

2 Hume Highway, Chullora NSW
Air Quality and Odour Impact Assessment

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Prepared for:

Charter Hall Core Plus Industrial Fund
Bieson Pty Limited as trustee of the CPIF Hume Highway Logistics Trust
Commercial & Industrial Property Pty Limited

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2 Hume Highway, Chullora NSW

Air Quality and Odour Impact Assessment

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Executive Summary

SLR Consulting Australia Pty Ltd has been commissioned by Commercial & Industrial Property Pty Ltd to perform an Air Quality and Odour Impact Assessment for the development of a proposed warehouse and distribution facility located at 2 Hume Highway, Chullora NSW.

Secretary's Environmental Assessment Requirements (SEARS) have been provided by the NSW Department of Planning and Environment for the Development. The SEARS outline a number of requirements with regard to the assessment method and technical and policy guidelines to be referenced as part of the study.

This Air Quality and Odour Impact Assessment has been performed in accordance with all relevant guidelines and has considered each of the SEARS as they relate to air quality and odour.

Emissions of particulate matter from construction related activities and combustion related pollutants during operation have been quantified using industry best-practice techniques. The risk of odour emissions during the construction and operation phases of the Development has been considered to be negligible, and has not been considered in detail within this assessment.

Impacts of the identified air pollutants on surrounding sensitive receptors have been assessed using dispersion modelling techniques in accordance with the SEARS. In addition to the impact from the Development, the current air quality environment of the area surrounding the Development has been considered to determine the likelihood of exceedance of air quality criteria as outlined by the NSW EPA.

Results indicate that all pollutant concentrations resulting from Development construction and operation are below criteria concentrations, with the exception of annual average PM_{2.5}. Annual average PM_{2.5} concentrations in the area are shown to already exceed the adopted guideline value, with additional impacts from the Development predicted to be less than 0.6 µg/m³, or 7.5% of the criterion.

A range of management, mitigation and monitoring options are outlined within this assessment, which will act to further reduce the impact of the Development during both construction and operation.

It is concluded that the construction and operation of the Development will not cause unacceptable impacts on the surrounding environment.

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Commercial & Industrial Property Pty Ltd (CIP) to perform an Air Quality and Odour Impact Assessment (AQIA) for the development of a proposed warehouse and distribution facility located at 2 Hume Highway, Chullora NSW (hereafter 'the Development site').

1.1 Secretary's Environmental Assessment Requirements

NSW Department of Planning and Environment (DPE) issued Secretary's Environmental Assessment Requirements (SEARs) for State Significant Development (SSD) 7235 on 15 September 2015. **Table 1** below identifies the SEARs relevant to Air Quality and Odour issues. The Air Quality and Odour issues have been addressed in the relevant sections of this report.

Table 1 Secretary's Environmental Assessment Requirements – SSD 7235

Key Issue	Assessment Requirement	Addressed in Section
Air Quality and Odour	A quantitative air quality assessment of the air quality and odour impacts of the proposed development including impacts on any surrounding receivers. The assessment must consider impacts from construction and operation, and include:	
	• Detail of the air emission inputs and outputs	Section 5 (inputs) Section 6 (outputs)
	• Identification of all pollutants of concern	Section 3.1
	• A quantitative assessment of all potential impacts using dispersion modelling, including adequate justification and validation (where appropriate) of all model inputs and outputs	Section 5 (inputs) Section 6 (outputs)
	• A cumulative assessment of all existing and proposed emission sources	Section 6
	• Details of the proposed management and monitoring measures	Section 7

Source: NSW Department of Planning and Environment Major Projects Portal
(http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=7235).

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

Air Quality

- *Protection of Environment Operations (Clean Air) Regulation* (NSW Parliament, 2010);
- *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (NSW DEC, 2006)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW DEC, 2005); and,
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia* (TRC, 2011).

Odour

- *Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW* (NSW DEC, 2006); and,
- *Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW* (NSW DEC, 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*" (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 2.3** and **Section 2.2** respectively).
- Establishment of air quality assessment criteria (**Section 3**).
- Description of existing air quality environment (**Section 4.1**).
- Analysis of climate and dispersion meteorology for the region (**Sections 4.2** and **Section 5.2**).
- Compilation of a comprehensive emissions inventory for proposed operations (**Section 5.1**).
- Preparation of an air quality impact assessment report comprising the above.

Potential emissions to air from the proposed operation have been identified and where appropriate, emission rates have been estimated using relevant emission factors published in the literature. These emission rates have then been used in an air dispersion modelling study to assess the potential for any off-site air quality impacts in the surrounding area.

2 DEVELOPMENT OVERVIEW

The Development site is located at 2 Hume Highway in Chullora, NSW (Lot 12 in DP834734) and covers an area of 10.28 hectares (ha). The current use of the site is a Fairfax Media Limited newspaper printing and distribution facility.

All land uses located north/west of the Hume Highway surrounding the Development site are of a similar industrial scale and comprise a number of warehouse facilities used for manufacturing, warehousing and distribution. Land uses located on the opposite side of the Hume Highway include car dealerships, motel, fuel station and some urban residential development.

The Development site is located within the portion of the West Central Industrial Belt, described within the Draft Bankstown North Central Local Area Plan as the Employment Lands Precinct. The precinct includes over 245 ha comprising of the Chullora Technology Park, Potts Hill Business Park and Chullora Industrial Precinct.

The site is specifically included within the area described as the Chullora Technology Park. The Technology Park is regulated by the State Environmental Planning Policy (Western Sydney Employment Area). The site is an important regional hub for major logistics, distribution, warehousing and production industries, with strategic access to Sydney's key arterial road network including M7 and M4 motorways.

2.1 Proposed Development

Consent is sought to develop the site for the purposes of a Warehouse and Distribution Facility. Use of the facility will be for warehousing and distribution on a 24 hour, 7 day basis, consistent with surrounding operations.

The layout of the proposed Development is presented in **Figure 1**.

2.1.1 Construction

The construction phase of the Development will consist of three main stages:

- Demolition (subject to a separate Early Works DA).
- Earthworks.
- Building and construction.
- Integrated building fit-out and commissioning.

The works programme for the development is presented in **Table 2** and indicates that a significant quantity of material is required to be imported to site (~345,000 cubic metres (m³)) to allow levelling of each of three pads (Stage 1, 2A and 2B). The staged development will allow building and other structural works to commence in conjunction with importation and placement of the required fill. Vehicles bringing fill would enter the site via the existing site entrance on Worth St.

Approximately 150 to 200 construction-related jobs would be created by the Development.

Figure 1 Proposed Development Layout

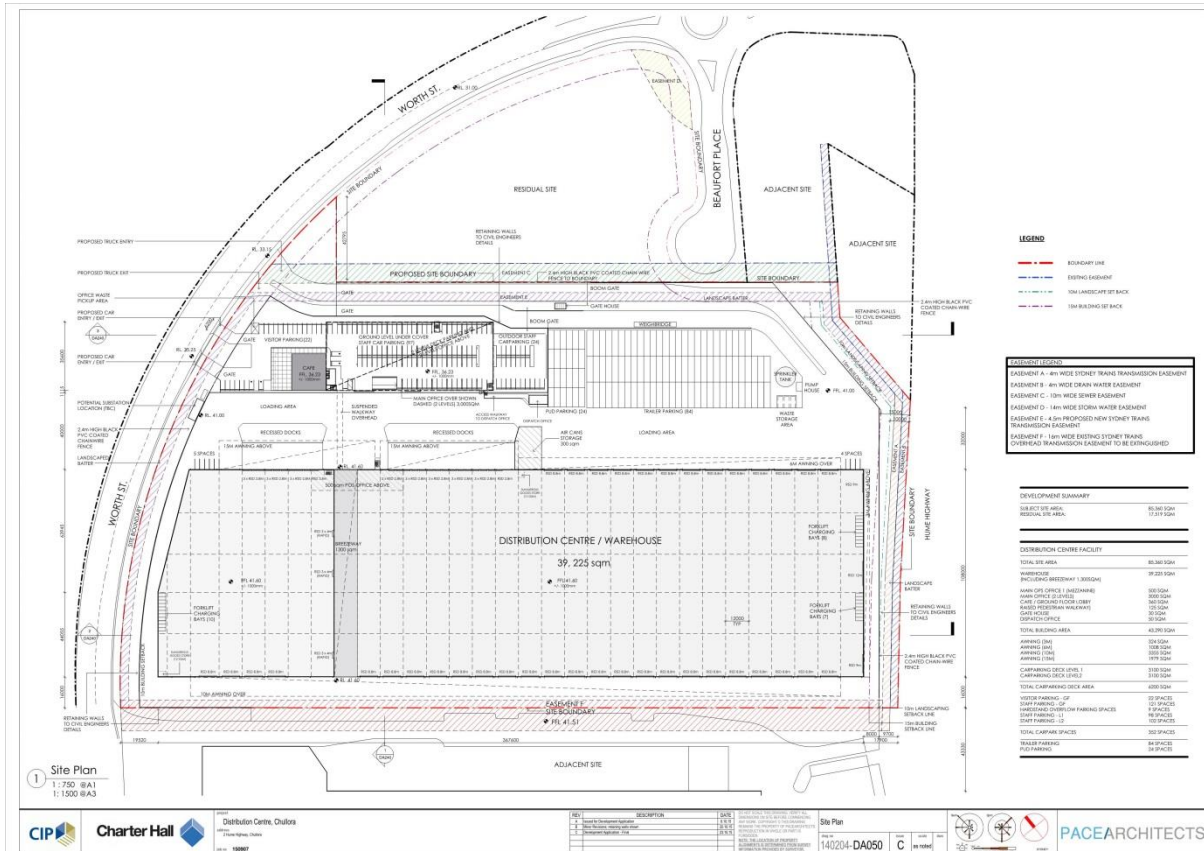


Table 2 2 Hume Highway, Chullora Development Program

Stage	Element	Duration	Notes
Site Works	Total	230 days	
	Commence import and stockpile (45,000 m ³)	30 days	
	Continue import/stockpile/place (~405,000 m ³)	200 days	
Early Works	Total	253 days	Concurrent with site works above
	Demolition works	80 days	
	Import and place fill	223 days	
Construction Works	Total	225 days	Many elements will be performed whilst importation and placement of fill is occurring – staged process
	Groundworks/substructure	105 days	
	Structural Steel and panels	135 days	
	Roofing and metal cladding	135 days	
	Main warehouse concrete slab	118 days	
	Services and finishes	155 days	
	Bulk building	82 days	
	Main office	225 days	
	Warehouse office	101 days	
	External works	200 days	
	Early access	120 days	

Details of each of the Development particulars are provided in **Table 3**.

Table 3 Development Particulars

Structure	Area (m ²)
Warehouse	39,225
Office	3,500
Café / Ground floor lobby	360
Raised pedestrian walkway	125
Dispatch office	50
Gatehouse	30
Total	43,290

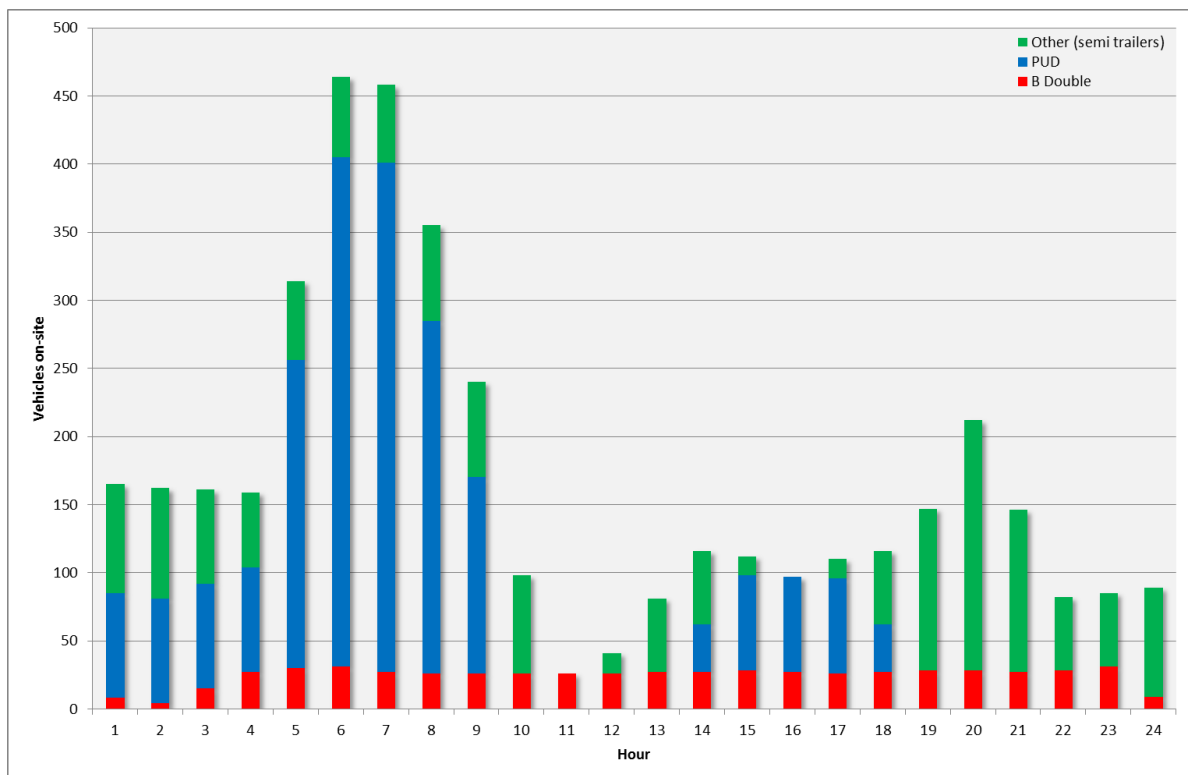
2.1.2 Operation

Operation of the development would generate approximately 300 full time equivalent jobs. The site includes 352 car parking spaces and docks for up to 51 semi-trailers, 95 pick-up and delivery vehicles (PUD) and four B-Doubles.

A number of vehicles may enter the site and be stationary for a period of time whilst parked (staff vehicles) or unloading/loading (B-Doubles, PUDs, and others including semi-trailers).

A likely hourly distribution of non-passenger vehicles on site at any one time has been provided, with the potential hourly distribution as shown in **Figure 2**. The maximum number of non-passenger vehicles on-site at any one time may be 470.

Figure 2 Likely Non-Passenger Vehicle Use of Development Site



2.2 Sensitive Receptors

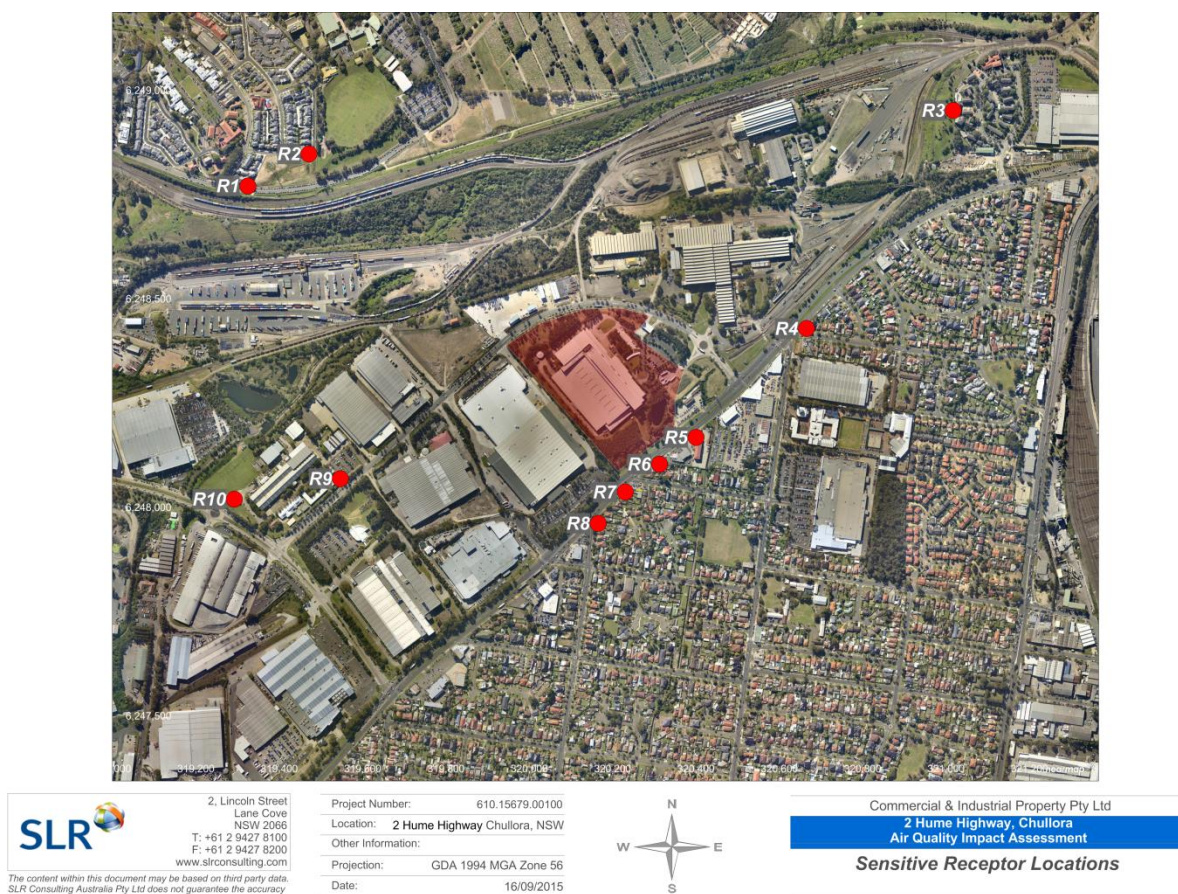
The Development site is largely surrounded by similar industrial development, with some urban residential development. The closest residential area is approximately 50 m to the east of the site boundary along Hume Highway. Other areas of residential development are located in all directions at varying distance from the Development site. Surrounding sensitive receptors identified for this assessment are listed in **Table 4** and presented in **Figure 3**.

Receptor 10 has been selected as a sensitive receptor location, firstly because it is within the grounds of the Southern Sydney TAFE and would represent a location of likely exposure for students (as does R9 which is approximately 250 m closer to the Development site). Secondly, this is also the location of the NSW OEH Chullora Air Quality Monitoring Station (AQMS) and predictions of air quality at this location can be directly added to existing air quality concentrations to determine the likely cumulative impact of the Development. Further detail regarding the Chullora AQMS is presented in **Section 4.1**.

Table 4 List of Identified Sensitive Receptors

Receptor ID	Easting (m)	Northing (m)	Description	Distance / Direction from Development Site Boundary
R1	319,324	6,248,771	28 Herdsmans Avenue, Lidcombe	725 m / WNW
R2	319,471	6,248,848	37 Tallowood Avenue, Lidcombe	650 m / NNW
R3	321,017	6,248,952	21 Marlene Crescent, Greenacre	940 m / NNE
R4	320,665	6,248,429	46 Lawford Street, Greenacre	315 m / NE
R5	320,400	6,248,168	3/97 Hume Highway, Greenacre	50 m / E
R6	320,312	6,248,104	99 Hume Highway, Greenacre	50 m / E
R7	320,230	6,248,037	107 Hume Highway, Greenacre	60 m / SE
R8	320,165	6,247,962	313 Noble Avenue, Greenacre	135 m / SSE
R9	319,546	6,248,069	12 Muir Road, Chullora (Southern Sydney TAFE)	510 m / SW
R10	319,292	6,248,020	12 Muir Road, Chullora (Southern Sydney TAFE)	780 m / SW

Figure 3 Locations of Identified Sensitive Receptors



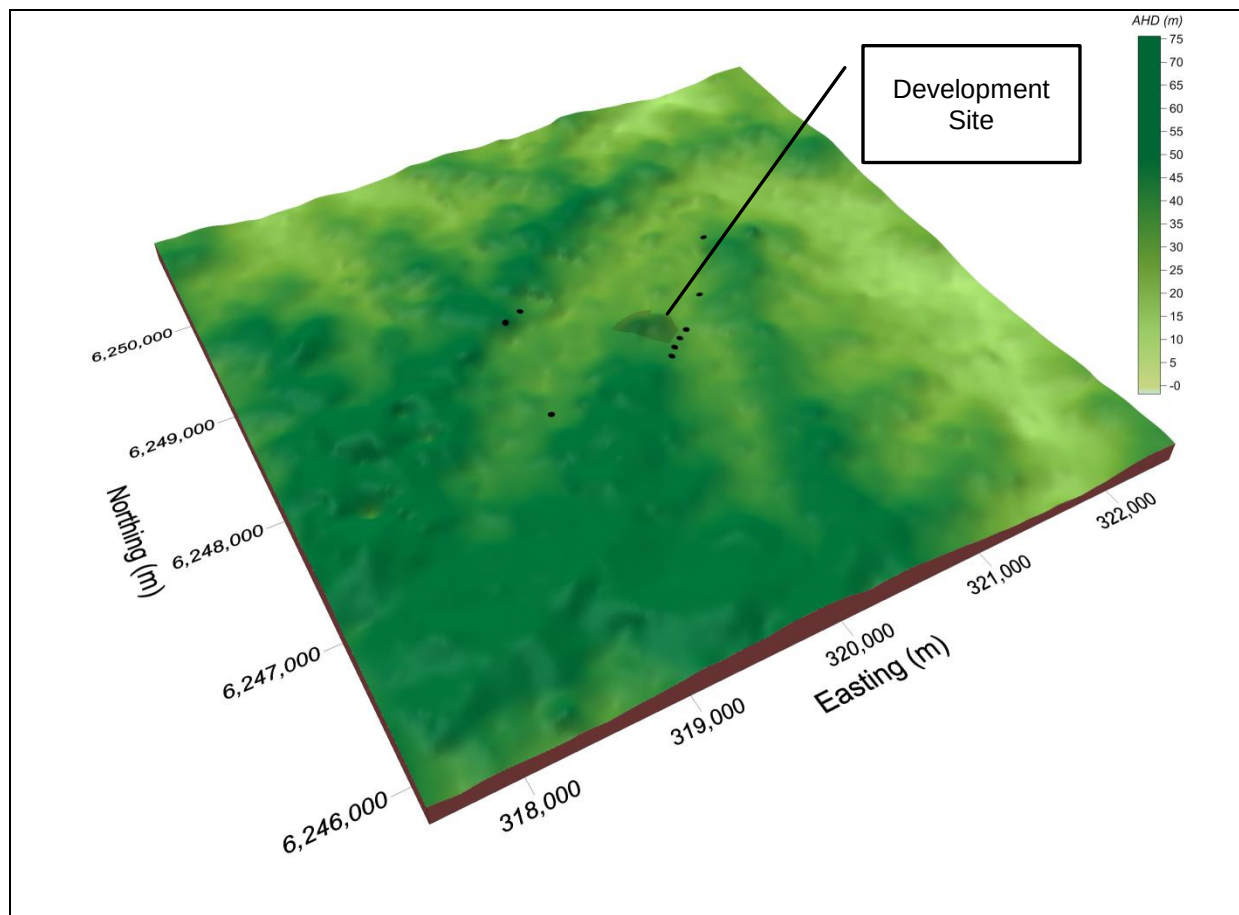
Indicative Development site boundary only shown in red

2.3 Local Topography

Figure 4 illustrates the topography of the region surrounding the Development site. The topographical data used in the modelling assessment was sourced from the United States Geological Service's Shuttle Radar Topography Mission database that has recorded topography across Australia with a 3 arc second (approximately 90 m) spacing.

The topography of the area surrounding the site is characterised by gently undulating terrain, with an approximate range of 10 m to 75 m, Australian Height Datum (AHD).

Figure 4 Local Topographical Features



Location of sensitive receptors shown for context. See **Figure 3** and **Table 4** for receptor details

3 ADOPTED STANDARDS AND GUIDELINES

3.1 Pollutants of Interest

Potential emissions to air during the construction phase will be emissions of particulate matter (dust as TSP, PM₁₀ and PM_{2.5}), from clearing (subject to early works DA), excavation, material handling activities and demolition of the existing warehouse (subject to early works DA). Dust from the construction activities will be controlled using the best management practices outlined in **Section 7.1**. Emissions of combustion related pollutants (oxides of nitrogen [NO_x], carbon monoxide [CO], particulate matter, sulphur dioxide [SO₂] and volatile organic compounds [VOCs]) will also be emitted as a result of diesel combustion in construction vehicles.

During the operational phase, wheel-generated dust from vehicles which are likely to travel on sealed roads and exhaust emissions from heavy vehicles travelling to, from and idling at the site are likely to be the main sources of emissions.

State air quality guidelines adopted by the NSW EPA relating to these pollutants are published in the Approved Methods.

It is not anticipated that odour would be emitted in any significant quantity by the Development during construction works. Analysis of soil samples collected during investigation works (as detailed in the Environmental Site Assessment performed by WSP (WSP, 2015)) indicate that concentrations of benzene, toluene, ethylbenzene and xylenes (BTEX), Poly Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) (all with the potential to result in odour) were either at non-detect concentrations in the soil or below the relevant site assessment criteria. It is therefore anticipated that any invasive ground works would not result in the emission of odour and it is not considered further within this assessment. No odour is anticipated to be emitted from the Development during operation.

The guidance provided in the Approved Methods has been consulted during the preparation of this assessment report. The Approved Methods lists the statutory methods that are to be used to assess the emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods outlines the impact assessment criteria relevant to the Development. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC and WHO) and are the defining ambient air quality criteria for NSW, and are considered to be appropriate for the setting.

3.2 Particulate Matter (as TSP, PM₁₀ 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 particulate matter. In common usage, the terms “dust” and “particulates” are often used interchangeably. The term “particulate matter” refers to a category of airborne particles, typically less than 50 microns (µm) in diameter and ranging down to 0.1 µm and is termed Total Suspended Particulate (TSP). The annual goal for TSP recommended by the NSW EPA is 90 micrograms per cubic metre of air (µg/m³) (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 PM₁₀ 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 PM₁₀ 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 PM₁₀ assessment goals set out in the Approved Methods are as follows:

- a 24-hour maximum of 50 µg/m³; and

- an annual average of 30 $\mu\text{g}/\text{m}^3$.

The Approved Methods do not set any assessment goals for $\text{PM}_{2.5}$. In December 2000, the National Environment Protection Council (NEPC) initiated a review to determine whether a national ambient air quality criterion for $\text{PM}_{2.5}$ 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 was sufficient community concern regarding $\text{PM}_{2.5}$ 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 $\text{PM}_{2.5}$, setting the following Interim Advisory Reporting Standards for $\text{PM}_{2.5}$ (NEPC, 2003):

- a 24-hour average concentration of 25 $\mu\text{g}/\text{m}^3$; and
- an annual average concentration of 8 $\mu\text{g}/\text{m}^3$.

It is noted that the NEPM Advisory Reporting Standards relating to $\text{PM}_{2.5}$ particles are reporting guidelines only at the present time and not intended to represent air quality criteria. A summary of the particulate guidelines is shown in **Table 5**.

Table 5 EPA Criteria for Particulates

Pollutant	Averaging Time	Criteria
TSP	Annual	90 $\mu\text{g}/\text{m}^3$
PM_{10}	24 Hours	50 $\mu\text{g}/\text{m}^3$
	Annual	30 $\mu\text{g}/\text{m}^3$
$\text{PM}_{2.5}$	24 Hours	25 $\mu\text{g}/\text{m}^3$ (interim <u>advisory</u> reporting standard only)
	Annual	8 $\mu\text{g}/\text{m}^3$ (interim <u>advisory</u> reporting standard only)

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

3.2.1 Potential Changes to the Ambient Air Quality NEPM

On 29 April 2014, Environment Ministers signalled their intent to vary the Ambient Air Quality NEPM based on the latest scientific understanding of the health risks resulting from airborne particulate pollution. On 15 July 2015 Ministers agreed in-principle to adopt reporting standards for annual average and 24-hour $\text{PM}_{2.5}$ as outlined in **Table 6** with a move to 7 $\mu\text{g}/\text{m}^3$ and 20 $\mu\text{g}/\text{m}^3$ over the longer term. Ministers agreed to finalise their consideration of the matter by 31 December 2015, including appropriate standards for PM_{10} .

Table 6 Proposed Variation to the Ambient Air Quality NEPM

Metric	Averaging Period	Current Standard	Options for Standard	Allowed Exceedances
PM_{10}	Annual average	None	No standards with consideration of 20 $\mu\text{g}/\text{m}^3$	N/A
	24-hour mean	50 $\mu\text{g}/\text{m}^3$	50 $\mu\text{g}/\text{m}^3$, with consideration of 45 $\mu\text{g}/\text{m}^3$ and 40 $\mu\text{g}/\text{m}^3$	See note below
$\text{PM}_{2.5}$	Annual average	8 $\mu\text{g}/\text{m}^3$ (advisory)	8 $\mu\text{g}/\text{m}^3$	N/A
	24-hour mean	25 $\mu\text{g}/\text{m}^3$ (advisory)	25 $\mu\text{g}/\text{m}^3$	See note below

Source: (NEPC, 2014)

The four options for the form of the 24-hour standards and specifically the treatment of exceedances, for both PM₁₀ and PM_{2.5} are as follows:

- Business as usual option; a rule that allows a fixed number of exceedances of a PM standard in a given year, with no exclusion of data for exceptional events.
- A rule that allows a fixed number of exceedances of a PM standard in a given year, but with exclusion of data for exceptional events.
- A rule in which the 98th percentile PM concentration in a given year is compared with a standard, with no exclusion of data for exceptional events.
- A rule in which the 98th percentile PM concentration in a given year is compared with a standard, but with exclusion of data for exceptional events.

It has been identified by the NEPC that it is likely that jurisdictions will want to identify local issues that affect the form of the standards and therefore the options for this standard were left open for the consultation phase, which closed in October 2014.

3.2.2 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 7 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 7 EPA Goals for Allowable Dust Deposition

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

Source: (NSW DEC, 2005)

3.3 Combustion-Related Pollutants

Emissions associated with road traffic and the combustion of automotive fuel (diesel, petrol, etc.) will include particulate matter, NO_x, CO, SO₂, and VOCs.

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 and is therefore not considered within this assessment.

3.3.1 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 (NO₂). 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 NO₂ 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 NO₂ soon after leaving a vehicle exhaust.

3.3.2 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.

3.3.3 Sulphur Dioxide (SO₂)

Vehicle exhausts can contain emissions of sulphur dioxide (SO₂) due to impurities in the fuel. The sulphur content in diesel fuel has significantly reduced over the years and a timeline of the sulphur content in diesel fuels in Australia is shown in **Table 8**.

Table 8 The Environmental and Operability Standard in Australia – Diesel Fuel Quality Standard

Pollutant	National Standard	Date of Effect	Test Method
Sulphur Content of Fuel	10 ppm (max)	1-Jan-09	ASTM D5453
	50 ppm (max)	1-Jan-06	
	500 ppm (max)	31-Dec-02	

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

3.3.4 Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOC) may be emitted as a result of 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 potential for air quality exceedance of VOCs.

3.3.5 Summary of Combustion-Related Pollutants

Experience in performing assessments of the impact of combustion-related emissions determines that the principal 'indicator' pollutants from fuel combustion are NO₂ and PM₁₀ (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 the annual averages.

The NSW EPA 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 is provided in **Table 9**.

Table 9 NSW 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)
Sulphur 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	50 µg/m ³	NEPC (1998)
	Annual	30 µg/m ³	
PM _{2.5}	24 Hours	25 µg/m ³ (interim <u>advisory</u> reporting standard only)	NEPC (1998)
	Annual	8 µg/m ³ (interim <u>advisory</u> reporting standard only)	

Source: (NSW DEC, 2005)

3.4 Summary of Air Quality Criteria Adopted for this Assessment

The air quality goals adopted for this assessment, which conform to current NSW EPA and Federal air quality criteria, are summarised in **Table 10**. 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.
- Total impact (incremental impact plus background) must be reported as the 100th percentile (maximum) (or 99th percentile for odour) in concentration or deposition units consistent with the impact assessment criteria and compared with the relevant impact assessment criteria.

Table 10 Air Quality Criteria Adopted for this Assessment

Pollutant	Averaging Period	Criteria ($\mu\text{g}/\text{m}^3$)	Source
Sulphur 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)
Benzene	1 hour	29	NEPC (1998)
PM_{10}	24 hours	50	NEPC (1998)
	Annual	30	EPA (1998)
$\text{PM}_{2.5}$	24 hours	25	NEPC (2003)
	Annual	8	NEPC (2003)
TSP	Annual	90	NHMRC (1996)
Criteria ($\text{g}/\text{m}^2/\text{month}$)			
Deposited dust	Annual	2 (maximum increase in deposited dust level) 4 (maximum total deposited dust level)	NERDDC (1988)
Criteria (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.

4 EXISTING ENVIRONMENT

4.1 Air Quality

Air quality monitoring is performed by the NSW OEH at an AQMS within 1 km of the Development site. The details of this AQMS are provided in **Table 11**.

Table 11 Details of Air Quality Monitoring Surrounding the Project Site

AQMS Name	Distance / Direction from Project Site	Location (m, Australian Map Grid, zone 56)		Parameters Measured	AQMS Commissioned
		Easting	Northing		
Chullora	780 m / SW	319,292	6,248,020	Ozone (O ₃) CO SO ₂ NO, NO ₂ , NO _x 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	2003
Located within grounds of the Southern Sydney TAFE, (12 Muir Road)					

Note: TEOM – Tapered Element Oscillating Microbalance

The location of the AQMS is also presented in **Figure 3** (as Receptor 10) and **Figure 5**.

Air quality measured at the Chullora AQMS provides a good representation of the existing air quality experienced in close proximity to the Development site, without the impact of the Development itself. The predicted impact of the Development during both construction and operation can be added to these data with the *existing + predicted* value (the *cumulative* impact) for each pollutant of interest being directly compared to the air quality criteria as outlined in **Section 3**.

A review of the NSW DPE Major Projects Assessment portal indicates that no other Developments in the area are proposed which would have the potential to result in a cumulative impact on air quality. Therefore, the measurements taken at the Chullora AQMS in 2014 can be considered to appropriately represent the existing air quality environment.

Hourly average measurements of CO, NO₂, SO₂, PM₁₀ and PM_{2.5} were obtained from NSW OEH for the Chullora AQMS for the calendar year 2014 (contemporary with the year selected for dispersion modelling [refer **Section 5.2**]). Concentrations of each pollutant relevant to the criteria averaging periods as presented in **Table 10** were calculated and are presented in **Table 12**.

Graphical representation air quality monitoring data for each pollutant of relevance to this assessment as measured at the Chullora AQMS during 2014 is presented in **Appendix A**.

In the case of sub-hourly averaging periods (ie 15-minute maximum CO and 10-minute maximum SO₂), the 1/5th power law ratio has been used to derive the background value as follows:

$$C_1 = C_0 \times \left(\frac{t_0}{t_1}\right)^{0.2}$$

where:

C_1 is the concentration of desired averaging time (10 or 15 minutes)

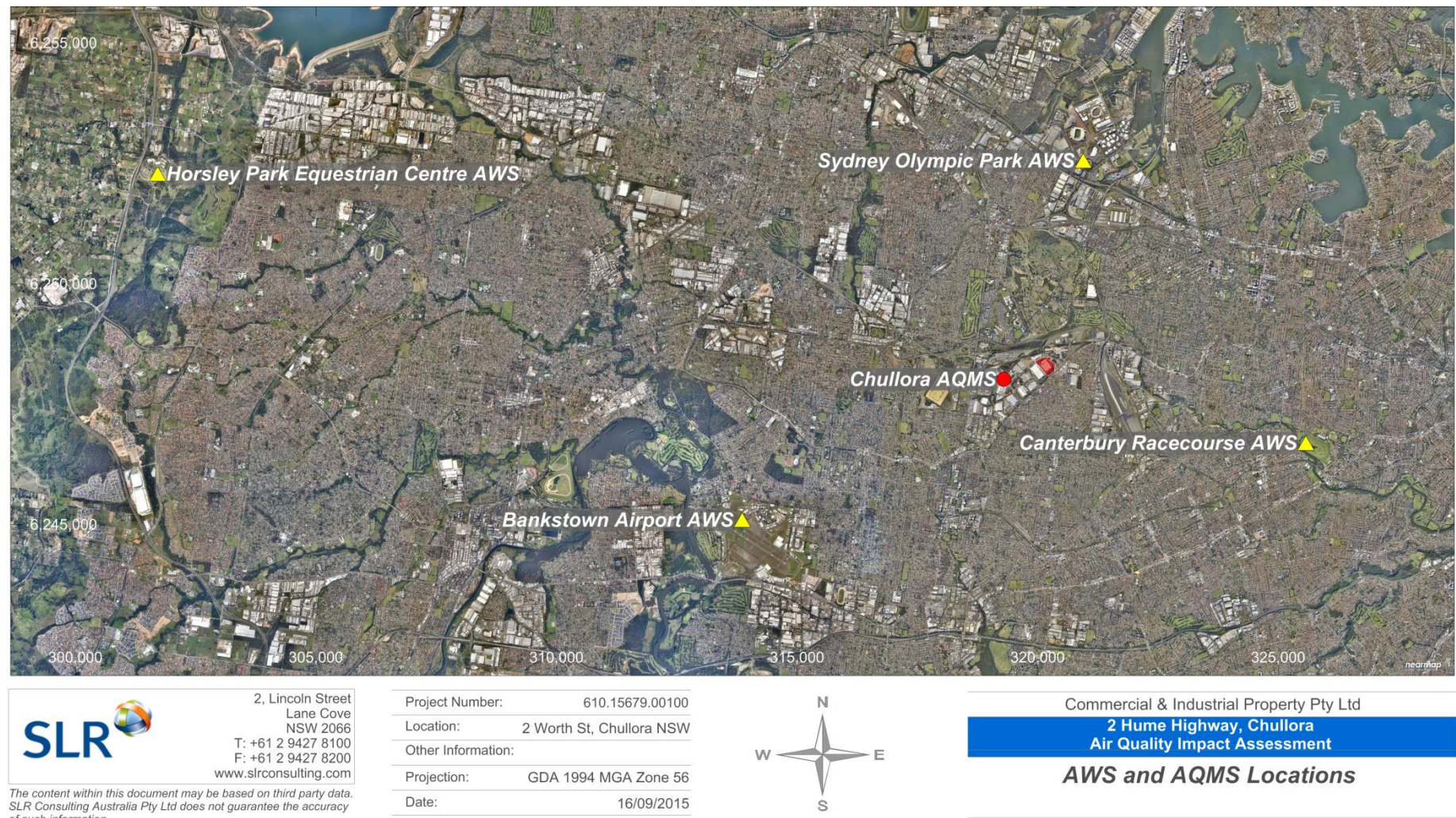
C_0 is the concentration over original averaging time (60 minutes)

t_1 is the desired averaging period (10 or 15 minutes)

t_0 is the initial averaging period (60 minutes)

from (Turner, 1969).

Figure 5 Locations of Automatic Weather Stations and Air Quality Monitoring Stations used for Assessment Purposes



Concentrations of TSP are not measured at the Chullora AQMS. As PM₁₀ represents a fraction of the broader particulate concentration, relationships between TSP and PM₁₀ 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 B**. Analysis indicates that the annual average TSP concentration can be assumed to be 2.42 times the annual average PM₁₀ concentration (ie PM₁₀ represents 42% of total TSP). This multiplier has been applied to the annual average PM₁₀ concentration measured at Chullora in 2014 to obtain the annual average TSP concentration at this location.

Although many of the TSP/PM₁₀ data are associated with areas in which sources of particulate matter may not be identical to those surrounding the Development 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 TSP concentration experienced in the area.

As is the case with TSP, there is no dust deposition data available in close proximity to the Development site for use in this study. Therefore, the assumed background level of deposited dust defaults to 2 g/m²/month, as outlined in the *Approved Methods* (NSW DEC, 2005)

No measurements of VOCs are performed at the Chullora AQMS, or in the area surrounding the Development site. In the absence of information, existing concentrations of benzene (used as an indicator of VOC concentration) have been assumed to be negligible. Although not a conservative assumption, the conclusions of this assessment as they relate to the 1 hour benzene concentration are not dependent on highly accurate calculation of the existing concentration experienced in the area.

A summary of the existing air quality as measured, calculated or assumed in the area surrounding the Development site is presented in **Table 12**. These data represent the maximum concentrations measured.

Table 12 Summary of Air Quality Monitoring Data (Chullora 2014)

Pollutant	Averaging Period	Measured Concentration	Criteria ($\mu\text{g}/\text{m}^3$)	Approximate Percentage of Criterion represented by Existing Measurements
Sulphur dioxide (SO_2)	10 minutes	77.8	712	11%
	1 hour	54.3	570	10%
	24 hours	10.3	228	5%
	Annual	1.7	60	3%
Nitrogen dioxide (NO_2)	1 hour	131.2	246	53%
	Annual	26.9	62	43%
Benzene	1 hour	0.0 (assumed negligible)	29	-
PM_{10}	24 hours	40.0	50	80%
	Annual	18.0	30	60%
$\text{PM}_{2.5}$	24 hours	23.1	25	92%
	Annual	9.0	8	113%
TSP	Annual	43.7	90	49%
Criteria ($\text{g}/\text{m}^2/\text{month}$)				
Deposited dust	Annual	2 $\text{g}/\text{m}^2/\text{month}$ (assumed)	2 (maximum increase in deposited dust level) 4 (maximum total deposited dust level)	-
Criteria (mg/m^3)				
Carbon monoxide (CO)	15 minutes	3.8	100	4%
	1 hour	2.9	30	10%
	8 hours	2.1	10	21%

Note: Bold italicised values are derived from other directly measured values as described

With the exception of the annual average $\text{PM}_{2.5}$ concentration, all pollutants of concern are shown to be below the relevant criteria. SO_2 concentrations are less than approximately 10%, NO_2 concentrations approximately 50%, and CO concentrations are all less than approximately 20% of the relevant criteria. Maximum 24 hour average PM_{10} concentrations are shown to be 80% of the criterion, with the annual average representing 60% of the criterion.

The maximum 24 hour average $\text{PM}_{2.5}$ concentration is shown to be close to the criterion (at 92%) and the annual average is in exceedance of the criterion of $8 \mu\text{g}/\text{m}^3$, measured at $9 \mu\text{g}/\text{m}^3$ in 2014 at Chullora.

The assessment of the existing air quality environment therefore indicates that during both construction and operation of the Development, focus should be on the minimisation and mitigation of particulate matter emissions.

4.2 Meteorology

The Australian Government Bureau of Meteorology (BoM) maintains a network of automatic weather stations (AWS) across Australia. The closest such stations to the Development site are Canterbury Racecourse (Station # 66194), Bankstown Airport (Station # 66137), Sydney Olympic Park (Station # 66212) and Horsley Park Equestrian Centre (Station # 67119). The locations of each of these AWS in relation to the Development are shown in **Figure 5**.

Of these four AWS, the longest period of measurements available is from Bankstown Airport (1968-2015). Graphical representation of these long-term temperature and rainfall measurements is presented in **Appendix C**.

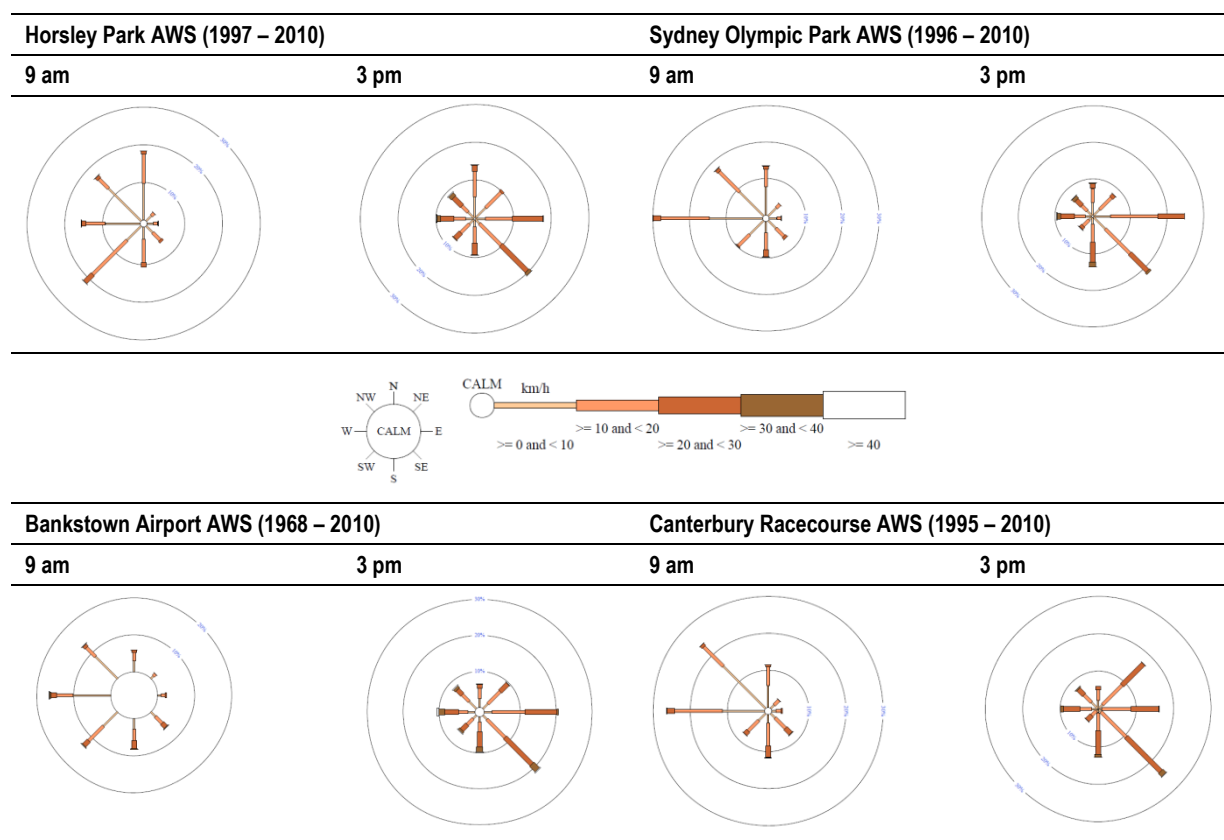
Mean maximum temperatures range from approximately 17°C in winter to above 28°C in summer, while mean minimum temperatures range from approximately 5°C in winter to around 18°C in summer. The highest recorded temperature was 46.1°C, recorded on 18 January 2013.

Rainfall is relatively evenly distributed throughout the year, with a slight peak in the highest rainfall totals in February through to August. The highest ever daily rainfall total was 243 mm, recorded on 6 August 1986. Monthly rainfall can also be low, with most months recording <1 mm at some point during 1968 to 2015. The average annual rainfall is 871 mm.

As rainfall is relatively steady throughout the year, the data do not indicate that there is a particular “dry season” when there would be an increased potential for dust emissions during construction or operation.

Visualisation of the longer term wind patterns in the area surrounding the Development site is presented in **Figure 6**. The 9 am and 3 pm wind roses indicate that for all four AWS surrounding the Development, winds in the morning show a dominance of those with a large westerly component. In the afternoon, winds tend to be stronger and predominantly from an easterly or south easterly direction. These wind roses show the wind behaviour for the entire period although seasonal differences will be observable. The seasonal variation in meteorology has been considered in this assessment with further detail provided in **Section 5.2**.

Figure 6 Long Term 9am and 3pm Wind Measurements



Generally speaking, greater impacts on the closest sensitive receptors to the east of the Development site (R4 to R6) might be experienced during the morning, with winds acting to transport any pollutants generated by the Development away from these receptors during the afternoon. Detailed assessment of the impacts of meteorology on air quality impacts at all receptors is presented in **Section 6**.

5 IMPACT ASSESSMENT METHODOLOGY

The approach to the assessment of potential impacts of the Development on air quality has been guided by the Approved Methods as required by the SEARS (refer **Section 1.1**). The assessment has also been performed in accordance with *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia* (TRC, 2011) as required by the SEARS where appropriate.

5.1 Emission Estimation

Emissions of pollutants identified in **Section 3.1** resulting from the construction and operation of the Development were estimated based on the following assumptions:

- During the construction phase, trucks are likely to travel at onsite at low speed (<30 km/hr) and are unlikely to stay idle for any significant period of time within the site boundary.
- During the operational phase, vehicles (B-Double, Semitrailers and PUDs) are likely to stay idle during the loading/unloading operations and emissions from onsite vehicle movements are likely to be minimal compared to that from long-duration idling.

5.1.1 Construction

Potential particulate emissions associated with the construction phase of the project were estimated using emission factors sourced from:

- National Pollutant Inventory Emission Estimation Technique for Mining Version 3.1 January 2012 (DoE, 2012) (*adopted in the absence of construction specific emission factors*);
- AP 42 Compilation of Air Pollutant Emission Factors, Volume 1, Fifth Edition (US EPA, 1995 and updates):
 - Chapter 13.2.2 – Unpaved Roads; and
 - Chapter 13.2.4 – Aggregate Handling and Storage Piles.

Potential emissions associated with the combustion of fuel onsite (trucks, bulldozers, roller) were estimated using the 'Computer Programme to calculate Emissions from Road Transport' (COPERT) Australia software, developed by a joint effort of EMISIA and the Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA). COPERT Australia is a software tool that is designed to develop:

- National or state level motor vehicle emission inventories; and
- Emission factors as a function of vehicle speed for road-based emission calculations.

COPERT Australia is based on the European version of the COPERT model and has been adapted by UniQuest to develop a national Motor Vehicle Emission Inventory (MVEI) for each state and territory for the Australian Government Department of Environment. The software has been adopted by the National Pollutant Inventory (NPI) as the tool for calculating emissions from motor vehicles (UniQuest, 2014).

Estimated emissions based on the methodology outlined above are presented in **Table 13**. A detailed emissions inventory for the construction phase of the project is presented in **Appendix D**.

Table 13 Estimated Emissions – Construction

Pollutant	Emission Rate (kg/annum)
TSP	26,502
PM ₁₀	7,592
PM _{2.5}	2,012
NO _x	1,018
SO ₂	0.4
CO	197
VOCs	70

5.1.2 Operation

Potential emissions associated with the combustion of fuel onsite during the operational phase of the project were estimated using emission factors sourced from:

- Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy Duty Trucks (US EPA Office of Transport and Air Quality, 2008), EPA420-F-08-025;

It is understood that the total number of onsite vehicles and number of vehicles in each category (PUDs, Semitrailers and B-Double) will vary during the operational hours. The estimated diurnal variation in total vehicle numbers and vehicles in each category is presented in **Figure 2**.

Emission factors used in estimating the potential emission rate and estimated emission rate for the operational phase of the project is presented in **Table 14**.

Table 14 Emission Factors and Estimated Emission Rates – Operation

Pollutant	Emission Factor (g/hr)		Estimated Emission Rate (g/s)
	B-Double	PUDs and other	
NO _x	33.763	4.065	0.78
CO	25.628	72.725	8.97
PM _{2.5}	1.100	0.000	0.01
PM ₁₀	1.196	0.000	0.01
Benzene	0.140	0.194	0.02

Benzene emission rate was calculated assuming that benzene constitutes 4% of the total hydrocarbon in the exhaust (USEPA 1990)

5.2 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, 2004).

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.

5.2.1 Selection of the Meteorological Year

The Bureau of Meteorology (BoM) maintains automatic weather stations (AWS) throughout Australia. The closest such stations were identified as Canterbury (Station # 66194), Bankstown Airport AWS (Station # 66137), Sydney Olympic Park (Station # 66212), Horsley Park Equestrian Centre (Station # 67119).

In order to determine a representative meteorological year for use in dispersion modelling, the last five years of meteorological data (2010-2014) were analysed against the long term meteorological conditions. Specifically, the following parameters were analysed:

- Percentage of calm wind speed events (wind speed <0.5 m/s). Calm wind conditions are conducive to higher concentrations of combustion related pollutants due to poor dispersion of the plume.
- Percentage of high wind speed events (wind speed >5.4 m/s). High wind speed conditions are conducive to lower concentrations of odour due to higher dispersion of the odour plume.
- Hourly wind speeds observed at 9 am and 3 pm.

Based on the above parameters, all five years reviewed (2010 – 2014) showed similar trends as the long term data. In the absence of one particular year being shown to be more representative of typical meteorological patterns in the area, the calendar year 2014 was adopted, based on it being the latest full year of meteorological data available at the time of conducting this assessment.

5.2.2 TAPM

In order to calculate all 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 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 may assimilate actual local wind observations so that they can optionally be included in a model solution. However, given that TAPM is known to under-predict calm wind conditions, the wind speed and direction observations obtained for Sydney Airport AWS have instead been used in the CALMET component of the modelling as described in **Section 5.2.3** below.

Table 15 Meteorological Parameters used in Assessment (TAPM v 4.0.4)

Modelling period	1 January 2014 to 31 December 2014
Centre of analysis	328,543 E 6,240,843 N (UTM Coordinates)
Number of grid points	25 × 25 × 35
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Data assimilation	Canterbury Racecourse AWS (Station # 66194)

	Bankstown Airport AWS (Station # 66137)
	Sydney Olympic Park AWS (Station # 66212)
	Horsley Park Equestrian Centre AWS (Station # 67119)
Terrain	AUSLIG 9 second DEM

The upper air data from TAPM was output and used as input for the diagnostic meteorological model, CALMET.

5.2.3 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. The final wind field thus reflects the influences of local topography and land uses.

CALMET modelling was conducted using the nested CALMET approach, where the final results from a coarse-grid run were used as the initial guess of a fine-grid run. This has the advantage that off-domain terrain features including slope flows and blocking effects can be allowed to take effect and the larger scale wind flow provides a better start in the fine-grid run.

The outer domain (38 km × 28 km) was modelled with a resolution of 1 km. TAPM-generated 3-dimensional meteorological data was used as the initial guess wind field and the local topography and available surface weather observations in the area were used to refine the wind field predetermined by TAPM data. Hourly surface meteorological data from BoM stations located at Canterbury Racecourse, Bankstown Airport, Horsley Park Equestrian Centre and Sydney Airport were incorporated in the outer domain modelling.

The output from the outer domain CALMET modelling was then used as the initial guess field for the mid domain CALMET modelling. The mid domain encompasses an area of 10 km × 10 km. A horizontal grid spacing of 0.3 km was used to adequately represent the important local terrain features and land use.

The output from the mid domain CALMET modelling was then used as the initial guess field for the inner domain CALMET modelling. The inner domain encompassed an area of 5 km × 5 km with a horizontal grid spacing of 0.1 km to adequately represent the important local terrain features and land use. The fine scale local topography and land use information were used in this run to refine the wind field parameters predetermined by the coarse CALMET run. **Table 16** details the parameters used in the CALMET modelling.

The approach to CALMET modelling taken within this assessment is identified in (TRC, 2011) as the CALMET Hybrid Mode and is considered to be an 'advanced model simulation'. The values of all critical CALMET variables as identified by TRC (2011) used in modelling are presented in **Appendix E**.

Table 16 Meteorological Parameters used in this Assessment (CALMET v 6.42)

Outer Domain	
Meteorological grid	38 km × 28 km
Meteorological grid resolution	1 km
Surface station data	Canterbury, Bankstown Airport, Horsley Park Equestrian Centre and Sydney Airport BoM Stations
Initial guess field	3D output from TAPM modelling (refer Section 5.2.2)
Mid Domain	
Meteorological grid	10 km × 10 km
Meteorological grid resolution	0.3 km
Initial guess field	3D output from outer domain model run
Inner Domain	
Meteorological grid	5 km × 5 km
Meteorological grid resolution	0.1km
Initial guess field	3D output from mid domain model run

The outputs of the CALMET modelling extracted at the Chullora AQMS are presented in **Appendix F**. Predictions of wind speed by season, mixing height by time of day and annual stability class frequency are provided.

5.2.4 Validation of Meteorological Modelling

Outputs of the CALMET modelling extracted at the Chullora AQMS have been compared to observations at this location for the year 2014. A comparison of the predicted and observed wind behaviour is presented as wind roses in **Figure 7** and **Figure 8**.

The wind roses indicate that certain features observed at the Chullora AQMS are not replicated by the CALMET modelling. A higher frequency of winds from the south-west and north-east are shown to be observed during 2014, a feature not simulated through CALMET modelling. The high frequency of occurrence of these south-westerly and north-easterly winds is shown to be observed across all seasons.

Predicted wind behaviour at the Chullora AQMS indicates that annually, winds are predicted to occur predominantly from the northwest quadrant, with the predominance of direction changing by season. Winds during the summer are predominantly predicted to occur from the northeast, and during autumn winter and spring months from the northwest.

A review of the location of the Chullora AQMS, and specifically the associated meteorological station indicates that the site does not comply with the relevant Australian Standard for location of air monitoring equipment given that there are trees located within 20 m to the east and north-east of the station. Furthermore, the meteorological station is located approximately 35 m to the west of buildings associated with the Southern Sydney TAFE. The locations of these obstacles may be acting to result in the high frequency of south-westerly and north-easterly winds across all seasons.

Figure 7 Wind Roses for the Chullora AQMS as Predicted by CALMET (2014)

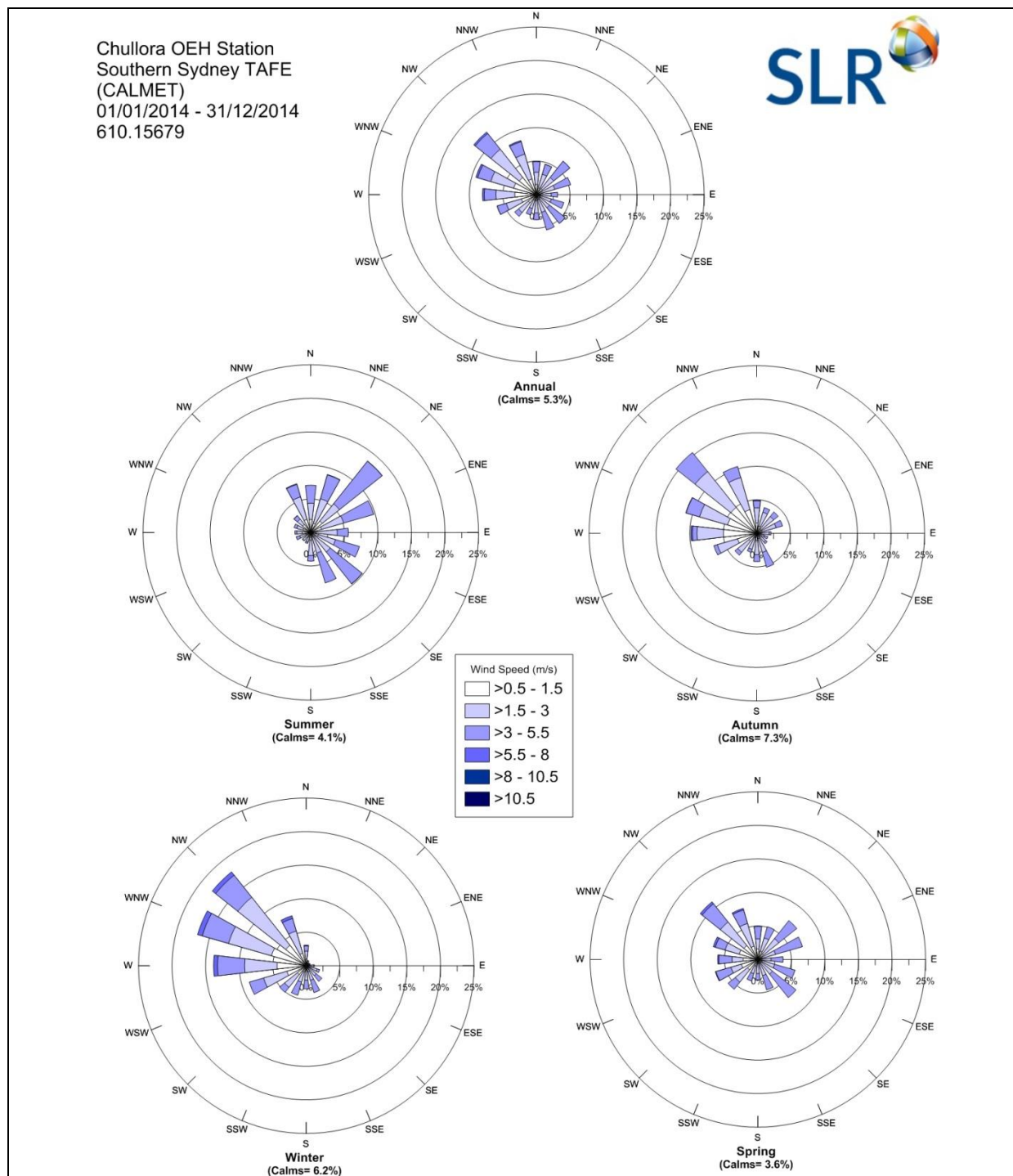
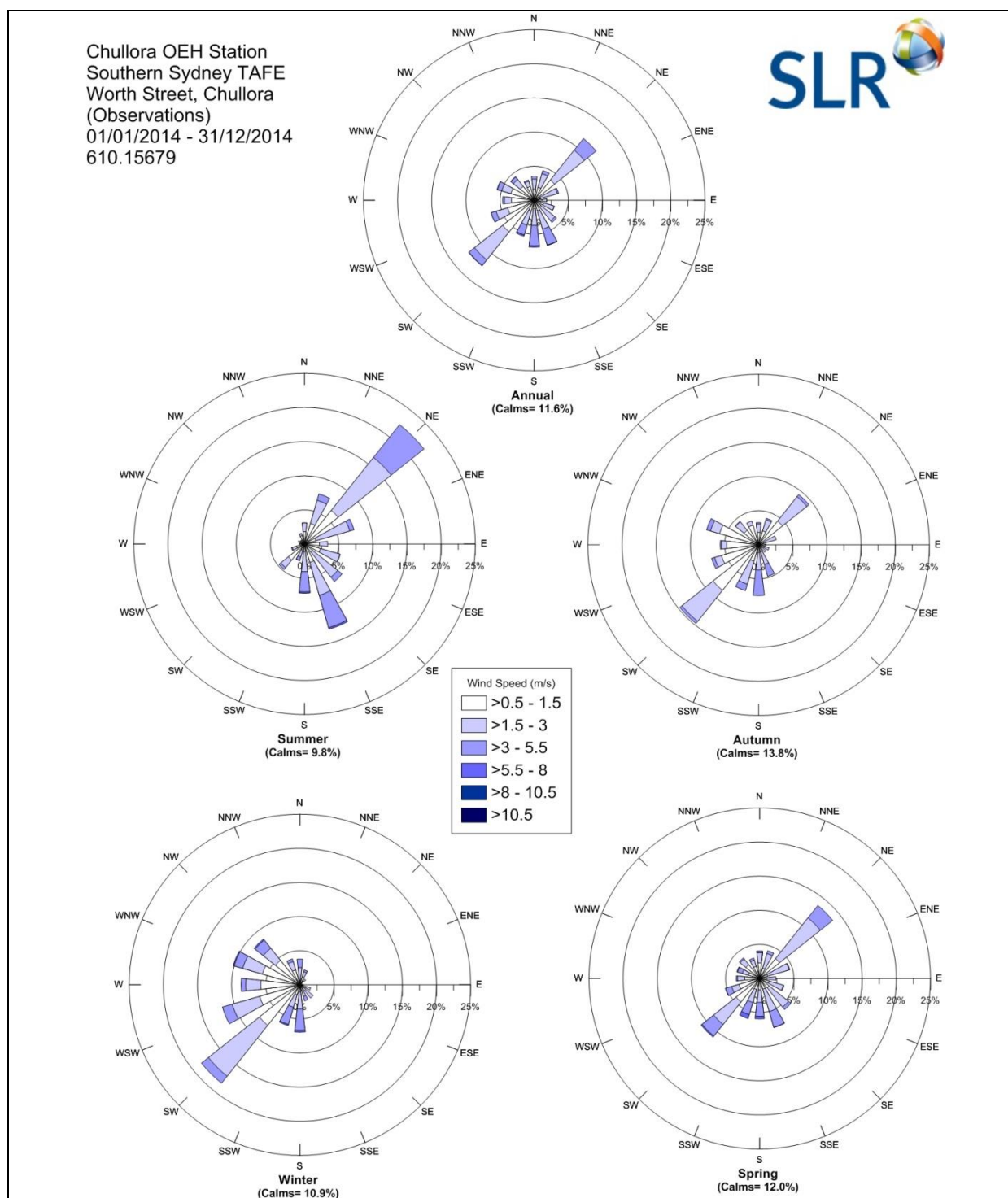


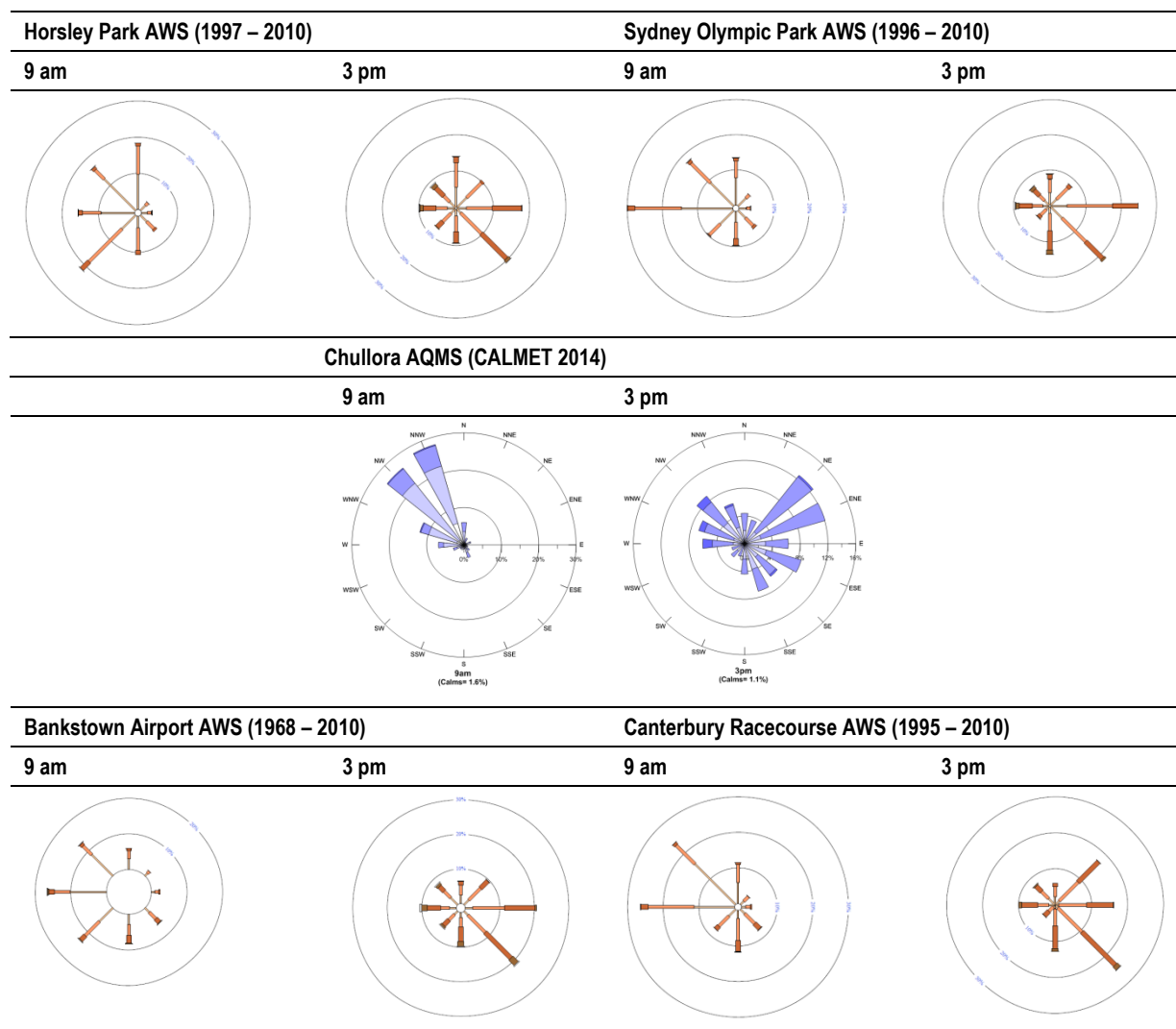
Figure 8 Wind Roses for the Chullora AQMS – Observed Data (2014)



A further validation has been performed, comparing the predicted 9 am and 3 pm wind conditions at the Chullora AQMS for the year 2014 with those at BoM AWS over the longer term (as previously presented in **Figure 6**). The wind roses as presented in **Figure 9** indicate that the predicted 9 am and 3 pm wind behaviour at the Chullora AQMS shows the appropriate dominant features of changing wind directions from westerly to easterly winds across the day. The features predicted are most similar with the Canterbury Racecourse AWS windroses, although they show similarities with observed data from all AWS within the immediate area.

Based on the assessment above, it is considered that the predicted CALMET meteorological dataset generated is appropriate for use within this assessment. The assessment seeks to predict the maximum impacts at each receptor over a one year timeframe and not to accurately and directly predicted the hour to hour variation in pollutant concentrations.

Figure 9 Comparison of CALMET Predicted Wind Measurements (2014) with Long Term 9am and 3pm Wind Measurements



5.3 Dispersion Modelling

For this assessment, dispersion modelling was conducted using the US EPA's CALPUFF (Version 6) modelling system, as recommended by the NSW EPA. CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way.

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 8,760 hour (1 year) simulation for user-selected averaging periods.

The advantages of using CALPUFF (rather than using a steady state Gaussian dispersion model such as Ausplume) is its ability to handle calm wind speeds (<0.5 m/s), complicated terrain and cumulative pollution impacts. Steady state models assume that meteorology is unchanged by topography over the modelling domain and may result in significant over or under estimation of air quality impacts. Further and general information on the accuracy of dispersion modelling is presented in **Appendix F**.

5.4 Application of Existing Air Quality Data

As described in **Section 4.1**, the characterisation of the existing air quality of the area surrounding the Development site has been performed using measurements collected at the Chullora AQMS in 2014. Although the data in **Table 12** represents the maximum concentration measured (for comparison with the criteria), 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.

5.4.1 NO_x to NO₂ Conversion

For NO₂, predictions are made using emission rates of NO_x (refer **Section 5.1**) with corresponding impacts assessed at sensitive receptors. A conservative assumption can be made that all NO_x emitted will be converted to NO₂ with the background NO₂ concentration added to allow comparison with the cumulative NO₂ 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 NO₂ conversion is limited by the ambient ozone (O₃) 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 (NO₂). Once emitted into the atmosphere, the NO is oxidised to NO₂, predominantly (although not exclusively) through reaction with O₃.

The OLM assumes that all the available O₃ in the atmosphere will react with NO in the plume until either all the O₃ 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 (O₃ and NO₂ from the Chullora AQMS).

The OLM is presented below:

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

Where:

$[NO_2]_{total}$ = the predicted concentration of NO_2 in $\mu g/m^3$

$[NO_x]_{pred}$ = the dispersion model prediction of the ground level concentration of NO_x in $\mu g/m^3$

MIN = the minimum of the two quantities within the braces

$[O_3]_{bkgd}$ = the background ambient O_3 concentration in $\mu g/m^3$

$\left(\frac{46}{48}\right)$ = the molecular weight of NO_2 divided by the molecular weight of O_3

$[NO_2]_{bkgd}$ = the background ambient NO_2 concentration in $\mu g/m^3$

6 AIR QUALITY IMPACT ASSESSMENT

Impacts upon air quality in the area surrounding the Development site may be anticipated during both the construction and operational phases. The following sections outline in detail the results of the quantitative assessment for both the construction and operational phases of the Development.

A summary of the status of compliance with the air quality criteria outlined in **Section 3** is presented in **Table 17** for the construction phase and in **Table 18** for the operational phase of the Development.

Cumulative concentrations of pollutants have been calculated as described in **Section 5.4**.

Table 17 Assessment of Compliance - Construction

Pollutant	Averaging Period	Maximum Increment / Receptor	Maximum Cumulative / Receptor	Criterion	Compliance
NO ₂	1 hour	49.2 / R8 (NO _x)	137.9 / R6 (NO ₂)	246 µg/m ³	✓
	Annual	1.5 / R6	49.2 / R8 (NO ₂)	62 µg/m ³	✓
CO	15 minutes	<0.1 / ALL	<3.9 / ALL	100 mg/m ³	✓
	1 hour	<0.1 / ALL	<3.0 / ALL	30 mg/m ³	✓
	8 hours	<0.1 / ALL	<2.2 / ALL	10 mg/m ³	✓
SO ₂	10 minutes	<0.1 / ALL	<77.8 / ALL	712 µg/m ³	✓
	1 hour	<0.1 / ALL	<54.3 / ALL	570 µg/m ³	✓
	24 hours	<0.1 / ALL	<10.2 / ALL	228 µg/m ³	✓
	Annual	<0.1 / ALL	<1.7 / ALL	60 µg/m ³	✓
Benzene	1 hour	3.4 / R8	3.4 / R8	29 µg/m ³	✓
TSP	Annual	5.9 / R6	49.6 / R6	90 µg/m ³	✓
PM ₁₀	24 hours	14.6 / R5	49.7 / R6	50 µg/m ³	✓
	Annual	2.2 / R6	20.2 / R6	30 µg/m ³	✓
PM _{2.5}	24 hours	4.8 / R6	23.4 / R7	25 µg/m ³	✓
	Annual	0.6 / R6	9.6 / R6	8 µg/m ³	✗

Table 18 Assessment of Compliance - Operation

Pollutant	Averaging Period	Maximum Increment / Receptor	Maximum Cumulative / Receptor	Criterion	Compliance
NO ₂	1 hour	108.4 / R8 (NO _x)	177.7 / R6	246 µg/m ³	✓
	Annual	9.4 / R6 (NO _x)	34.4 / R6 (NO ₂)	62 µg/m ³	✓
CO	15 minutes	5.6 / R6	9.1 / R6	100 mg/m ³	✓
	1 hour	5.4 / R6	6.9 / R6	30 mg/m ³	✓
	8 hours	4.2 / R6	4.9 / R7	10 mg/m ³	✓
Benzene	1 hour	14.8 / R6	14.8 / R6	29 µg/m ³	✓
PM ₁₀	24 hours	2.7 / R6	41.6 / R6	50 µg/m ³	✓
	Annual	0.6 / R6	18.6 / R6	30 µg/m ³	✓
PM _{2.5}	24 hours	2.4 / R6	23.6 / R7	25 µg/m ³	✓
	Annual	0.6 / R6	9.6 / R6	8 µg/m ³	✗

6.1 Construction

Dispersion modelling predictions at the residences/properties nominated in **Section 2.3** are presented in **Section 6.1.1** to **Section 6.1.5** for the construction phase of the Development. Pollutant isopleth plots are also provided in the respective sections which show the maximum predicted incremental (Development only) concentrations and deposition rates of the pollutants assessed.

As discussed in **Section 4.1** a detailed assessment of the existing pollutant concentrations in the area surrounding the Development has been performed. Within this results section the predicted contribution from the Development activities has been added to the background dataset in order to provide information on the cumulative impact of the Development on air quality within the local area.

6.1.1 Dust Deposition

Table 19 presents the incremental annual average dust deposition rates predicted at surrounding representative sensitive receptors. It is noted that the predicted cumulative annual average dust deposition rates at all receptors are below the relevant NSW EPA guideline (<65% of the criterion).

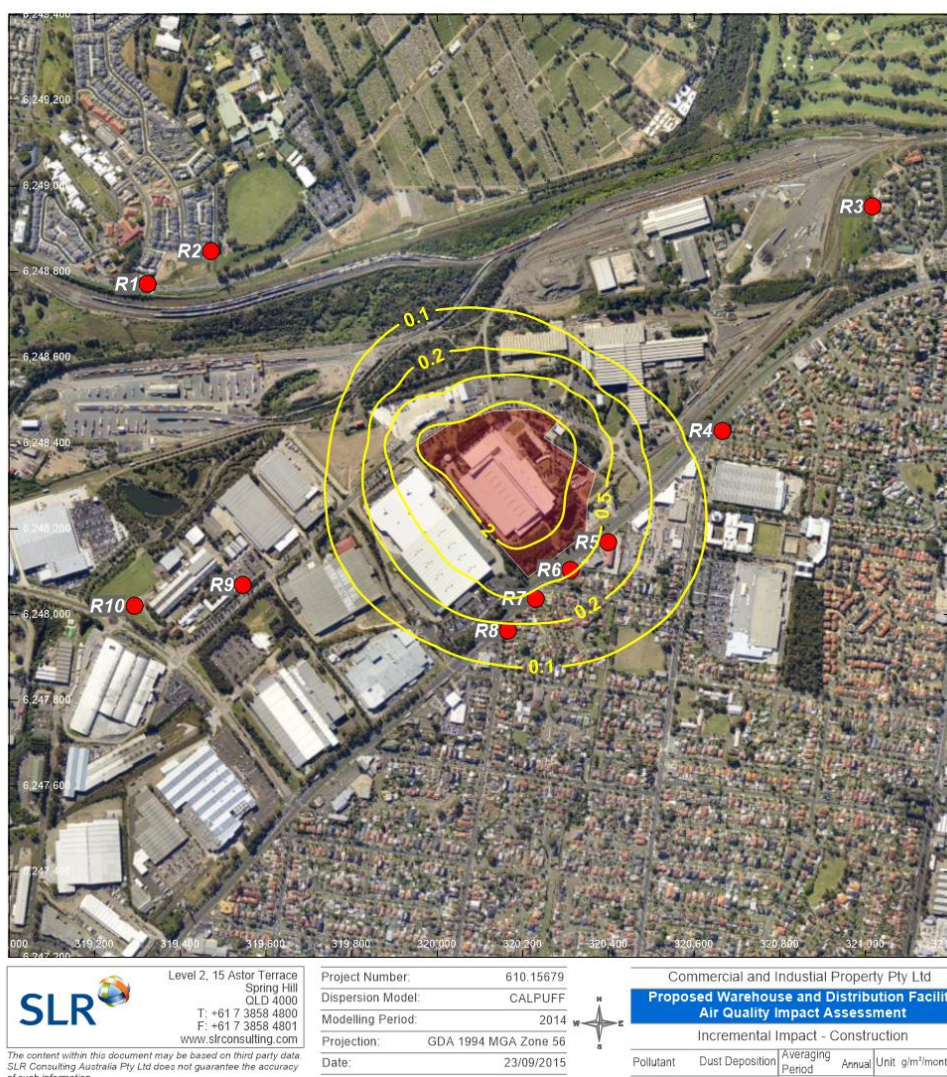
Contour plots of the predicted incremental annual average dust deposition rates are presented in **Figure 10**.

Table 19 Predicted Annual Average Dust Deposition Rates at Sensitive Receptors - Construction

Receptor ID	Incremental Impact (g/m ² /month)	Assumed Background (g/m ² /month) ¹	Cumulative Impact (g/m ² /month)
R1	<0.1	2.0	<2.1
R2	<0.1	2.0	<2.1
R3	<0.1	2.0	<2.1
R4	<0.1	2.0	<2.1
R5	0.4	2.0	2.4
R6	0.5	2.0	2.5
R7	0.3	2.0	2.3
R8	0.2	2.0	2.2
R9	<0.1	2.0	<2.1
R10	<0.1	2.0	<2.1
Criterion	2	-	4

Note 1: Refer **Section 4.1**

Figure 10 Predicted Annual Average Dust Deposition Rates - Construction



6.1.2 Particulates (as TSP)

Table 20 presents the incremental and cumulative annual average TSP concentrations predicted at surrounding representative sensitive receptors. It can be observed from **Table 20** that the predicted cumulative annual average TSP concentrations at all receptors are lower than to the relevant OEH guideline (<55% of the criterion).

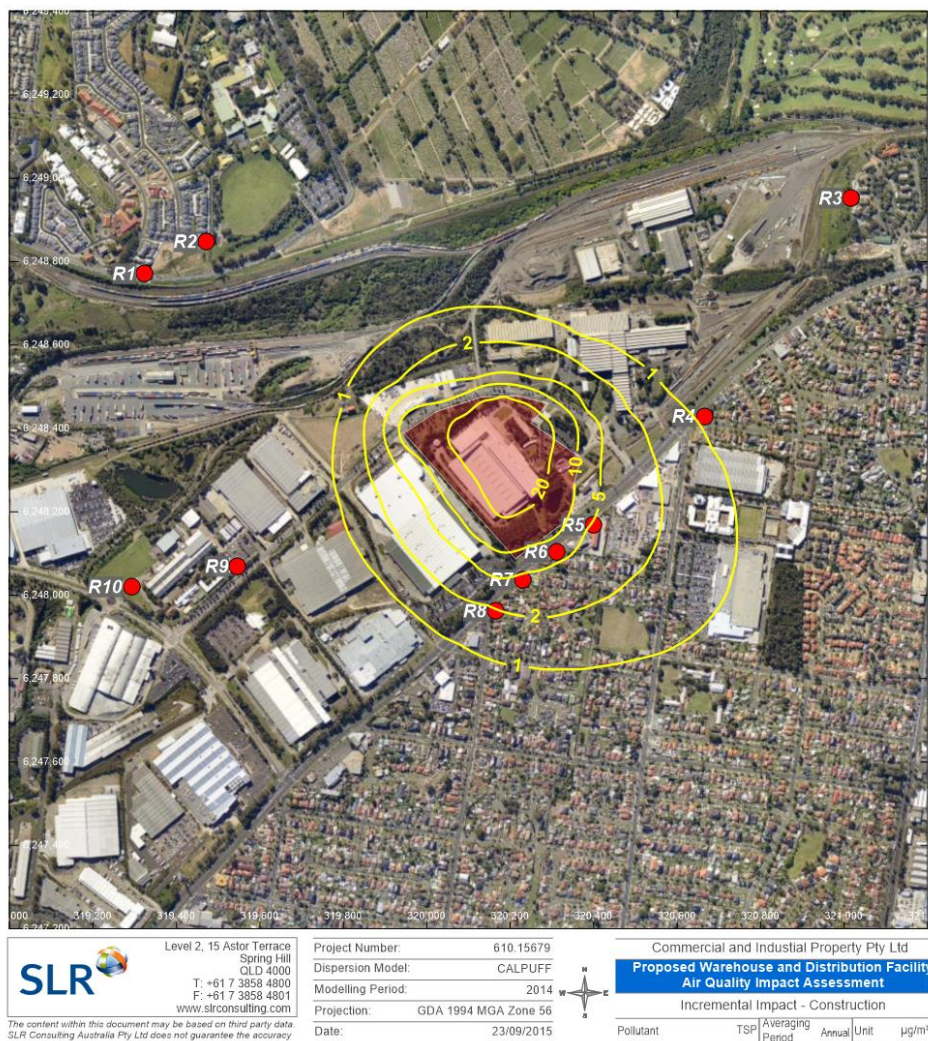
Contour plots of the predicted incremental annual average TSP concentrations are presented in **Figure 11**.

Table 20 Predicted Annual Average TSP Concentrations at Sensitive Receptors - Construction

Receptor ID	Incremental Impact ($\mu\text{g}/\text{m}^3$)	Assumed Background ($\mu\text{g}/\text{m}^3$) ¹	Cumulative Impact ($\mu\text{g}/\text{m}^3$)
R1	0.1	43.7	43.8
R2	0.2	43.7	43.9
R3	0.1	43.7	43.8
R4	0.9	43.7	44.6
R5	4.7	43.7	48.4
R6	5.9	43.7	49.6
R7	3.9	43.7	47.6
R8	1.9	43.7	45.6
R9	0.3	43.7	44.0
R10	0.2	43.7	43.9
Criterion	-	-	90

Note 1: Refer **Section 4.1**

Figure 11 Predicted Annual Average TSP Concentrations – Construction



6.1.3 Particulates (as PM₁₀)

To assess the maximum cumulative 24-hour average PM₁₀ concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed following the Approved Methods. At each receptor, each individual incremental prediction was added to the corresponding day's measured background concentration at the Chullora AQMS site to predict the cumulative 24-hour average PM₁₀ impacts.

Table 21 presents a summary of the contemporaneous analysis at each receptor listed in **Section 2.2**. It can be observed from **Table 21** that the incremental and cumulative 24-hour average PM₁₀ concentrations predicted at each surrounding sensitive receptor as a result of construction emissions are below the relevant criterion.

Table 21 Summary of 24-Hour PM₁₀ Cumulative Impact Analysis - Construction

Receptor ID	Date of Highest Background	PM ₁₀ 24-Hour Average Concentrations (µg/m ³)			Date of Highest Increment	PM ₁₀ 24-Hour Average Concentrations (µg/m ³)		
		Highest Background	Increment	Total Impact		Background	Highest Increment	Total Impact
R1	06/08/2014	40.0	<0.1	<40.1	18/06/2014	22.9	1.0	23.9
R2	06/08/2014	40.0	<0.1	<40.1	18/06/2014	22.9	1.4	24.3
R3	06/08/2014	40.0	0.1	40.1	09/07/2014	22.8	0.8	23.6
R4	06/08/2014	40.0	1.3	41.3	20/06/2014	30.0	5.0	35.0
R5	06/08/2014	40.0	7.1	47.1	22/06/2014	14.5	14.6	29.1
R6	06/08/2014	40.0	9.7	49.7	22/06/2014	16.4	14.5	30.9
R7	06/08/2014	40.0	6.2	46.2	13/06/2014	30.2	13.2	43.4
R8	06/08/2014	40.0	2.3	42.3	15/07/2014	21.2	9.3	30.5
R9	06/08/2014	40.0	<0.1	<40.1	10/04/2014	21.0	1.9	22.9
R10	06/08/2014	40.0	<0.1	<40.1	10/04/2014	21.0	1.3	22.3
Criterion				50				
								50

Note 1: Refer **Section 4.1**

Table 22 presents a summary of the incremental and cumulative annual average PM₁₀ concentrations predicted at each identified sensitive receptor location. It can be observed that the incremental annual average PM₁₀ impacts predicted as a result of the proposed operations are minimal and that the cumulative annual average PM₁₀ concentrations predicted at all surrounding sensitive receptor locations are well below the relevant criterion.

Table 22 Predicted Annual Average PM₁₀ Concentrations at Sensitive Receptors - Construction

Receptor ID	Incremental Impact (µg/m ³)	Assumed Background (µg/m ³) ¹	Cumulative Impact (µg/m ³)
R1	0.1	18.0	18.1
R2	0.1	18.0	18.1
R3	0.1	18.0	18.1
R4	0.4	18.0	18.4
R5	1.8	18.0	19.8
R6	2.2	18.0	20.2
R7	1.5	18.0	19.5
R8	0.8	18.0	18.8
R9	0.1	18.0	18.2
R10	0.1	18.0	18.1
Criterion	-	-	30

Note 1: Refer **Section 4.1**

Contour plots of the maximum 24-hour and annual average incremental PM₁₀ concentrations are presented in **Figure 12** and **Figure 13**.

Figure 12 Predicted Maximum 24 Hour Average PM₁₀ Concentrations - Construction

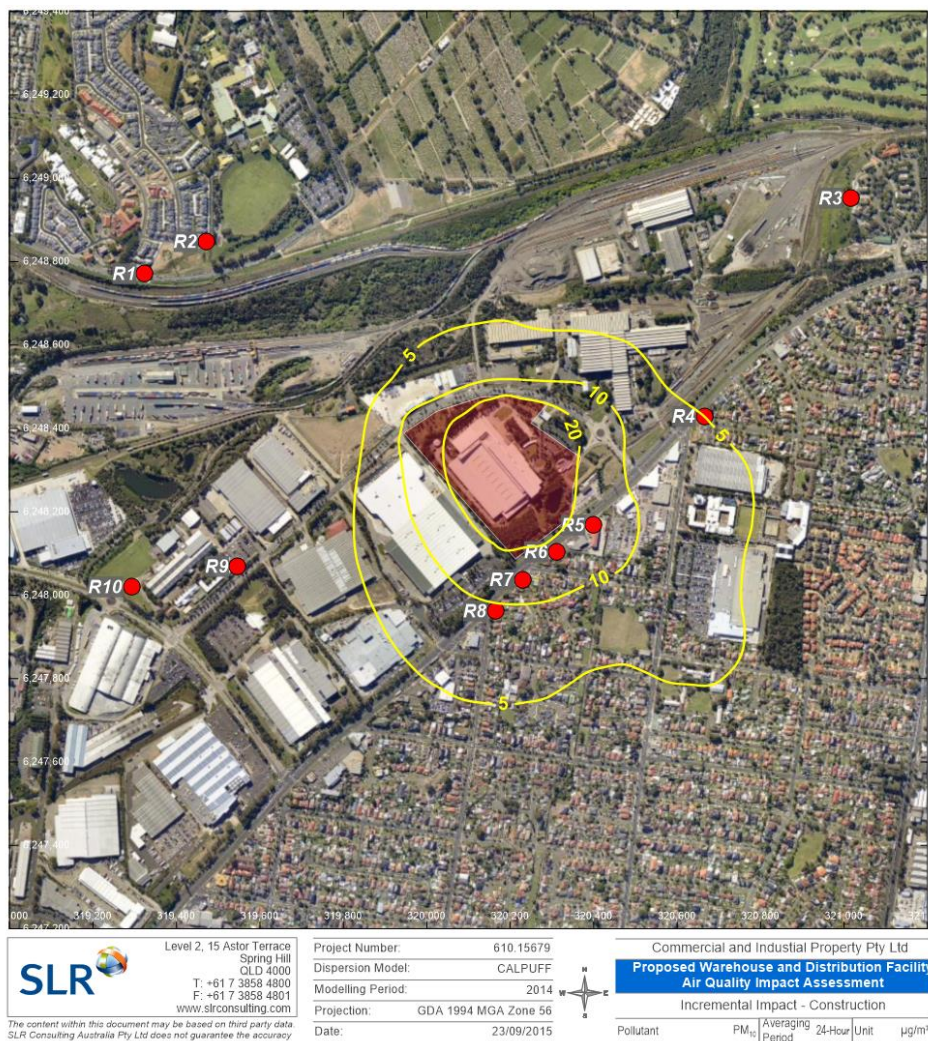
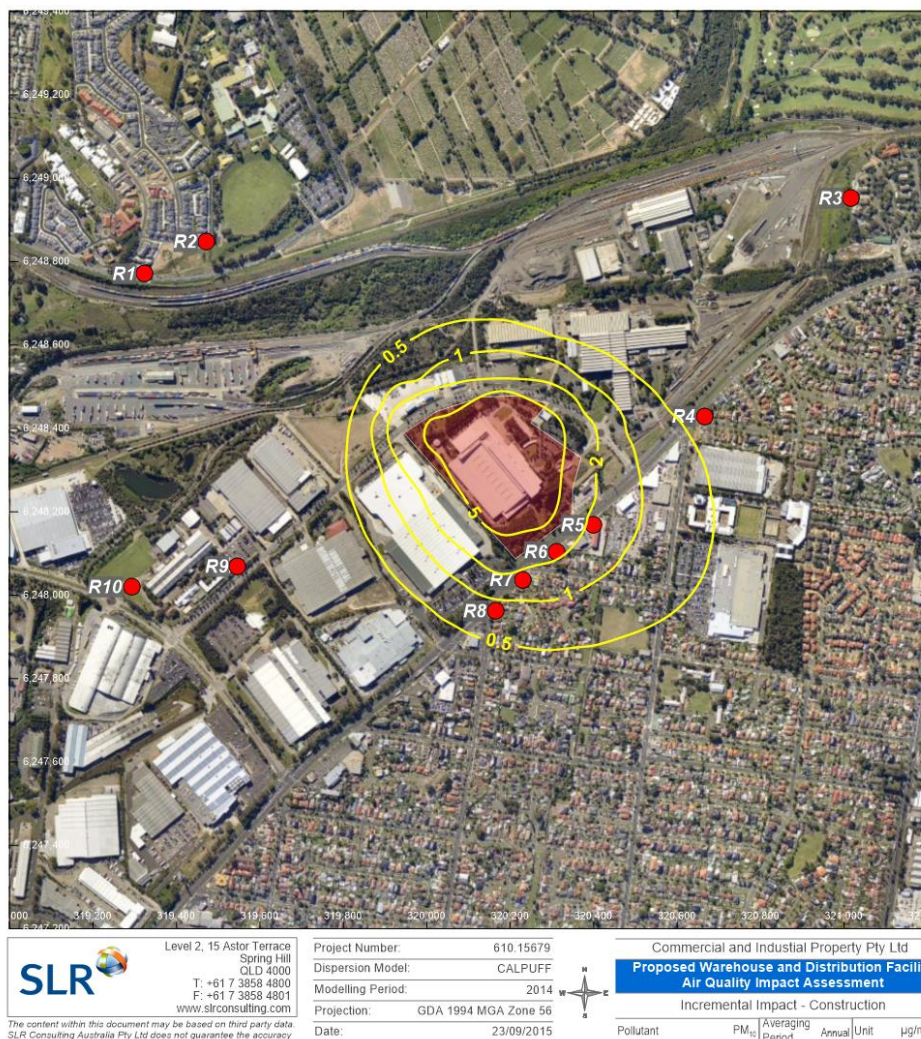


Figure 13 Predicted Annual Average PM₁₀ Concentrations - Construction



6.1.4 Particulates (as PM_{2.5})

To assess the maximum cumulative 24-hour average PM_{2.5} concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed following the Approved Methods. At each receptor, each individual incremental prediction was added to the corresponding day's measured background concentration at the Chullora AQMS site to predict the cumulative 24-hour average PM_{2.5} impacts.

Table 23 presents a summary of the contemporaneous analysis at each receptor listed in **Section 2.2**. It can be observed that the incremental and cumulative 24-hour average PM_{2.5} concentrations predicted at each surrounding sensitive receptor as a result of construction emissions are below the relevant criterion.

Table 23 Summary of 24-Hour PM_{2.5} Cumulative Impact Analysis - Construction

Receptor ID	Date of Highest Background	PM _{2.5} 24-Hour Average Concentrations (µg/m³)			Date of Highest Increment	PM _{2.5} 24-Hour Average Concentrations (µg/m³)		
		Highest Background	Increment	Total Impact		Background	Highest Increment	Total Impact
R1	12/10/2014	23.1	<0.1	<23.2	23/07/2014	13.5	0.3	13.8
R2	12/10/2014	23.1	<0.1	<23.2	18/06/2014	6.7	0.4	7.1
R3	12/10/2014	23.1	<0.1	<23.2	20/06/2014	13.5	0.2	13.7
R4	12/10/2014	23.1	<0.1	<23.2	20/06/2014	13.5	1.3	14.8
R5	12/10/2014	23.1	0.1	23.2	22/06/2014	8.6	4.1	12.7
R6	12/10/2014	23.1	0.2	23.3	22/06/2014	8.6	4.8	13.4
R7	12/10/2014	23.1	0.3	23.4	13/06/2014	16.2	3.8	20.0
R8	12/10/2014	23.1	0.2	23.3	15/07/2014	12.4	2.7	15.1
R9	12/10/2014	23.1	0.1	23.2	15/07/2014	12.4	0.5	12.9
R10	12/10/2014	23.1	<0.1	<23.2	15/05/2014	11.9	0.3	12.2
Criterion				25				
								25

Note 1: Refer **Section 4.1**

Table 24 presents a summary of the incremental and cumulative annual average PM_{2.5} concentrations predicted at each identified sensitive receptor location. It can be observed that the incremental annual average PM_{2.5} impacts predicted as a result of the proposed operations are minimal (<0.6 µg/m³) although the cumulative annual average PM_{2.5} concentrations exceed the criterion due to the addition of the already exceeding background concentrations.

Table 24 Predicted Annual Average PM_{2.5} Concentrations at Sensitive Receptors - Construction

Receptor ID	Incremental Impact (µg/m³)	Assumed Background (µg/m³) ¹	Cumulative Impact (µg/m³)
R1	<0.1	9.0	<9.1
R2	<0.1	9.0	<9.1
R3	<0.1	9.0	<9.1
R4	0.1	9.0	9.1
R5	0.5	9.0	9.5
R6	0.6	9.0	9.6
R7	0.4	9.0	9.4
R8	0.2	9.0	9.2
R9	<0.1	9.0	<9.1
R10	<0.1	9.0	<9.1
Criterion	-	-	8

Note 1: Refer **Section 4.1**

Contour plots of the maximum 24-hour and annual average incremental PM_{2.5} concentrations are presented in **Figure 14** and **Figure 15**.

Figure 14 Predicted Maximum 24 Hour Average PM_{2.5} Concentrations - Construction

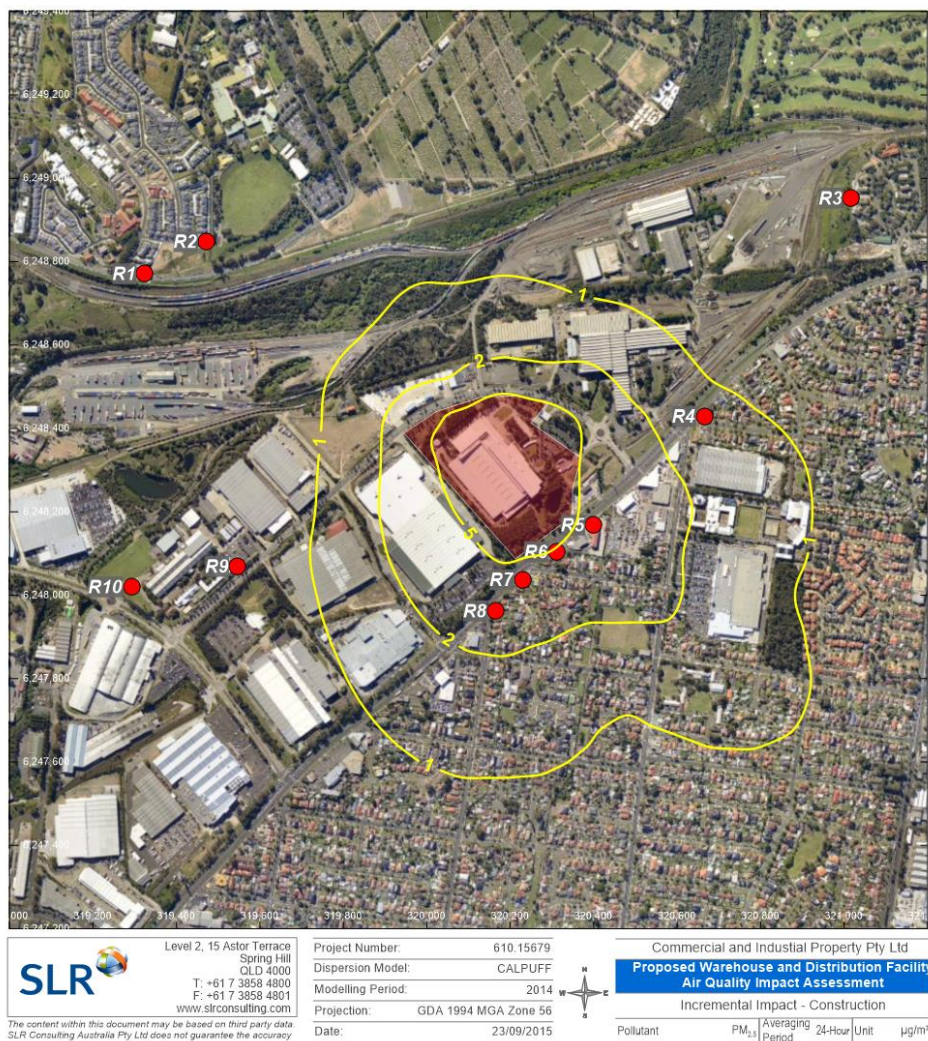
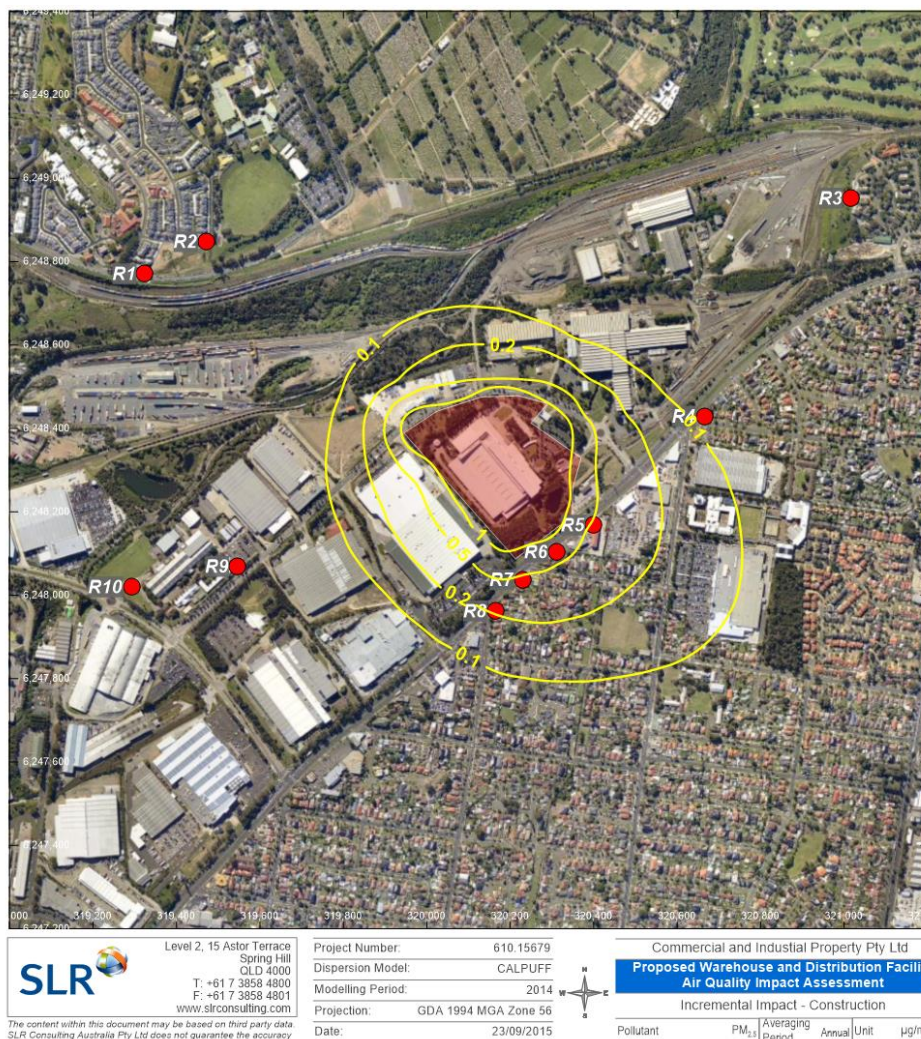


Figure 15 Predicted Annual Average PM_{2.5} Concentrations - Construction



6.1.5 Carbon Monoxide (CO), Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂) and Benzene

Predicted concentrations of CO, SO₂, NO₂ and benzene for the relevant averaging period for each pollutant are presented in **Table 25**, **Table 26**, **Table 27** and **Table 28**, respectively.

Concentrations of CO and SO₂ are predicted to be insignificant, with concentrations of all pollutants predicted to be well below the relevant criteria. No further detailed analysis of the results has therefore been performed.

Table 25 Predicted Carbon Monoxide Concentrations - Construction

Receptor	Maximum 15 minute Average CO (mg/m ³)		Maximum 1 hour Average CO (mg/m ³)		Maximum 8 hour Average CO (mg/m ³)	
	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
R1	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R2	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R3	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R4	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R5	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R6	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R7	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R8	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R9	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
R10	<0.1	<3.9	<0.1	<3.0	<0.1	<2.2
Criterion	-	100	-	30	-	10

Table 26 Predicted Sulphur Dioxide Concentrations - Construction

Receptor	Maximum 10 minute Average SO ₂ (µg/m ³)		Maximum 1 hour Average SO ₂ (µg/m ³)		Maximum 24 hour Average SO ₂ (µg/m ³)		Annual Average SO ₂	
	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
R1	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R2	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R3	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R4	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R5	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R6	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R7	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R8	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R9	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
R10	<0.1	77.8	<0.1	54.3	<0.1	10.2	<0.1	1.7
Criterion	-	712	-	570	-	228	-	60

Table 27 Predicted Nitrogen Dioxide Concentrations - Construction

Receptor	Maximum 1 hour Average ($\mu\text{g}/\text{m}^3$)		Annual Average ($\mu\text{g}/\text{m}^3$)	
	Increment (NO_x)	Cumulative (NO_2)	Increment (NO_x)	Cumulative (NO_2)
R1	18.9	131.2	0.1	18.9
R2	23.6	131.2	0.1	23.6
R3	10.3	131.5	0.1	10.3
R4	21.3	136.1	0.8	21.3
R5	30.3	137.3	1.5	30.3
R6	39.4	137.9	1.5	39.4
R7	46.1	137.8	1.1	46.1
R8	49.2	137.4	0.8	49.2
R9	22.7	131.9	0.2	22.7
R10	9.9	131.3	0.1	9.9
Criterion	-	246	-	62

Table 28 Predicted Benzene Concentrations - Construction

Receptor	Maximum 1 hour Average Benzene ($\mu\text{g}/\text{m}^3$)
	Increment / Cumulative
R1	1.3
R2	1.6
R3	0.7
R4	1.5
R5	2.1
R6	2.7
R7	3.2
R8	3.4
R9	1.6
R10	0.7
Criterion	29

6.2 Operation

Dispersion modelling predictions at the residences/properties nominated in **Section 2.3** are presented in **Section 6.2.1** to **Section 6.2.3**. No contour plots are provided for the operational phase impacts given that all incremental impacts are minimal.

Impacts associated with dust deposition, annual average TSP and SO_2 concentrations have not been assessed for the operational phase of the Development as no emission factors associated with vehicle idling were available in the literature for these pollutants. Annual average PM_{10} can be viewed as a surrogate for compliance purposes, with NO_2 providing a similar surrogate for SO_2 .

6.2.1 Particulates (as PM₁₀)

To assess the maximum cumulative 24-hour average PM₁₀ concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed following the Approved Methods. At each receptor, each individual incremental prediction was added to the corresponding day's measured background concentration at the Chullora AQMS site to predict the cumulative 24-hour average PM₁₀ impacts.

Table 29 presents a summary of the contemporaneous analysis at each receptor listed in **Section 2.2**. It can be observed from **Table 29** that the incremental and cumulative 24-hour average PM₁₀ concentrations predicted at each surrounding sensitive receptor as a result of operational emissions are well below the relevant criterion. Therefore it is concluded that the proposed operation is unlikely to cause any additional exceedences of the 24-hour average guideline at these locations.

Table 29 Summary of 24-Hour PM₁₀ Cumulative Impact Analysis - Operation

Receptor ID	Date of Highest Background	PM ₁₀ 24-Hour Average Concentrations (µg/m³)			Date of Highest Increment	PM ₁₀ 24-Hour Average Concentrations (µg/m³)		
		Highest Background	Increment	Total Impact		Background	Highest Increment	Total Impact
R1	06/08/2014	40.0	<0.1	<40.1	08/08/2014	21.3	0.1	21.4
R2	06/08/2014	40.0	<0.1	<40.1	16/08/2014	11.1	0.2	11.3
R3	06/08/2014	40.0	<0.1	<40.1	07/11/2014	22.6	0.1	22.7
R4	06/08/2014	40.0	0.2	40.2	05/08/2014	39.8	0.4	40.2
R5	06/08/2014	40.0	1.0	41.0	20/06/2014	30.0	1.7	31.7
R6	06/08/2014	40.0	1.6	41.6	20/06/2014	30.0	2.7	32.7
R7	06/08/2014	40.0	0.8	40.8	22/06/2014	14.5	1.8	16.3
R8	06/08/2014	40.0	0.3	40.3	10/04/2014	21.0	1.0	22.0
R9	06/08/2014	40.0	<0.1	<40.1	10/04/2014	21.0	0.3	21.3
R10	06/08/2014	40.0	<0.1	<40.1	09/01/2014	10.8	0.2	11.0
Criterion				50				
								50

Note 1: Refer **Section 4.1**

Table 30 presents a summary of the incremental and cumulative annual average PM₁₀ concentrations predicted at each identified sensitive receptor location. It can be observed from **Table 30** that the incremental annual average PM₁₀ impacts predicted as a result of the proposed operations are minimal and that the cumulative annual average PM₁₀ concentrations predicted at all surrounding sensitive receptor locations are well below the relevant criterion.

Given the low concentrations predicted (and as they are lower than those predicted for the construction phase) no contour plots are provided for operational PM₁₀ impacts.

Table 30 Predicted Annual Average PM₁₀ Concentrations at Sensitive Receptors - Operation

Receptor ID	Incremental Impact (µg/m ³)	Assumed Background (µg/m ³) ¹	Cumulative Impact (µg/m ³)
R1	<0.1	18.0	<18.1
R2	<0.1	18.0	<18.1
R3	<0.1	18.0	<18.1
R4	0.1	18.0	18.1
R5	0.4	18.0	18.4
R6	0.6	18.0	18.6
R7	0.4	18.0	18.4
R8	0.2	18.0	18.2
R9	<0.1	18.0	<18.1
R10	<0.1	18.0	<18.1
Criterion	-	-	30

Note 1: Refer **Section 4.1**

6.2.2 Particulates (as PM_{2.5})

To assess the maximum cumulative 24-hour average PM₁₀ concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed following the Approved Methods. At each receptor, each individual incremental prediction was added to the corresponding day's measured background concentration at the Chullora AQMS site to predict the cumulative 24-hour average PM_{2.5} impacts.

Table 31 presents a summary of the contemporaneous analysis at each receptor listed in **Section 2.2**. It can be observed from **Table 31** that the incremental and cumulative 24-hour average PM_{2.5} concentrations predicted at each surrounding sensitive receptor as a result of operational emissions are well below the relevant criterion. Therefore it is concluded that the proposed operation is unlikely to cause any additional exceedences of the guideline at these locations.

Table 32 presents a summary of the incremental and cumulative annual average PM₁₀ concentrations predicted at each identified sensitive receptor location. It can be observed that the incremental annual average PM_{2.5} impacts predicted as a result of the proposed operations are minimal (<0.6 µg/m³) although the cumulative annual average PM_{2.5} concentrations exceed the criterion due to the addition of the already exceeding background concentrations.

Table 31 Summary of 24-Hour PM_{2.5} Cumulative Impact Analysis - Operation

Receptor ID	Date of Highest Background	PM _{2.5} 24-Hour Average Concentrations (µg/m ³)			Date of Highest Increment	PM _{2.5} 24-Hour Average Concentrations (µg/m ³)		
		Highest Background	Increment	Total Impact		Background	Highest Increment	Total Impact
R1	12/10/2014	23.1	<0.1	<23.2	08/08/2014	12.9	0.1	13.0
R2	12/10/2014	23.1	<0.1	<23.2	16/08/2014	10.3	0.1	10.4
R3	12/10/2014	23.1	<0.1	<23.2	07/11/2014	9.1	0.1	9.2
R4	12/10/2014	23.1	<0.1	23.2	05/08/2014	18.2	0.4	19.2
R5	12/10/2014	23.1	0.3	23.4	20/06/2014	13.5	1.6	15.1
R6	12/10/2014	23.1	0.4	23.5	20/06/2014	13.5	2.4	15.9
R7	12/10/2014	23.1	0.5	23.6	22/06/2014	8.6	1.7	10.3
R8	12/10/2014	23.1	0.4	23.5	10/04/2014	7.5	0.9	8.4
R9	12/10/2014	23.1	<0.1	<23.2	10/04/2014	7.5	0.3	7.8
R10	12/10/2014	23.1	<0.1	<23.2	09/01/2014	4.3	0.2	4.5
Criterion				25				
								25

Note 1: Refer **Section 4.1**

Table 32 Predicted Annual Average PM_{2.5} Concentrations at Sensitive Receptors - Operation

Receptor ID	Incremental Impact (µg/m ³)	Assumed Background (µg/m ³) ¹	Cumulative Impact (µg/m ³)
R1	<0.1	9.0	<9.1
R2	<0.1	9.0	<9.1
R3	<0.1	9.0	<9.1
R4	0.1	9.0	9.1
R5	0.4	9.0	9.4
R6	0.6	9.0	9.6
R7	0.3	9.0	9.3
R8	0.2	9.0	9.2
R9	<0.1	9.0	<9.1
R10	<0.1	9.0	<9.1
Criterion	-	-	8

Note 1: Refer **Section 4.1**

6.2.3 Carbon Monoxide (CO), Nitrogen Dioxide (NO₂) and Benzene

Predicted concentrations of CO, NO₂ and benzene for the relevant averaging period for each pollutant are presented in **Table 33**, **Table 34** and **Table 35**, respectively.

Concentrations of all pollutants are predicted to be well below the relevant criteria. A worst case assessment has been performed which has assumed that emissions from idling vehicles occurs constantly. In reality this is highly unlikely to occur and the results can be viewed as highly conservative.

Table 33 Predicted Carbon Monoxide Concentrations - Operation

Receptor	Maximum 15 minute Average CO (mg/m ³)		Maximum 1 hour Average CO (mg/m ³)		Maximum 8 hour Average CO (mg/m ³)	
	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
R1	0.5	3.8	0.9	2.9	0.4	2.1
R2	0.5	3.9	1.0	3.0	0.4	2.1
R3	0.4	4.4	0.6	3.3	0.3	2.1
R4	1.3	5.4	1.5	4.1	1.0	2.3
R5	3.6	6.7	3.4	5.1	2.7	3.0
R6	5.6	9.1	5.4	6.9	4.2	3.8
R7	4.5	8.5	5.0	6.4	3.4	4.9
R8	2.9	6.7	3.7	5.1	2.2	4.0
R9	1.0	3.8	1.5	2.9	0.7	2.9
R10	0.6	3.8	1.0	2.9	0.5	2.1
Criterion	-	100	-	30	-	10

Table 34 Predicted Nitrogen Dioxide Concentrations - Operation

Receptor	Maximum 1 hour Average (µg/m ³)		Annual Average (µg/m ³)	
	Increment (NO _x)	Cumulative (NO ₂)	Increment (NO _x)	Cumulative (NO ₂)
R1	55.6	131.3	0.5	25.5
R2	60.1	131.3	0.6	25.6
R3	33.8	131.8	0.7	25.7
R4	52.4	137.2	2.2	27.2
R5	77.3	154.4	6.9	31.9
R6	98.6	177.7	9.4	34.4
R7	108.6	163.6	6.2	31.2
R8	108.4	148.4	3.7	28.7
R9	56.4	133.2	1.0	26.0
R10	46.7	131.6	0.7	25.7
Criterion	-	246	-	62

Table 35 Predicted Benzene Concentrations - Operation

Receptor	Maximum 1 hour Average (µg/m ³)
	Increment /Cumulative
R1	2.4
R2	2.7
R3	1.7
R4	4.0
R5	9.2
R6	14.8
R7	13.7
R8	10.0
R9	4.1
R10	2.8
Criterion	29

7 MITIGATION, MANAGEMENT AND MONITORING

The results of the impact assessment indicate that all pollutants are anticipated to meet the required goals both during Development construction and operation. Cumulative annual average PM_{2.5} concentrations are exceeded although this is due to an existing exceedance in the background level used for assessment purposes. Annual average PM_{2.5} impacts predicted at sensitive receptor locations as a result of the proposed Development activities are less than 0.6 µg/m³, which is well below the criterion of 8 µg/m³ (ie 7.5%).

The impact assessment indicates that air quality impacts would not constrain either the construction or operation of the Development. However, as required by the SEARS (refer **Section 1.1**), details of the proposed management and monitoring measures to be implemented at the Development site are required to be outlined. The following sections outline a number of measures which would be employed during both construction and operation.

7.1 Construction

A detailed Construction Environment Management Plan (CEMP) is proposed to be developed and implemented prior to construction works (as part of the SSD application), and will 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.

The following outlines a number of measures which will be considered for inclusion within the CEMP.

7.1.1 Nuisance Dust Control Measures

Ambient dust emissions from wheel-generated dust, excavation and rehabilitation, demolition, clearing and grading, truck loading and unloading, and wind erosion areas would be the primary focus of dust control during construction works at the Development 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 meteorological conditions, such as strong winds blowing in the direction of sensitive receptors. A wind sock should be installed and be visible to all areas of an active construction site to assist in reactive response procedures (ie 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.
- Erecting solid screens or barriers around dusty activities or the site boundary to prevent windblown dust being transported offsite.
- 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.

- Restricting vehicle speeds on site to minimise wheel-generated dust.
- If dirt track out is causing problems, avoid dry sweeping of large areas. Manual brushing of the truck's flanks and wheels, or a wheel wash, could be implemented as a further precaution.

7.1.2 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.

7.1.3 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 designed 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 Australian Standard, 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.

7.1.4 Site Management

Air emissions associated with all construction activities should also be managed through compliance with the CEMP. 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 banded.
- Ensure spill kits are appropriately located and stocked.

7.1.5 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 redevelopment activities throughout the construction phase, and to ensure identified incidents are dealt with through investigation and implementation of corrective treatments.

7.1.6 Air Quality Monitoring

During construction works, no air quality monitoring is considered to be necessary given the results predicted within this assessment. However, suspended particulate monitoring on the boundary in closest proximity to the Hume Highway, and/or Receptors R4 and R5 may be performed to assist in dust management and to confirm the mitigation measures are being effectively implemented, especially in the morning periods when winds are more likely to transport material from construction works.

7.2 Operation

7.2.1 Vehicle Operation

Control measures relating to vehicles that may be utilised during the operational phase include:

- Ensuring vehicles 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.

7.2.2 Complaints Handling

The complaints logging system maintained during construction works would be continued during operation.

7.2.3 Air Quality Monitoring

During operation, no air quality monitoring is considered to be necessary, given the results of this assessment.

8 CONCLUSIONS

SLR has been commissioned by CIP to perform an Air Quality and Odour Impact Assessment for the development of a proposed warehouse and distribution facility located at 2 Hume Highway, Chullora NSW.

The assessment has considered emissions to air and resulting impacts on a number of surrounding sensitive receptor locations during both construction and operation of the Development. Impacts have been assessed through the implementation of dispersion modelling techniques, in accordance with the SEARS.

The current air quality environment of the area surrounding the Development has been considered within this assessment, with impacts associated with the Development added to the current air quality to determine the likelihood of exceedance of air quality criteria as outlined by the NSW EPA.

Results indicate that all pollutant concentrations resulting from Development construction and operation are below criteria concentrations, with the exception of annual average PM_{2.5}. Annual average PM_{2.5} concentrations in the area are shown to currently exceed the adopted guideline value, and additional impacts from the Development are predicted to be less than 0.6 µg/m³, 7.5% of the criterion.

A range of management, mitigation and monitoring options are outlined within this assessment, which will act to minimise the impact of the Development.

It is concluded that the construction and operation of the Development will not cause unacceptable impacts on the surrounding environment.

9 REFERENCES

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AIR QUALITY DATA – CHULLORA 2014

Figure A1 1 Hour Average CO Concentration – Chullora 2014

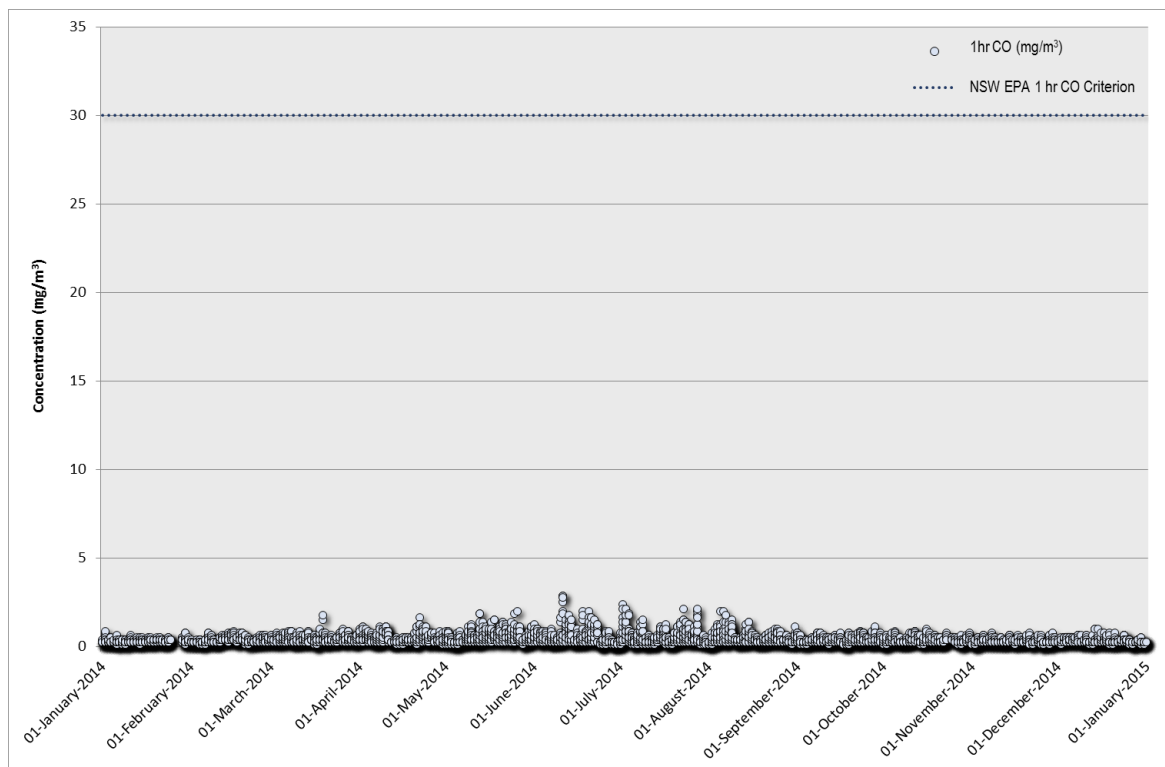
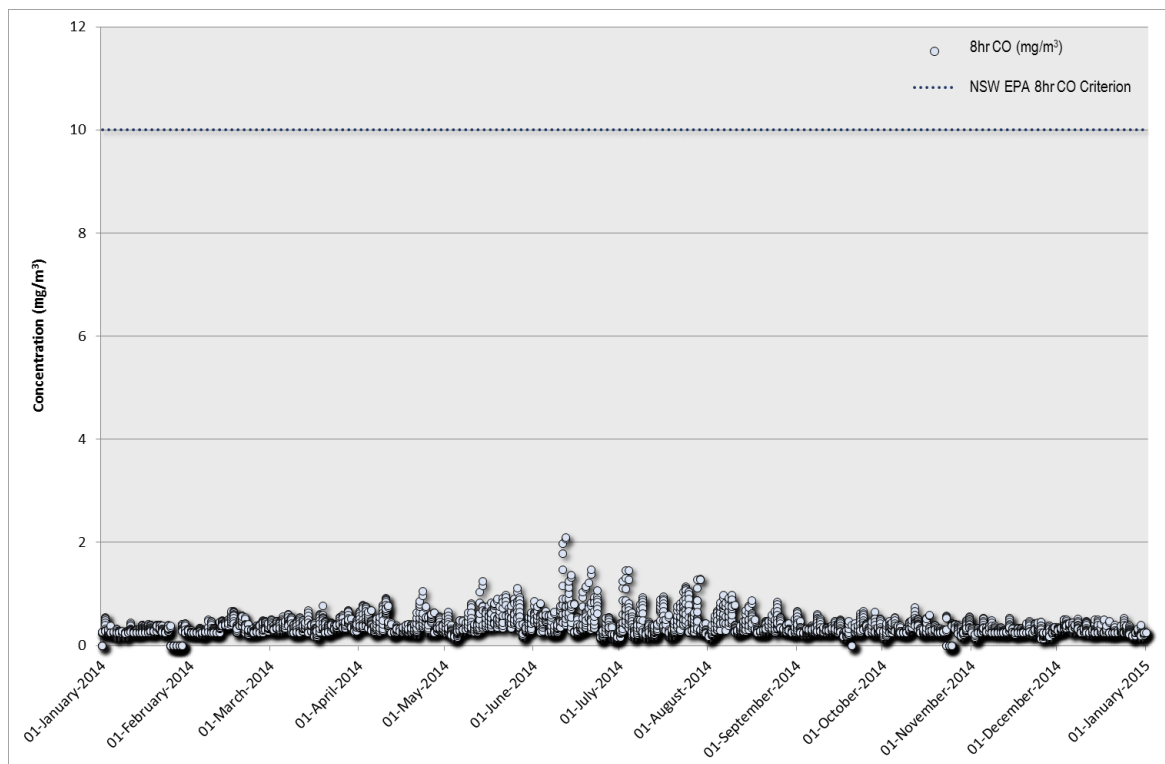


Figure A2 8 Hour Average CO Concentration – Chullora 2014



AIR QUALITY DATA – CHULLORA 2014

Figure A3 1 Hour Average SO₂ Concentration – Chullora 2014

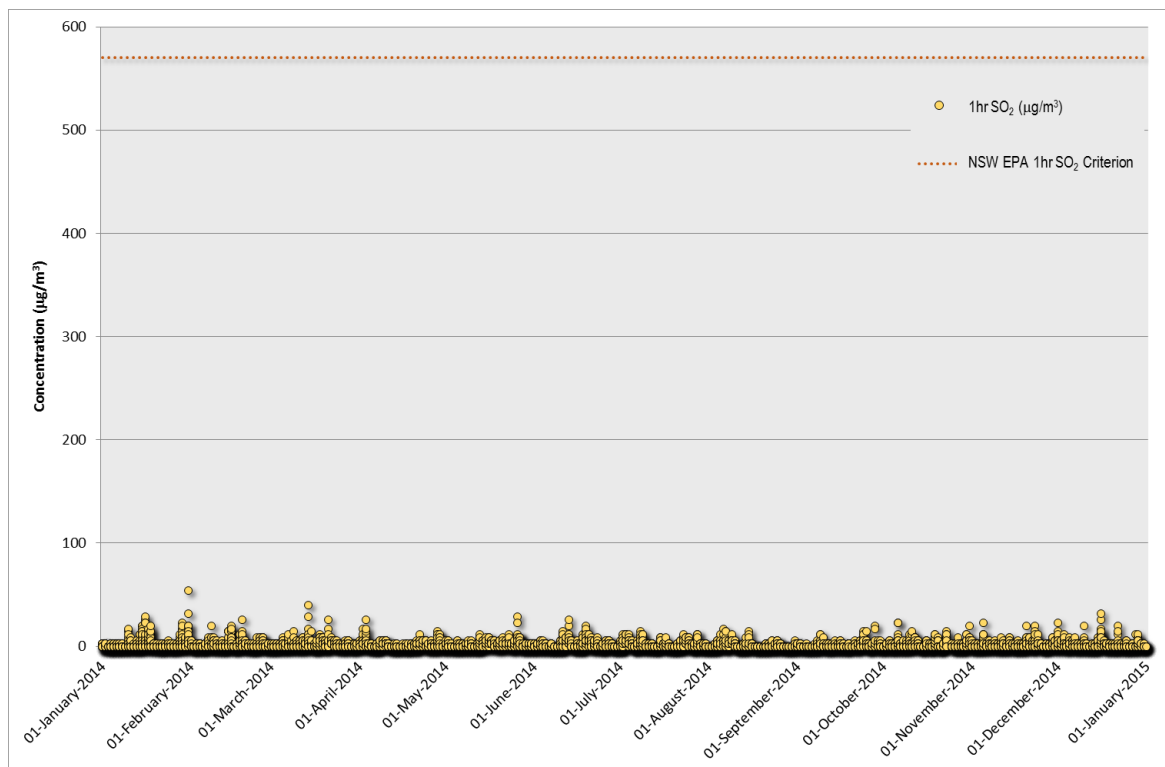
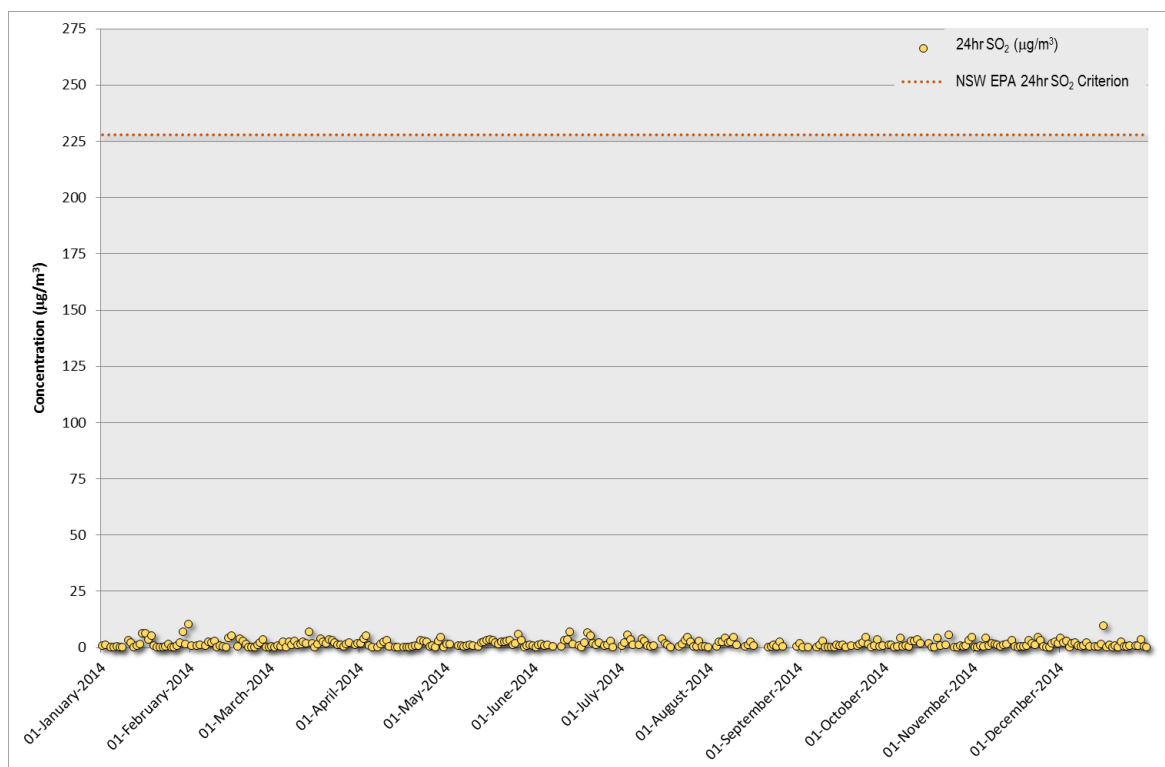


Figure A4 24 Hour Average SO₂ Concentration – Chullora 2014



AIR QUALITY DATA – CHULLORA 2014

Figure A5 1 Hour Average NO₂ Concentration – Chullora 2014

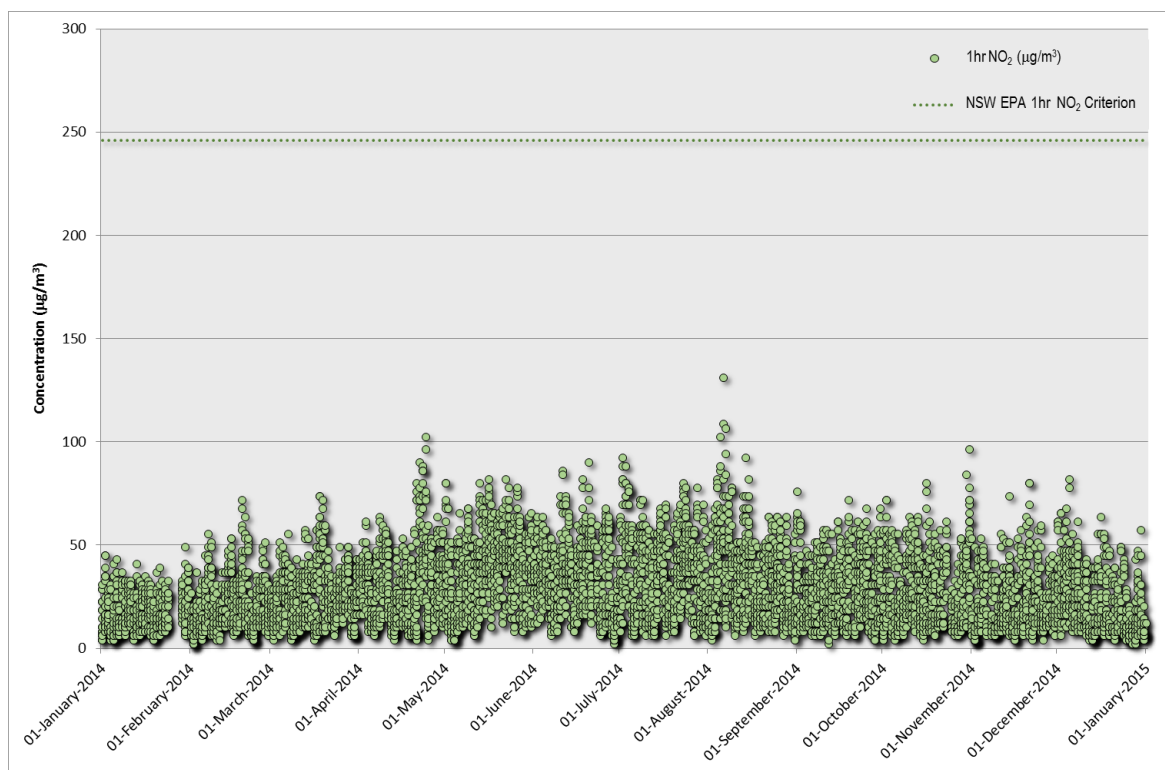
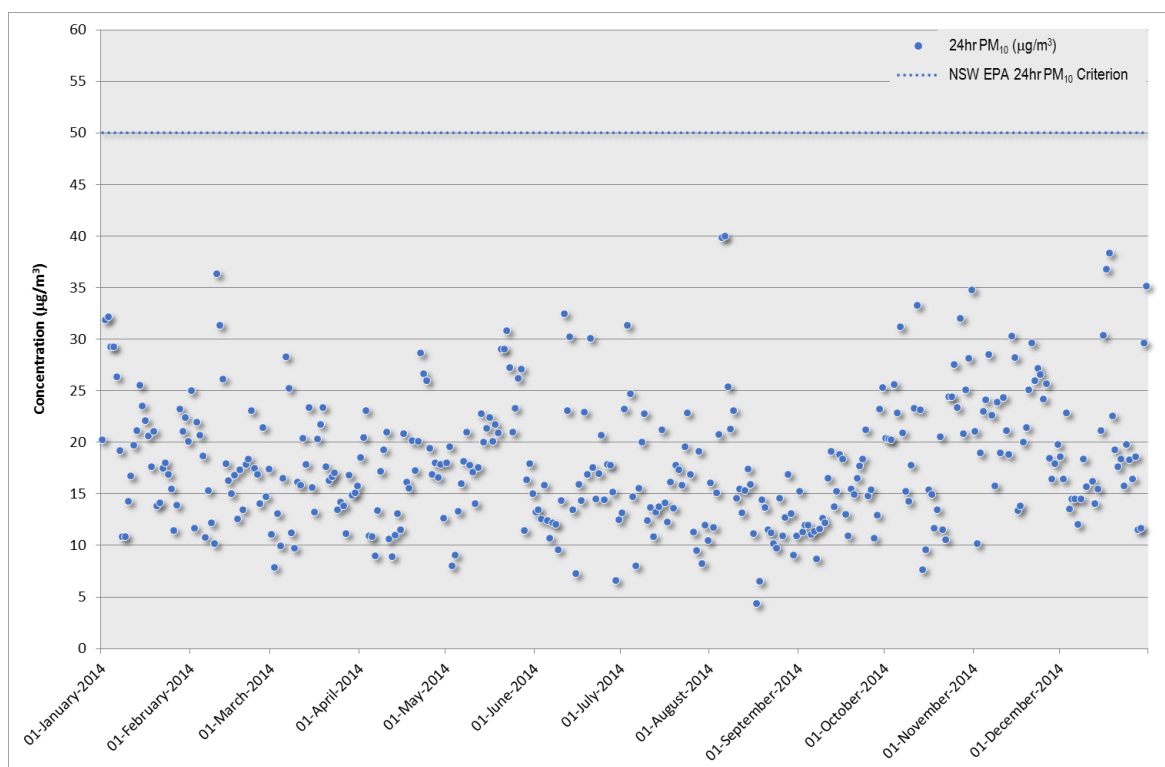


Figure A6 24 Hour Average PM₁₀ Concentration – Chullora 2014



AIR QUALITY DATA – CHULLORA 2014

Figure A7 24 Hour Average PM_{2.5} Concentration – Chullora 2014

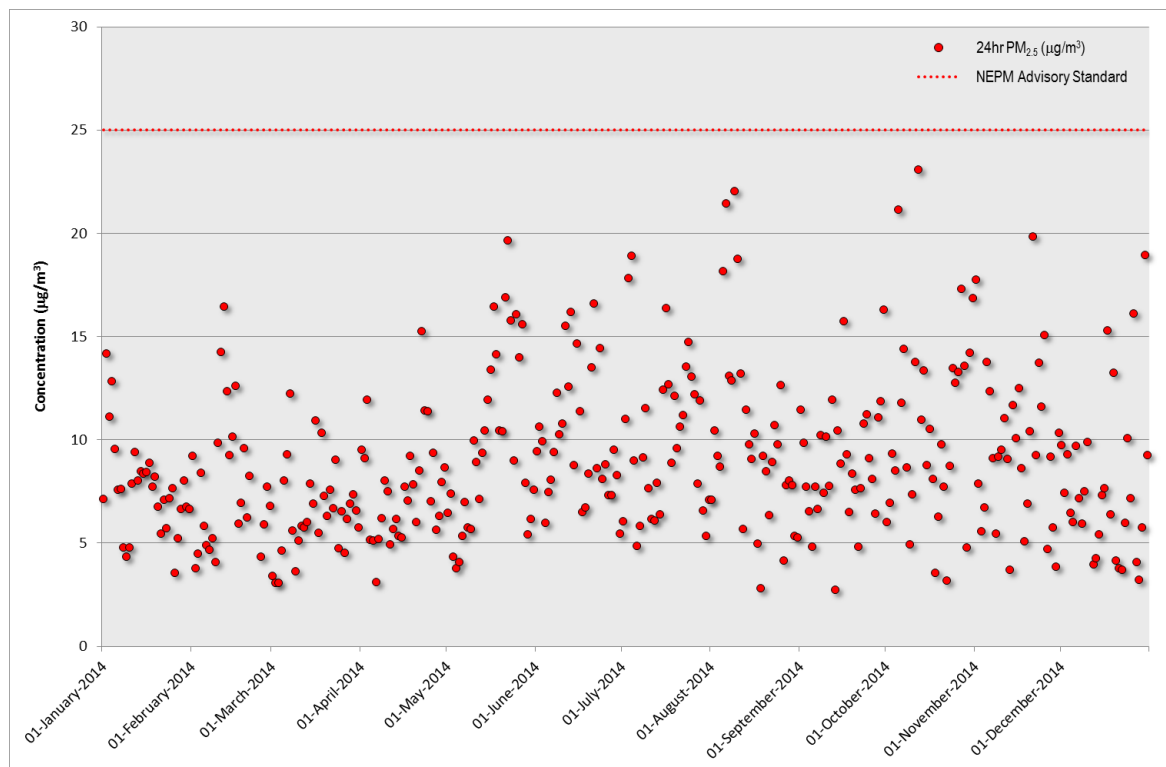
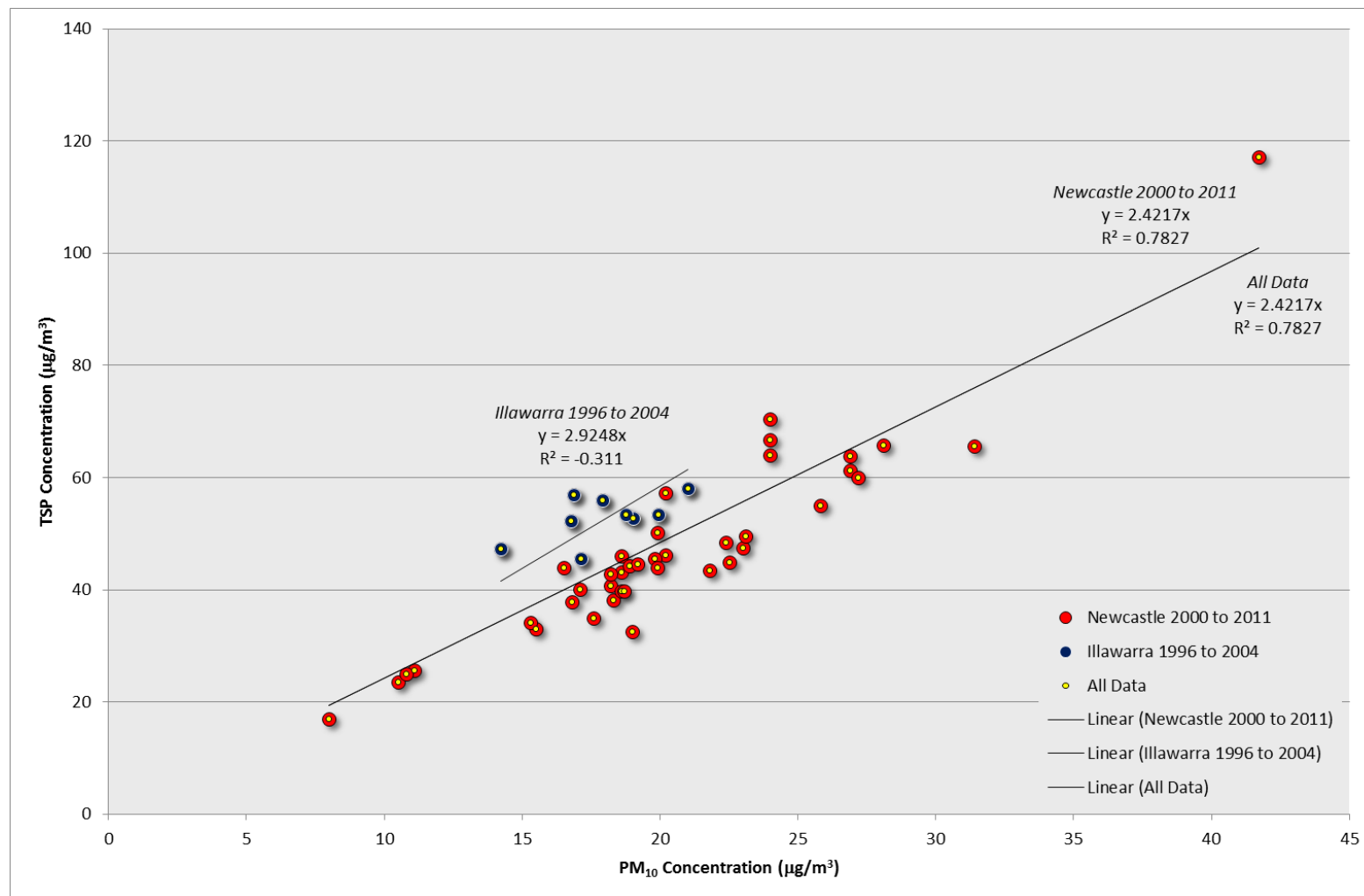


Figure B1 Analysis of PM₁₀ and TSP HVAS Data, Newcastle Region (2000 to 2011) and Illawarra Region (1996 to 2004)



LONG TERM METEOROLOGICAL ANALYSIS – BANKSTOWN AIRPORT 1968 - 2015

Figure C1 Long Term Temperature Data Summary for Bankstown Airport AWS

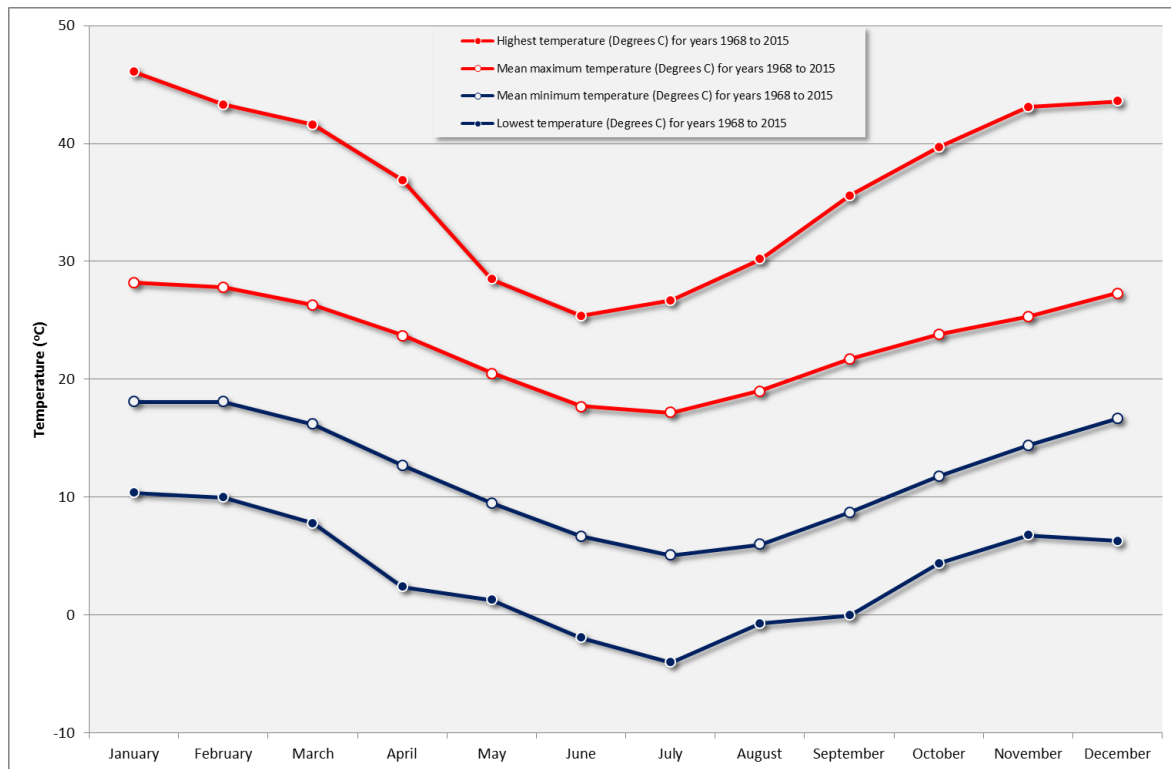
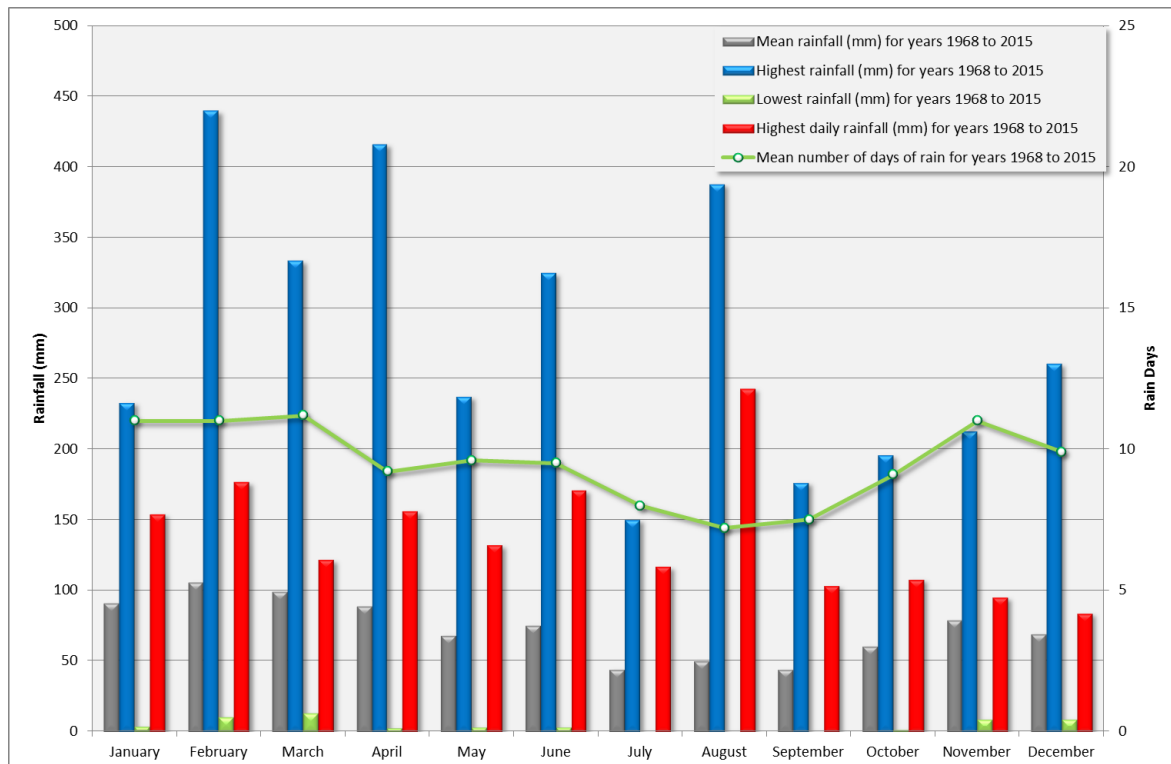


Figure C2 Long Term Rainfall Data Summary for Bankstown Airport AWS



EMISSION FACTOR CALCULATIONS - CONSTRUCTION

Activity Information

Parameter	Data (based on daily maximum)	Unit
Material throughput	1,051,200	t/annum
Moisture Content - import material	2	%
Moisture Content - onsite material	10	%
OB - Silt Content	10	%
OB - Dozer	6,570	hr/annum
OB - Haul road silt content	10.0	%
OB - Haul road length	1.0	km/return trip
OB - Haul truck empty weight	12.0	tonnes
OB - Haul truck gross weight	42.5	tonnes
OB - Number of return trips	34,466	trips/annum
Maximum number of trucks at onsite at any given time	3	trucks
Operating hours	11	hrs/day
Maximum area exposed to wind erosion	1	ha
Operational Days	365 ¹	Days/annum

¹The estimated actual operational days would be 230 days/annum.

Emission Rate Calculation

Activity	Annual Emission Rate (kg/annum)			Emission Factor			Unit
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	
Import material and handling	4,518	2,137	324	0.0014	0.0007	0.00010	kg/t
Dozers/Rollers	13,569	2,792	1,425	2.1	0.4	0.2	kg/h
Material hauling - onsite	7,539	2,225	223	0.115	0.034	0.003	kg/t
WE - Open pit	876	438	41	0.40	0.20	0.02	kg/ha/hour

CRITICAL MODEL INPUT VALUES

Table E1 List of Key CALMET Model Options

Parameter	Brief Description	Recommended Value	Value Used in Assessment
TERRAD	Terrain radius of influence (km). Value used in computing slope flow effects	No default	10
RMAX1	Maximum radius of influence (km) for meteorological stations in Layer 1 (Step 2) and Layers aloft (Step 2)	No default	0.1
RMAX2		No default	0.1
R1	Weighting parameter (km) for Step 1 wind field vs. observations in Layer 1 (R1) and Layer 2 and above (R2)	No default	0.1
R2		No default	0.1
IEXTRP	Switch to allow vertical extrapolation of surface data or not	Extrapolate using similarity theory (-4 in model)	-4
BIAS (NZ)	Used in complex terrain simulations to weight data between surface and upper air observations	NZ × 0	-1,0,0,0,0,...,0 (n=10)

Table E2 List of Key CALPUFF Model Options

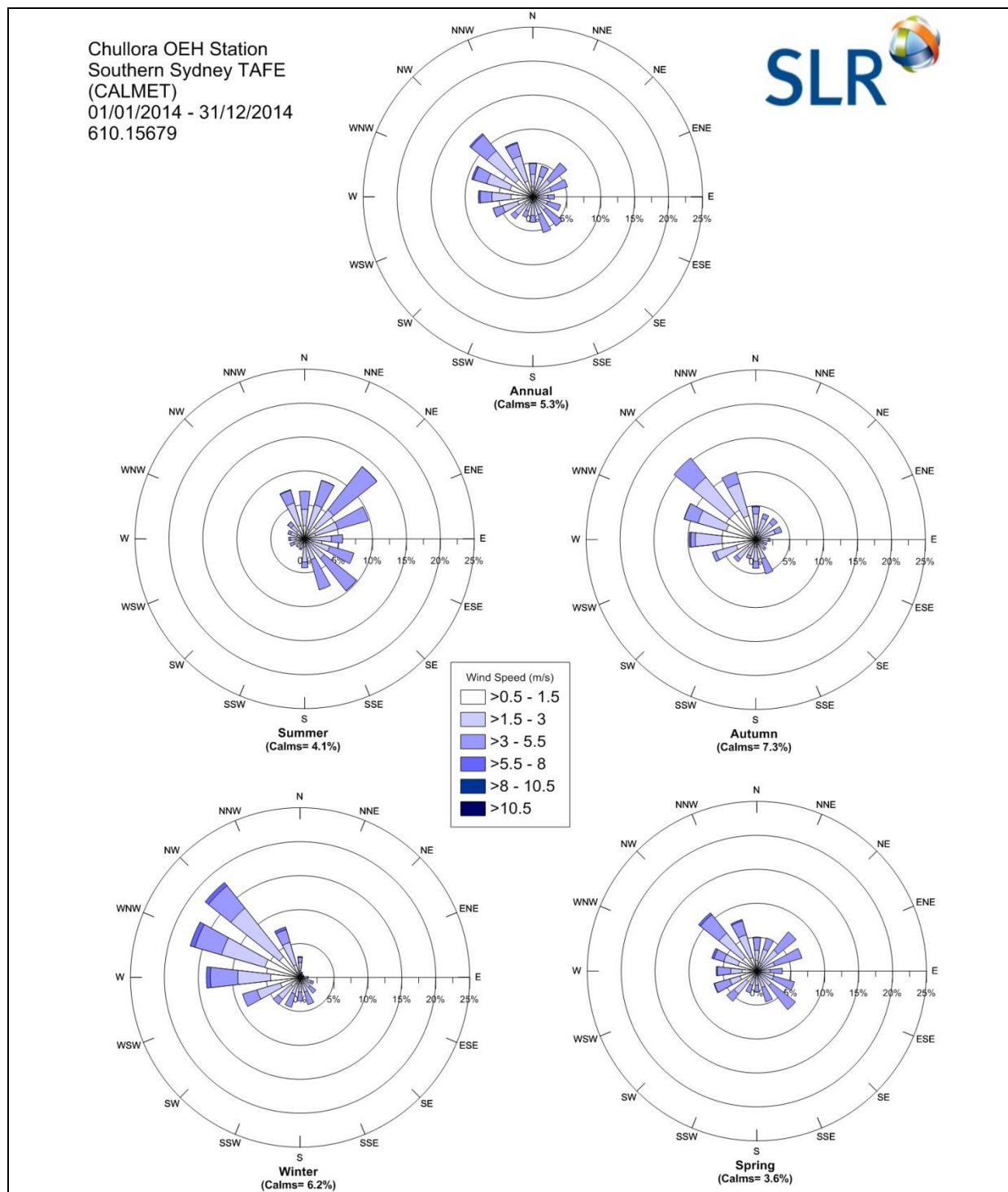
Parameter	Brief Description	Recommended Value	Value Used in Assessment
MGAUSS	Vertical distribution used in near field	1	1
MCTADJ	Terrain adjustment method	3	3
MSLUG	Near-field puffs modelled as slugs	0	0
MSPLIT	Puff splitting allowed	0	0
MCHEM	Chemical transformation	1	0 (transformation of NO _x to NO ₂ performed as per Section 5.4.1)
MWET	Wet removal	1	0 (worst case)
MDRY	Dry removal	1	0 (worst case)
MDISP	Dispersion coefficients	2	2

CALMET OUTPUTS

Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET for the Chullora AQMS is presented in **Figure F1**.

Figure F1 Wind Roses for the Chullora AQMS as Predicted by CALMET (2014)



CALMET OUTPUTS

Atmospheric Stability

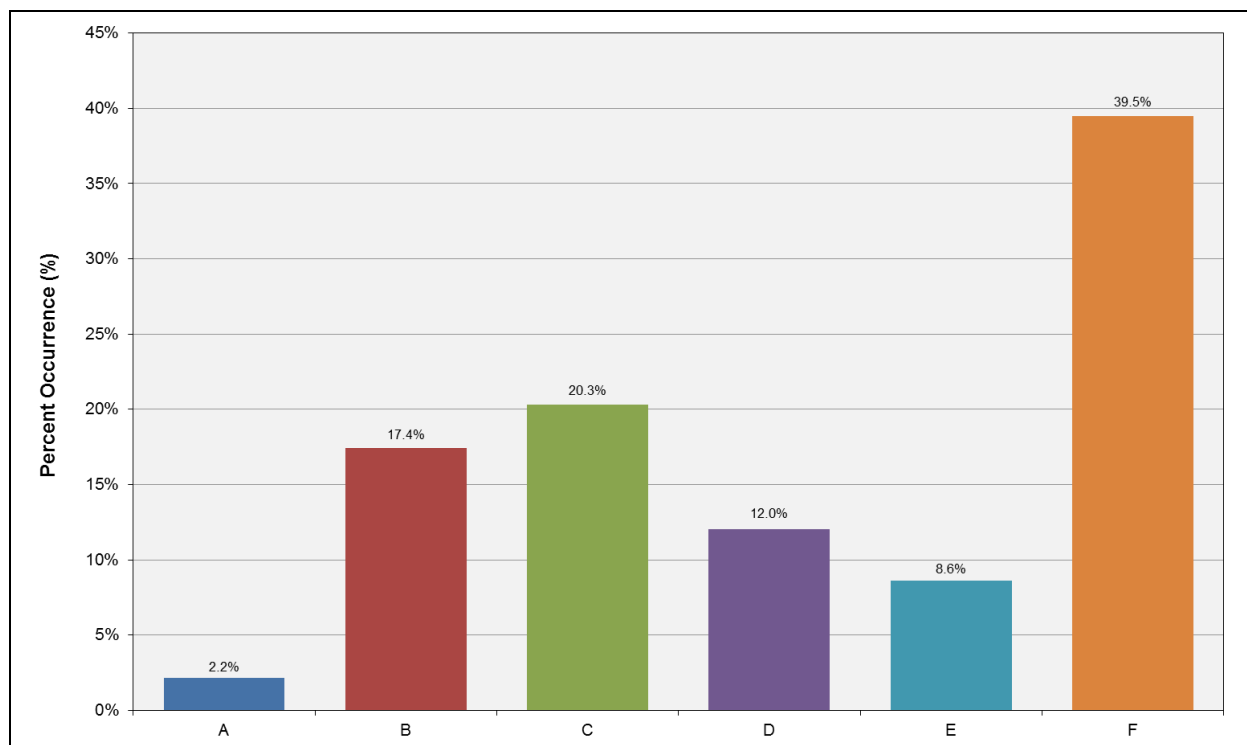
Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability (see **Table F1**). These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models.

The frequency of each stability class predicted by CALMET is presented in **Figure F2**. The results indicate a high frequency of conditions typical to Stability Class F. Stability Class F is indicative of very stable night time conditions, conducive to a low level of pollutant dispersion due to mechanical mixing resulting in higher pollutant concentrations.

Table F1 Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category Description
A	Very unstable Low wind, clear skies, hot daytime conditions
B	Unstable Clear skies, daytime conditions
C	Moderately unstable Moderate wind, slightly overcast daytime conditions
D	Neutral High winds or cloudy days and nights
E	Stable Moderate wind, slightly overcast night-time conditions
F	Very stable Low winds, clear skies, cold night-time conditions

Figure F2 Stability Class Distribution Predicted at the Chullora AQMS by CALMET (2014)

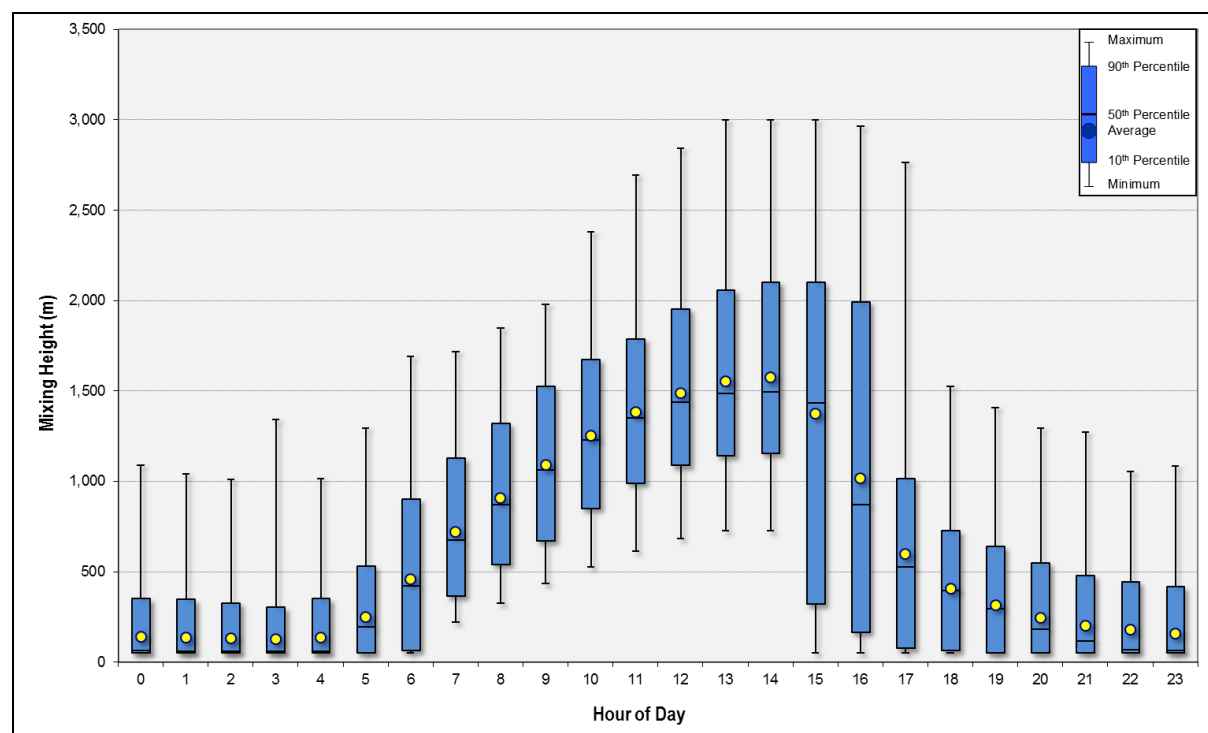


CALMET OUTPUTS

Mixing Heights

Diurnal variations in maximum and average mixing depths predicted by CALMET at the Chullora AQMS during 2014 are illustrated in **Figure F3**. As would be expected, an increase in the mixing depth 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 the growth of the convective mixing layer.

Figure F3 Mixing Heights Predicted at the Chullora AQMS by CALMET (2014)



DISPERSION MODEL ACCURACY

Atmospheric dispersion models such as CALPUFF, Ausplume, AERMOD and even specialist models like DEGADIS, CALINE4 and SLAB all represent a simplification of the many complex processes involved in the dispersion of pollutants in the atmosphere. To obtain good quality results it is important that the most appropriate model is used and the quality of the input data (meteorological, terrain, source characteristics) is adequate.

The main sources of uncertainty in dispersion models, and their effects, are discussed below.

- **Oversimplification of physics:** This can lead to both under-prediction and over-prediction of ground level pollutant concentrations. Errors are greater in Gaussian plume models as they do not include the effects of non-steady-state meteorology (ie spatially- and temporally-varying meteorology).
- **Errors in emission rates:** Ground level concentrations are proportional to the pollutant emission rate. In addition, most modelling studies assume constant worst case emission levels or are based on the results of a small number of stack tests, however operations (and thus emissions) are often quite variable. Accurate measurement of emission rates and source parameters requires continuous monitoring.
- **Errors in source parameters:** Plume rise is affected by source dimensions, temperature and exit velocity. Inaccuracies in these values will contribute to errors in the predicted height of the plume centreline and thus ground level pollutant concentrations.
- **Errors in wind direction and wind speed:** Wind direction affects the direction of plume travel, while wind speed affects plume rise and dilution of plume. Errors in these parameters can result in errors in the predicted distance from the source of the plume impact, and magnitude of that impact. In addition, aloft wind directions commonly differ from surface wind directions. The preference to use rugged meteorological instruments to reduce maintenance requirements also means that light winds are often not well characterised.
- **Errors in mixing height:** If the plume elevation reaches 80% or more of the mixing height, more interaction will occur, and it becomes increasingly important to properly characterise the depth of the mixed layer as well as the strength of the upper air inversion.
- **Errors in temperature:** Ambient temperature affects plume buoyancy, so inaccuracies in the temperature data can result in potential errors in the predicted distance from the source of the plume impact, and magnitude of that impact.
- **Errors in stability estimates:** Gaussian plume models use estimates of stability class, and 3D models use explicit vertical profiles of temperature and wind (which are used directly or indirectly to estimate stability class for Gaussian models). In either case, errors in these parameters can cause either under-prediction or over-prediction of ground level concentrations. For example, if an error is made of one stability class, then the computed concentrations can be off by 50% or more.

The US EPA makes the following statement in its Modelling Guideline (US EPA, 2005) on the relative accuracy of models:

“Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ± 10 to 40% are found to be typical, i.e., certainly well within the often quoted factor-of-two accuracy that has long been recognised for these models. However estimates of concentrations that occur at a specific time and site, are poorly correlated with actually observed concentrations and are much less reliable.”