -42  -47  -30  -36  -41  -45  -47
 -48  -52  -55
 Across-flow distance from stack   28   24   19   14   37   35   31   27   22
 17   10    4

 Flow direction                  250° 260° 270° 280° 290° 300° 310° 320° 330°
 340° 350° 360°
 Effective building width          40   41   40   39   36   33   37   39   40
 40   40   41
 Effective building height         35   35   35   35   35   35   29   29   29
 29   35   35
 Along-flow building length        38   40   41   41   39   36   17   20   26
 30   40   40
 Along-flow distance from stack   -57  -57  -55  -52  -47  -40   12   15   16
 17  -11   -4
 Across-flow distance from stack   -3  -10  -16  -22  -27  -31  -28  -24  -19
 -14  -37  -35

                 (Constant) emission rate = 3.19E+00 grams/second
                     No gravitational settling or scavenging.


                      STACK SOURCE: DS-NOX

   X(m)     Y(m)   Ground Elev.  Stack Height  Diameter Temperature  Speed
  379948  6361623       12m          60m        0.80m       32C    14.0m/s

            ______ Effective building dimensions (in metres) ______
 Flow direction                   10°  20°  30°  40°  50°  60°  70°  80°  90°
 100° 110° 120°
 Effective building width          41   39   64   61   63   65   66   64   96
 96   92   86
 Effective building height         35   35   22   22   22   22   22   22   18
 18   18   18
 Along-flow building length        39   36   39   29   34   43   51   57   78
```

```
 78   75   77
 Along-flow distance from stack    53   50   32   37   32   23   14    5  -47
 -51  -54  -62
 Across-flow distance from stack   20   33    0    9   17   25   32   39   47
 44   40   34

 Flow direction                  130° 140° 150° 160° 170° 180° 190° 200° 210°
 220° 230° 240°
 Effective building width          77   39   35   38   40   41   41   39   64
 61   63   66
 Effective building height         18   29   35   35   35   35   35   35   22
 22   22   22
 Along-flow building length        79   20   37   40   40   40   39   36   39
 29   34   43
 Along-flow distance from stack   -70 -107  -87  -93  -95  -95  -92  -86  -71
 -65  -66  -66
 Across-flow distance from stack   28   29   31   18    6   -8  -20  -32    0
 -9  -17  -25

 Flow direction                  250° 260° 270° 280° 290° 300° 310° 320° 330°
 340° 350° 360°
 Effective building width          66   64   96   96   92   86   77   48   35
 38   40   41
 Effective building height         22   22   18   18   18   18   18   29   35
 35   35   35
 Along-flow building length        51   57   78   78   75   77   79   62   37
 40   40   40
 Along-flow distance from stack   -65  -62  -31  -27  -21  -15   -9   46   50
 54   55   55
 Across-flow distance from stack  -33  -39  -47  -44  -40  -35  -28  -34  -31
 -19   -6    8

                (Constant) emission rate = 2.90E+00 grams/second
                    No gravitational settling or scavenging.

 ____________________________________________________________________________

1               ________________________________________________

                  Knauf Model Run - NOx - 30 m Terrain Spacing

                               RECEPTOR LOCATIONS

                ________________________________________________

 The Cartesian receptor grid has the following x-values (or eastings):
 378864.m  378894.m  378924.m  378954.m  378985.m  379015.m  379045.m
 379076.m  379106.m  379136.m  379167.m  379197.m  379227.m  379258.m
 379288.m  379318.m  379349.m  379379.m  379409.m  379439.m  379470.m
 379500.m  379530.m  379561.m  379591.m  379621.m  379652.m  379682.m
 379712.m  379743.m  379773.m  379803.m  379834.m  379864.m  379894.m
 379924.m  379955.m  379985.m  380015.m  380046.m  380076.m  380106.m
 380137.m  380167.m  380197.m  380228.m  380258.m  380288.m  380319.m
 380349.m  380379.m  380409.m  380440.m  380470.m  380500.m  380531.m
 380561.m  380591.m  380622.m  380652.m  380682.m  380713.m  380743.m
 380773.m  380804.m  380834.m  380864.m  380894.m  380925.m  380955.m
 380985.m  381016.m  381046.m  381076.m  381107.m  381137.m  381167.m
 381198.m  381228.m  381258.m  381289.m  381319.m  381349.m  381379.m
 381410.m  381440.m  381470.m  381501.m  381531.m  381561.m  381592.m
 381622.m  381652.m  381683.m  381713.m  381743.m  381774.m  381804.m
 381834.m  381864.m  381895.m

 and these y-values (or northings):
6360148.m 6360177.m 6360205.m 6360234.m 6360262.m 6360291.m 6360319.m
6360348.m 6360376.m 6360405.m 6360433.m 6360462.m 6360490.m 6360519.m
6360547.m 6360576.m 6360604.m 6360633.m 6360661.m 6360690.m 6360718.m
6360747.m 6360775.m 6360804.m 6360832.m 6360861.m 6360889.m 6360918.m
6360946.m 6360975.m 6361003.m 6361032.m 6361060.m 6361089.m 6361117.m
```

```
6361146.m 6361174.m 6361203.m 6361231.m 6361260.m 6361288.m 6361317.m
6361345.m 6361374.m 6361402.m 6361431.m 6361459.m 6361488.m 6361516.m
6361545.m 6361573.m 6361602.m 6361630.m 6361659.m 6361687.m 6361716.m
6361744.m 6361773.m 6361801.m 6361830.m 6361858.m 6361887.m 6361915.m
6361944.m 6361972.m 6362001.m 6362029.m 6362058.m 6362086.m 6362115.m
6362143.m 6362172.m 6362200.m 6362229.m 6362257.m 6362286.m 6362314.m
6362343.m 6362371.m 6362400.m 6362428.m 6362457.m 6362485.m 6362514.m
6362542.m 6362571.m 6362599.m 6362628.m 6362656.m 6362685.m 6362713.m
6362742.m 6362770.m 6362799.m 6362827.m 6362856.m 6362884.m 6362913.m
6362941.m 6362970.m 6362998.m

 DISCRETE RECEPTOR LOCATIONS (in metres)

 No.     X       Y    ELEVN  HEIGHT      No.     X       Y    ELEVN  HEIGHT
  1   379719 6361533    22.0    1.0        6   379911 6361311    29.0    1.0
  2   379751 6361472    25.0    1.0        7   379963 6361262    24.0    1.0
  3   379783 6361428    29.0    1.0        8   380005 6361216    21.0    1.0
  4   379824 6361386    31.0    1.0        9   380040 6361162    22.0    1.0
  5   379870 6361347    31.0    1.0
```

Example Scenario 2 Ausplume Output file

```
1              ________________________________________________

                 Knauf Model Run - NOx - 30 m Terrain Spacing

               ________________________________________________

 Concentration or deposition                          Concentration
 Emission rate units                                  grams/second
 Concentration units                                  microgram/m3
 Units conversion factor                              1.00E+06
 Constant background concentration                             0.00E+00
 Terrain effects                                      Egan method
 Smooth stability class changes?                      No
 Other stability class adjustments ("urban modes")    None
 Ignore building wake effects?                        No
 Decay coefficient (unless overridden by met. file)   0.000
 Anemometer height                                    10 m
 Roughness height at the wind vane site               0.300 m
 Use the convective PDF algorithm?                    No

                    DISPERSION CURVES
 Horizontal dispersion curves for sources <100m high  Pasquill-Gifford
 Vertical  dispersion  curves for sources <100m high  Pasquill-Gifford
 Horizontal dispersion curves for sources >100m high  Briggs Rural
 Vertical  dispersion  curves for sources >100m high  Briggs Rural
 Enhance horizontal plume spreads for buoyancy?       Yes
 Enhance  vertical  plume spreads for buoyancy?       Yes
 Adjust horizontal P-G formulae for roughness height? Yes
 Adjust  vertical  P-G formulae for roughness height? Yes
 Roughness height                                     0.400m
 Adjustment for wind directional shear                None

                     PLUME RISE OPTIONS
 Gradual plume rise?                                  Yes
 Stack-tip downwash included?                         Yes
 Building downwash algorithm:                        PRIME method.
 Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
 Partial penetration of elevated inversions?          No
 Disregard temp. gradients in the hourly met. file?   No

 and in the absence of boundary-layer potential temperature gradients
 given by the hourly met. file, a value from the following table
 (in K/m) is used:

    Wind Speed                Stability Class
     Category       A      B      C      D      E      F
   ________________________________________________________
        1         0.000  0.000  0.000  0.000  0.020  0.035
        2         0.000  0.000  0.000  0.000  0.020  0.035
        3         0.000  0.000  0.000  0.000  0.020  0.035
        4         0.000  0.000  0.000  0.000  0.020  0.035
        5         0.000  0.000  0.000  0.000  0.020  0.035
        6         0.000  0.000  0.000  0.000  0.020  0.035

 WIND SPEED CATEGORIES
 Boundaries between categories (in m/s) are:  1.54,  3.09,  5.14,  8.23, 10.80

 WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

 AVERAGING TIMES
  1 hour
  average over all hours

 ____________________________________________________________________________

1              ________________________________________________

                 Knauf Model Run - NOx - 30 m Terrain Spacing
```

```
                         SOURCE CHARACTERISTICS
               _________________________________________________


                    STACK SOURCE: ES-NOX

   X(m)     Y(m)   Ground Elev.  Stack Height  Diameter Temperature  Speed
  379940  6361698       11m           35m        0.75m      280C    30.0m/s

           ______ Effective building dimensions (in metres) ______
 Flow direction                  10°  20°  30°  40°  50°  60°  70°  80°  90°
 100° 110° 120°
 Effective building width         41   39   36   32   34   37   40   41   40
 39   36   32
 Effective building height        35   35   35   35   35   35   35   35   35
 35   35   35
 Along-flow building length       39   36   32   28   31   35   38   40   41
 41   39   36
 Along-flow distance from stack  -20  -18  -16  -14  -16  -18  -19  -20  -20
 -20  -19  -17
 Across-flow distance from stack  -1   -1   -1   -1   -1    0    0    0    0
 0    0    1

 Flow direction                 130° 140° 150° 160° 170° 180° 190° 200° 210°
 220° 230° 240°
 Effective building width         28   31   35   38   40   41   41   39   36
 32   34   37
 Effective building height        35   35   35   35   35   35   35   35   35
 35   35   35
 Along-flow building length       32   34   37   40   40   40   39   36   32
 28   31   35
 Along-flow distance from stack  -16  -17  -18  -20  -20  -20  -20  -18  -16
 -14  -16  -18
 Across-flow distance from stack   0    0    0    0    0    1    1    1    1
 1    1    0

 Flow direction                 250° 260° 270° 280° 290° 300° 310° 320° 330°
 340° 350° 360°
 Effective building width         40   41   40   39   36   33   28   31   35
 38   40   41
 Effective building height        35   35   35   35   35   35   35   35   35
 35   35   35
 Along-flow building length       38   40   41   41   39   36   32   34   37
 40   40   40
 Along-flow distance from stack  -19  -21  -21  -21  -20  -19  -17  -17  -19
 -20  -20  -20
 Across-flow distance from stack   0    0    0    0    0    0    0    0    0
 0    0   -1

              (Constant) emission rate = 1.39E+00 grams/second
                  No gravitational settling or scavenging.


                    STACK SOURCE: DS-NOX

   X(m)     Y(m)   Ground Elev.  Stack Height  Diameter Temperature  Speed
  379948  6361623       12m           60m        3.90m       32C    14.0m/s

           ______ Effective building dimensions (in metres) ______
 Flow direction                  10°  20°  30°  40°  50°  60°  70°  80°  90°
 100° 110° 120°
 Effective building width         41   39   64   61   63   65   66   64   96
 96   92   86
 Effective building height        35   35   22   22   22   22   22   22   18
 18   18   18
 Along-flow building length       39   36   39   29   34   43   51   57   78
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 78   75   77
 Along-flow distance from stack    53   50   32   37   32   23   14    5  -47
 -51  -54  -62
 Across-flow distance from stack   20   33    0    9   17   25   32   39   47
 44   40   34

 Flow direction                  130° 140° 150° 160° 170° 180° 190° 200° 210°
 220° 230° 240°
 Effective building width          77   39   35   38   40   41   41   39   64
 61   63   66
 Effective building height         18   29   35   35   35   35   35   35   22
 22   22   22
 Along-flow building length        79   20   37   40   40   40   39   36   39
 29   34   43
 Along-flow distance from stack   -70 -107  -87  -93  -95  -95  -92  -86  -71
 -65  -66  -66
 Across-flow distance from stack   28   29   31   18    6   -8  -20  -32    0
 -9  -17  -25

 Flow direction                  250° 260° 270° 280° 290° 300° 310° 320° 330°
 340° 350° 360°
 Effective building width          66   64   96   96   92   86   77   48   35
 38   40   41
 Effective building height         22   22   18   18   18   18   18   29   35
 35   35   35
 Along-flow building length        51   57   78   78   75   77   79   62   37
 40   40   40
 Along-flow distance from stack   -65  -62  -31  -27  -21  -15   -9   46   50
 54   55   55
 Across-flow distance from stack  -33  -39  -47  -44  -40  -35  -28  -34  -31
 -19   -6    8

              (Constant) emission rate = 2.90E+00 grams/second
                  No gravitational settling or scavenging.

 ____________________________________________________________________________

1              _______________________________________________

               Knauf Model Run - NOx - 30 m Terrain Spacing

                            RECEPTOR LOCATIONS

               _______________________________________________

 The Cartesian receptor grid has the following x-values (or eastings):
 378864.m  378894.m  378924.m  378954.m  378985.m  379015.m  379045.m
 379076.m  379106.m  379136.m  379167.m  379197.m  379227.m  379258.m
 379288.m  379318.m  379349.m  379379.m  379409.m  379439.m  379470.m
 379500.m  379530.m  379561.m  379591.m  379621.m  379652.m  379682.m
 379712.m  379743.m  379773.m  379803.m  379834.m  379864.m  379894.m
 379924.m  379955.m  379985.m  380015.m  380046.m  380076.m  380106.m
 380137.m  380167.m  380197.m  380228.m  380258.m  380288.m  380319.m
 380349.m  380379.m  380409.m  380440.m  380470.m  380500.m  380531.m
 380561.m  380591.m  380622.m  380652.m  380682.m  380713.m  380743.m
 380773.m  380804.m  380834.m  380864.m  380894.m  380925.m  380955.m
 380985.m  381016.m  381046.m  381076.m  381107.m  381137.m  381167.m
 381198.m  381228.m  381258.m  381289.m  381319.m  381349.m  381379.m
 381410.m  381440.m  381470.m  381501.m  381531.m  381561.m  381592.m
 381622.m  381652.m  381683.m  381713.m  381743.m  381774.m  381804.m
 381834.m  381864.m  381895.m

 and these y-values (or northings):
6360148.m 6360177.m 6360205.m 6360234.m 6360262.m 6360291.m 6360319.m
6360348.m 6360376.m 6360405.m 6360433.m 6360462.m 6360490.m 6360519.m
6360547.m 6360576.m 6360604.m 6360633.m 6360661.m 6360690.m 6360718.m
6360747.m 6360775.m 6360804.m 6360832.m 6360861.m 6360889.m 6360918.m
6360946.m 6360975.m 6361003.m 6361032.m 6361060.m 6361089.m 6361117.m
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6361146.m 6361174.m 6361203.m 6361231.m 6361260.m 6361288.m 6361317.m
6361345.m 6361374.m 6361402.m 6361431.m 6361459.m 6361488.m 6361516.m
6361545.m 6361573.m 6361602.m 6361630.m 6361659.m 6361687.m 6361716.m
6361744.m 6361773.m 6361801.m 6361830.m 6361858.m 6361887.m 6361915.m
6361944.m 6361972.m 6362001.m 6362029.m 6362058.m 6362086.m 6362115.m
6362143.m 6362172.m 6362200.m 6362229.m 6362257.m 6362286.m 6362314.m
6362343.m 6362371.m 6362400.m 6362428.m 6362457.m 6362485.m 6362514.m
6362542.m 6362571.m 6362599.m 6362628.m 6362656.m 6362685.m 6362713.m
6362742.m 6362770.m 6362799.m 6362827.m 6362856.m 6362884.m 6362913.m
6362941.m 6362970.m 6362998.m

 DISCRETE RECEPTOR LOCATIONS (in metres)

 No.     X       Y    ELEVN  HEIGHT      No.     X       Y    ELEVN  HEIGHT
  1  379719 6361533    22.0    1.0        6  379911 6361311    29.0    1.0
  2  379751 6361472    25.0    1.0        7  379963 6361262    24.0    1.0
  3  379783 6361428    29.0    1.0        8  380005 6361216    21.0    1.0
  4  379824 6361386    31.0    1.0        9  380040 6361162    22.0    1.0
  5  379870 6361347    31.0    1.0
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