AIR QUALITY IMPACT ASSESSMENT

BULK RECOVERY SOLUTIONS, INGLEBURN

Koby Development and Property Consultants

3 December 2018

Job Number 16100621

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Air Quality Impact Assessment

Bulk Recovery Solutions, Ingleburn

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Koby Development and Property Consultants (KDC) on behalf of Bulk Recovery Solutions Pty Ltd (BRS) (hereafter referred to as the Proponent). The report presents an assessment of potential air quality and odour impacts associated with the proposed modifications to the BRS facility located at Ingleburn, New South Wales (NSW) (hereafter referred to as the Project).

To assess the potential air quality impacts associated with the Project, this report incorporates the following aspects:

- A background and description of the Project;
- A review of the existing meteorological and air quality environment of the Project site;
- A description of the dispersion modelling approach used to assess potential air quality impacts;
- Presentation of the predicted results and a discussion of the potential air quality impacts;
- An outline of air quality mitigation measures for the Project; and,
- An estimate of potential greenhouse gas emissions for the Project.

This air quality impact assessment has been prepared in general accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**). The assessment forms part of the environmental impact assessment prepared to accompany the application for the Project.

2 PROJECT BACKGROUND

2.1 Project setting

The Project site is located at 16 Kerr Road, Ingleburn NSW, approximately 1.5 kilometres (km) north of the Ingleburn town centre and approximately 9.5km southwest of Liverpool.

The Project site is situated within an existing industrial precinct and bounded by industrial warehouses and estates on three sides to the northeast, northwest and southwest. The southern railway line is adjacent to the site to the southeast with residential land located beyond this. The nearest sensitive receptors are located approximately 80 metres (m) to the southeast.

Figure 2-1 presents the location of the Project and the sensitive receptors assessed as discrete receptors in this assessment.

Figure 2-1: Project setting

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project.

The Project area can be characterised as relatively flat and situated in a slight depression which follows a northeast to southwest axis, the topography slopes towards higher elevations to the southeast and northwest of the site.

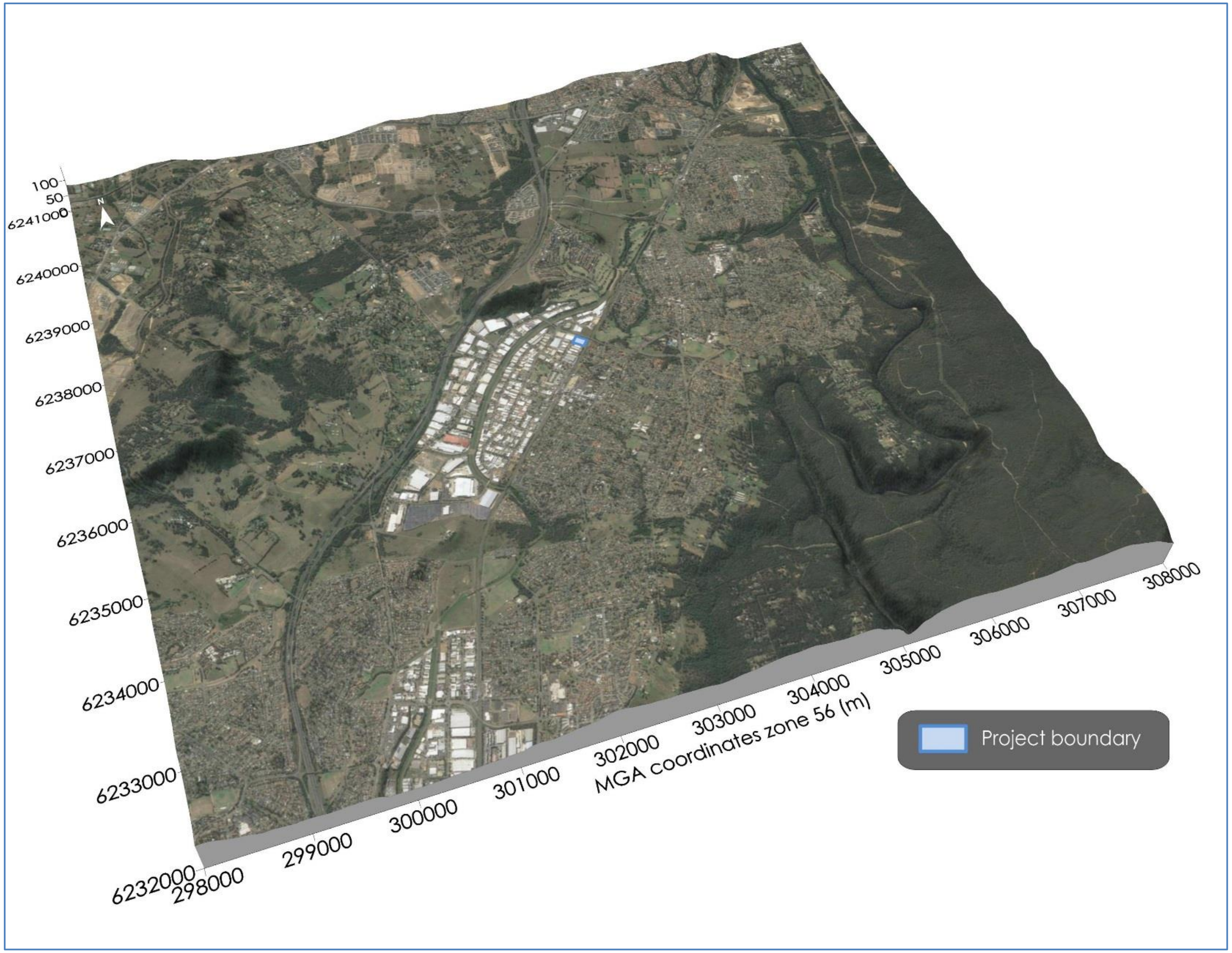

Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Existing operations

The BRS resource recovery process involves the acceptance of a range waste materials that is subject to various non-thermal treatments specific to the waste type. The existing operations are approved for the following:

- The processing of up to 30,000 tonnes per annum (tpa) of approved materials;
- Extraction, crushing and screening of the resource;
- Operating a concrete batching plant; and,
- The storage on-site at any given time of up to 5,000 tonnes (t) of approved waste.

The recovery process results in very little waste generated with a range of finished products including sand, aggregate, road base, recovered fines and concrete blocks.

2.3 Proposed modifications

The proposed modifications that comprise the Project essentially involve an expansion of the existing operations to include:

- Processing of up to 225,000tpa of approved materials;
- Stockpiling of up to 90,000t at any one time; and,
- Upgrading of the existing concrete batching equipment.

Operational hours for liquid and muddy water operations are proposed to occur 24 hours per day, 7 days per week. Crushing activity and heavy vehicle movements to drop-off or pick-up material would remain as per the existing approved hours of 7:00am to 10:00pm. Concrete batching activities are proposed to occur between the hours of 3:00am to 10:00pm.

2.4 Project description

The plant processes at the Project are defined by the type of material accepted and include liquid, muddy and solid waste types.

Liquid waste processing at the Project would include dissolved air flotation (DAF), biological treatment, sludge thickening and dewatering, in addition to chemical addition and pH correction, depending on the waste to be treated. The liquid waste processing would be vacuum pressured and would incorporate charcoal filters to mitigate odour from this process. The sludge material resulting from the processing of liquid wastes would be collected and encapsulated in concrete to minimise the generation of odour from this source.

Muddy waste processing essentially involves dewatering and passing through a filter press to generate a solid resource. Only clean drilling muds, free from contamination, would be accepted at the site and are not projected to be a significant source of odour.

The solid waste processing at the Project involves the crushing, screening and blending of materials to generate desired products. The solid waste processing and raw material stockpiling would occur within an enclosed space with water misting sprays applied to supress dust within the building.

Only finished products would be stockpiled in outdoor areas in external storage bays enclosed by besser block walls. Application of water would be used to mitigate dust emissions and minimise wind generated dust emissions from this source.

The expected breakdown of material accepted at the Project, subject to market demand, would primarily comprise of solid waste materials, approximately 50%, with liquid and muddy materials comprising approximately 35% and 15%, respectively.

The finished products generated at the Project include:

- aggregate <10mm & <20mm;
- concrete blocks (2.3t and 0.9t);
- crossover 40/70;
- crushed aggregate dust;
- road base <20mm; and,
- turf underlay.

An indicative site layout is presented in **Figure 2-3**.

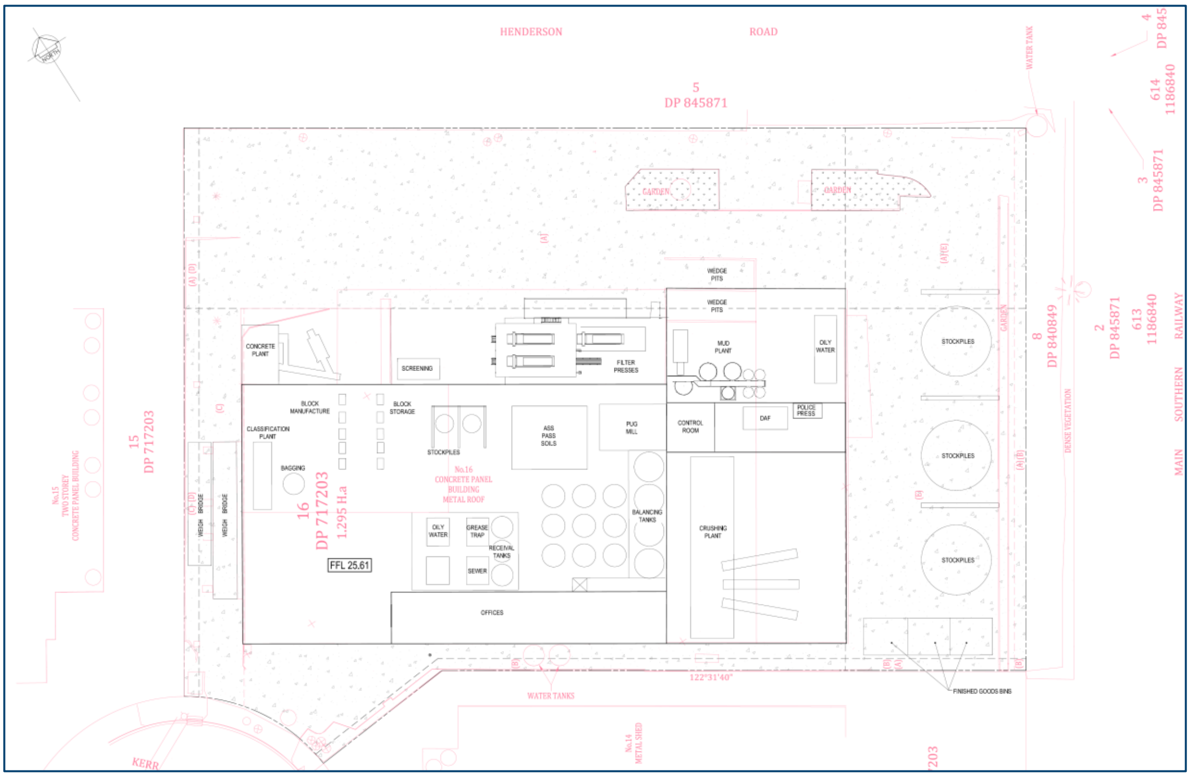

Figure 2-3: Indicative layout for the Project

3 STUDY REQUIREMENTS

The purpose of this report is to provide an assessment of the maximum likely effects on air quality and odour which may arise due to the Project. The assessment presented in this report addresses the planning and regulatory agency requirements, as set out below.

3.1 Secretary's Environmental Assessment Requirements

In preparing this Air Quality Impact Assessment, the Secretary's Environmental Assessment Requirements issued for the Project in September 2017 have been addressed. The key matters raised for consideration in this Air Quality and Odour Assessment are outlined in **Table 3-1** along with a reference as to where the requirements are addressed in the report.

Table 3-1: Secretary's Environmental Assessment Requirements (SEAR No. 8593)

Specific Issue		Section
Air quality and Odour – including:	A quantitative assessment of the potential air quality, dust and odour impacts of the development in accordance with relevant Environment Protection Authority guidelines;	This report
	The details of building and air handling systems and strong justification for any material handling, processing or stockpiling external to a building;	2.3 and 8
	A greenhouse gas assessment; and	9
	Details of proposed mitigation, management and monitoring measures.	8

3.2 NSW Environmental Protection Authority

This Air Quality Impact Assessment has been prepared in general accordance with the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**) and the specific requirements outlined in **Table 3-2** along with a reference as to where the requirements are addressed in the report.

Table 3-2: NSW EPA comments for air quality (SEAR No. 8593)

Air quality	Section
• Identify the existing air quality environment and identify applicable air quality goals in line with relevant guidance/standards; and	4 & 5
• Identify potential air quality and odour impacts (including point source emissions from any site based plant and equipment and/or fugitive dust or other emissions) during both construction and operational stages and identify mitigation strategies to minimise point and/or fugitive and/or odour emissions/impacts.	6.3 & 8

4 AIR QUALITY CRITERIA

4.1 Preamble

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

4.2 Particulate matter

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

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

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

4.2.1 NSW EPA impact assessment criteria

Table 4-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

The air quality criteria for particulates refers to the cumulative impact and not just the dust from the proposed modification. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

Table 4-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Cumulative	90µg/m^3
PM_{10}	Annual	Cumulative	25µg/m^3
	24 hour	Cumulative	50µg/m^3
$PM_{2.5}$	Annual	Cumulative	8µg/m^3
	24 hour	Cumulative	25µg/m^3
Deposited dust	Annual	Incremental	2g/m^2/month
		Cumulative	4g/m^2/month

Source: NSW EPA, 2017
µg/m^3 = micrograms per cubic metre
g/m^2/month = grams per square metre per month

4.3 Odour

4.3.1 Introduction

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

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

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

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

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

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

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

4.3.2 Complex Mixtures of Odorous Air Pollutants

Table 4-2 presents the assessment criteria as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**). This criterion has been refined to take into account the population densities of specific areas and is based on a 99th percentile of dispersion model predictions calculated as 1-second averages (nose-response time).

Table 4-2: Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile)

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

Source: NSW EPA, 2017

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

Peak-to-mean factors are applied to account for any odour fluctuation above and below the mean odour level of the 1-hour averaging time. The criteria in **Table 4-2** are compared with modelled results that include peaking factors to account for the time-averaging limitations of air dispersion models. The peak-to-mean factors developed by **Katestone Scientific Pty Ltd** (**1995, 1998**) for the NSW EPA are applied to convert the modelled (1-hour) averaging time to 1-second peak concentrations.

A summary of the peak-to-mean values is provided in **Table 4-3**.

Table 4-3: Peak-to-mean values

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

*Ratio of peak 1-second average concentrations

5 EXISTING ENVIRONMENT

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

5.1 Local climatic conditions

Long-term climatic data from the Bureau of Meteorology (BoM) weather station at Bankstown Airport Automatic Weather Station (AWS) (Site No. 066137) were analysed to characterise the local climate in the proximity of the Project. The Bankstown Airport AWS weather station is located approximately 13.9km northeast of the Project.

Table 5-1 and **Figure 5-1** present a summary of data from the Bankstown Airport AWS weather station collected over a 37 to 50 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 28.4 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 5.1°C.

Rainfall peaks during the months of summer and autumn and declines during late winter and early spring. Annual average rainfall for the station is 871.8 millimetres (mm) over 81.5 days. The data indicate that February is the wettest month with an average rainfall of 102.1mm over 7.9 days and September is the driest month with an average rainfall of 42.9mm over 5.3 days.

Relative humidity exhibits little variability and seasonal flux across the year. Mean 9am relative humidity ranges from 62% in October to 80% in June. Mean 3pm relative humidity levels range from 44% in August to 57% in February.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the cooler months. Mean 9am wind speeds range from 6.6 kilometres per hour (km/h) in March, June and July to 10.6km/h in October. Mean 3pm wind speeds range from 12.9km/h in May to 22.6km/h in December.

Table 5-1: Monthly climate statistics summary – Bankstown Airport AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	28.4	27.9	26.4	23.8	20.6	17.8	17.3	19.0	21.7	23.9	25.4	27.5	23.3
Mean min. temp. (°C)	18.2	18.2	16.3	12.8	9.4	6.8	5.1	6.0	8.7	11.8	14.4	16.7	12.0
Rainfall													
Rainfall (mm)	91.8	102.1	98.7	84.5	64.7	80.7	43.9	50.3	42.9	58.4	76.5	67.5	871.8
No. of rain days (≥1mm)	8.0	7.9	8.5	6.7	6.7	6.8	5.3	4.6	5.3	6.6	8.0	7.1	81.5
9am conditions													
Mean temp. (°C)	22.2	21.6	20.2	17.4	13.8	10.7	9.6	11.6	15.1	18.2	19.3	21.4	16.8
Mean R.H. (%)	72	77	77	75	79	80	78	70	64	62	67	67	72
Mean W.S. (km/h)	8.2	7.4	6.6	6.7	6.7	6.6	6.6	9.0	10.3	10.6	9.7	9.1	8.1
3pm conditions													
Mean temp. (°C)	26.8	26.4	25.0	22.6	19.5	17.0	16.4	18.0	20.2	22.1	23.5	25.9	22.0
Mean R.H. (%)	54	57	55	54	55	55	50	44	45	48	52	51	52
Mean W.S. (km/h)	20.9	19.0	17.6	15.3	12.9	13.6	14.1	17.6	19.9	20.9	21.6	22.6	18.0

Source: **Bureau of Meteorology, 2018 (August 2018)**

R.H. – Relative Humidity, W.S. – wind speed

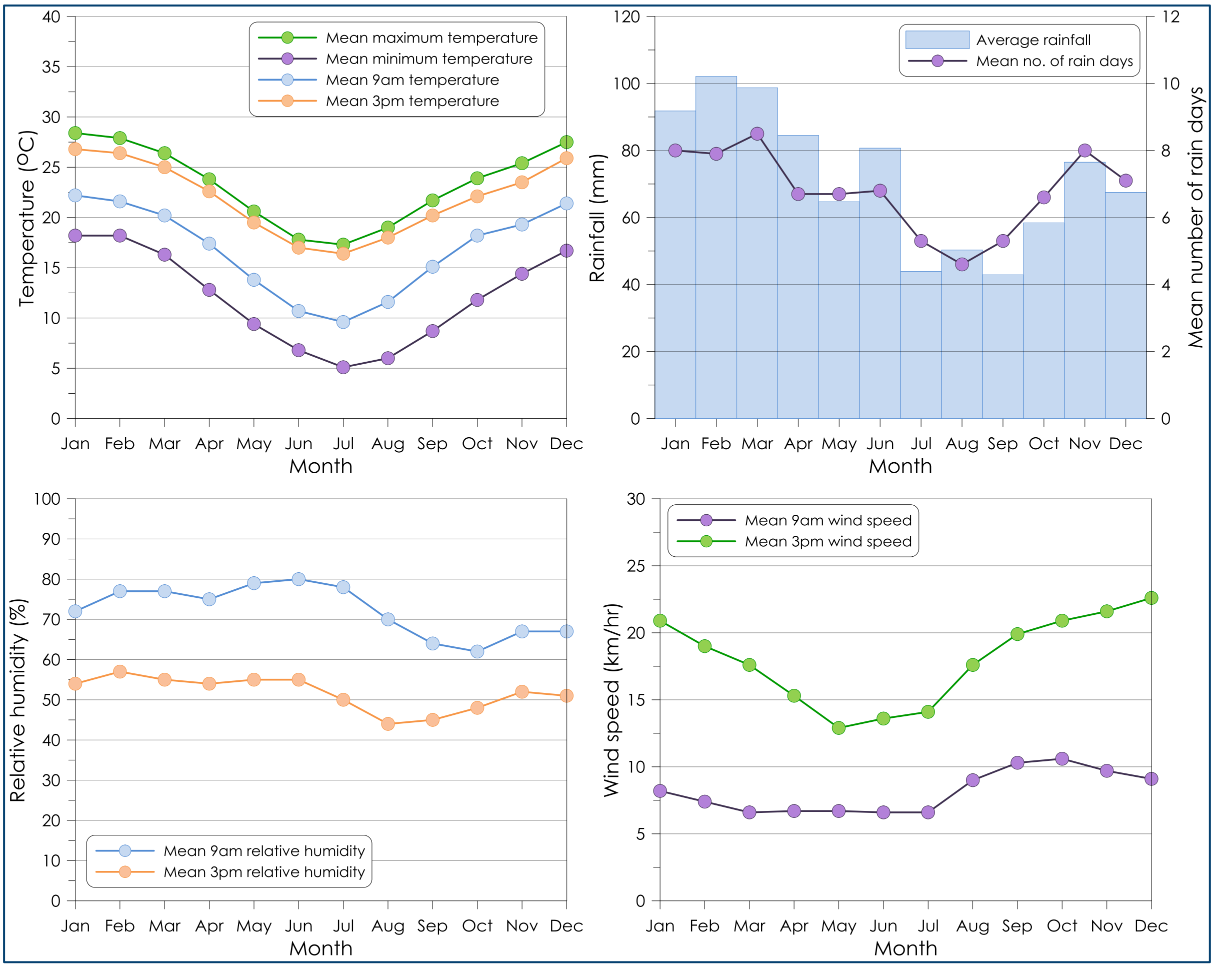

Figure 5-1: Monthly climate statistics summary – Bankstown Airport AWS

5.2 Local meteorological conditions

Annual and seasonal windroses for the Holsworthy Control Range weather station during the 2012 calendar period are presented in **Figure 5-2**. The Holsworthy Control Range weather station is located approximately 5.3km east-northeast of the Project.

On an annual basis, winds from the west-southwest and the southwest are the most frequent. In summer, the wind frequencies are relatively similar, extending from the east-northeast to the south-west. In autumn and winter, winds are most frequent from the west-southwest and the southwest. Spring experiences frequent winds from the west-southwest and the south-west, and for all other directions, the wind frequencies are relatively similar.

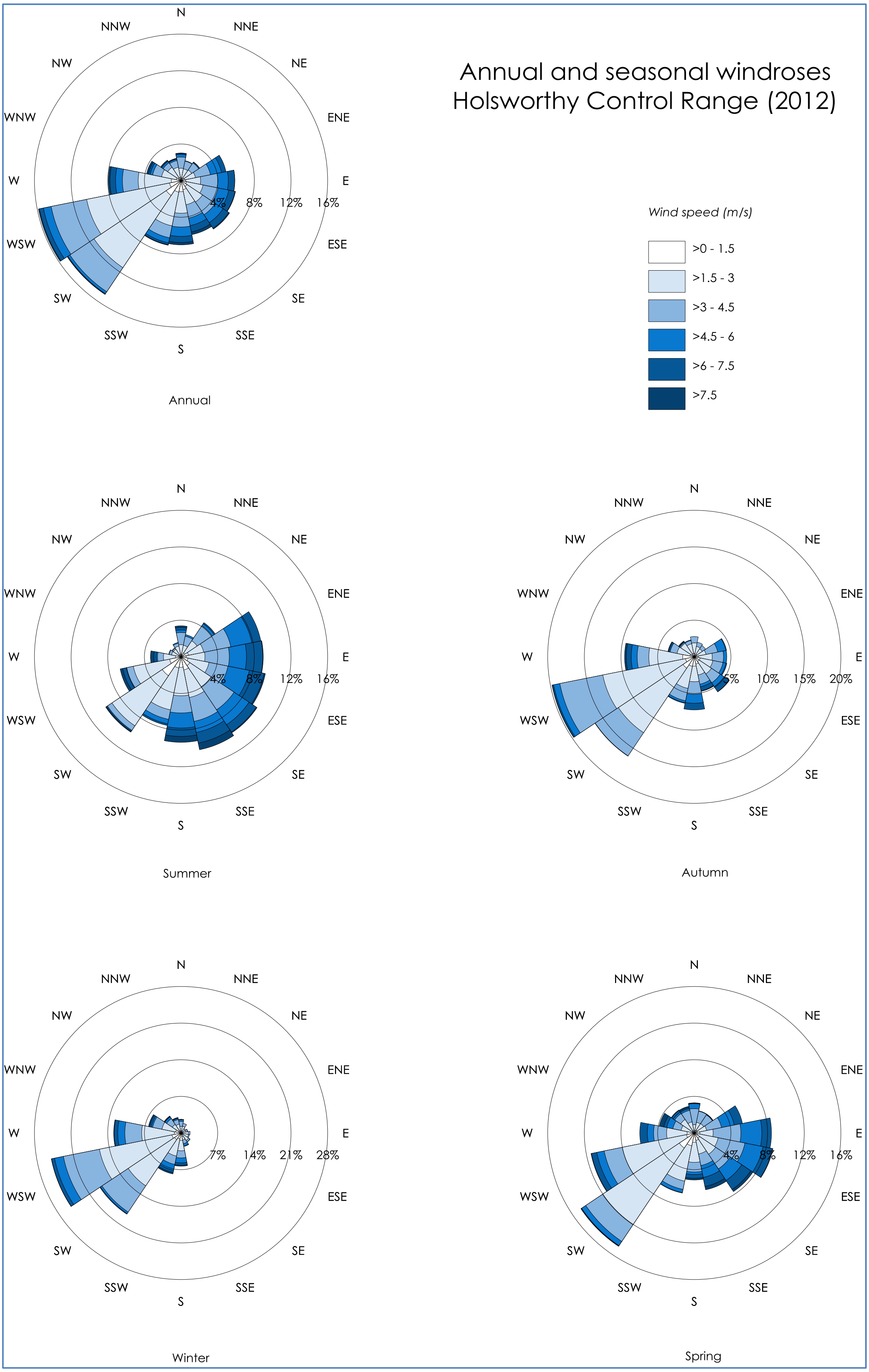

Figure 5-2 : Annual and seasonal windroses – Holsworthy Control Range (2012)

5.3 Local air quality monitoring

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

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

The NSW OEH air quality monitors at Liverpool and Campbelltown West are located approximately 7.5km and 10.8km from the site respectively and are taken to be generally representative of the background levels in the vicinity of the Project site. The data from these monitors have therefore been used to quantify the existing ambient levels of air pollutants in this study.

5.3.1 PM_{10} monitoring

A summary of the available data from the NSW OEH monitoring stations is presented in **Table 5-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 5-3**.

A review of **Table 5-2** indicates that the annual average PM_{10} concentrations for each monitoring station were below the relevant criterion of 25µg/m^3. The maximum 24-hour average PM_{10} concentrations recorded at these stations were found to exceed the relevant criterion of 50µg/m^3 during the review period (see **Figure 5-3**).

Table 5-2: Summary of PM_{10} levels from NSW OEH monitoring (µg/m^3)

Year	Liverpool	Campbelltown West (1)	Criterion
	Annual average		
2012	19.8	-	25
2013	21.0	15.5	25
2014	19.1	17.0	25
2015	18.5	15.6	25
2016	19.6	16.1	25
2017	20.8	15.7	25
	Maximum 24-hour average		
2012	42.5	-	50
2013	**98.5**	**56.9**	50
2014	40.8	49.4	50
2015	**68.6**	**69.7**	50
2016	**68.7**	**50.1**	50
2017	**74**	**53.1**	50

(1)Data available from August 2012

It can be seen from **Figure 5-3** that PM_{10} concentrations are relatively constant throughout the year with periods of elevated levels typically associated with bushfires and other widespread events.

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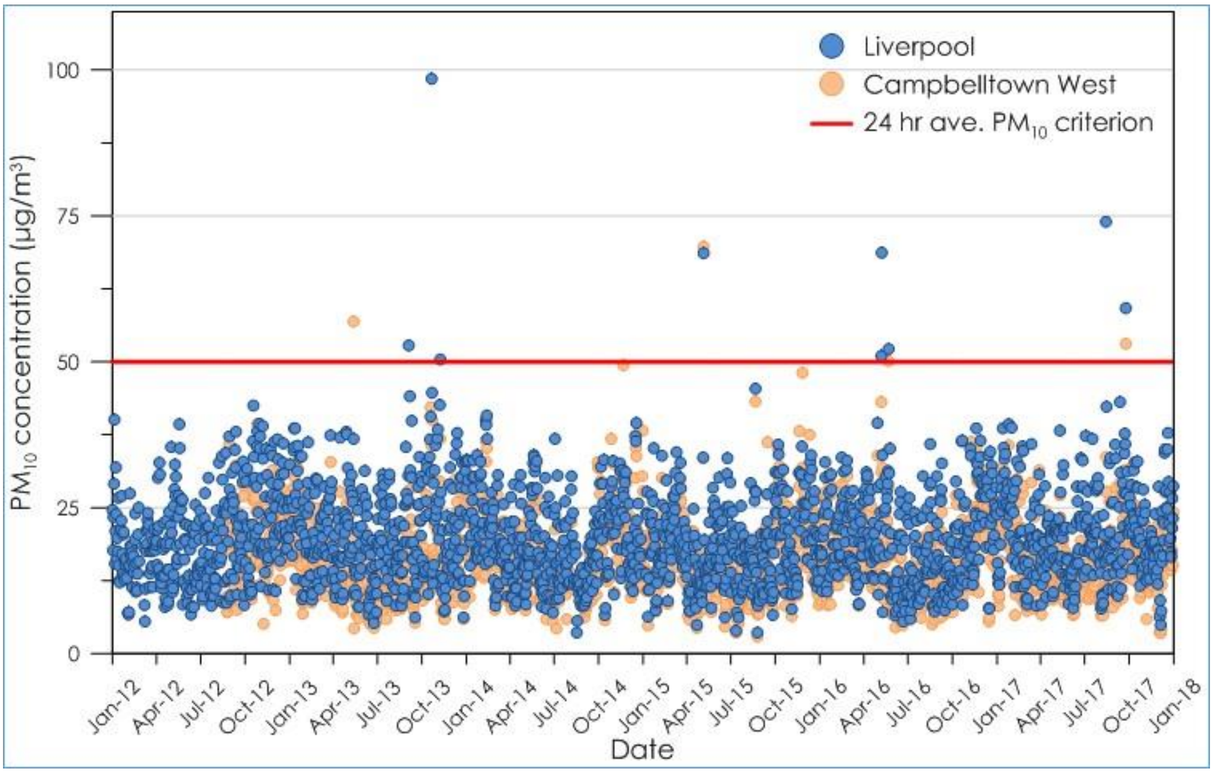

Figure 5-3: 24-hour average PM_{10} concentrations

5.3.2 $PM_{2.5}$ monitoring

A summary of the $PM_{2.5}$ readings from the NSW OEH monitoring stations is presented in **Table 5-3**. The recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 5-4**.

Table 5-3 indicates that the annual average $PM_{2.5}$ concentrations for the Liverpool monitoring station were above the annual average criterion of 8µg/m³ for the years reviewed. The levels recorded at the Campbelltown West monitoring station were below the annual average criterion when data were available. The maximum 24-hour average $PM_{2.5}$ concentrations recorded at these stations were found to exceed the relevant criterion of 25µg/m³ during the review period (see **Figure 5-4**).

It is noted that the Liverpool monitoring station is located adjacent to a Liverpool City Council depot and carpark which is a source of vehicle exhaust emissions which may contribute to the readings at this monitor.

A review of **Figure 5-4** indicates a seasonal trend in 24-hour average $PM_{2.5}$ concentrations, with nominally higher levels in the winter months which can be attributed to combustion emissions arising from domestic wood heaters.

Table 5-3: Summary of $PM_{2.5}$ levels from NSW OEH monitoring (µg/m³)

Year	Liverpool	Campbelltown West [(1)]
	Annual average	
2012	**8.5**	-
2013	**9.4**	-
2014	**8.6**	-
2015	**8.5**	-
2016	**8.7**	7.9
2017	**8.9**	7.4
	Maximum 24-hour average	
2012	24.9	-
2013	**73.8**	-
2014	24.3	-
2015	**32.2**	-
2016	**50.8**	**35.8**
2017	**56.4**	25

[(1)]Data available from September 2015

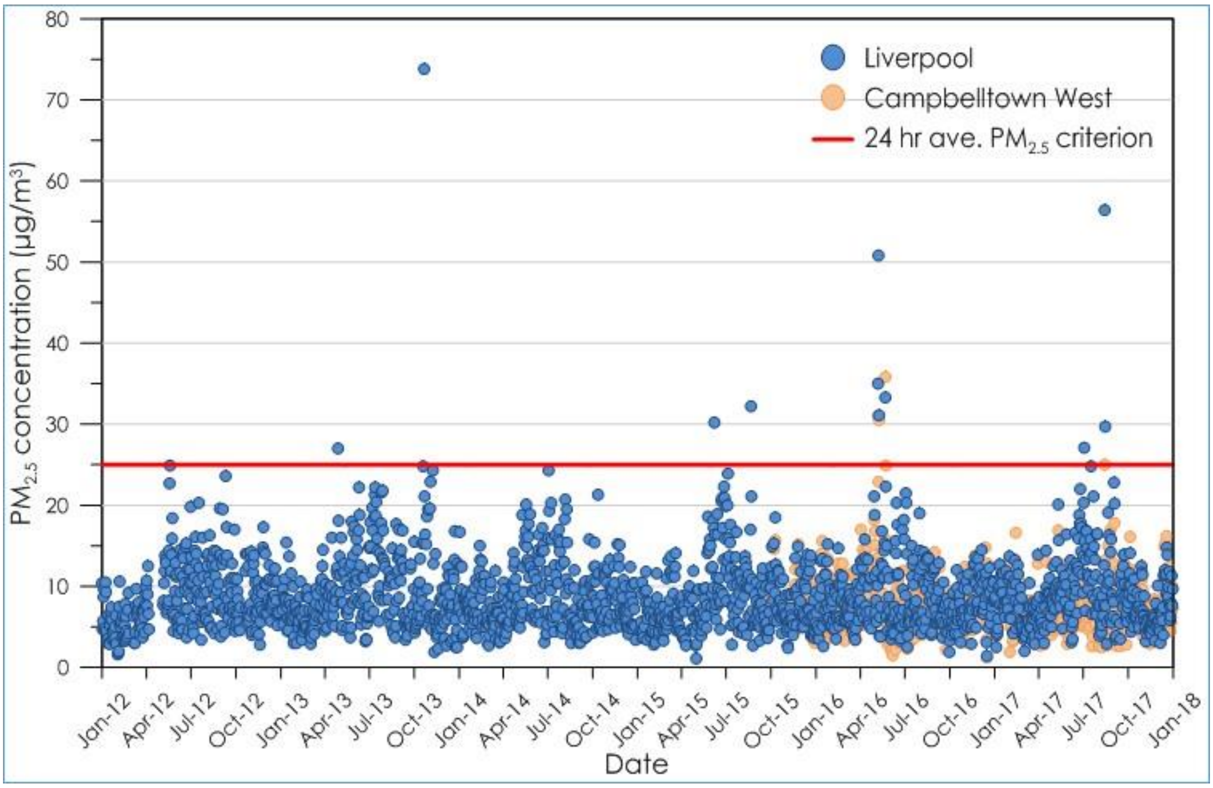

Figure 5-4: 24-hour average $PM_{2.5}$ concentrations

Bushfire events can have a significant impact on ambient air quality levels. Most noticeable was the bushfire event which occurred in late 2013 and impacted the majority of the Sydney basin. **Figure 5-5** presents satellite imagery showing the extent of the smoke plume on 21 October 2013, noting that the red patches in the images indicate the position of the active fire.

The elevated levels associated with the bushfire events in **Figure 5-4** are identified to occur in 2015, 2016 and 2017 and skew the ambient levels and therefore may not provide a reliable estimate if considered in the prevailing data for background levels.

Source: **NASA, 2016**

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

5.3.3 Estimated background dust levels

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

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

Annual average PM_{10} and $PM_{2.5}$ values from the Liverpool monitoring station for the 2012 calendar period were used to represent the background levels for the Project (see **Table 5-2** and **Table 5-3**), as they were the highest of the selected monitoring sites. The 2012 calendar period corresponds to the period of meteorological modelling used in this assessment.

It is noted that the annual average $PM_{2.5}$ value from the Liverpool monitoring station for the 2012 calendar period was above the annual average criterion of 8µg/m^3. To demonstrate compliance, the contribution of $PM_{2.5}$ from the Project should be minimised as far as practical with appropriate management practices implemented.

5.3.3.2 TSP and Deposited dust

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

This relationship assumes that an annual average PM_{10} concentration of 25µg/m^3 corresponds to a TSP concentration of 90µg/m^3 and a dust deposition value of 4g/m^2/month. This assumption is based on the NSW EPA air quality impact criteria.

Applying this relationship with the measured annual average PM_{10} concentration of 19.8µg/m^3 indicates an approximate annual average TSP concentration and deposition value of 71.3µg/m^3 and 3.2g/m^2/month, respectively.

5.3.3.3 Summary of background dust levels

The annual average background air quality levels applied in this assessment are as follows:

- PM_{10} concentrations – 19.8µg/m^3;
- $PM_{2.5}$ concentrations – 8.5µg/m^3;
- TSP concentrations – 71.3µg/m^3; and,
- Deposited dust levels – 3.2g/m^2/month.

6 DISPERSION MODELLING APPROACH

6.1 Introduction

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

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

6.2 Modelling methodology

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

6.2.1 Meteorological modelling

TAPM was applied to the available data to generate a 3D upper air data file for use in CALMET. The centre of analysis for TAPM was 33deg59.5min south and 150deg52min east. The simulation involved an outer grid of 30 km, with three nested grids of 10 km, 3 km and 1 km with 35 vertical grid levels. The CALMET domain was run on a 10 x 10 km area with 0.1 km grid resolution.

The 2012 calendar year was selected as the meteorological year for the dispersion modelling based on analysis of long-term data trends in meteorological data recorded for the area as outlined in **Appendix A**. The available meteorological data for January 2012 to December 2012 from relevant BoM meteorological monitoring sites were included in the simulation. **Table 6-1** outlines the parameters used from each station

Table 6-1: Surface observation stations

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Bankstown Airport AWS (BoM) (Station No. 066137)	✓	✓	✓	✓	✓	✓	✓
Campbelltown (Mount Annan) (BoM) (Station No. 068257)	✓	✓			✓	✓	
Holsworthy Control Range (BoM) (Station No. 067117)	✓	✓			✓	✓	
Badgerys Creek AWS (BoM) (Station No. 067108)	✓	✓			✓	✓	✓
Camden Airport AWS (BoM) (Station No. 068192)	✓	✓	✓	✓	✓	✓	✓

WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity, SLP = station level pressure

Local land use and detailed topographical information was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 6-1.**

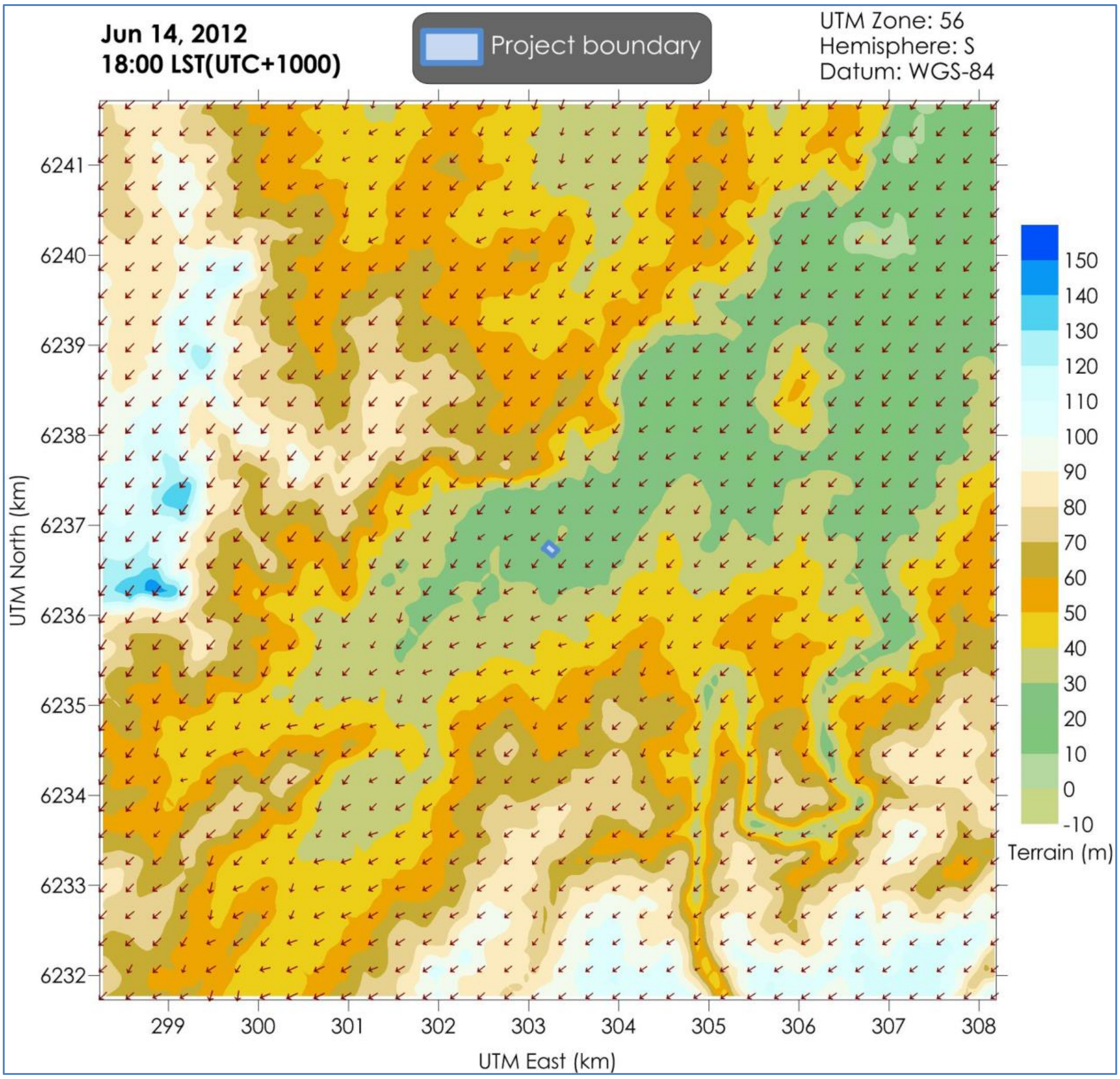

Figure 6-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 6-2** and **Figure 6-3**.

Figure 6-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds.

Figure 6-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and show sensible trends considered to be representative of the area.

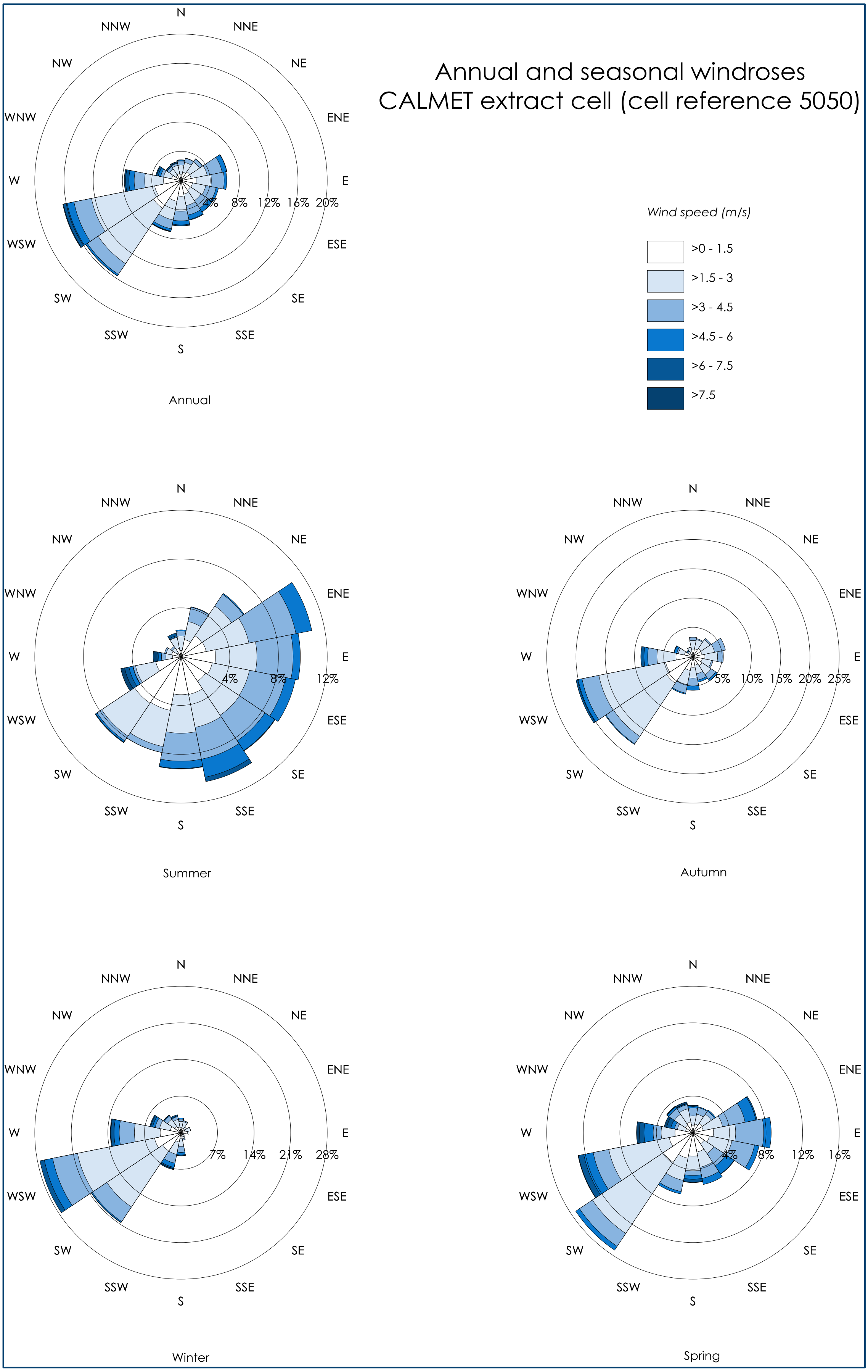

Figure 6-2: Annual and seasonal windroses from CALMET (Cell reference 5050)

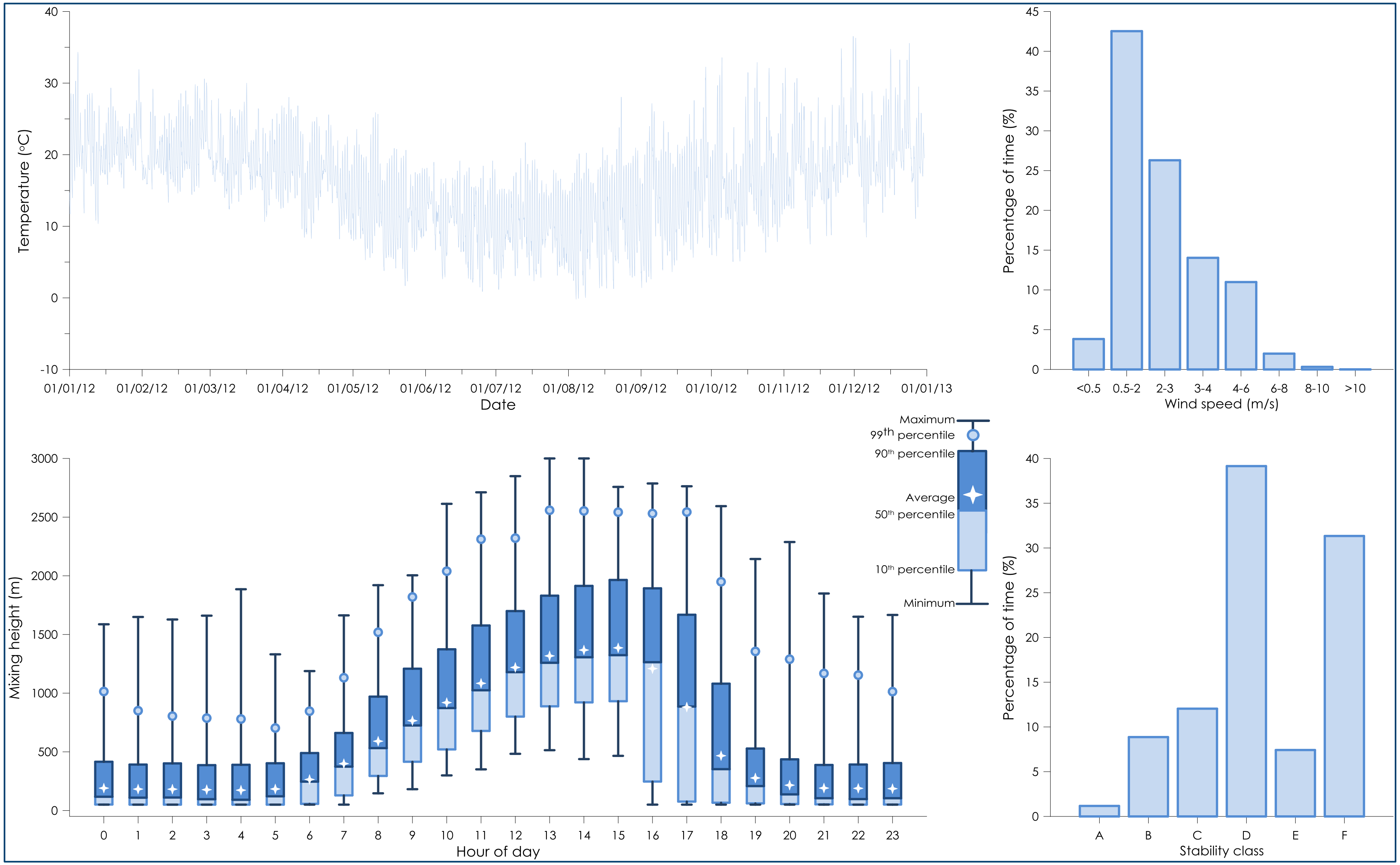

Figure 6-3: Meteorological analysis of CALMET (Cell Ref 5050)

6.2.2 Dispersion modelling

The CALPUFF air dispersion model has been used to predict the potential dust and odour levels in the ambient air in the wider area around the Project.

Modelling of the key odour and dust emission sources was conducted using the emissions rates and parameters outlined in the following section and utilising the meteorological data described in the previous section.

6.3 Emission estimation

6.3.1 Dust emissions

The significant dust generating activities associated with operation of the Project are identified as loading/unloading of material, crushing and screening of material, concrete batching processes, vehicles travelling on-site and windblown dust generated from stockpiles. The on-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

This assessment considers a potential worst-case scenario for dust generation at the Project based on the maximum proposed amount of material processed via crushing, i.e. 225,000tpa, and a yearly production of approximately 10,000t of concrete.

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

As a conservative measure all dust emissions sources at the Project are assumed to be located out in the open.

The estimated dust emissions for activities associated with the operation are presented in **Table 6-2**. Detailed calculations of the dust emission estimates are provided in **Appendix B**.

Table 6-2: Estimated annual dust emissions for the Project

Activity	Emissions (kg/year)		
	TSP	PM_{10}	$PM_{2.5}$
Crushing			
Delivering material on-site	1,966	377	91
Unloading material to stockpile	314	149	23
Loading material to crusher	314	149	23
Crushing - tertiary	135	61	11
Screening - tertiary	248	83	6
Crushing - fines	338	135	8
Screening - fines	405	248	17
Unloading material to stockpile	314	149	23
Concrete batching			
Loading FEL with sand and aggregate for hopper	12	6	1
Unloading sand and aggregate to hopper	12	6	1
Delivering cement material onsite	14	3	1
Unloading cement to storage silo	1	0	0
Weigh hopper loading	26	13	2
Mixer loading (central mix)	13	7	2
Agitator truck travelling onsite (paved road)	122	23	6
Other			
Loading product to haul truck	314	149	23

Activity	Emissions (kg/year)		
	TSP	PM_{10}	$PM_{2.5}$
Delivering material off-site	2,735	525	127
Wind erosion - entire site	1,091	545	82
Diesel exhaust	32	32	31
Total emissions (kg/year)	**8,405**	**2,659**	**474**

6.3.2 Odour emissions

The potential odour sources associated with operation of the Project are identified to arise from the stockpiling of foundry sand from the DAF treatment of liquid waste located within the building at the Project site.

The Project would apply appropriate measures to minimise the generation of odour from these sources including blending the foundry sand with other materials to dilute the material and the use of charcoal filters with the DAF process.

Odour emissions estimates for the Project have been calculated based on the approximate dimensions of the foundry sand and the DAF sources at the Project modelled as volume sources. An odour concentration of 220 OU for the foundry sand (**Benbow Environmental, 2016**) and an odour concentration of 3,981 OU for a sludge bay obtained from Sydney Water Database representing the DAF system was applied.

The estimated odour emission rates applied in the modelling for these sources are presented in **Table 7-4**. The odour sources at the Project have been assumed to emit at a constant rate and have been assumed to be located out in the open.

Table 6-3: Estimated odour emissions for the Project

Odour source	Odour emission rate (OUV/s)
Foundry sand	160
Dissolved air flotation system	839

7 DISPERSION MODELLING RESULTS

This section presents the predicted impacts on air quality which may arise from air emissions generated by the Project.

7.1 Dust concentrations

The dispersion model predictions presented in this section include those for the operation of the Project in isolation (incremental impact) and the operation of the Project with consideration of other sources (total cumulative impact). The results show the predicted:

- Maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average $PM_{2.5}$, PM_{10} and TSP concentrations; and,
- Annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations that were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) in the one year long modelling period.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix C**.

Table 7-1 presents the predicted incremental particulate dispersion modelling results at each of the assessed sensitive receptor locations. The results show that low incremental effects would arise at the sensitive receptor locations due to the Project.

Table 7-1: Particulate dispersion modelling results for sensitive receptors – Incremental impact

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/month)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	Air quality impact criteria					
	-	-	-	-	-	2
R1	0.4	0.1	1.9	0.3	0.8	<0.1
R2	0.5	0.1	2.2	0.3	0.7	<0.1
R3	0.5	<0.1	2.2	0.2	0.6	<0.1
R4	1.2	0.1	6.0	0.5	1.5	0.1
R5	2.0	0.2	11.1	1.0	2.8	0.2
R6	2.7	0.3	14.5	1.5	4.6	0.3
R7	2.6	0.3	13.6	1.7	5.3	0.4
R8	2.5	0.4	12.7	2.0	6.3	0.5
R9	0.4	0.1	1.7	0.3	0.8	<0.1
R10	0.4	0.1	2.0	0.4	1.2	<0.1
R11	0.4	0.1	2.0	0.5	1.3	<0.1
R12	0.4	0.1	1.8	0.4	1.3	<0.1

*Deposited dust

The cumulative (total) impact is defined as the modelling impact associated with the operation of the Project combined with the estimated ambient background levels in **Section 5.3.3**.

The predicted cumulative annual average $PM_{2.5}$, PM_{10}, TSP and dust deposition levels due to the Project with the estimated background levels are presented in **Table 7-2**.

The results in **Table 7-2** indicate that all of the assessed sensitive receptors are predicted to experience levels below the relevant criteria for the assessed dust metrics with the exception of annual average $PM_{2.5}$.

As stated in **Section 5.3** the annual average $PM_{2.5}$ background level is already above the relevant criterion of 8µg/m³. A review of the incremental predictions of annual average $PM_{2.5}$ in **Table 7-1** indicate only minimal contribution from the Project and would not be discernible from the existing background level. The cumulative annual average $PM_{2.5}$ predictions in **Table 7-2** are therefore not considered significant for the Project. Nonetheless, appropriate mitigation and management practices will be implemented at the Project to minimise $PM_{2.5}$ emissions as far as it is practical.

Table 7-2: Particulate dispersion modelling results for sensitive receptors – Cumulative impact

Receptor ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Annual average			
	Air quality impact criteria			
	8	25	90	4
R1	**8.6**	20.1	72.1	3.2
R2	**8.6**	20.1	72.0	3.2
R3	**8.5**	20.0	71.8	3.2
R4	**8.6**	20.3	72.7	3.2
R5	**8.7**	20.8	74.1	3.3
R6	**8.8**	21.3	75.9	3.5
R7	**8.8**	21.5	76.6	3.5
R8	**8.9**	21.8	77.5	3.6
R9	**8.6**	20.1	72.1	3.2
R10	**8.6**	20.2	72.5	3.2
R11	**8.6**	20.3	72.6	3.2
R12	**8.6**	20.2	72.6	3.2

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

As shown in **Section 5.3**, the maximum measured 24-hour concentrations of $PM_{2.5}$ and PM_{10} have in the past exceeded or come close to the relevant criterion level on occasion.

As a result, the NSW EPA Level 1 contemporaneous assessment approach of adding maximum background levels to maximum predicted levels from the Project would show levels above the criterion whether or not the Project was operating.

In such situations, the NSW EPA applies a Level 2 contemporaneous assessment approach where the measured background levels are added to the day's corresponding predicted dust level from the Project.

Ambient (background) $PM_{2.5}$ and PM_{10} concentration data corresponding with the year of modelling (2012) from the NSW OEH monitoring site at Liverpool have been applied in this case to represent the prevailing background levels in the vicinity of the Project and at sensitive receptor locations.

Table 7-3 provides a summary of the findings from the Level 2 assessment at sensitive receptor locations for both $PM_{2.5}$ and PM_{10}. Detailed tables of the contemporaneous assessment results for selected receptors are provided in **Appendix D**.

The results indicate that the Project does not increase the number of days above the 24-hour average criterion at the assessed receptors for PM_{10} and only one additional day above the 24-hour average criterion for $PM_{2.5}$ is predicted for receptors, R7, R8, R9, R10, R11 and R12.

Table 7-3: NSW EPA contemporaneous assessment – maximum number of additional days above 24-hour average $PM_{2.5}$ and PM_{10} criterion

Receptor ID	$PM_{2.5}$	PM_{10}
R1	0	0
R2	0	0
R3	0	0
R4	0	0
R5	0	0
R6	0	0
R7	1	0
R8	1	0
R9	1	0
R10	1	0
R11	1	0
R12	1	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for receptors R2, R4, R8 and R10 are presented in **Figure 7-1** to **Figure** 7-4. The orange bars in the figures represent the contribution from the Project and the blue bars represent the background levels. It can be seen from the figures that during the modelling period, the Project has a relatively small influence at the assessed receptor locations.

With regard to the predicted additional day above the 24-hour average $PM_{2.5}$ criterion at receptors R7, R8, R9, R10, R11 and R12, the measured $PM_{2.5}$ background level on this day was 24.9µg/m^3. The incremental contribution from the Project at R7, R8, R9, R10, R11 and R12 was 0.2µg/m^3, and 0.4µg/m^3, 0.2µg/m^3, 0.3µg/m^3, 0.3µg/m^3 and 0.2µg/m^3, respectively.

We note that the emissions estimation for this Project was conservative in assuming a worst-case scenario with the maximum amount of solid material processed resulting in the maximum amount of potential dust generated from the Project. The modelling also conservatively assumes the dust emissions sources are located out in the open. The predicted impact from the Project is minor even with the conservative assumption and predicted impacts are unlikely to occur in reality. Nevertheless, appropriate mitigation measures would be implemented on-site to minimise emissions of $PM_{2.5}$ as detailed in **Section 8**.

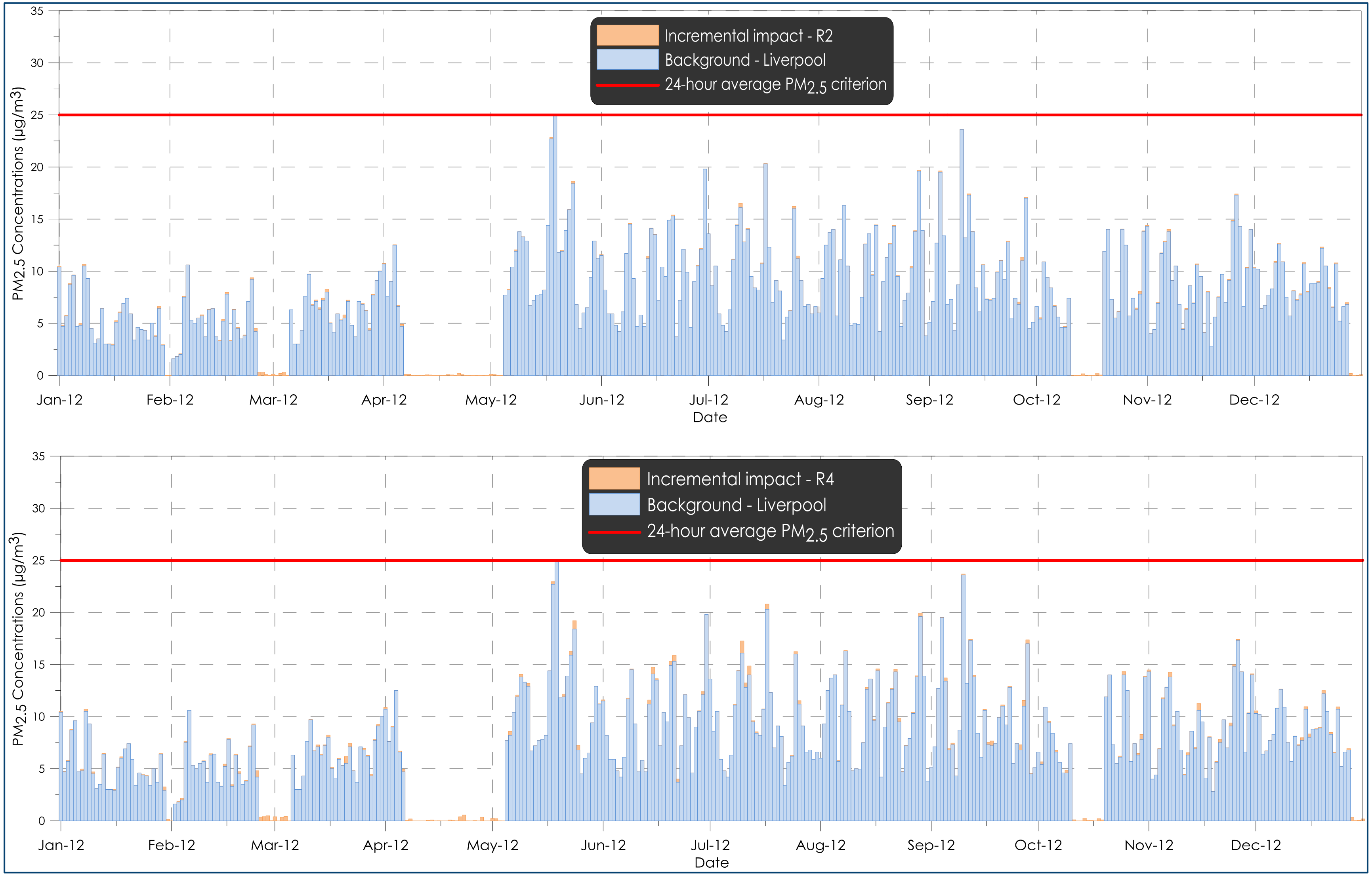

Figure 7-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for R2 and R4

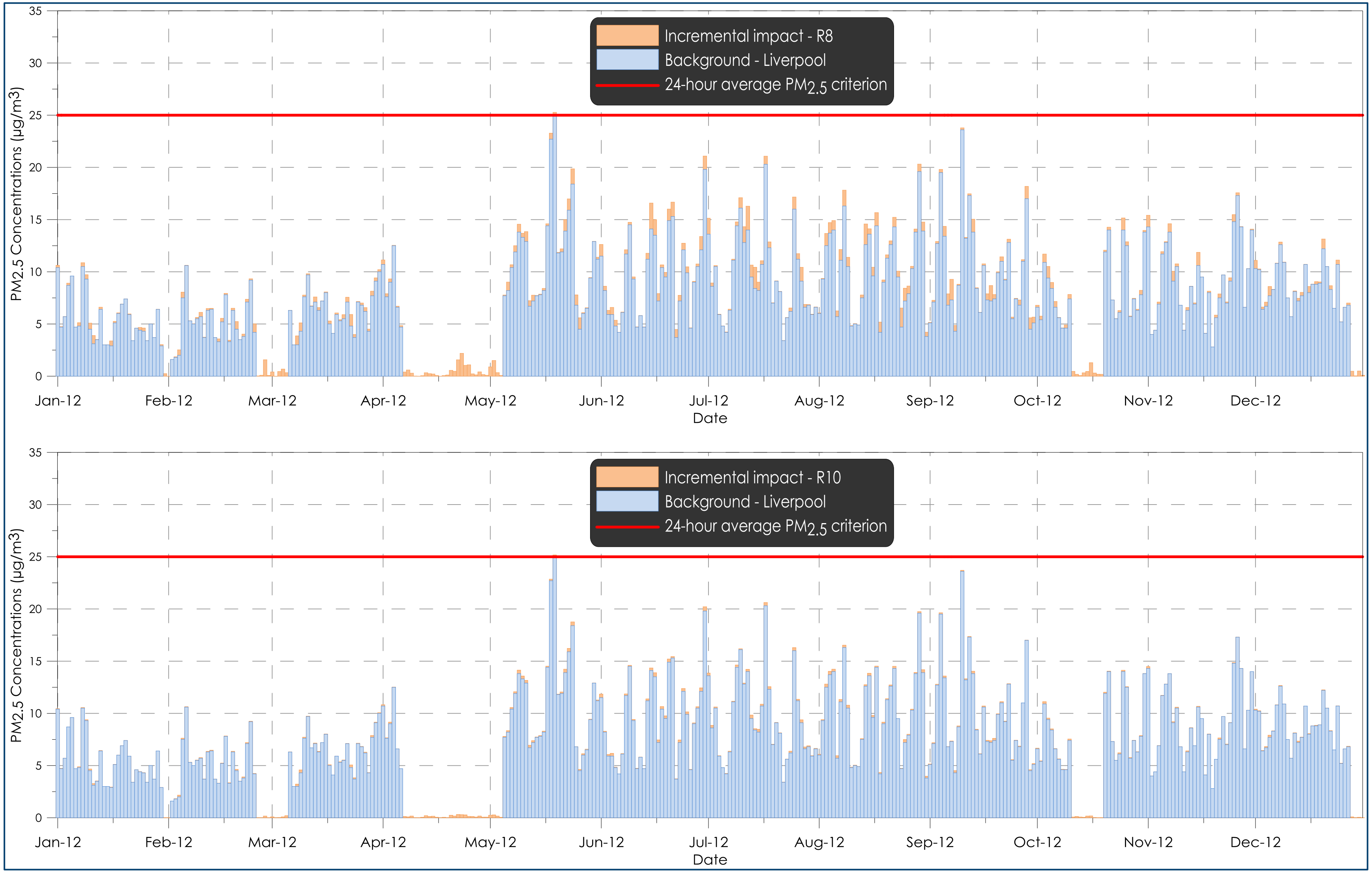

Figure 7-2: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for R8 and R10

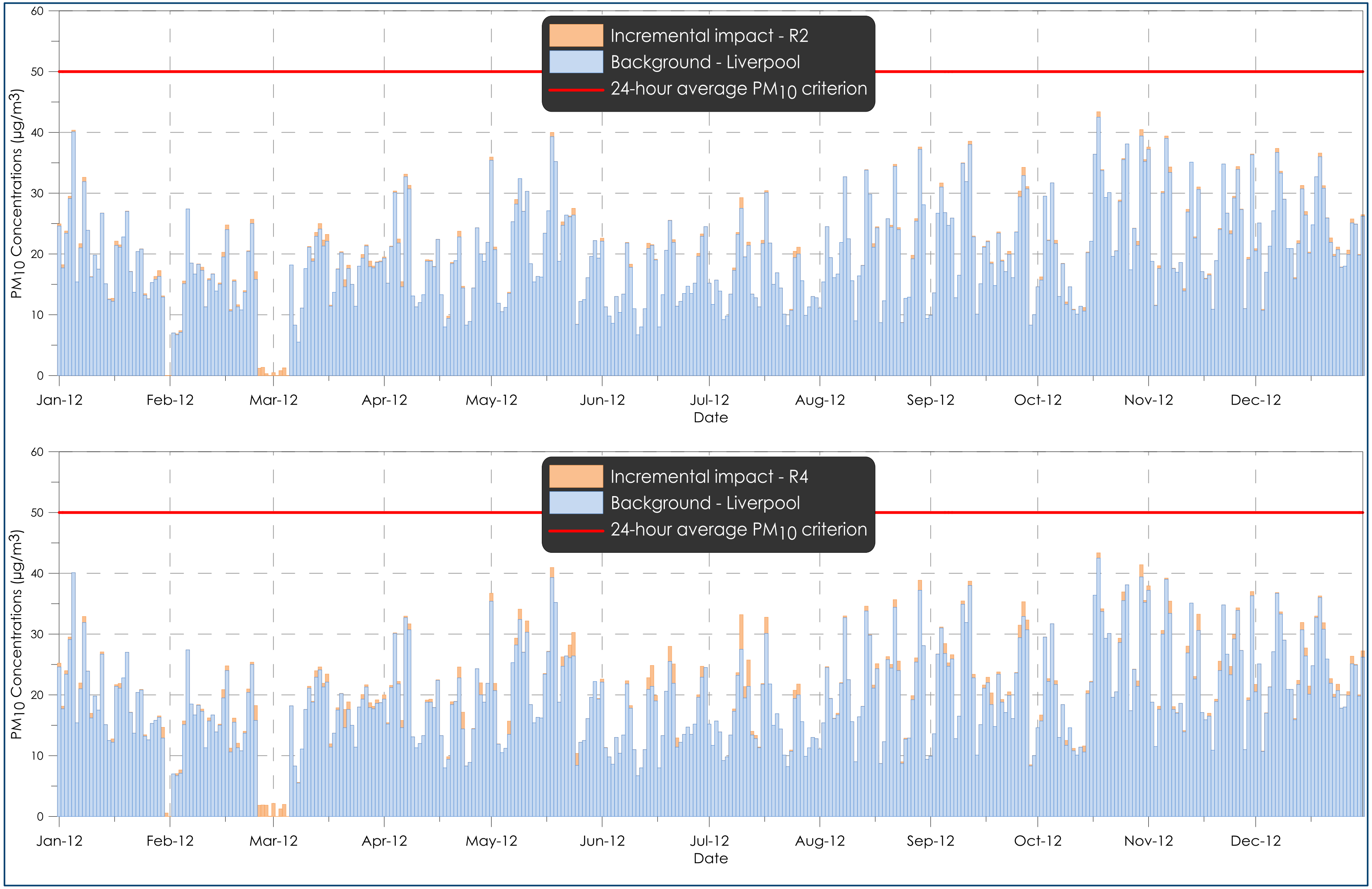

Figure 7-3: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R2 and R4

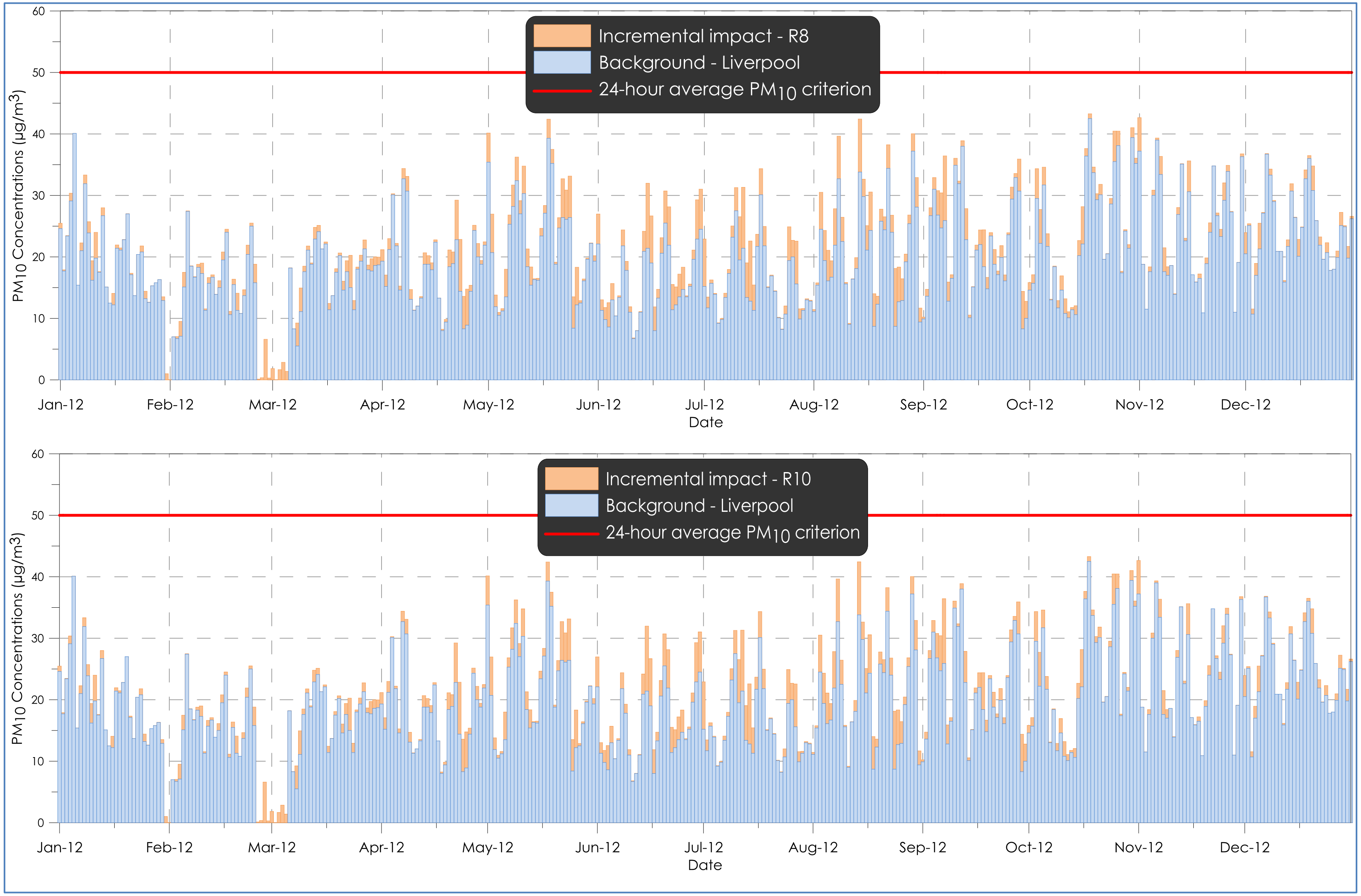

Figure 7-4: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R8 and R10

7.3 Odour concentrations

Table 7-4 presents the discrete dispersion modelling results at each of the assessed sensitive receptor locations.

The results indicate that odour levels due the Project will be below the applicable criteria at all assessed sensitive receptor locations.

The spatial distribution of the dispersion modelling predictions for the modelled odour sources at the Project are presented as an isopleth diagram showing the 99th percentile noise-response ground level odour concentrations in **Appendix C**.

Table 7-4: 99th percentile nose-response average ground level odour concentrations – Project (OU)

Receptor ID	Predicted level	Odour assessment criterion
R1	0.3	2
R2	0.3	2
R3	0.3	2
R4	0.6	2
R5	0.9	2
R6	1.2	2
R7	1.3	2
R8	1.4	2
R9	0.2	2
R10	0.3	2
R11	0.3	2
R12	0.3	2

8 AIR QUALITY MITIGATION AND MANAGEMENT

The proposed operations at the Project have the potential to generate dust and odour emissions.

To ensure activities associated with the Project have a minimal effect on the surrounding environment and at sensitive receptor locations, it is recommended that appropriate operational and physical mitigation measures should be implemented where feasible and reasonable as outlined in **Table 8-1**.

Table 8-1: Potential operational dust and odour mitigation options

Source	Mitigation Measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of dust cannot be maintained using the available means).
	Weather forecast to be checked prior to undertaking material handling or processing.
	Engines of on-site vehicles and plant switched off when not in use.
	Vehicles and plant are to be fitted with pollution reduction devices where practicable.
	Maintain and service vehicles according to manufacturer's specifications.
	External area is to be kept clean, any incidental spills to be cleaned immediately.
	Water misting sprays used for dust suppression within building.
	Regular sweeping and/ or watering of hardstand area.
	Sprinkler system used in rear yard area.
	Conduct visual checks for dust beyond the boundary.
Material processing	Solid waste processing and raw material stockpiling occurs primarily within the enclosed building where practicable.
	Wet suppression used for crushing and screening processes.
	Cement storage silos are fitted with dust filters.
	Daily inspections and regular servicing of dust suppression equipment on plant.
	Identified odorous materials to be blended with other materials to minimise odour.
	Sludge material to be processed and encapsulated in concrete as soon as practicable.
	Liquid waste processing to be vacuum pressurised to prevent the release of odour.
	Charcoal filters to be installed on DAF to mitigate odour from this process.
Materials storage	Material to be primarily stored inside where possible to prevent wind erosion.
	Finished products to be stored in storage bays enclosed on three sides by besser blocks.
	Water sprays used on finished product storage to minimise windblown dust.
	Material stockpile size maintained appropriately.
Material handling	Reduce drop heights from loading and handling equipment where practical.
	Dampen aggregates and other material when excessively dusty.
	All conveyor transfer points to be enclosed.
Hauling activities	Sealed driving surfaces on the site to be cleaned regularly.
	Vehicles are to abide by site speed limits.
	Vehicle loads are covered when transporting material on and off-site.
	The access driveway to the site is checked and any dust, material or mud tracked onto the public road is cleaned immediately.

Prior to commencement of operations at the Project, a detailed Air Quality Management Plan will be developed for the site. The Air Quality Management Plan would outline the measures to manage dust and odour emissions at the site and include aspects such as key performance indicators, monitoring methods, response mechanisms, compliance reporting and complaints management.

9 GREENHOUSE GAS ASSESSMENT

9.1 Introduction

Dynamic interactions between the atmosphere and surface of the earth create the unique climate that enables life on earth. Solar radiation from the sun provides the heat energy necessary for this interaction to take place, with the atmosphere acting to regulate the complex equilibrium. A large part of this regulation occurs from the "greenhouse effect" with the absorption and reflection of the solar radiation dependent on the composition of specific greenhouse gases in the atmosphere.

Over the last century, the composition and concentration of greenhouse gases in the atmosphere has increased due to increased anthropogenic activity. Climatic observations indicate that the average pattern of global weather is changing as a result. The measured increase in global average surface temperatures indicate an unfavourable and unknown outcome if the rate of release of greenhouse gas emissions remain at the current rate.

This assessment aims to estimate the predicted emissions of greenhouse gases (GHG) to the atmosphere due to the proposed modification and to provide a comparison of the direct emissions from the Project at the state and national level.

9.2 Greenhouse Gas Inventory

The National Greenhouse Accounts (NGA) Factors document published by the Department of the Environment and Energy defines three scopes (Scope 1, 2 and 3) for different emission categories based on whether the emissions generated are from "direct" or "indirect" sources.

Scope 1 emissions encompass the direct sources from the Project defined as:

"*...from sources within the boundary of an organisation and as a result of that organisation's activities*" (**Department of the Environment and Energy, 2018c**).

Scope 2 and 3 emissions occur due to the indirect sources from the Project as:

"*...emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation*" (**Department of the Environment and Energy, 2018c**).

For the purpose of this assessment, emissions generated in all three scopes defined above provide a suitable approximation of the total GHG emissions generated from the Project.

We note that Scope 3 emissions have the potential to arise from a greater number of sources associated with the operation of the Project. As these are often difficult to quantify due to the diversity of sources and relatively minor individual contributions, they have not been considered in this assessment.

9.2.1 Emission sources

Scope 1 and 2 GHG emission sources identified from the operation of the Project are the on-site combustion of diesel fuel and the on-site consumption of electricity.

Scope 3 emissions have been identified as resulting from the purchase of diesel, electricity for use on-site and the transport of the materials to their final destination.

The estimated quantities of materials that have the potential to emit GHG emissions associated with the Project have been summarised in **Table 9-1** below. The assessment provides a reasonable worst-case approximation of the potential GHG emissions for the purpose of this assessment.

Table 9-1: Summary of quantities of materials estimated for the Project

Period	Diesel (on-site) (kL)	Electricity (on-site) (kWh)	Diesel (transport of materials) (kL)
Annual	96	312,000	180

The quantity of diesel fuel required to transport the product materials to the final destination has been estimated based on an approximate return travel distance for the material. It is assumed the production material would be transported to various locations in the Sydney region (average distance of 50km return). The calculated annual kilometres travelled are 312,500km per year. To estimate the consumption of diesel fuel required for these activities, the average fuel consumption of 57.7L/100km for articulated trucks is applied (**ABS, 2013**).

9.2.2 Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the Project, emission factors have been obtained from the NGA Factors (**Department of the Environment and Energy, 2018c**) and other sources as required and are summarised in **Table 9-2**.

Table 9-2: Summary of emission factors

Type	Energy content factor	Emission factor			Units	Scope
		CO_2	CH_4	N_2O		
Diesel	38.6	69.9	0.1	0.5	kg CO_2-e/GJ	1
		3.6	-	-		3
Electricity	-	0.82	-	-	kg CO_2-e/kWh	2
		0.10	-	-		3

9.3 Summary of greenhouse gas emissions

Table 9-3 summarises the estimated annual CO_2-e emissions due to the operation of the Project.

Table 9-3: Summary of CO_2-e emissions for the project (t CO_2-e)

Period	Diesel		Electricity		Transport
	Scope 1	Scope 3	Scope 2	Scope 3	Scope 3
Annual	261	13	256	31	25

9.4 Contribution of greenhouse gas emissions

Table 9-4 summarises the emissions associated with the Project based on Scopes 1, 2 and 3.

Table 9-4: Summary of CO_2-e emissions per scope (t CO_2-e)

Period	Scope 1	Scope 2	Scope 3	Scope 1+2
Annual	261	256	70	517

The estimated annual greenhouse emissions for Australia for the year to December 2017 period was 533.7Mt CO_2-e (**Department of the Environment and Energy, 2018b**). In comparison, the estimated annual greenhouse emission for the Project is 0.00052Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of greenhouse emissions from the Project in comparison to the Australian greenhouse emissions is conservatively estimated to be approximately 0.0001 per cent.

At a state level, the estimated greenhouse emissions for NSW in the 2016 period was 131.6 Mt CO_2-e (**Department of the Environment and Energy, 2018a**). The annual contribution of greenhouse emissions from the Project in comparison to the NSW greenhouse emissions for the 2016 period is conservatively estimated to be approximately 0.00039 per cent.

9.5 Greenhouse gas management

The Project will utilise various mitigation measures to minimise the overall generation of greenhouse gas emissions. These measures would include developing a basis for identifying and implementing energy efficiency opportunities and mitigation measures for various activities.

Examples of various mitigation and energy management measures to reduce GHG emissions are as follows:

- Monitor the consumption of fuel and regularly maintain diesel powered equipment to ensure operational efficiency;
- Turning diesel equipment off when not in use for extended periods;
- Minimise double handling of material and using efficient transport routes;
- Monitor the total site electricity consumption and investigate avenues to minimise the requirement;
- Conduct a review of alternative renewable energy sources;
- Provide energy awareness programs for staff and contractors; and
- Minimise the production of waste generated on-site.

11 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the proposed modifications to the BRS facility located in Ingleburn, NSW.

Air dispersion modelling was used to predict the potential for off-site dust and odour impacts in the surrounding area due to the operation of the Project.

The estimated emissions of dust applied in the modelling are likely to be conservative and would overestimate the actual impacts. Predicted impacts were below the relevant criteria for all of the assessed dust metrics with the exception of 24-hour average and annual average $PM_{2.5}$ levels.

The predicted additional day above the 24-hour average $PM_{2.5}$ criterion of 25µg/m^3 at receptors R7, R8, R9, R10, R11 and R12 occurs on a single day when the background level was 24.9µg/m^3. It was demonstrated that the Project would only have a very minor incremental impact on sensitive receptors on this day that would not be discernible in reality.

The annual average $PM_{2.5}$ background levels from the NSW OEH Liverpool monitoring station are already above the relevant criterion of 8µg/m^3, and regardless of the minimal contribution from the Project, is above the criterion.

The Project would apply a range of appropriate air quality management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

The predicted odour modelling indicates that potential odour levels from the Project would be below the most stringent impact assessment criterion of 2 OU at the identified sensitive receptors.

The estimated annual average greenhouse emission for the Project is 0.00052Mt CO_2-e (Scope 1 and 2), approximately 0.0001 per cent of the Australian greenhouse emissions for the 2017 period and approximately 0.00039 per cent of the NSW greenhouse emissions for the 2016 period.

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

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Appendix A
Selection of Meteorological Year

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Selection of meteorological year

A statistical analysis of the latest six years of meteorological data from the nearest BoM weather station with suitable available data, Bankstown Airport AWS, is presented in **Table A-1**. The standard deviation of five years of meteorological data spanning 2012 to 2016 was analysed against the mean measured wind speed, temperature and relative humidity.

The analysis indicates that 2012 is closest to the average for wind speed, temperature and relative humidity compared to the other years.

Figure A-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2012 year compared with the mean of the 2012 to 2016 data set. The 2012 year data appear to be well aligned with the mean data.

Therefore, based on this analysis it was determined that 2012 is generally representative of the long-term trends compared to other years and is thus suitable for the purpose of modelling.

Table A-1: Statistical analysis results for Bankstown Airport AWS

Year	Wind speed	Temperature	Relative humidity
2012	0.3	0.5	3.6
2013	0.4	0.8	5.1
2014	0.4	0.7	5.3
2015	0.4	0.7	5.7
2016	0.5	0.9	5.4
2017	0.5	0.9	4.8

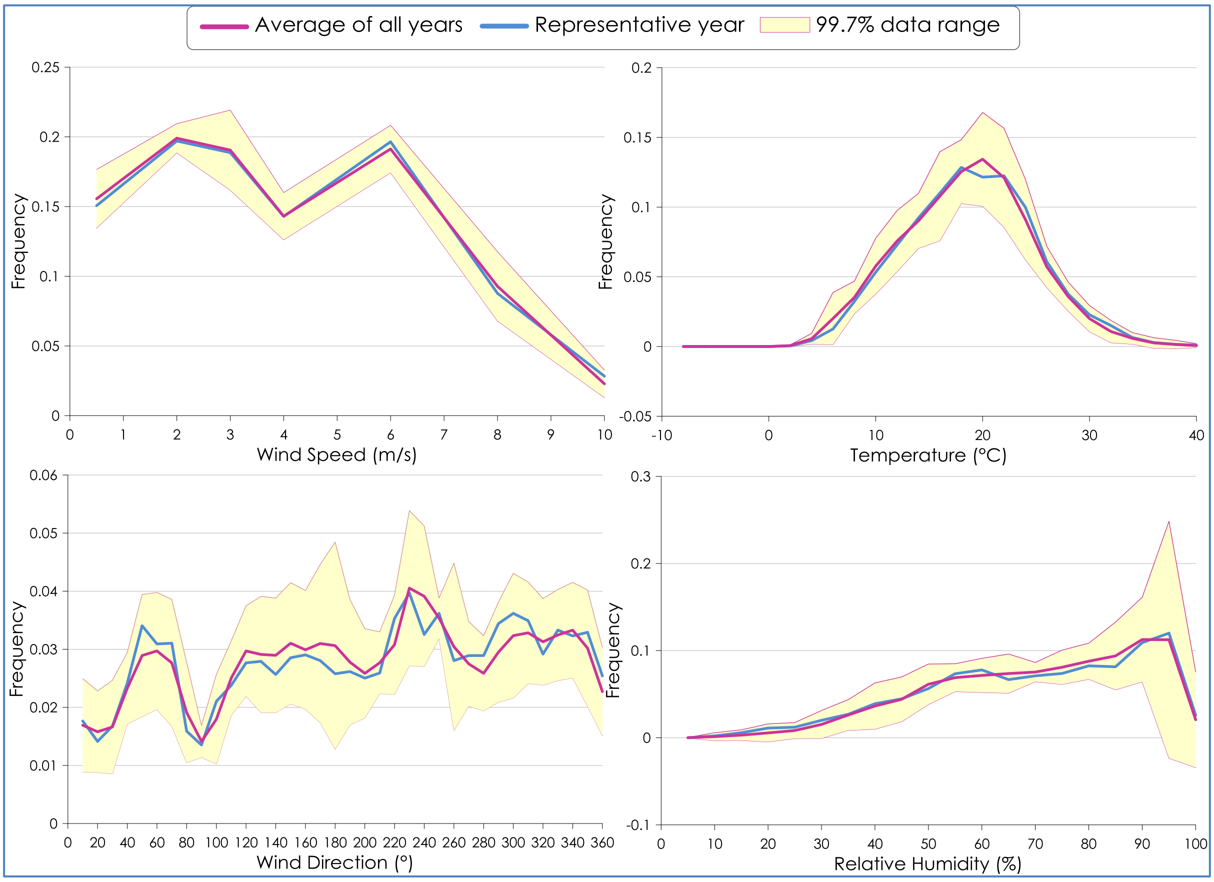

Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Emission Calculations

Dust generating activity

The dust emissions from the Project have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors have been sourced from the US EPA AP42 Emission Factors (**US EPA 1998, US EPA 2004, US EPA 2006 and US EPA 2011**).

Table B-1: Emission factor equations

Activity	Emission factor equation	Variable	Control factor
Loading and unloading of material	$EF = k \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	K_{tsp} = 0.74 U = wind speed (m/s) M = moisture content (%)	-
Hauling on sealed surfaces	$EF = k \times (sL)^{0.91} \times (W)^{1.02}\ kg/VKT$	k = 3.23 (g/VKT) sL = road surface silt loading (g/m²) W = average weight of vehicles (tons)	-
Crushing – tertiary	$EF = 0.0006\ kg/tonne$	-	Controlled emission
Screening – tertiary	$EF = 0.0011\ kg/tonne$	-	Controlled emission
Crushing – fines	$EF = 0.0015\ kg/tonne$	-	Controlled emission
Screening - fines	$EF = 0.0018\ kg/tonne$	-	Controlled emission
Cement unloading to silo	$EF = 0.0005\ kg/tonne$	-	Controlled emission
Weigh hopper loading	$EF = 0.0026\ kg/tonne$	-	Controlled emission
Mixer loading	$EF_{(\frac{lbs}{ton})} = 0.19 \times 0.0032 \times U^{0.95} / M^{0.9} + 0.001$	U = wind speed at drop point (mph) M = moisture content (%)	-
Wind erosion from exposed areas and conveyors	$EF = 850\ kg/ha/year$	-	-

Table B-2: Emissions Inventory

Activity	TSP emission	PM10 emission	PM25 emission	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Var. 1	Units	Var. 2	Units	Variable 3 - TSP / PM10 / PM2.5	Units	Var.4	Units	Var. 5	Units
Crushing																			
Delivering material onsite	1,966	377	91	225,000	t/yr	0.0087	0.0017	0.0004	kg/t	32	t/load	0.5	km/trip	0.5 / 0.1 / 0.02	kg/VKT	5.0	S.L. (g/m^2)	36	Ave. weight (tons)
Unloading material to stockpile	314	149	23	225,000	t/yr	0.0014	0.0007	0.0001	kg/t	1.18	Ave. $(WS/2.2)^{1.3}$	2.0	M.C. (%)						
Loading material to crusher	314	149	23	225,000	t/yr	0.0014	0.0007	0.0001	kg/t	1.18	Ave. $(WS/2.2)^{1.3}$	2.0	M.C. (%)						
Crushing - tertiary	135	61	11	225,000	t/yr	0.0006	0.0003	0.0001	kg/t										
Screening - tertiary	248	83	6	225,000	t/yr	0.0011	0.0004	0.0000	kg/t										
Crushing - fines	338	135	8	225,000	t/yr	0.0015	0.0006	0.0000	kg/t										
Screening - fines	405	248	17	225,000	t/yr	0.0018	0.0011	0.0001	kg/t										
Unloading material to stockpile	314	149	23	225,000	t/yr	0.0014	0.0007	0.0001	kg/t	1.18	Ave. $(WS/2.2)^{1.3}$	2.0	M.C. (%)						
Concrete batching																			
Loading FEL with sand and aggregate for hopp	12	6	1	8,400	t/yr	0.0014	0.0007	0.0001	kg/t	1.18	Ave. $(WS/2.2)^{1.3}$	2.0	M.C. (%)						
Unloading sand and aggregate to hopper	12	6	1	8,400	t/yr	0.0014	0.0007	0.0001	kg/t	1.18	Ave. $(WS/2.2)^{1.3}$	2.0	M.C. (%)						
Delivering cement material onsite	14	3	1	1,600	t/yr	0.0087	0.0017	0.0004	kg/t	32	t/load	0.5	km/trip	0.5 / 0.1 / 0.02	kg/VKT	5.0	S.L. (g/m^2)	36	Ave. weight (tons)
Unloading cement to storage silo	1	0	0	1,600	t/yr	0.0005	0.0002	0.0000	kg/t										
Weigh hopper loading	26	13	2	10,000	t/yr	0.0026	0.0013	0.0002	kg/t										
Mixer loading (central mix)	13	7	2	10,000	t/yr	0.0013	0.0007	0.0002	kg/t	5.32	WS at drop point	2.0	M.C. (%)						
Agitator truck travelling onsite (paved road)	122	23	6	10,000	t/yr	0.0122	0.0023	0.0006	kg/t	23	t/load	0.5	km/trip	0.5 / 0.1 / 0.02	kg/VKT	5.0	S.L. (g/m^2)	36	Ave. weight (tons)
Other																			
Loading product to haul truck	314	149	23	225,000	t/yr	0.0014	0.0007	0.0001	kg/t	1.18	Ave. $(WS/2.2)^{1.3}$	2.0	M.C. (%)						
Delivering material off-site	2,735	525	127	225,000	t/yr	0.0122	0.0023	0.0006	kg/t	23	t/load	0.5	km/trip	0.5 / 0.1 / 0.02	kg/VKT	5.0	S.L. (g/m^2)	36	Ave. weight (tons)
Wind erosion - entire site	1,091	545	82	1.28	ha	850	425	64	kg/ha/yr										
Diesel exhaust	32	32	31																
Total TSP emissions (kg/yr)	**8,405**	**2,659**	**474**																

M.C. = Moisture content, S.L. = silt loading, Ave. = Average

Appendix C

Isopleth Diagrams

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

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

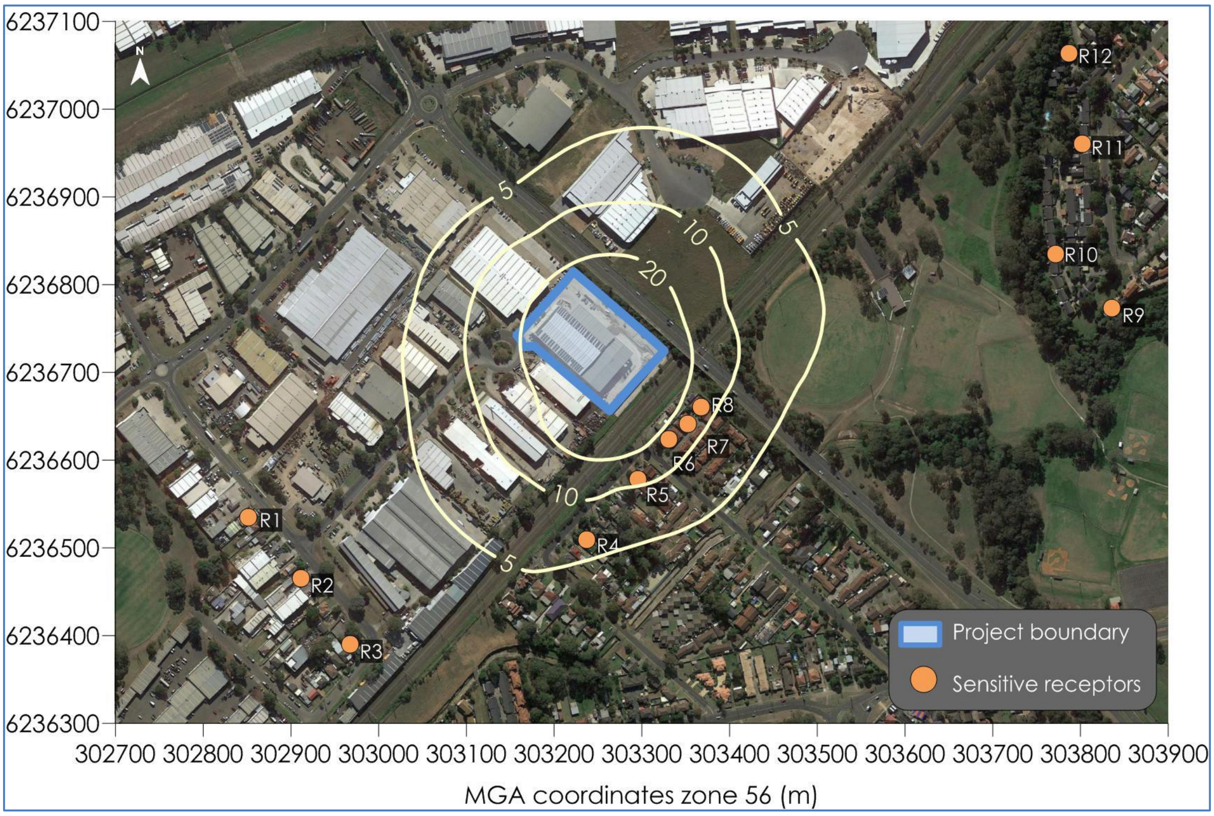

Figure C-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

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

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

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

Figure C-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

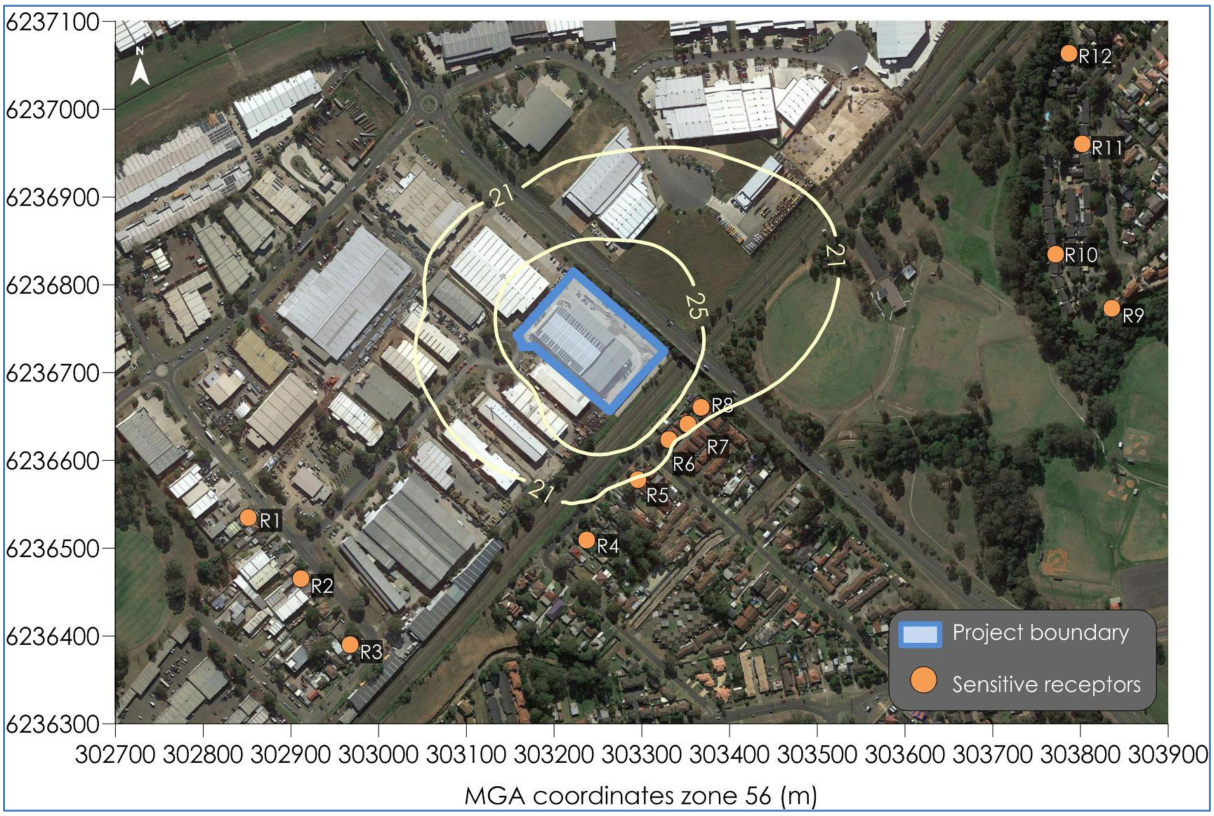

Figure C-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

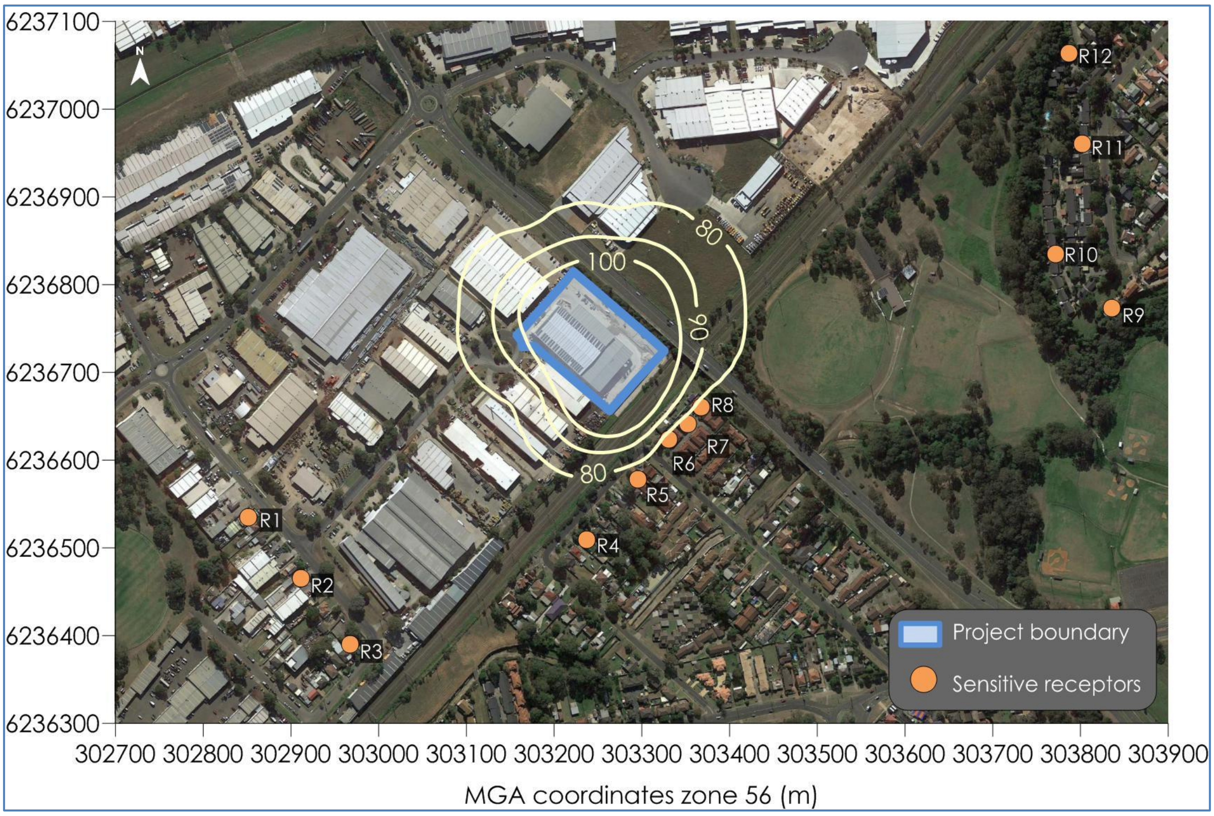

Figure C-9: Predicted cumulative annual average TSP concentrations (µg/m³)

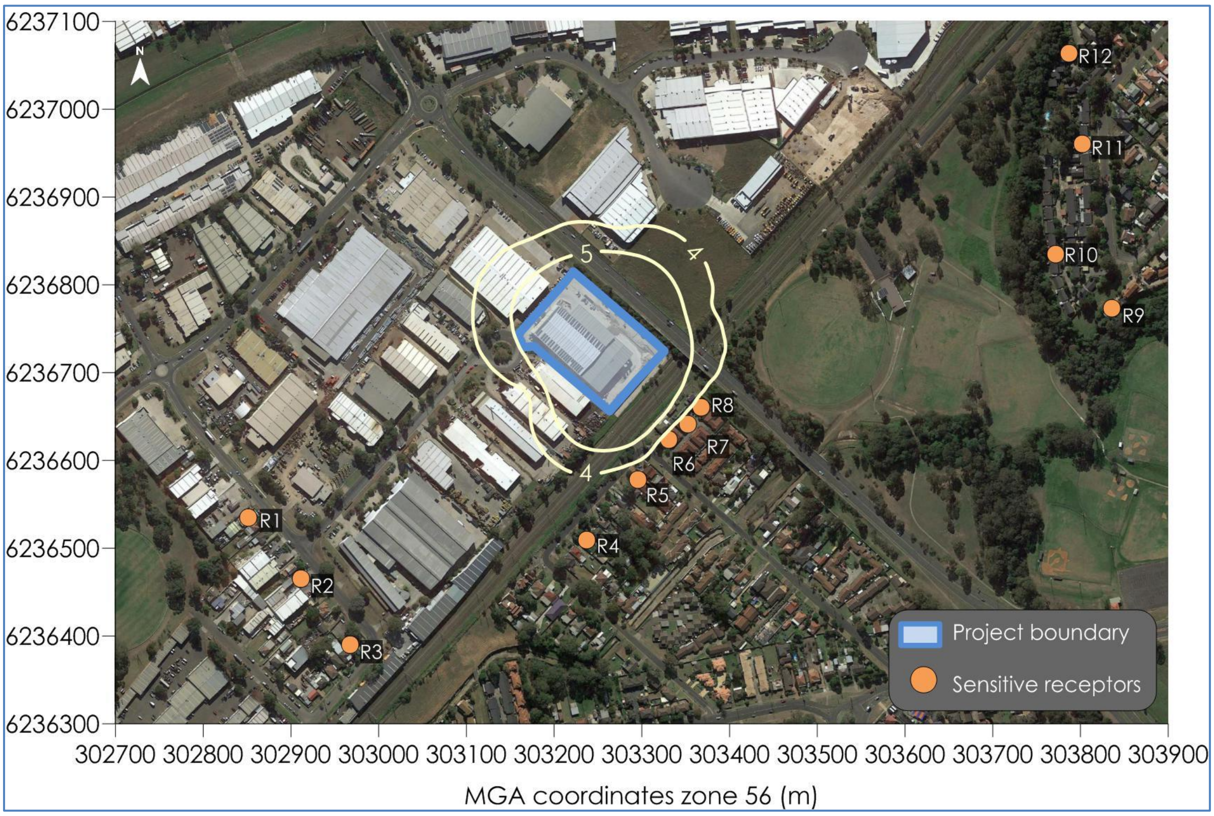

Figure C-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

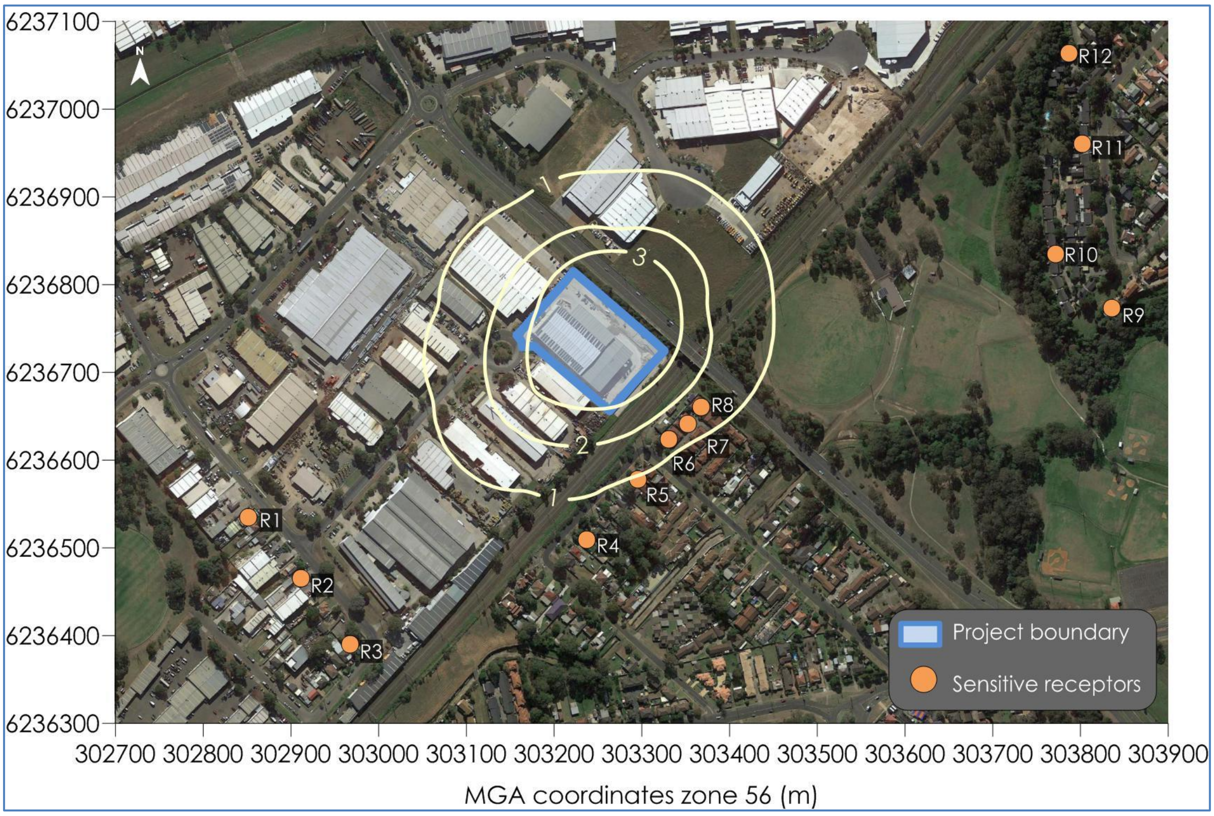

Figure C-11: Predicted 99th percentile nose-response average ground level odour concentrations (OU)

Appendix D

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

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

The analysis below provides a cumulative 24-hour average $PM_{2.5}$ and PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 46 to 47 of the Approved Methods.

The background level is the ambient level at Liverpool monitoring station for $PM_{2.5}$ and PM_{10}.

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

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

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

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

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

The orange shading represents days where the measured background level is already over the criteria.

Any value above the $PM_{2.5}$ criterion of 25µg/m^3 or above the PM_{10} criterion of 50µg/m^3 is in **bold red.**

Tables D-1 to **D-8** show the predicted maximum cumulative levels at receptors R2, R4, R8 and R10.

Table D-1: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
19/05/2012	24.9	0.0	24.9	10/07/2012	16.1	0.4	16.5
10/09/2012	23.6	0.0	23.6	27/09/2012	11.0	0.3	11.3
18/05/2012	22.7	0.1	22.8	27/02/2012	-	0.3	-
17/07/2012	20.3	0.1	20.4	25/02/2012	4.2	0.3	4.5
30/06/2012	19.8	0.0	19.8	4/03/2012	-	0.3	-
29/08/2012	19.6	0.1	19.7	21/03/2012	5.5	0.3	5.8
4/09/2012	19.5	0.1	19.6	26/02/2012	-	0.3	-
24/05/2012	18.4	0.2	18.6	16/03/2012	8.0	0.3	8.3
12/09/2012	17.3	0.1	17.4	30/10/2012	7.8	0.3	8.1
26/11/2012	17.3	0.1	17.4	26/07/2012	11.2	0.3	11.5

- No data available

Table D-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
19/05/2012	24.9	0.0	24.9	10/07/2012	16.1	1.2	17.3
10/09/2012	23.6	0.1	23.7	12/07/2012	14.0	0.9	14.9
18/05/2012	22.7	0.3	23.0	24/05/2012	18.4	0.8	19.2
17/07/2012	20.3	0.5	20.8	21/03/2012	5.5	0.7	6.2
30/06/2012	19.8	0.0	19.8	15/11/2012	10.6	0.7	11.3
29/08/2012	19.6	0.3	19.9	15/06/2012	14.1	0.6	14.7
4/09/2012	19.5	0.0	19.5	25/02/2012	4.2	0.6	4.8
24/05/2012	18.4	0.8	19.2	21/06/2012	15.3	0.6	15.9
12/09/2012	17.3	0.1	17.4	27/09/2012	11.0	0.6	11.6
26/11/2012	17.3	0.1	17.4	23/04/2012	-	0.6	-

- No data available

Table D-3: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R8

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
19/05/2012	24.9	0.4	**25.3**	15/06/2012	14.1	2.5	16.6
10/09/2012	23.6	0.2	23.8	12/07/2012	14.0	2.3	16.3
18/05/2012	22.7	0.6	23.3	23/04/2012	-	2.2	-
17/07/2012	20.3	0.8	21.1	14/07/2012	8.4	2.0	10.4
30/06/2012	19.8	1.3	21.1	7/09/2012	7.3	2.0	9.3
29/08/2012	19.6	0.7	20.3	14/08/2012	12.6	2.0	14.6
4/09/2012	19.5	0.3	19.8	24/08/2012	4.7	1.8	6.5
24/05/2012	18.4	1.5	19.9	28/02/2012	-	1.6	-
12/09/2012	17.3	0.2	17.5	22/04/2012	-	1.6	-
26/11/2012	17.3	0.3	17.6	1/07/2012	13.6	1.5	15.1

-No data available

Table D-4: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R10

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
19/05/2012	24.9	0.3	**25.2**	30/06/2012	19.8	0.4	20.2
10/09/2012	23.6	0.1	23.7	16/06/2012	13.5	0.4	13.9
18/05/2012	22.7	0.2	22.9	24/05/2012	18.4	0.4	18.8
17/07/2012	20.3	0.3	20.6	1/06/2012	11.5	0.3	11.8
30/06/2012	19.8	0.4	20.2	9/05/2012	13.8	0.3	14.1
29/08/2012	19.6	0.2	19.8	22/05/2012	13.9	0.3	14.2
4/09/2012	19.5	0.1	19.6	29/06/2012	12.1	0.3	12.4
24/05/2012	18.4	0.4	18.8	13/07/2012	9.5	0.3	9.8
12/09/2012	17.3	0.1	17.4	23/05/2012	15.9	0.3	16.2
26/11/2012	17.3	0.0	17.3	17/07/2012	20.3	0.3	20.6

Table D-5: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
18/10/2012	42.5	1.2	43.7	10/07/2012	27.5	2.2	29.7
5/01/2012	40.1	0.4	40.5	4/03/2012	-	1.9	1.9
30/10/2012	39.4	1.1	40.5	27/09/2012	32.9	1.6	34.5
18/05/2012	39.3	0.7	40.0	27/02/2012	-	1.5	1.5
6/11/2012	39.0	0.4	39.4	25/02/2012	15.8	1.5	17.3
26/10/2012	38.1	0.0	38.1	25/07/2012	19.4	1.5	20.9
12/09/2012	38.0	1.0	39.0	16/03/2012	22.1	1.5	23.6
29/08/2012	37.2	0.6	37.8	26/02/2012	-	1.4	1.4
1/11/2012	37.2	0.4	37.6	24/05/2012	26.4	1.4	27.8
7/12/2012	36.7	1.0	37.7	14/06/2012	20.9	1.4	22.3

-No data available

Table D-6: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
18/10/2012	42.5	0.8	43.3	10/07/2012	27.5	6.0	33.5
5/01/2012	40.1	0.0	40.1	12/07/2012	21.4	5.1	26.5
30/10/2012	39.4	2.0	41.4	24/05/2012	26.4	4.7	31.1
18/05/2012	39.3	1.4	40.7	21/06/2012	21.9	3.8	25.7
6/11/2012	39.0	0.2	39.2	15/06/2012	21.4	3.6	25.0
26/10/2012	38.1	0.0	38.1	17/07/2012	30.1	3.5	33.6
12/09/2012	38.0	0.6	38.6	21/03/2012	14.6	2.9	17.5
29/08/2012	37.2	1.5	38.7	22/04/2012	22.8	2.8	25.6
1/11/2012	37.2	0.7	37.9	23/04/2012	14.4	2.7	17.1
7/12/2012	36.7	0.1	36.8	14/06/2012	20.9	2.7	23.6

Table D-7: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R8

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
18/10/2012	42.5	0.7	43.2	12/07/2012	21.4	12.7	34.1
5/01/2012	40.1	0.0	40.1	14/08/2012	33.8	11.4	45.2
30/10/2012	39.4	1.6	41.0	7/09/2012	25.9	10.9	36.8
18/05/2012	39.3	3.6	42.9	14/07/2012	12.8	10.7	23.5
6/11/2012	39.0	0.3	39.3	15/06/2012	21.4	10.5	31.9
26/10/2012	38.1	2.0	40.1	8/08/2012	32.7	9.6	42.3
12/09/2012	38.0	0.8	38.8	16/06/2012	19.0	9.5	28.5
29/08/2012	37.2	2.8	40.0	1/07/2012	15.2	9.2	24.4
1/11/2012	37.2	5.1	42.3	24/08/2012	8.7	9.1	17.8
7/12/2012	36.7	0.1	36.8	23/04/2012	14.4	8.8	23.2

Table D-8: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R10

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
18/10/2012	42.5	0.0	42.5	30/06/2012	24.5	2.0	26.5
5/01/2012	40.1	0.0	40.1	16/06/2012	19.0	1.9	20.9
30/10/2012	39.4	0.2	39.6	1/06/2012	22.1	1.8	23.9
18/05/2012	39.3	0.8	40.1	9/05/2012	32.4	1.7	34.1
6/11/2012	39.0	0.0	39.0	22/05/2012	26.4	1.7	28.1
26/10/2012	38.1	0.3	38.4	20/06/2012	25.5	1.7	27.2
12/09/2012	38.0	0.3	38.3	3/08/2012	24.5	1.7	26.2
29/08/2012	37.2	0.6	37.8	24/06/2012	13.5	1.6	15.1
1/11/2012	37.2	0.7	37.9	4/08/2012	19.4	1.5	20.9
7/12/2012	36.7	0.1	36.8	17/07/2012	30.1	1.5	31.6