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Air Quality Impact Assessment  
Enfield Intermodal - SSD 05\_0147 MOD14

Report Number 610.17807-R01

26 February 2018

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# Air Quality Impact Assessment

## Enfield Intermodal - SSD 05\_0147 MOD14

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## 1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) was commissioned by Goodman Property Services (Australia) Pty Ltd (the Proponent) to perform an Air Quality Impact Assessment (AQIA) for a proposed modification (MOD 14) to the Enfield Intermodal Logistics Centre (the Enfield ILC).

The development approval for the Enfield ILC was granted on 5 September 2007 (the Approval). The Enfield ILC includes the active Enfield Intermodal Terminal (IMT) currently operated by Aurizon, proposed empty container storage parks, an existing warehouse and tarp shed, dedicated ecological areas and 30 hectares (ha) of remaining developable industrial zoned land. The Approval included construction of seven (7) warehouses with a total footprint area 109,300 square meters (m<sup>2</sup>). To date, only one warehouse has been erected on site (URBIS 2017).

MOD 14 seeks to modify the Approval to modify built form parameters, including modifications to the site layout and approved building footprints to enable the construction of fourteen (14) warehouses and nineteen (19) strata units, encompassing 125,630 m<sup>2</sup>, as well as approval to increase the building heights to a maximum of 13.7 metres (m). MOD 14 also seeks to modify the operational parameters to provide greater flexibility, such as extension of operating hours, permit warehouse and distributions uses and allow truck-to-truck freight movements for smaller sites with no direct interface with rail sidings.

### 1.1 Background

An AQIA was completed by SKM in 2005 as part of the original Environmental Impact Statement (EIS) for the Enfield ILC Project (SKM 2005) (hereafter the '2005 SKM report'). A quantitative assessment was performed to assess the cumulative air quality impacts at a total of five (5) sensitive receptors for both the construction and operational phases of the Project.

The dispersion modelling was conducted using AUSPLUME modelling software. The cumulative impacts of particulates (as PM<sub>10</sub>) and nitrogen dioxide (NO<sub>2</sub>) were assessed against the relevant NSW EPA criteria in force at the time of the assessment. Other anticipated air pollutants from on-site activities (carbon monoxide, sulfur dioxide, and volatile organic compounds) were identified as 'low risk' air pollutants and therefore not assessed as part of the assessment.

The maximum cumulative short term (1-hour average) and long term (annual average) NO<sub>2</sub> impacts were predicted to be approximately 77% and 91% respectively of the relevant criteria. The maximum cumulative short term (24-hour average) and long term (annual average) PM<sub>10</sub> impacts were predicted to be approximately 93% and 66% respectively of the relevant criteria.

Further it was concluded that:

*"The air dispersion modelling results for ILC operations show compliance with NSW Environment Protection Authority ambient air quality criteria. The modelling results for ILC construction show that there is a risk of some exceedances of the NSW EPA criterion for maximum 24-hour average PM<sub>10</sub> (i.e., 50 µg/m<sup>3</sup>), and there may be one or two exceedances of the corresponding National Environment (Ambient Air Quality) Measure criterion."*

Since the completion of the 2005 SKM Report and the Project approval in 2007, the following updates have occurred within the relevant air quality assessment regulations:

- The AUSPLUME model has been replaced by AERMOD for regulatory purposes by its developers (Victorian EPA).
- In February 2016, a variation to the Ambient Air Quality National Environment Protection Measure (NEPM) was made to extend its coverage to PM<sub>2.5</sub>, setting reporting standards for PM<sub>2.5</sub> with no allowable exceedances (NEPC 2016). The air quality criterion for annual average PM<sub>10</sub> was also revised from 30 µg/m<sup>3</sup> to 25 µg/m<sup>3</sup> (EPA 2017).
- The Air Quality Monitoring Station (AQMS) at Lidcombe has also been decommissioned by the NSW Office of Environment and Heritage (OEH).

Given the above, it is considered appropriate to perform an updated dispersion modelling study to predict air quality impacts due to the modified operations of the Enfield ILC. To enable an assessment of the incremental impacts associated with the proposed modifications compared to the approved activities, the updated modelling methodology was used to assess the potential off-site impacts of both the approved and proposed operational activities.

## 1.2 Secretary’s Environmental Assessment Requirements

This report has been prepared as part of the Environmental Impact Statement (EIS) for MOD14. The NSW Department of Planning and Environment (DPE) issued Secretary’s Environmental Assessment Requirements (SEARs) for MOD14 in November 2017. The objective of this report is to assess the potential impacts of the modified Enfield ILC on air quality and has been prepared in accordance with relevant state and federal guidelines and regulations, and to address the SEARs relevant to air quality, as shown in **Table 1**.

**Table 1 Secretary’s Environmental Assessment Requirements – Enfield ILC (MOD14)**

Key Issue	Assessment Requirement	Addressed in Section
Air Quality	A description of all potential sources of air and odour emissions during construction and operation, and	<b>Section 2.6</b>
	an air quality impact assessment in accordance with relevant Environment Protection Authority guidelines, specifically the ability to comply with the Protection of the Environment Operations Act 1997 and the Protection of the Environment Operations (Clean Air) Regulation (2010)	<b>Section 6</b>

Source: SEARs for application number MP05\_0147 MOD 14, 9 November 2017.

## 1.3 Outline of Assessment

The NSW Environment Protection Authority (EPA) “*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*” (EPA 2017) (hereafter ‘Approved Methods’) outlines the requirements for conducting an AQIA, as follows (with identification of where each requirement has been met in this report):

- Description of local topographic features and sensitive receptor locations (**Section 2.3** and **Section 2.7** respectively).  
*Note: The same five sensitive receptors as were assessed in the SKM assessment have been assessed in addition to eight other identified sensitive receptors.*
- Establishment of air quality assessment criteria (**Section 3**).  
*Note: This assessment contains the updated annual average PM<sub>10</sub> criterion.*
- Description of the existing air quality environment (**Section 4**).  
*Note: The background air quality concentrations are sourced from Chullora AQMS which is located approximately 2 km from Enfield ILC.*
- Analysis of climate and dispersion meteorology for the region (**Sections 5.2.2**).
- Compilation of a comprehensive emissions inventory for proposed operations (**Section 5.2.4**).
- Preparation of an air quality impact assessment report comprising the above.

Potential emissions to air from the proposed construction and operation of MOD14 of the Enfield ILC 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 PROJECT OVERVIEW

### 2.1 Regional Setting

The Enfield ILC is approximately 15 kilometres from the Sydney Central Business District by road and 18 kilometres (km) from Port Botany by rail.

The Enfield ILC site is located within South Strathfield on the land generally bound by Cosgrove Road to the east, Punchbowl Road to the south, the Port Botany Freight Rail Line to the west and Roberts Road to the north (see **Figure 1**). It covers an area of approximately 60 hectares and is approximately 0.5 km in width and over 2 km in length. The Enfield ILC has the legal description Lots 1 - 23 DP 1183316. The main entrance to the Enfield ILC is via Cosgrove Road.

**Figure 1 Regional Setting of the Enfield Intermodal Logistics Centre**



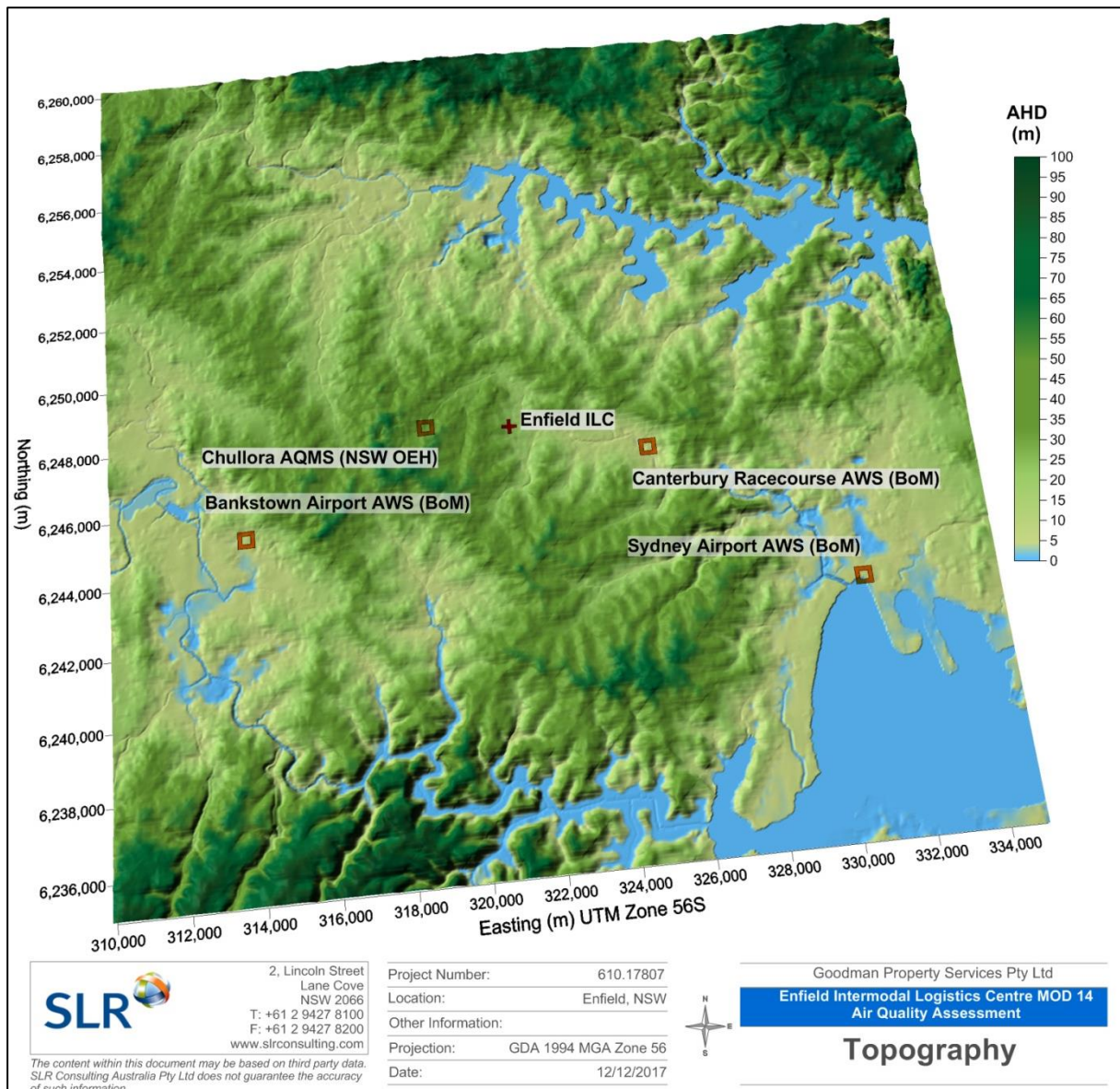


### 2.3 Regional Topography

The topographical data used in this AQIA was sourced from the United States Geological Service's Shuttle Radar Topography Mission (SRTM) database that has recorded topography across Australia with a 3 arc second (~90 metre (m)) spacing.

**Figure 3** illustrates the topography of the region surrounding the Enfield ILC based on the SRTM data. The ground elevation ranges from approximately 5 – 100 m within 500 m of the site.

**Figure 3 Topography Surrounding the Enfield ILC**



## 2.4 Approved Development Activities

The Approval for the Enfield ILC includes the following activities:

- Demolition, relocation or removal of former railway buildings and structures;
- Earthworks and drainage including the levelling of the site, formation of landscape mounds and detention basins and removal of unsuitable materials, as required;
- Construction and operation of:
  - An intermodal terminal for the loading and unloading of containers between road and rail and the short-term storage of containers, with a capacity to handle 300,000 twenty-foot equivalent unit (TEU) per annum;
  - Rail sidings, railway lines and associated works to connect to the existing freight line;
  - Warehousing for the packing and unpacking of containers and the short-term storage of cargo;
  - Empty container storage facilities, for the storage of empty containers to be later packed or transferred back to the port by rail;
  - Light industrial/commercial area fronting Cosgrove Road complementary to operations at the site;
  - Access works including the construction of a road bridge over the new marshalling yards for access to Wentworth Street and an upgrade of the entrance to the site from Cosgrove Road; and
  - Internal roads, administration buildings, diesel and LPG storage and fuelling facilities, container wash down area, vehicle maintenance shed, and installation of site services (all utilities, stormwater and sewerage).

The Enfield ILC is currently operating well below its approved throughput capacity of 300,000 TEU per annum, with the current annual throughput estimated to be approximately 50,000 TEU per annum (URBIS 2017).

## 2.5 Proposed Development Activities (MOD 14)

### 2.5.1 Construction Activities

MOD 14 seeks to modify the approved masterplan to increase the number of buildings to fourteen (14) warehouses and nineteen (19) small strata units (compared to seven (7) warehouses allowed for in the Approval). This will include additional earthworks, encompassing approximately 142,050 m<sup>3</sup> of cut material that will be utilised within the Enfield ILC as fill and importing an additional 52,425 m<sup>3</sup> of fill material (AT&L 2018).

The construction assessment aims to assess construction impacts related to the additional earthworks and construction of the warehouses and strata units only. Construction of the intermodal terminal, rail sidings etc is not addressed as these facilities have already been approved and partially constructed.

### 2.5.2 Operational Activities

MOD 14 seeks to modify the operational parameters to provide greater flexibility and enable the Enfield ILS to service Greater Sydney's 24/7 port supply chain. Specifically, the proposed changes are:

- Extend the operating hours to 24/7;
- Allow for warehouse and distribution uses; and
- Allow truck-to-truck freight movements for smaller sites with no direct interface with the rail sidings.

The operational assessment aims to quantify air quality impacts related to road traffic emissions, especially those associated with idling truck engines while the truck-to-truck freight movements are taking place.

## 2.6 Identification of Atmospheric Pollutants

### 2.6.1 Construction

The main emissions to air during the construction phase will be emissions of particulate matter (dust), from minor excavation activities and material handling activities. Dust from the construction activities will be controlled using the best management practices outlined in **Section 7.1**.

### 2.6.2 Operations

During the operational phase, the key emission sources and pollutants of interest have been identified as follows:

- Particulate emissions (as Total Suspended Particulate (TSP), particulate matter less than 10 microns (PM<sub>10</sub>) and particulate matter less than 2.5 microns (PM<sub>2.5</sub>)) resulting from traffic movements on paved roads;
- Truck exhaust emissions within the Enfield ILC, namely oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO), particulate matter (as TSP, PM<sub>10</sub> and PM<sub>2.5</sub>), sulphur dioxide (SO<sub>2</sub>) and volatile organic compounds (VOCs);
- Locomotive idling emissions, namely NO<sub>x</sub>, CO, TSP, PM<sub>10</sub> and PM<sub>2.5</sub>, SO<sub>2</sub> and VOCs;
- Emissions due to combustion of LPG in on-site forklifts, namely NO<sub>x</sub> and CO, and
- Off-site air emissions associated with truck movements on the road network accessing the Enfield ILC.

All sewer systems within the Enfield ILC will be underground, therefore it can be assumed that the operations will not contribute any odour.

With regards to the off-site exhaust emissions associated with truck movements on the road network accessing the Enfield ILC, the SKM report concluded that the incremental increase in emissions of NO<sub>2</sub> and PM<sub>10</sub> due to increased truck traffic on surrounding roads was insignificant, and therefore they are not considered any further in this assessment.

Due to the low background concentrations of CO, SO<sub>2</sub> and VOCs, these pollutants are likely to be low impact pollutants, and are therefore not considered any further in this assessment.

## 2.7 Sensitive Receptors

The closest residential areas are approximately 30 m from the Enfield ILC boundary (R1). Surrounding sensitive receptors identified for consideration in this assessment are listed in **Table 3** and presented in **Figure 4**.

**Table 3 List of Identified Sensitive Receptors**

Receptor ID	Easting (m)	Northing (m)	Distance from the closest boundary (m)
R1 <sup>a</sup>	322,244	6,246,913	30
R2 <sup>a</sup>	322,308	6,246,713	30
R3 <sup>a</sup>	321,873	6,246,255	360
R4 <sup>a</sup>	321,760	6,246,437	285
R5 <sup>a</sup>	321,249	6,248,585	100
R6	322,229	6,247,885	400

Receptor ID	Easting (m)	Northing (m)	Distance from the closest boundary (m)
R7	322,137	6,248,159	450
R8	322,125	6,248,528	600
R9	321,745	6,248,731	340
R10	321,186	6,248,214	110
R11	321,185	6,247,944	120
R12	321,104	6,247,425	350
R13	321,038	6,247,042	560

Note: <sup>a</sup> Receptors 1 to 5 are the same as were assessed in the 2005 SKM Report (SKM 2005).

**Figure 4** Locations of Identified Sensitive Receptors



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Project Number: 610.17807  
 Location: Enfield, NSW  
 Other Information:  
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Goodman Property Services (Australia) Pty Ltd  
 Enfield Intermodal - SSD 05\_0147 MOD14  
 Air Quality Impact Assessment

**Sensitive Receptors**

### 3 RELEVANT AIR QUALITY CRITERIA

#### 3.1 Particulate Matter

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 health effects of particulate matter are strongly influenced by the size of the airborne particles. Smaller particles can penetrate further into the respiratory tract, with the smallest particles having a greater impact on human health as they penetrate to the gas exchange areas of the lungs. Larger particles primarily cause nuisance associated with coarse particles settling on surfaces.

The term “particulate matter” refers to a category of airborne particles, typically less than 30 microns ( $\mu\text{m}$ ) in diameter and ranging down to 0.1  $\mu\text{m}$  and is termed total suspended particulate (TSP). Particulate matter with an aerodynamic diameter of 10 microns or less is referred to as  $\text{PM}_{10}$ . The  $\text{PM}_{10}$  size fraction is sufficiently small to penetrate the large airways of the lungs, while  $\text{PM}_{2.5}$  (2.5 microns or less) particulates are generally small enough to be drawn in and deposited into the deepest portions of the lungs. Potential adverse health impacts associated with exposure to  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

#### 3.2 Products of Combustion

Emissions associated with the combustion of automotive fuel (diesel, petrol, LPG etc.) in road vehicles and diesel in locomotive engines will include carbon monoxide (CO), oxides of nitrogen ( $\text{NO}_x$ ), particulate matter ( $\text{PM}_{10}$  and  $\text{PM}_{2.5}$ ), sulfur dioxide ( $\text{SO}_2$ ) and volatile organic compounds (VOCs).

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.

Oxides of nitrogen ( $\text{NO}_x$ ) is a general term used to describe any mixture of nitrogen oxides formed during combustion. In atmospheric chemistry,  $\text{NO}_x$  generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide ( $\text{NO}_2$ ). NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to  $\text{NO}_2$  which can have significant health effects including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. NO will be converted to  $\text{NO}_2$  soon after leaving a vehicle exhaust.

Vehicle exhausts can contain emissions of sulfur dioxide ( $\text{SO}_2$ ) due to impurities in the fuel. The sulfur content in diesel has significantly reduced over the years and a timeline of the sulfur content in diesel fuels in Australia is shown in **Table 4**.

**Table 4 The Environmental and Operability Standard in Australia – Diesel Fuel Quality Standard**

Pollutant	National Standard	Date of Effect	Test Method
Sulfur Content of Fuel	10 ppm (max)	1-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 17 November 2017.

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.

### 3.3 Air Quality Criteria

State air quality guidelines specified by the NSW Environmental Protection Agency (EPA) for the pollutants identified in **Section 2.6** are published in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2017) [hereafter 'the Approved Methods']. The ground level air quality impact assessment criteria listed in Section 7 of the Approved Methods have been established by NSW EPA to achieve appropriate environmental outcomes and to minimise associated risks to human health. They have been derived from a range of sources and are the defining ambient air quality criteria for NSW, and are considered to be appropriate for use in this assessment.

A summary of the relevant impact assessment criteria for particulate matter and products of combustion is provided in **Table 5**.

**Table 5 NSW EPA Goals for Particulate Matter and Combustion Gases**

Pollutant	Averaging Period	Concentration
NO <sub>2</sub>	1 hour	246 µg/m <sup>3</sup>
	Annual	62 µg/m <sup>3</sup>
TSP	Annual	90 µg/m <sup>3</sup>
PM <sub>10</sub>	24 Hours	50 µg/m <sup>3</sup>
	Annual	25 µg/m <sup>3</sup>
PM <sub>2.5</sub>	24 Hours	25 µg/m <sup>3</sup>
	Annual	8 µg/m <sup>3</sup>

Source: EPA 2017

It is noted that the air quality criteria prescribed by the Approved Methods are largely based on the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM). The desired environmental outcome of the AAQ NEPM is to achieve ambient air quality that allows for the adequate protection of human health and wellbeing.

The potential health impacts due to the construction and operation of Enfield ILC are only assessed for off-site receptors and by comparison against the criteria prescribed by Approved Methods. The assessment of potential occupational exposures for construction workers or operational staff is beyond the scope of this assessment.

## 4 EXISTING AIR QUALITY

Ambient air quality monitoring is performed by the NSW OEH at Chullora AQMS, located approximately 2 km west of the Enfield ILC (see **Figure 3**). The details of this AQMS are provided in **Table 6**.

**Table 6** Details of Air Quality Monitoring Surrounding the Project Site

AQMS Name	Distance / Direction from Project Site	UTM Zone 56S		Parameters Measured	AQMS Commissioned
		Easting	Northing		
Chullora	2.3 km / W	319,292	6,248,020	Ozone (O <sub>3</sub> ) CO SO <sub>2</sub> NO, NO <sub>2</sub> , NO <sub>x</sub> Fine particles (by nephelometry) Fine particles (PM <sub>10</sub> and PM <sub>2.5</sub> 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

Air quality measured at the Chullora AQMS provides a good representation of the existing air quality experienced in close proximity to the Enfield ILC, without the impact of current operations at the Enfield ILC itself. The impacts predicted as a result of the proposed operations at the Enfield ILC can therefore be added to these measured background levels to estimate the *cumulative* impact for each pollutant of interest, which can then be directly compared to the air quality criteria as outlined in **Section 3**.

Hourly average measurements of NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> were obtained from the NSW OEH Chullora AQMS for the calendar year 2014 (contemporaneous with the year selected for dispersion modelling, as prescribed by the Approved Methods).

Concentrations of TSP are not measured at the Chullora AQMS. As PM<sub>10</sub> represents a fraction of the broader particulate concentration, relationships between TSP and PM<sub>10</sub> vary depending on the regional and local emission sources. In the absence of any monitored data, it is a standard industry practice to assume TSP concentrations to be twice those of PM<sub>10</sub> concentrations in urban areas. This multiplier has been applied to the annual average PM<sub>10</sub> concentration measured at Chullora in 2014 to derive an estimated annual average TSP concentration at this location.

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.

A summary of the existing air quality as measured or estimated in the area surrounding the Enfield ILC is presented in **Table 7**. Graphical representations of the 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**.

**Table 7 Summary of Air Quality Monitoring Data (Chullora AQMS 2014)**

Pollutant	Averaging Period	Measured Concentration ( $\mu\text{g}/\text{m}^3$ )	Criteria ( $\mu\text{g}/\text{m}^3$ )	Approximate Percentage of Criterion represented by Existing Measurements
NO <sub>2</sub>	Maximum 1 hour	131.2	246	53%
	Annual	26.9	62	43%
PM <sub>10</sub>	Maximum 24 hours	40.0	50	80%
	Annual	18.0	25	72%
PM <sub>2.5</sub>	Maximum 24 hours	23.1	25	92%
	Annual	9.0	8	113%
TSP	Annual	36.0	90	49%

With the exception of the annual average PM<sub>2.5</sub> concentration, the background concentrations of all pollutants of concern are shown to be below the relevant criterion. The background 1-hour and annual average NO<sub>2</sub> concentrations are approximately 50% of the relevant criterion. The maximum measured 24 hour average PM<sub>10</sub> concentration is 80% of the criterion, with the annual average representing 72% of the criterion.

The maximum measured 24 hour average PM<sub>2.5</sub> concentration is approaching the criterion (at 92%) and the annual average PM<sub>2.5</sub> concentration of 9  $\mu\text{g}/\text{m}^3$  recorded at Chullora in 2014 exceeded the criterion of 8  $\mu\text{g}/\text{m}^3$ .

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

## 5 IMPACT ASSESSMENT METHODOLOGY

### 5.1 Construction Activities

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

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

### 5.2 Operational Activities

As stated in **Section 2.6.2**, wheel-generated dust from the on-site traffic movements and on-site combustion emissions from road traffic, idling locomotives and ancillary vehicles (forklifts etc) have been identified as the main sources of potential emissions from the proposed operations at the Enfield ILC. Emissions of TSP, PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>x</sub> from these proposed operational activities have been modelled using the US EPA's CALPUFF (Version 6.267) modelling system to predict off-site impacts at sensitive receptor locations, as described below.

#### 5.2.1 Dispersion Modelling Methodology

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.

CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further in **Section 5.2.2**. 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 hourly concentrations or deposition values evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

##### 5.2.1.1 Accuracy of Modelling

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 (i.e., 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  $\pm 10$  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.”*

This study utilises the CALPUFF dispersion model in full 3D mode, incorporating 3D meteorological output from TAPM and CALMET. The meteorological dataset has been compiled using observations from nearby automatic weather stations and a five year period of meteorological data was reviewed to ensure that the year selected for use in the modelling is representative of long-term meteorological conditions.

## 5.2.2 Meteorological Modelling Methodology

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 1998). To adequately characterise the dispersion meteorology of the study site, information is needed on the prevailing wind regime, mixing height and atmospheric stability and other parameters such as ambient temperature, rainfall and relative humidity.

### 5.2.2.1 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 Racecourse (Station # 66194), Bankstown Airport AWS (Station # 66137), Sydney Airport (Station # 66037). The locations of these AWSs are shown in **Figure 3**.

In order to determine a representative meteorological year for use in dispersion modelling, five years of meteorological data (2012-2016) recorded by the closest BoM station (Canterbury Racecourse) were analysed against the long term (5-year average) 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 air 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 due to higher dispersion of the plume.
- Hourly wind speeds observed at 9 am and 3 pm.
- Wind directions in the form of wind roses

Based on the above parameters, all five years reviewed (2012 – 2016) showed similar trends as the long term data, although 2014 was more aligned with the long term trends compared to other years. Therefore, the 2014 calendar year was adopted for use in this assessment.

### 5.2.2.2 TAPM

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

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

TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. The wind speed and direction observations obtained from the nearest BoM stations have also been used in the TAPM modelling as well as the subsequent CALMET component of the modelling (see **Table 8** and **Table 9**).

**Table 8 Meteorological Parameters used for this Study (TAPM v 4.0.4)**

Modelling Period	1 January 2014 to 31 December 2014
Centre of analysis	321,636 mE 6,247,701 mN (UTM Coordinates)
Number of grid points	25 x 25 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km, 300 m)
Data assimilation	Canterbury Racecourse AWS (Station # 66194) Bankstown Airport AWS (Station # 66137) Sydney Airport AWS (Station # 66037) Chullora Air Quality Monitoring Station (Chullora AQMS)
Terrain	AUSLIG 9 second DEM

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

### 5.2.2.3 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 current land uses.

CALMET modelling was conducted using the 'with Obs' CALMET approach. TAPM-generated upper air data and available surface weather observations in the area were used to refine the wind field predetermined by TAPM data. Hourly surface meteorological data from the nearest BoM stations were incorporated in the CALMET modelling. A horizontal grid spacing of 100 m was used to adequately represent the important local terrain features and land use. **Table 9** details the parameters used in the CALMET meteorological modelling.

**Table 9 CALMET Configuration Used for this Study**

Modelling Period	1 January 2014 to 31 December 2014
Centre of analysis	319,739 mE 6,247,547 mN (UTM Coordinates)
Meteorological grid domain (Meteorological grid resolution)	14 km x 14 km (0.1 km)
Vertical Resolution (Cell Heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)
Data Assimilation	Canterbury Racecourse AWS (Station # 66194) Bankstown Airport AWS (Station # 66137)* Chullora Air Quality Monitoring Station (Chullora AQMS) TAPM - upper air data (313,638 mE; 6,241,701 mN)

Note: \* Bankstown Airport AWS was included to utilise cloud cover data

## 5.2.3 Meteorological Data Used in this Assessment

### 5.2.3.1 Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET at the Enfield ILC is presented as wind roses in **Figure 5**.

Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (degrees from North). The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus it is possible to visualise how often winds of a certain direction and strength occur over a long period, either for all hours of the day, or for particular periods during the day. The following description of wind speeds references the Beaufort Wind Scale, as outlined in **Table 10**. Use of the Beaufort Wind Scale is consistent with terminology used by the BoM.

**Table 10 Beaufort Wind Scale**

Beaufort Scale #	Description	m/s	Description on land
0	Calm	0-0.5	Smoke rises vertically
1	Light air	0.5-1.5	Smoke drift indicates wind direction
2-3	Light/gentle breeze	1.5-5.3	Wind felt on face, leaves rustle, light flags extended, ordinary vanes moved by wind
4	Moderate winds	5.3-8.0	Raises dust and loose paper, small branches are moved
5	Fresh winds	8.0-10.8	Small trees in leaf begin to sway, crested wavelets form on inland waters
6	Strong winds	>10.8	Large branches in motion, whistling heard in telephone wires; umbrellas used with difficulty

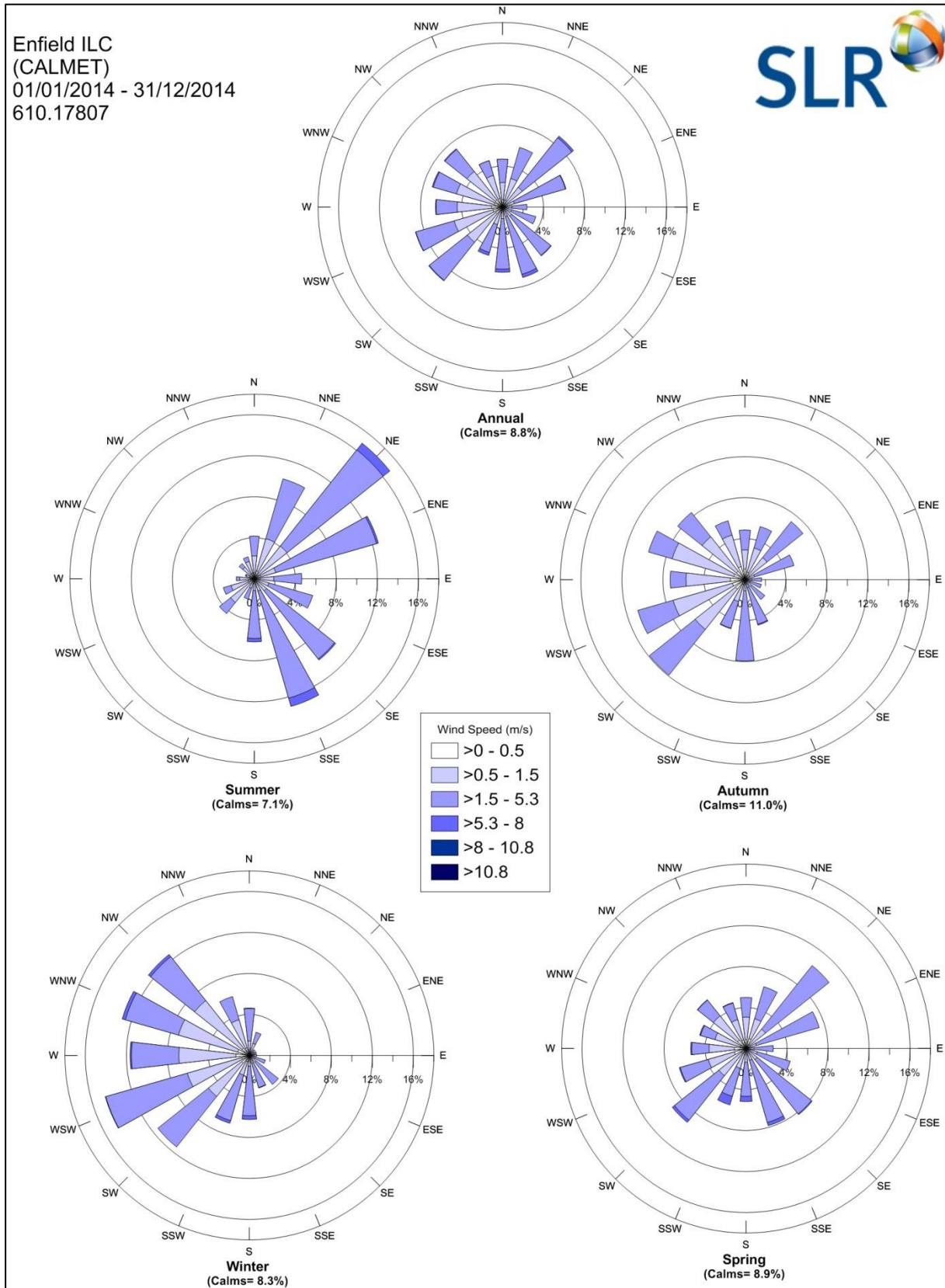
Source: <http://www.bom.gov.au/lam/glossary/beaufort.shtml>

**Figure 5** indicates that winds experienced at the Enfield ILC are predominantly moderate to high (between 1.5 m/s and 8 m/s) with a small percentage of strong winds (>10.5 m/s). The predominant wind direction is seasonally dependent. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur approximately 7%-11% of the year.

The seasonal wind roses indicate that typically:

- In summer, wind speeds range from light to moderate winds (between 0.5 m/s and 6.7 m/s). The majority of winds blow from the northeast and south-southeast, with very few winds from the west and north. Calm wind conditions were predicted to occur approximately 7% of the time during summer.
- In autumn, wind speeds ranged from light to moderate winds (between 0.5 m/s and 5.6 m/s). The majority of winds blow from between the southwest and northwest, with very few winds from the east. Calm wind conditions were predicted to occur approximately 11% of the time during autumn.
- In winter, wind speeds ranged from light to moderate winds (between 0.5 m/s and 7.3 m/s). As in autumn, the majority of winds blow from between southwest and northwest directions, with very few winds from the east. Calm wind conditions were predicted to occur approximately 8% of the time during winter.
- In spring, wind speeds ranged from light to moderate winds (between 0.5 m/s and 7.5 m/s). The winds blow almost evenly from all directions with the exception of the northeast, southeast and southwest directions, from which the winds blew slightly more frequently. Calm wind conditions were predicted to occur approximately 9% of the time during spring.

**Figure 5 Predicted Seasonal Wind Roses for the Enfield ILC (CALMET, 2014)**



### 5.2.3.2 Atmospheric Stability

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

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

The meteorological conditions defining each Pasquill stability class are shown in **Table 11**.

**Table 11 Meteorological Conditions Defining Pasquill Stability Classes**

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

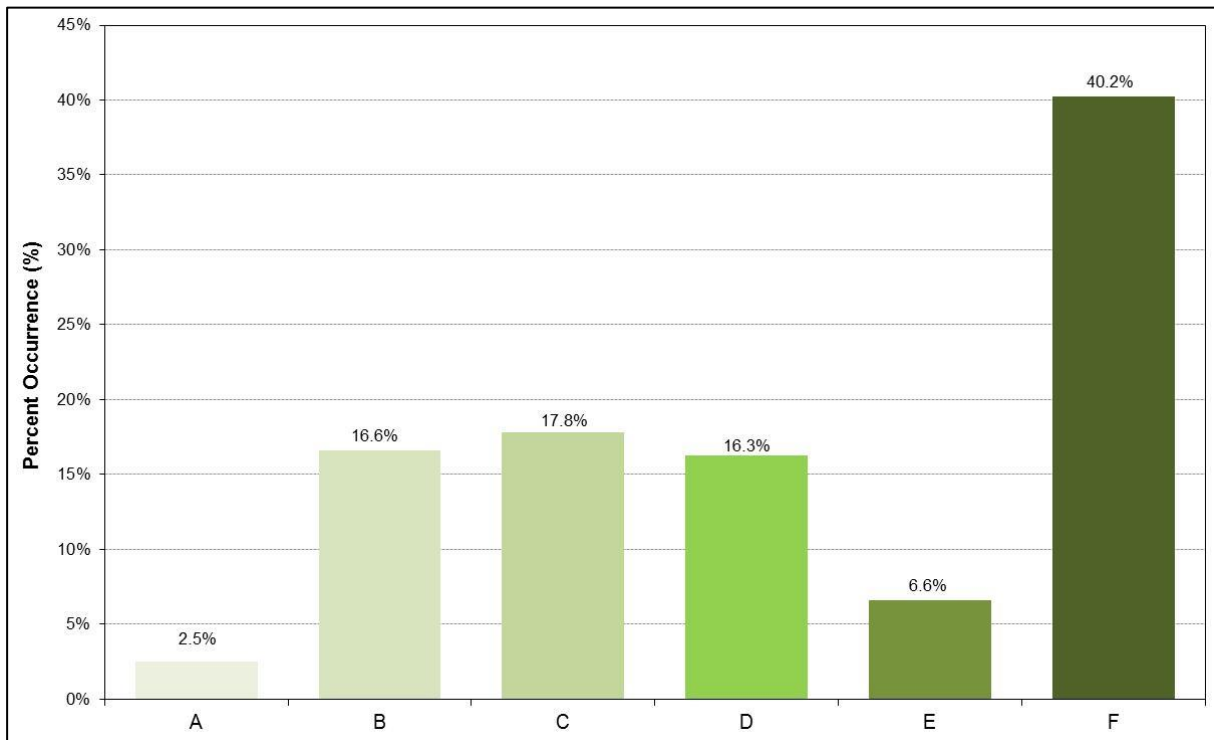
Source: Pasquill 1961

Notes:

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

The frequency of each stability class predicted by CALMET during the modelling period, extracted at the centre of the Enfield ILC, is presented in **Figure 6**. The results indicate a high frequency of conditions typical to Stability Class F. Stability Class F is indicative of stable night time conditions, which will inhibit pollutant dispersion resulting in higher pollutant concentrations.

**Figure 6 Predicted Stability Class Frequencies at the Enfield ILC (CALMET, 2014)**



### 5.2.3.3 Mixing Heights

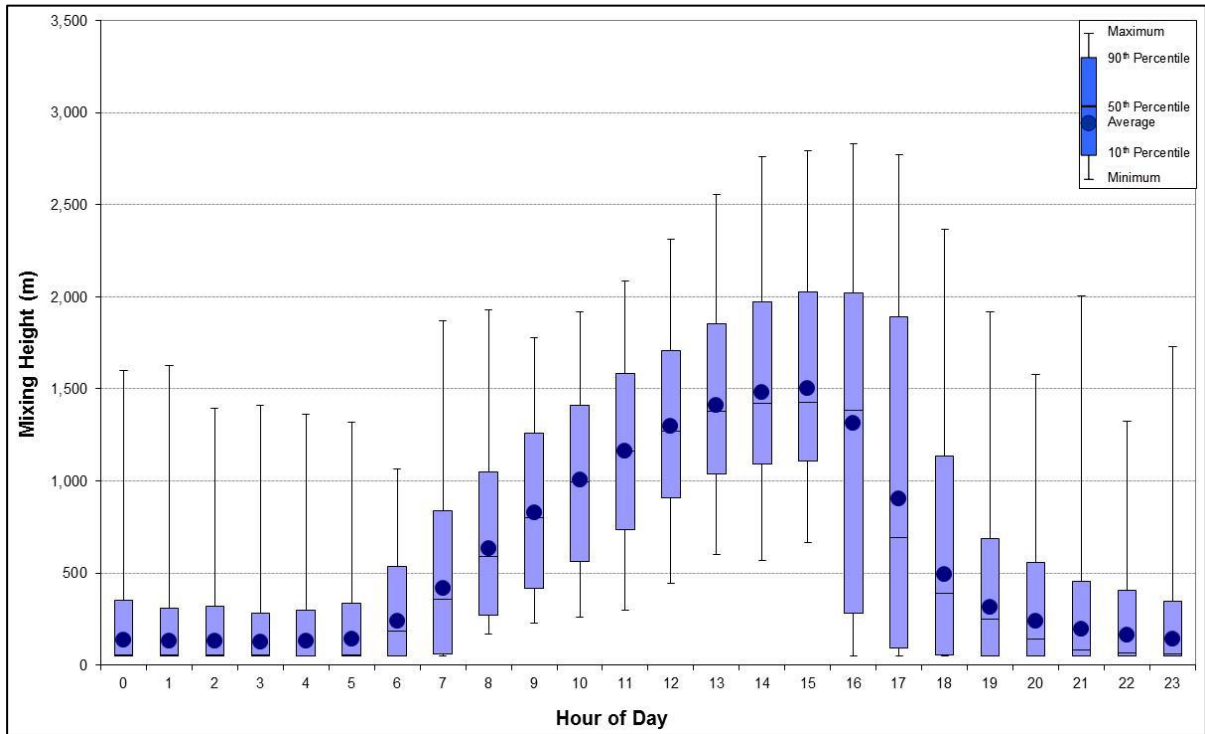
Diurnal variations in maximum and average mixing heights predicted by CALMET at the Enfield ILC during the 2014 modelling period are illustrated in **Figure 7**.

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

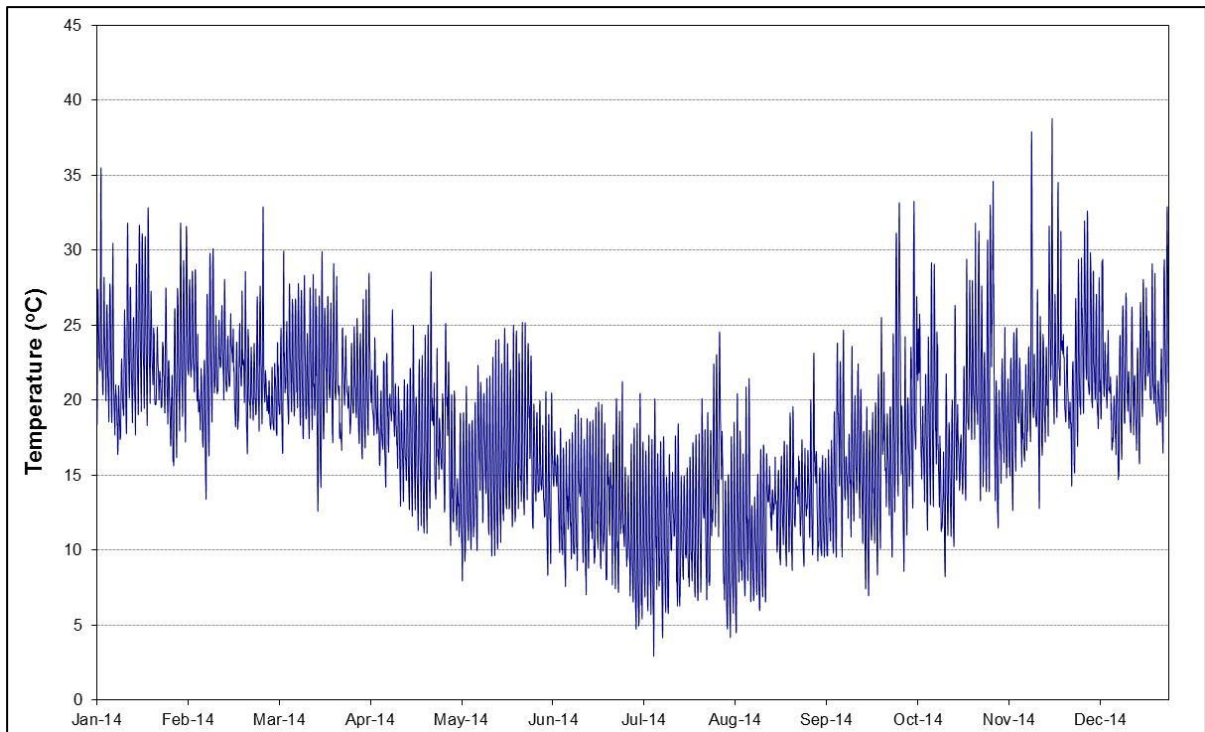
### 5.2.3.4 Ambient Temperature

The modelled temperature variations as predicted at the Enfield ILC during 2014 are illustrated in **Figure 8**. The maximum temperature (38.8°C) was predicted on 21 November 2014 and the minimum temperature (2.9°C) was predicted on 9 July 2014.

**Figure 7 Predicted Mixing Heights at the Enfield ILC (CALMET, 2014)**



**Figure 8 Predicted Temperatures at the Enfield ILC (CALMET, 2014)**



## 5.2.4 Emission Estimation

### 5.2.4.1 Emission Factors

#### Wheel Generated Dust

Potential particulate emissions from the on-site traffic movements were estimated using emission factor equations sourced from the United States Environmental Protection Agency (US EPA) AP-42 Emission Factor Handbook (US EPA 2011).

The emission factors used in estimating potential emissions from the proposed operations are summarised in **Table 12**.

**Table 12 Emission Factors for Wheel Generated Dust on Paved Roads**

Activity	Emission Factor Equation	Units	Source	Variables
Wheel generated dust	$EF_{TSP} = 3.23 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$ $EF_{PM10} = 0.62 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$ $EF_{PM2.5} = 0.15 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$	g/VKT	US EPA (2011)	sL = road surface silt loading (0.2 g/m <sup>2</sup> ) W = average weight of vehicles: 4 t for PUD's 36.6 t for B Doubles

#### Combustion Emissions from Idling and Moving Vehicles

Potential NO<sub>x</sub> and particulate emissions from idling trucks were sourced from US EPA document "Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy Duty Trucks" (US EPA 2008).

Emission factors used in estimating the potential exhaust emission rates for the operational phase of the project are presented in **Table 13**.

**Table 13 Emission Factors for Idling Diesel Vehicles**

Pollutant	Idling Emission Factor (g/hr)	
	PUDs	Trucks
NO <sub>x</sub>	3.515	33.763
PM <sub>10</sub>	0.000	1.196
PM <sub>2.5</sub>	0.000	1.100

It is noted that vehicle exhaust emissions will be released during idling of vehicles as well as a result of vehicle movements within the Enfield ILC. The emission factors presented in **Table 13** reflect the emissions during idling of vehicles, which are higher compared to published emission factors for when the vehicle is travelling on a road. The use of these factors for both idling and moving vehicles within the Enfield ILC will result in a conservative estimate of emissions.

#### Idling Locomotives

Potential emissions associated with the idling of locomotives at the Enfield ILC were estimated using emission factors sourced from the National Pollutant Inventory Emission Estimation Technique for Rail Yard Operations (DEWHA 2008b).

The emissions released from locomotives during idling are better represented by the emission factors for rail yard terminals compared to emission factors for moving line haul locomotives.

Emission factors used in estimating the emissions from locomotives at the Enfield ILC are presented in **Table 14**.

**Table 14 Emission Factors for Idling Locomotives**

Pollutant	Emission Factor (kg/kL)
NO <sub>x</sub>	44.37
PM <sub>10</sub>	3.53
PM <sub>2.5</sub>	3.39

#### Ancillary Vehicles

Potential emissions associated with operations of ancillary on-site vehicles (forklifts etc) were estimated using emission factors sourced from the National Pollutant Inventory Emission Estimation Technique for Combustion Engines (DEWHA 2008b).

Although it is likely that mostly electronic forklifts will be employed, the emissions have been estimated assuming that LPG forklifts will be used to provide a conservative assessment. Emission factors used in estimating the potential emission rate from the operation of LPG forklifts are presented in **Table 15**.

**Table 15 Emission Factors for LPG Forklift Operations**

Pollutant	Emission Factor (kg/m <sup>3</sup> )
NO <sub>x</sub>	25
PM <sub>10</sub>	0
PM <sub>2.5</sub>	0

#### 5.2.4.2 Activity Data

The activity data used for the estimation of emissions using emission factors listed in **Section 5.2.4.1** are shown in **Table 16**.

It is understood that the total number of on-site vehicles and number of vehicles in each category (Pickup and Delivery vehicles (PUDs), Semitrailers and B-Doubles) will vary during the operational hours. To estimate a distribution of vehicle types, reference has been made to the Traffic Impact Assessment completed by Ason group (ASON 2017), which estimated that the trucks will constitute approximately 42% of the total vehicles accessing the Enfield ILC. There is no diurnal variation in total vehicle numbers and vehicles types available for inclusion in this assessment.

**Table 16 Activity Data Used for Emissions Estimation**

Parameter	Value	Unit	Reference
<b>Wheel Generated Dust</b>			
Silt Loading	0.2	g/m <sup>2</sup>	USEPA 2011 (ADT 500-5,000)
Fleet Weight <sup>1</sup>	17.6	t	Calculated as weighted mean
Total number of vehicles	3,390	v/d	Traffic Impact Assessment (Ason 2017)
Total distance	3.2	km	Based on estimated maximum distance travelled by vehicle in one round trip
Total VKT	10,848	VKT/day	Based on Design Masterplan; EILC MP01 (P12), 22 December 2017
AM/PM peak hour number of vehicles	370 334	v/h	Applicable 7AM to 8AM and 5PM to 6PM
Off peak hours number of vehicles	122	v/h	Applicable to 8AM to 5PM and 6PM to 7AM
<b>On-site Idling Vehicles</b>			
Number of idling PUDs	15	v/h	Assumed one vehicle per warehouse
Number of idling trucks	30	v/h	Assumed two trucks per warehouse
<b>Idling Locomotives</b>			
Fuel consumption rate	14	L/h	SKM 2005
<b>Ancillary Vehicles</b>			
Fuel consumption rate	2.14	kg/h	<a href="https://www.supagas.net.au/lpg-15kg-cylinder.html">https://www.supagas.net.au/lpg-15kg-cylinder.html</a>

<sup>1</sup> For the purpose of calculation of emissions factors, a fleet weight of 17.6 t was used, based on a ratio of 58% for PUDs and 42% trucks.

#### 5.2.4.3 Emissions Inventory

The estimated emissions using the emission factors listed in **Section 5.2.4.1** and activity data listed in **Section 5.2.4.2** are shown in **Table 17**.

**Table 17 Estimated Emissions for the Operational Phase**

<b>Wheel Generated Emissions</b>	<b>PUDs</b>	<b>Trucks</b>
TSP (kg/day)	97.1	69.5
PM <sub>10</sub> (kg/day)	18.6	13.3
PM <sub>2.5</sub> (kg/day)	4.5	3.2
<b>On-site Idling vehicles</b>	<b>PUDs</b>	<b>Trucks</b>
PM <sub>10</sub> (kg/day)	0.0	0.9
PM <sub>2.5</sub> (kg/day)	0.0	0.8
NO <sub>x</sub> (kg/day)	1.3	24.3
<b>Idling Locomotives</b>		
PM <sub>10</sub> (kg/day)		1.2
PM <sub>2.5</sub> (kg/day)		1.1
NO <sub>x</sub> (kg/day)		14.9
<b>Ancillary Vehicles</b>		
PM <sub>10</sub> (kg/day)		0
PM <sub>2.5</sub> (kg/day)		0
NO <sub>x</sub> (kg/day)		2.5
<b>TOTAL EMISSIONS</b>	<b>(kg/day)</b>	<b>(kg/year)</b>
TSP	169	61,563
PM <sub>10</sub>	34	12,421
PM <sub>2.5</sub>	10	3,529
NO <sub>x</sub>	43	15,682

### 5.2.5 Application of Existing Air Quality Data

As described in **Section 4**, the existing air quality of the area surrounding the Enfield ILC has been assessed using measurements collected at the Chullora AQMS in 2014. Although the data in **Table 7** represents the maximum short-term (1-hour and 24-hour average) concentrations measured for comparison with the criteria, hourly-varying data have 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.

### 5.2.6 NO<sub>x</sub> to NO<sub>2</sub> Conversion

NO<sub>x</sub> emissions from combustion sources are principally comprised of nitric oxide (NO) with low concentrations of nitrogen dioxide (NO<sub>2</sub>). Once emitted into the atmosphere, the NO is oxidised to NO<sub>2</sub>, predominantly (although not exclusively) through reaction with O<sub>3</sub>. Modelling of NO<sub>2</sub> emissions is therefore performed using emission rates of NO<sub>x</sub> (refer **Section 5.2.4**) with corresponding NO<sub>x</sub> concentrations predicted at sensitive receptors. To enable a comparison of the predicted results against regulatory guidelines for NO<sub>2</sub> exposures, an assumption must then be made regarding the NO<sub>2</sub>/NO<sub>x</sub> ratio in the plume at the downwind receptor locations.

A conservative assumption can be made that all NO<sub>x</sub> emitted will be converted to NO<sub>2</sub> with the background NO<sub>2</sub> concentration then added to estimate the cumulative NO<sub>2</sub> concentration. However, this method is highly simplistic and conservative; hence the Approved Methods provides alternative methods for more detailed assessment. Method 2, which assumes the NO to NO<sub>2</sub> conversion is limited by the ambient ozone (O<sub>3</sub>) concentration (OLM), has been adopted as per Section 8.1.2 of the Approved Methods.

The OLM assumes that all the available O<sub>3</sub> in the atmosphere will react with NO in the plume until either all the O<sub>3</sub> or all the NO is used up. This approach assumes that the atmospheric reaction is instant. In reality the reaction takes place over a number of hours.

The level 2 assessment method of the OLM has been adopted in this assessment, which uses contemporaneous predicted and background concentrations (O<sub>3</sub> and NO<sub>2</sub> from the Chullora AQMS).

The OLM relationship 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<sub>2</sub> in µg/m<sup>3</sup>
- $[NO_x]_{pred}$  = the dispersion model prediction of the ground level concentration of NO<sub>x</sub> in µg/m<sup>3</sup>
- $MIN$  = the minimum of the two quantities within the braces
- $[O_3]_{bkgd}$  = the background ambient O<sub>3</sub> concentration in µg/m<sup>3</sup>
- $\left(\frac{46}{48}\right)$  = the molecular weight of NO<sub>2</sub> divided by the molecular weight of O<sub>3</sub>
- $[NO_2]_{bkgd}$  = the background ambient NO<sub>2</sub> concentration in µg/m<sup>3</sup>

## 6 AIR QUALITY IMPACT ASSESSMENT

### 6.1 Construction

The key potential air pollution and amenity issues associated with construction at the Enfield ILC are:

- Annoyance due to dust deposition (soiling of surfaces) and visible dust plumes
- Elevated suspended particulate concentrations (PM<sub>10</sub>) due to dust-generating activities

Modelling of dust from construction projects is generally not considered appropriate, as emission rates can vary significantly depending on a combination of the construction activity and prevailing meteorological conditions (i.e., rainfall and wind speed), which cannot be reliably predicted. The following sections therefore describe the methodology used to perform a qualitative assessment of the potential risks to air quality associated with dust from construction activities at the Enfield ILC.

#### 6.1.1 Step 1 – Screening Based on Separation Distance

The nearest existing residential receptors have been identified as being located approximately 30 m southeast of the of the Enfield ILC boundary.

As the sensitive receptors are located within 350 m from the boundary of the site, less than 50 m from the route used by construction vehicles on public roads and within 500 m from the site entrance, further assessment is required.

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

Based upon the above assumptions and the IAQM definitions presented in **Appendix B**, the dust emission magnitudes have been categorised as presented in **Table 18**.

Demolition activities have not been considered as demolition activities are not expected to change as a result of MOD14.

**Table 18** Categorisation of Dust Emission Magnitude

Activity	Dust Emission Magnitude	Basis
Earthworks	Large	Total site area greater than 10,000 m <sup>2</sup> , potentially dusty soil type (eg clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved more than 100,000 t.  <i>Note: Even though the total developable area is approximately 311,800 m<sup>2</sup>, the earthworks are proposed to be conducted in a limited area only (in addition to the approved Project). The total volume of excavated material to be handled onsite is estimated to be approximately 142,050 m<sup>3</sup> (AT&amp;L 2018). Assuming the average density of material to be 1,500 kg/m<sup>3</sup>, the total material moved is estimated to be ~213,000 tonnes.</i>
Construction	Large	Total building volume greater than 100,000 m <sup>3</sup> .  <i>Note: The height of the warehouse buildings is proposed to be 13.7 m and total area of 111,045 m<sup>2</sup>, equating to a total building volume of 1,521,317 m<sup>3</sup>. Also, it is noted that on-site batching and sand blasting will be very unlikely to be employed, so a classification of 'large' is considered to be conservative based on the IAQM definition.</i>
Trackout	Medium	Between 10 and 50 heavy vehicle movements per day, surface materials with a moderate potential for dust generation, between 50 m and 100 m of unpaved road length.

### 6.1.3 Step 2b – Risk Assessment

#### Receptor Sensitivity

Based on the criteria listed in **Table B1** in **Appendix B**, the sensitivity of the identified receptors in this study is concluded to be *high* for health impacts and *high* for dust soiling, as they include residential areas where people may be reasonably expected to be present continuously as part of the normal pattern of land use.

#### Sensitivity of an Area

Using the classifications shown in **Table B2** in **Appendix B**, the sensitivity of the area to dust soiling is classified as '*low*' and the sensitivity of the surrounding area to health effects (**Table B3** in **Appendix B**) has also been classified as '*low*'. This categorisation has been made taking into account the individual receptor sensitivities derived above, the annual mean background PM<sub>10</sub> concentration of 18 µg/m<sup>3</sup> recorded at Chullora AQMS (OEH 2017) and the anticipated number of receptors present (1-10 within 50 m for dust soiling, and 1-10 within 50 m for health impacts, refer **Table 3**).

#### Risk Assessment

Given the sensitivity of the general area is classified as '*low*' for dust soiling and '*low*' for health effects, and the dust emission magnitudes for the various construction phase activities as shown in **Table 18**, the resulting risk of air quality impacts is as presented in **Table 19**. The results indicate that there is a medium risk of adverse dust soiling and human health impacts occurring at the off-site sensitive receptor locations if no mitigation measures were to be applied to control emissions from the building construction and trackout.

**Table 19 Preliminary Risk of Air Quality Impacts from Construction Activities (Uncontrolled)**

Impact	Sensitivity of Area	Dust Emission Magnitude			Preliminary Risk		
		Earthworks	Construction	Trackout	Earthworks	Construction	Trackout
Dust Soiling	Low	Large	Large	Medium	Low Risk	Low Risk	Low Risk
Human Health	Low				Low Risk	Low Risk	Low Risk

### 6.1.4 Step 3 - Mitigation Measures

**Table 20** lists the relevant mitigation measures designated as *highly recommended* (H) or *desirable* (D) by the IAQM methodology for a development shown to have a low risk of adverse impacts.

Not all these measures would be practical or relevant to the proposed works at the Enfield ILC hence a detailed review of the recommendations should be performed as part of the development of the Construction Environmental Management Plan (CEMP) and the most appropriate measures adopted.

**Table 20 Site-Specific Management Measures Recommended by the IAQM**

<b>1 Communications</b>		
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H
1.2	Display the head or regional office contact information.	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Local Authority.	D
<b>2 Site Management</b>		
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	H
2.2	Make the complaints log available to the local authority when asked.	H
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	H
<b>3 Monitoring</b>		
3.1	Perform daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100 m of site boundary.	D
3.2	Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked.	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H
<b>4 Preparing and Maintaining the Site</b>		
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	H
4.2	Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.	H
4.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	D
4.4	Avoid site runoff of water or mud.	H
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	D
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below	D
4.7	Cover, seed or fence stockpiles to prevent wind erosion	D
<b>5 Operating Vehicle/Machinery and Sustainable Travel</b>		
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles	H
5.3	Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable	H
5.4	Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on un-surfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).	D
<b>6 Operations</b>		
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.	H
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate	H
6.3	Use enclosed chutes and conveyors and covered skips	H

6.4	Minimise drop heights from loading shovels and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	H
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	D
<b>7</b>	<b>Waste Management</b>	
7.1	Avoid bonfires and burning of waste materials.	H
<b>8</b>	<b>Construction</b>	
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	D
8.2	Ensure 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.	D
<b>9</b>	<b>Trackout</b>	
9.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D
9.2	Avoid dry sweeping of large areas.	D
9.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D
9.4	Record all inspections of haul routes and any subsequent action in a site log book.	D
9.5	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	D

H = Highly recommended; D = Desirable

#### 6.1.5 Step 4 - Residual Impacts

A reappraisal of the predicted unmitigated air quality impacts on sensitive receptors has been performed to demonstrate the opportunity for minimising risks associated with the use of mitigation strategies. These are termed 'residual impacts'. The results of the reappraisal are presented below in **Table 21**.

**Table 21 Residual Risk of Air Quality Impacts from Construction**

Impact	Sensitivity of Area	Residual Risk		
		Earthworks	Construction	Trackout
Dust Soiling	Low	Negligible Risk	Negligible Risk	Negligible Risk
Human Health	Low	Negligible Risk	Negligible Risk	Negligible Risk

The mitigated dust deposition and human health impacts for earthworks, construction activities and trackout are anticipated to be *negligible*. For almost all construction activity, the IAQM Methods notes that the aim should be to prevent significant effects on receptors through the use of effective mitigation and experience shows that this is normally possible.

## 6.2 Operation

Dispersion modelling predictions of TSP, PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub> at the residences/properties nominated in **Section 2.7** are presented in **Section 6.2.1** to **Section 6.2.4**. Pollutant isopleth plots are also provided in the respective sections which show the maximum predicted incremental (Project operations only) concentrations of the pollutants assessed.

As discussed in **Section 4** a detailed assessment of the background concentrations in the area surrounding the Enfield ILC has been performed. Within this results section, where applicable, the predicted contribution from the proposed operational activities has been added to the background dataset in order to provide information on the cumulative impact of activities at the Enfield ILC on the air quality within the local area.

### 6.2.1 Particulates (as TSP)

**Table 22** presents the incremental and cumulative annual average TSP concentrations predicted at surrounding representative sensitive receptors. It can be observed from **Table 22** that the predicted cumulative annual average TSP concentrations at all receptors are below the relevant OEH guideline (<52% of the criterion). The main source of TSP emissions estimated for the site is wheel-generated dust. These estimates are expected to be very conservative over-estimates of actual emission rates given the low silt content expected on the roads and low vehicle speeds that would occur within the distribution centre. Actual impacts from the Enfield ILC are therefore expected to be significantly lower than the predicted concentrations presented in this assessment.

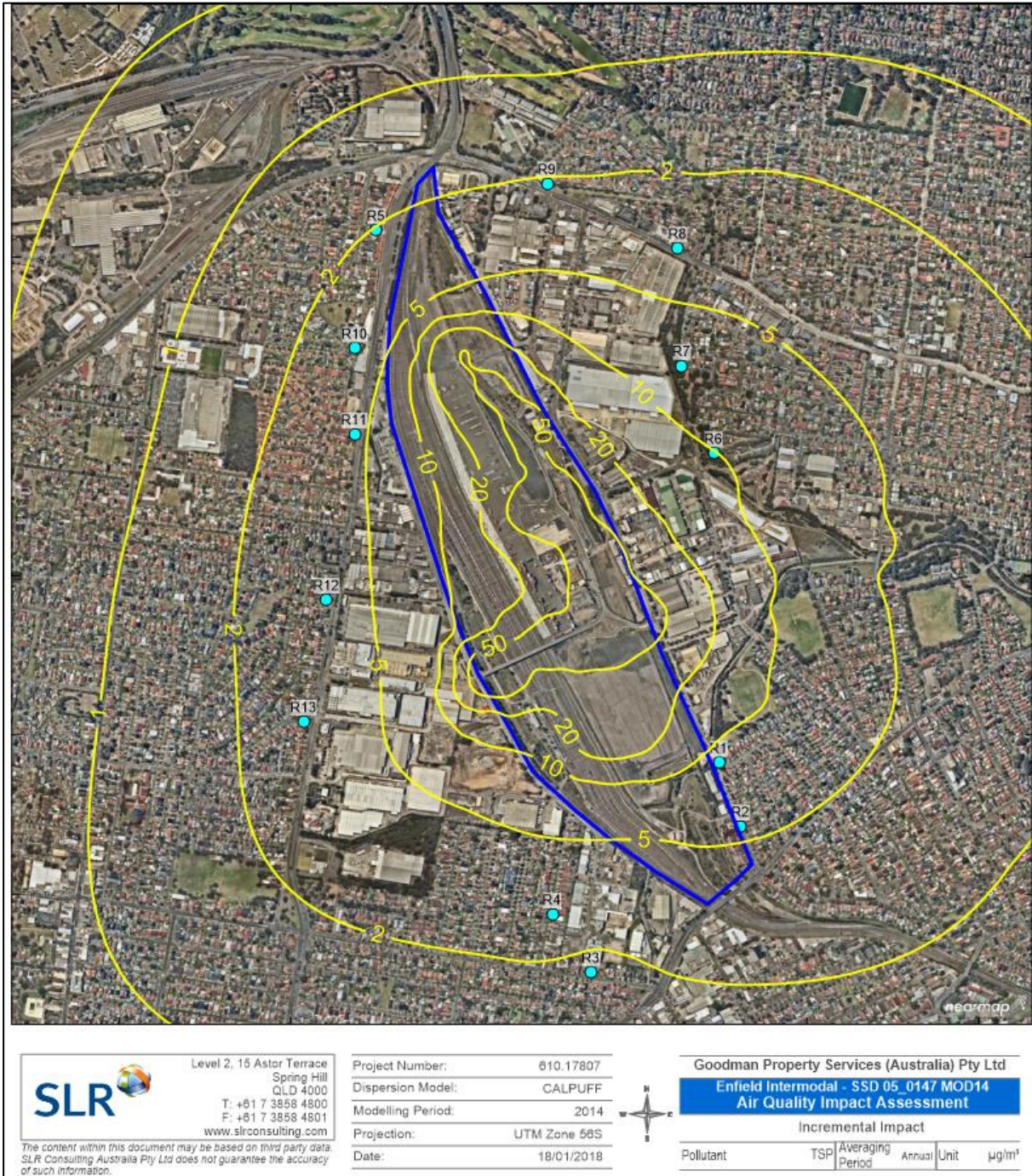
Contour plots of the predicted incremental annual average TSP concentrations are presented in **Figure 9**.

**Table 22 Predicted Annual Average TSP Concentrations at Sensitive Receptors**

Receptor ID	Annual Average TSP Concentrations ( $\mu\text{g}/\text{m}^3$ )		
	Background	Incremental Impact	Cumulative Impact
R1	36.1	8.8	44.9
R2	36.1	5.6	41.7
R3	36.1	1.8	37.9
R4	36.1	2.7	38.8
R5	36.1	2.1	38.1
R6	36.1	10.1	46.2
R7	36.1	7.5	43.6
R8	36.1	3.5	39.6
R9	36.1	2.1	38.2
R10	36.1	3.3	39.4
R11	36.1	4.3	40.4
R12	36.1	3.6	39.7
R13	36.1	2.9	39.0
<b>Assessment Criterion</b>			<b>90</b>

The 2005 SKM report did not present modelling for TSP, therefore no comparison is presented to the results presented in **Table 22**.

**Figure 9 Predicted Incremental Annual Average TSP Concentrations - Operation**



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Pollutant	Incremental Impact			Unit
	TSP	Averaging Period	Annual	
				µg/m <sup>3</sup>

## 6.2.2 Particulates (as PM<sub>10</sub>)

To assess the maximum cumulative 24-hour average PM<sub>10</sub> concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed as required by the Approved Methods. At each receptor, each individual incremental 24-hour average prediction was added to the corresponding day's measured background concentration at the Chullora AQMS site to predict the cumulative 24-hour average PM<sub>10</sub> impacts.

**Table 23** presents a summary of the contemporaneous analysis at each receptor listed in **Section 2.7**.

**Table 23 Summary of 24-Hour PM<sub>10</sub> Cumulative Impact Analysis - Operation**

Receptor ID	Date of Highest Cumulative	PM <sub>10</sub> 24-Hour Average Concentrations (µg/m <sup>3</sup> )			Date of Highest Increment	PM <sub>10</sub> 24-Hour Average Concentrations (µg/m <sup>3</sup> )		
		Background	Increment	Highest Cumulative		Background	Highest Increment	Total Impact
R1	6/08/2014	40.0	9.5	49.4	15/07/2014	21.2	19.1	40.3
R2	6/08/2014	40.0	6.7	46.7	15/07/2014	21.2	15.1	36.3
R3	6/08/2014	40.0	2.2	42.1	15/07/2014	21.2	5.1	26.3
R4	6/08/2014	40.0	2.5	42.5	15/07/2014	21.2	6.1	27.3
R5	5/08/2014	39.8	0.9	40.8	7/04/2014	13.4	4.6	18.0
R6	6/08/2014	40.0	7.2	47.2	11/06/2014	32.5	13.4	45.9
R7	5/08/2014	39.8	5.0	44.8	11/06/2014	32.5	11.3	43.8
R8	5/08/2014	39.8	2.5	42.4	11/06/2014	32.5	6.3	38.8
R9	5/08/2014	39.8	1.2	41.0	11/06/2014	32.5	5.5	38.0
R10	18/12/2014	38.3	3.9	42.2	9/01/2014	10.8	6.6	17.4
R11	18/12/2014	38.3	5.3	43.6	9/01/2014	10.8	8.9	19.7
R12	18/12/2014	38.3	4.1	42.5	9/01/2014	10.8	7.2	18.0
R13	18/12/2014	38.3	2.5	40.8	13/02/2014	18.0	7.1	25.1
<b>Assessment Criterion</b>				<b>50</b>	<b>50</b>			

It can be observed from **Table 23** that the cumulative 24-hour average PM<sub>10</sub> concentrations predicted at each surrounding sensitive receptor as a result of operational emissions are below the relevant OEH guideline. Therefore it is concluded that the proposed operation is unlikely to cause any additional exceedances of the criterion at these locations.

**Table 24** presents a summary of the incremental and cumulative annual average PM<sub>10</sub> concentrations predicted at each identified sensitive receptor location. It can be observed from **Table 24** that the incremental annual average PM<sub>10</sub> impacts predicted as a result of the proposed operations are minimal and that the cumulative annual average PM<sub>10</sub> concentrations predicted at all surrounding sensitive receptor locations are well below the relevant OEH guideline.

Contour plots of the maximum 24-hour and annual average incremental PM<sub>10</sub> concentrations are presented in **Figure 10** and **Figure 11**.

**Table 24 Predicted Annual Average PM<sub>10</sub> Concentrations at Sensitive Receptors - Operation**

Receptor ID	Annual Average PM <sub>10</sub> Concentrations (µg/m <sup>3</sup> )		
	Background	Incremental Impact	Cumulative Impact
R1	18.0	3.1	21.1
R2	18.0	2.2	20.2
R3	18.0	0.8	18.9
R4	18.0	1.2	19.2
R5	18.0	0.8	18.8
R6	18.0	3.4	21.5
R7	18.0	2.6	20.6
R8	18.0	1.3	19.4
R9	18.0	0.8	18.9
R10	18.0	1.2	19.2
R11	18.0	1.6	19.6
R12	18.0	1.4	19.4
R13	18.0	1.2	19.2
<b>Assessment Criterion-</b>			<b>25</b>

The predicted cumulative concentrations for PM<sub>10</sub> presented in 2005 SKM report for receptors R1 to R5 were slightly lower than those presented in **Table 23**. This could be attributed to the differences between the assessments i.e. the 2005 SKM report used AUSPLUME model and different background concentrations (Lidcombe and Earlwood).

**Figure 10 Maximum Predicted Incremental 24-Hour Average PM<sub>10</sub> Concentrations - Operation**



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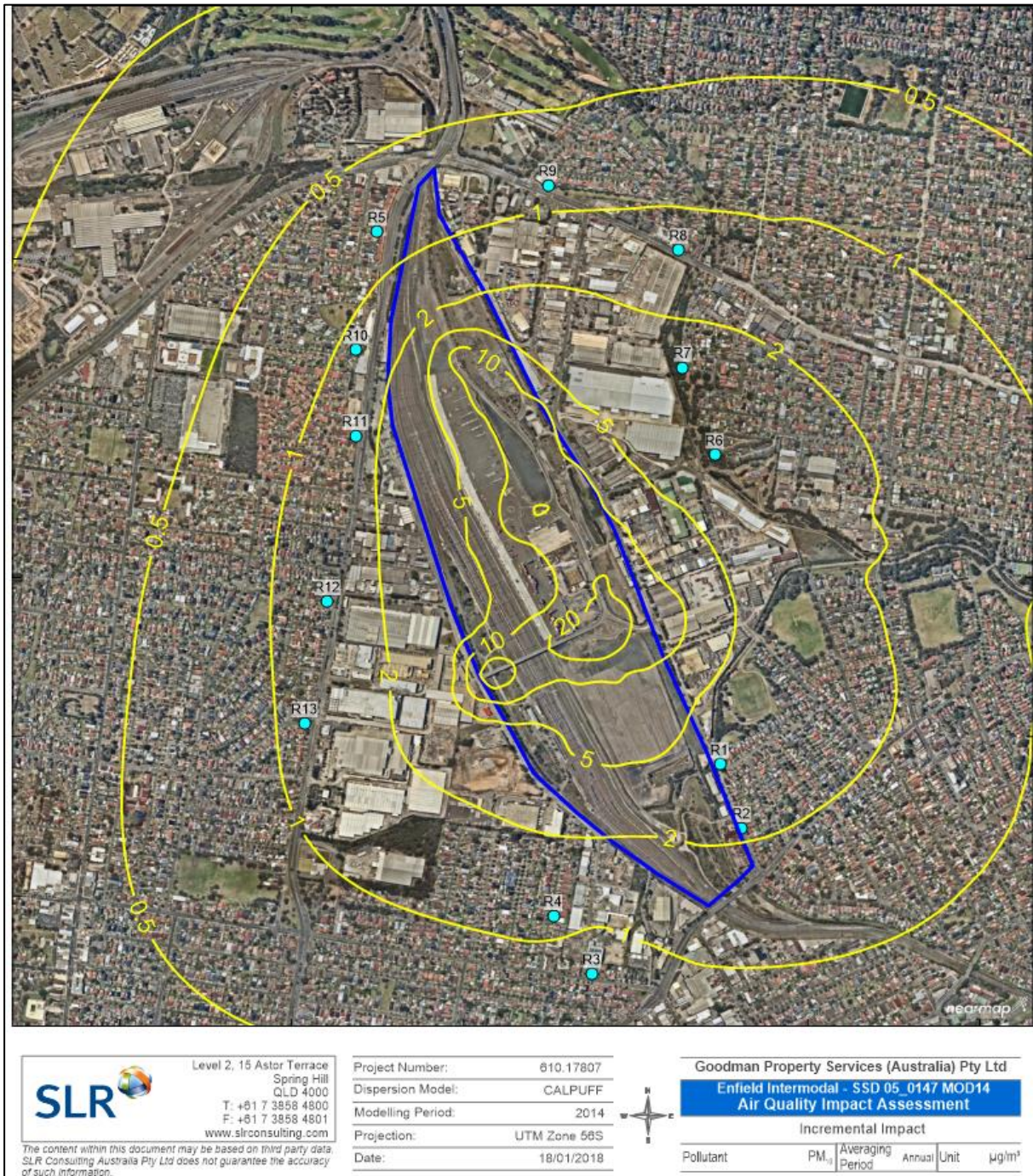
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 Projection: UTM Zone 56S  
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Incremental Impact			
Pollutant	PM <sub>10</sub>	Averaging Period	24-Hour
Unit	µg/m <sup>3</sup>		

Figure 11 Predicted Incremental Annual Average PM<sub>10</sub> Concentrations - Operation



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Pollutant	Incremental Impact			Unit
	PM <sub>10</sub>	Averaging Period	Annual	
				µg/m <sup>3</sup>

### 6.2.3 Particulates (as PM<sub>2.5</sub>)

To assess the maximum cumulative 24-hour average PM<sub>2.5</sub> concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed following the Approved Methods as described above for PM<sub>10</sub>.

**Table 25** presents a summary of the contemporaneous analysis at each receptor listed in **Section 2.7**. It can be observed from **Table 25** that the incremental and cumulative 24-hour average PM<sub>2.5</sub> concentrations predicted at each surrounding sensitive receptor as a result of operational emissions are below the relevant OEH guideline for all but one receptor (R1).

**Table 25 Summary of 24-Hour PM<sub>2.5</sub> Cumulative Impact Analysis - Operation**

Receptor ID	Date of Highest Cumulative	PM <sub>10</sub> 24-Hour Average Concentrations (µg/m <sup>3</sup> )			Date of Highest Increment	PM <sub>10</sub> 24-Hour Average Concentrations (µg/m <sup>3</sup> )		
		Background	Increment	Highest Cumulative		Background	Highest Increment	Total Impact
R1	9/08/2014	22.1	3.6	25.7	15/07/2014	12.4	5.5	17.9
R2	9/08/2014	22.1	2.8	24.9	15/07/2014	12.4	4.4	16.9
R3	12/10/2014	23.1	0.5	23.7	15/07/2014	12.4	1.6	14.0
R4	12/10/2014	23.1	0.8	24.0	15/07/2014	12.4	1.9	14.3
R5	12/10/2014	23.1	0.2	23.4	7/04/2014	5.2	1.4	6.6
R6	12/10/2014	23.1	1.2	24.3	11/06/2014	15.5	3.9	19.4
R7	12/10/2014	23.1	0.8	23.9	11/06/2014	15.5	3.3	18.9
R8	12/10/2014	23.1	0.4	23.5	11/06/2014	15.5	1.9	17.4
R9	12/10/2014	23.1	0.3	23.4	11/06/2014	15.5	1.7	17.2
R10	12/10/2014	23.1	0.5	23.6	10/01/2014	4.8	2.2	7.0
R11	12/10/2014	23.1	0.9	24.0	9/01/2014	4.4	3.0	7.3
R12	12/10/2014	23.1	1.0	24.1	9/01/2014	4.4	2.3	6.6
R13	12/10/2014	23.1	0.9	24.0	13/02/2014	12.4	2.2	14.5
<b>Assessment Criterion</b>				<b>25</b>	<b>25</b>			

As shown in **Table 25**, the exceedance predicted to occur at R1 on 9 August 2014 is dominated by the high background concentration (85%) recorded at Chullora on this day. Therefore it is concluded that the proposed operational activities at the Enfield ILC is unlikely to cause any additional exceedances of the criterion at this location.

**Table 26** presents a summary of the incremental and cumulative annual average PM<sub>2.5</sub> concentrations predicted at each identified sensitive receptor location. It can be observed from **Table 26** that the incremental annual average PM<sub>2.5</sub> impacts predicted as a result of the proposed operations are minimal (maximum of 1 µg/m<sup>3</sup> at R6) although the cumulative annual average PM<sub>2.5</sub> concentrations exceed the criterion due to the addition of the already exceeding background concentration.

Contour plots of the maximum 24-hour and annual average incremental PM<sub>2.5</sub> concentrations are presented in **Figure 12** and **Figure 13**.

The 2005 SKM report did not conduct modelling for PM<sub>2.5</sub>, therefore no comparison is presented to the results presented in **Table 26**.

Figure 12 Maximum Predicted Incremental 24-Hour Average PM<sub>2.5</sub> Concentrations - Operation



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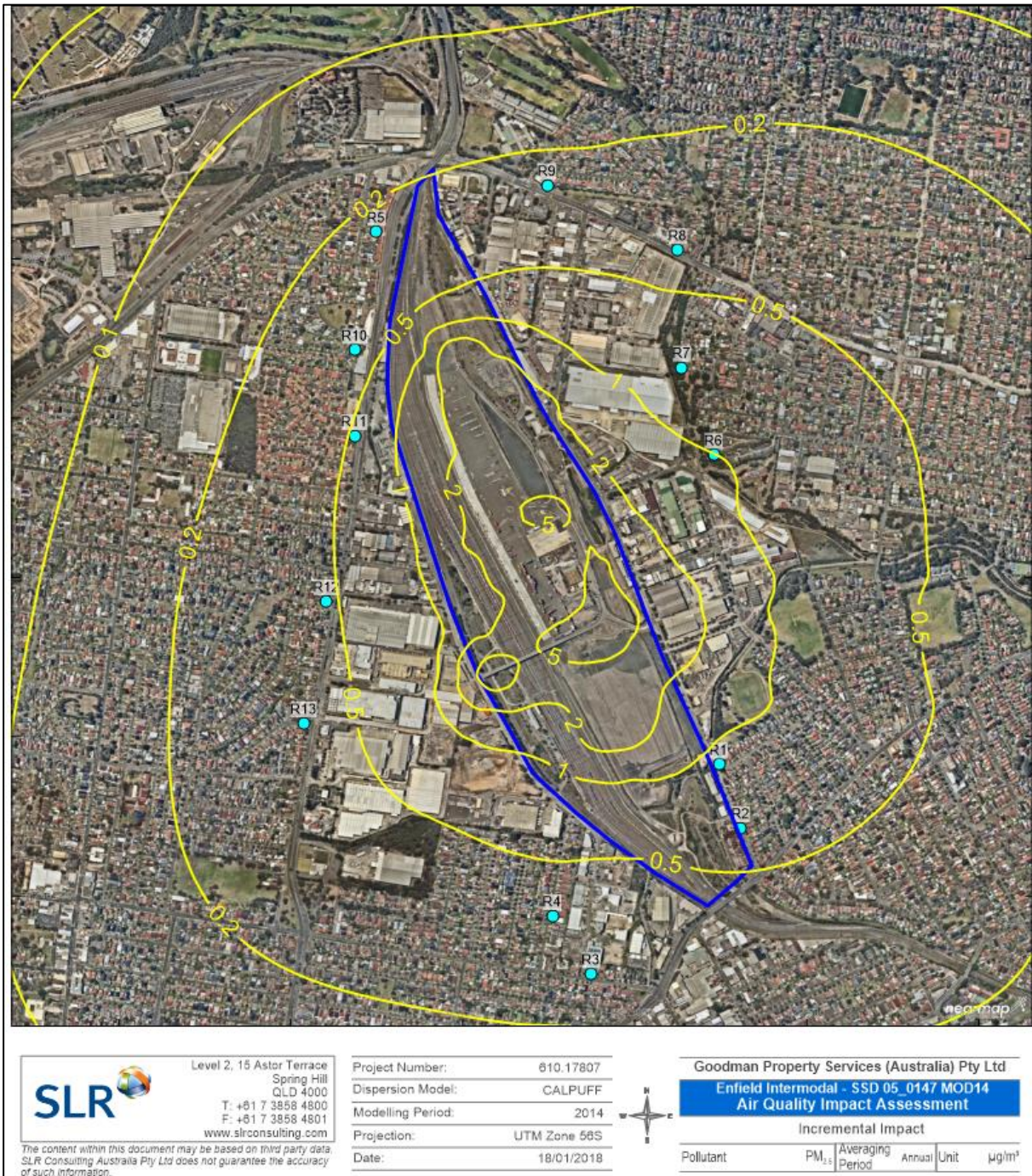
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Incremental Impact					
Pollutant	PM <sub>2.5</sub>	Averaging Period	24-Hour	Unit	µg/m <sup>3</sup>

Figure 13 Predicted Incremental Annual Average PM<sub>2.5</sub> Concentrations - Operation



**Table 26 Predicted Annual Average PM<sub>2.5</sub> Concentrations at Sensitive Receptors - Operation**

Receptor ID	Annual Average PM <sub>2.5</sub> Concentrations (µg/m <sup>3</sup> )		
	Background	Incremental Impact	Cumulative Impact
R1	9.0	0.9	9.8
R2	9.0	0.6	9.6
R3	9.0	0.2	9.2
R4	9.0	0.4	9.3
R5	9.0	0.2	9.2
R6	9.0	1.0	10.0
R7	9.0	0.8	9.7
R8	9.0	0.4	9.4
R9	9.0	0.3	9.2
R10	9.0	0.4	9.3
R11	9.0	0.5	9.5
R12	9.0	0.5	9.4
R13	9.0	0.4	9.3
<b>Assessment Criterion</b>			<b>8</b>

#### 6.2.4 Nitrogen Dioxide (NO<sub>2</sub>)

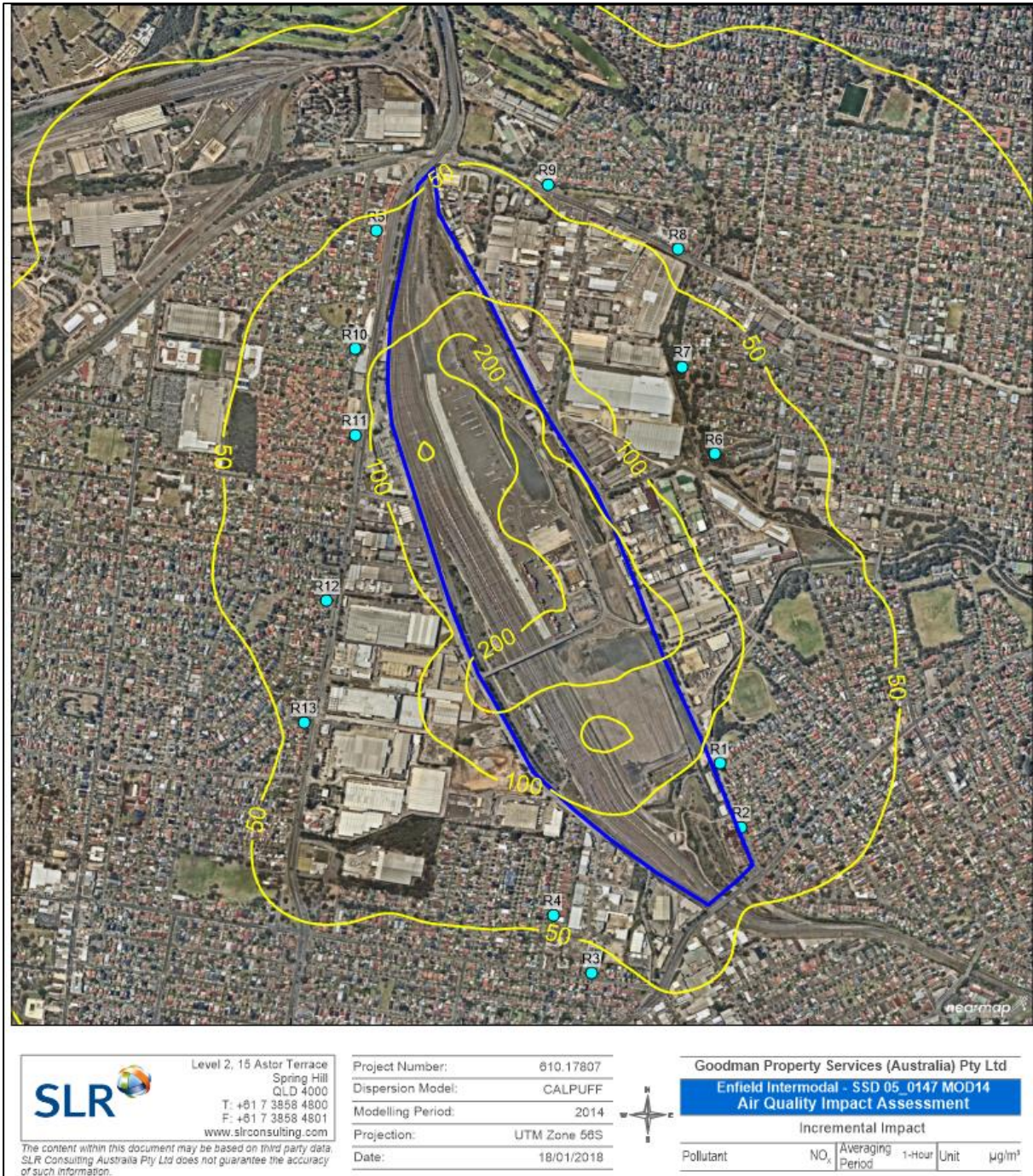
**Table 27** presents the incremental and cumulative 1-hour and annual average NO<sub>2</sub> concentrations predicted at each receptor identified in **Section 2.7**. The NO<sub>2</sub> concentrations were estimated using the predicted NO<sub>x</sub> concentrations and the OLM method, as prescribed by the Approved Methods. The results presented in **Table 27** show that the predicted cumulative 1-hour and annual average NO<sub>2</sub> concentrations are well below the relevant OEH criteria at all receptors.

**Table 27 Predicted Maximum 1-Hour and Annual Average NO<sub>2</sub> Concentrations at Sensitive Receptors**

ID	1-Hour Averages		Annual Averages	
	Incremental (NO <sub>x</sub> ) (µg/m <sup>3</sup> )	Cumulative (NO <sub>2</sub> ) (µg/m <sup>3</sup> )	Incremental (NO <sub>x</sub> ) (µg/m <sup>3</sup> )	Cumulative (NO <sub>2</sub> ) (µg/m <sup>3</sup> )
R1	92.3	127.3	4.6	24.5
R2	82.7	126.3	3.2	24.1
R3	46.5	125.8	1.2	23.5
R4	53.8	126.2	1.7	23.7
R5	53.6	124.7	1.3	23.7
R6	66.2	126.6	4.6	24.7
R7	64.4	126.2	3.7	24.4
R8	45.8	125.1	2.0	23.9
R9	46.5	125.0	1.3	23.6
R10	87.9	125.3	2.3	24.1
R11	91.9	125.5	3.4	24.6
R12	63.7	125.0	2.8	24.3
R13	54.2	124.7	2.1	24.0
<b>Criteria</b>		<b>246</b>		<b>62</b>

The maximum predicted 1-hour and annual average incremental NO<sub>x</sub> concentrations are presented as contour plots in **Figure 14** and **Figure 15**. It is noted that due to the inability of the dispersion model to incorporate OLM calculations, only incremental NO<sub>x</sub> concentrations are presented in the contour plots.

**Figure 14 Maximum Predicted Incremental 1-Hour Average NO<sub>x</sub> Concentrations - Operation**



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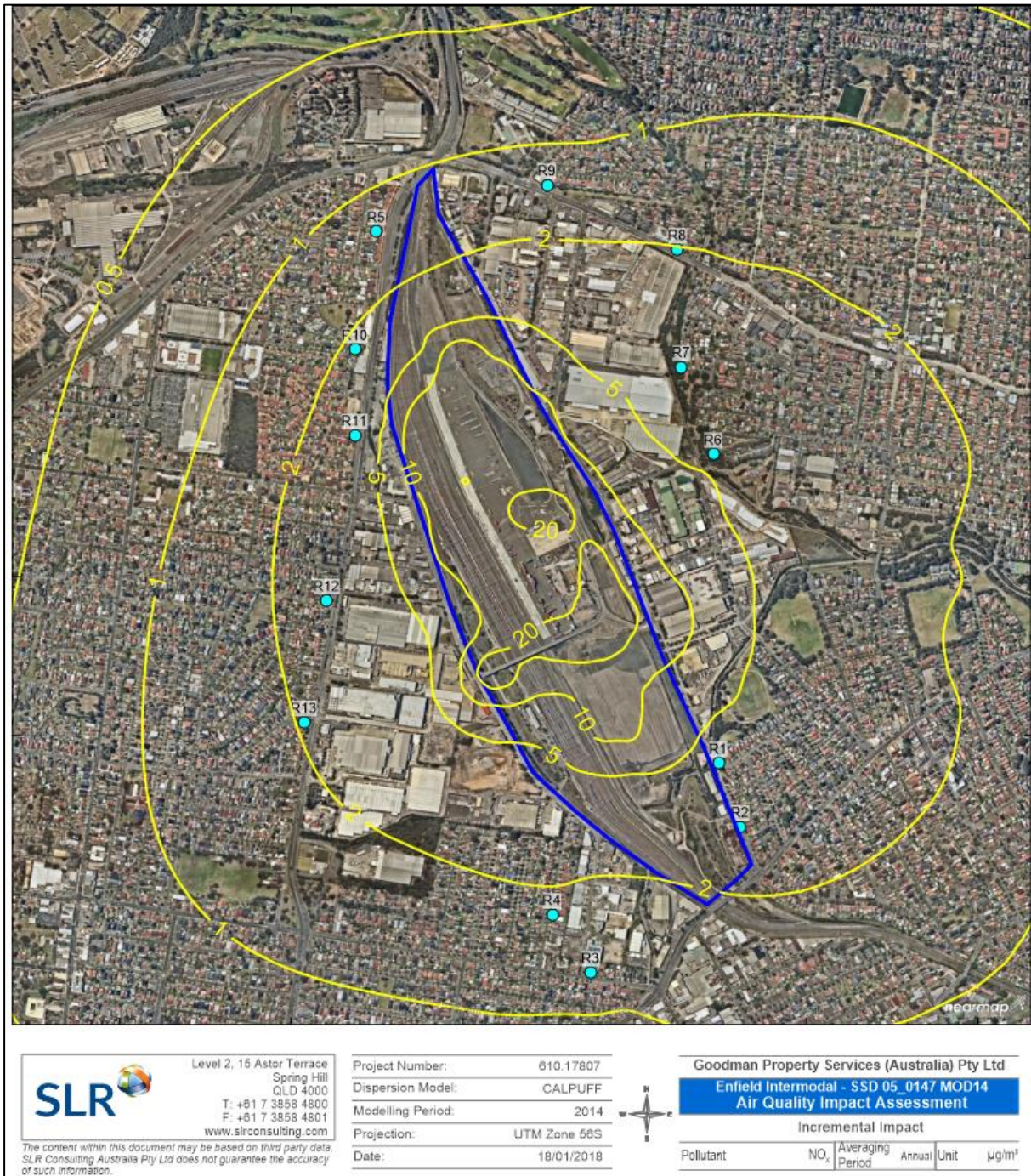
Project Number:	610.17807
Dispersion Model:	CALPUFF
Modelling Period:	2014
Projection:	UTM Zone 56S
Date:	18/01/2018

**Goodman Property Services (Australia) Pty Ltd**  
**Enfield Intermodal - SSD 05\_0147 MOD14**  
**Air Quality Impact Assessment**

Incremental Impact

Pollutant	NO <sub>x</sub>	Averaging Period	1-Hour	Unit	µg/m <sup>3</sup>
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Figure 15 Predicted Incremental Annual Average NO<sub>x</sub> Concentrations - Operation



The predicted cumulative concentrations for NO<sub>2</sub> presented in 2005 SKM report for receptors R1 to R5 were slightly higher than those presented in **Table 23**. This could be attributed to the differences between the assessments i.e. the 2005 SKM report used AUSPLUME model and different background concentrations (Lidcombe and Earlwood).

## 7 MITIGATION, MANAGEMENT AND MONITORING

The results of the impact assessment indicate that operations at the Enfield ILC are unlikely to cause exceedance of the regulatory criteria at the nearest sensitive receptors.

Cumulative 24-hour average PM<sub>2.5</sub> concentrations were predicted to be slightly exceeded at one sensitive receptor (R1), however this was due to very high contributing background level used for assessment purposes.

Cumulative annual average PM<sub>2.5</sub> concentrations were predicted to be exceeded at all sensitive receptors however this was due to an existing exceedance in the background level used for assessment purposes. Annual average PM<sub>2.5</sub> impacts predicted at sensitive receptor locations as a result of the proposed Enfield ILC activities are less than 1 µg/m<sup>3</sup>, which is far below the criterion of 8 µg/m<sup>3</sup> (i.e 12.5%).

The impact assessment indicates that air quality impacts would not constrain either the construction or operation of the Development. Notwithstanding the above, 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) will be developed and implemented prior to construction works, 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 (minor) and rehabilitation, clearing and grading, truck loading and unloading, and wind erosion areas (minor) would be the primary focus of dust control during construction works. 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). The SKM report (SKM 2005) concluded from modelling assessment of construction impacts that the construction works should be halted when wind speeds are greater than 5 m/s or when wind direction is in the sector 210° to 340°.
- 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 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**

Under Condition 2.20 of the Approval, a meteorological monitoring station was required to be installed and operated until all large exposed areas have either been landscaped or sealed. All large exposed areas have either been landscaped or sealed since the Approval, and therefore monitoring station has been decommissioned.

Similarly, Condition 3.2 of the Approval states that continuous ambient dust concentrations be monitored from the commencement of soil disturbing works on the site until all large exposed areas have either been landscaped or sealed. As all large exposed areas have either been landscaped or sealed, there is no ongoing monitoring of dust.

Further, given the results predicted within the 2005 SKM Report and this assessment, no further air quality monitoring is considered to be necessary during 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 should 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 Goodman to conduct an Air Quality Impact Assessment (AQIA) in preparing for the Modification application (MOD 14) for the already approved State Significant Development of Enfield Intermodal Logistics Centre, NSW.

The assessment has considered emissions to air and resulting impacts on a number of surrounding sensitive receptor locations during operation of the Enfield ILC. Impacts have been assessed through the use of dispersion modelling techniques, in accordance with the Approved Methods.

The current air quality environment of the area surrounding the Enfield ILC has been considered within this assessment, with the incremental impacts associated with the proposed Enfield ILC operational activities added to the estimated background air quality to determine cumulative impacts and the likelihood of exceedance of air quality criteria as outlined by the NSW EPA.

Results indicate that all pollutant concentrations resulting from operation of the Enfield ILC are below the respective concentrations, with the exception of 24-hour average  $PM_{2.5}$  and annual average  $PM_{2.5}$ . Annual average  $PM_{2.5}$  concentrations recorded at the nearest monitoring station in 2014 exceeded the adopted guideline value, however the additional impacts from the Enfield ILC activities were predicted to be less than  $1 \mu\text{g}/\text{m}^3$  at the nearest sensitive receptor, which is only 12.5% of the criterion.

It is noted that the predicted impacts are based on worst case operational activity data and the use of conservative emission factors from the literature to estimate the emissions. As a result, all predictions in the assessment should be viewed as conservatively high, with levels expected to be lower during normal operation of the facility.

A qualitative assessment of potential off-site air quality impacts concluded that the earthworks, construction and trackout activities have a very low potential to give rise to nuisance of health impacts.

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

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- USEPA 2011, United States Environmental Protection Authority (2011) Compilation of Air Pollutant Emission Factors AP-42 - Chapter 13.2.1 Paved Roads.

Figure A1 1 Hour Average CO Concentration – Chullora 2014

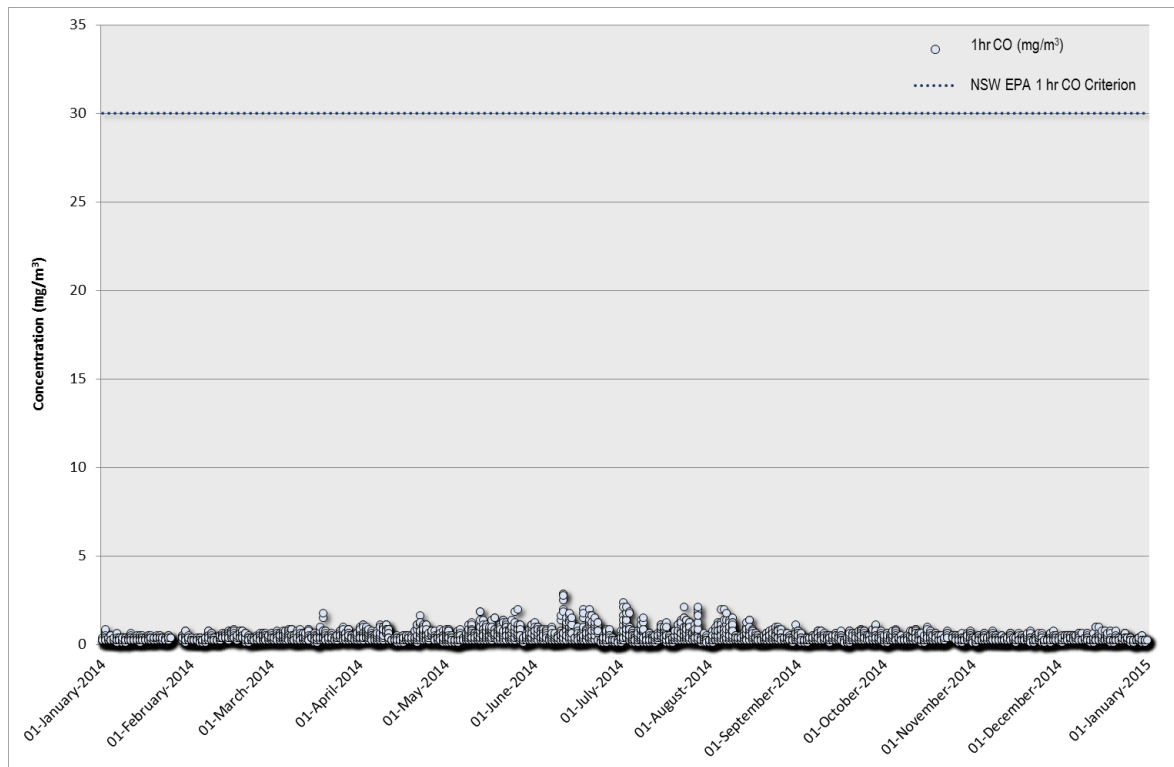


Figure A2 8 Hour Average CO Concentration – Chullora 2014

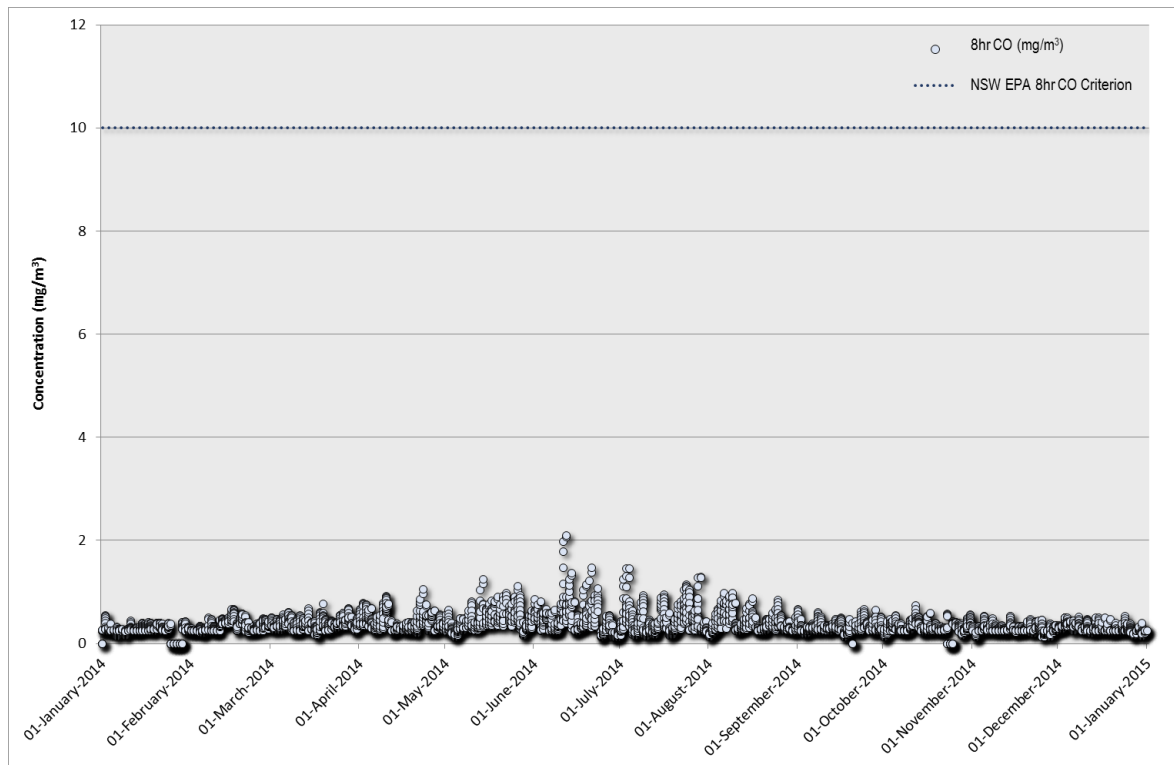


Figure A3 1 Hour Average SO<sub>2</sub> Concentration – Chullora 2014

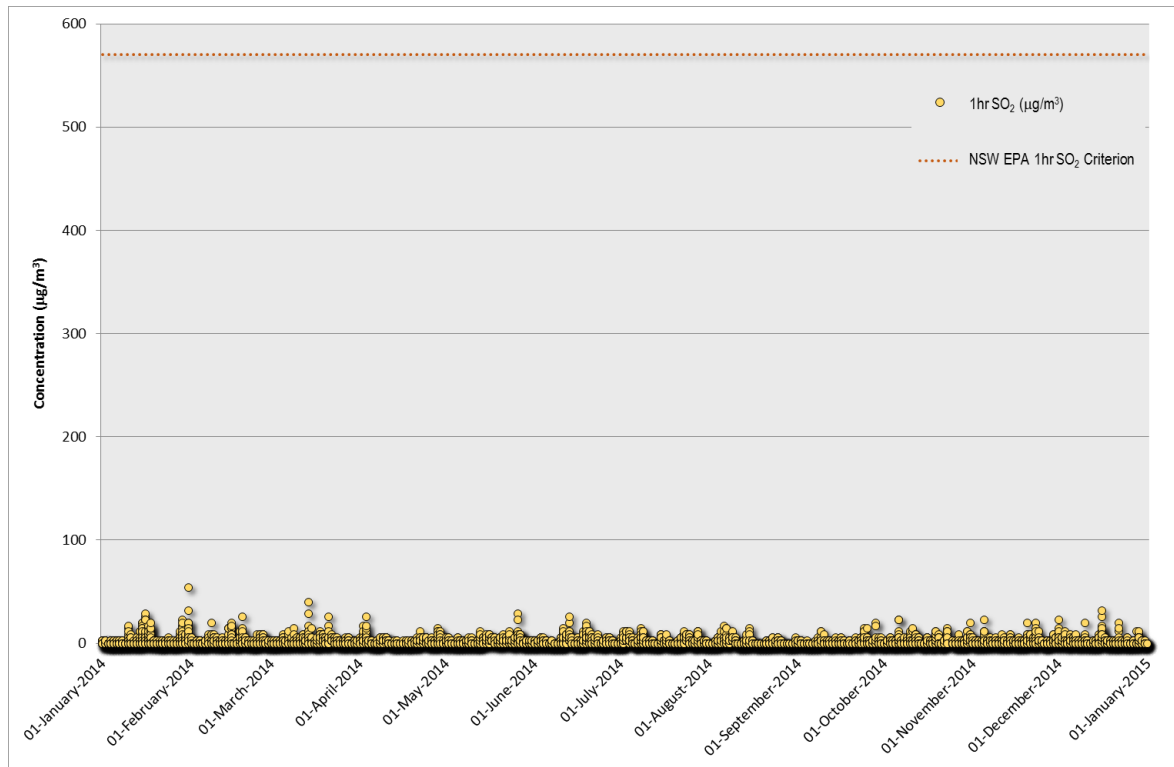


Figure A4 24 Hour Average SO<sub>2</sub> Concentration – Chullora 2014

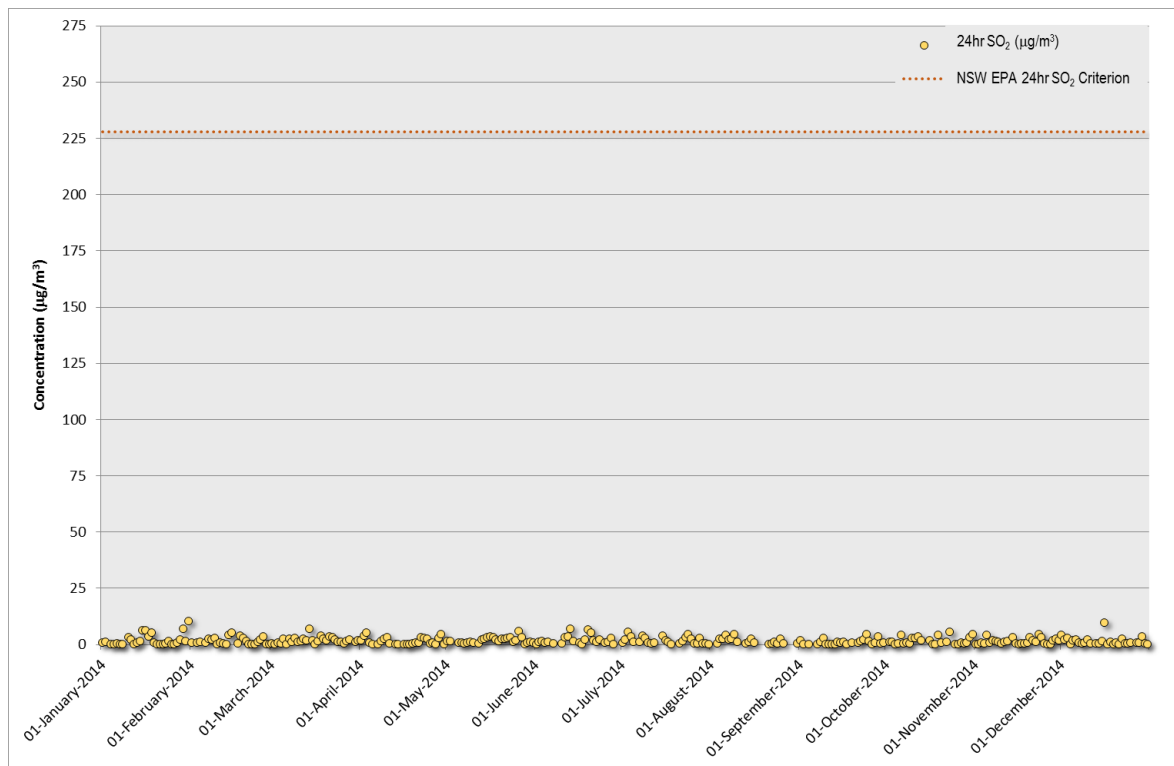


Figure A5 1 Hour Average NO<sub>2</sub> Concentration – Chullora 2014

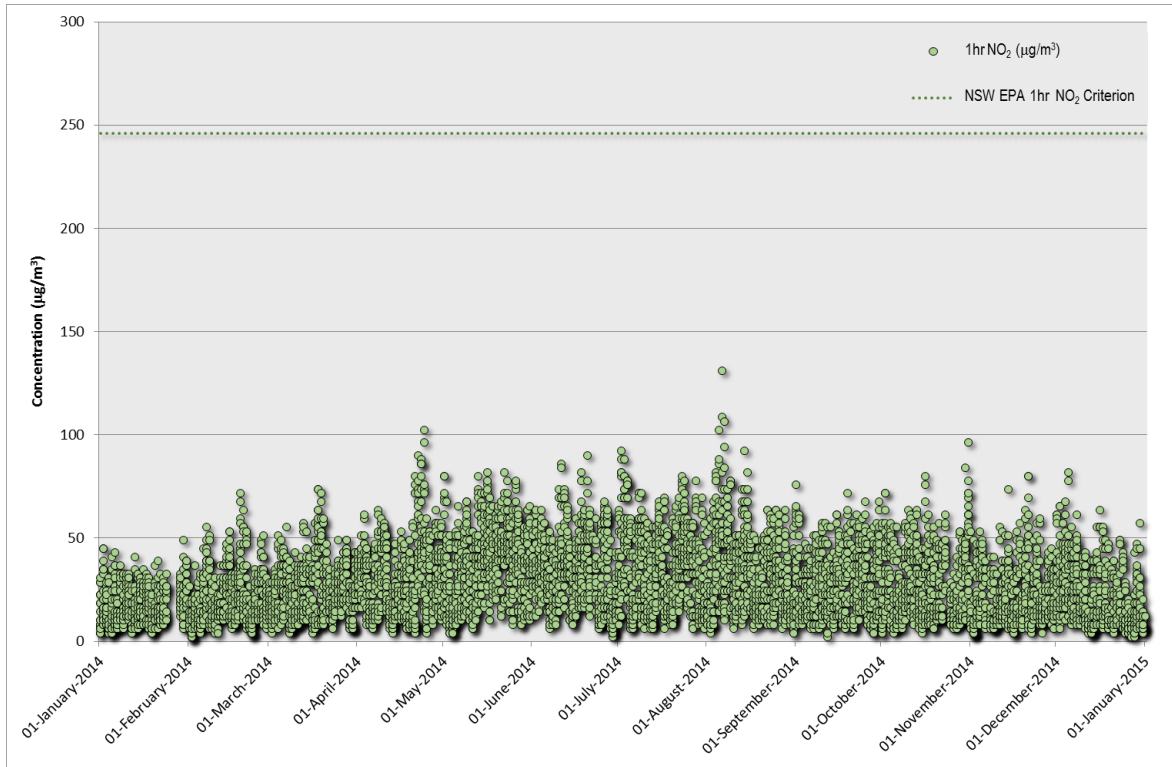


Figure A6 24 Hour Average PM<sub>10</sub> Concentration – Chullora 2014

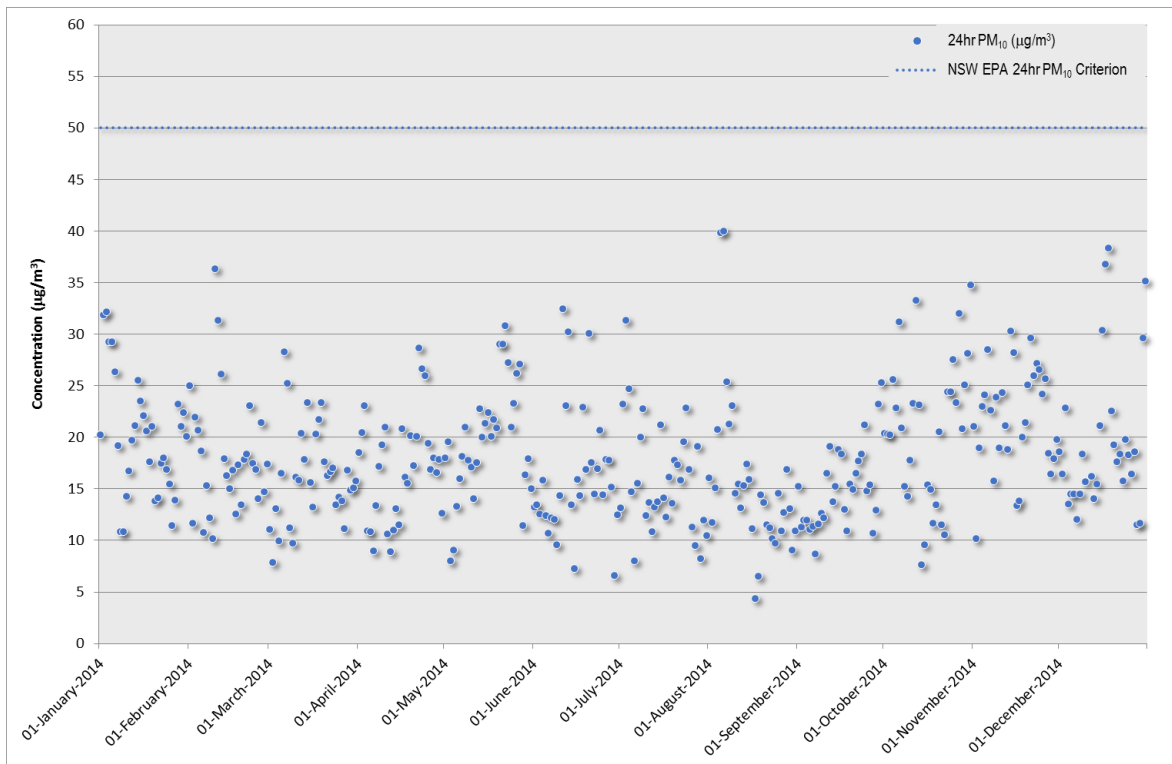
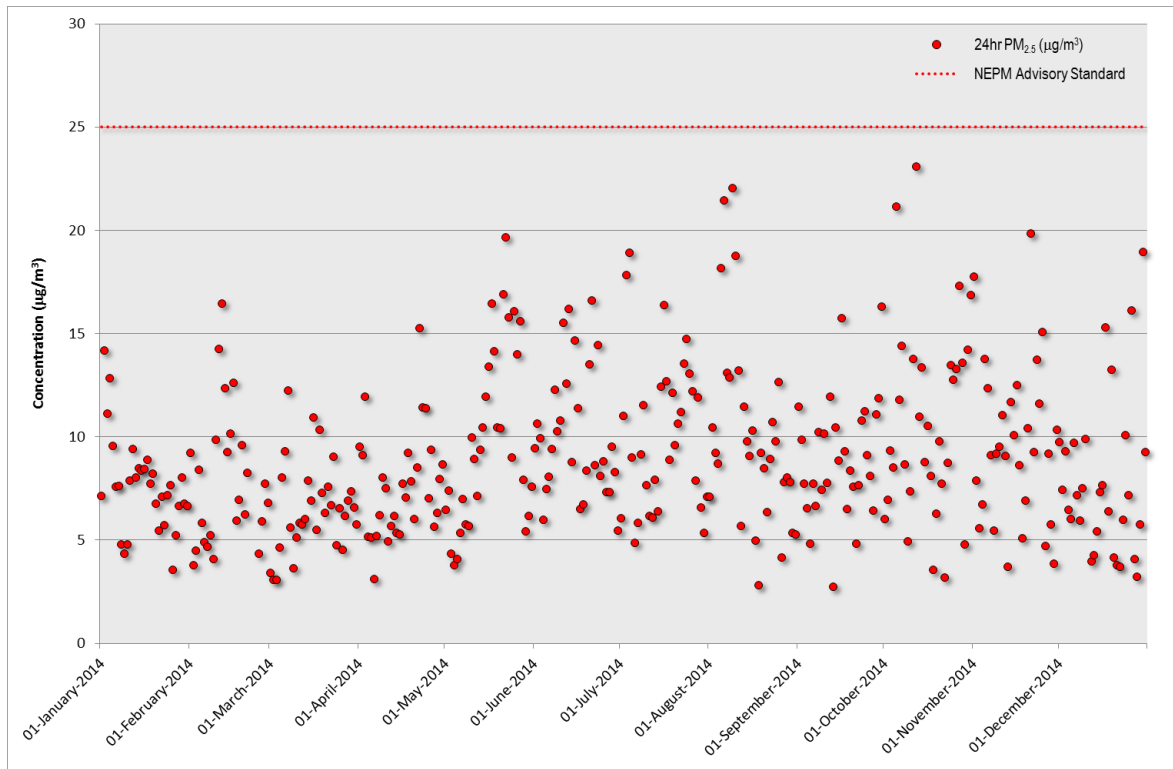


Figure A7 24 Hour Average PM<sub>2.5</sub> Concentration – Chullora 2014



## Step 1 – Screening Based on Separation Distance

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

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

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

*Demolition (Any activity involved with the removal of an existing structure [or structures]. This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time):*

- **Large:** Total building volume >50,000 m<sup>3</sup>, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level;
- **Medium:** Total building volume 20,000 m<sup>3</sup> – 50,000 m<sup>3</sup>, potentially dusty construction material, demolition activities 10-20 m above ground level; and
- **Small:** Total building volume <20,000 m<sup>3</sup>, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months.

*Earthworks (Covers the processes of soil-stripping, ground-levelling, excavation and landscaping):*

- **Large:** Total site area greater than 10,000 m<sup>2</sup>, potentially dusty soil type (eg clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved more than 100,000 t.
- **Medium:** Total site area 2,500 m<sup>2</sup> to 10,000 m<sup>2</sup>, moderately dusty soil type (eg silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 t to 100,000 t.
- **Small:** Total site area less than 2,500 m<sup>2</sup>, soil type with large grain size (eg sand), less than five heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 t, earthworks during wetter months.

*Construction (Any activity involved with the provision of a new structure (or structures), its modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc):*

- **Large:** Total building volume greater than 100,000 m<sup>3</sup>, piling, on site concrete batching; sandblasting.
- **Medium:** Total building volume 25,000 m<sup>3</sup> to 100,000 m<sup>3</sup>, potentially dusty construction material (eg concrete), piling, on site concrete batching.
- **Small:** Total building volume less than 25,000 m<sup>3</sup>, construction material with low potential for dust release (eg metal cladding or timber).

*Track-out (The transport of dust and dirt from the construction / demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network):*

- **Large:** More than 50 heavy vehicle movements per day, surface materials with a high potential for dust generation, greater than 100 m of unpaved road length.

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- **Medium:** Between 10 and 50 heavy vehicle movements per day, surface materials with a moderate potential for dust generation, between 50 m and 100 m of unpaved road length.
- **Small:** Less than 10 heavy vehicle movements per day, surface materials with a low potential for dust generation, less than 50 m of unpaved road length.

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

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

## Step 2b – Risk Assessment

### Assessment of the Sensitivity of the Area

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

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

Individual receptors are classified as having *high*, *medium* or *low* sensitivity to dust deposition and human health impacts (ecological receptors are not addressed using this approach). The IAQM method provides guidance on the sensitivity of different receptor types to dust soiling and health effects as summarised in **Table B1**. It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

**Table B1 IAQM Guidance for Categorising Receptor Sensitivity**

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

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Value	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
	<i>Examples: Residential properties, hospitals, schools and residential care homes.</i>	<i>Examples: Office and shop workers, but will generally not include workers occupationally exposed to PM10.</i>	<i>Examples: Public footpaths, playing fields, parks and shopping street.</i>

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

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

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in **Table B2**. The sensitivity of the area should be derived for each of activity relevant to the project (ie construction and earthworks).

**Table B2 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects**

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

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

A modified version of the IAQM guidance for assessing the *sensitivity of an area* to health impacts is shown in **Table B3**. For high sensitivity receptors, the IAQM methods takes the existing background concentrations of PM<sub>10</sub> (as an annual average) experienced in the area of interest into account and is based on the air quality objectives for PM<sub>10</sub> in the UK. As these objectives differ from the ambient air quality criteria adopted for use in this assessment (ie an annual average of 20 µg/m<sup>3</sup> for PM<sub>10</sub>) the IAQM method has been modified slightly.

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

- any history of dust generating activities in the area;

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- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area, and if relevant the season during which the works will take place;
- any conclusions drawn from local topography;
- duration of the potential impact; and
- any known specific receptor sensitivities which go beyond the classifications given in this document.

**Table B3 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects**

Receptor sensitivity	Annual mean PM <sub>10</sub> conc	Number of receptors <sup>a,b</sup>	Distance from the source (m)			
			<20	<50	<100	<350
High	15-22.5 µg/m <sup>3</sup>	>100	High	Medium	Low	Low
		10-100	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
	<15 µg/m <sup>3</sup>	>100	Medium	Low	Low	Low
		10-100	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low
	-	1-10	Medium	Low	Low	Low
Low	-	>1	Low	Low	Low	Low

Notes: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m); noting that only the highest level of area sensitivity from the table needs to be considered.  
(b) In the case of high sensitivity receptors with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

### Risk Assessment

The dust emission magnitude from Step 2a and the receptor sensitivity from Step 2b are then used in the matrices shown in **Table B4** (earthworks and construction) and **Table B5** (track-out) to determine the risk category with no mitigation applied.

**Table B4 Risk Category from Earthworks and Construction Activities**

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

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**Table B5 Risk Category from Track-out Activities**

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

**Step 3 - Site-Specific Mitigation**

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

**Step 4 – Residual Impacts**

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