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GLASS RECOVERY SERVICES PTY LTD

DUST AND ODOUR IMPACT ASSESSMENT
126 ANDREWS ROAD, PENRITH

REFERENCE NO. S9496-A1

JANUARY 2017

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REPORT

for

DUST AND ODOUR IMPACT ASSESSMENT
126 ANDREWS ROAD, PENRITH
NSW 2750

Prepared for

GLASS RECOVERY SERVICES PTY LTD

126 Andrews Road,
PENRITH NSW 2750

by

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January 2017

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Date: 17 January 2017

126 ANDREWS ROAD, PENRITH
DUST AND ODOUR IMPACT ASSESSMENT

EXECUTIVE SUMMARY

This report presents the findings of an assessment undertaken to determine the potential air quality (dust and odour) impacts associated with the proposed increase in processing capacity from 150,000 tonnes per annum (tpa) to 200,000 tpa at the existing Glass Recovery Services facility located at 126 Andrews Road, Penrith NSW. The assessment was conducted in general accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW DEC, 2005).

Glass Recovery Services Pty Ltd (GRS) is an Australian owned company with its head office based in Victoria. GRS operate a glass recycling facility at 126 Andrews Road, Penrith (Lot 1 in DP 747153). The site is currently zoned IN1 – General Industrial under the Penrith City Council Local Environmental Plan 2010.

The assessment was conducted utilising air dispersion modelling to predict the potential for offsite dust and odour impacts to the identified sensitive receivers surrounding the site. The modelling has conservatively assumed that all site operations would occur out in the open, although in practice operations will primarily be contained within a processing shed. Therefore, the estimated dust and odour emissions applied in the modelling are likely to be conservative and would overestimate the actual impacts.

Dust and odour impacts from the current GRS site operations are being effectively controlled through site design, existing management procedures, separation distance, and the local topography between site and closest sensitive receivers. The site has not received any dust or odour complaints since it started operations in 2014.

The results of the air dispersion modelling predicted that the air pollutants (dust and odour) generated by the site operations with increased processing capacity would comply with the applicable assessment criteria at all sensitive receivers.

In summary, this assessment demonstrates that GRS Penrith site can operate with a proposed increased processing capacity of 200,000 tpa without causing any significant dust and odour impact at sensitive receivers in the surrounding environment.

126 ANDREWS ROAD, PENRITH
DUST AND ODOUR IMPACT ASSESSMENT

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1.0 INTRODUCTION

This report presents the findings of an assessment undertaken to determine the potential air quality (dust and odour) impacts associated with a proposed increase in processing capacity from 150,000 tonnes per annum (tpa) to 200,000 tpa at the existing Glass Recovery Services facility located at 126 Andrews Road, Penrith NSW (the site). The assessment was conducted in general accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW DEC, 2005).

1.1 Background Information

Glass Recovery Services Pty Ltd (GRS) is an Australian owned company with its head office based in Victoria. GRS operate a glass recycling facility at 126 Andrews Road, Penrith (Lot 1 in DP 747153). The site is currently zoned IN1 – General Industrial under the Penrith City Council Local Environmental Plan 2010. GRS proposes to modify Schedule 2, Condition 5 of the current development approval DA/SSD5267 to raise the maximum permissible quantity of glass material processed from 150,000 tonnes per year to 200,000 tonnes per year.

The Statement of Environmental Effects (SEE)[1] provides details of the proposals. The proposed maximum permissible quantity of glass material processed is within the capacity of the existing processing plant. Therefore there is no proposed significant modification to the existing infrastructure or equipment to process the additional materials. However, from our discussion with the site management we note that GRS has proposed further improvements to assist with the management of dust generated at the site which include:

i. Two new bag filters and new suction above points in the process to manage dust levels within the processing shed and further reduce fugitive dust emissions;

ii. Additional water suppression sprays at various points in the process and at entrances to the processing shed;

iii. Improvements to the water sprays applied for the outside product glass cullet stockpiles; and,

iv. Overall improvements to dust management training for employees at the site.

In response to the SEE, the NSW Department of Planning and Environment (DPE) has requested[2], inter alia, that a Air Impact Assessment be conducted and stated:

[1] Carlo Ranieri & Associates Pty Ltd. Statement of Environmental Effects, Section 96 Amendment, Glass Recovery Services, 126 Andrews Road Penrith. 150916GRS SEE. Issue: A. 18 September 2015

[2] NSW Department of Planning and Environment. Letter to Glass Recovery Services, SSD 5267 (MOD1). 28 July 2016.

Air quality

The air assessment in the SEE for the modification has not considered the potential air impacts (particularly dust and odour) with the increase in processing capacity of 50,000tpa at the site. In order to understand and assess these potential impacts associated with the modification, the Department requires an Air Impact Assessment to be undertaken by an experienced and qualified consultant in accordance with EPA's Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2005).

This is commensurate with the response to the SEE provided by Penrith City Council (PCC)[3] that stated:

- The consent for the current operation includes requirements for the preparation and submission of an Odour Management Plan and an Odour Verification Report. Should consent be issued for the increased capacity, it is requested that the Department ensure that these reports are required to be prepared and submitted to assess the full operation of the modified, increased capacity operation.

- In regard to dust emissions, it is considered satisfactory that the Dust Impact Validation Report required by the current consent be required for the proposed increased operation, should consent be granted. As dust emissions are directly dependent upon ongoing operational practices and dust management protocols, it is considered most appropriate that dust emissions be monitored and addressed, as required, through the process of site monitoring and the Dust Impact Validation process established through the current consent.

1.2 Consultant's Brief

Accordingly, this report provides an air quality impact assessment to determine the likely or worst case magnitude and significance of offsite dust and odour impacts from the operation of the existing facility if the processing capacity is increased to 200,000 tonnes per year. Air dispersion modelling was used to predict the potential offsite dust and odour impacts to the closest sensitive receivers surrounding the subject facility.

The air dispersion modelling and impact assessment was conducted by Todoroski Air Sciences Pty Ltd on behalf of Hibbs & Associates Pty Ltd. The study was peer reviewed by Mr Ritesh Patel, Principal Occupational Hygienist at Hibbs & Associates Pty Ltd. The assessment is primarily based on the relevant available information and data and observations from a site visit conducted by Mr Ritesh Patel of Hibbs & Associates Pty Ltd and Mr Philip Henschke of Todoroski Air Sciences Pty Ltd on 14 December 2016.

[3] Penrith City Council. Letter to NSW Department of Planning and Environment. 16 June 2016.

1.3 Structure of the Report

This report summarises the findings and conclusions from the air quality impact assessment. A detailed Air Quality Impact Assessment report prepared by Todoroski Air Sciences Pty Ltd is presented as an Appendix to this report. The detailed report in the Appendix includes details of the assessment methodology, assessment criteria, overview of the air dispersion modelling used in this assessment, details of relevant assumptions and reference information used, results of dispersion modelling, interpretation and conclusion.

2.0 REPORT LIMITATIONS AND DISCLAIMER

This report was prepared for Glass Recovery Services Pty Ltd solely for the purposes set out herein and it is not intended that any other person use or rely on the contents of the Report. The information contained in this report is based on a limited remote (online) review of the site and review of documentation provided to Hibbs & Associates Pty Ltd at the time of the review. Whilst the information contained in the Report is accurate to the best of our knowledge and belief, Hibbs & Associates Pty Ltd cannot guarantee the completeness or accuracy of any of the descriptions or conclusions based on the information supplied to it or obtained during the investigations.

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3.0 SUMMARY AND CONCLUSION

The Glass Recovery Services Pty Ltd (GRS) site at 126 Andrews Road, Penrith operates as a facility for the recovery and recycling of glass materials. Operations include screening, separating and optical sorting that result in a product called “Glass Cullet”. Site operations are 24 hours per day, seven days per week with maintenance activities occurring from 7:00 hours Saturday to 23:00 hours Sunday. Truck movements and deliveries to and from the site occur between 6:00 and 18:00 hours.

The land use in the surrounding area is characterised as a mix of general commercial/ industrial, residential and recreational. The site is bounded by Nepean Rugby Park to the east, Andrews Road to the north and Owens Illinois (O-I) glass container factory to the west. The closest sensitive receivers are in Koala Glen, which is approximately 200 m east-northeast from the site boundary and separated from the site by Andrews Road; and Echo Place, which is approximately 300 m southeast of the site boundary and separated from the site by Nepean Rugby Park. The areas to the west and south comprise industrial, manufacturing and utilities usage. Penrith Lakes is a recent area of residential development approximately 300 m north of the site boundary and separated from the site by Andrews Road. The closest houses are no closer to the site than the closest houses in Koala Glen. The Penrith Lakes development comprises of terrace ‘single façade’ houses facing north.

Dust and odour impacts from the current GRS site operations are being effectively controlled through site design, existing management procedures, separation distance, and the local topography between site and closest sensitive receivers. The site has not received any dust or odour complaints since it started operations in 2014.

This assessment included potential worst-case dust and odour impact assessment associated with the operation of GRS with proposed increased processing capacity. The assessment was conducted utilising air dispersion modelling to predict the potential for offsite dust and odour impacts to the identified sensitive receivers surrounding the site. The modelling has conservatively assumed that all site operations would occur out in the open, although in practice operations will primarily be contained within a processing shed. Therefore, the estimated dust and odour emissions applied in the modelling are likely to be conservative and would overestimate the actual impacts.

The results of the air dispersion modelling predicted that the air pollutants (dust and odour) generated by the site operations with increased processing capacity would comply with the applicable assessment criteria at all sensitive receivers. Therefore, the proposed increase in processing capacity is not expected to lead to any unacceptable level of dust and odour impact in the surrounding area. Nevertheless, the site management is currently in the process of implementing the following management measures to further minimise air emissions and further control any potential occurrence of excessive dust or odour emissions from the site:

i. Two new bag filters and new suction above points in the process to manage dust levels within the processing shed and further reduce fugitive dust emissions;

ii. Additional water suppression sprays at various points in the process and at entrances to the processing shed;

iii. Improvements to the water sprays applied for the outside product glass cullet stockpiles; and,

iv. Overall improvements to dust management training for employees at the site.

In summary, this assessment demonstrates that GRS Penrith site can operate with a proposed increased processing capacity of 200,000 tpa without causing any significant dust and odour impact at sensitive receivers in the surrounding environment.

126 ANDREWS ROAD, PENRITH
DUST AND ODOUR IMPACT ASSESSMENT

APPENDIX: AIR QUALITY IMPACT ASSESSMENT REPORT

(The page numbering ends at this page, this appendix contains a detailed report on Air Quality Impact Assessment prepared by Todoroski Air Sciences Pty Ltd on behalf of Hibbs & Associates Pty Ltd; Report reference # 16090605 dated 17 January 2017)

AIR QUALITY IMPACT ASSESSMENT

GLASS RECOVERY SERVICES

126 ANDREWS ROAD, PENRITH

Hibbs & Associates Pty Ltd

17 January 2017

Job Number 16090605

Prepared by

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Air Quality Impact Assessment

Glass Recovery Services

126 Andrews Road, Penrith

Author(s): Philip Henschke | Dan Kjellberg

Position: Atmospheric Physicist | Atmospheric Scientist

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FINAL - 002	17/01/2017	P Henschke	

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Hibbs & Associates Pty Ltd on behalf of Glass Recovery Services (hereafter referred to as the Proponent). It presents an assessment of the potential air quality impacts (dust and odour) associated with the proposed increase in production rate from 150,000 tonnes per annum (tpa) to 200,000tpa at the existing Glass Recovery Services facility located in Penrith, New South Wales (NSW) (hereafter referred to as the Project).

This air quality assessment has been prepared in general accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW DEC, 2005**). The assessment forms part of the *Statement of Environmental Effects* (**Carlo Ranieri & Associates, 2016**) prepared to accompany the application for the Project.

2 PROJECT BACKGROUND

2.1 Project setting

The Project site is located at 126 Andrews Road, Penrith approximately 2.5 kilometres (km) northeast of Penrith and 7km northwest of St Marys. The land use in the surrounding area is characterised as a mix of general commercial/ industrial, residential and recreational.

Figure 2-1 presents the location of the Project. To the west of the site are industrial facilities, including the Owens Illinois (O-I) glass container facility which receives product material from the Project. To the north of the site is a new commercial/ industrial precinct and a new residential development. The nearest sensitive receivers to the Project are located to the northeast and east. Recreational parks are situated immediately to the east of the site and provide a buffer distance separating the site to other residential areas to the east. **Figure 2-1** presents the location of the sensitive receivers assessed as discrete receptors in this assessment.

Figure 2-2 presents a pseudo three-dimensional (3D) visualisation of the topography in the general vicinity of the Project area. The Project site can be characterised as relatively flat, with gently undulating hills to the north and east. Water bodies including the Penrith Lakes and the Nepean River are located to the west of the site.

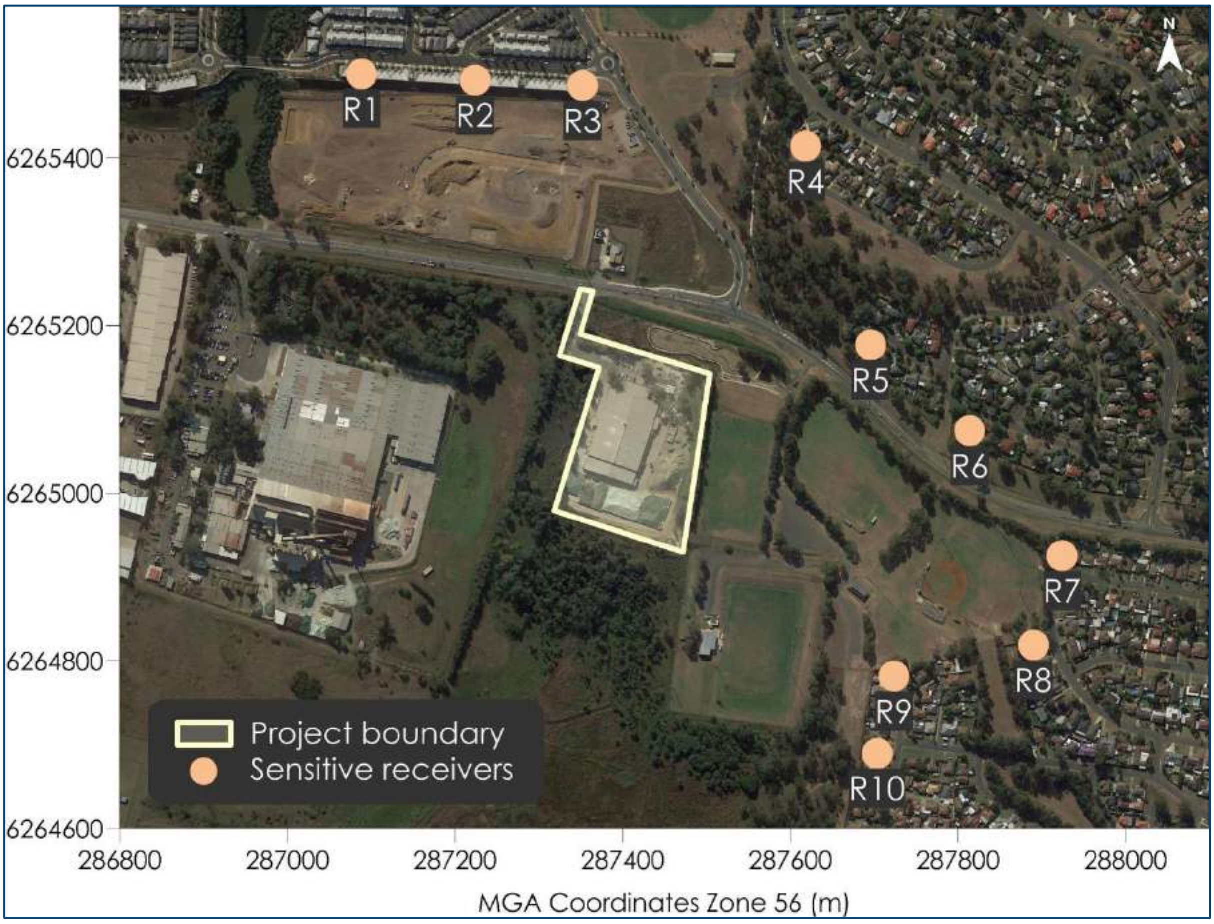


Figure 2-1: Project setting

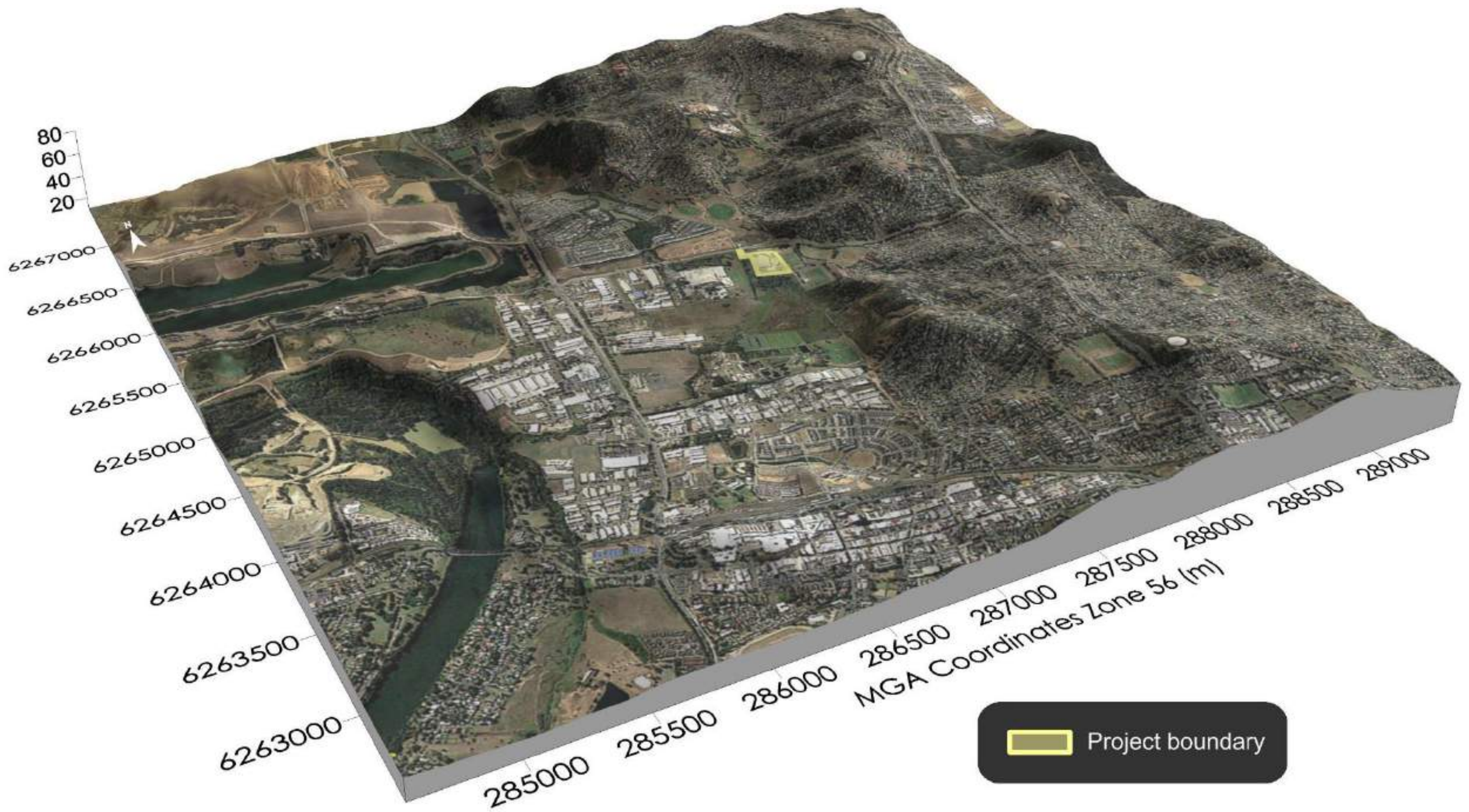


Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Project description

Activities at the Project involve the recovery and recycling of glass materials by means of screening, separating and optical sorting which results in a product called "Glass Cullet".

Recycled glass delivered to the Project is unloaded and stockpiled within the facility before being loaded to a hopper with a front-end loader. The glass is processed via multiple screens connected with various conveyors. The glass material is subject to a de-labelling process, sorting processes to remove foreign materials and an optical sorter to sort the glass cullet into colours of green, amber and flint.

Foreign materials generated in the process can include a variety of recovered recyclable material including: metals, plastics, and paper and soil. These materials are stockpiled in designated bays or containers depending on the type of material and dispatched off-site on a regular basis. Odour emissions from the sorted waste materials are not expected to be significant and would most likely arise from raw glass material received at the site prior to processing.

The processing activities all occur within a processing shed which assists to contain potential air emissions generated by the Project. The final product glass cullet is stockpiled in designated bays outside the shed, ready for delivery to customers. **Figure 2-3** presents an indicative plant layout.

Operating times for the Project are 24 hours per day, seven days per week with maintenance activities occurring from 7:00am Saturday to 11:00pm Sunday. Truck movements and deliveries to and from the site occur from 6:00am to 6:00pm.

It is understood that the Project has not received any complaints for dust or odour to date and would suggest that any potential air impacts are constrained to the site and within the processing shed.

The Project is not proposing any significant modification to existing infrastructure or equipment to process the additional materials. The Project however has proposed further improvements to assist with the management of dust generated at the site which include:

- Two new bag filters and new suction above points in the process to manage dust levels within the processing shed and further reduce fugitive dust emissions;
- Additional water suppression sprays at various points in the process and at entrances to the processing shed;
- Improvements to the water sprays applied for the outside product glass cullet stockpiles; and,
- Overall improvements to dust management training for employees at the site.

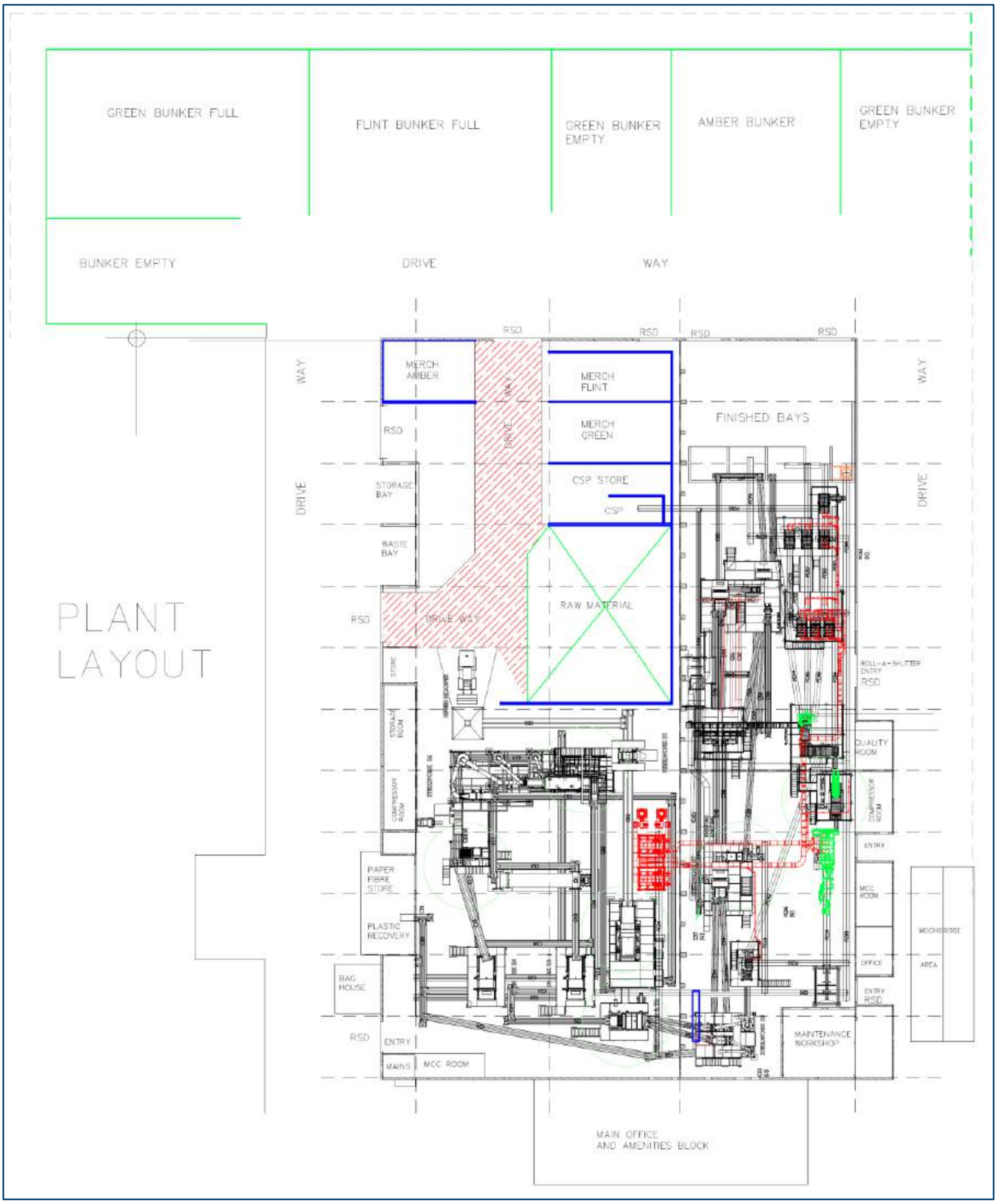


Figure 2-3: Indicative plant layout

3 AIR QUALITY CRITERIA

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the proposed modification and the applicable air quality criteria.

The air quality goals that are relevant to this study are sourced from the NSW EPA document "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (**NSW DEC, 2005**).

3.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

3.1.1 NSW EPA impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW DEC, 2005**).

The air quality goals for total impact relate to the total dust burden in the air and not just the dust from the proposed modification. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90µg/m³
PM_{10}	Annual	Total	30µg/m³
	24 hour	Total	50µg/m³
Deposited dust	Annual	Incremental	2g/m²/month
		Total	4g/m²/month

Source: **NSW DEC (2005)**
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

3.1.2 National Environment Protection (Ambient Air Quality) Measure

The *National Environment Protection Council (NEPC) Act 1994* and subsequent amendments define the National Environment Protection Measures (NEPMs) as instruments for setting environmental objectives in Australia.

It is important to note that NEPM air quality standards are not designed to be applied to specific projects. The NEPM standards apply to the average exposure to air pollutants of the general population, in each state. The NEPM requires that the states report to the Commonwealth on the trends in air quality by way of reference to the standards.

The National Environment Protection Council agreed to vary the Ambient Air Quality National Environment Protection Measure by approving an amending instrument on 15 December 2015. The amending instrument took effect on 4 February 2016.

The Ambient Air Quality NEPM specifies national ambient air quality standards for air pollutants including PM_{10} and $PM_{2.5}$. The standard for PM_{10} and $PM_{2.5}$ is outlined in **Table 3-2**.

Table 3-2: NEPM standards for PM_{10} and $PM_{2.5}$ concentrations

Pollutant	Averaging Period	Maximum concentration
PM_{10}	24 hour	50µg/m³
	Annual	25µg/m³
$PM_{2.5}$	24 hour	25µg/m³
	Annual	8µg/m³

Source: **NEPC (2016)**

As with each of the NEPM standards, these apply to the average, or general exposure of a population, rather than to "hot spot" locations near industry, where impacts are assessed via impact assessment criteria.

3.2 Crystalline Silica

Silica occurs in nature in a crystalline or amorphous form, and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz and is a component of glass.

The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis (**NIOSH, 1974**).

The NSW EPA do not have an impact assessment criteria for respirable crystalline silica. The Victorian (VIC) EPA assessment criterion for respirable crystalline silica is adopted from Californian reference exposure level values, and occupational standards and is assessed as a $PM_{2.5}$ annual average of 3µg/m³ (**VIC EPA, 2007**).

Table 3-3 presents the Victorian impact assessment criteria for respirable crystalline silica applied for this assessment.

Table 3-3: Air Quality Criterion for Respirable Silica

Pollutant	Averaging period	Criterion (µg/m³)	Organisation
Respirable crystalline silica (as $PM_{2.5}$)	Annual	3	VIC EPA

Source: **VIC EPA (2007)**

3.3 Odour

3.3.1 Introduction

Odour in a regulatory context needs to be considered in two similar, but different ways depending on the situation.

NSW legislation prohibits emissions that cause offensive odour to occur at any off-site receptor. Offensive odour is evaluated in the field by authorised officers, who are obliged to consider the odour in the context of its receiving environment, frequency, duration, character etc. and to determine whether the odour would interfere with the comfort and repose of the normal person unreasonably. In this context, the concept of offensive odour is applied to operational facilities and relates to actual emissions in the air.

However, in the approval and planning process for proposed new operations or modifications to existing projects, no actual odour exists and it is necessary to consider hypothetical odour. In this context, odour concentrations are used and are defined in odour units. The number of odour units represents the number of times that the odour would need to be diluted to reach a level that is just detectable to the human nose. Thus, by definition, odour less than an odour unit (1 OU), would not be detectable to most people.

The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour. The wide ranging response in how any particular odour is perceived by any individual poses specific challenges in the assessment of odour impacts and the application of specific air quality goals related to odour. The *Technical Framework* (**NSW DEC, 2006**) sets out a framework specifically to deal with such issues.

It needs to be noted that the term “odour” refers to complex mixtures of odours, and not “pure” odour arising from a single chemical. Odour from a single, known chemical rarely occurs (when it does, it is best to consider that specific chemical in terms of its concentration in the air). In most situations odour will be comprised of a cocktail of many substances that is referred to as a complex mixture of odour, or more simply odour.

For activities with potential to release significant odour it may be necessary to predict the likely odour impact that may arise. This is done by using air dispersion modelling which can calculate the level of dilution of odours emitted from the source at the point that such odour reaches surrounding receptors. This approach allows the air dispersion model to produce results in terms of odour units.

The NSW criteria for acceptable levels of odour range from 2 to 7OU, with the more stringent 2OU criteria applicable to densely populated urban areas and the 7OU criteria applicable to sparsely populated rural areas, as outlined below.

3.3.2 Complex Mixtures of Odorous Air Pollutants

Table 3-4 presents the assessment criteria as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC, 2005**). This criterion has been refined to take into account the population densities of specific areas and is based on a 99th percentile of dispersion model predictions calculated as 1-second averages (nose-response time).

Table 3-4: Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Source: NSW DEC, 2005

The NSW odour goals are based on the risk of odour impact within the general population of a given area. In sparsely populated areas, the criteria assume there is a lower risk that some individuals within the community would find the odour unacceptable, hence higher criteria apply.

For this assessment an impact assessment criteria of 2OU is applied.

Peak-to-mean factors are applied to account for any odour fluctuation above and below the mean odour level of the 1-hour averaging time. The criteria in **Table 3-4** are compared with modelled results that include peaking factors to account for the time-averaging limitations of air dispersion models. The peak-to-mean factors developed by **Katestone Scientific Pty Ltd** (**1995, 1998**) for the NSW EPA are applied to convert the modelled (1-hour) averaging time to 1-second peak concentrations.

A summary of the peak-to-mean values is provided in **Appendix A**.

4 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Project.

4.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) weather station at the Penrith Lakes Automatic Weather Station (AWS) (Site No. 067113) were analysed to characterise the local climate in the proximity of the Project. The Penrith Lakes AWS is located approximately 3km west-northwest of the Project.

Table 4-1 and **Figure 4-1** present a summary of data from the Penrith Lakes AWS collected over a 14 to 21-year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 30.7 degrees Celsius (ºC) and July is the coldest month with a mean minimum temperature of 5.5ºC.

Rainfall generally peaks during the warmer months and declines during the cooler months, with an annual average rainfall of 728.1 millimetres (mm) over 71.8 days. The data indicate that February is the wettest month with an average rainfall of 121.4mm over 7.8 days and July is the driest month with an average rainfall of 30.6mm over 4.1 days.

Relative humidity exhibits little variability across the year. Mean 9am relative humidity ranges from 60% in October to 85% in June. Mean 3pm relative humidity levels range from 40% in September to 55% in June.

Wind speeds also vary across the year, somewhat inversely to relative humidity. Mean 9am wind speeds range from 7.2 kilometres per hour (km/h) in May to 10.6km/h in October. Mean 3pm wind speeds range from 12.2km/h in May to 18.4km/h in September.

Table 4-1: Monthly climate statistics summary – Penrith Lakes AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temperature (ºC)	30.7	29.4	27.6	24.5	21.1	18.1	17.7	19.8	23.2	25.8	27.3	29.2	24.5
Mean min. temperature (ºC)	18.5	18.5	16.7	13.2	9.3	6.9	5.5	6.2	9.4	12.1	15.0	16.9	12.4
Rainfall													
Rainfall (mm)	100.8	121.4	69.2	51.1	38.8	59.9	30.6	31.4	32.0	51.5	82.6	62.4	728.1
Mean No. of rain days (≥1mm)	7.6	7.8	7.5	5.7	4.5	5.8	4.1	3.6	4.8	5.3	7.9	7.2	71.8
9am conditions													
Mean temperature (ºC)	22.3	21.7	19.7	17.6	13.8	10.5	9.6	11.7	15.8	18.5	19.6	21.4	16.8
Mean relative humidity (%)	73	79	80	76	81	85	83	72	64	60	68	69	74
Mean wind speed (km/h)	9.3	9.2	7.7	8.1	7.2	7.7	7.4	8.7	10.5	10.6	10.4	9.3	8.8
3pm conditions													
Mean temperature (ºC)	29.0	27.7	26.1	23.3	19.8	17.1	16.6	18.6	21.7	23.7	25.3	27.6	23.0
Mean relative humidity (%)	47	53	52	49	52	55	50	41	40	41	46	45	48
Mean wind speed (km/h)	15.7	14.3	13.7	13.2	12.2	12.7	13.5	16.5	18.4	18.0	17.4	16.4	15.2

Source: **Bureau of Meteorology, 2016 (December 2016)**

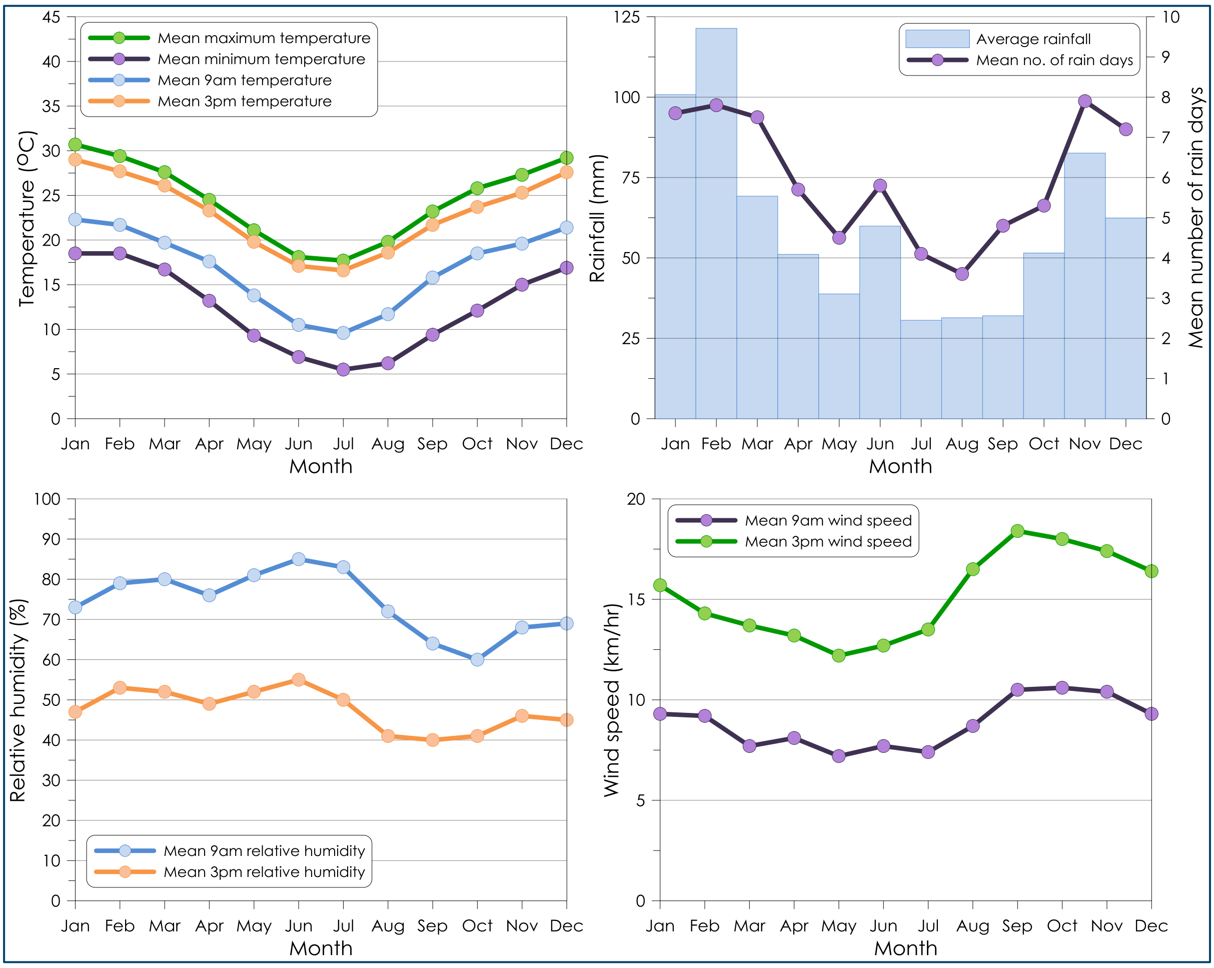


Figure 4-1: Monthly climate statistics summary – Penrith Lakes AWS

4.2 Local meteorological conditions

Annual and seasonal windroses for the Penrith Lakes AWS during the 2012 calendar period are presented in **Figure 4-2**.

On an annual basis and across all seasons with the exception of spring, winds from the south-southwest dominate the distribution followed by winds from the south, with fewer winds from the other directions. During winter, winds from the east are almost non-existent. In spring, winds are more varied and are most frequently from the south and south-southwest followed by winds from the north.

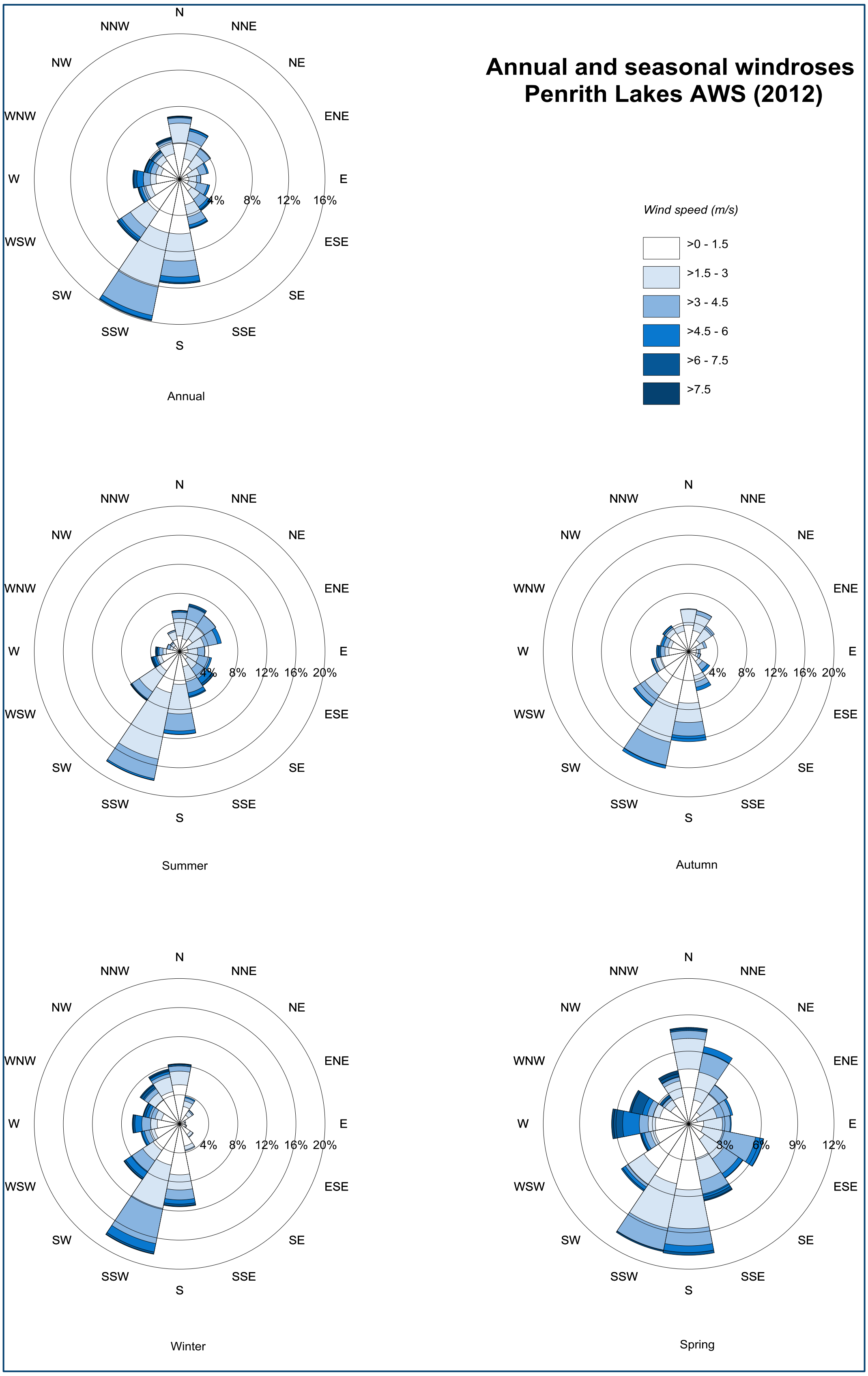


Figure 4-2: Annual and seasonal windroses – Penrith Lakes AWS (2012)

4.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the Project include emissions from local anthropogenic activities such as various commercial or industrial activities, motor vehicle exhaust and domestic wood heaters.

Ambient air quality monitoring data at the Project site are not available. Therefore the available data from the nearest air quality monitor operated by the NSW Office of Environment and Heritage (OEH) were used to quantify the existing background level for assessing pollutants at the Project site.

The NSW OEH air quality monitoring sites at St Marys, Richmond and Vineyard are approximately 9km to the southeast, 13km to the north-northeast and 15km to the northeast of the site respectively. Due to their proximity to the Project these are considered to be broadly representative of the background levels in the vicinity of the Project site.

4.3.1 PM_{10} monitoring

A summary of the available ambient PM_{10} monitoring data from the St Marys, Richmond and Vineyard NSW OEH monitoring sites during 2012 to 2016 is presented in **Table 4-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-3**.

A review of **Table 4-2** indicates that the annual average PM_{10} concentrations at St Marys, Richmond and Vineyard were below the relevant criterion of 30µg/m^3 for the period reviewed with levels ranging from 12.8µg/m^3 to 17.3µg/m^3.

The maximum 24-hour average PM_{10} concentrations recorded at the three sites were found to exceed the relevant criterion of 50µg/m^3 on occasion at Richmond in 2012, at St Marys and Vineyard in 2015 and at all monitors in 2013 and 2016 (see **Figure 4-3**). The majority of the elevated PM_{10} readings are likely due to smoke associated with bushfires or widespread regional dust storms.

Table 4-2: Summary of PM_{10} levels from NSW OEH TEOM monitoring (µg/m^3)

Station	Annual average					Maximum 24-hour average				
	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016*
St Marys	14.5	16.0	16.7	15.0	16.1	34.3	**93.0**	45.0	**53.0**	**100.2**
Richmond	15.1	17.3	15.4	12.8	16.0	**99.2**	**104.6**	40.0	49.3	**102.8**
Vineyard	14.4	16.1	16.3	15.9	17.0	34.3	**67.8**	41.9	**59.0**	**105.4**

It can be seen from **Figure 4-3** that PM_{10} concentrations follow a seasonal trend with levels nominally highest in the spring and summer months with the warmer weather raising the potential for drier ground elevating the occurrence of windblown dust, bushfires and increased pollen levels.

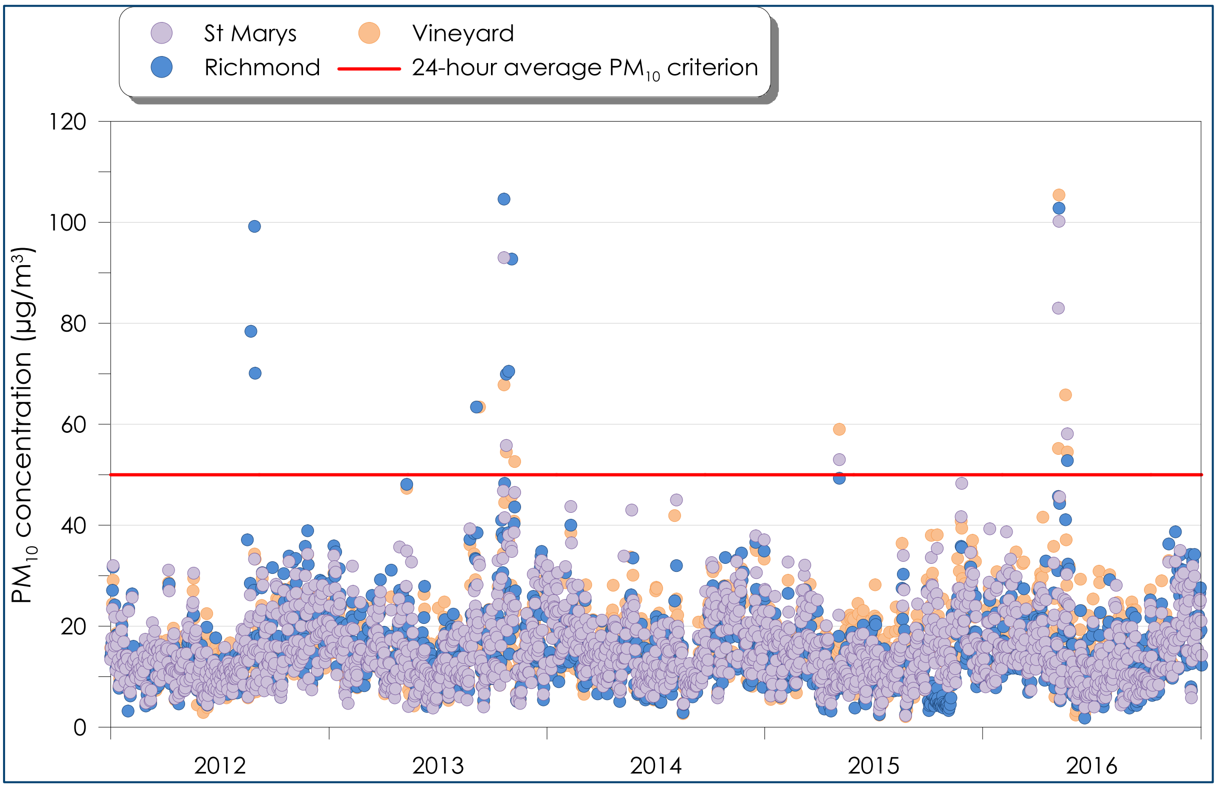


Figure 4-3: 24-hour average PM_{10} concentrations

4.3.2 $PM_{2.5}$ monitoring

A summary of the available ambient $PM_{2.5}$ monitoring data from the St Marys and Richmond NSW OEH monitoring sites during 2012 to 2016 is presented in **Table 4-3**. The recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-4**.

Table 4-3 indicates that the recorded annual average $PM_{2.5}$ concentrations were below the NEPM standard of 8µg/m³ for all years with the exception of the Richmond monitoring site in 2013. The maximum 24-hour average $PM_{2.5}$ concentrations recorded at both monitoring locations were above the NEPM standard of 25µg/m³ on occasion in 2012, 2013 and 2016.

Table 4-3: Summary of $PM_{2.5}$ levels from NSW OEH BAM monitoring (µg/m³)

Station	Annual average					Maximum 24-hour average				
	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
St Marys	-	-	-	-	7.8*	-	-	-	-	**93.2***
Richmond	5.3	**8.3**	6.7	7.7	7.9	**116.7**	**68.0**	24.7	24.5	**83.4**

*Data available from 15/03/2016

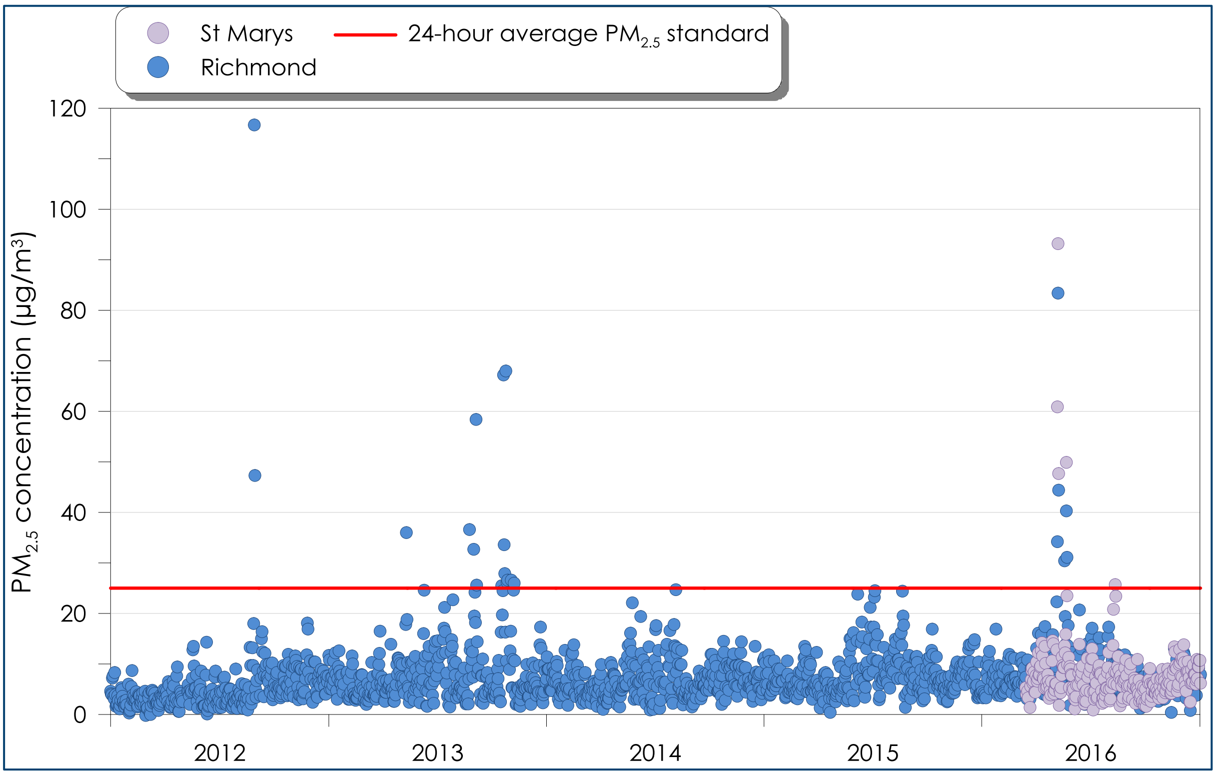


Figure 4-4: 24-hour average $PM_{2.5}$ concentrations

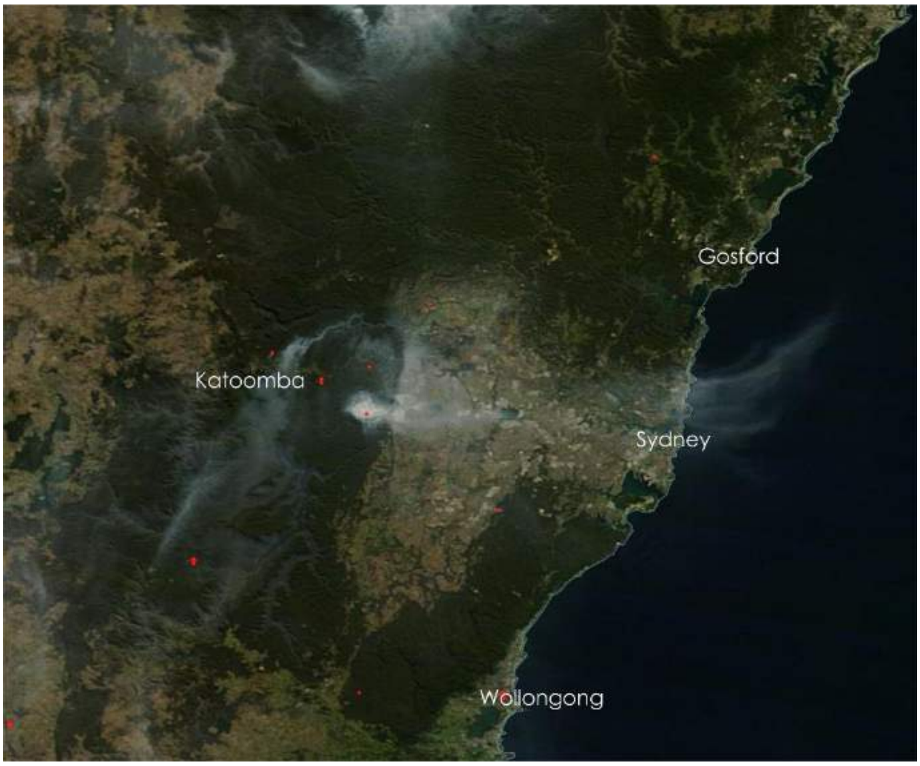
Bushfire events (including hazard reduction burns) can have a significant impact on ambient air quality levels as indicated by elevated $PM_{2.5}$ levels. A notable bushfire event occurred in late 2013 and impacted the majority of the Sydney basin and Central Coast. **Figure 4-5** presents satellite imagery showing the extent of the smoke plume on 21 October 2013, noting that the red patches in the images indicate the position of the active fire.

More recently hazard reduction burns occurring in late autumn of 2016 had a noticeable impact with smoke lingering in the Sydney basin. **Figure 4-6** presents satellite imagery showing the extent of the smoke plume on 7 May 2016.

The bushfire smoke affected the ambient air quality levels as seen in the graph in **Figure 4-4**. The elevated levels associated with bushfire events skew the ambient levels and do not provide a reliable estimate for background levels.

Source: **NASA, 2016**

Figure 4-5: Satellite imagery showing smoke plume from bushfires on 21 October 2013



Source: **NASA, 2016**

Figure 4-6: Satellite imagery showing smoke plume from hazard reduction burns on 7 May 2016

4.3.3 Estimated background air quality levels

4.3.3.1 PM_{10} and $PM_{2.5}$ concentrations

As outlined above, there are no readily available site specific monitoring data for the site, and therefore, the background dust levels around the Project site were estimated to be similar to those recorded at the NSW OEH monitoring sites at St Marys, Richmond and Vineyard.

For this assessment, the average of the annual average PM_{10} and $PM_{2.5}$ values from the available monitoring sites at St Marys, Richmond and Vineyard for the 2012 to 2016 period were used to represent the background levels for the Project (see **Table 4-2** and **Table 4-3**). This method provides a reasonable estimate for background air quality levels in the absence of site specific background monitoring data.

4.3.3.2 TSP and Deposited dust

In the absence of data, estimates of the annual average background TSP and deposited dust concentrations can be determined from a relationship between $PM_{10,}$ TSP and deposited dust concentrations and the measured PM_{10} levels.

This relationship assumes that an annual average PM_{10} concentration of 30µg/m^3 corresponds to a TSP concentration of 90µg/m^3 and a dust deposition value of 4g/m^2/month. This assumption is based on the NSW EPA air quality impact criteria.

Applying this relationship with the applied annual average PM_{10} concentration of 15.6µg/m^3 indicates an approximate annual average TSP concentration and deposition value of 46.9µg/m^3 and 2.1g/m^2/month, respectively.

4.3.3.3 Summary of background air quality levels

The annual average background air quality levels applied in this assessment are outlined in **Table 4-4**.

Table 4-4: Summary of background air quality levels

Pollutant	Averaging Period	Units	Value
PM_{10}	Annual	µg/m³	15.6
$PM_{2.5}$	Annual	µg/m³	7.3
TSP	Annual	µg/m³	46.9
Deposited dust	Annual	g/m²/month	2.1

5 DISPERSION MODELLING APPROACH

5.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach applied for the assessment.

The CALPUFF model is an advanced "puff" model which can deal with the effects of complex local terrain on the dispersion meteorology over the entire modelling domain in a three-dimensional, hourly varying time step. CALPUFF is an air dispersion model approved by NSW EPA for use in air quality impact assessments. The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia* (**TRC**, **2011**).

5.2 Modelling methodology

Modelling was undertaken using a combination of The Air Pollution Model (TAPM) and the CALPUFF Modelling System. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for three-dimensional simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model which uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a three-dimensional gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the three dimensional meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

5.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a three dimensional upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 33deg44.0min south and 150deg42.5min east (287689mE, 6265052mN). The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

CALMET modelling used a nested approach where the three dimensional wind field from the coarser grid outer domain is used as the initial guess (or starting) field for the finer grid inner domain. This approach has several advantages over modelling a single domain. Observed surface wind field data from the near field as well as from far field monitoring sites can be included in the model to generate a more representative three dimensional wind field for the modelled area. Off domain terrain features for the finer grid domain can be allowed to take effect within the finer domain, as would occur in reality, also the coarse scale wind flow fields give a better set of starting conditions with which to operate the finer grid run.

The CALMET initial domain was run on a 50 x 50km area with a 0.3km grid resolution and refined for a final domain on a 10 x 10km grid with a 0.05km grid resolution. The available meteorological data for the 2012 calendar period from Penrith Lakes AWS were included in this run. Three dimensional upper air data were sourced from TAPM output.

Local land use and detailed topographical information was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 5-1**. The model is able to consider the effects of local terrain on the wind field, as shown by the channelling of winds around terrain and the increased wind speed over ridges and decreased winds in sheltered valleys. The use of advanced meteorological modelling such as this, for each hour of the full year allows more accurate predictions of any potential impacts to be made.

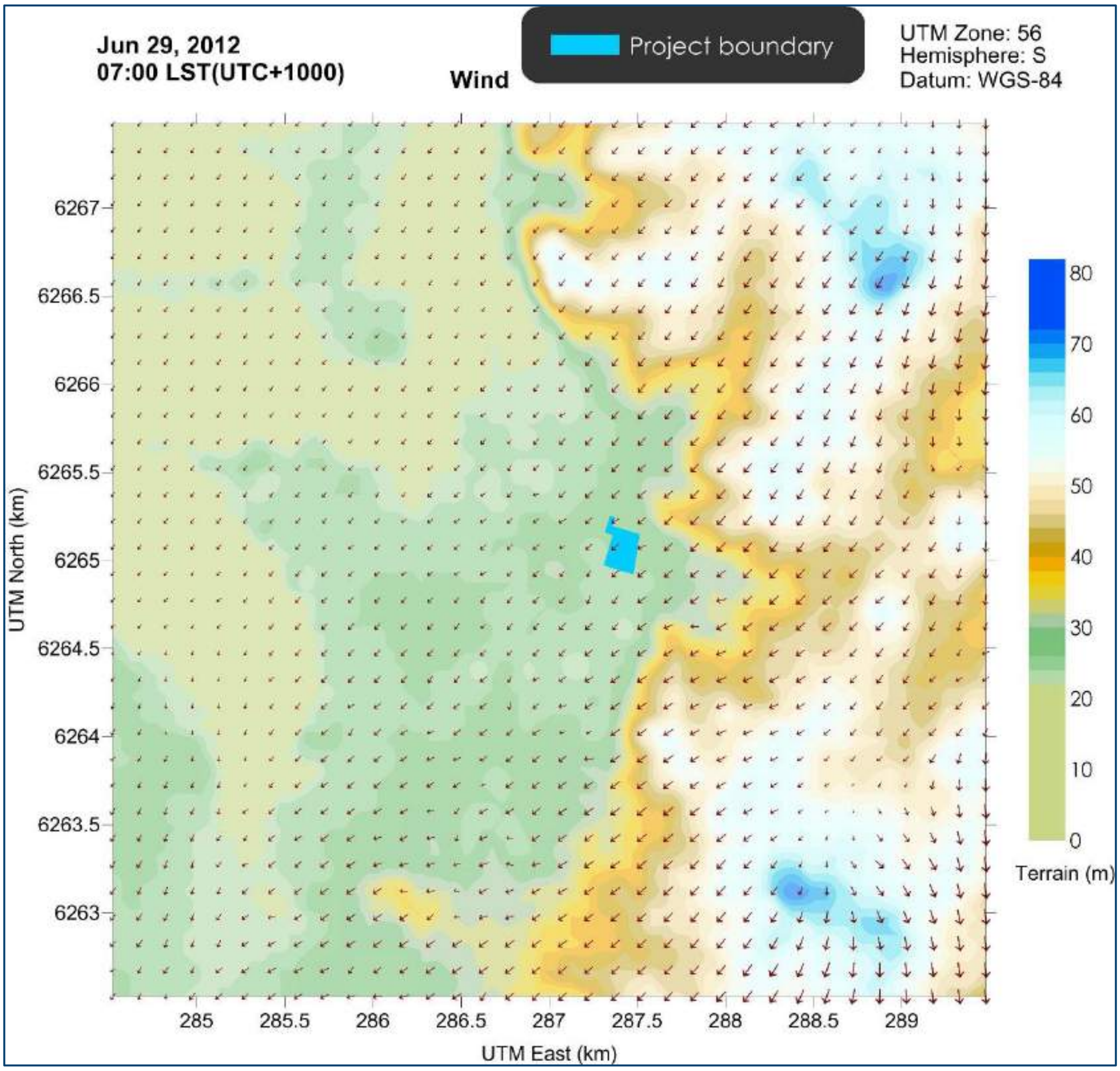


Figure 5-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 5-2** and **Figure 5-3**.

Figure 5-2 presents the annual and seasonal windroses from the CALMET data. The CALMET modelling results reflect the expected wind distribution patterns of the area based on consideration of the measured data and the expected terrain effects on the prevailing winds. The wind distribution of the CALMET data shows a similar trend to that of the Penrith Lakes AWS (see **Figure 4-2**).

Figure 5-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and is consistent with the conditions expected to occur in the area.

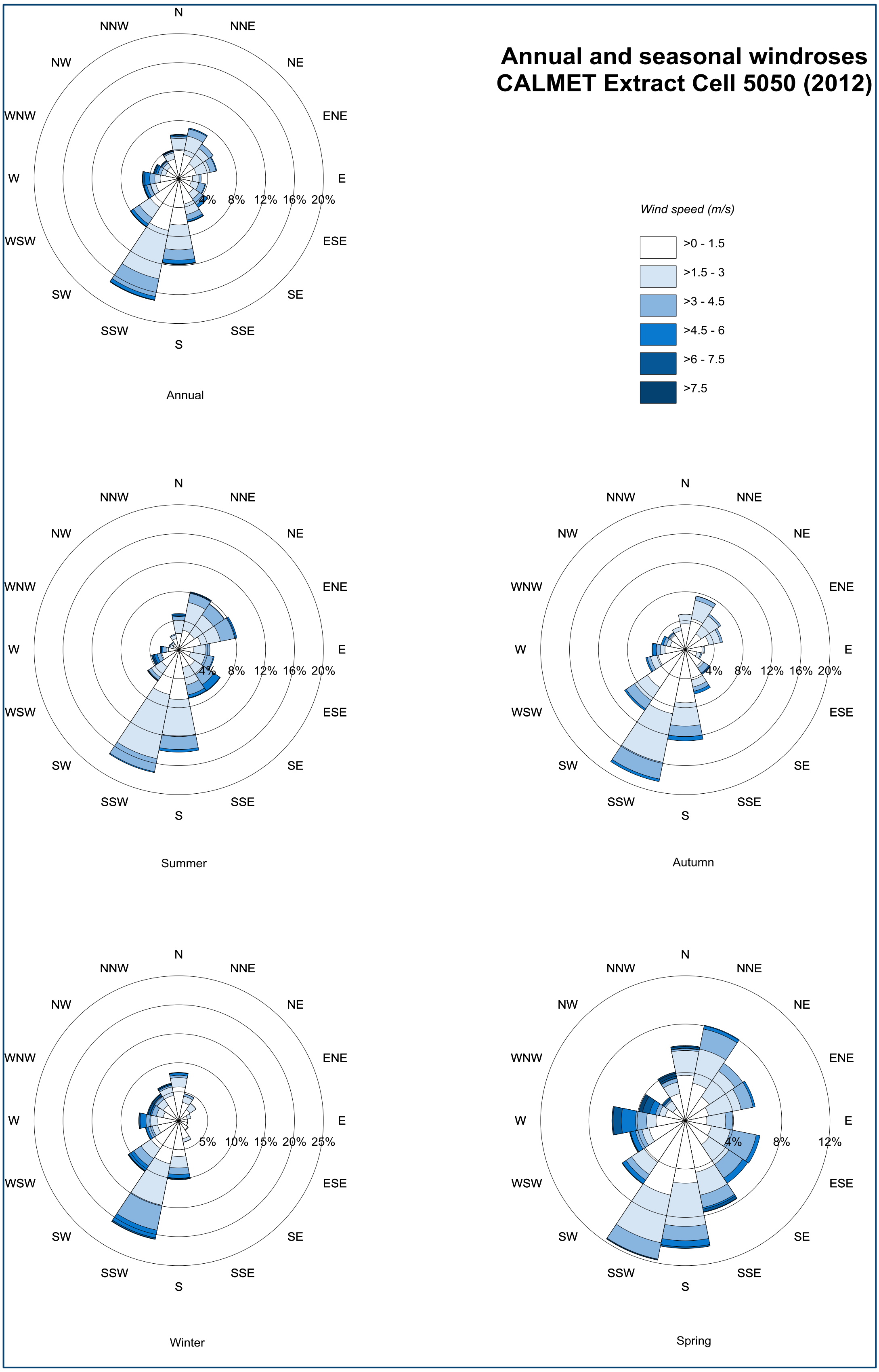


Figure 5-2: Windroses from CALMET extract (cell ref 5050)

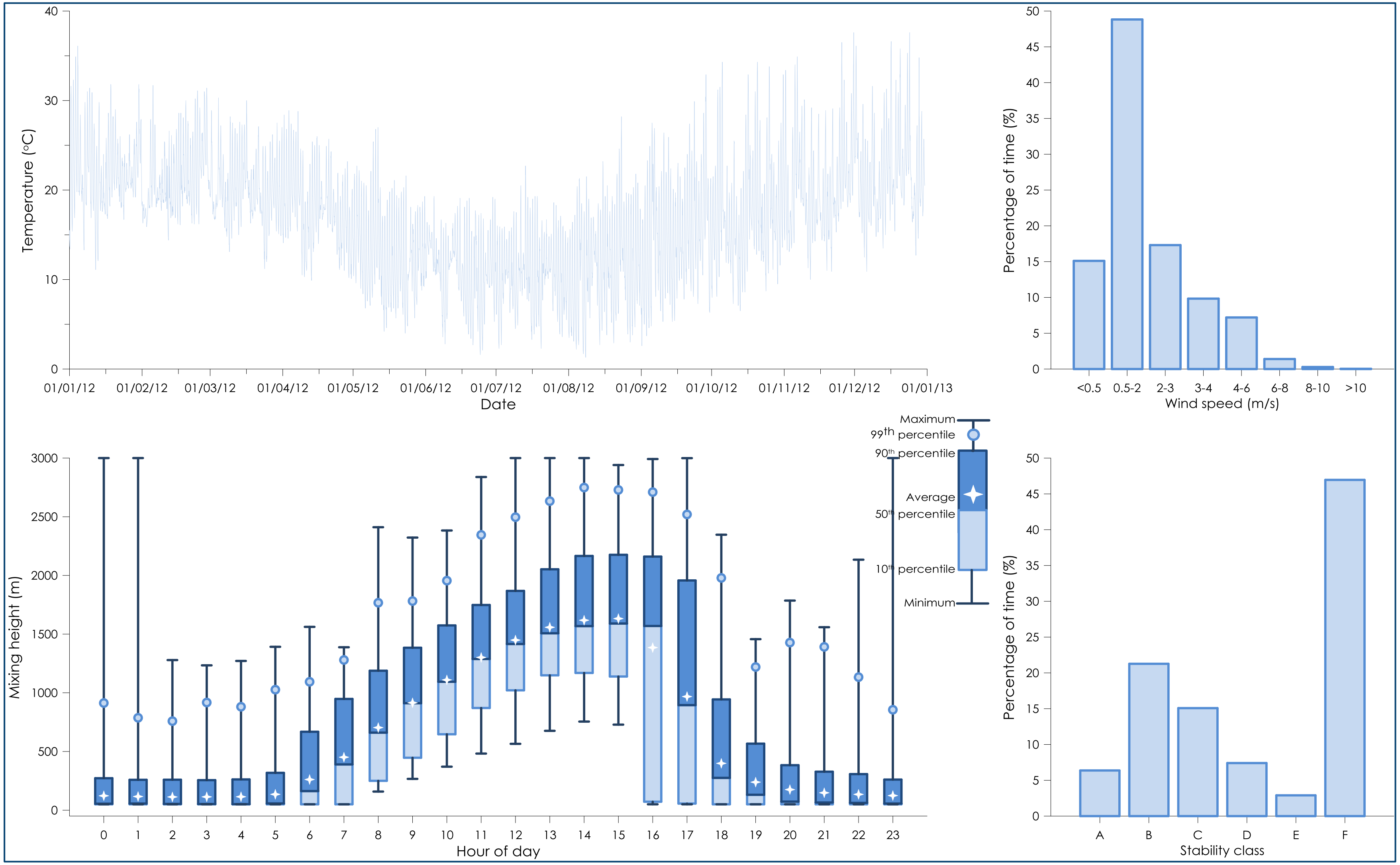


Figure 5-3: Meteorological analysis of CALMET extract (cell ref 5050)

5.2.2 Dispersion modelling

Dust emissions from each activity were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

Odour emissions from the stockpiles of materials were represented as area sources and assumed to emit continuously during the modelling period. A peak-to-mean ratio of 2.5 is applied to the modelling predictions.

5.3 Estimated dust emissions

The operations at the Project include two components, activities that occur within the processing shed and those that occur outside. For this assessment those activities which occur within the facility shed have been modelled assuming they are out in the open. This is conservative and would overestimate the potential emissions released into the environment.

Activities associated with the Project that have the potential to generate dust emissions include; loading/unloading of material, transport of material, screening of material, and windblown dust generated from stockpiles.

The on-site vehicle movements have the potential to generate air emissions from the exhaust and wheel generated dust when travelling on roads. Vehicles would travel on a paved road surface and are generally expected to be on-site for relatively short periods of time due to the short travel path.

Dust emission estimates for the Project have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emission factors sourced from US EPA developed documentation (**US EPA, 1985 and Updates**).

The estimated dust emissions for activities associated with the operation are presented in **Table 5-1**. Further details regarding each of the emission estimation techniques applied to estimate the TSP emissions are provided in **Appendix B**.

Table 5-1: Estimated annual TSP emission rate for the Project

Activity	TSP emission (kg/year)
Hauling of raw materials to site (paved road)	3,841
Unloading of raw materials in processing shed	1,451
Rehandle of raw materials in processing shed	290
Loading raw materials to hopper in processing shed	1,451
Conveying within processing shed	85
Screening (coarse) of materials within processing shed (x4)	880
Screening (fines) of materials within processing shed (x2)	720
Transfers within processing shed (x10)	14,513
Unloading waste material to stockpile	1,451
Unloading of product material to finished bays	1,451
Pick up product material with front-end-loader	1,451

Activity	TSP emission (kg/year)
Transport product material to outside stockpiles	3,474
Unloading of product material to stockpiles	1,451
Rehandle product material at stockpiles	290
Loading of product material to trucks for delivery	1,451
Hauling materials off-site	3,841
Wind erosion from product stockpiles	340
Wind erosion from product + rerun material stockpile	213
Wind erosion from waste material stockpile	26
Total TSP emissions	**38,433**

5.4 Estimated odour emissions

The storage of the raw glass material at the Project has the potential to result in odorous emissions. The raw glass material is stockpiled within the processing shed before it is loaded into the hopper for processing.

There are no site specific odour emission data available for the Project. However, the odour level from the raw glass stockpiles is considered to be similar or lower than levels of odours from a landfill tipping face. Landfill odour emission rate data are available and were therefore used in this assessment to conservatively approximate potential odours that may be emitted from the raw glass stockpiles at the Project.

Odour measurements for various landfill operations were obtained from their respective air quality studies (**Golder Associates (2012), HAS (2008), Heggies (2009), PAEHolmes (2010), SLR (2011), SLR (2012) and TOU (2014)**) with the average level applied for the raw glass stockpile odour source.

Table 5-2 summarises the range of specific odour emission rate data for landfill tipping face from the various studies. In reality, the glass stockpiles are likely to have an odour emission rate lower than that of a landfill tipping face and therefore the emission rates used are conservative.

Table 5-2: Odour measurements for Landfill tipping face

	Specific odour emission rate (SOER) ($ou.m^3/m^2/s$)	Source
Landfill tipping face	1.57	SLR (2012)
	0.23	Heggies (2009)
	0.7	SLR (2011)
	3.83	HAS (2008)
	2.6	Golder Associates (2012)
	8.36	TOU (2014)
	1.91	PAEHolmes (2010)
	0.361	
	3.65	
Average	**2.58**	

6 DISPERSION MODELLING RESULTS

6.1 Dust concentrations

Figure 6-1 to **Figure 6-6** present isopleths of the spatial distribution of predicted incremental impacts associated with the operations of the Project (alone) over the modelling domain for maximum 24-hour average $PM_{2.5}$ and PM_{10}, annual average $PM_{2.5}$, PM_{10}, TSP and deposited dust levels.

Table 6-1 presents the predicted particulate dispersion modelling results at each of the assessed sensitive receiver locations. The predicted cumulative $PM_{2.5}$, PM_{10}, TSP and dust deposition levels due to the Project with the estimated background levels are presented in **Table 6-2**. The results indicate the predicted levels would be below the relevant criteria at the assessed sensitive receiver locations. It is noted that the modelling predictions are based on activities occurring out in the open and in reality would overestimate the impacts.

Table 6-1: Particulate dispersion modelling results for sensitive receivers – Incremental impact

Receiver ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)
	Incremental impact					
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	-	-	-	-	-	2
R1	1.1	0.2	8.4	1.7	3.0	0.1
R2	1.6	0.4	13.0	2.9	5.3	0.2
R3	2.2	0.6	17.5	4.5	8.8	0.3
R4	2.3	0.6	18.7	4.5	8.8	0.3
R5	2.1	0.4	16.9	3.4	6.5	0.3
R6	1.6	0.2	12.9	1.9	3.5	0.1
R7	0.9	0.1	7.2	1.1	2.0	0.1
R8	0.7	0.1	5.4	1.1	1.9	0.1
R9	1.2	0.2	9.4	1.7	3.1	0.1
R10	1.0	0.2	8.4	1.3	2.5	0.1

Table 6-2: Particulate dispersion modelling results for sensitive receivers – Cumulative impact

Receiver ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Cumulative impact			
	Annual average			
	8*	30	90	4
R1	7.5	17.3	49.9	2.2
R2	7.7	18.5	52.2	2.3
R3	7.9	20.1	55.7	2.4
R4	7.9	20.1	55.7	2.4
R5	7.7	19.0	53.4	2.4
R6	7.5	17.5	50.4	2.2
R7	7.4	16.7	48.9	2.2
R8	7.4	16.7	48.8	2.2
R9	7.5	17.3	50.0	2.2
R10	7.5	16.9	49.4	2.2

*NEPM Standard

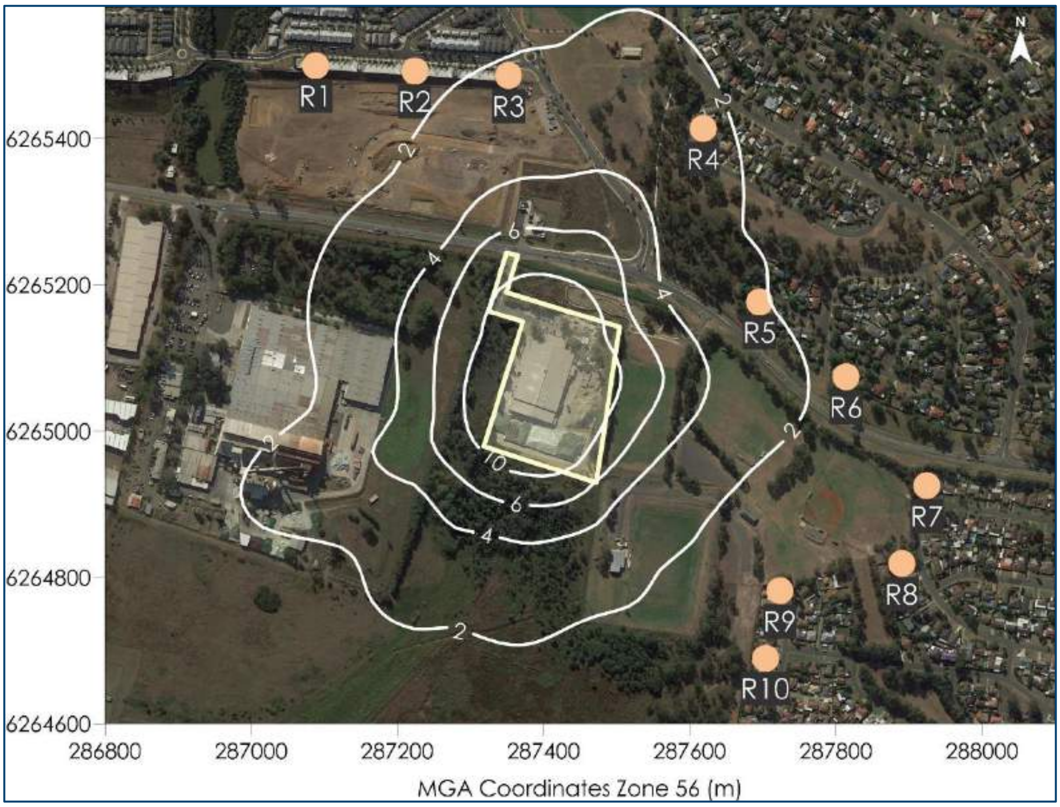


Figure 6-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

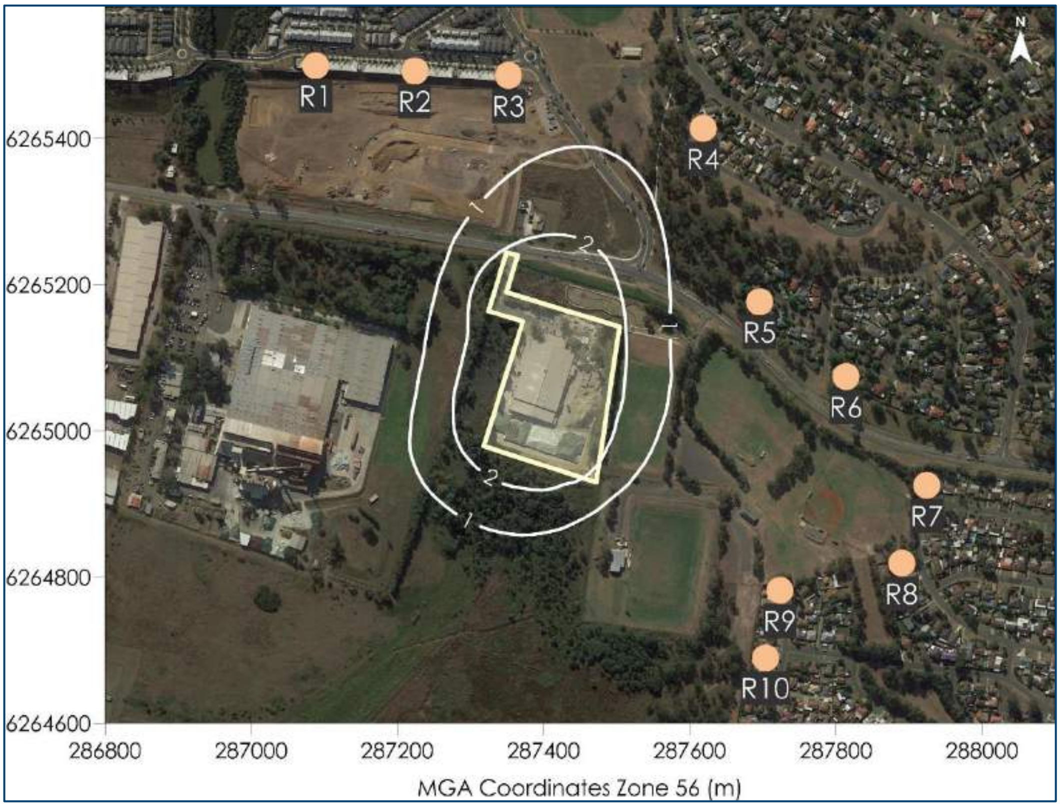


Figure 6-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

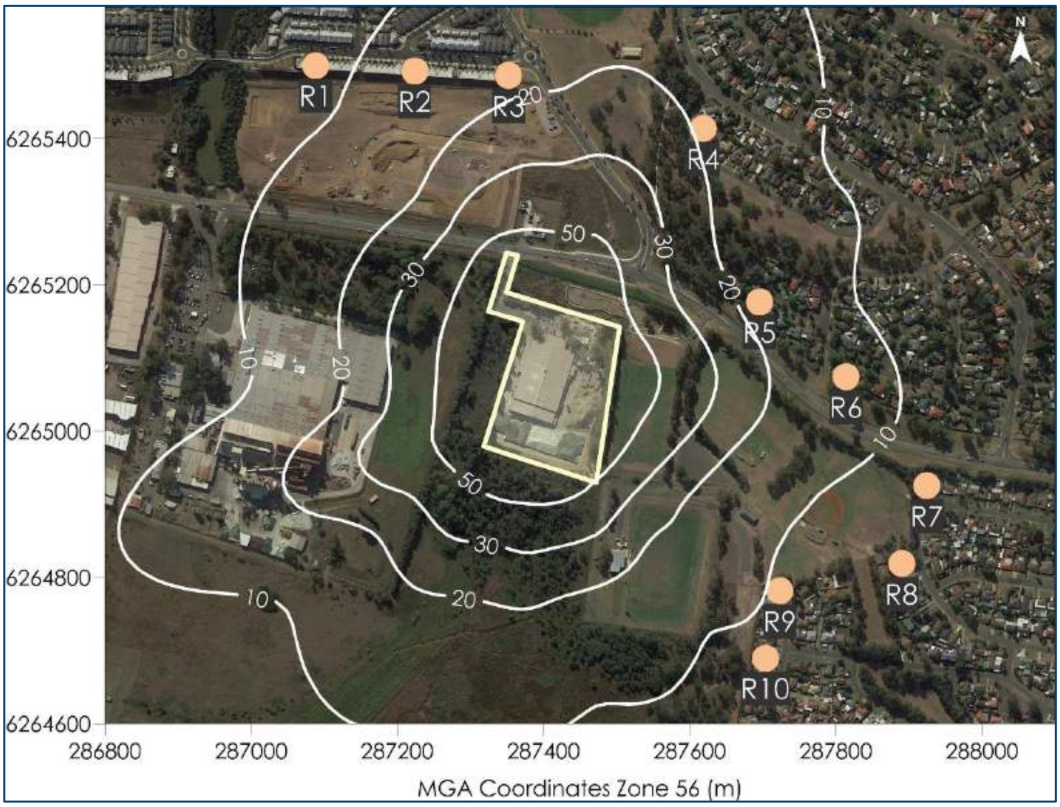


Figure 6-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

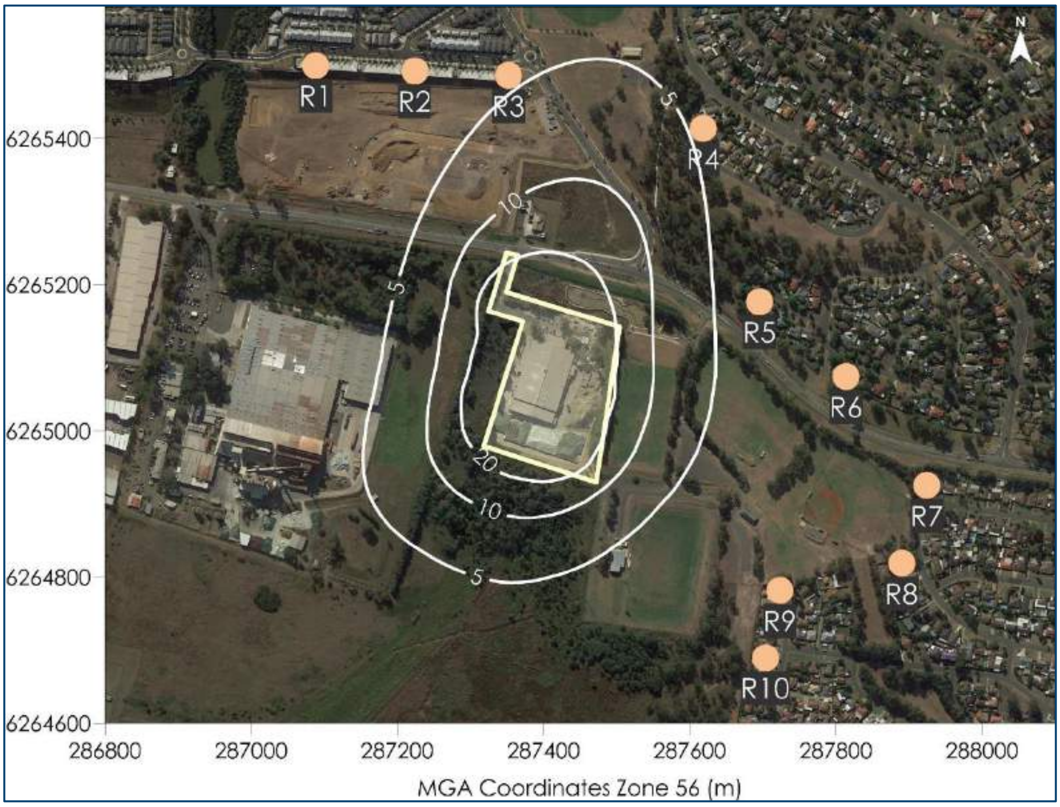


Figure 6-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

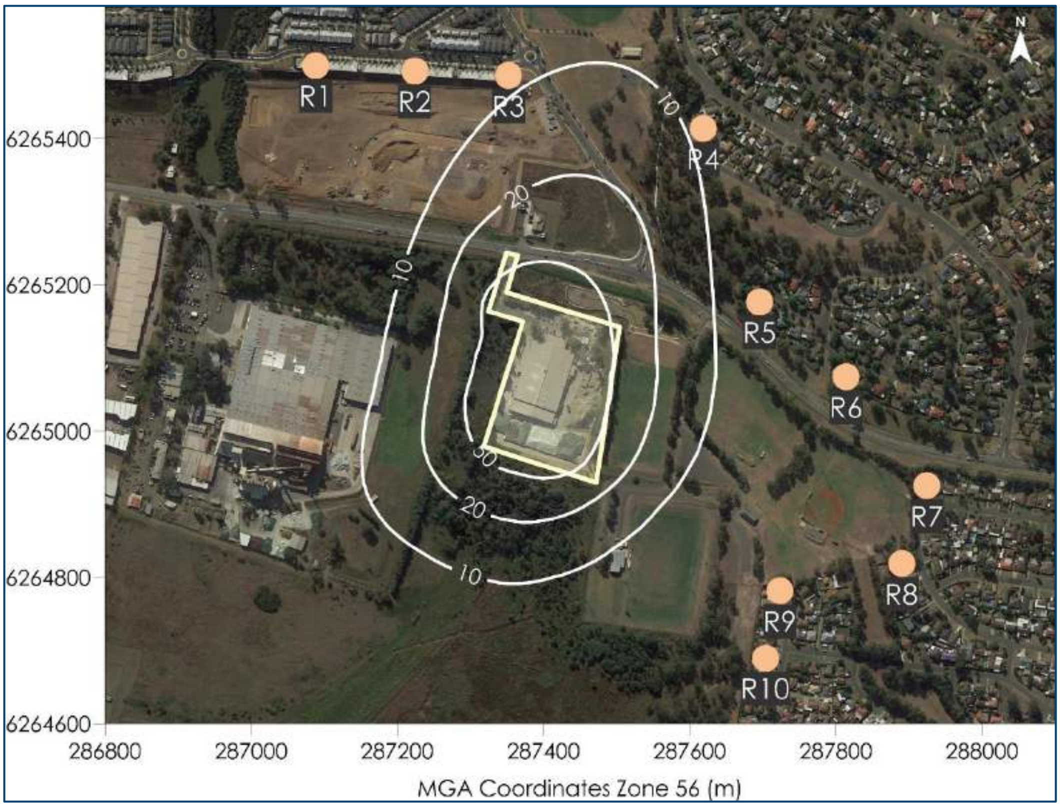


Figure 6-5: Predicted incremental annual average TSP concentrations (µg/m³)

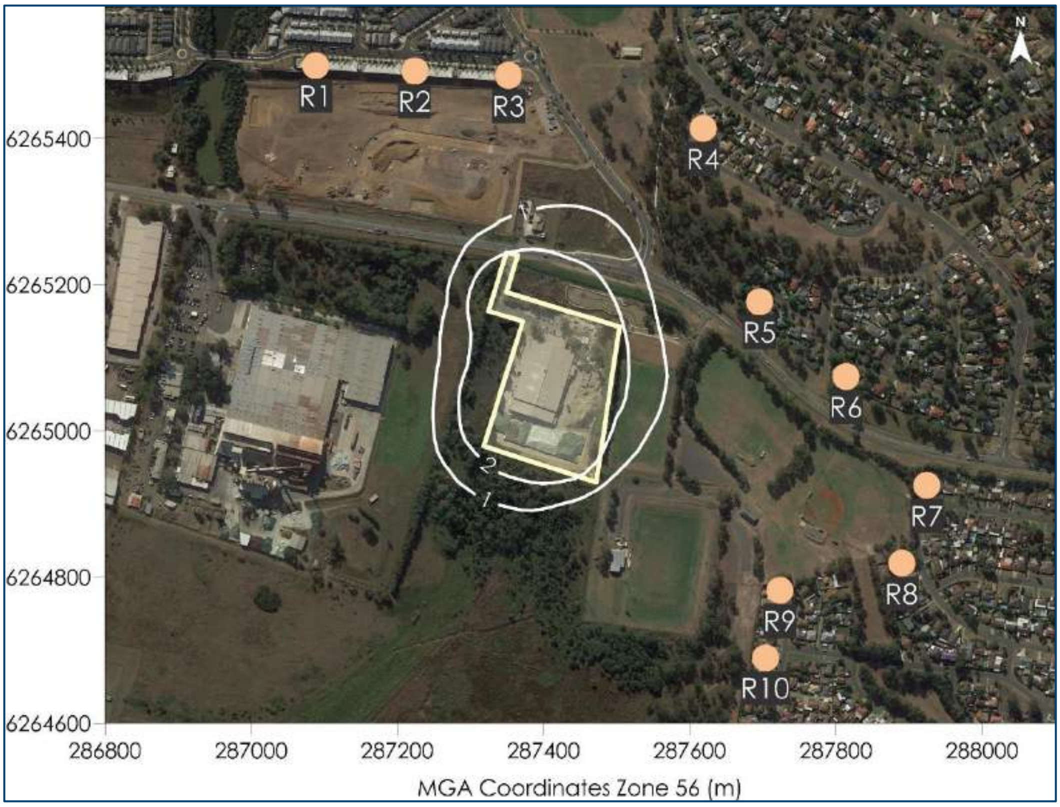


Figure 6-6: Predicted incremental annual average dust deposition levels (g/m²/month)

6.2 Assessment of Total (Cumulative) 24-hour average $PM_{2.5}$ and PM_{10} Concentrations

An assessment of total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in general accordance with the methods outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC**, **2005**).

As shown in **Section 4.3**, maximum background level data for the contemporaneous period have approached or exceeded the criterion level on some days. As a result, the Level 1 assessment approach of adding maximum background levels to the maximum predicted level from the Project would show levels above the respective criterion and hence a Level 1 approach is unsuitable. Therefore a Level 2 assessment was conducted.

The Level 2 contemporaneous assessment of cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts requires further and more detailed analysis of background conditions and the projected incremental impacts due to the Project. The Level 2 assessment involves adding the predicted incremental impact of the Project to each day's measured background levels. This method accounts for the highly varying background dust level on any given day, and also the effects of the weather conditions on each day in regard to a Project's emissions.

Monitoring data from the NSW OEH monitoring sites at St Marys and Richmond were used as these sites are relatively close to the Project and the air quality levels are likely to be reasonably representative of the Project area.

The NSW EPA contemporaneous impact assessment approach was applied at the most impacted receiver locations, R3, R4 and R5. Detailed tables of the full assessment results are provided in **Appendix C**.

Table 6-3 provides a summary of the findings from the Level 2 assessment at the assessed receiver location. The results in **Table 6-3** indicate that it is unlikely that cumulative impacts would arise at the most impacted location and therefore it is inferred that the maximum impact at the other sensitive receivers of the Project would not exceed the criteria.

Table 6-3: Summary of NSW EPA contemporaneous assessment for $PM_{2.5}$ and PM_{10} impacts

Receiver ID	Number of additional days above 24-hour average $PM_{2.5}$ NEPM standard	Number of additional days above 24-hour average PM_{10} criterion
R3	0	0
R4	0	0
R5	0	0

A time series plot of the predicted cumulative 24-hour PM_{10} concentrations for R4 is presented in **Figure 6-7**. The blue bars in the figure represent the measured background levels at the St Marys and Richmond monitoring sites and the orange bars represent the predicted incremental levels due to the Project. It is clear from the figure that the Project would have only a minor influence at this receiver location and is unlikely to be discernible beyond the existing background level at times.

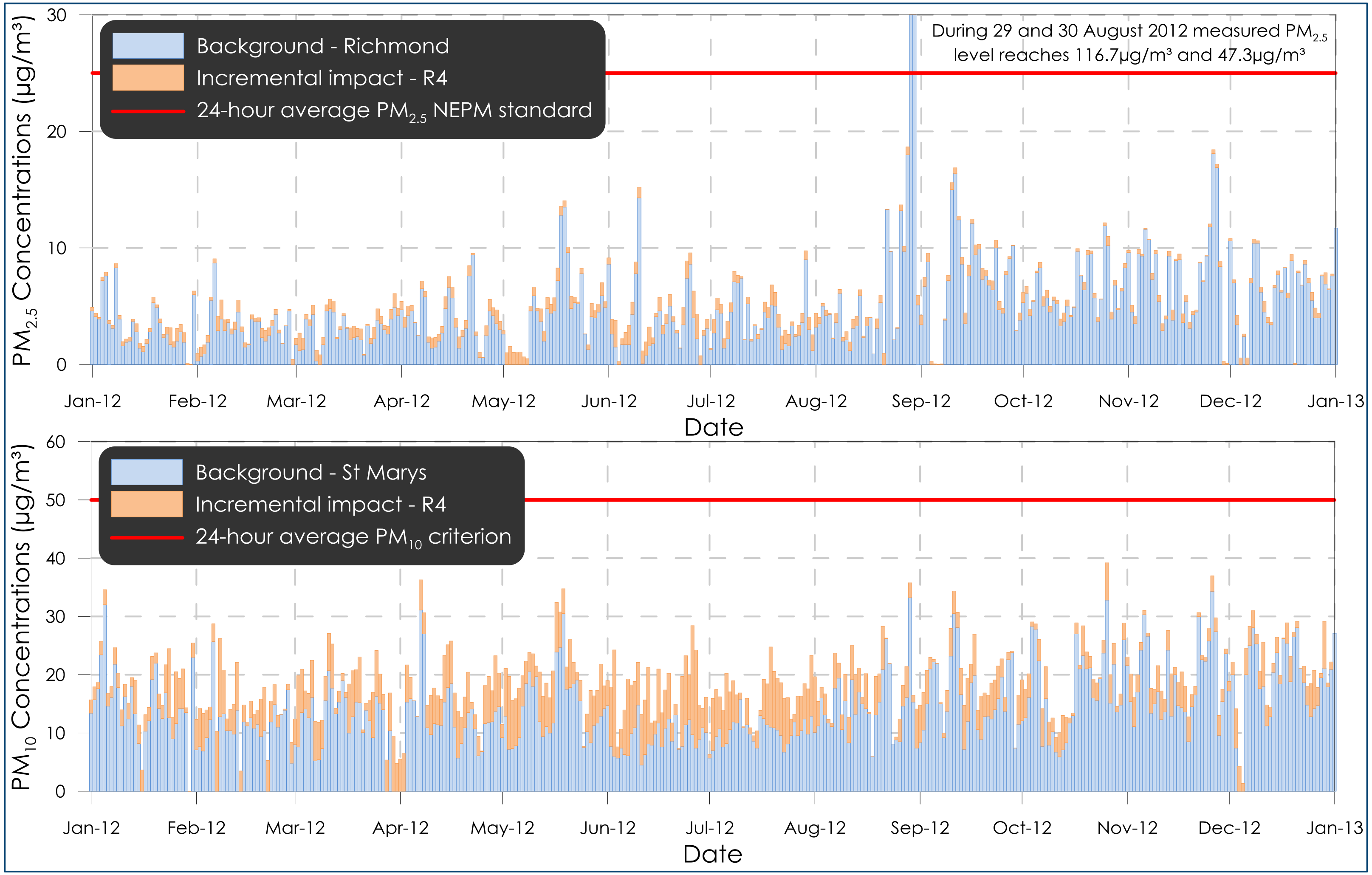


Figure 6-7: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for R4

6.3 Respirable Crystalline Silica

The assessment results in **Table 6-1** show that the most affected sensitive receiver (R4) has a predicted annual average $PM_{2.5}$ concentration level of 0.6µg/m^3 due to the Project which is below the VIC EPA criteria of 3µg/m^3 for respirable crystalline silica.

The predicted level assumes the total dust from the site is respirable crystalline silica, where in reality it is likely to comprise of only a small portion of silica. Also the modelling predictions assume that the highest dust generating activities occur out in the open and would therefore overestimate the actual impacts. Thus the Project is not predicted to result in an unacceptable level of respirable crystalline silica in the ambient air at sensitive receiver locations.

6.4 Odour

The spatial distribution of the dispersion modelling predictions for the modelled Project is presented as an isopleth diagram showing the 99th percentile nose-response ground level odour concentrations in **Figure 6-8.**

The dispersion modelling results indicate that the predicted odour impacts are generally restricted to the immediate area around the operations. We note that the modelling is based on conservative assumptions for the operation of the Project, which include modelling the odour source in the open and applying odour emission rates for putrescible material measured at a landfill.

The odour impact from the Project is expected to be lower in reality and thus the indication is that the Project could operate without significant adverse impact in the surrounding environment.

Table 6-4: Predicted odour concentration at sensitive receivers

Receiver ID	99th percentile odour level (OU)
	Odour criterion – 2 OU
R1	1
R2	1
R3	1
R4	1
R5	1
R6	1
R7	<1
R8	<1
R9	1
R10	1

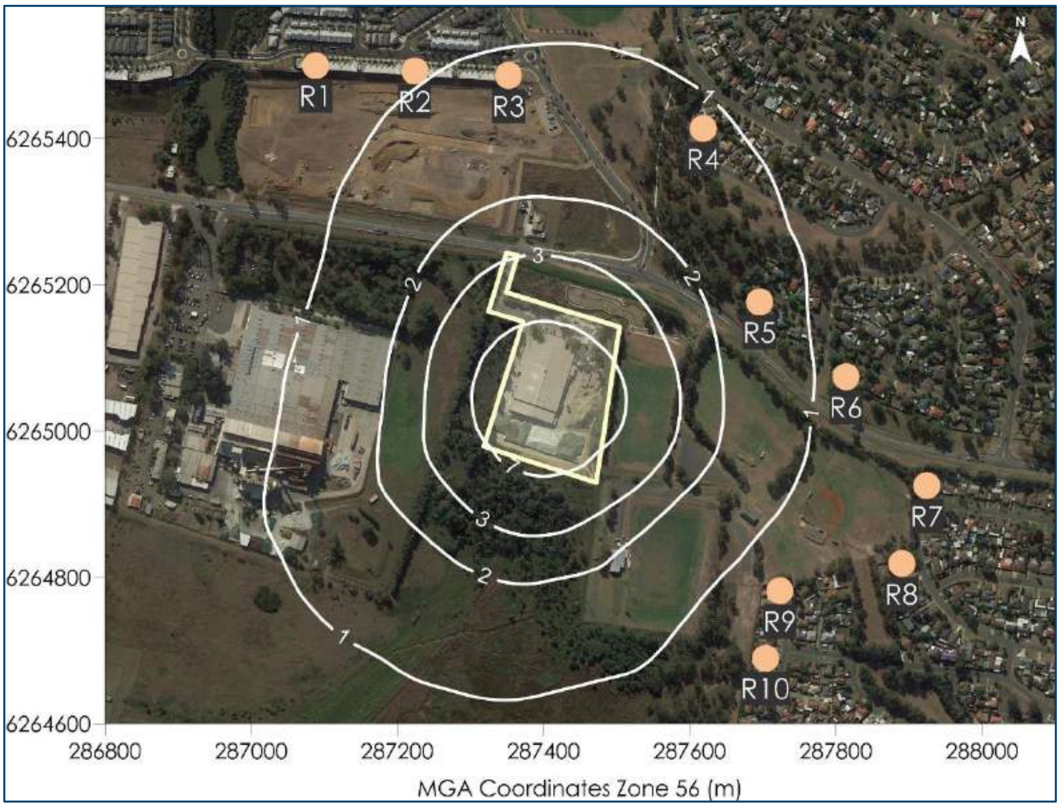


Figure 6-8: Predicted 99th percentile nose-response average ground level odour concentrations

7 DUST MITIGATION AND MANAGEMENT

The activities at the Project will generate dust emissions, therefore it is prudent to take reasonable and practicable measures to prevent and minimise excessive generation of dust emissions to the surrounding environment.

To ensure that dust generation during operational activities is managed and the potential for off-site impacts is reduced, appropriate operational and physical mitigation measures would be utilised. A summary of key control measures recommended to be applied to the operations at the Project site is presented in **Table 7-1**.

Table 7-1: Dust mitigation and management options

Source	Mitigation Measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of visible dust cannot be maintained using the available means).
	Review forecast weather and plan daily activities accordingly.
	Engines of on-site vehicles and plant switched off when not in use.
	Vehicles and plant fitted with pollution reduction devices as appropriate.
	Maintain and service vehicles according to manufacturer's specifications.
	Yard swept regularly and to be wetted down at times to prevent fugitive dust from leaving site.
	Where possible keep all doors of processing shed closed to minimise the emission of dust from the processing shed.
	Process controls include suction points above screens and baghouse filter to capture dust emissions.
	Regular cleaning within processing shed.
Exposed stockpiles	Minimise area of exposed surfaces and amount of material stockpiled.
	Water suppression on all external stockpiles.
	Implementation of water sprays during dusty periods and when digging into stockpiles.
Material handling	Minimise fall distance of materials during loading and unloading.
	Wet material down before handling.
	Use water sprays to manage dust emissions during material handling activity.
	All incoming materials would be unloaded within the processing shed.
	Water sprays when loading trucks and containers.
Hauling activities	Regular maintenance/ cleaning of road surface.
	Impose speed limits.
	Street cleaning to remove dirt tracked onto sealed roads.
	Covering vehicle loads when transporting material off- site.
	Trafficable areas clearly marked; vehicle movement restricted to these areas.

8 SUMMARY AND CONCLUSIONS

This report has assessed the potential worst-case air quality impacts associated with the operation of the Project.

Air dispersion modelling was used to predict the potential for off-site dust and odour impacts in the surrounding area due to the operation the Project. The modelling has conservatively assumed that all activity would occur out in the open where in reality it would primarily be contained within the processing shed. The estimated emissions of dust and odour applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that all the assessed air pollutants generated by the Project would comply with the applicable assessment criteria at all sensitive receivers and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area.

Nevertheless, the site would apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

Overall, the assessment demonstrates that even using conservative assumptions, the Project can operate without causing any significant air quality impact at sensitive receivers in the surrounding environment.

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Appendix A
Peak-to-mean ratios

Peak-to-mean ratios

The following table shows the recommended factors to be applied for estimating peak concentrations from different source types, stabilities and distances.

Source Type	Pasquill-Gifford stability class	Near field P/M 60*	Far field P/M 60*
Area	A, B, C, D	2.5	2.5
	E, F	2.3	1.9
Line	A-F	6	6
Surface point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

*Ratio of peak 1-second average concentrations

Appendix B

Emission Inventory

Table B-1: Emission factor equations

Activity	Emission factor equation	Variable
Loading / emplacing material	$EF = k \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} \Big/ \frac{M}{2}^{1.4}\right) kg/tonne$	K_{tsp} = 0.74 U = wind speed (m/s) M = moisture content (%)
Hauling on sealed surfaces	$EF = k \times (sL)^{0.91} \times (W)^{1.02}\ kg/VKT$	k = 3.23 (g/VKT) sL = road surface silt loading (g/m^2) W = average weight of vehicles (tons)
Screening (coarse)	$EF = 0.0011\ kg/tonne$	-
Screening (fine)	$EF = 0.0018\ kg/tonne$	-
Wind erosion from exposed areas	$EF = 850\ kg/ha\ /year$	-

Table B-2: Emissions Inventory

Activity	TSP emission (kg/y)	Intensity	Units	Emission Factor - TSP	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units
Hauling of raw materials to site (paved road)	3,841	200,000	tonnes/year	0.019	kg/t	32	tonnes/load	0.8	km/return	0.8	kg/VKT	7.4	g/m²	35.8	ave. weight
Unloading of raw materials in processing shed	1,451	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %				silt loading		of vehicles (tons)
Rehandle of raw materials in processing shed	290	40,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Loading raw materials to hopper in processing shed	1,451	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Conveying within processing shed	85	0.1	ha	850.0	kg/ha/year										
Screening (coarse) of materials within processing shed (x4	880	200,000	tonnes/year	0.001	kg/t										
Screening (fines) of materials within processing shed (x2)	720	200,000	tonnes/year	0.002	kg/t										
Transfers within processing shed (x10)	14,513	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Unloading waste material to stockpile	1,451	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Unloading of product material to finished bays	1,451	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Pick up product material with front-end-loader	1,451	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Transport product material to outside stockpiles	3,474	200,000	tonnes/year	0.017	kg/t	4.64	tonnes/load	0.24	km/return	0.3	kg/VKT	7.4	g/m²	15.9	ave. weight
Unloading of product material to stockpiles	1,451	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %				silt loading		of vehicles (tons)
Rehandle product material at stockpiles	290	40,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Loading of product material to trucks for delivery	1,451	200,000	tonnes/year	0.007	kg/t	0.880	m/s [ave. of $(WS/2.2)^{1.3}$]	0.5	moisture content in %						
Hauling materials off-site	3,841	200,000	tonnes/year	0.019	kg/t	32	tonnes/load	0.8	km/return	0.8	kg/VKT	7.4	g/m²	35.8	ave. weight
Wind erosion from product stockpiles	340	0.4	ha	850.000	kg/ha/year								silt loading		of vehicles (tons)
Wind erosion from product + rerun material stockpile	213	0.3	ha	850.000	kg/ha/year										
Wind erosion from waste material stockpile	26	0.0	ha	850.000	kg/ha/year										
Total TSP emissions (kg/yr)	**38,433**														

Appendix C

Further detail regarding 24-hour $PM_{2.5}$ and PM_{10} analysis

Further detail regarding 24-hour $PM_{2.5}$ and PM_{10} analysis

The analysis below provides a cumulative 24-hour PM_{10} impact assessment per the NSW EPA Approved Methods (**NSW DEC, 2005**); refer to the worked example on Page 52 to 54 of the Approved Methods.

The background level is the total ambient measured level at the nearest monitoring station to the receiver assessed in each table.

The predicted increment is the level predicted to occur at the receiver due to the Project.

The total is the sum of the background level and the predicted level.

Each table assesses one receiver. The left hand half of the table examines the cumulative impact during the periods of highest background levels and the right hand side of the table examines the cumulative impact during the periods of highest contribution from the Project.

The orange shading represents days where the existing background level is already above the criteria. This can be the result of bushfire events and dust storms, and is included for completeness.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

The values in **bold red** are above the criteria.

Tables C-1 to **C-6** show the predicted maximum cumulative levels at each receiver surrounding the Project. There are no days in the year assessed that have higher total levels than those shown in the tables.

The results show that:

1. No exceedance is predicted to arise due to Project;
2. The contribution to dust levels from the Project are low on the days with the highest background level.

Table C-1: Receiver R3 – $PM_{2.5}$ 24-hr average concentration (µg/m³)

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
29/08/2012	116.7	0.3	117.0	-	-	-	-
30/08/2012	47.3	0.3	47.6	-	-	-	-
26/11/2012	18.1	1.0	19.1	2/06/2012	2.6	2.2	4.8
28/08/2012	18.0	0.6	18.6	28/05/2012	4.0	2.2	6.2
27/11/2012	16.9	0.7	17.6	7/07/2012	4.5	1.8	6.3
11/09/2012	16.4	1.0	17.4	30/05/2012	5.9	1.8	7.7
10/09/2012	15.0	0.4	15.4	3/06/2012	1.5	1.7	3.2
10/06/2012	14.3	1.0	15.3	27/06/2012	2.2	1.7	3.9
19/05/2012	13.5	0.4	13.9	4/05/2012		1.7	1.7
22/08/2012	13.3	0.1	13.4	25/01/2012	1.5	1.7	3.2
26/08/2012	13.2	0.6	13.8	1/08/2012	3.2	1.5	4.7
18/05/2012	12.8	1.0	13.8	27/05/2012	4.1	1.5	5.6

Table C-2: Receiver R4 – $PM_{2.5}$ 24-hr average concentration (µg/m³)

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
29/08/2012	116.7	0.3	117.0	-	-	-	-
30/08/2012	47.3	0.1	47.4	-	-	-	-
26/11/2012	18.1	0.3	18.4	26/06/2012	4.0	2.3	6.3
28/08/2012	18.0	0.7	18.7	3/06/2012	1.5	2.3	3.8
27/11/2012	16.9	0.3	17.2	27/06/2012	2.2	2.1	4.3
11/09/2012	16.4	0.5	16.9	19/07/2012	5.1	1.7	6.8
10/09/2012	15.0	0.6	15.6	8/02/2012	3.9	1.6	5.5
10/06/2012	14.3	0.9	15.2	7/06/2012	1.7	1.6	3.3
19/05/2012	13.5	0.5	14.0	13/06/2012	1.6	1.6	3.2
22/08/2012	13.3	0.0	13.3	3/05/2012		1.6	1.6
26/08/2012	13.2	0.5	13.7	2/03/2012	1.2	1.5	2.7
18/05/2012	12.8	0.8	13.6	6/07/2012	2.2	1.5	3.7

Table C-3: Receiver R5 – $PM_{2.5}$ 24-hr average concentration (µg/m³)

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
29/08/2012	**116.7**	0.5	**117.2**	-	-	-	-
30/08/2012	**47.3**	0.4	**47.7**	-	-	-	-
26/11/2012	18.1	0.1	18.2	19/06/2012	5.0	2.1	7.1
28/08/2012	18.0	0.7	18.7	17/06/2012	2.6	2.1	4.7
27/11/2012	16.9	0.3	17.2	8/09/2012	3.8	1.9	5.7
11/09/2012	16.4	0.2	16.6	2/07/2012	2.7	1.8	4.5
10/09/2012	15.0	0.8	15.8	6/05/2012		1.8	1.8
10/06/2012	14.3	0.5	14.8	28/07/2012	3.6	1.7	5.3
19/05/2012	13.5	0.7	14.2	13/05/2012	2.0	1.5	3.5
22/08/2012	13.3	0.0	13.3	24/06/2012	7.4	1.5	8.9
26/08/2012	13.2	0.3	13.5	23/03/2012	1.8	1.4	3.2
18/05/2012	12.8	0.8	13.6	9/03/2012	1.7	1.4	3.1

Table C-4: Receiver R3 – PM_{10} 24-hr average concentration (µg/m³)

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
26/11/2012	34.3	8.4	42.7	28/05/2012	11.3	17.5	28.8
29/08/2012	33.3	2.0	35.3	2/06/2012	7.7	17.4	25.1
26/10/2012	32.8	0.9	33.7	7/07/2012	10.6	14.5	25.1
5/01/2012	32.0	1.9	33.9	30/05/2012	12.9	14.2	27.1
7/04/2012	31.1	8.4	39.5	3/06/2012	6.0	13.6	19.6
19/05/2012	30.5	3.1	33.6	4/05/2012	7.3	13.6	20.9
11/09/2012	30.5	8.5	39.0	27/06/2012	7.4	13.6	21.0
6/11/2012	30.3	8.5	38.8	25/01/2012	9.0	13.4	22.4
22/11/2012	30.0	5.4	35.4	27/05/2012	8.3	12.1	20.4
4/10/2012	28.3	1.1	29.4	1/08/2012	10.1	12.1	22.2

Table C-5: Receiver R4 – PM_{10} 24-hr average concentration (µg/m³)

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
26/11/2012	34.3	2.7	37.0	26/06/2012	9.7	18.7	28.4
29/08/2012	33.3	2.5	35.8	3/06/2012	6.0	18.3	24.3
26/10/2012	32.8	6.4	39.2	27/06/2012	7.4	16.8	24.2
5/01/2012	32.0	2.6	34.6	19/07/2012	11.0	13.8	24.8
7/04/2012	31.1	5.2	36.3	8/02/2012	12.8	13.4	26.2
19/05/2012	30.5	4.3	34.8	7/06/2012	6.1	13.2	19.3
11/09/2012	30.5	3.9	34.4	13/06/2012	8.1	13.1	21.2
6/11/2012	30.3	0.7	31.0	3/05/2012	7.2	12.5	19.7
22/11/2012	30.0	0.7	30.7	2/03/2012	7.6	12.2	19.8
4/10/2012	28.3	0.8	29.1	6/07/2012	8.2	12.1	20.3

Table C-6: Receiver R6 – PM_{10} 24-hr average concentration (µg/m³)

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
26/11/2012	34.3	1.0	35.3	19/06/2012	12.4	16.9	29.3
29/08/2012	33.3	4.0	37.3	17/06/2012	7.6	16.5	24.1
26/10/2012	32.8	2.1	34.9	8/09/2012	9.2	14.5	23.7
5/01/2012	32.0	1.7	33.7	2/07/2012	7.0	14.3	21.3
7/04/2012	31.1	2.6	33.7	6/05/2012	9.2	14.2	23.4
19/05/2012	30.5	5.9	36.4	28/07/2012	10.4	13.6	24.0
11/09/2012	30.5	1.2	31.7	24/06/2012	11.4	11.7	23.1
6/11/2012	30.3	0.2	30.5	30/06/2012	10.1	11.3	21.4
22/11/2012	30.0	0.0	30.0	3/06/2012	6.0	11.2	17.2
4/10/2012	28.3	1.4	29.7	9/03/2012	7.3	11.2	18.5