Proposed Warehouse/Distribution and Industrial Facility

Lot 2 Horsley Drive Business Park (SSD7564)

Air Quality Impact Assessment

Report Number 610.16281-R02-v1.0

4 May 2016

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Version: Revision 0

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
610.16281-R02-v1.0	Revision 0	4 May 2016	A Radford	K Lawrence	K Lawrence
610.16281-R02-v0.1	Draft	3 May 2016	A Radford	K Lawrence	DRAFT

Table of Contents

1 INTRODUCTION 6
1.1 Secretary's Environmental Assessment Requirements 6
1.2 Outline of Assessment 6

2 PROJECT OVERVIEW 8
2.1 Proposed Project 8
2.1.1 Traffic Generation 10
2.2 Identification of Potential Emissions to Atmosphere 10
2.2.1 Construction Phase 10
2.2.2 Operational Phase 10

3 STUDY AREA 11
3.1 Local Topography 11
3.2 Sensitive Receptors 11

4 ASSESSMENT CRITERIA 14
4.1 Particulate Matter 14
4.1.1 Particulates (as TSP, PM_{10} and $PM_{2.5}$) 14
4.1.2 Particulates (as Deposited Dust) 15
4.2 Combustion-Related Pollutants 16
4.3 Summary of Project Air Quality Goals 17

5 EXISTING AIR QUALITY 19

6 EMISSIONS ESTIMATION 22
6.1 Pollutants of Interest 22
6.2 Scenarios 22
6.3 Construction Phase 23
6.4 Operational Phase 23

7 AIR DISPERSION MODELLING METHODOLOGY 26
7.1 Model Selection 26
7.2 Meteorological Modelling 26
7.2.1 Selection of Representative Meteorological Data 26
7.2.2 TAPM 31
7.2.3 CALMET 31
7.2.4 Meteorological Data Used in Modelling 32
7.3 Background Air Quality Data Used for Cumulative Impact Assessment 39
7.3.1 NO_X to NO_2 Conversion 40

8 POTENTIAL AIR QUALITY IMPACTS OF THE PROPOSAL 41
8.1 Construction Phase 41

Table of Contents

8.1.1 Construction Air Quality Risk Assessment Methodology 41
8.1.2 Step 1 – Screening Based on Separation Distance 42
8.1.3 Step 2a – Assessment of Scale and Nature of the Works 42
8.1.4 Step 2b – Risk Assessment 42
8.1.5 Step 3 - Mitigation Measures 43
8.1.6 Step 4 - Residual Impacts 45
8.2 Operational Phase 45
8.2.1 Particulate Matter (TSP, PM_{10} and $PM_{2.5}$) 45
8.2.2 Nitrogen Dioxide (NO_2) 50
8.2.3 Mitigation Measures and Ongoing Air Quality Monitoring 54
9 GREENHOUSE GAS ASSESSMENT 55
9.1 Emission Types 55
9.2 Emission Scopes 55
9.3 Assessment Methodology 56
9.4 Operational Emissions Quantitative Assessment 56
9.5 GHG Mitigation and Management Measures 57
9.5.1 Refrigerant Usage 58
9.5.2 Electricity Usage 58
9.5.3 Vehicles and Equipment 58
10 CONCLUSION 59
11 REFERENCES 60

TABLES

Table 1 Secretary’s Environmental Assessment Requirements (SSD 7564) 6
Table 2 Lot 2 Development Schedule 9
Table 3 RMS Traffic Generation Rates 10
Table 4 List of Identified Sensitive Receptors 13
Table 5 EPA Goals for Particulates 15
Table 6 EPA Goals for Allowable Dust Deposition 15
Table 7 The Environmental and Operability Standard in Australia – Diesel Fuel Quality Standard 16
Table 8 EPA Goals for Combustion-Related Pollutants 17
Table 9 Project Air Quality Goals 18
Table 10 Details of AQMS surrounding the Project Site 19
Table 11 Summary of Air Quality Monitoring Data (2013) 20
Table 12 Highest Ten PM_{10} and $PM_{2.5}$ Concentrations 20
Table 13 Adopted Background Pollutant Concentrations 21
Table 14 Emission Factors 23
Table 15 Activity Data Used for Emissions Estimation 24
Table 16 Detailed Emissions Estimation – Scenario 1 24
Table 17 Detailed Emissions Estimation – Scenario 2 25
Table 18 Meteorological Parameters used for this Study (TAPM v 4.0.4) 31

Table of Contents

Table 19 CALMET Configuration Used for this Study 32
Table 20 Meteorological Conditions Defining Pasquill Stability Classes (Source: Pasquill, 1961) 34
Table 21 Categorisation of dust emission magnitude 42
Table 22 Risk of Air Quality Impacts from Construction Activities - Earthworks 43
Table 23 Residual Risk of Air Quality Impacts from Construction 45
Table 24 Predicted Annual Average Dust Deposition Levels and TSP Concentrations at Sensitive Receptors 46
Table 25 Predicted Annual Average PM_{10} and $PM_{2.5}$ Concentrations at Sensitive Receptors 46
Table 26 Predicted Maximum 24-Hour Average PM_{10} Concentrations at Sensitive Receptors 47
Table 27 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations at Sensitive Receptors 47
Table 28 Predicted Annual Average NO_2 Concentrations at Sensitive Receptors 51
Table 29 Predicted Maximum 1-Hour Average NO_2 Concentrations at Sensitive Receptors 52
Table 30 1-Hour NO_2 Cumulative Impact Analysis – Highest Background at Receptor 1 53
Table 31 1-Hour NO_2 Cumulative Impact Analysis – Highest Increment at Receptor 1 53
Table 32 Greenhouse Gas Emission Types 55
Table 33 Greenhouse Gas Scopes 55
Table 34 Scope 1 and 2 Emission Sources for Operation of Project 56
Table 35 Electricity Consumption Source Data 56
Table 36 Emissions Factors 57
Table 37 Annual GHG Emissions 57
Table 38 Key Initiatives for 6 star Green Star Proposed Project 57

FIGURES

Figure 1 Regional Location of the Project Site 8
Figure 2 Site Plan 9
Figure 3 3-Dimensional Representation of Surrounding Topography 11
Figure 4 Surrounding Sensitive Receptors 12
Figure 5 Wind Speed at 9 am at Horsley Park AWS for 2009 – 2013 28
Figure 6 Wind Speed at 3 pm at Horsley Park AWS for 2009 – 2013 28
Figure 7 Temperature at 9 am at Horsley Park AWS for 2009-2013 29
Figure 8 Temperature at 3 pm at Horsley Park AWS for 2009-2013 29
Figure 9 Relative Humidity at 9 am Horsley Park AWS for 2009 – 2013 30
Figure 10 Relative Humidity at 3 pm Horsley Park AWS for 2009 – 2013 30
Figure 11 Predicted Seasonal Wind Roses for the Project Site (CALMET predictions, 2013) 33
Figure 12 Predicted Stability Class Frequencies at the Project Site (CALMET predictions, 2013) 35
Figure 13 Predicted Mixing Heights at the Project Site (CALMET predictions, 2013) 36
Figure 14 Predicted Temperatures at the Project site (CALMET predictions, 2013) 37
Figure 15 Location of the St Marys Monitoring Station 38
Figure 16 Comparison of Wind Roses at St Marys Monitoring Station – Observed Vs CALMET 38
Figure 17 Observed Meteorological Data Monitored at Badgerys Creek and Horsley Park (2013) 39
Figure 18 Predicted Maximum Incremental 24-Hour Average PM_{10} Concentrations 49
Figure 19 Predicted Maximum Incremental 24-Hour Average $PM_{2.5}$ Concentrations 50
Figure 20 Predicted Maximum Incremental 1-Hour Average NO_2 Concentrations 54

APPENDIX

Appendix A Analysis of TSP and PM_{10} data
Appendix B Risk Assessment Methodology

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Frasers Property Industrial Constructions Pty Ltd (Frasers) to perform an Air Quality Impact Assessment (AQIA) for the proposed construction and operation of a warehouse/distribution and industrial facility located at Lot 2 on the corner of Horsley Drive and Cowpasture Road, Wetherill Park, NSW (the Project site). This assessment forms a part of the Environmental Impact Statement (EIS) for the Project.

The Environmental Planning and Assessment Act 1979 (EP&A Act) forms the statutory framework for planning approval and environmental assessment in NSW. The development qualifies as State Significant Development (SSD) under *State Environmental Planning Policy (State and Regional Development) 2011* due to its location with land covered by *State Environmental Planning Policy (Western Sydney Parklands) 2009* and capital investment value.

1.1 Secretary's Environmental Assessment Requirements

NSW Department of Planning and Environment (DPE) issued Secretary's Environmental Assessment Requirements (SEARs) for the Project in April 2016. **Table 1** below identifies the SEARs relevant to this Air Quality Assessment report and the relevant sections of the report in which they have been addressed.

Table 1 Secretary's Environmental Assessment Requirements (SSD 7564)

Key Issue	Assessment Requirement	Addressed in Section
Air Quality and Odour	An assessment of the air quality impacts at private properties during the construction and operation of the development, in accordance with relevant Environmental Protection Authority guidelines.	**Section 8.1** **Section 8.2**
	Details of mitigation, management and monitoring measures for preventing and minimising emissions.	**Section 8.1.5 &** **Section 8.2.3**
Greenhouse Gas and Energy Efficiency	An assessment of the energy use on site, and demonstrate what measures would be implemented to ensure the proposal is energy efficient.	**Section 9**

Issued: April 2016; Department of Planning & Environment, NSW Government, File Reference: SSD 7564.

The SEARs require that the assessment be performed in accordance with relevant policies, guidelines and plans including:

- *Protection of Environment Operations (Clean Air) Regulation* (2010);
- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005); and,
- *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (2006).

This assessment addresses the key issues raised within the SEARs and is performed in accordance with the relevant policies and guidelines.

1.2 Outline of Assessment

The NSW Office of Environment and Heritage (OEH) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (DEC 2005) (hereafter the Approved Methods) outline the requirements for conducting an AQIA, as follows (with identification of where each requirement has been met):

- Description of local topographic features and sensitive receptor locations (**Section 3.1** & **Section 3.2** respectively).
- Establishment of air quality assessment criteria (**Section 4**).

- Analysis of climate and dispersion meteorology for the region (**Section 6.2**).
- Description of existing air quality environment (**Section 5**).
- Compilation of a comprehensive emissions inventory for proposed operations (**Section 5**).
- Completion of atmospheric dispersion modelling and analysis of results (**Section 7** and **Section 8**).
- Preparation of an air quality impact assessment report comprising the above.

2 PROJECT OVERVIEW

2.1 Proposed Project

Frasers proposes to operate a warehousing / distribution and industrial facility at Lot 2 on the corner of Horsley Drive and Cowpasture Road, Wetherill Park. The Project will occupy approximately 3.45 hectares of land within easy access to Sydney's primary motorways (the M7, M4 and M5) and is located within Fairfield City Council Local Government Area (LGA).

The regional setting and location of the Project site is shown in **Figure 1** and the site plan is provided in **Figure 2**. The development schedule for Lot 2 is presented below in **Table 2**.

Figure 1 Regional Location of the Project Site

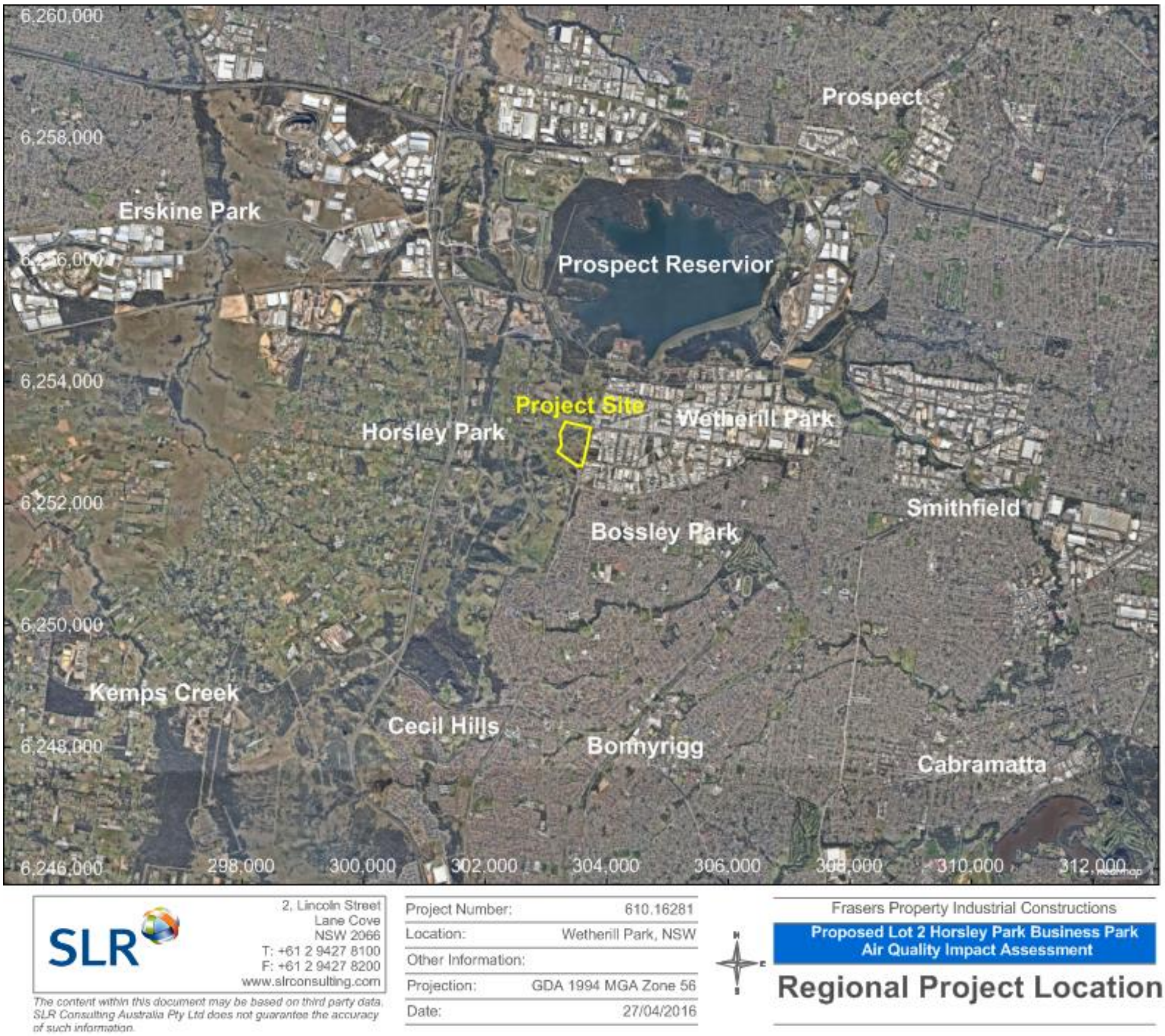
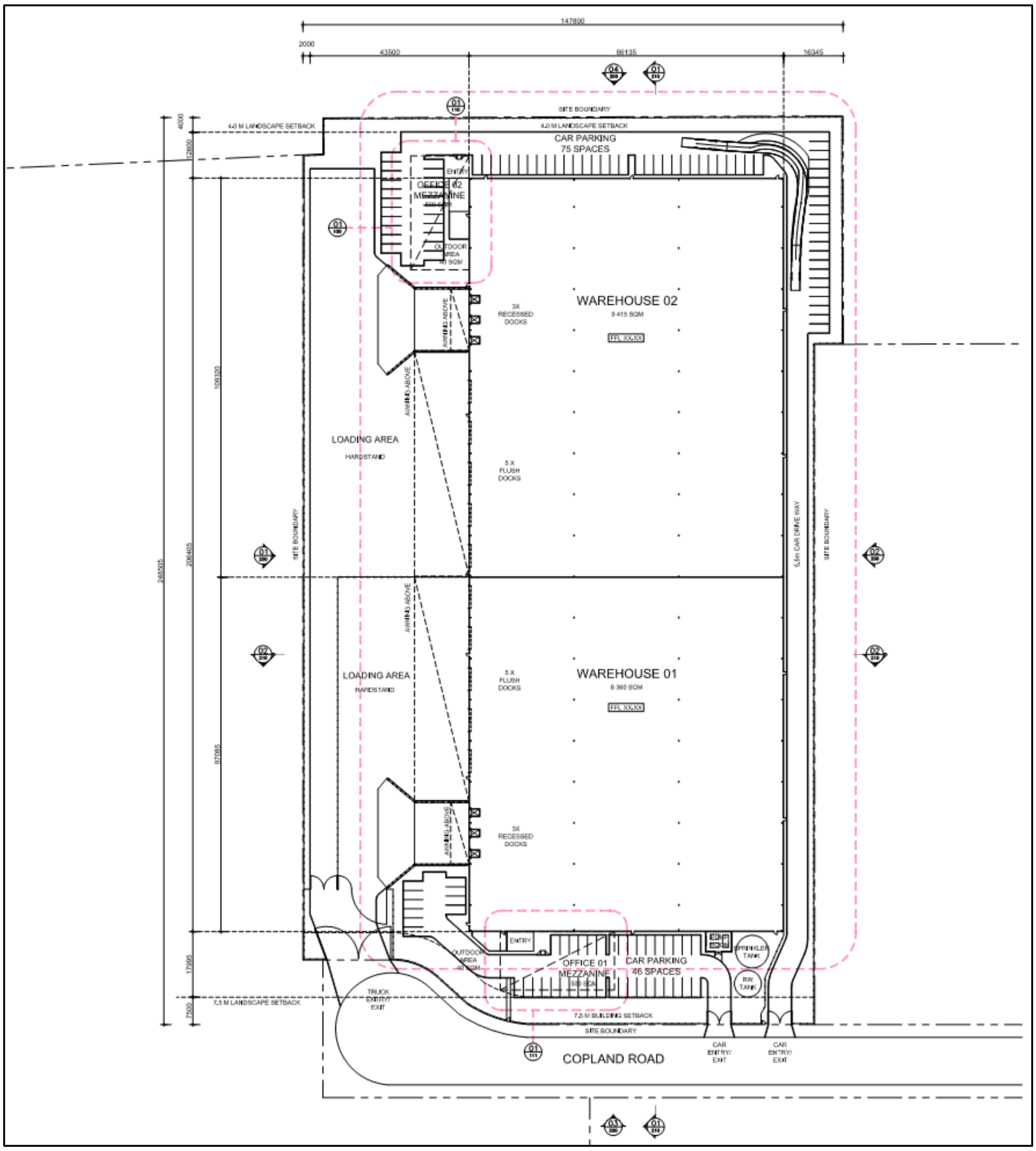


Table 2 Lot 2 Development Schedule

Site Description	Number	Unit
Site Area	**34,538**	**sqm**
Warehouses	17,670	sqm
Offices	1,100	sqm
Total Building Area	**18,770**	**sqm**
Awning	2,030	sqm
Site coverage	54.6	%
Car parking	117	spaces

Figure 2 Site Plan



2.1.1 Traffic Generation

The trip generation rate adopted for this assessment follows the Roads and Maritime Services (RMS) guide, as shown in **Table 3**.

Based on the RMS guide, the Project will generate 817 vehicle trips daily, with 220 vehicle trips, including heavy vehicles trips, occurring during the morning and evening commuter peak periods combined. Generally, the morning peak hour generation can be split in the ratio 85/15 between inbound and outbound trips respectively, while the evening peak hour trips can be split 15/85:

- 110 vehicle trips during the morning peak = 93 inbound, 17 outbound
- 110 vehicle trips during the evening peak = 17 inbound, 93 outbound.

Table 3 RMS Traffic Generation Rates

Speculative Development Component	Area (m^2)	Daily Generation (vehicle trips per day)	Peak Hour Generation (vehicles trips per hour)
Warehouse 01	8,355	334	42
Office 01	550	55	11
Warehouse 02	9,315	373	46
Office 02	550	55	11
TOTAL	18,770	817	110

Note:

1. No retail operations are envisaged at the site.
2. Daily RMS Trip Rate for warehouses is 4/100m^2 (GFA) and 0.5/100m^2 (GFA) for AM peak hour, respectively.
3. Daily RMS Trip Rate for offices is 10/100m^2 (GFA) and 2.0/100m^2 (GFA) for AM peak hour, respectively.

Based on the known operational characteristics of comparable facilities it have been assumed that heavy vehicle movements will predominantly occur during business and off peak hours with only an average of 10% of Class 3 to Class 10 heavy vehicle truck movements envisaged during the morning and evening peaks (11 vehicles per hour, respectively).

2.2 Identification of Potential Emissions to Atmosphere

2.2.1 Construction Phase

The main emissions to air during the construction phase will be emissions of particulate matter (dust), from construction activities, including material handling activities. Dust from the construction activities will be managed using the best management practices outlined in **Section 8.1.5**.

2.2.2 Operational Phase

During the operational phase, wheel-generated dust from vehicles travelling on sealed roads and road traffic exhaust emissions are considered likely to be the main sources of emissions to air. On this basis, particulate emissions (TSP, PM_{10} and $PM_{2.5}$) resulting from traffic movements on paved roads and emissions resulting from the combustion of fuel (oxides of nitrogen (NO_X)) have been identified as key pollutants and have been assessed in **Section 8.2**.

Emissions of odour are not anticipated to be of concern, given that no food preparation occurs on-site, and stored products are frozen, chilled or sealed. Correspondingly, potential impacts of odour are not considered further in this assessment.

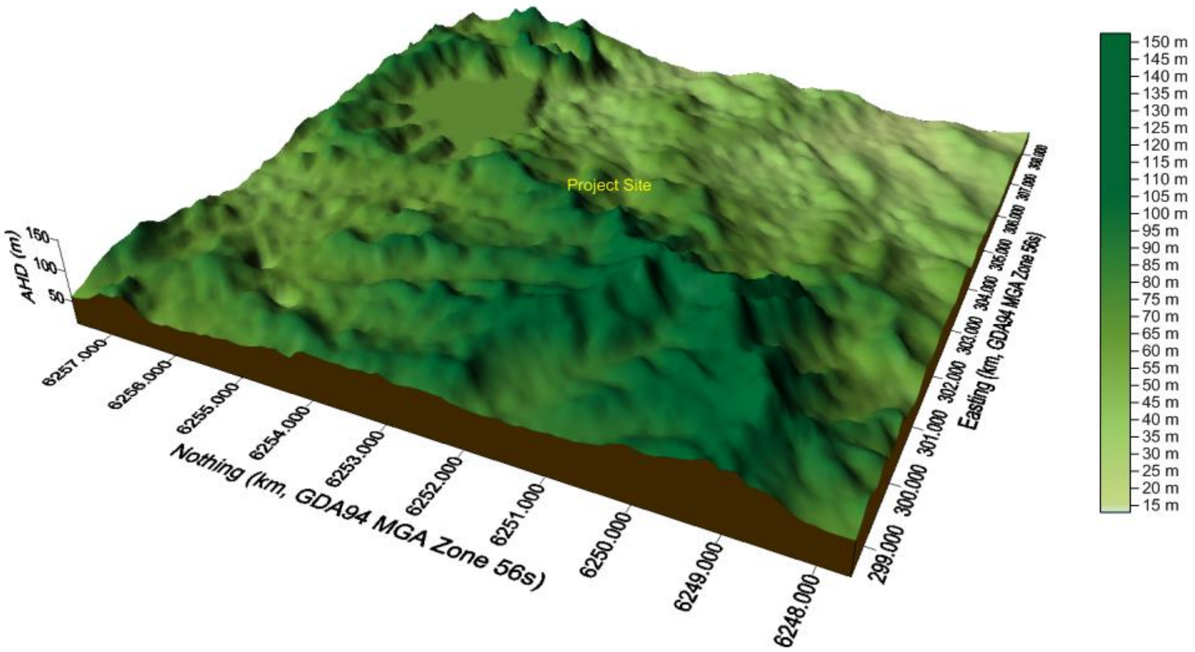
3 STUDY AREA

3.1 Local Topography

The topography in the area surrounding the Project site ranges from 15 m Australian Height Datum (AHD) to approximately 150 m AHD. The Project site is at an elevation of approximately 65 m to 75 m AHD. A representation of the surrounding topography is presented in **Figure 3**.

It is noted that, since construction of the approved facilities at Horsley Drive Business Park, the site has been levelled. This new topography has not been reflected in the meteorological modelling but would not be expected to have a material impact on the conclusions of this assessment.

Figure 3 3-Dimensional Representation of Surrounding Topography



3.2 Sensitive Receptors

The Project site is surrounded by industrial development to the east and northeast, high density residential development in Bossley Park to the south and southeast, single residential dwellings and Western Sydney Parklands to the southwest, low density rural dwellings to the north and east in Wetherill Park and Horsley Park.

The surrounding sensitive receptors identified for this assessment and presented in **Figure 4** and are listed in **Table 3**.

Figure 4 Surrounding Sensitive Receptors

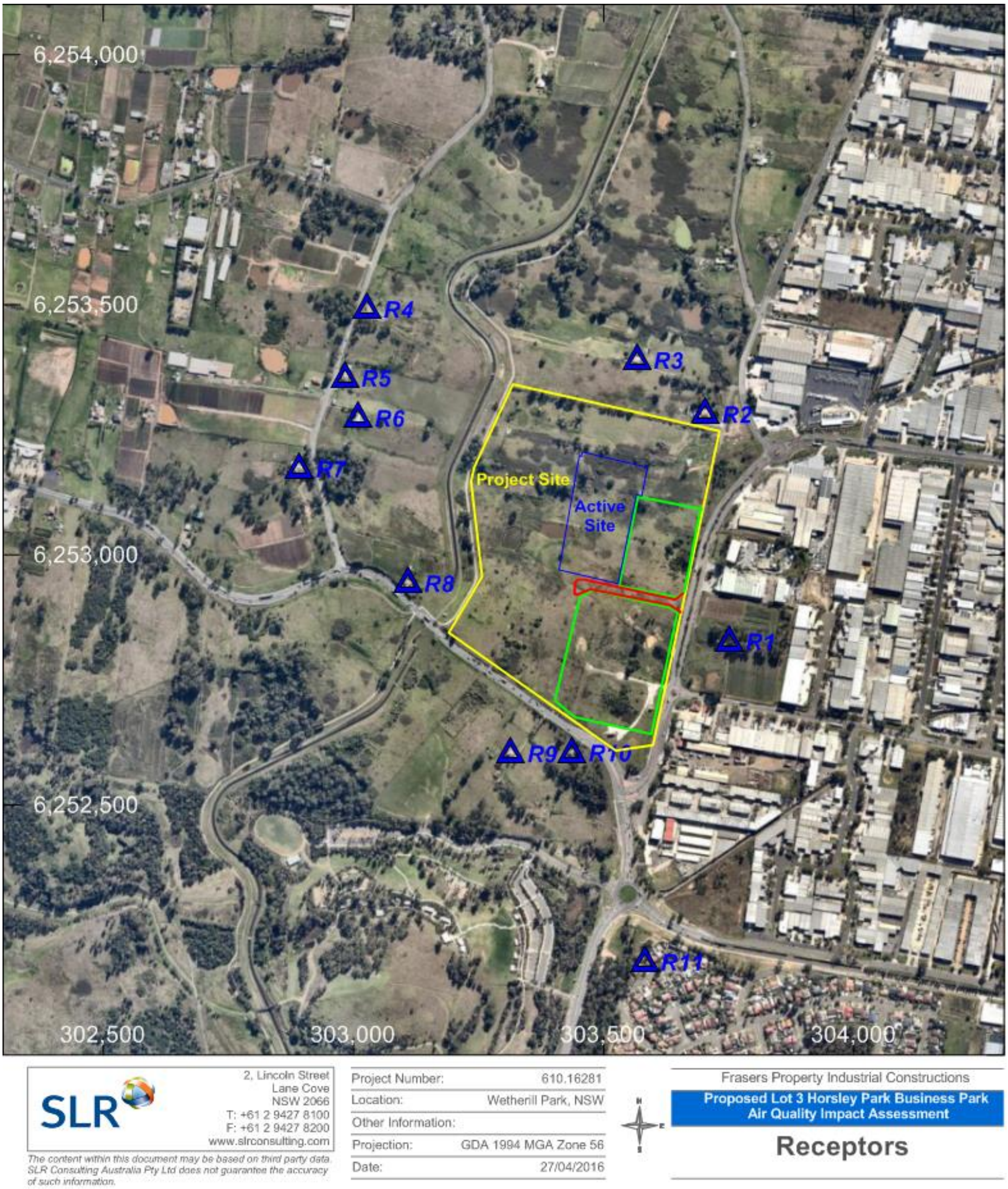


Table 4 List of Identified Sensitive Receptors

Receptor ID	Easting (km)	Northing (km)	Address	Distance to Active Site Boundary (m) and Direction
R1	303,750	6,252,826	189-203 Cowpasture Road, Wetherill Park 2164	280 m E
R2	303,703	6,253,280	144-154 Cowpasture Road, Wetherill Park 2164	160 m N
R3	303,566	6,253,388	132-142 Cowpasture Road, Wetherill Park 2164	215 m N
R4	303,027	6,253,490	70-84 Ferrers Road, Horsley Park 2175	500 m NW
R5	302,982	6,253,352	46-56 Ferrers Road, Horsley Park 2175	500 m WNW
R6	303,009	6,253,272	34-44 Ferrers Road, Horsley Park 2175	450 m W
R7	302,891	6,253,171	31-37 Ferrers Road, Horsley Park 2175	550 m W
R8	303,108	6,252,942	1570 The Horsley Drive, Horsley Park 2175	300 m W
R9	303,314	6,252,601	1538 The Horsley Drive, Abbotsbury 2176	380 m SW
R10	303,436	6,252,603	1532 The Horsley Drive, Abbotsbury 2176	320 m SSW
R11	303,581	6,252,185	9 Derwent Place, Bossley Park 2176	750 m SE

4 ASSESSMENT CRITERIA

State air quality guidelines adopted by the NSW EPA are published in the The Approved Methods which has been consulted during the preparation of this assessment report.

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the Project. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC and WHO). The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW, and are considered to be appropriate for the setting.

4.1 Particulate Matter

4.1.1 Particulates (as TSP, PM_{10} and $PM_{2.5}$)

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulates. In common usage, the terms "dust" and "particulates" are often used interchangeably. The term "particulate matter" specifically refers to a category of airborne particles, typically less than 30 micrometres (µm) in diameter and ranging down to 0.1 µm and is also termed total suspended particulate (TSP). The annual goal for TSP recommended by the NSW EPA is 90 micrograms per cubic metre of air (µg/m^3) (NHMRC, 1996).

The TSP goal was developed before the more recent results of epidemiological studies which suggested a relationship between health impacts and exposure to concentrations of finer particulate matter.

Emissions of particulate matter less than 10 µm and 2.5 µm in diameter (referred to as PM_{10} and $PM_{2.5}$ respectively) are considered important pollutants due to their ability to penetrate into the respiratory system. In the case of the $PM_{2.5}$ category, recent health research has shown that this penetration can occur deep into the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The NSW EPA PM_{10} assessment goals set out in the Approved Methods are as follows:

- a 24-hour maximum of 50 µg/m^3; and
- an annual average of 30 µg/m^3.

The Approved Methods do not set any assessment goals for $PM_{2.5}$. In December 2000, the National Environment Protection Council (NEPC) initiated a review to determine whether a national ambient air quality criterion for $PM_{2.5}$ was required in Australia, and the feasibility of developing such a criterion. The review found that:

- there are health effects associated with these fine particles;
- the health effects observed overseas are supported by Australian studies; and
- fine particle standards have been set in Canada and the USA, and an interim criterion is proposed for New Zealand.

The review concluded that there is sufficient community concern regarding $PM_{2.5}$ to consider it an entity separate from PM_{10}.

As such, in July 2003, a variation to the Ambient Air Quality NEPM was made to extend its coverage to $PM_{2.5}$, setting the following Interim Advisory Reporting Standards for $PM_{2.5}$ (NEPC, 2003):

- a 24-hour average concentration of 25 µg/m^3; and

- an annual average concentration of 8 µg/m³.

It is noted that the NEPM Advisory Reporting Standards relating to $PM_{2.5}$ particles are reporting guidelines only at the present time and not intended to represent air quality criteria.

The National Clean Air Agreement (NCAA) was endorsed by Commonwealth, state and territory Environment Ministers on 15 December 2015. Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles as follows:

For PM_{10}:

- a 24-hour average concentration of 50 µg/m³ (unchanged from the Approved Methods); and
- an annual average of 25 µg/m³ (compared to a value of 30 µg/m³ in the Approved Methods).

For $PM_{2.5}$:

- a 24-hour average concentration of 25 µg/m³; and
- an annual average concentration of 8 µg/m³.

All jurisdictions have agreed to implement strengthened standards for particles, as well as move to even tighter standards for annual average and 24-hour $PM_{2.5}$ in 2025. As these standards have not yet been adopted by NSW EPA, this assessment is based on the current assessment goals set out in the Approved Methods. A summary of the suspended particulate guidelines is shown in **Table 5**.

Table 5 EPA Goals for Particulates

Pollutant	Averaging Time	Goal
TSP	Annual	90 µg/m³
PM_{10}	24 Hours Annual	50 µg/m³ 30 µg/m³
$PM_{2.5}$	24 Hours Annual	25 µg/m³ 8 µg/m³

Source: (NSW DEC, 2005), (NEPC, 2003)

4.1.2 Particulates (as Deposited Dust)

The preceding section is concerned in large part with the health impacts of airborne particulate matter. Nuisance impacts need also to be considered, mainly in relation to deposited dust. In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4 grams per square metre per month (g/m²/month).

Table 6 presents the impact assessment goals set out in the Approved Methods for dust deposition, showing the allowable increase in dust deposition level over the ambient (background) level to avoid dust nuisance.

Table 6 EPA Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m²/month	4 g/m²/month

Source: (NSW DEC, 2005)

4.2 Combustion-Related Pollutants

Emissions associated with road traffic and the combustion of automotive fuel (diesel, petrol, etc.) will include oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOCs), lead (Pb) and particulates (TSP, PM_{10} and $PM_{2.5}$).

Oxides of Nitrogen (NO_X): Oxides of nitrogen (NO_X) is a general term used to describe any mixture of nitrogen oxides formed during combustion. In atmospheric chemistry, NO_X generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide (NO_2). NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to NO_2 which can have significant health effects, including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. NO will be converted to NO_2 after leaving a vehicle exhaust in the presence of sunlight at a rate dependent on background ozone and VOC levels.

Carbon Monoxide (CO): CO is an odourless, colourless gas formed from the incomplete burning of fuels in motor vehicles. It can be a common pollutant at the roadside and highest concentrations are found at the kerbside with concentrations decreasing rapidly with increasing distance from the road. CO in urban areas results almost entirely from vehicle emissions and its spatial distribution follows that of traffic flow. The incomplete combustion of fuel in diesel powered vehicles can generate particulate in the form of black soot.

Sulfur Dioxide (SO_2): Vehicle exhausts can contain emissions of sulfur dioxide (SO_2) due to impurities in the fuel. The emission rate of SO_2 is directly proportional to the sulfur content of the fuel being combusted. It is noted that a portion of the vehicles in operation at the Project site are likely to be industrial vehicles (ie diesel-fuelled vehicles). The sulfur content in diesel fuel in Australia has significantly reduced over the years as shown in **Table 7**.

Table 7 The Environmental and Operability Standard in Australia – Diesel Fuel Quality Standard

Pollutant	National Standard	Date of Effect	Test Method
Sulfur Content of Fuel	10 ppm (max)	1 January 2009	ASTM D5453
	50 ppm (max)	1 January 2006	
	500 ppm (max)	31 December 2002	

Source: http://www.environment.gov.au/topics/environment-protection/fuel-quality/standards/diesel, accessed on 19 June 2015.

Volatile Organic Compounds (VOCs): Volatile organic compounds (VOC) are emitted from the incomplete combustion of fuel. VOC emissions are reducing significantly due to the improved combustion processes offered by modern engines. The Approved Methods prescribe the air quality criterion for individual VOCs such as benzene, 1,3-butadiene etc. Generally for VOCs, the most stringent criteria of the individual VOCs (i.e. benzene) is used to assess the air quality exceedances of traffic-related VOCs.

Lead (Pb): On 15 March 2000, the Australian Government announced a phase-out of leaded petrol in Australia under the National Fuel Quality Standards Act 2000. On 1 January 2002, that phase-out was completed. The sale of leaded petrol in Australia is now prohibited, except in cases specifically authorised by the Minister.

Experience in performing assessments of the impact of combustion-related emissions has shown that the principal ‘indicator’ pollutants from fuel combustion are NO_2 and PM_{10} (and to a lesser extent CO) and the risk of non-compliance with the relevant criteria is typically associated with the short-term criteria rather than annual averages.

The NSW OEH has established ground level air quality impact assessment criteria for air pollutants to achieve appropriate environmental outcomes and to minimise associated risks to human health as published in the Approved Methods. A summary of the relevant impact assessment criteria for the pollutants discussed above is provided in **Table 8**.

Table 8 EPA Goals for Combustion-Related Pollutants

Pollutant	Averaging Period	Concentration		Source
Nitrogen dioxide (NO_2)	1 hour	12 pphm	246 µg/m^3	NEPC (1998)
	Annual	3 pphm	62 µg/m^3	NEPC (1998)
Carbon monoxide (CO)	15 minutes	87 ppm	100 mg/m^3	WHO (2000)
	1 hour	25 ppm	30 mg/m^3	WHO (2000)
	8 hours	9 ppm	10 mg/m^3	NEPC (1998)
Sulfur dioxide (SO_2)	10 minutes	25 pphm	712 µg/m^3	NHMRC (1996)
	1 hour	20 pphm	570 µg/m^3	NEPC (1998)
	24 hours	8 pphm	228 µg/m^3	NEPC (1998)
	Annual	2 pphm	60 µg/m^3	NEPC (1998)
Lead	Annual	-	0.5 µg/m^3	NEPC (1998)
Benzene	1 hour	0.009 ppm	29 µg/m^3	NEPC (1998)
TSP	Annual	-	90 µg/m^3	NEPC (1998)
PM_{10}	24 Hours Annual	-	50 µg/m^3 30 µg/m^3	NEPC (1998) NEPC (1998)
$PM_{2.5}$	24 Hours Annual	-	25 µg/m^3 8 µg/m^3	NEPC (1998) NCAA (2015)

Experience in performing assessments of the impact of road traffic exhaust emissions has shown that the principal ‘indicator’ pollutants from road traffic are NO_2 and PM_{10}, and that the risk of non-compliance with the relevant criteria is typically associated with the short-term criteria rather than the annual averages. To provide a comprehensive assessment, predicted concentrations are compared to all relevant averaging periods for the ‘indicator’ pollutants.

4.3 Summary of Project Air Quality Goals

The air quality goals adopted for this assessment, which confirm to current EPA and Commonwealth air quality criteria, are summarised in **Table 9**. All criteria are referenced as mass concentration.

The impact assessment criteria are required to be applied as follows:

- At the nearest existing or likely future off-site sensitive receptor.
- The incremental impact (predicted impacts due to the pollutant source alone) for each pollutant must be reported in units and averaging periods consistent with the impact assessment criteria.
- Background concentrations must be included using the procedures specified in Section 5 of the Approved Methods.

Table 9 Project Air Quality Goals

Pollutant	Averaging Time	Goal (µg/m^3)	Source
Sulfur dioxide (SO_2)	10 minutes	712	NHMRC (1996)
	1 hour	570	NEPC (1998)
	24 hours	228	NEPC (1998)
	Annual	60	NEPC (1998)
Nitrogen dioxide (NO_2)	1 hour	246	NEPC (1998)
	Annual	62	NEPC (1998)
Lead	Annual	0.5	NEPC (1998)
Benzene	1 hour	29	NEPC (1998)
PM_{10}	24 hours	50	NEPC (1998)
	Annual[1]	30	NCAA (2015)
$PM_{2.5}$	24 hours	25	NEPC (2003)
	Annual	8	NEPC (2003)
TSP	Annual	90	NHMRC (1996)
		Goal (g/m^2/month)	
Deposited dust	Annual	2 (maximum increase) 4 (maximum total deposited dust level)	NERDDC (1988)
		Goal (mg/m^3)	
Carbon monoxide (CO)	15 minutes	100	WHO (2000)
	1 hour	30	WHO (2000)
	8 hours	10	NEPC (1998)

Source: The Approved Methods, NSW DEC 2005, WHO 2005.

Notes:

1. The NCAA goal is lower at 25 µg/m^3.

5 EXISTING AIR QUALITY

The air quality in the region surrounding the Project Site is influenced by emissions generated by a range of sources, originating from both within and outside of the local area. Specifically, for the area surrounding the Project, air quality will be influenced by pollution transported into the area from more distant “regional” sources, emissions from other commercial and industrial sources in the area; non-Project related traffic-generated pollution and pollution generated by the Project itself, once operational.

To determine the *incremental* impact of particulate emissions from the Project on the surrounding environment and sensitive receptors, a dispersion modelling exercise has been performed.

To appropriately assess the *cumulative* impact of the Project, a background dataset for the local area has been constructed.

Air quality monitoring is performed by the NSW OEH at three Air Quality Monitoring Stations (AQMS) within approximately 10 km radius of the Project Site. Details of these stations are provided in **Table 10**. Given the nature of the activities undertaken surrounding these monitoring station (ie proximity to transport corridors, residential sources and industrial sources), St Mary’s is deemed to best represent the local air quality of the Project site, even though it is not necessarily closest.

Table 10 Details of AQMS surrounding the Project Site

AQMS Name	Distance /Direction from Project Site	Location (km, Australian Map Grid, zone 56)		Parameters Measured	AQMS Commissioned
		Easting	Northing		
Prospect Located in William Lawson Park, Myrtle Street	~6.5 km / NE	306.9	6258.7	Ozone (O_3) NO, NO_2, NO_X CO Fine particles (by nephelometry) Fine particles (PM_{10} using a TEOM) Wind speed, wind direction and sigma theta) Ambient temperature Relative humidity Solar radiation	February 2007 -
St Mary’s Located off Mamre Rd	11.5 km / NW	293.2	6258.1	Ozone (O_3) NO, NO_2, NO_X Fine particles (by nephelometry) Fine particles (PM_{10} using a TEOM) Wind speed, wind direction and sigma theta) Ambient temperature Relative humidity	October 1992 -
Liverpool Located off Rose St.	10 km / SW	306.4	6243.3	O_3 NO, NO_2, NO_X CO Fine particles (by nephelometry) Fine particles (PM_{10} and $PM_{2.5}$ using a TEOM) Wind speed, wind direction and sigma theta) Ambient temperature Relative humidity Solar radiation	1990

Note: TEOM – Tapered Element Oscillating Microbalance

The monitoring data for NO_2 indicate that the 1 hour maximum criterion of 246 µg/m^3 is easily achieved at the St Mary's AQMS with the maximum 1 hour NO_2 concentration measured during 2013 being 75.9 µg/m^3, representing 31% of the criterion. The annual average NO_2 concentration in 2013 was measured as 9.5 µg/m^3 which represents approximately 15% of the criterion of 62 µg/m^3. Review of the NEPM compliance report for 2013 also indicates that SO_2 and CO concentrations across all AQMS in NSW were substantially below the relevant criteria.

Table 11 Summary of Air Quality Monitoring Data (2013)

Pollutant	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**O_3**
AQMS	St Mary's	St Mary's	Liverpool	St Mary's
Units	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Averaging Period	1 hour	24 hour	24 hour	1 hour
Criterion	246	50	25	-
Maximum	75.9	93.0	73.8	216
Averaging Period	Annual	Annual	Annual	Annual
Criterion	62	30	8	-
Mean	9.5	15.6	9.4	69

The monitoring data for PM_{10} and $PM_{2.5}$ indicate that exceedances of the relevant short term criteria (for PM_{10} and $PM_{2.5}$) and annual average criterion (for $PM_{2.5}$) were recorded during 2013 at the St Mary's and Liverpool AQMS. Exceedances for both PM_{10} and $PM_{2.5}$ were recorded during October 2013. Review of the NEPM compliance report for 2013 indicates that the exceedances were generally attributable to the NSW bushfire emergency which extended into early November 2013 (**Table 12**).

Table 12 Highest Ten PM_{10} and $PM_{2.5}$ Concentrations

<table>
<tr><th>Statistic</th><th>PM_{10} Conc^n (µg/m^3)</th><th>Date</th><th>Comments from NEPM Compliance Report [1]</th><th>$PM_{2.5}$ Conc^n (µg/m^3)</th><th>Date</th><th>Comments from NEPM Compliance Report</th></tr>
<tr><td>Maximum</td><td>93.0</td><td>21 October</td><td rowspan="5">Bushfire Emergency</td><td>73.8</td><td>21 October</td><td>Bushfire Emergency</td></tr>
<tr><td>2nd Highest</td><td>55.8</td><td>25 October</td><td>27.0</td><td>28 April</td><td>N/A[2]</td></tr>
<tr><td>3rd Highest</td><td>46.8</td><td>20 October</td><td>24.8</td><td>19 October</td><td rowspan="3">Bushfire Emergency</td></tr>
<tr><td>4th Highest</td><td>46.5</td><td>8 November</td><td>24.3</td><td>8 November</td></tr>
<tr><td>5th Highest</td><td>39.8</td><td>22 October</td><td>22.9</td><td>3 November</td></tr>
<tr><td>6th Highest</td><td>39.3</td><td>25 August</td><td>Hazard Reduction Burn</td><td>22.2</td><td>10 June</td><td>N/A[2]</td></tr>
<tr><td>7th Highest</td><td>38.6</td><td>7 November</td><td>N/A[2]</td><td>22.2</td><td>13 July</td><td>N/A[2]</td></tr>
<tr><td>8th Highest</td><td>38.0</td><td>29 October</td><td>Bushfire Emergency</td><td>21.8</td><td>28 July</td><td>N/A[2]</td></tr>
<tr><td>9th Highest</td><td>36.1</td><td>27 October</td><td>Bushfire Emergency</td><td>21.6</td><td>26 July</td><td>N/A[2]</td></tr>
<tr><td>10th Highest</td><td>35.7</td><td>29 April</td><td>N/A[2]</td><td>21.3</td><td>12 July</td><td>N/A[2]</td></tr>
</table>

Note 1: Comments associated with nearby stations (St Mary's is not a NEPM Compliance AQMS)
Note 2: No event can be clearly identified as causing the exceedance / elevated concentration

Concentrations of TSP are not measured at the St Mary's AQMS. As PM_{10} represents a fraction of the broader particulate concentration, relationships between TSP and PM_{10} as measured at four sites in the Newcastle area between 2000 and 2011 (NSW OEH, 2012) and in the Illawarra region between 1996 and 2004 have been examined and are presented in **Appendix A**. This analysis indicates that the annual average TSP concentration is approximately 2.4 times the annual average PM_{10} concentration (ie PM_{10} represents 41% of total TSP). This multiplier has been applied to the annual average PM_{10} concentration measured at St Mary's in 2013 to estimate the annual average TSP concentration at this location.

Although many of the TSP/PM_{10} data have been measured in areas in which the sources of particulate matter may not be identical to those surrounding the Project site, the broad relationship is considered to be appropriate for use within this assessment. It is noted that the conclusions of this assessment as they relate to the annual average TSP concentration are not dependent on highly accurate calculation of the existing background TSP concentration experienced in the area.

As is the case with TSP, there is no dust deposition data available in close proximity to the Project site for use in this study. Therefore, the assumed background level of deposited dust defaults to 2 g/m^2/month, as outlined in the Approved Methods (NSW DEC, 2005).

For this assessment, the predicted NO_2 concentrations are calculated from the NO_X predictions given by the modelling using the Ozone Limiting Method (OLM). This is in agreement with Method 2 for NO_2 assessment prescribed in the Approved Methods. The ozone measurements for the year 2013 recorded at St Marys AQMS are shown in **Table 11**.

An annual maximum 1-hourly average ozone concentration of 216 µg/m^3 from St Mary's AQMS in 2013 was used to calculate the conversion of 1-hour average concentrations of NO_X to NO_2 using the OLM method. An annual average ozone concentration of 69 µg/m^3 from St Mary's AQMS in 2013 was used to calculate the conversion of annual average concentrations of NO_X to NO_2 using the OLM method. Using a conservative and fixed ozone concentration allowed for contour plots of the predicted NO_2 concentrations to be produced.

Table 13 provides a summary of the assumed background concentrations used in this report to evaluate the cumulative impacts of the proposed Project.

Table 13 Adopted Background Pollutant Concentrations

Pollutant	Averaging Period	Maximum Concentration	Source
NO_2	1 hour	75.9 µg/m^3	St Mary's AQMS
	Annual	9.5 µg/m^3	
TSP	Annual	37.7 µg/m^3	Estimated based on a PM_{10}:TSP ratio of 0.41
PM_{10}	24 hours	38.6 µg/m^3	St Mary's AQMS –highest measured concentration not due to bushfire
	Annual	15.6 µg/m^3	St Mary's AQMS
$PM_{2.5}$	24 hours	22.2 µg/m^3	Liverpool AQMS – Highest concentration which is not an exceedance nor due to bushfire
	Annual	9.4 µg/m^3	Liverpool AQMS
Dust Deposition	Annual	2 g/m^2/month	(NSW OEH, 2005)

6 EMISSIONS ESTIMATION

6.1 Pollutants of Interest

As previously discussed, the most significant air quality emissions from the operation of the Project will be associated with road traffic exhaust emissions which will be generated from the incoming and outgoing trucks. The potential pollutants that will be emitted as a result of the Project include products of fuel combustion from the vehicles (as discussed in **Section 2**), including:

- particles (as PM_{10});
- particles (as $PM_{2.5}$);
- carbon monoxide (CO)
- oxides of nitrogen (NO_X);
- sulphur oxides (SO_x);
- volatile organic compounds (VOCs);
- dioxins and furans (PCDD/DF); and
- polyaromatic hydrocarbons (PAHs).

Given the small scale of the operations, the small emission rates of VOCs, dioxins and furans, and PAHs, and the relative distances between the Project and nearby sensitive receptors, the proposed operation would not be expected to result in a significant increase in ambient concentrations of these pollutants at surrounding sensitive receptors and therefore have not been quantitatively assessed in this study (NPI, 2008) (National Dioxins Program, 2004).

In terms of this assessment, the focus has been upon a select number of key pollutants that are recognised as the key indicators of road traffic exhaust emissions; namely particulates (as TSP, PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2).

6.2 Scenarios

Two scenarios have been constructed for the purposes of this AQIA:

Scenario 1 This scenario was derived as an appropriate approximation of likely site operations. This scenario is suitable to assess longer-term impacts, such as the annual average and 24-hour average approval criteria. The scenario is described by average daily truck movements, which include 812 one-way vehicles trips per day. The number of truck trips per hour has been calculated as 10% of the vehicle trips during peak hour (11 trucks/hour) and 40% of the vehicles trips during all other hours (11 trucks/hour). There are a total of 16 receival bays for both warehouse 1 and 2. While it is proposed that trucks will turn off their engines once docked in bays, this assessment has conservatively included emissions from idling trucks. This scenario assumes that an average number of bays are occupied by idling trucks per hour (ie total trucks per day divided by 24 hours of proposed operation, gives 6 occupied docking bays in any one hour).

Scenario 2 This scenario was derived as an appropriate approximation of worst case hourly site operations. This scenario is suitable to assess 1-hour and sub-hourly average approval criteria, which apply only to NO_2. The scenario is described by the peak hour truck movements occurring for every hour of the day. This scenario assumes that all bays are occupied by idling trucks (ie all 16 bays are occupied). It is noted that this is unlikely however it represents a ‘worst case’ condition that needs to be demonstrated to comply with the 1-hour NO_2 air quality criterion.

Potential emissions from the operations were estimated based on the emission factors presented in the following documents:

- *Emission Estimation Technique Manual for Combustion Engines* (hereafter, "NPI Manual"), Version 3.0 (NPI, 2008) and;
- *Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transport Conformity* (US EPA, 2004).

Details of the emission factors and emission estimation techniques used to estimate the potential emissions to air are provided below.

6.3 Construction Phase

Emissions from construction phase activities (principally dust) have been assessed using a qualitative assessment methodology, which targets the key sources of construction emissions for mitigation and control. The methodology for this is outlined in **Appendix B**. As such, the quantification of emissions from the construction phase activities is not required.

6.4 Operational Phase

As stated in **Section 2.2.2**, wheel-generated dust from the on-site traffic movements and combustion emissions from road traffic exhaust emissions on-site have been identified as the main sources of potential emissions for the proposed operational phase.

Potential particulate emissions from the on-site traffic movements were estimated using emission factor equations sourced from the United States Environmental Protection Agency (US EPA) AP-42 Emission Factor Handbook (US EPA 2011). Potential NO_x and particulate emissions from idling trucks were sourced from US EPA documents on "*Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity*" (US EPA 2004).

The emission factors used in estimating potential emissions from the proposed operations are summarised in **Table 14** and the activity data assumed in the calculations are summarised in **Table 15**. The estimated total emission rates for the proposed operations are presented in **Table 16**.

Table 14 Emission Factors

Activity	Emission Factor Equation	Units	Source	Variables
Wheel generated dust	$EF_{TSP} = 3.23 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$ $EF_{PM10} = 0.62 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$ $EF_{PM2.5} = 0.15 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$	g/VKT	US EPA (2011)	sL = road surface silt loading (0.06 g/m²) W = average weight of vehicles: - 4.5 t for passenger vehicles , - 62.5 t for B Doubles
Idling combustion	$EF_{NOx} = 135$ $EF_{PM10} = 3.68$	g/hr	US EPA (2004)	

Table 15 Activity Data Used for Emissions Estimation

Parameter	Value	Unit	Reference
Silt loading	0.06	g/m^2	USEPA 2011
Total distance	1.06	km	Based on estimated maximum distance travelled by vehicle in one trip
AM/PM peak hour number of vehicles	110	vph	*per comms* Glen Varley via Paul Solomon, 14 April 2016
Total number of vehicles (conservatively assumed in model)	817	vpd	*per comms* Glen Varley via Paul Solomon, 14 April 2016
Total VKT	866	VKT/ day	Assumed peak traffic for every hour of the day and maximum distance travelled
Proportion of heavy vehicles in peak hours	10	%	*per comms* Glen Varley via Paul Solomon, 14 April 2016
Proportion of heavy vehicles outside peak hours	40	%	calculated
Number of loading bays	16	-	Draft Architecturals.pdf, provided *per comms* Paul Solomon, 28 April 2016

Table 16 Detailed Emissions Estimation – Scenario 1

Wheel Generated Emissions	Passenger Vehicles	B Doubles
Vehicle Weight (t)	4.5	62.5
Wheel generated dust EFs - TSP (g/VKT)	1.3	18.7
Wheel generated dust EFs - PM_{10} (g/VKT)	0.2	3.6
Wheel generated dust EFs - $PM_{2.5}$ (g/VKT)	0.1	0.9
Ratio of vehicles	60%	40%
Wheel Generated Emissions - TSP (kg/h)	0.028	0.269
Wheel Generated Emissions - PM_{10} (kg/h)	0.005	0.052
Wheel Generated Emissions - $PM_{2.5}$ (kg/h)	0.001	0.012
Combustion Emissions	**Passenger Vehicles**	**B Doubles**
Combustion (Onsite Idling EFs) - NO_X (g/h)	135.0	135.0
Combustion (Onsite Idling EFs) - PM_{10} (g/h)	3.7	3.7
Combustion (Onsite Idling EFs) - $PM_{2.5}$ (g/h)	1.2	1.2
Number of vehicles idling[1]	-	6
Combustion Emissions - NO_X (kg/h)	-	0.81
Combustion Emissions - PM_{10} (kg/h)	-	0.02
Combustion Emissions - $PM_{2.5}$ (kg/h)	-	0.007
TOTAL EMISSIONS	**All Vehicles[2]**	
TSP (kg/h/source)	0.013	
PM_{10} (kg/h/source)	0.003	
$PM_{2.5}$ (kg/h/source)	0.0008	
NO_X (kg/h/source)	0.032	

Note:

1. It has been assumed that 40% of the docking bays available will be full of B-Doubles idling each hour.
2. Emission rates have been applied as continuous emission rates for every hour of the year in the model.

Table 17 Detailed Emissions Estimation – Scenario 2

Wheel Generated Emissions	**Passenger Vehicles**	**B Doubles**
Vehicle Weight (t)	4.5	62.5
Ratio of vehicles	90%	10%
Combustion Emissions	**Passenger Vehicles**	**B Doubles**
Combustion (Onsite Idling EFs) - NO_X (g/h)	135.0	135.0
Number of vehicles idling[1]	-	16
Combustion Emissions - NO_X (kg/h)	-	2.16
TOTAL EMISSIONS	**All Vehicles[2]**	
NO_X (kg/h/source)	0.086	

Note:

1. It is assumed that each of the docking bays will be full of B-Doubles idling each hour.
2. Emission rates have been applied as continuous emission rates for every hour of the year in the model.

7 AIR DISPERSION MODELLING METHODOLOGY

7.1 Model Selection

Emissions from the Project operations have been modelled using the US EPA's CALPUFF (Version 6.267) modelling system. CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

7.2 Meteorological Modelling

Meteorological mechanisms govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction, and the variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading.

Pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Oke, 1988).

To adequately characterise the dispersion meteorology of the study site, information is needed on the prevailing wind regime, mixing depth and atmospheric stability and other parameters such as ambient temperature, rainfall and relative humidity.

Meteorological data collected over the period 2009-2013 at the nearest BOM station (Horsley Park [station number 67119]) were analysed to select a representative year for dispersion modelling.

7.2.1 Selection of Representative Meteorological Data

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

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

Dispersion is the combined effect of these processes.

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

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

Data collected from 2009 to 2013 is summarised in **Figure 5** to **Figure 10**. Examination of the data indicates the following:

- **2009**
  - **Figure 5** and **Figure 6** indicate that 2009 exhibits wind speeds in autumn and spring that are above the long term average and the four other years of data.
  - **Figure 7** and **Figure 8** show that temperature is higher than the long term average in November and December.
- **2010**
  - **Figure 7** and **Figure 8** show that temperature is higher than the long term average in late summer.
  - **Figure 9** indicates that the 2010 9 am relative humidity is slightly lower than the long term average in the late summer months.
- **2011**
  - **Figure 5** and **Figure 6** indicate that 2011 exhibits wind speeds that are below the long term average.
  - **Figure 9** and **Figure 10** indicate that relative humidity at 3 pm in 2011 is higher than the long term average.
- **2012**
  - **Figure 5** and **Figure 6** indicate that 2012 exhibits wind speeds that are below the long term average.
  - **Figure 9** indicates that the 2012 9 am relative humidity is slightly higher than the long term average in a few months.
- **2013**
  - **Figure 5** and **Figure 6** indicate that 2013 exhibits wind speeds that are below the long term average.
  - **Figure 8** shows that 3 pm temperature is higher than the long term average in spring in 2013.

Figure 5 Wind Speed at 9 am at Horsley Park AWS for 2009 – 2013

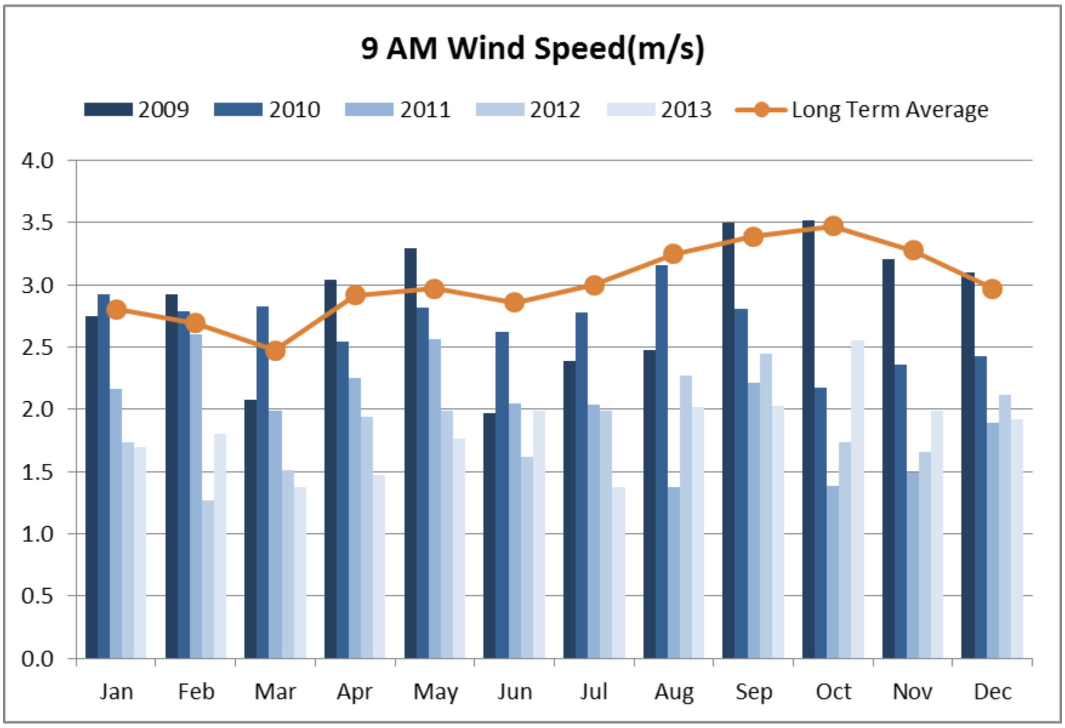


Figure 6 Wind Speed at 3 pm at Horsley Park AWS for 2009 – 2013

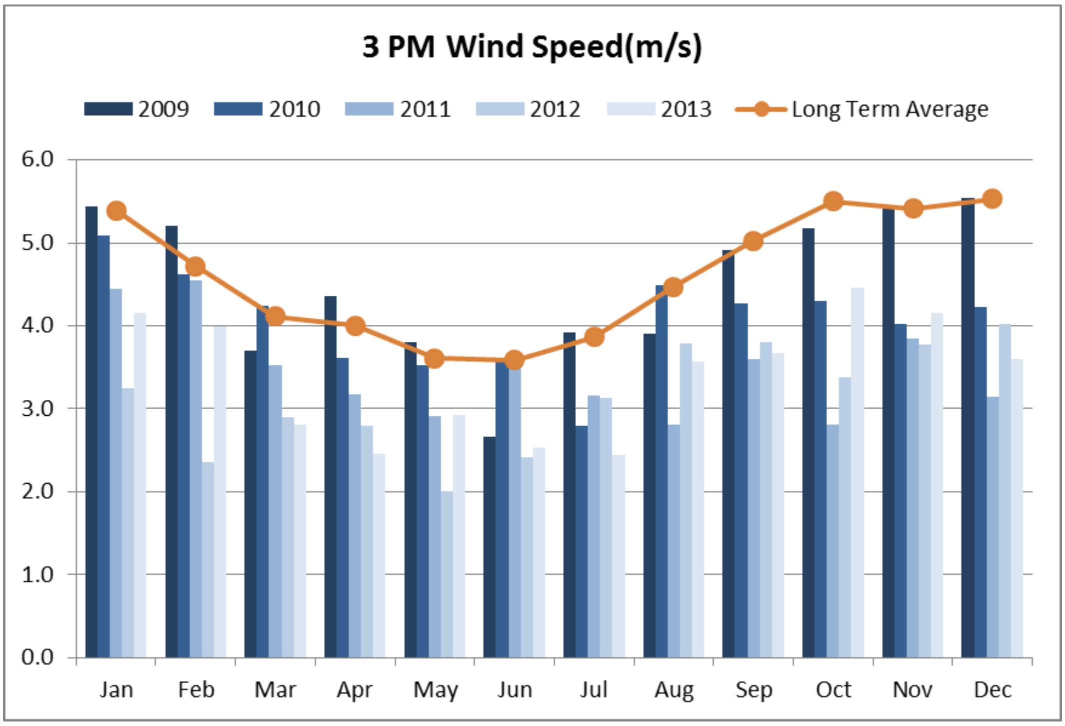


Figure 7 Temperature at 9 am at Horsley Park AWS for 2009-2013

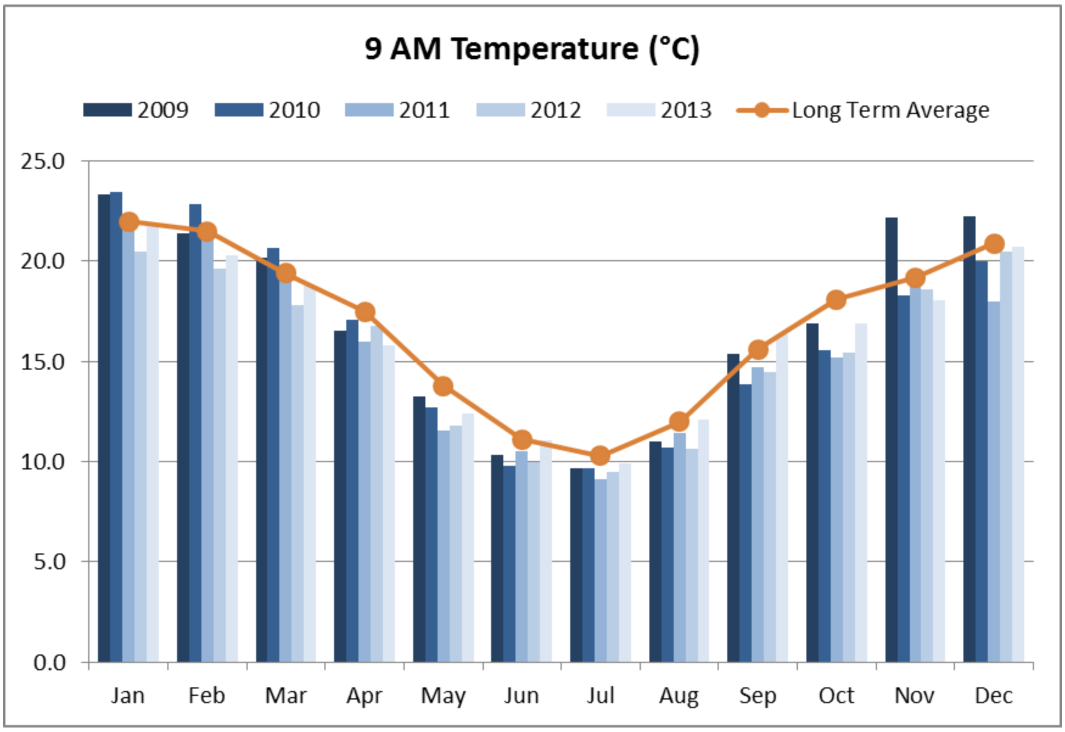


Figure 8 Temperature at 3 pm at Horsley Park AWS for 2009-2013

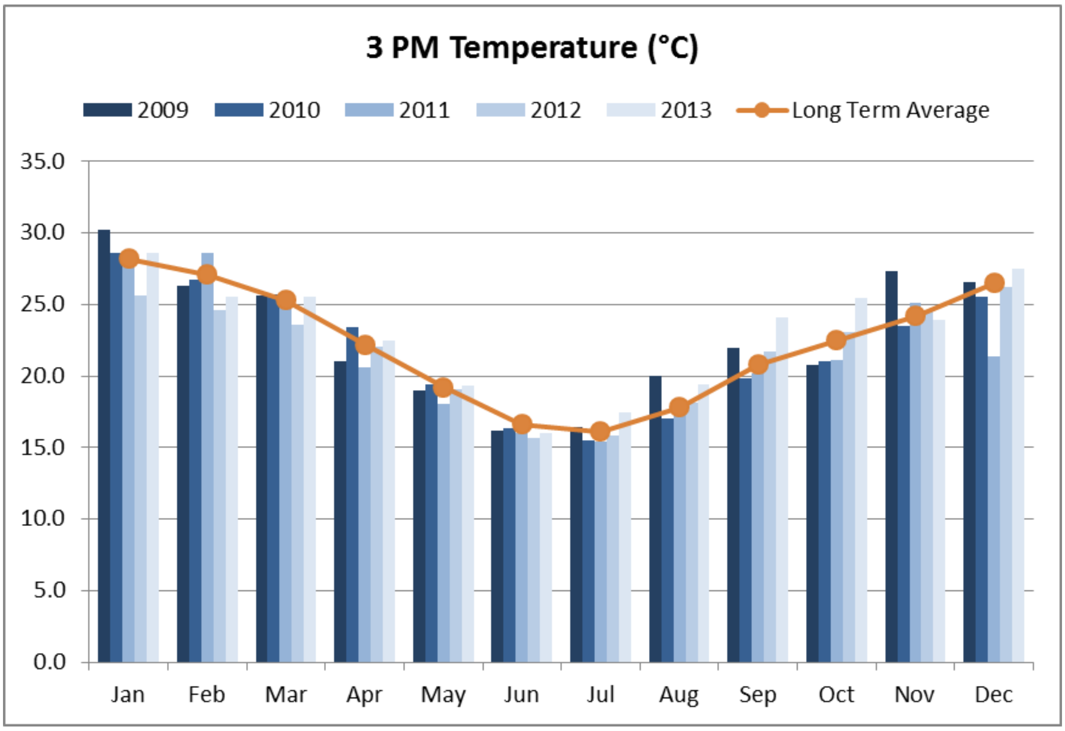


Figure 9 Relative Humidity at 9 am Horsley Park AWS for 2009 – 2013

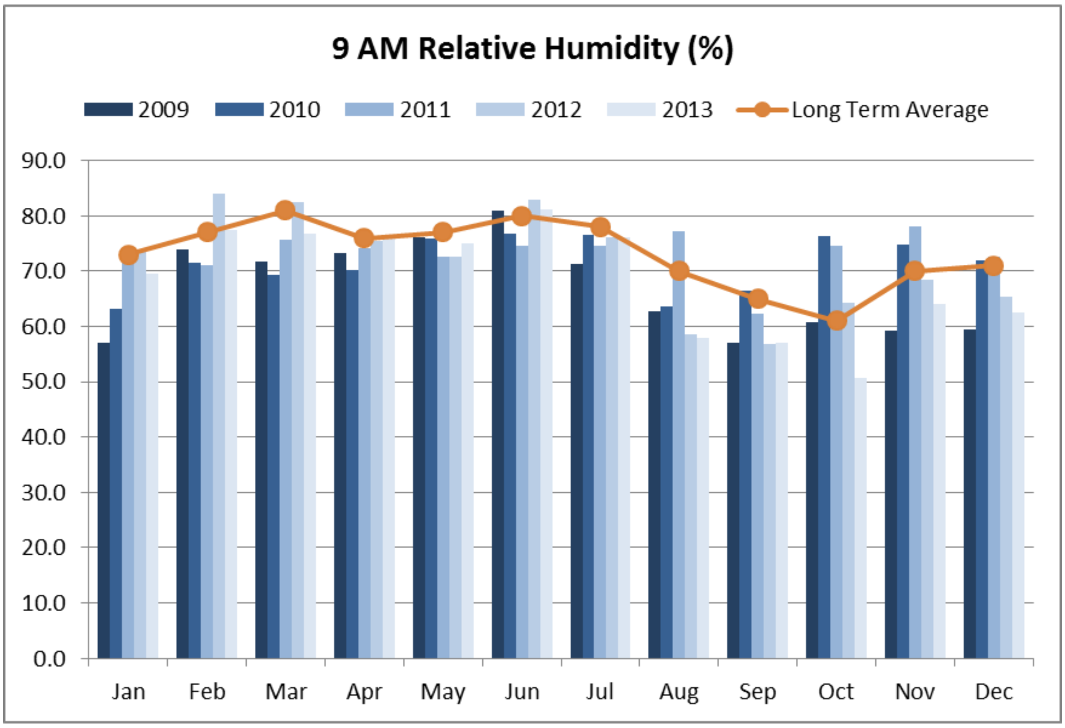
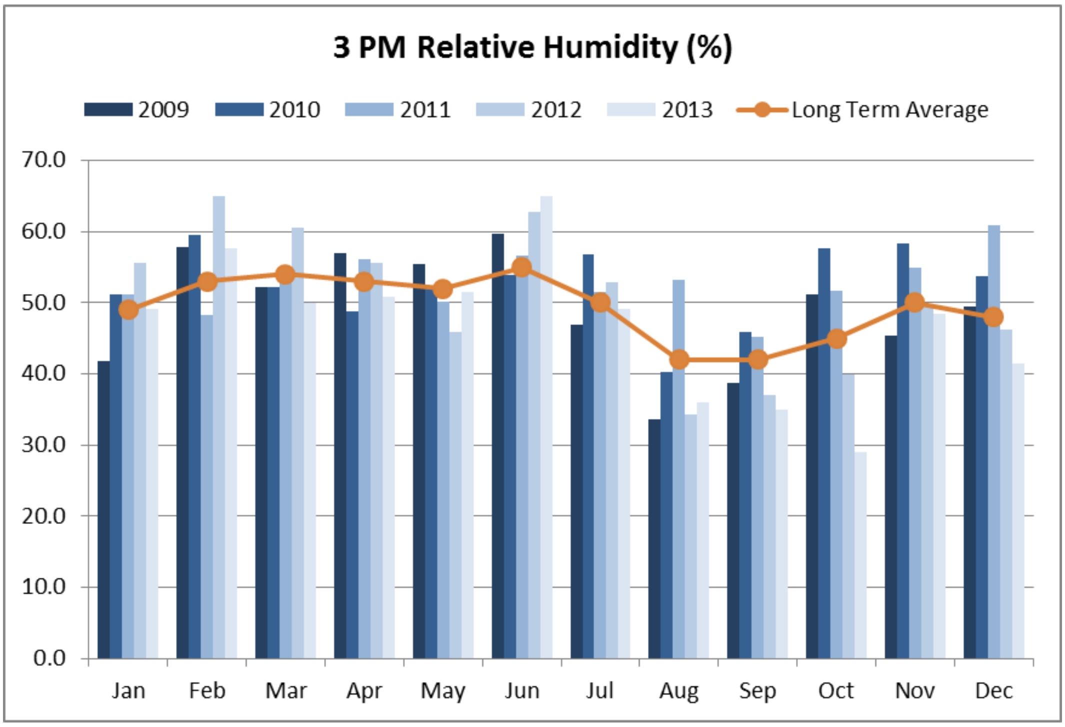


Figure 10 Relative Humidity at 3 pm Horsley Park AWS for 2009 – 2013



Years 2011, 2012 and 2013 all indicate wind speeds that are lower than the long term average. Using these years as the representative year would be a conservative approach because low wind speeds are associated with less effective plume dispersion. No other parameters significantly deter the use of any one of these years of data. Where data sets are deemed equally representative, the most recent data set is selected. Consequently, 2013 was selected as a suitably representative year of meteorology.

7.2.2 TAPM

In order to calculate all required meteorological parameters required by the dispersion modelling process, meteorological modelling using The Air Pollution Model (TAPM, v 4.0.4) has been performed. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. However, given that TAPM is acknowledged to under-predict calm wind conditions, the wind speed and direction observations obtained from the nearest BoM stations have also been used in the subsequent CALMET component of the modelling as described in **Section 7.2.3** below.

Table 18 Meteorological Parameters used for this Study (TAPM v 4.0.4)

Modelling Period	1 January 2013 to 31 December 2013
Centre of analysis	295,309 mE 6,255,681 mN (UTM Coordinates)
Number of grid points	40 × 40 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Data assimilation	Penrith Lakes AWS (Station # 67113) Badgery's Creek AWS (Station # 67108) Horsley Park Equestrian Centre AWS (Station # 67119)
Terrain	AUSLIG 9 second DEM

The three dimensional upper air data from TAPM output was used as input for the diagnostic meteorological model (CALMET).

7.2.3 CALMET

In the simplest terms, CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field and thus the final wind field reflects the influences of local topography and current land uses.

CALMET modelling was conducted using the 'with Obs' CALMET approach. TAPM generated upper air data and available surface weather observations in the area were used to refine the wind field predetermined by TAPM data. Hourly surface meteorological data from the nearest BoM stations were incorporated in the CALMET modelling.

A horizontal grid spacing of 100 m was used to adequately represent the important local terrain features and land use. **Table 19** details the parameters used in the meteorological modelling.

Table 19 CALMET Configuration Used for this Study

Modelling Period	1 January 2013 to 31 December 2013
Centre of analysis – outer grid Centre of analysis – mid grid Centre of analysis – inner grid	295,309 mE 6,255,681 mN (UTM Coordinates) 303,500 mE 6,252,500 mN (UTM Coordinates) 303,500 mE 6,252,600 mN (UTM Coordinates)
Meteorological grid domain (Meteorological grid resolution)	38 km x 38 km (1 km) 15 km x 15 km (0.3 km) 10 km x 10 km (0.1 km)
Vertical Resolution (Cell Heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)
Data Assimilation	Penrith Lakes AWS (Station # 67113) Badgery's Creek AWS (Station # 67108) Horsley Park Equestrian Centre AWS (Station # 67119) Bankstown Airport AWS (Station # 66137)* Holsworthy Aerodrome AWS (Station # 66161)* TAPM - upper air data (313,309 mE; 6,273,681 mN)

Note: *Holsworthy Aerodrome AWS was included to utilise cloud cover data

7.2.4 Meteorological Data Used in Modelling

7.2.4.1 Wind Speed and Direction

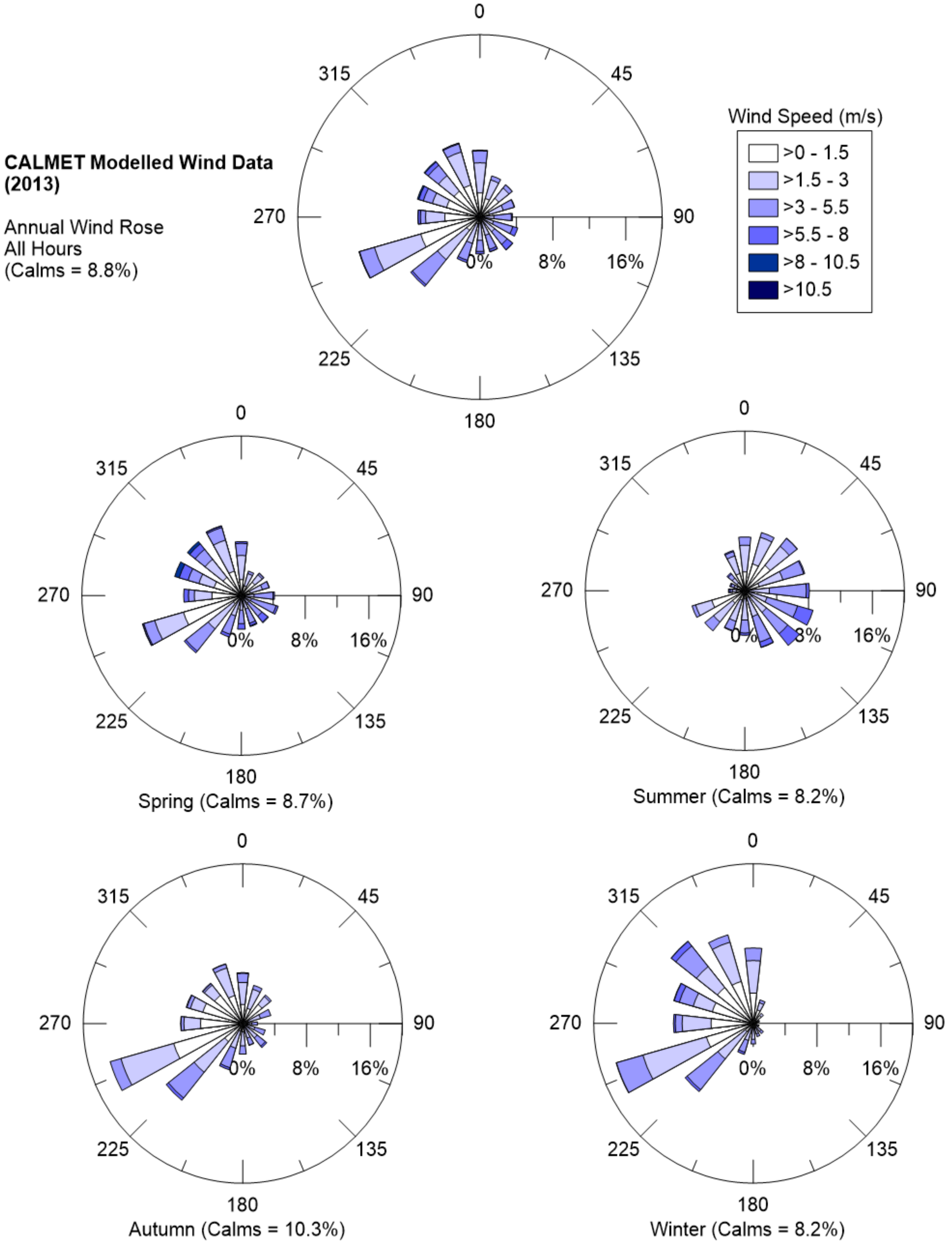
A summary of the annual wind behaviour predicted by CALMET at the Project Site is presented as wind roses in **Figure 11**.

Figure 11 indicates that winds experienced at the site are predominantly moderate to high (between 1.5 m/s and 8 m/s) and wind direction is seasonally dependent. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur approximately 8.8% of the time throughout the modelling period.

The seasonal wind roses indicate that typically:

- In summer, winds are moderate to strong predominantly from between the northeast and southeast with very few winds from the western quadrant.
- In autumn, winds are moderate predominantly from the west-southwest.
- In winter, moderate winds from the west southwest still predominate with a contribution from moderate winds from the northwest quadrant.
- In spring, winds are moderate to strong with high percentage of winds from northern, western and southern quadrants and strong winds experienced only from the northwestern quadrant.

Figure 11 Predicted Seasonal Wind Roses for the Project Site (CALMET predictions, 2013)



7.2.4.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorize the degree of atmospheric stability as follows:

- A = Extremely unstable conditions
- B = Moderately unstable conditions
- C = Slightly unstable conditions
- D = Neutral conditions
- E = Slightly stable conditions
- F = Moderately stable conditions

The meteorological conditions defining each Pasquill stability class are shown in **Table 20**.

Table 20 Meteorological Conditions Defining Pasquill Stability Classes (Source: Pasquill, 1961)

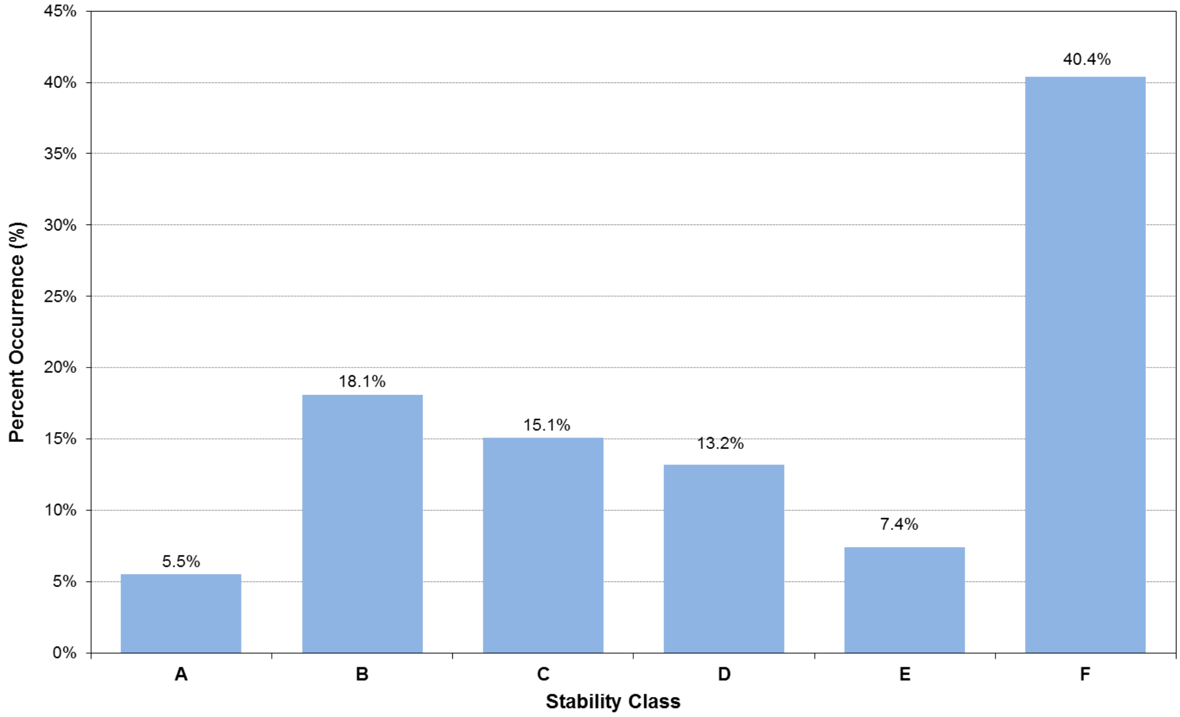
Surface wind speed (m/s)	Daytime insolation			Night-time conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

Notes:

1. Strong insolation corresponds to sunny midday in midsummer in England; slight insolation to similar conditions in midwinter.
2. Night refers to the period from 1 hour before sunset to 1 hour after sunrise.
3. The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above.

The frequency of each stability class predicted by CALMET during the modelling period, extracted at the centre of the Project Site, is presented in **Figure 12**. The results indicate a high frequency of conditions typical to Stability Class F. Stability Class F is indicative of stable night time conditions, which will inhibit pollutant dispersion resulting in higher pollutant concentrations.

Figure 12 Predicted Stability Class Frequencies at the Project Site (CALMET predictions, 2013)

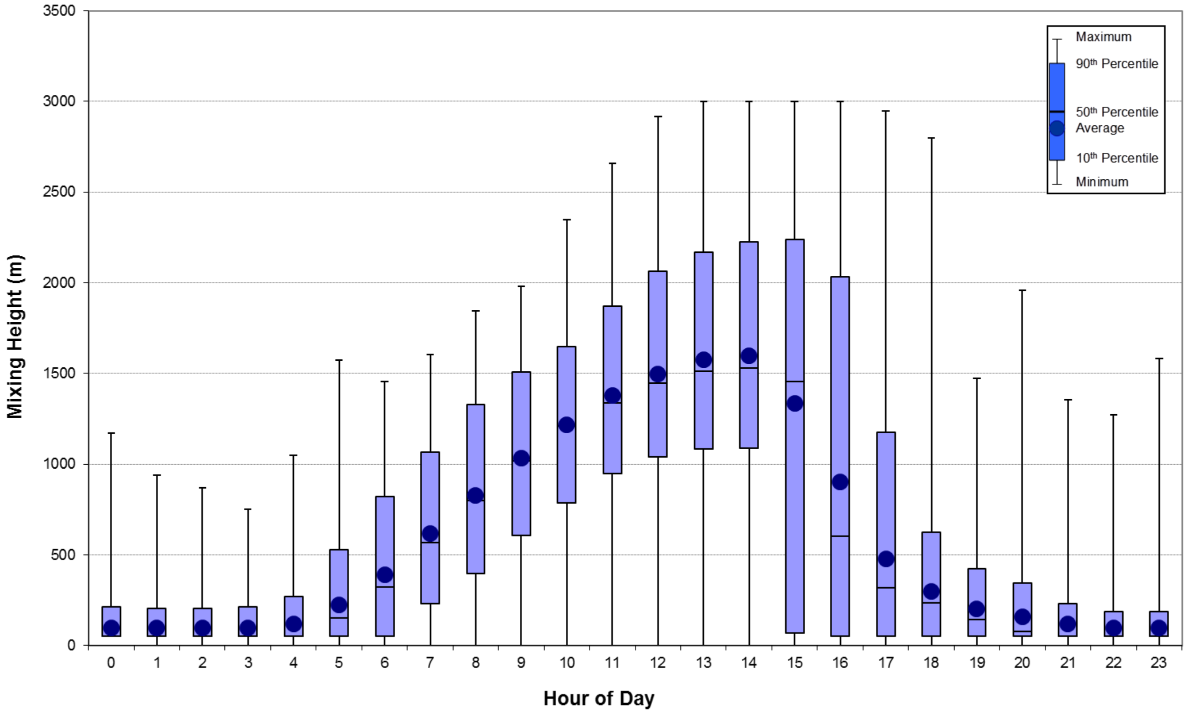


7.2.4.3 Mixing Heights

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Project Site during the 2013 modelling period are illustrated in **Figure 13**.

As would be expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure 13 Predicted Mixing Heights at the Project Site (CALMET predictions, 2013)

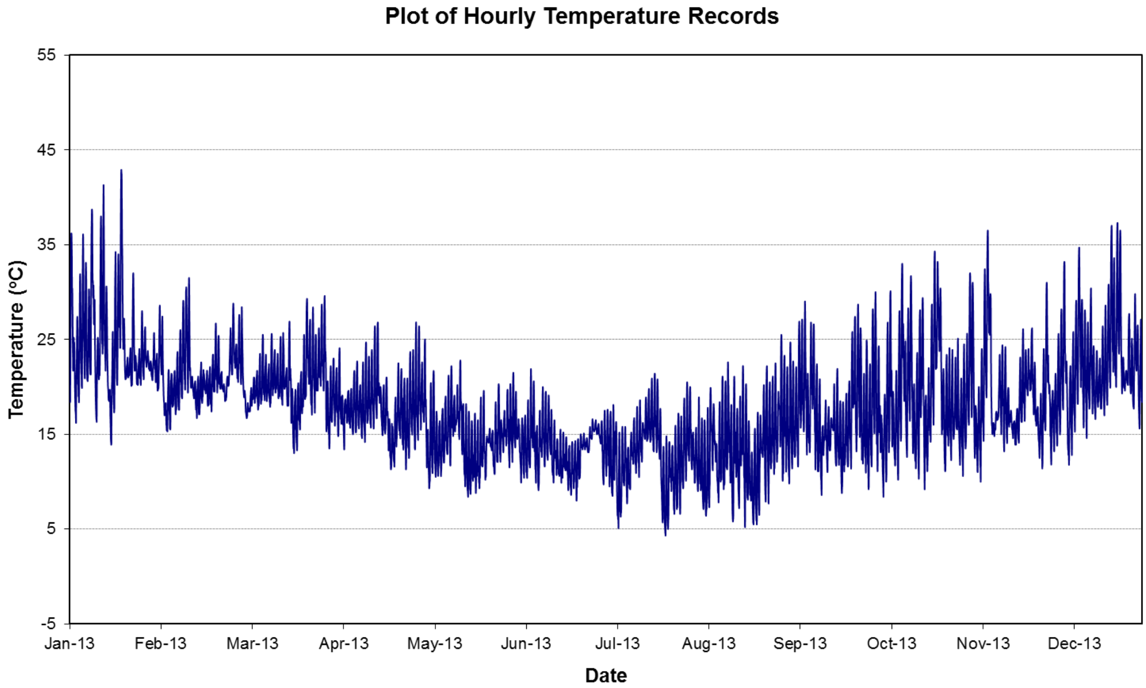


7.2.4.4 Temperature

The modelled temperature variations as predicted at the Project Site during 2013 are illustrated in **Figure 14**.

The maximum temperature (42.9°C) was predicted on 18 January 2013 and the minimum temperature (4.3°C) was predicted on 22 July 2013.

Figure 14 Predicted Temperatures at the Project site (CALMET predictions, 2013)



7.2.4.5 Modelled Meteorological Data Validation

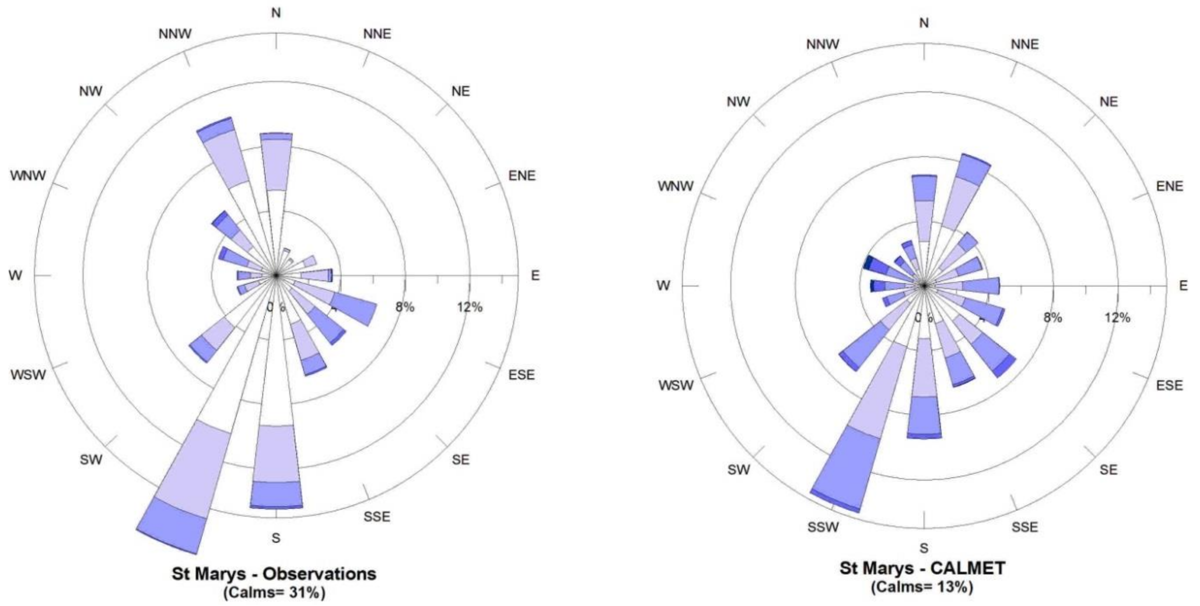
NSW OEH operates air quality network across various locations in NSW and the nearest such station is located at Mamre Road in St Mary's (approximately 3 km from the Project Site). It is noted that meteorological data (wind speed, wind direction, sigma theta and ambient temperature) are also monitored at St Marys monitoring station. The location of the St Marys monitoring station is shown in **Figure 15**.

Figure 15 Location of the St Marys Monitoring Station

Source: Google Earth (2014)

In the absence of any site specific meteorological data, the meteorological data from St Marys monitoring station has been used to validate the meteorological modelling approach. A summary of the comparison between modelled meteorological data and observed meteorological data at St Marys monitoring station is presented as wind roses and is shown in **Figure 16**.

Figure 16 Comparison of Wind Roses at St Marys Monitoring Station – Observed Vs CALMET



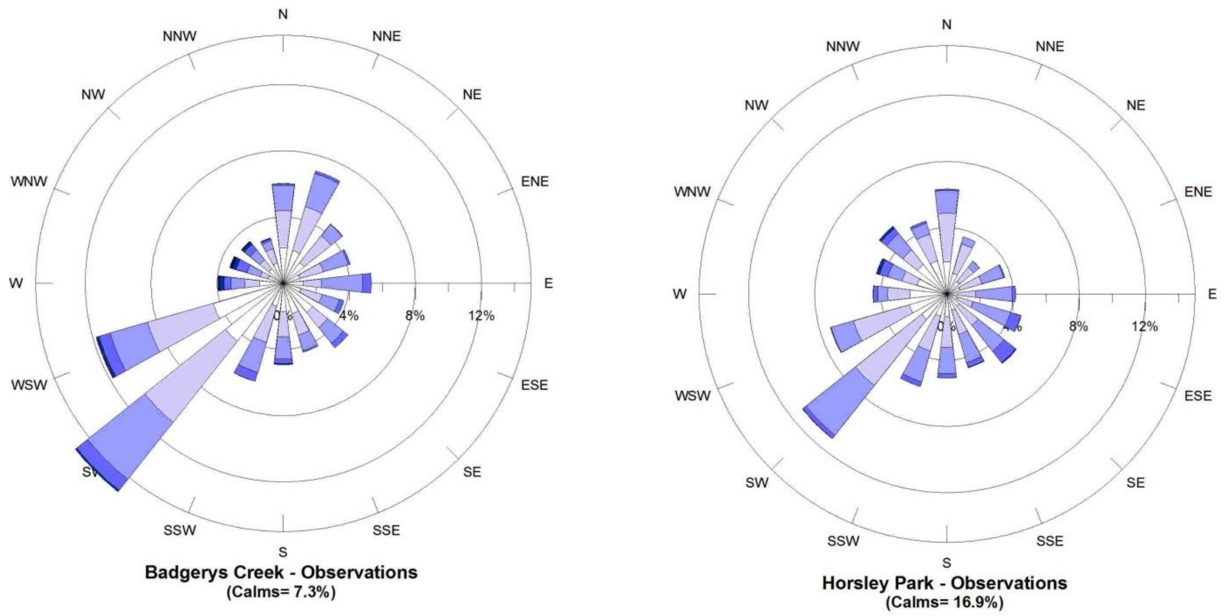
Notes:

1. The CALMET predicted wind rose was extracted from an inner meteorological file centred on a different location but was run using the same outer meteorological file, which contained all the observed data from surrounding BoM stations.

It is noted that the observed meteorological data broadly compares well with the modelled meteorological data at St Marys monitoring station, with the exception of winds from north-northeast direction and significantly higher calm conditions (31% compared to 13%) for Observed Data.

It is considered appropriate to analyse the monitored meteorological data in a regional context to analyse the north-northeast component of winds. The nearest BoM stations are located at Horsley Park and Badgerys Creek stations. The observed meteorological data at Badgerys Creek and Horsley Park is shown in **Figure 17**.

Figure 17 Observed Meteorological Data Monitored at Badgerys Creek and Horsley Park (2013)



It is noted from the observed meteorological data at Badgerys Creek and Horsley Park station that there is a consistent northeast and southwest wind component in the region, which has been predicted by the CALMET meteorological modelling at St Marys monitoring station.

It can be concluded from the above analysis that at St Marys monitoring station, the low percentage of winds from the north northeast direction and higher percentage of calm conditions can be attributed to the obstruction (large building) present in the northeast direction of the St Marys monitoring station (shown in **Figure 15**).

7.3 Background Air Quality Data Used for Cumulative Impact Assessment

As described in **Section 5**, the existing air quality of the area surrounding the Project site has been characterised using measurements collected at the Liverpool and St Mary's AQMS in 2013. Although the data in **Table 11** represents the maximum concentrations measured (for comparison with the criteria), in some instances time series data has been used in this assessment to allow contemporaneous hour by hour assessment of predicted plus background concentrations. The resulting time series of cumulative concentrations have then been analysed to determine the compliance status against each criterion.

7.3.1 NO_X to NO_2 Conversion

For NO_2, predictions are made using emission rates of NO_X (refer **Section 6.4**) with corresponding impacts assessed at sensitive receptors. A conservative assumption can be made that all NO_X emitted will be converted to NO_2 with the background NO_2 concentration added to allow comparison with the cumulative NO_2 criterion. However, this method is highly simplistic and conservative with the Approved Methods providing for more detailed assessment. Method 2, which assumes the NO to NO_2 conversion is limited by the ambient ozone (O_3) concentration (OLM), has been adopted as per Section 8.1.2 of the Approved Methods.

NO_X emissions from combustion sources are principally comprised of nitric oxide (NO) with low concentrations of nitrogen dioxide (NO_2). Once emitted into the atmosphere, the NO is oxidised to NO_2, predominantly (although not exclusively) through reaction with O_3.

The OLM assumes that all the available O_3 in the atmosphere will react with NO in the plume until either all the O_3 or all the NO is used up. The approach assumes that the atmospheric reaction is instant. In reality the reaction takes place over a number of hours. The level 2 assessment of the OLM has been adopted in this assessment, which uses contemporaneous predicted and background concentrations (O_3 and NO_2 from the St Marys AQMS).

The OLM is presented below:

$$[NO_2]total = \{0.1 \times [NO_x]pred\} + MIN\left\{(0.9) \times [NO_x]pred \ or \ \left(\frac{46}{48}\right) \times [O_3]bkgd\right\} + [NO_2]bkgd$$

Where:

$[NO_2]total$ = the predicted concentration of NO_2 in µg/m^3
$[NO_x]pred$ = the dispersion model prediction of the ground level concentration of NO_X in µg/m^3
MIN = the minimum of the two quantities within the braces
$[O_3]bkgd$ = the background ambient O_3 concentration in µg/m^3
$\left(\frac{46}{48}\right)$ = the molecular weight of NO_2 divided by the molecular weight of O_3
$[NO_2]bkgd$ = the background ambient NO_2 concentration in µg/m^3

8 POTENTIAL AIR QUALITY IMPACTS OF THE PROPOSAL

Air quality impacts in the area surrounding the Project site may be potentially anticipated during both the construction and operational phases. The following sections outline a qualitative approach to the assessment of the potential risks associated with construction phase and a quantitative approach to the assessment of the potential risks associated with operational phase of the proposed Project.

In the absence of detailed information on the construction schedule, a qualitative risk based approach to assess the potential for construction-phase impacts has been undertaken and is presented in **Section 8.1**. A quantitative assessment of the risks associated with Project operation has been performed as outlined in **Section 7** and is presented in **Section 8.2**. Given the nature of the Project, it is considered that air quality impacts during construction works would present a greater risk to health and amenity than those during ongoing operation.

It is noted that the wider Horsley Drive Business Park will be developed and include other tenants. The potential that construction of multiple warehouse developments will occur concurrently has been considered. The operation of multiple facilities can be considered for the known uses of the remainder of the Business Park (ie Martin Brower Company SSD 7078).

8.1 Construction Phase

The proposed construction works would involve construction of multiple warehouse structures and distribution related facilities across the site.

The following qualitative risk-based assessment has been performed to determine the potential risks of construction on air quality at nearby sensitive receptors.

Further details of the risk assessment methodology adopted for use in this AQIA is described in **Appendix B**.

8.1.1 Construction Air Quality Risk Assessment Methodology

Construction of the warehouse structures will result in the generation of fugitive dust emissions. These emissions have the potential to result in elevated TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates in the vicinity of the works. Elevations in emissions of combustion related pollutants due to site vehicle operations would also be anticipated but operations due to construction activities of the scale proposed would generally be limited to impacts of dust.

For this assessment, the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* (IAQM, 2014) developed in the United Kingdom by the Institute of Air Quality Management (IAQM) has been used to provide a qualitative assessment method. The IAQM method uses a four-step process for assessing dust impacts from construction activities:

- **Step 1**: Screening based on distance to the nearest sensitive receptor; whereby the sensitivity to dust deposition and human health impacts of the identified sensitive receptors is determined.
- **Step 2**: Assess risk of dust effects from activities based on:
    a. the scale and nature of the works, which determines the potential dust emission magnitude; and
    b. the sensitivity of the area surrounding dust-generating activities.
- **Step 3**: Determine site-specific mitigation for remaining activities with greater than negligible effects.
- **Step 4**: Assess significance of remaining activities after management measures have been considered.

8.1.2 Step 1 – Screening Based on Separation Distance

In the case of the proposed Project, sensitive receptors are noted to be located between 160 m (R2) and 750 m (R11) from the Project site boundary. Given that the majority of receptors are located within 500 m of the site entrance, with some being with within 350 m of the site boundary, further assessment is required.

8.1.3 Step 2a – Assessment of Scale and Nature of the Works

The footprint of the total site is approximately 34,538 m^2. Although the Project involves no demolition work, the following works are required:

- ground clearance of the site (34,538 m^2 in area to a nominal 0.5 m depth);
- the establishment of hard standing on approximately 55% of the site; and
- the construction of a steel framed building covering approximately 18,770 m^2 to an assumed height of 13.7 m above ground level (AGL) (equating to 257,149 m^3 in building volume).

The assumed access route around the site during construction works may be up to approximately 2.0 km in total length.

Based upon the above assumptions, the dust emission magnitudes are as presented in **Table 21**.

Table 21 Categorisation of dust emission magnitude

Activity	Dust Emission Magnitude
Demolition	N/A
Earthworks	Large
Construction	Large
Trackout	Large

8.1.4 Step 2b – Risk Assessment

Receptor Sensitivity

Based on the criteria listed in **Section 4.3**, the sensitivity of the identified receptors in this study is concluded to be *high* for health impacts and *high* for dust soiling, as the receptors are dwellings where people may be reasonably expected to be present continuously as part of the normal pattern of land use.

Sensitivity of an Area

Using the classifications shown in **Appendix B**, the sensitivity of the surrounding area to health effects has been classified as 'low', and the sensitivity of the area to dust soiling is classified as '*low*'. This categorisation has been made taking into account the distances between receptors and the Project site, the annual mean background PM_{10} concentration of 15.6 µg/m^3 (refer **Table 11**) and the low number of receptors present.

Risk Assessment

Given the sensitivity of the identified individual receptors is classified as '*high*' for dust soiling and health effects, the sensitivity of the general area as '*low'* for dust soiling and health effects, and the dust emission magnitudes for the various construction phase activities as shown in **Table 21**, the resulting risk of air quality impacts is as presented in **Table 22**. The results indicate that there is a low risk of adverse dust soiling impacts occurring at the off-site receptor locations if no mitigation measures were to be applied to control emissions from earthworks, construction and trackout. The risk of adverse human health impacts is also designated as low.

Table 22 Risk of Air Quality Impacts from Construction Activities - Earthworks

Impact	Sensitivity of Area	Dust Emission Magnitude				Preliminary Risk			
		Demolition	Earthworks	Construction	Trackout	Demolition	Earthworks	Construction	Trackout
Dust Soiling	Low	N/A	Large	Large	Large	N/A	Low	Low	Low
Human Health	Low					N/A	Low	Low	Low

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

8.1.5 Step 3 - Mitigation Measures

8.1.5.1 Nuisance Dust Control Measures

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

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

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

8.1.5.2 Plant and Machinery

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

- Ensuring vehicles and machinery are maintained in accordance with manufacturer's specifications.
- Minimising truck queuing and unnecessary trips through logistical planning of materials delivery and work practices.
- Ensure all vehicles switch off engines when stationary so that there are no idling vehicles.
- Fixed plant should be located as far from local receptors as practicable.

8.1.5.3 Fuel Storage Areas

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

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

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

8.1.5.4 Site Management

Air emissions associated with all construction activities should also be managed through compliance with the Construction Environmental Management Plan (CEMP). The CEMP has been prepared and will be lodged with the Development Approval. The CEMP would be implemented so that:

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

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

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

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

- Ensure spill kits are appropriately located and stocked.

8.1.5.5 Complaints Handling

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

8.1.6 Step 4 - Residual Impacts

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

The results of the reappraisal are presented below in **Table 23**.

Table 23 Residual Risk of Air Quality Impacts from Construction

Impact	Sensitivity of Area	Preliminary Risk			
		Demolition	Earthworks	Construction	Trackout
Dust Soiling	Low	N/A	Negligible	Negligible	Negligible
Human Health	Low	N/A	Negligible	Negligible	Negligible

The mitigated dust deposition and human health impacts of Project construction works is anticipated to be *negligible*. A detailed CEMP should be constructed and implemented prior to construction works, and should include contingency plans and response procedures (eg proactive response procedures, non-compliance and continued non-compliance response procedures, complaints handling procedures) and suitable reporting and performance monitoring procedures.

8.2 Operational Phase

8.2.1 Particulate Matter (TSP, PM_{10} and $PM_{2.5}$)

Table 24 and **Table 25** present the predicted incremental and cumulative annual average dust levels and TSP, PM_{10} and $PM_{2.5}$ concentrations predicted at surrounding representative sensitive receptors resulting from the operation of the Project. It is demonstrated that the predicted incremental impacts of all modelled annual average particulate levels and concentrations are minor, and all easily meet the respective criterion. The incremental impacts from the previously assessed and approved warehousing facility also located on the corner of Horsley Drive and Cowpasture Road, Wetherill Park (SSD 7078) have been included in the predicted cumulative impacts (outlined in green in **Figure 18**).

Given the minor predicted concentrations, no contour plots are provided.

It is noted that the monitoring data for $PM_{2.5}$ indicate that the annual average criterion was exceeded during 2013 at the Liverpool AQMS. A significant contributor to this exceedance was the NSW bushfire emergency which extended from October into early November 2013. The incremental contribution to annual average $PM_{2.5}$ concentrations predicted at the sensitive receptors indicates that under normal conditions, the proposed Project would not be expected to cause an exceedance of the annual average $PM_{2.5}$ criterion.

Table 24 Predicted Annual Average Dust Deposition Levels and TSP Concentrations at Sensitive Receptors

Receptor ID	Annual Average Dust Deposition			Annual Average TSP Concentration		
	Incremental Impact (g/m^2/month)	Previously Assessed Incremental Impact ($\mu g/m^3$)	Cumulative Impact (g/m^2/month)	Incremental Impact ($\mu g/m^3$)	Previously Assessed Incremental Impact ($\mu g/m^3$)	Cumulative Impact ($\mu g/m^3$)
R1	<0.1	0.1	<2.2	1.4	5.0	44.1
R2	<0.1	<0.1	<2.2	1.6	0.4	39.7
R3	<0.1	<0.1	<2.2	1.0	0.3	39.0
R4	<0.1	<0.1	<2.2	0.2	0.1	38.0
R5	<0.1	<0.1	<2.2	0.2	0.1	38.0
R6	<0.1	<0.1	<2.2	0.2	0.2	38.1
R7	<0.1	<0.1	<2.2	0.1	0.1	37.9
R8	<0.1	<0.1	<2.2	0.4	0.4	38.5
R9	<0.1	<0.1	<2.2	0.3	1.0	39.0
R10	<0.1	<0.1	<2.2	0.5	2.9	41.1
R11	<0.1	<0.1	<2.2	0.1	0.4	38.2
Criterion	2	2	4			90

Note:

1. The cumulative impact also includes the background concentrations of dust deposition and TSP respectively, which are outlined in **Section 5**.

Table 25 Predicted Annual Average PM_{10} and $PM_{2.5}$ Concentrations at Sensitive Receptors

Receptor ID	Annual Average PM_{10} Concentration			Annual Average $PM_{2.5}$ Concentration		
	Project site Incremental Impact ($\mu g/m^3$)	Previously Assessed Incremental Impact ($\mu g/m^3$)	Cumulative Impact ($\mu g/m^3$)	Incremental Impact ($\mu g/m^3$)	Previously Assessed Incremental Impact ($\mu g/m^3$)	Cumulative Impact ($\mu g/m^3$)
R1	0.5	1.3	17.4	0.1	0.4	9.9
R2	0.5	0.1	16.2	0.1	<0.1	<9.6
R3	0.3	0.1	16.0	0.1	<0.1	<9.6
R4	0.1	<0.1	<15.8	<0.1	<0.1	<9.6
R5	0.1	<0.1	<15.8	<0.1	<0.1	<9.6
R6	0.1	<0.1	<15.8	<0.1	<0.1	<9.6
R7	0.1	<0.1	<15.8	<0.1	<0.1	<9.6
R8	0.1	0.1	15.8	<0.1	<0.1	<9.6
R9	0.1	0.3	16.0	<0.1	0.1	<9.6
R10	0.2	0.7	16.5	<0.1	0.2	<9.7
R11	0.1	0.1	15.8	<0.1	<0.1	<9.6
Criterion			30			8

Note:

1. The cumulative impact also includes the background concentrations of PM_{10} and $PM_{2.5}$ respectively, which are outlined in **Section 5**.

Table 26 presents incremental and cumulative maximum 24-hour average PM_{10} concentration at each receptor listed in **Section 3.2**. The incremental and cumulative 24-hour average PM_{10} concentrations predicted at each sensitive receptor are well below the relevant OEH guideline and the proposed operation is unlikely to cause any exceedances of the guideline at these locations. The incremental impacts from the previously assessed and approved warehousing facility also located on the corner of Horsley Drive and Cowpasture Road, Wetherill Park (SSD 7078) have been included in the predicted cumulative impacts (outlined in green in **Figure 18**).

It can be observed that the predicted incremental 24-hour average PM_{10} concentrations at all receptors are minor (<5%) compared to the relevant ambient air quality guideline. The proposed operational activities are unlikely to cause any additional exceedances above background air quality concentrations of the 24-hour PM_{10} criterion at the sensitive receptor locations.

Table 26 Predicted Maximum 24-Hour Average PM_{10} Concentrations at Sensitive Receptors

Receptor ID	Maximum 24-hour Average PM_{10} Concentrations ($\mu g/m^3$)			
	Project site Incremental Impact	**Previously Assessed Incremental Impact**	**Background**	**Cumulative Impact**
R1	2.3	4.3	38.6	45.2
R2	1.6	0.5	38.6	40.7
R3	1.4	0.5	38.6	40.5
R4	0.5	0.3	38.6	39.4
R5	0.5	0.4	38.6	39.5
R6	0.6	0.4	38.6	39.6
R7	0.6	0.4	38.6	39.6
R8	1.1	0.9	38.6	40.6
R9	1.0	1.5	38.6	41.1
R10	1.1	2.7	38.6	42.4
R11	0.5	0.7	38.6	39.8
Criterion				**50**

Table 27 show the predicted incremental impacts for 24-hour average $PM_{2.5}$ concentrations at each receptor identified in **Section 3.2**.

The predicted incremental 24-hour average $PM_{2.5}$ concentrations at all receptors are minor (<3%) compared to the relevant ambient air quality guideline. Considering the relatively small predicted incremental contribution, it can be concluded that the proposed operational activities are unlikely to cause any additional exceedances above background air quality concentrations of the 24-hour average $PM_{2.5}$ criteria at the sensitive receptor locations. The incremental impacts from the previously assessed and approved warehousing facility also located on the corner of Horsley Drive and Cowpasture Road, Wetherill Park (SSD 7078) have been included in the predicted cumulative impacts (outlined in green in **Figure 18**).

Table 27 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations at Sensitive Receptors

Receptor ID	Maximum 24-hour Average PM_{10} Concentrations ($\mu g/m^3$)			
	Project Site Incremental Impact	**Previously Assessed Incremental Impact**	**Background**	**Cumulative Impact**
R1	0.6	1.4	22.2	24.2
R2	0.4	0.2	22.2	22.8
R3	0.4	0.2	22.2	22.8

Receptor ID	Maximum 24-hour Average PM_{10} Concentrations (µg/m^3)			
	Project Site Incremental Impact	Previously Assessed Incremental Impact	Background	Cumulative Impact
R4	0.1	0.1	22.2	22.4
R5	0.1	0.1	22.2	22.4
R6	0.2	0.1	22.2	22.5
R7	0.2	0.1	22.2	22.5
R8	0.3	0.3	22.2	22.8
R9	0.3	0.5	22.2	23.0
R10	0.3	0.9	22.2	23.4
R11	0.1	0.2	22.2	22.5
Criterion				**25**

Figure 18 Predicted Maximum Incremental 24-Hour Average PM_{10} Concentrations

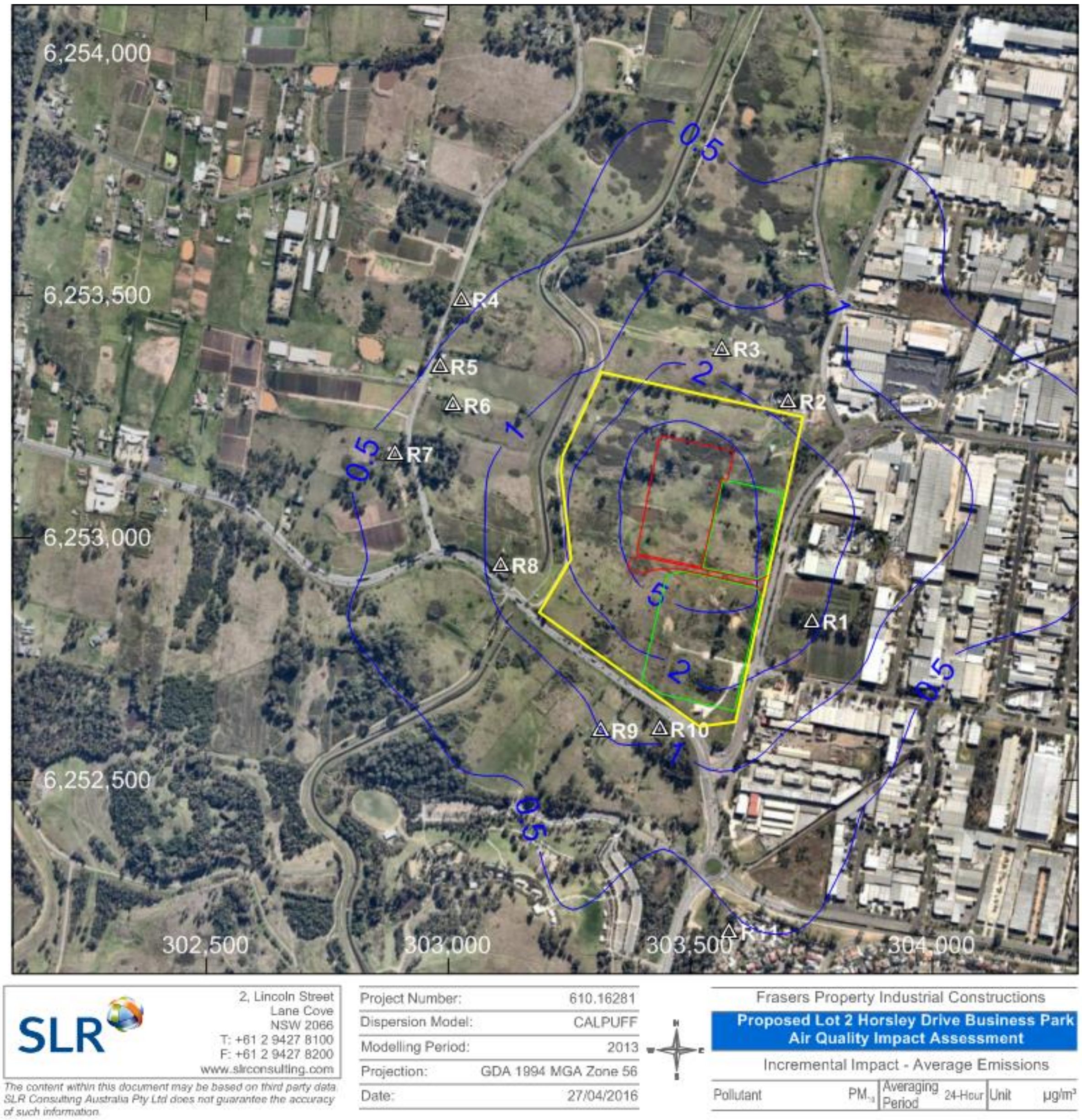
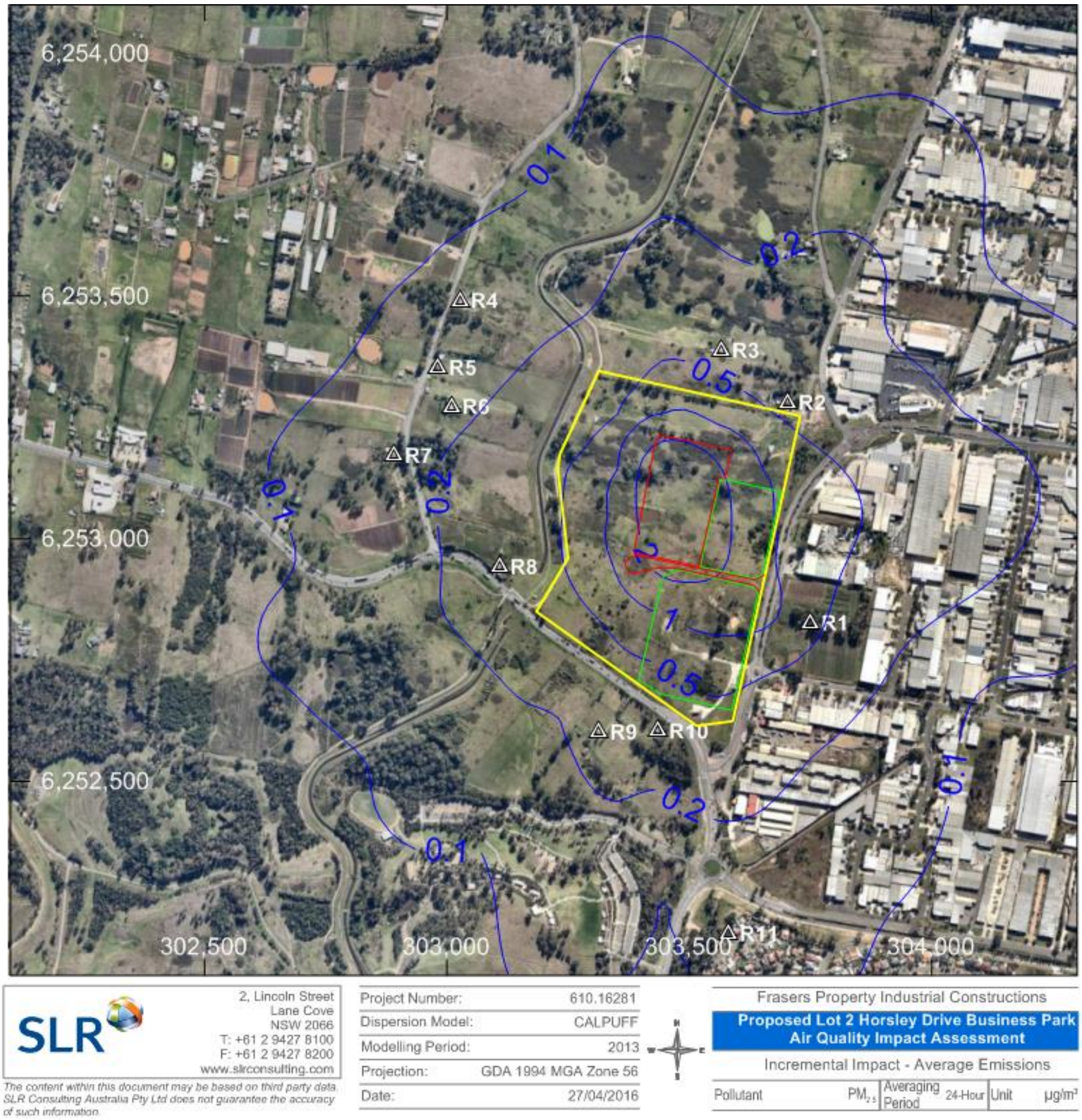


Figure 19 Predicted Maximum Incremental 24-Hour Average $PM_{2.5}$ Concentrations



8.2.2 Nitrogen Dioxide (NO_2)

Table 28 and **Table 29** present the incremental and cumulative 1-hour and annual average NO_2 concentrations predicted at each receptor identified in **Section 3.2**. The NO_2 concentrations have been estimated using the predicted NO_X concentrations and the OLM method (based on background ozone data), as prescribed by the Approved Methods. The ozone concentrations are discussed in detail in **Section 5**.

The results presented in **Table 28** show that the predicted cumulative annual average NO_2 concentrations are well below the relevant OEH criteria at all receptors. The incremental impacts from the previously assessed and approved warehousing facility also located on the corner of Horsley Drive and Cowpasture Road, Wetherill Park (SSD 7078) have been included in the predicted cumulative impacts (outlined in green in **Figure 18**).

Table 28 Predicted Annual Average NO_2 Concentrations at Sensitive Receptors

ID	Annual Average NO_2 Concentrations[1] ($\mu g/m^3$)			
	Project Site Incremental Impact[1]	Previously Assessed Incremental Impact[2]	Background	Cumulative Impact
R1	4.6	0.5	9.5	14.6
R2	5.2	<0.1	9.5	14.8
R3	3.4	<0.1	9.5	13.0
R4	0.5	<0.1	9.5	10.1
R5	0.5	<0.1	9.5	10.1
R6	0.7	<0.1	9.5	10.3
R7	0.5	<0.1	9.5	10.1
R8	1.4	<0.1	9.5	11.0
R9	1.1	0.1	9.5	10.7
R10	1.6	0.4	9.5	11.5
R11	0.5	<0.1	9.5	10.1
Criteria				**62**

Notes:

1. An annual average ozone concentration of 69 $\mu g/m^3$ from St Mary's AQMS in 2013 was used to calculate the conversion of NO_X to NO_2 using the OLM method.
2. An annual average ozone concentration of 33.3 $\mu g/m^3$ from 2013 was used to calculate the conversion of NO_X to NO_2 using the OLM method.

The results presented in **Table 29** show that the predicted cumulative maximum 1-hour average NO_2 concentrations are below the relevant OEH criteria at all receptors except at receptors R1, R3, R8, R9 and R10. It is worth noting that the following factors add to the conservatism associated with this cumulative impact:

1. scenario 2 assumes that vehicles are idling at all 16 bays simultaneously
2. scenario 2 assumes peak hour traffic conditions could happen during any hour the day, including those hours with the worst case dispersion which generally occur overnight
3. both scenarios assume that all heavy goods vehicles entering and leaving the site are B-Doubles, when in reality the vehicles will be a mix of Class 3 to Class 10 heavy goods vehicles. Assuming all the trucks are B-Doubles is a very conservative assumption, leading to a conservative output.
4. the background concentration of NO_2 represents the maximum 1-hour average concentration recorded for NO_2 in 2013
5. the incremental impact has been calculated using the OLM, which effectively takes the maximum 1-hour average NOx concentration predicted at the receptor and adds the maximum 1-hour average concentration recorded for NO_2 in 2013.

Given the conservative assumptions outlined above, it is expected that during normal operations the NO_2 concentrations will be below those listed in **Table 29**. The cumulative impact outlined in **Table 29** represents the absolute worst case. In addition, the incremental impacts from the previously assessed and approved warehousing facility also located on the corner of Horsley Drive and Cowpasture Road, Wetherill Park (SSD 7078) have been included in the predicted cumulative impacts (outlined in green in **Figure 18**).

Table 29 Predicted Maximum 1-Hour Average NO_2 Concentrations at Sensitive Receptors

ID	1-Hour Average NO_2 Concentrations[1] ($\mu g/m^3$)			
	Project Site Incremental Impact[1]	**Previously Assessed Incremental Impact[2]**	**Background**	**Cumulative Impact**
R1	191	52.8	75.9	**320**
R2	141	9.3	75.9	226
R3	172	9.5	75.9	**257**
R4	95	5.5	75.9	176
R5	104	8	75.9	188
R6	110	11.2	75.9	197
R7	108	9.8	75.9	194
R8	182	36.6	75.9	**295**
R9	128	43.5	75.9	**247**
R10	138	52.4	75.9	**266**
R11	53	5.5	75.9	134
Criteria				**246**

Notes:

1. An annual maximum 1-hourly average ozone concentration of 216 $\mu g/m^3$ from St Mary's AQMS in 2013 was used to calculate the conversion of NO_X to NO_2 using the OLM method.
2. An annual average ozone concentration of 33.3 $\mu g/m^3$ from 2013 was used to calculate the conversion of NO_X to NO_2 using the OLM method.

To further investigate the predicted exceedances, a contemporaneous analysis was performed following the Approved Methods to assess the maximum cumulative 1-hour average NO_2 concentrations at receptor 1 (the most impacted receptor). At receptor 1, each individual incremental prediction (from the Project site and the previously assessed site) was added to the corresponding hour's maximum daily 1-hour average background concentration measured at the St Marys AQMS to predict the cumulative 1-hour average NO_2 impacts. This analysis matches up the hourly predictions with background data from the same time period (both NO_2 background concentrations and the background O_3 concentrations used in the OLM method).

Table 30 and **Table 31** present a summary of the contemporaneous analysis at receptor 1. It can be observed that the incremental and cumulative 1-hour average NO_2 concentrations predicted at receptor 1 as a result of operational emissions are below the relevant OEH guideline, except for the 1-hour average NO_2 concentration predicted on the 8 November 2013 (**Table 30**).

The first three of the five factors that add to the conservatism associated with this cumulative impact combine to provide conditions that are unlikely to exist once the site is operational. This exceedance occurred at 1 am and it's worth noting the second of the factors that add to the conservatism of this assessment; the assumption that peak hour traffic conditions could happen during any hour the day, including those hours with the worst case dispersion which generally occur overnight. In addition, the assessment has conservatively assumed that all vehicles are B-Doubles, that the docking bays are all full, and that these trucks are all idling. In fact, it is highly likely that these trucks will turn off their engines while loading or unloading in the docking bays.

Therefore, in reality the proposed operation is unlikely to cause any exceedances of the guideline at receptor 1. Given receptor 1 is the most impacted receptor the proposed operation is also unlikely to cause any exceedances of the guideline at receptors R3, R8, R9 and R10.

Table 30 1-Hour NO_2 Cumulative Impact Analysis – Highest Background at Receptor 1

Date of Highest Background	NO_2 1-Hour Average Concentrations (µg/m³)				
	Highest Background[1]	Previously Assessed Incremental Impact	Combined Background	Increment[2]	Total
28/11/2013	29	143	171	3	175
08/11/2013	0	155	155	98	**253**
05/01/2013	10	129	139	41	180
22/12/2013	0	138	138	35	173
20/12/2013	39	97	136	14	150
01/01/2013	18	117	135	1	136
05/01/2013	8	123	131	98	229
27/03/2013	23	106	128	39	168
03/09/2013	16	111	128	18	146
19/02/2013	12	104	116	4	120
Criterion					**246**

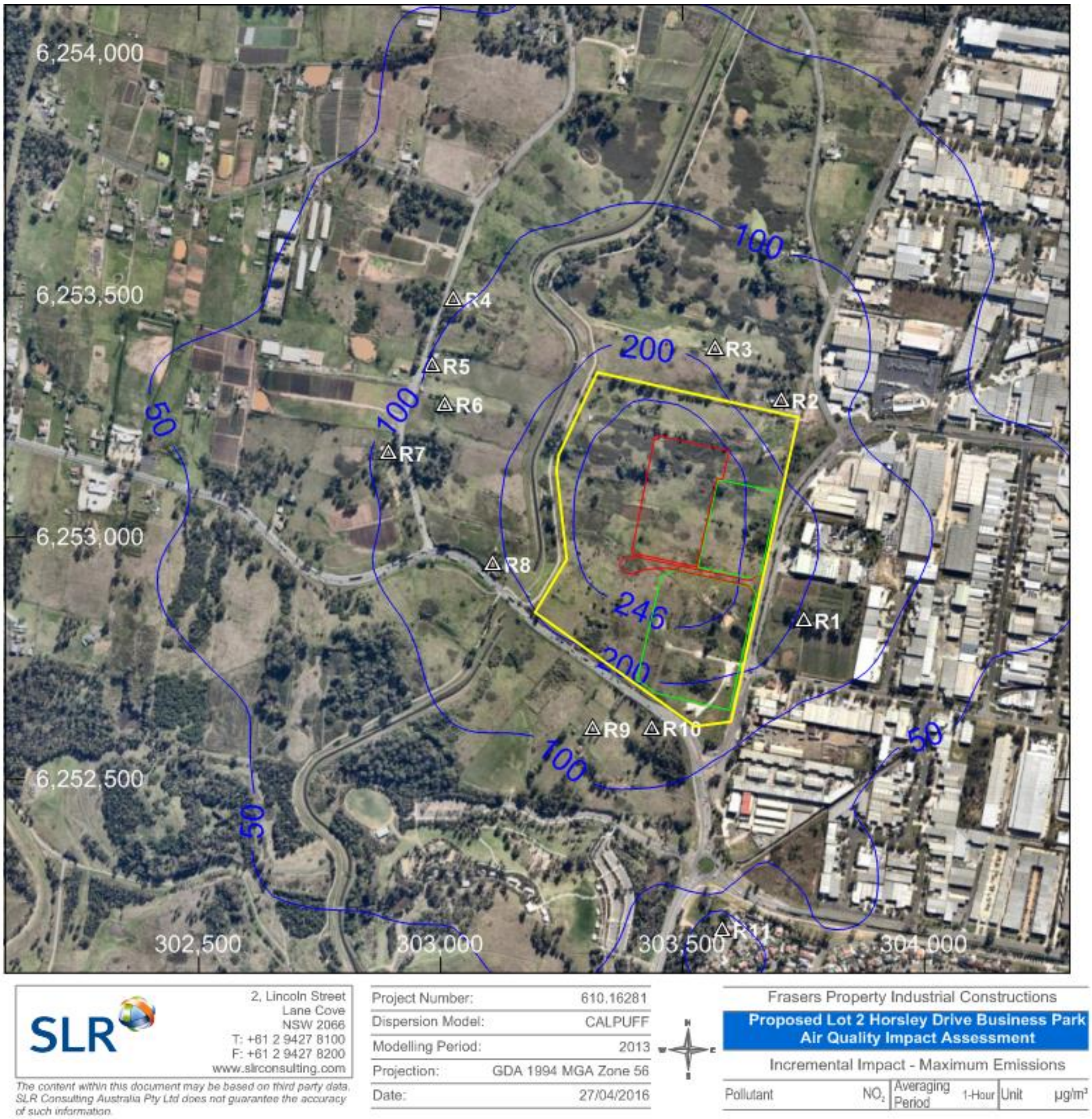
Note:
1. The NO_2 background concentrations are the 1-hour average from St Mary's AQMS.
2. The O_3 background concentrations used in calculating the conversion of NO_X to NO_2 are the daily maximum 1-hour average from St Mary's AQMS.

Table 31 1-Hour NO_2 Cumulative Impact Analysis – Highest Increment at Receptor 1

Date of Highest Increment	NO_2 1-Hour Average Concentrations (µg/m³)				
	Background[1]	Previously Assessed Incremental Impact	Combined Background	Highest Increment[2]	Total
19/10/13	0.0	25.2	25.2	125	150
16/01/13	0.0	0.1	0.1	122	122
20/10/13	20.5	<0.1	<20.6	118	138
16/03/13	10.3	29.1	39.3	118	157
12/10/13	14.4	14.3	28.7	117	146
11/10/13	16.4	1.4	17.8	115	133
07/08/13	18.5	13.7	32.1	115	147
30/09/13	20.5	<0.1	<20.6	114	134
07/08/13	0.0	9.4	9.4	114	123
07/08/13	12.3	12.8	25.1	113	138
					246

Note:
1. The NO_2 background concentrations are the 1-hour average from St Mary's AQMS.
2. The O_3 background concentrations used in calculating the conversion of NO_X to NO_2 are the daily maximum 1-hour average from St Mary's AQMS.

Figure 20 Predicted Maximum Incremental 1-Hour Average NO_2 Concentrations



8.2.3 Mitigation Measures and Ongoing Air Quality Monitoring

The operation of the Project is a closed system with no manufacturing or exhaust air from manufacturing processes generated. Therefore there is no need to specify or require any operational air quality monitoring. The only requirement is to ensure the operation of the Project is undertaken to comply with the *Protection of Environment Operations Act 1997.*

Due to the nature and quantum of emissions, ongoing monitoring is not warranted, particularly given no manufacturing is proposed on-site. The light industrial uses proposed do not compromise the assumptions contained within this assessment.

9 GREENHOUSE GAS ASSESSMENT

The purpose of this report is to undertake a Greenhouse Gas (GHG) Assessment that addresses Scope 1 and 2 emissions relating to the operation of the Project site.

Although the Secretary's Environmental Assessment Requirements (SEARs 7564) for the Project do not specifically require an assessment of GHG emissions to be provided, the assessment does provide:

- *an assessment of the energy use on site*
- *description of the measures that would be implemented on site to ensure the proposal is energy efficient.*

9.1 Emission Types

The Australian Government Department of the Environment (DoE) document, "National Greenhouse Accounts Factors" Workbook (NGA Factors) (DoE, 2015) defines two types of greenhouse gas emissions (see **Table 32**), *direct* and *indirect*. This assessment seeks to consider both direct emissions and indirect emissions.

Table 32 Greenhouse Gas Emission Types

Emissions	Definition
Direct	Produced from sources within the boundary of an organisation and as a result of that organisation's activities (e.g. consumption of petrol in on-site vehicles).
Indirect	Generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation (e.g. consumption of purchased electricity).

Note:. adapted from NGA Factors 2015

9.2 Emission Scopes

The NGA Factors identifies two 'scopes' of emissions for greenhouse gas accounting and reporting purposes as shown in **Table 33**.

Table 33 Greenhouse Gas Scopes

Scope	Definition
Scope 1	Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate scope 1 emissions.
Scope 2	Indirect emission factors are used to calculate scope 2 emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fuels (coal, natural gas, etc.) at the power station.

A third scope of emissions – *Scope 3 Emissions* are also recognised in some greenhouse gas assessments. The *Greenhouse Gas Protocol (GHG Protocol)* (World Business Council for Sustainable Development 2004) defines Scope 3 emissions as "*other indirect GHG emissions":*

> *Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.*

Scope 3 emissions related to the transport of goods and materials to and from the Project Site are not considered in this assessment, mainly as the tenant and their operations are unknown at this time and are beyond the control of the Developer.

9.3 Assessment Methodology

This assessment considers Scope 1 and 2 emissions from the operation of the proposed warehouse/distribution and industrial facility.

Emissions from *construction* were not considered within the scope of the assessment. Estimates were not undertaken, however the emissions are *expected to be immaterial* (less than 5%[1]) in the context of the broader operating emissions, given the short construction timeframe and minimal use of construction plant and equipment.

The boundary for the Project was determined to be the geographical boundary of the Project site for Scope 1 and Scope 2 emissions. The emissions sources identified for the assessment are shown in **Table 34**.

Table 34 Scope 1 and 2 Emission Sources for Operation of Project

Scope	Source
Scope 1	There is no known requirement for the consumption of purchased unleaded fuel, diesel fuel, or natural gas proposed for the operation of the warehouse/distribution and industrial facility
Scope 2	Consumption of purchased electricity

The quantitative assessment used the source data and emissions factors as outlined to determine the overall emissions for each source.

Possible additional measures to minimise, mitigate or offset the Project's emissions are discussed in **Section 9.5**.

9.4 Operational Emissions Quantitative Assessment

The source data was determined by estimating potential fuel usage from a number of key activities. Data for the proposed operations were sourced from information provided by Frasers.

The source data for anticipated annual electricity consumption is shown in **Table 35**.

Table 35 Electricity Consumption Source Data

Source	Estimated Annual Consumption (kWh)
Electricity	145,579

Emissions factors used for operation of the Project site were taken from the NGA Factors (see **Table 36**).

[1] 5% is a nominal, though commonly used, threshold for materiality in greenhouse gas accounting. The *National Greenhouse and Energy Reporting Act 2007* includes a threshold for reporting of energy consumption at 5%.

Table 36 Emissions Factors

Scope	Source	Emissions factor	Energy Content Factor[4]
Scope 1	Diesel fuel	70.5 kg CO_2-e /GJ	38.6 GJ/kL
	Gasoline (unleaded fuel)	69.7 kg CO_2-e /GJ	34.2 GJ/kL
	Natural Gas	51.53 kg CO_2-e /GJ	39.3 x 10^{-3} GJ/m^3
Scope 2	Electricity (NSW)	0.84 kg CO_2-e/kWh	NA

Notes:

1. Not all emission sources have an energy content factor, as per the NGA Factors this has been represented by an NA (Not Applicable).

This assessment presents estimated annual GHG emissions for the Project as presented in **Table 37**.

Table 37 Annual GHG Emissions

	Estimated Emissions (t CO_2-e)
Scope1	NA
Scope 2 - Electricity	122.3

The total estimated annual operational GHG emissions for the Project are estimated to be **122 tonnes of carbon dioxide equivalent (t CO_2-e)**. Some of these GHG emissions may be moderated by the installation of solar power (**Section 9.5**).

The NSW Office of Environment and Heritage (OEH) has published the NSW state emissions profile for 2010 as 157 million t CO_2-e. Therefore in the NSW state context, Scope 1 and 2 emissions resulting from the proposed Project operation represents approximately <0.0001% of the total state emissions.

9.5 GHG Mitigation and Management Measures

GHG mitigation has been considered in the design of the Project. Frasers is targeting six star Green Star Design and As-Built v1.1 rating from the Green Building Council of Australia for the Project site. The key initiatives that relate to the sustainability performance of the proposed Project site are outlined in **Table 38**.

Table 38 Key Initiatives for 6 star Green Star Proposed Project

Energy	
Building fabric	10% improvement on BCA – double glazing, increased façade & roof insulation
Translucent sheeting	10% of warehouse roof
Hot water system	Heat pump (air source or geothermal)
Office heating and cooling	Geothermal – reverse cycle ducted
Office outside air	Min 50% increase on OA
Lighting - Office	LED with individual control
Lighting - Warehouse	LED with daylight control
Lighting - External	LED with time clock control
Renewable energy	Solar PV system (100kW)
Energy storage	Customer dependant
Electric vehicles charging	Included

Water	
Water fixtures	5 & 6 star WELS rated
Recycled water	Rainwater for 80%+ irrigation & toilet flushing
Fire test water recycling	80%+ of fire test water recycled
Sub-metering	Electricity and water with web based monitoring system
Commissioning	Commissioning manager and plan

The additional greenhouse gas emission mitigation and management measures, which might be recommended for consideration, are listed below.

9.5.1 Refrigerant Usage

- Use of refrigerants (ammonia and glycol) that do not emit greenhouse gases.
- Undertake regular checks of seals on all refrigerated areas.

9.5.2 Electricity Usage

The following points could be considered to reduce the emissions caused from on-site electricity usage:

- Sensor lighting could be used in some areas to minimise the number of lights on during all hours of operation.
- Translucent Roof sheeting adopted in 10% of roof area.

9.5.3 Vehicles and Equipment

The following points could be considered to reduce overall fuel use from onsite and transport vehicles:

- All vehicles and machinery should be turned off when not in use and regularly serviced to ensure efficient operation.
- Truck routes and loading capacity should be designed to reduce the distance and effort required by the vehicles.
- Encourage car-pooling by employees.
- Where possible, B5 and E10 fuel should be used.

10 CONCLUSION

SLR Consulting Australia Pty Ltd has been engaged by Frasers Property Industrial Constructions Pty Ltd to perform an Air Quality Impact Assessment (AQIA) for the proposed construction and operation of a warehouse/distribution and industrial facility located at Lot 2 on the corner of Horsley Drive and Cowpasture Road, Wetherill Park, NSW (the Project site). This assessment forms a part of the Environmental Impact Statement (EIS) for the Project.

The Air Quality Impact Assessment has considered the potential emissions to air during both (i) the construction phase and (ii) the operational phase of the Project.

A qualitative risk based assessment of the potential impacts upon surrounding sensitive receptors during the construction phase has indicated that following implementation of dust management measures, impacts are anticipated to be negligible.

A quantitative assessment of the potential impacts during Project operation has been performed. The assessment of potential impacts has reflected a worst case scenario which is not anticipated to be realised during the operation of the Project. Even given the level of conservatism applied within the assessment, the predicted impacts resulting from the Project operation are not predicted to cause any exceedance of any air quality criteria and consequently, comply with the requirements of the POEO Act.

Due to the nature and quantum of emissions, ongoing monitoring is not warranted, particularly given no manufacturing is proposed on-site. The light industrial uses proposed do not compromise the assumptions contained within this assessment.

The total estimated annual operational GHG emissions for the Project are estimated to be 122 tonnes of carbon dioxide equivalent (t CO_2-e). The NSW Office of Environment and Heritage (OEH) has published the NSW state emissions profile for 2010 as 157 million t CO_2-e. Therefore in the NSW state context, Scope 1 and 2 emissions resulting from the proposed Project operation represents approximately <0.0001% of the total state emissions.

11 REFERENCES

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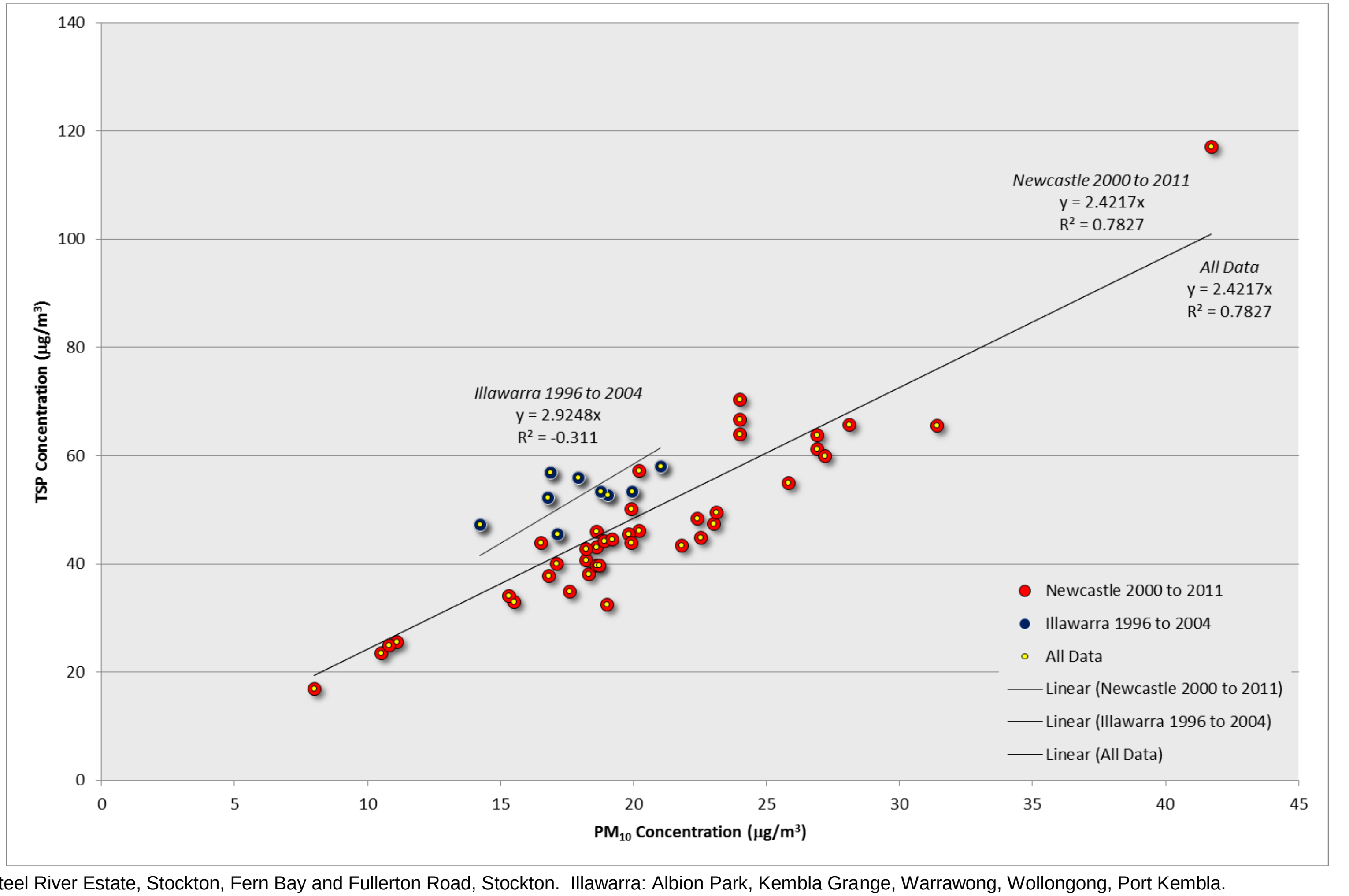
Figure A1 Analysis of PM_{10} and TSP HVAS Data, Newcastle Region (2000 to 2011) and Illawarra Region (1996 to 2004)



Newcastle: Mayfield, Steel River Estate, Stockton, Fern Bay and Fullerton Road, Stockton. Illawarra: Albion Park, Kembla Grange, Warrawong, Wollongong, Port Kembla.

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located more than 350 m from the boundary of the site, more than 50 m from the route used by construction vehicles on public roads and more than 500 m from the site entrance. This step is noted as having deliberately been chosen to be conservative, and will require assessments for most projects.

Step 2a – Assessment of Scale and Nature of the Works

Step 2a of the assessment provides "dust emissions magnitudes" for each of four dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles). The magnitudes are: *Large*; *Medium*; or *Small*, with suggested definitions for each category. The definitions given in the IAQM guidance for earthworks, construction activities and track-out, which are most relevant to this Project, are as follows:

- Earthworks:
  - ***Large***: Total site area greater than 10,000 m^2, potentially dusty soil type (eg clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved more than 100,000 t.
  - ***Medium***: Total site area 2,500 m^2 to 10,000 m^2, moderately dusty soil type (eg silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 t to 100,000 t.
  - ***Small***: Total site area less than 2,500 m^2, soil type with large grain size (eg sand), less than five heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 t, earthworks during wetter months.
- Construction:
  - ***Large***: Total building volume greater than 100,000 m^3, piling, on site concrete batching; sandblasting.
  - ***Medium***: Total building volume 25,000 m^3 to 100,000 m^3, potentially dusty construction material (eg concrete), piling, on site concrete batching.
  - ***Small***: Total building volume less than 25,000 m^3, construction material with low potential for dust release (eg metal cladding or timber).
- Track-out:
  - ***Large***: More than 50 heavy vehicle movements per day, surface materials with a high potential for dust generation, greater than 100 m of unpaved road length.
  - ***Medium***: Between 10 and 50 heavy vehicle movements per day, surface materials with a moderate potential for dust generation, between 50 m and 100 m of unpaved road length.
  - ***Small***: Less than 10 heavy vehicle movements per day, surface materials with a low potential for dust generation, less than 50 m of unpaved road length.

Note: No demolition of existing structures will be performed as part of this Project.

In order to provide a conservative assessment of potential impacts, it has been assumed that if at least one of the parameters specified in the 'large' definition is satisfied, the works are classified as large, and so on.

Step 2b – Assessment of the Sensitivity of the Area

Step 2b of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:

- The specific sensitivities that identified sensitive receptors have to dust deposition and human health impacts;
- The proximity and number of those receptors;
- In the case of PM_{10}, the local background concentration; and
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

Individual receptors are classified as having *high*, *medium* or *low* sensitivity to dust deposition and human health impacts (ecological receptors are not addressed using this approach). The IAQM method provides guidance on the sensitivity of different receptor types to dust soiling and health effects as summarised in **Table 39** (IAQM, 2014). It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

Based on the criteria listed in **Table 39**, the sensitivity of the identified receptors in this study is concluded to be *high* for health impacts and *high* for dust soiling, based upon the following assumptions:

- The identified sensitive receptor locations are dwellings where people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land.
- In general, the local population could reasonably expect a high level of amenity (i.e. low annual average TSP concentrations and dust deposition rates) given the highly vegetated nature of the area which would result in little natural wind-blown dust and low background dust levels.

Table 39 IAQM Guidance for Categorising Receptor Sensitivity

Value	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
Dust soiling	Users can reasonably expect a high level of amenity; or The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land. *Examples: Dwellings, museums, medium and long term car parks and car showrooms.*	Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or The appearance, aesthetics or value of their property could be diminished by soiling; or The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. *Examples: Parks and places of work.*	The enjoyment of amenity would not reasonably be expected; or Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. *Examples: Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.*
Health effects	Locations where the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: Residential properties, hospitals, schools and residential care homes.*	Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: Office and shop workers, but will generally not include workers occupationally exposed to PM10.*	Locations where human exposure is transient. *Examples: Public footpaths, playing fields, parks and shopping street.*

According to the IAQM methods, the sensitivity of the identified individual receptors (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, and the local background PM_{10} concentration (in the case of potential health impacts) and other site-specific factors. Additional factors to consider when determining the sensitivity of the area include:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area and if relevant, the season during which the works will take place;
- any conclusions drawn from local topography;
- the duration of the potential impact (as a receptor may be willing to accept elevated dust levels for a known short duration, or may become more sensitive or less sensitive (acclimatised) over time for long-term impacts); and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in **Table 40**. The sensitivity of the area should be derived for each of activity relevant to the project (ie construction and earthworks).

Table 40 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects

Receptor sensitivity	Number of receptors	Distance from the source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: Estimate the total number of receptors within the stated distance. Only the *highest level* of area sensitivity from the table needs to be considered. For example, if there are 7 high sensitivity receptors < 20m of the source and 95 high sensitivity receptors between 20 and 50 m, then the total of number of receptors < 50 m is 102. The sensitivity of the area in this case would be high.

A modified version of the IAQM guidance for assessing the *sensitivity of an area* to health impacts is shown in **Table 41**. For high sensitivity receptors, the IAQM methods takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest into account and is based on the air quality objectives for PM_{10} in the UK. As these objectives differ from the ambient air quality criteria adopted for use in this assessment (ie an annual average of 20 µg/m^3 for PM_{10}) the IAQM method has been modified slightly.

This approach is consistent with the IAQM guidance, which notes that in using the tables to define the *sensitivity of an area*, professional judgement may be used to determine alternative sensitivity categories, taking into account the following factors:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area, and if relevant the season during which the works will take place;

- any conclusions drawn from local topography;
- duration of the potential impact; and
- any known specific receptor sensitivities which go beyond the classifications given in this document.

Given the above, for the purposes of this study, all receptors have been classified based on the sensitivity classifications for a background annual average PM_{10} concentration of 15.6 µg/m^3 as outlined in **Section 5**.

Table 41 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Receptor sensitivity	Annual mean PM_{10} conc	Number of receptors [a,b]	Distance from the source (m)			
			<20	<50	<100	<350
High	15-22.5 µg/m^3	>100	High	Medium	Low	Low
		10-100	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
	<15 µg/m^3	>100	Medium	Low	Low	Low
		10-100	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low
	-	1-10	Medium	Low	Low	Low
Low	-	>1	Low	Low	Low	Low

Notes: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m); noting that only the highest level of area sensitivity from the table needs to be considered.
(b) In the case of high sensitivity receptors with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.
(c) The estimated background annual average PM_{10} concentration is taken from monitoring data as outlined within **Section 5**.

The dust emission magnitude from Step 2a and the receptor sensitivity from Step 2b are then used in the matrices shown in **Table 42** (earthworks and construction) and **Table 43** (track-out) to determine the risk category with no mitigation applied.

Table 42 Risk Category from Earthworks and Construction Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 43 Risk Category from Track-out Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 3 - Site-Specific Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the site is a low, medium or high risk site.

Step 4 – Residual Impacts

Following Step 3, the residual impact is then determined after management measures have been considered.