APPENDIX K

AIR QUALITY ASSESSMENT

AIR QUALITY IMPACT ASSESSMENT

CSR ADVANCED MANUFACTURING HUB

MODIFICATION 3

Element Environment

25 February 2019

Job Number 17030670

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Air Quality Impact Assessment

CSR Advanced Manufacturing Hub

Modification 3

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	27/11/2018	K Trahair & P Henschke	D Kjellberg
DRAFT - 002	21/12/2018	K Trahair	P Henschke
DRAFT - 003	04/02/2019	K Trahair & P Henschke	
FINAL - 001	21/02/2019	K Trahair & P Henschke	A Todoroski
FINAL - 002	25/02/2019	P Henschke	

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Element Environment on behalf of CSR Building Products Limited (hereafter referred to as the Proponent). It provides an assessment of the potential air quality impacts associated with the proposed modification 3 to the CSR Advanced Manufacturing Hub located at Badgerys Creek (hereafter referred to as the Project).

The Project essentially seeks to re-commence operations at the site, remove most of the existing brick manufacturing equipment and replace with new brick manufacturing equipment in the existing brick making facility and construct and operate a roof products manufacturing facility. Specific details pertaining to the Project are provided in **Section 4.2**. In very broad terms, the proposal would increase the number of bricks made using an advanced new facility and add a modern new tile making plant which has very low emissions. As quarrying would be little changed, additional material would need to be imported to the site.

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

- A background and description of the Project;
- Review of the existing meteorological and air quality environment surrounding the Project site;
- Description of the dispersion modelling approach used to assess potential air quality impacts;
- Presentation of the predicted operational air quality levels in the surrounding environment; and,
- Discussion of the potential air quality impacts.

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

Where relevant, the following documents were also considered in this assessment:

- *Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC, 2011**); and,
- *Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW* (**DEC, 2006**).

2 STUDY REQUIREMENTS

This air quality assessment has been prepared in general accordance with the Secretary's Environmental Assessment Requirements (presented in **Table 2-1**).

Table 2-1: Secretary's Environmental Assessment Requirements

Stakeholder	Requirement	Section
Department of Planning and Environment	Include detailed assessment of air quality	This report
Liverpool City Council	Undertake an air quality assessment of the proposal in accordance with the Department of Environment and Conservation (now known as the NSW Environment Protection Authority) 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (January 2017).	This report
	Identify all sources of air pollution and potential emissions.	Section 8.4
	Undertake an Odour report of the proposal in accordance with the Department of Environment & Conservation (now known as the NSW Environment Protection Authority) Technical Framework – Assessments and Management of Odour from Stationary Sources in NSW (November 2006).	This report
NSW EPA	The EIS must include an Air Quality Impact Assessment (AQIA).	This report
	The AQIA must identify and describe in detail all possible sources of air pollution from any activities/processes with the potential to cause odours and/or fugitive dust emissions beyond the boundary of any premises.	Section 8.4
	The AQIA must cover both the construction and operational phases of the development.	Sections 7 and 8
	The AQIA must include the cumulative impacts associated with existing development and any developments having been granted development consent but which have not commenced.	Sections 8.4.5, 9.1 and 9.2
	The EIS should demonstrate that the facility will operate within the EPA's objectives which are to minimise adverse effects on the amenity of local residents and sensitive land uses and to limit the effects of emissions on local, regional and interregional air quality.	Sections 9 and 10
	The EIS must describe in detail the measures or controls proposed to mitigate air quality impacts and the extent to which the mitigation measures are likely to be effective in complying with the requirements specified in the POEO Act and the Protection of the Environment Operations (Clean Air) Regulation 2010.	Section 10
	The AQIA must be prepared in accordance with the EPA's Approved Methods and Guidance for the 'Modelling and Assessment of Air Pollutants in NSW' and, with respect to the assessment of odour impacts, follow the principles outlined in the ' Technical framework for the assessment and management of odour from stationary sources in NSW '.	This report
	The AQIA must describe the methodology used and any assumption made to predict the impacts. ▪ Air pollutant emission rates, ▪ ambient air quality data and ▪ meteorological data used in the assessment must be clearly stated and justified.	Sections 8.4 & Appendix B Section 6 Sections 6 and 8.2

3 PROJECT SETTING

The Project site is located at 235 Martin Road, Badgerys Creek NSW, approximately 15 kilometres (km) west of Liverpool and covers an area of approximately 200 hectare (ha). The local land use surrounding the site is comprised of rural residences, quarrying, industrial and agricultural activities. The western boundary of the site borders the Western Sydney Airport development.

Figure 3-1 presents the location of the Project and the sensitive receptor locations assessed as discrete receptors in this study. The nearest sensitive receptors to the Project are located along Lawson Road and Martin Road in Badgerys Creek (Receptors R5 and R9), approximately 40 and 20 metres (m) respectively to the north from the Project boundary.

Figure 3-2 presents a pseudo three-dimensional visualisation of the topography surrounding the Project location. The site topography has been shaped by historic quarrying activities and consists of pits, elevated stockpiles and flat areas. The area surrounding the Project site can be characterised as relatively flat and gently undulating in places. The terrain rises approximately 3km away from the Project site to the north east.

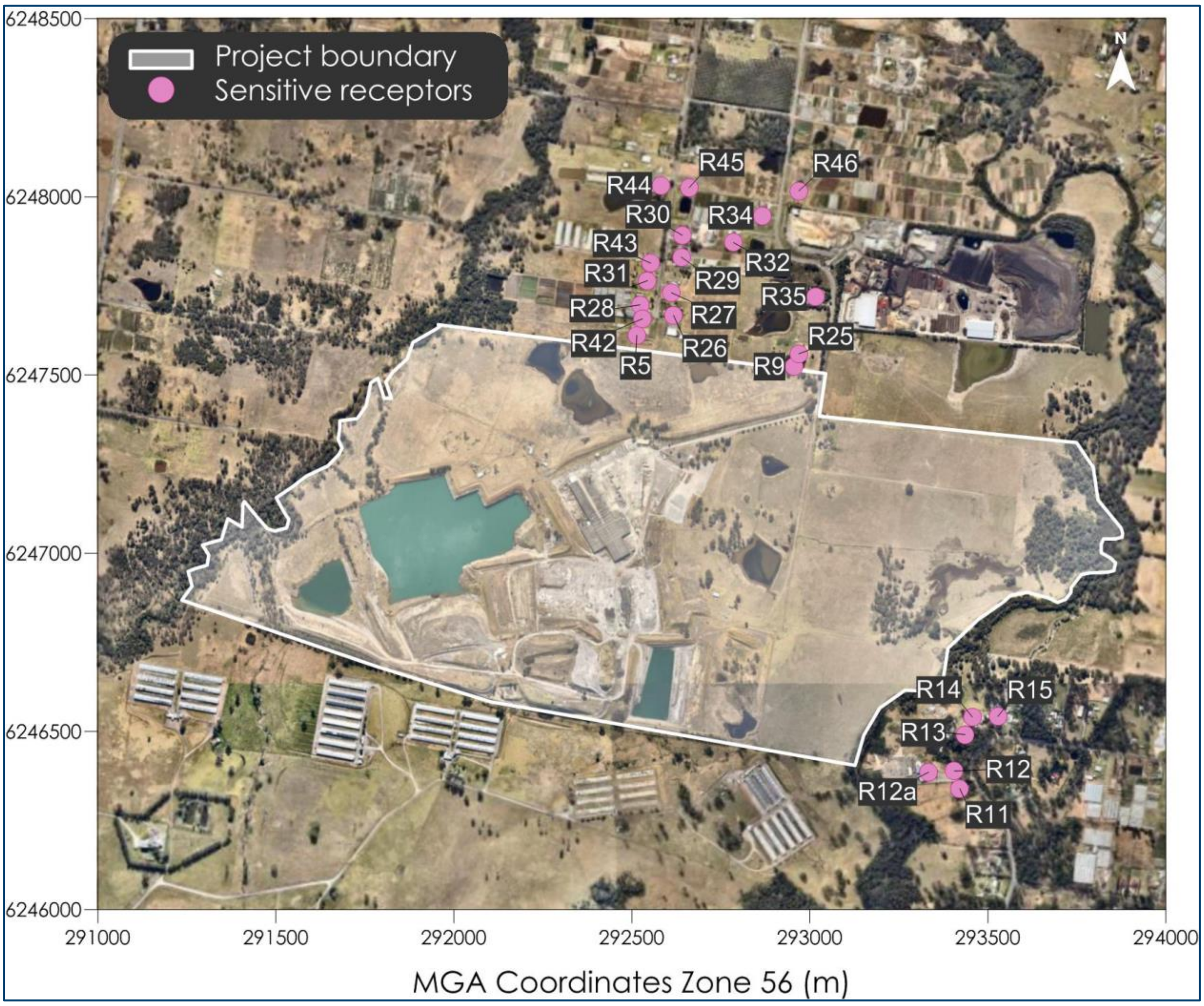

Figure 3-1: Project location

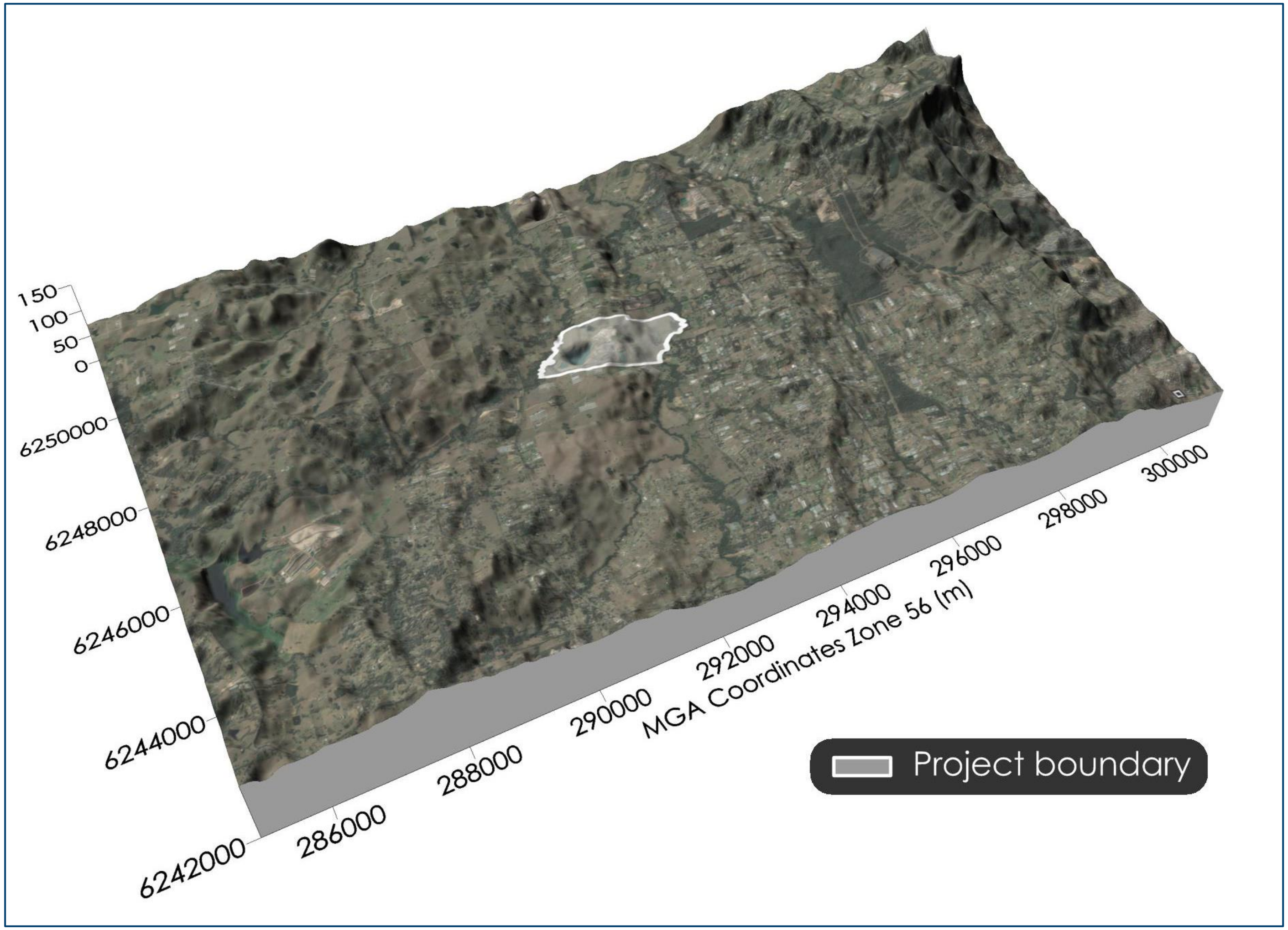

Figure 3-2: Representative view of topography surrounding the Project location

4 EXISTING OPERATIONS AND PROPOSED MODIFICATIONS

4.1 Existing operations

Boral Bricks Pty Limited (Boral) owned and operated the Badgerys Creek Quarry and Brick Making Facility at Badgerys Creek for over 30 years.

On 27 September 2011, project approval was issued under Section 75J of the EP&A Act for the ongoing production of bricks and the expansion of the existing quarrying operations at the Badgerys Creek site.

Due to uncertain economic conditions and a downturn in residential housing activity, Boral reviewed its bricks production capacity in NSW. Following this review, Boral determined to 'mothball' its operations at Badgerys Creek effective from 30 March 2012. Shutting down the site gave Boral the option to review its commercial position at a future stage and, if market conditions and business needs allowed, recommence production. During the shutdown period, the Boral Bringelly Brick Making Facility (now owned by CSR) supplied the Sydney market.

Because of the shutdown, Boral was unable to comply with the conditions of approval and applied to modify the Project Approval under Section 75W of the EP&A Act.

Modification application (10_0014 Mod 1) requested that post-March 2012 activities be limited to:

- Minor maintenance and inspection (e.g. water management, equipment testing);
- Operation of the retail display facility; and
- Irregular and occasional dispatch of bricks from the inventory remaining on-site.

In 2015, Boral and CSR formed a joint venture brick business called Boral CSR Bricks Pty Ltd. The assets held by the respective companies were transferred into the joint venture. At the end of October 2016, CSR acquired Boral's share of the brick business and with it, the Badgerys Creek Brick Making Facility.

Modification application (Mod 2) was approved for the following:

- Exportation of up to 275,000 tonnes of clay per annum; and
- Use of the sites hardstand storage yard for the temporary storage of finished building products from other CSR manufacturing facilities (to cease when MOD3 commences).

4.1.1 Approved project

The approved quarrying and brick making activities in Project Approval PA10_0014 include:

- Extraction of 420,000 tonnes of clay per calendar year;
- Production of 252,000 tonnes of bricks per calendar year;
- Extraction of any clay shale or carry out any work in the extraction area no deeper than 35 metres below the pre-existing natural surface of the ground;
- Receive 20,000 tonnes of raw material for brick making per calendar year; and,

- Dispatch more than 275,000 tonnes of raw materials from the site in any calendar year.

Product from the quarry and brick making facility is approved for transport entirely by road. The Project Approval limits the number of truckloads/heavy vehicle movements that can exit the site per day to:

- A maximum of 60 laden brick trucks entering and exiting the site (i.e. 120 movements) Monday to Friday; and,
- A maximum of 20 laden brick trucks entering and exiting the site (i.e. 40 movements) on Saturdays.

4.1.2 Approved quarrying activities

Approved quarrying activities involve the eastward progression of Pit 3 (where quarrying had already commenced), followed by the establishment of Pit 4 and then Pit 5. The establishment of a new pit involves the following works:

- Exploratory core drilling to a depth of 35 m below ground surface (bgs) across a 50m square grid;
- Assessment of cores for suitability for brick making;
- If the core is suitable, the area is fenced off and appropriate signage placed around the area;
- Removal of overburden and topsoil;
- Breaking up raw materials using a bulldozer with ripping attachment;
- Collection of raw materials with an excavator and placement into a 40-tonne dump truck;
- Transport and deposit of raw materials to the Raw Materials Stockpile area to the south of the brick making facility;
- Transport and deposit of unusable material to either the Central Stockpile or to an open void (Pit 2); and,
- Creation of new stormwater drainage systems and/or drainage pathways (where required) to be incorporated into and consistent with the Water Management Plan for the site.

Upon completion of quarrying in the nominated areas, the disturbed area would be rehabilitated.

4.1.3 Brick production

The primary machinery and equipment involved in the approved brick manufacturing process includes:

- Clay preparation equipment (crushing and grinding);
- Brick forming and handling equipment;
- Gas-fired kiln;
- Brick dryer;

- Brick unloading machine (Dehacker); and
- Compressor building.

The brick manufacturing process is generally described as follows:

- The as-mined clay material is crushed from <500 mm to <2 mm through a crushing process. Water is added during the process to take the material from 6-10% moisture content to 10-12% moisture content.
- To make bricks, the crushed raw material has more water added to bring the mixture to 13-14% and is then extruded. Various textures, sands, frits and clay suspensions are applied to the clay column to add aesthetic appeal. The extruded column is cut into brick sized units and stacked on kiln or dryer cars. These cars pass through a tunnel dryer over the course of two days during which the moisture content is reduced to <1%.
- The kiln cars stacked with dry bricks are then fed into the entrance of the gas-fired tunnel kilns at the rate of one car approximately every 60 minutes. One kiln car holds approximately 6500 bricks (or 18 brick stacks) stacked with gaps between them to allow the hot air to circulate between them and fire evenly. The stock is then raised to above 1000°C and cooled back to room temperature in less than two days. Waste heat is drawn from the kiln in the cooling stage and is used to dry the bricks in the dryer.
- The fired stock is unloaded from the kiln car and packaged into brick packs by the Dehacker before being driven along a conveyor to be transported to the storage yard for dispatch. All equipment is housed within the brick making facility with the exception of the unloading conveyor and exhaust stacks.

Previous additions and alterations to the brick making facility were approved by Liverpool City Council to enable an increase in the efficiency of the existing brick making process. The additions and alterations included a dust collector, air receiver and brick dipping tanks. The additions and alterations were aimed at reducing dust in the brick making process and reducing the incidence of cracking in bricks, hence yielding a higher quantity and quality of product for export.

4.1.4 Transport of raw materials and finished product

Raw materials required for brick making which cannot be extracted on-site, were imported by truck and stockpiled in the Raw Materials Stockpile area to the south of the brick making facility.

The brick product storage yard is located to the north-east of the brick making facility. Forklifts loaded the bricks from the yard on to trucks for transport off-site.

4.1.5 Stockpiles

Stockpile areas within the site include:

- Raw material stockpiles situated in the centre of the site, which provided the feedstock for the brick making process;

- Overburden stockpiles which contain upper level excavated materials that was not suitable for brick making;
- Unusable material stockpiles which contain deeper level excavated material that was not suitable for brick making, but may be suitable in the future if upgrades were made to the clay preparation equipment; and
- Rehabilitated stockpiles in the far west and along the southern boundary of the site.

4.1.6 Operating hours

Approved operating hours for the site are outlined in detail in **Table 4-1**.

Table 4-1: Approved operating hours

Activity	Day	Time
Quarrying operations (excluding removal of overburden, truck arrival, loading and dispatch)	Monday-Saturday Sunday and public holidays	7:00am to 6:00pm None
Removal of overburden and construction of noise bunds	Monday-Friday Saturday Sunday and public holidays	7:00am to 6:00pm 8:00am to 1:00pm None
Brick making facility and storage yard	Monday-Sunday	24 hours
Truck arrival and dispatch (excluding finished building products)	Monday-Friday Saturday Sunday and public holidays	6:00am to 10:00pm 6:00am to 6:00pm None
Truck arrival and dispatch (finished building products only)	Monday-Saturday Sunday and public holidays	7:00am to 10:00pm None
Maintenance	At any time, provided that these activities are not audible at any privately-owned residence outside of permissible hours for quarrying operations	

4.2 Proposed modifications

CSR is now seeking to modify the Project Approval (10_0014) to permit or allow the following key additional development or changes to the approved project as Modification 3:

4.2.1 Advanced Manufacturing - Brick Production

- Removal of most of the existing brick manufacturing equipment and replacement with new brick manufacturing equipment in the existing brick making facility;
- Increase in the building footprint of the existing brick making facility;
- Increase in the building footprint of the existing administration building;
- Production of 300,000 tonnes of bricks per calendar year;
- Increase in the importation of raw materials for brick production to 215,000 tonnes per calendar year;
- A NATA (National Association of Testing Authorities) Accredited Advanced Testing Laboratory; and,

- Other ancillary infrastructure.

An indicative site layout of the proposed brick making facility is shown in **Figure 4-1**.

4.2.2 Advanced Manufacturing - Roof Products Production

- Construction and operation of a roof products manufacturing facility on CSR owned land, outside the approved project boundary, immediately east of Pit 4;
- Modification to the approved project boundary to include the proposed roof products manufacturing facility, located on the adjacent property;
- The processing of sandstone (overburden material not used in brick production) for use in the manufacture of roof products on-site;
- Production of 132,000 tonnes of roof products per calendar year;
- Importation of 124,000 tonnes per annum of raw materials from off-site for use in roof products manufacturing; and,
- Importation of 8,000 tonnes per annum of finished roof products.

An indicative site layout of the proposed roof products manufacturing facility is shown in **Figure 4-2**.

4.2.3 General

- Re-commence operations at the site as approved in the Project Approval (PA10_0014), and expel the current mothballed status of the site;
- Amendment to the extent of Pit 5 to include a 200m buffer zone to neighbouring residential properties required under the *Mining Act 1992*; and,
- Modifications to the approved noise bunds.

4.3 Comparison with approved project

A comparison key aspects and operational hours of the approved operations at the site with the proposed modification is set out in **Table 4-2** and **Table 4-3**, respectively.

Table 4-2: Comparison of approved project and proposed modifications

Aspect	Existing Project Approval	Proposed Modification	Variance to Approved Project
Brick Production	252,000 tonnes of bricks per calendar year	300,000 tonnes of bricks per calendar year	48,000 tonnes of bricks per calendar year
Roof Products Production	Nil	132,000 tonnes of roof products per calendar year	Increased production of 132,000 roof products per calendar year
Quarrying	Extract 420,000 tonnes of clay shale per calendar year	No change	Nil
Receiving raw materials	Receive 20,000 tonnes of raw materials for brick production per calendar year	Importation of 215,000 tonnes of raw materials for brick production and 124,000 tonnes for roof product production per calendar year	Increase of 319,000 tonnes of imported raw materials for brick and roof product production per calendar year

Aspect	Existing Project Approval	Proposed Modification	Variance to Approved Project
Dispatching of raw materials	Dispatch more than 275,000 tonnes of raw materials from the site per calendar year	No change	Nil
Truck Movements	Maximum of 60 laden brick trucks (i.e. 120 vehicle movements) exiting the site per day Monday to Friday	Maximum of 272 heavy vehicles exiting the site per day Monday to Friday	Increase of 212 heavy vehicles exiting the site per day Monday to Friday
	Maximum of 20 laden brick trucks (i.e. 40 vehicle movements) exiting the site per day on Saturday	Maximum of 79 heavy vehicles exiting the site per day on Saturday	Increase of 59 heavy vehicles exiting the site per day on Saturday
Duration of Project Approval	27 September 2031	30 years from date of approval of Modification 3	As the quarry and brick making facility would have been in a mothballed state over the first six years of the Project Approval and the Project Approval is only for a 20-year period, CSR wishes to include an extension of the Project Approval duration to 30 years and requests that the 30 years commences from the date of the approval of Modification 3

Table 4-3: Comparison of approved hours of operation and proposed modifications

Activity	Existing Project Approval	Proposed Modification	Variance to Approved Project
Quarrying operations (excluding removal of overburden, truck arrival, loading and dispatch)	Monday-Saturday 7:00am to 6:00pm Sunday and public holidays None	Monday-Saturday 7:00am to 6:00pm Sunday and public holidays None	No change
Removal of overburden and construction of noise bunds	Monday-Friday 7:00am to 6:00pm Saturday 8:00am to 1:00pm Sunday and public holidays None	Monday-Friday 7:00am to 6:00pm Saturday 8:00am to 1:00pm Sunday and public holidays None	No change
Brick making facility and storage yard	Monday-Sunday 24 hours	Monday-Sunday 24 hours	No change
Roof products manufacturing facility and storage yard	Nil	Monday-Sunday 24 hours	Roof products manufacturing facility and storage yard to operate 24 hours Monday-Sunday
Truck arrival and dispatch (excluding finished building products i.e. raw materials)	Monday-Friday 6:00am to 10:00pm Saturday 6:00am to 6:00pm	Monday-Friday 6:00am to 10:00pm Saturday 6:00am to 6:00pm	No change

Activity	Existing Project Approval	Proposed Modification	Variance to Approved Project
	Sunday and public holidays None	Sunday and public holidays None	
Truck arrival and dispatch (finished building products only)	Monday-Saturday 7:00am to 10:00pm Sunday and public holidays None	Monday-Friday 5:00am to 10:00pm Saturday 6:00am to 6:00pm Sunday and public holidays None	Deliveries and dispatch to be extended by one hour earlier in the morning to allow finished product trucks to arrive at site at 5:00am, load, and be ready for dispatch at 6:00am
Sales Selection / Cash Sales	Nil	Monday-Saturday 6:00am to 6:00pm Sunday and public holidays None	Additional operating hours for sales selection and cash sales activities for finished brick products
Customer Display Centre	Nil	Monday-Sunday 8:00am to 5:00pm Public Holidays None	Additional operating hours for finished brick products customer display centre

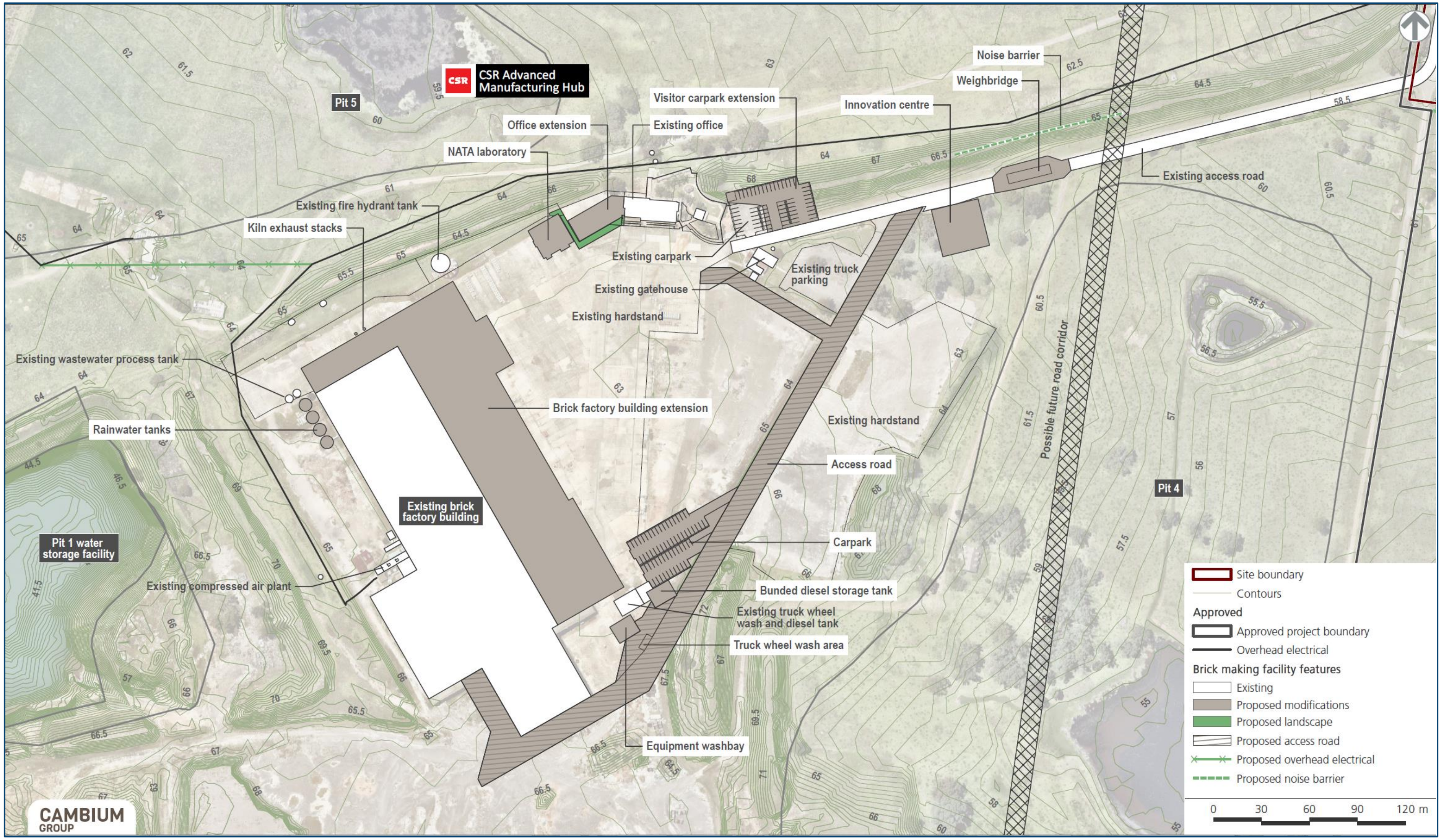

Figure 4-1: Indicative site layout – Brick Production facility

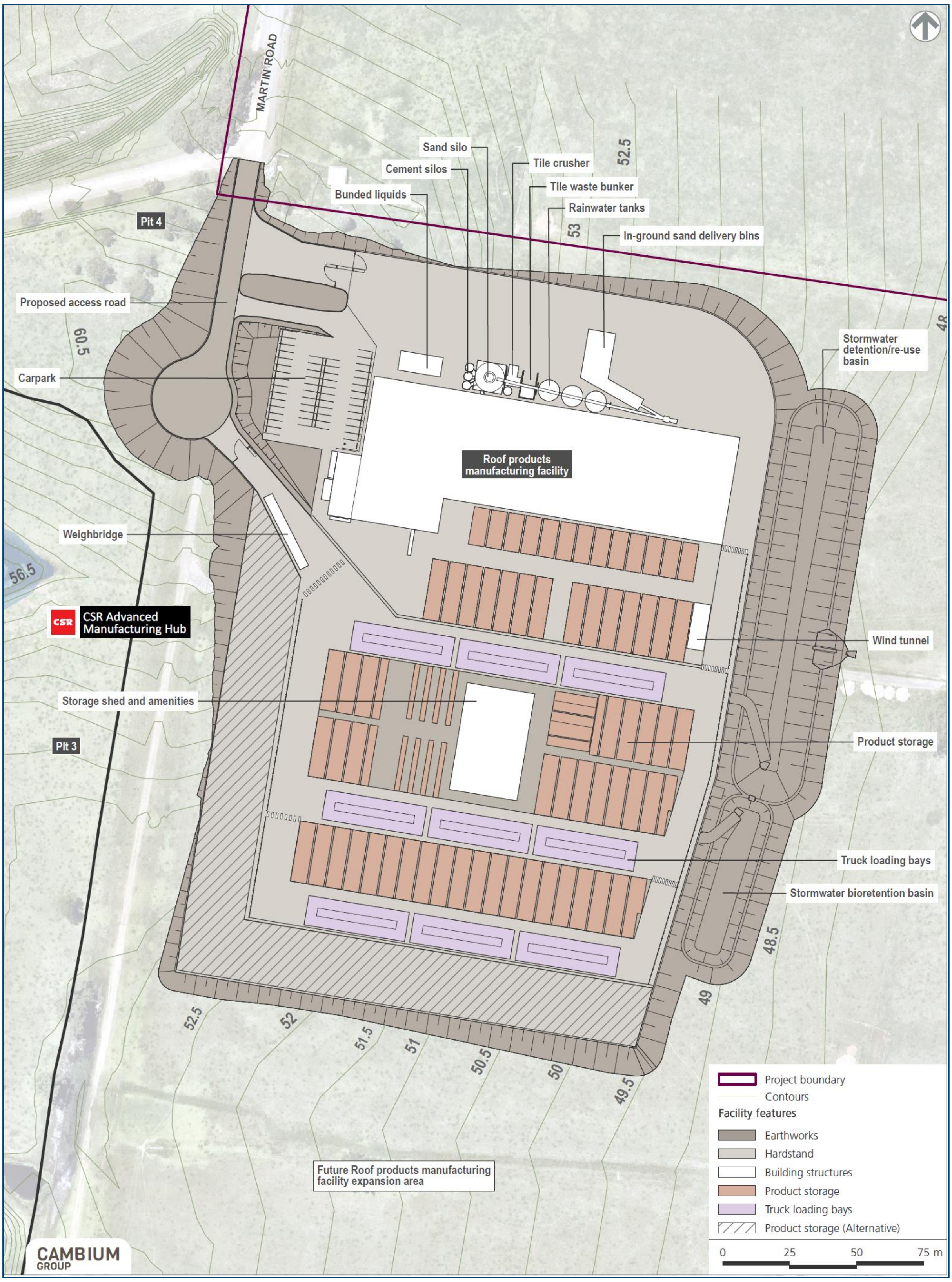

Figure 4-2: Indicative site layout – Roof Products facility

5 AIR QUALITY CRITERIA

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

5.1 NSW EPA impact assessment criteria

Table 5-1 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 goals for total impact relate to the total pollutant burden in the air and not just the pollutants from the Project. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

Table 5-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Percentile	Impact	Criterion		Application
TSP	Annual	100	Total	90 $\mu g/m^3$		Sensitive receptors
PM_{10}	Annual	100	Total	25 $\mu g/m^3$		Sensitive receptors
	24 hour	100	Total	50 $\mu g/m^3$		Sensitive receptors
$PM_{2.5}$	Annual	100	Total	8 $\mu g/m^3$		Sensitive receptors
	24 hour	100	Total	25 $\mu g/m^3$		Sensitive receptors
Deposited dust	Annual	100	Incremental	2 g/m^2/month		Sensitive receptors
		100	Total	4 g/m^2/month		Sensitive receptors
Sulfur dioxide (SO_2)	10 minutes	100	Total	712 $\mu g/m^3$		Sensitive receptors
	1 hour	100	Total	570 $\mu g/m^3$		Sensitive receptors
	24 hour	100	Total	228 $\mu g/m^3$		Sensitive receptors
	Annual	100	Total	60 $\mu g/m^3$		Sensitive receptors
Nitrogen dioxide (NO_2)	1 hour	100	Total	246 $\mu g/m^3$		Sensitive receptors
	Annual	100	Total	62 $\mu g/m^3$		Sensitive receptors
Hydrogen fluoride (HF)	90 days	100	Total	[1]0.5 $\mu g/m^3$	[2]0.25 $\mu g/m^3$	Sensitive receptors
	30 days	100	Total	[1]0.84 $\mu g/m^3$	[2]0.4 $\mu g/m^3$	Sensitive receptors
	7 days	100	Total	[1]1.7 $\mu g/m^3$	[2]0.8 $\mu g/m^3$	Sensitive receptors
	24 hours	100	Total	[1]2.9 $\mu g/m^3$	[2]1.5 $\mu g/m^3$	Sensitive receptors
Chlorine	1 hour	99.9	Incremental	0.05 mg/m^3		Boundary
Sulfur trioxide (SO_3) as sulfuric acid (H_2SO_4)	1 hour	99.9	Incremental	0.018 mg/m^3		Boundary
Odour	1 hour peak to mean corrected	99	Incremental	2 OU		Sensitive receptors

Source: NSW EPA, 2017

[1] General land use, which includes all areas other than specialised land use

[2] Specialised land use, which includes all areas with vegetation sensitive to fluoride, such as grape vines and stone fruit

$\mu g/m^3$ = micrograms per cubic metre

g/m^2/month = grams per square metre per month

5.2 NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP)

Part of the NSW VLAMP dated September 2018 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 5-2** at any residence on privately owned land or workplace. [1]

Table 5-2: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation criterion		Impact type
$PM_{2.5}$	Annual	8µg/m³*		Human health
$PM_{2.5}$	24 hour	25µg/m³**		Human health
PM_{10}	Annual	25µg/m³*		Human health
PM_{10}	24 hour	50µg/m³**		Human health
TSP	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: NSW Government (2018b)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

Voluntary acquisition rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 5-3** at any residence on privately owned land, workplace or on more than 25 per cent of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 5-3: Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition criterion		Impact type
$PM_{2.5}$	Annual	8µg/m³*		Human health
$PM_{2.5}$	24 hour	25µg/m³**		Human health
PM_{10}	Annual	25µg/m³*		Human health
PM_{10}	24-hour	50µg/m³**		Human health
TSP	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: NSW Government (2018b)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

5.3 Protection of the Environment Operations Act 1997

The general obligations of the *Protection of the Environment Operations Act, 1997* and the Regulations made under the Act (namely the *Protection of the Environment Operations (Clean Air) Regulation, 2010*) would be followed at the Project. The Project would operate in accordance with the relevant regulatory framework for air quality to ensure compliance with this legislation.

[1] Where any exceedance would be unreasonably detrimental to workers health or carrying out of the business.

6 EXISTING ENVIRONMENT

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

6.1 Local climatic conditions

Long-term climatic data from the Bureau of Meteorology (BoM) weather station at Badgerys Creek Automatic Weather Station (AWS) (Site No. 067108) were used to characterise the local climate in the proximity of the Project. The Badgerys Creek AWS is located approximately 1.5km west of the Project.

Table 6-1 and **Figure 6-1** present a summary of data from the Badgerys Creek station collected over an approximate 14 to 23 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 30.1 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 4.1°C.

Rainfall exhibits variability and seasonal fluctuations across the year. The data indicate that February is the wettest month with an average rainfall of 98.5 millimetres (mm) over 7.3 days and July is the driest month with an average rainfall of 22.6mm over 3.7 days.

Humidity levels exhibit variability and seasonal flux across the year. Mean 9am humidity levels range from 62 per cent (%) in October to 84% in June. Mean 3pm humidity levels range from 44% in August and September to 56% in June.

Mean 9am wind speeds range from 8.4 kilometres per hour (km/h) in March to 11.8km/h in October. Mean 3pm wind speeds range from 13.7km/h in June to 19.9km/h in October.

Table 6-1: Monthly climate statistics summary – Badgerys Creek AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	30.1	28.8	26.9	24.1	20.8	17.8	17.5	19.2	22.6	24.9	26.4	28.5	24.0
Mean min. temp. (°C)	17.1	17.1	15.3	11.5	7.7	5.6	4.1	4.7	7.7	10.5	13.5	15.5	10.9
Rainfall													
Rainfall (mm)	79.4	98.5	81.3	49.4	37.0	61.4	22.6	35.4	33.2	53.8	69.0	57.1	680.9
No. of rain days (≥1mm)	7.0	7.3	7.4	5.7	3.8	5.5	3.7	3.4	4.7	5.7	7.0	6.6	67.8
9am conditions													
Mean temp. (°C)	21.8	21.2	19.0	17.3	13.7	10.5	9.8	11.7	15.5	18.1	19.1	20.9	16.6
Mean R.H. (%)	73	80	83	76	80	84	81	72	66	62	69	69	75
Mean W.S. (km/h)	9.4	8.7	8.4	9.8	9.6	9.1	9.6	10.6	11.7	11.8	11.0	9.8	10.0
3pm conditions													
Mean temp. (°C)	28.1	26.9	25.3	22.4	19.4	16.7	16.1	17.9	21.0	22.8	24.3	26.5	22.3
Mean R.H. (%)	49	55	55	52	53	56	50	44	44	45	50	48	50
Mean W.S. (km/h)	17.9	15.9	14.5	14.4	13.9	13.7	15.4	17.8	19.2	19.9	18.9	18.5	16.7

Source: **Bureau of Meteorology, 2018 (accessed November 2018)**

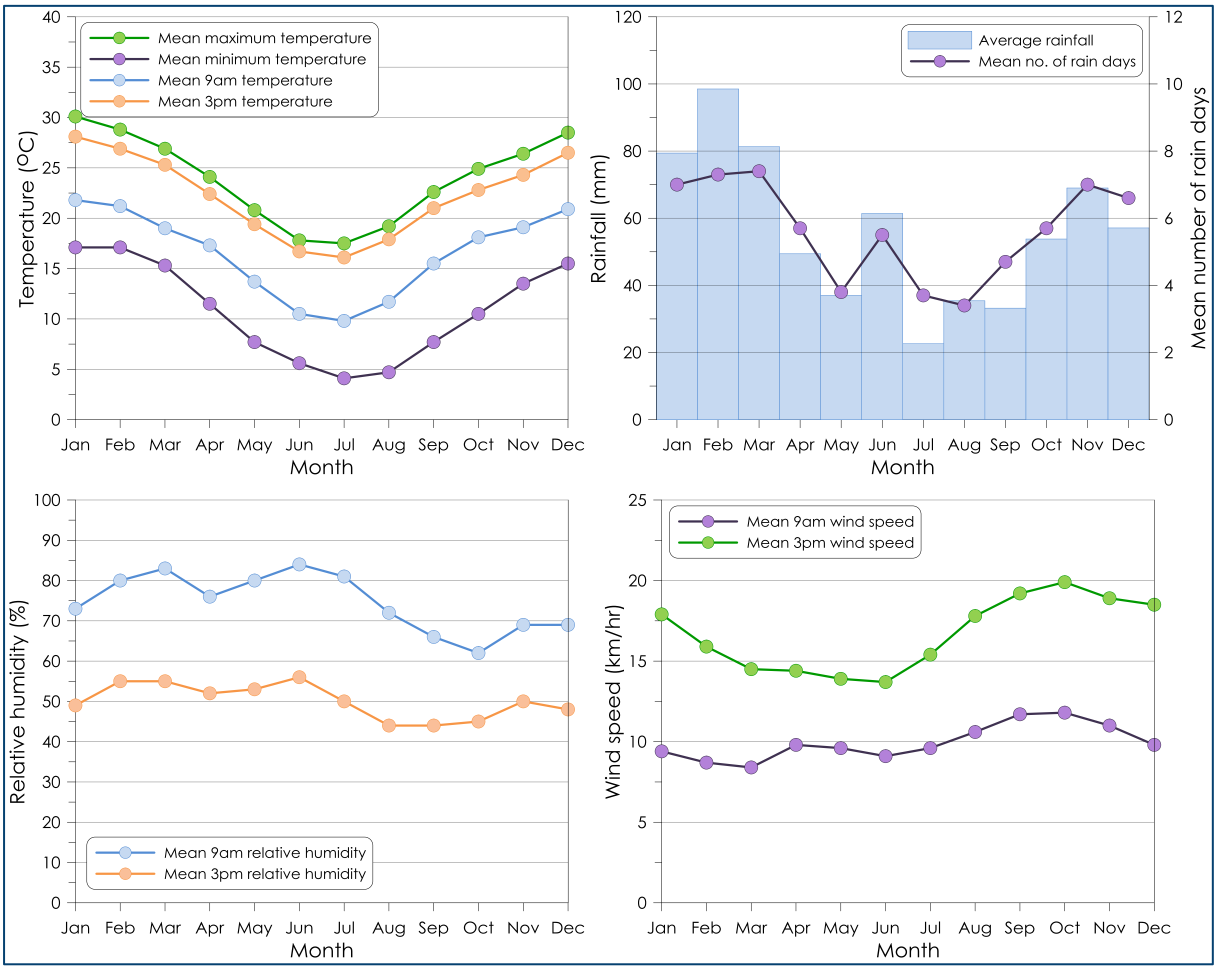

Figure 6-1: Monthly climate statistics summary – Badgerys Creek AWS

6.2 Local meteorological conditions

The Badgerys Creek (AWS) has been used to represent local meteorological conditions that would be experienced at the Project site. The Badgerys Creek AWS is located approximately 1.5km west of the Project. Annual and seasonal windroses prepared from data collected for the 2014 calendar year are presented in **Figure 6-2**. The 2014 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**.

Analysis of the windroses shows that on an annual basis, winds are predominately from the southwest sector. During summer there is are high percentage of winds from the north-northeast to east-south-east sectors and southwest. In autumn, winter and spring prevailing winds the highest percentage of winds come from the southwest and west-southwest.

The windroses show a wind distribution pattern that is typical of the expected patterns for this area considering the location of the station in relation to local terrain features.

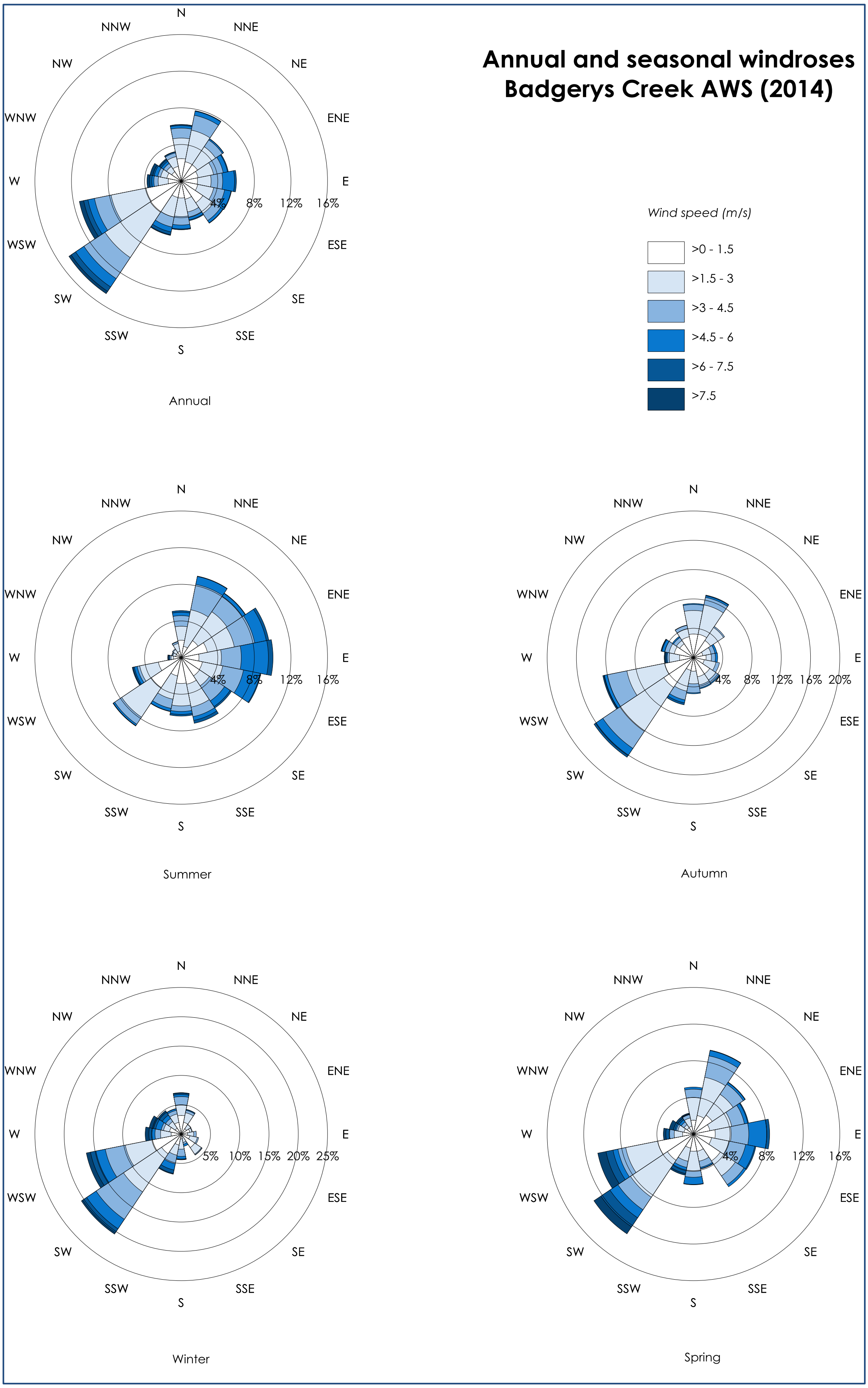

Figure 6-2: Annual and seasonal windroses for Badgerys Creek AWS (2014)

6.3 Ambient air quality

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

This section reviews the available ambient air quality monitoring data sourced from on-site monitoring and other available ambient air quality monitors operated by the NSW Office of Environment and Heritage (OEH) and the Western Sydney Airport.

6.3.1 Onsite Monitoring

A high volume air sampler (HVAS) is operated on-site to measure ambient 24-hour average PM_{10} levels. **Figure 6-3** provides a summary of the available measured 24-hour average PM_{10} data from October 2016 to March 2018.

A review of **Figure 6-3** maximum 24-hour average PM_{10} concentrations recorded at the station found concentrations to be below the relevant criterion of 50µg/m³ during the review period.

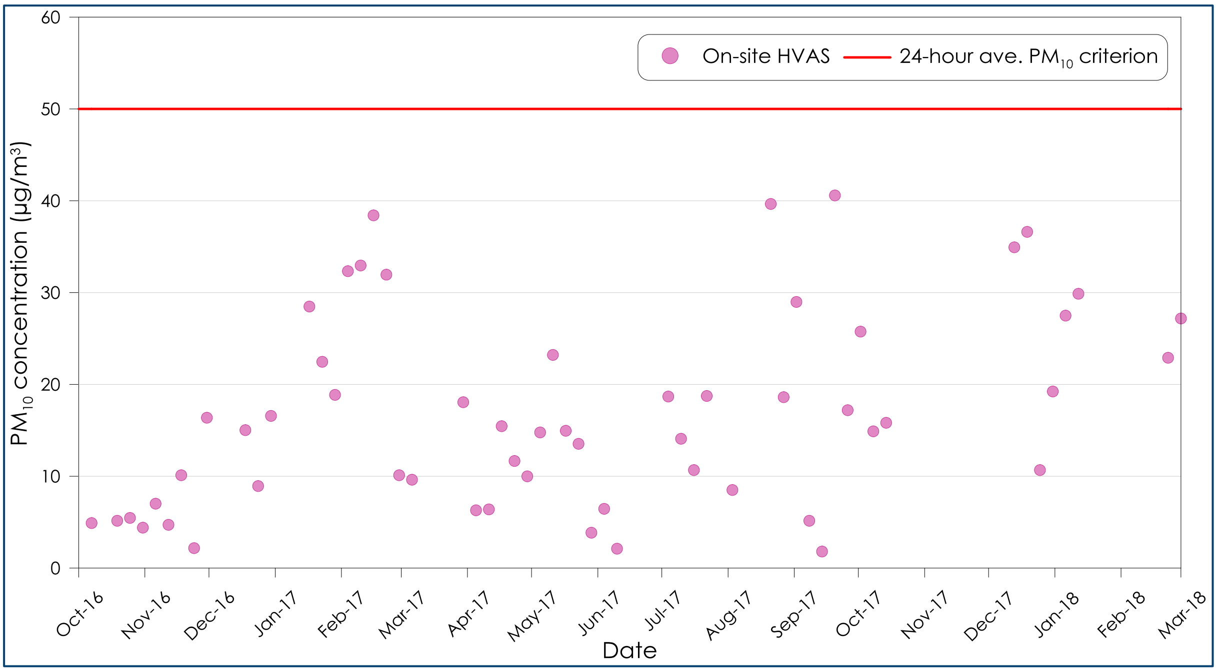

Figure 6-3: 24-hour average PM_{10} monitoring data - HVAS

The site also operates four dust deposited monitors and **Table 6-2** provides a summary of the measured annual average dust deposition data for 2017. The results indicate that dust deposition levels are below the relevant criterion of 4g/m²/month and indicate dust deposition levels are generally good in the vicinity of the Project.

Table 6-2: Summary of measured dust deposition

ID	Location	Annual average insoluble solids (g/m²/month)
D1	Martin Rd near resident	0.9
D2	Hay shed	1.5
D3	Bundwall near Inghams	1.4

ID	Location	Annual average insoluble solids (g/m²/month)
D4	Old house	1.7

6.3.2 NSW OEH Monitoring

The available PM_{10} monitoring data from the nearest air quality monitors operated by the NSW OEH have been reviewed and are summarised in **Table 6-3**. Recorded 24-hour average PM_{10} concentrations are presented graphically in **Figure 6-4**.

A review of **Table 6-3** indicates that the annual average PM_{10} concentrations at Bringelly, St Marys and Liverpool were below the relevant criterion of 25µg/m³. The maximum 24-hour average PM_{10} concentrations recorded at these stations exceed the relevant criterion of 50µg/m³ at times during the review period.

Examination of the potential cause of the elevated PM_{10} levels indicates that they typically coincide with regional dust events and bushfires which affect a wide area, for example as indicated by other air quality monitoring stations in the surrounding region also recording elevated levels on such days. At other times, potential sources such as local agricultural sources, industrial activity and other sources may have contributed to periods of elevated PM_{10} levels.

Table 6-3: Summary of PM_{10} levels from NSW OEH monitoring (µg/m³)

Year	Bringelly	St Marys	Liverpool
Annual average			
2013	17.0	16	21
2014	16.6	16.7	19.1
2015	15.8	15	18.5
2016	16.9	16.1	19.6
2017	19.8	16.2	20.8
Maximum 24-hour average			
2013	97.2	93.0	98.5
2014	42.6	45.0	40.8
2015	57.0	53.0	68.6
2016	61.6	100.2	68.7
2017	83.7	49.8	74.0
Number of days above criterion (50 µg/m³)			
2013	3	2	3
2014	0	0	0
2015	1	1	1
2016	3	3	3
2017	6	0	2

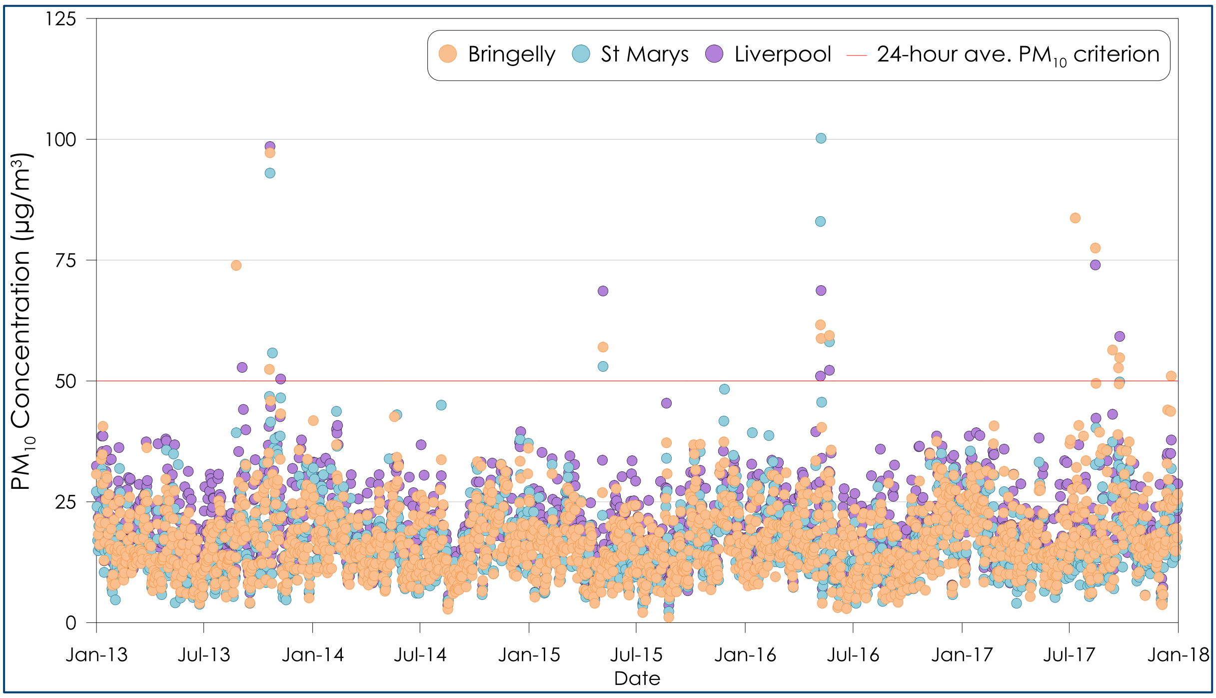

Figure 6-4: 24-hour average PM_{10} concentrations – NSW OEH

A summary of the available $PM_{2.5}$ monitoring data from the NSW OEH monitoring stations is presented in **Table 6-4**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented graphically in **Figure 6-5**.

A review of **Table 6-4** indicates that the annual average $PM_{2.5}$ concentrations at Liverpool were above the relevant criterion of 8µg/m³ for the period reviewed. The annual average levels of $PM_{2.5}$ concentrations for the Bringelly and St Marys monitors were below the relevant criterion of 8µg/m³ for the 2017 period.

The maximum 24-hour average $PM_{2.5}$ concentrations recorded at the monitoring stations were found to exceed the relevant criterion of 25µg/m³ at times during the review period.

Recorded 24-hour average $PM_{2.5}$ concentrations are presented graphically in **Figure 6-5**. A seasonal trend in 24-hour average $PM_{2.5}$ concentrations for the monitoring stations can be seen in **Figure 6-5** with elevated levels occurring in the cooler months. This is opposite to the seasonal trend for PM_{10} concentrations which has elevated levels during the warmer months.

Table 6-4: Summary of $PM_{2.5}$ levels from NSW OEH monitoring (µg/m³)

Year	Bringelly	St Marys	Liverpool
Annual average			
2013	-	-	9.4
2014	-	-	8.6
2015	-	-	8.5
2016	-	-	8.7
2017	7.5	7	8.9
Maximum 24-hour average			
2013	-	-	73.8
2014	-	-	24.3
2015	-	-	32.2
2016	21.6	93.2	50.8
2017	52.5	38.2	56.4
Number of days above criterion (25 µg/m³)			
2013	-	-	2
2014	-	-	0
2015	-	-	2
2016	0	5	4
2017	2	3	3

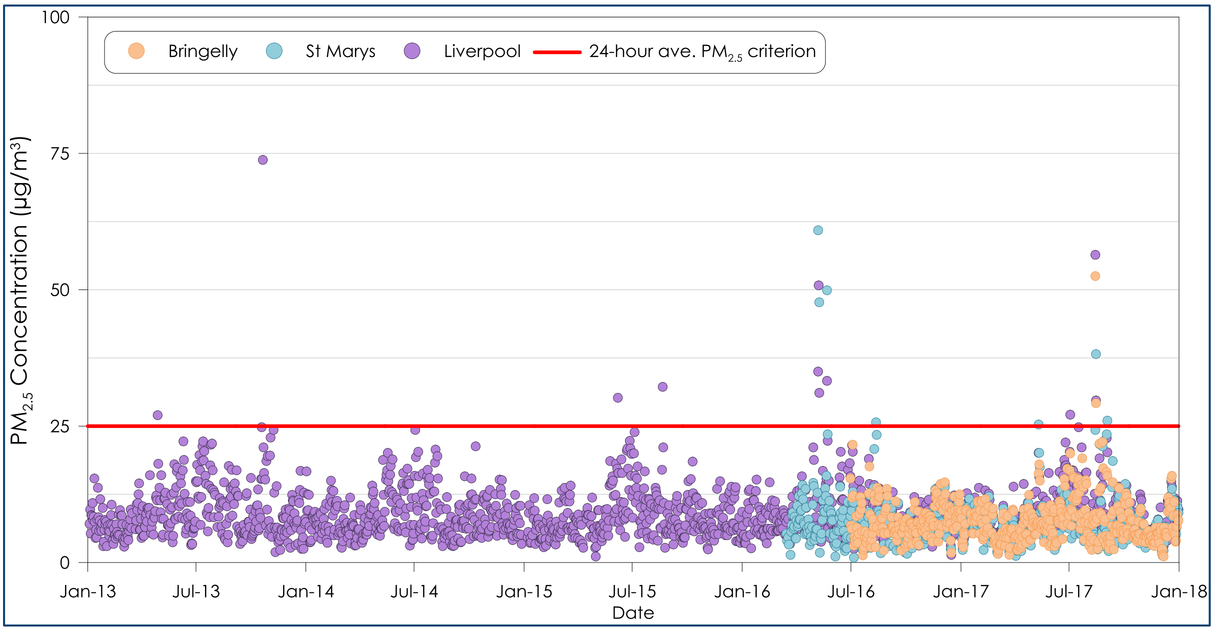

Figure 6-5: 24-hour average $PM_{2.5}$ concentrations – NSW OEH

A summary of the available SO_2 monitoring data from the NSW OEH monitoring stations is presented in **Table 6-5**. A review of **Table 6-5** indicates that the annual, 24-hour and 1-hour average SO_2 concentrations at the monitoring stations were below the relevant criterion of 60µg/m^3, 228µg/m^3 and 570µg/m^3, respectively.

Table 6-5: Summary of SO_2 levels from NSW OEH monitoring (µg/m^3)

Year	Bringelly	Liverpool
Annual average		
2013	0.7	-
2014	0.7	-
2015	0.4	-
2016	0.6	-
2017	0.7	2.9
Maximum 24-hour average		
2013	5.7	-
2014	8.6	-
2015	2.9	-
2016	5.7	5.7
2017	5.7	8.6
Maximum 1-hour average		
2013	31.5	-
2014	25.7	-
2015	20.0	-
2016	17.2	20.0
2017	25.7	31.5

A summary of the available NO_2 monitoring data from the NSW OEH monitoring stations is presented **Table 6-6**. A review of **Table 6-6** indicates that the annual and 1-hour average NO_2 concentrations at the monitoring stations were below the relevant criterion of 62µg/m^3 and 246µg/m^3, respectively.

Table 6-6: Summary of NO_2 levels from NSW OEH monitoring (µg/m^3)

Year	Bringelly	St Marys	Liverpool
Annual average			
2013	10.3	10.3	22.6
2014	8.2	8.2	20.5
2015	8.2	8.2	20.5
2016	10.3	8.2	24.6
2017	10.3	8.2	24.6
Maximum 1-hour average			
2013	75.9	75.9	114.8
2014	51.3	63.6	90.2
2015	55.4	65.6	123.0
2016	61.5	86.1	96.4
2017	73.8	75.9	131.2

6.3.3 Western Sydney Airport Monitoring

Ambient PM_{10} and $PM_{2.5}$ baseline monitoring has been undertaken in the vicinity of the site for the Western Sydney Airport using a Dust Master Pro 7200 real time particle counter. **Figure 6-6** presents the Western Sydney Airport baseline monitoring locations.

The PM_{10} and $PM_{2.5}$ baseline monitoring data have been obtained from various *Western Sydney Airport – air quality and noise monitoring* reports (**GHD 2017a, 2017b, 2017c, 2018a, 2018b, 2018c** and **2018d**).

Recorded 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented graphically in **Figure 6-7** and **Figure 6-8**, respectively. The graphs indicate that the 24-hour average PM_{10} and $PM_{2.5}$ concentrations exceed the relevant criterion on occasion for the Northern, Southern and Western monitoring sites during the review period. The Eastern monitoring site is closest to the Project and indicates much lower levels compared to the other monitoring sites.

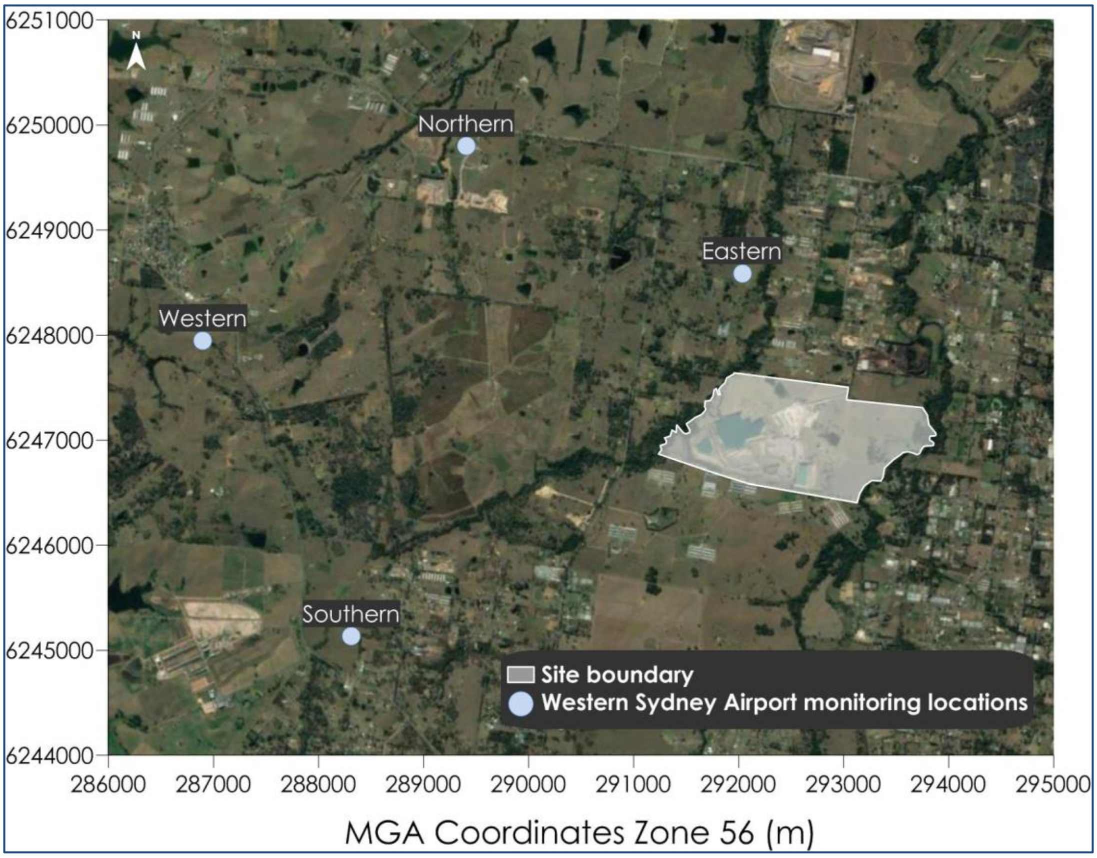

Figure 6-6: Western Sydney Airport baseline monitoring locations

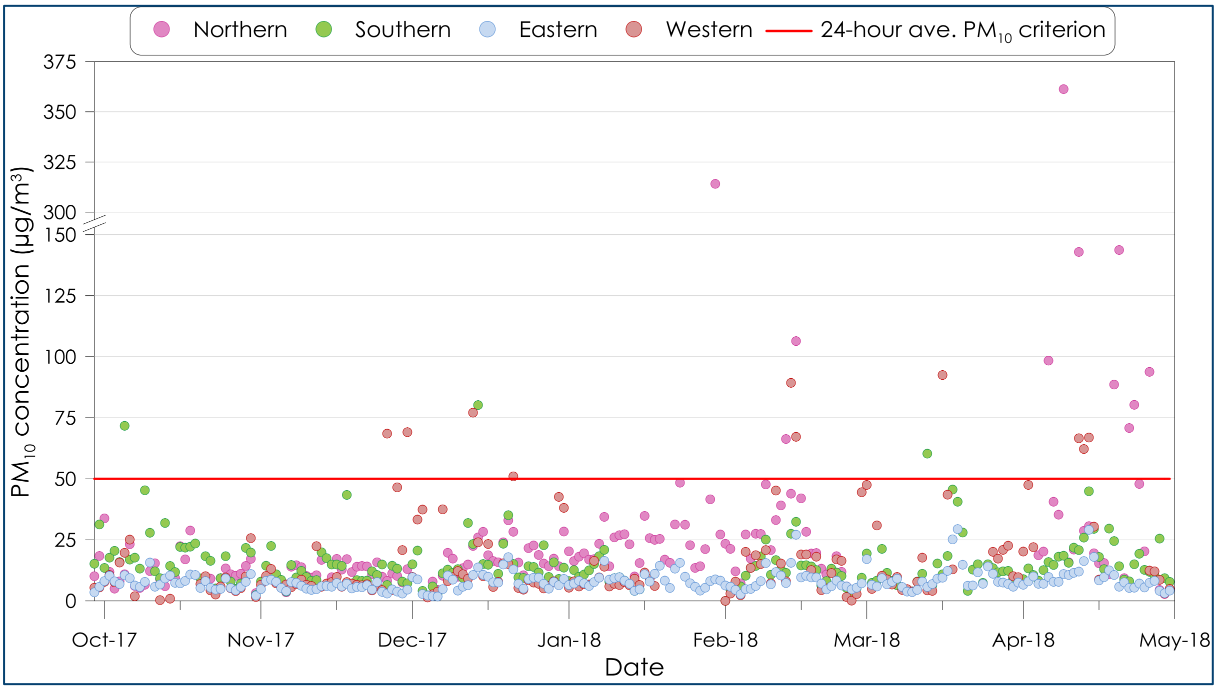

Figure 6-7: Western Sydney Airport baseline 24-hour PM_{10} monitoring data

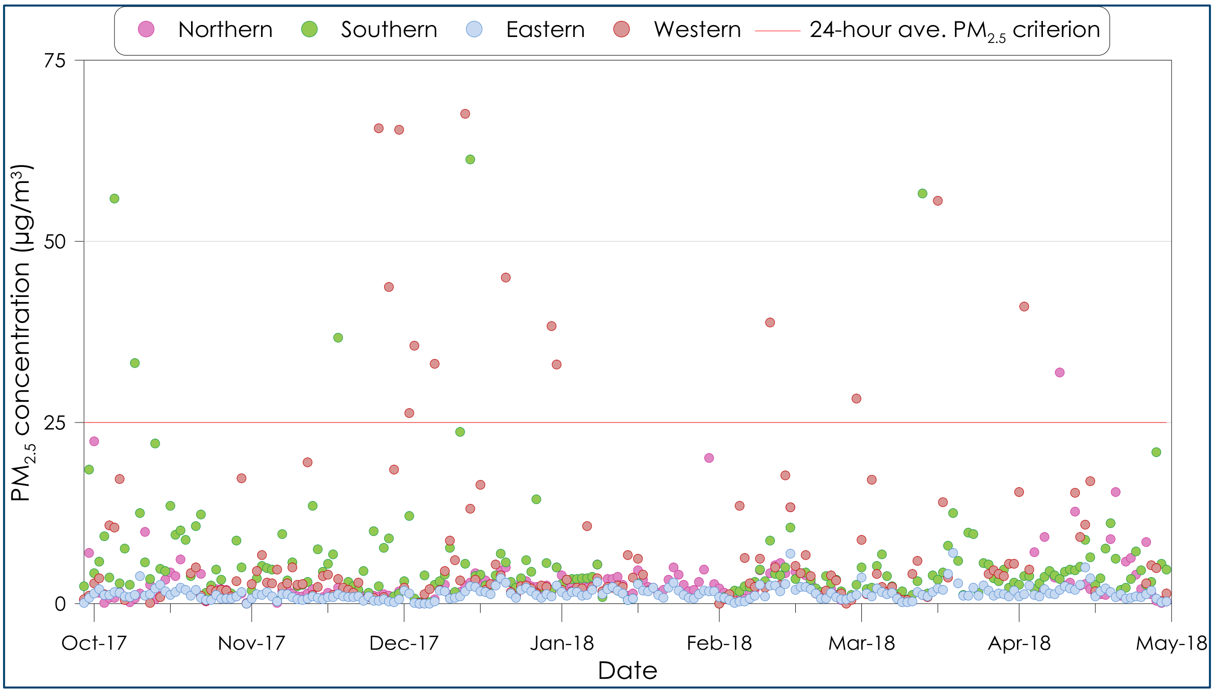

Figure 6-8: Western Sydney Airport baseline 24-hour $PM_{2.5}$ monitoring data

6.3.4 Estimated background air quality levels

In correlation with the meteorological data set used, the 2014 calendar year air quality monitoring data were selected to represent background concentrations at the Project site.

The NSW OEH Bringelly monitoring station, located approximately 1.7km southeast of the Project is considered generally most representative of the background levels in the vicinity of the site for the 2014 calendar year. We note that the measured HVAS data and Western Sydney Airport Eastern monitor data are lower than the NSW OEH Bringelly levels over the relevant monitoring periods. Thus the use of the NSW OEH monitoring data provide a conservative estimate of background levels in the vicinity of the Project site.

In the absence of available data, estimates of the annual average background TSP and deposited dust concentrations have 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 applied annual average PM_{10} concentration of 16.6µg/m^3 indicates an approximate annual average TSP concentration and deposition value of 59.8µg/m^3 and 2.7g/m^2/month, respectively.

We note that the NSW OEH Bringelly and St Marys monitoring stations did not record $PM_{2.5}$ data in the 2014 calendar year, however have available data for the 2017 calendar year. The NSW OEH Liverpool site has data for both periods, however due to differences in local land use and proximity to local sources is not considered to be suitably representative with regard to background $PM_{2.5}$ concentrations for the Project site.

To estimate background $PM_{2.5}$ concentrations for the Project site, we assumed the ratio of the average level at the Bringelly and St Marys monitoring stations during 2017 to the Liverpool monitoring station would be similar for the 2014 period. This results in an estimated background $PM_{2.5}$ concentration of 7µg/m^3.

A summary of the background concentrations applied in this assessment are outlined in **Table 6-7.**

Table 6-7: Summary of background pollutant concentrations

Pollutant	Averaging Period	Units	Concentration
TSP	Annual	µg/m³	59.8
PM_{10}	Annual	µg/m³	16.6
	24 Hour	µg/m³	42.6
$PM_{2.5}$	Annual	µg/m³	7
	24 Hour	µg/m³	24.3
Deposited dust	Annual	g/m²/month	2.7
NO_2	Annual	µg/m³	8.2
	1 Hour	µg/m³	51.3
SO_2	Annual	µg/m³	0.7
	24 Hour	µg/m³	8.6
	1 Hour	µg/m³	25.7

7 POTENTIAL CONSTRUCTION DUST EMISSIONS

The Project requires the construction of various infrastructure and associated facilities including the construction of the roof products manufacturing facility, extension of the brick making facility, replacement of brick manufacturing equipment, extension of the administration building and construction of other ancillary infrastructure. These construction activities associated with the Project have the potential to generate dust emissions.

Potential construction dust emissions will be primarily generated from material handling, vehicle movements and windblown dust from exposed areas. The operation of construction vehicles and plant will also generate exhaust emissions.

The potential particulate impacts due to these activities is difficult to accurately quantify on any given day due to the short sporadic periods of dust generating activity which may occur over the construction time frame. The sources of construction dust are temporary in nature and will only occur during the construction period.

The total amount of dust generated from the construction process is unlikely to be significant given the nature of the activities. As construction activities for the proposed modification would be generally located away from the sensitive receptors, any potential dust impacts would be unlikely to be discernible beyond the existing levels of dust in the area surrounding the Project. Given that the activities would occur for a limited period, no significant or prolonged effect at any off-site receptors is predicted to arise due to the construction activity.

To ensure dust generation is controlled during the construction activities and the potential for off-site impacts is reduced, appropriate (operational and physical) mitigation measures in **Table 7-1** will be implemented as necessary.

Table 7-1: Construction dust mitigation measures

Source	Mitigation measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of visible dust cannot be maintained)
	Engines of on-site vehicles and plant to be switched off when not in use
	Vehicles and plant are to be fitted with pollution reduction devices where practicable
	Vehicles are to be maintained and serviced according to manufacturer's specifications
	Visual monitoring of construction activities is to be undertaken to identify dust generation
Hauling material	Active haul roads are to be kept moist
	Public and private sealed haul roads are to be cleaned regularly
	Construction vehicle traffic is to be restricted to designated routes
	Construction speed limits are to be enforced
	Vehicle loads are to be covered when travelling off-site
	A wheel wash or rumble grids are to be established near exit points from construction sites onto public roads, to minimise mud/ dirt track out
Material handling	Drop heights from loading and handling equipment are to be reduced as much as practical
Exposed areas / stockpiles / noise bunds	The extent of exposed surfaces and stockpiles is to be kept to a minimum
	Exposed areas and stockpiles are to be dampened with water as far as is practicable if dust emissions are visible
	Disturbed areas are to be rehabilitated as soon as practicable after completion of works and in a staged manner

8 DISPERSION MODELLING APPROACH

8.1 Introduction

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

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

8.2 Modelling methodology

8.2.1 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from The Air Pollution Model (TAPM) with surface observations from surrounding weather stations for input in the CALMET model.

The centre of analysis for TAPM was 33deg53.5min south and 150deg45min east (292330mE, 6247576mN). The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

The CALMET modelling used a nested approach where the 3D wind field from the coarser grid outer domain is used as the initial guess (or starting) field for the finer grid inner domain. This approach has several advantages over modelling a single domain. Observed surface wind field data from the near field as well as from far field monitoring sites can be included in the model to generate a more representative 3D wind field for the modelled area. Off domain terrain features for the finer grid domain can be allowed to take effect within the finer domain, as would occur in reality. Also, the coarse scale wind flow fields give a better set of starting conditions with which to operate the finer grid run.

The CALMET outer domain was run on a 30 x 30km area with a 0.6km grid resolution, refined for an inner domain on a 10 x 10km area with a 0.1km grid resolution.

The 2014 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. Further detail on the selection of the meteorological year is outlined in **Appendix A.**

The available meteorological data for January 2014 to December 2014 from relevant BoM meteorological monitoring sites were included in the simulation. **Table 8-1** outlines the parameters used from each station.

Table 8-1: Surface observation stations

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Badgerys Creek (BoM) (Station No. 067108)	✓	✓			✓	✓	
Bringelly (OEH)	✓	✓			✓	✓	
Horsley Park Equestrian Centre AWS (BoM) (Station No. 067119)	✓	✓			✓	✓	
Holsworthy Aerodrome (BoM) (Station No. 066161)	✓	✓	✓	✓	✓	✓	✓
Camden Airport (BoM) (Station No. 068192)	✓	✓	✓	✓	✓	✓	✓
Penrith Lakes (BoM) (Station No. 067113)	✓	✓			✓	✓	
Bankstown Airport (BoM) (Station No. 066137)	✓	✓	✓	✓	✓	✓	✓
Campbelltown (Mount Annan) (BoM) (Station No. 068257)	✓	✓			✓	✓	

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

The seven critical parameters used in the CALMET modelling are presented in **Table 8-2**.

Table 8-2: Seven critical parameters used in CALMET

Parameter	Value	
TERRAD	10	
IEXTRP	-4	
BIAS (NZ)	-1, -0.5, -0.25, 0, 0, 0, 0, 0	
R1 and R2	5,5	2,2
RMAX1 and RMAX2	10,10	5,5

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extracted data.

Figure 8-1 presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period. The wind fields are seen to follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

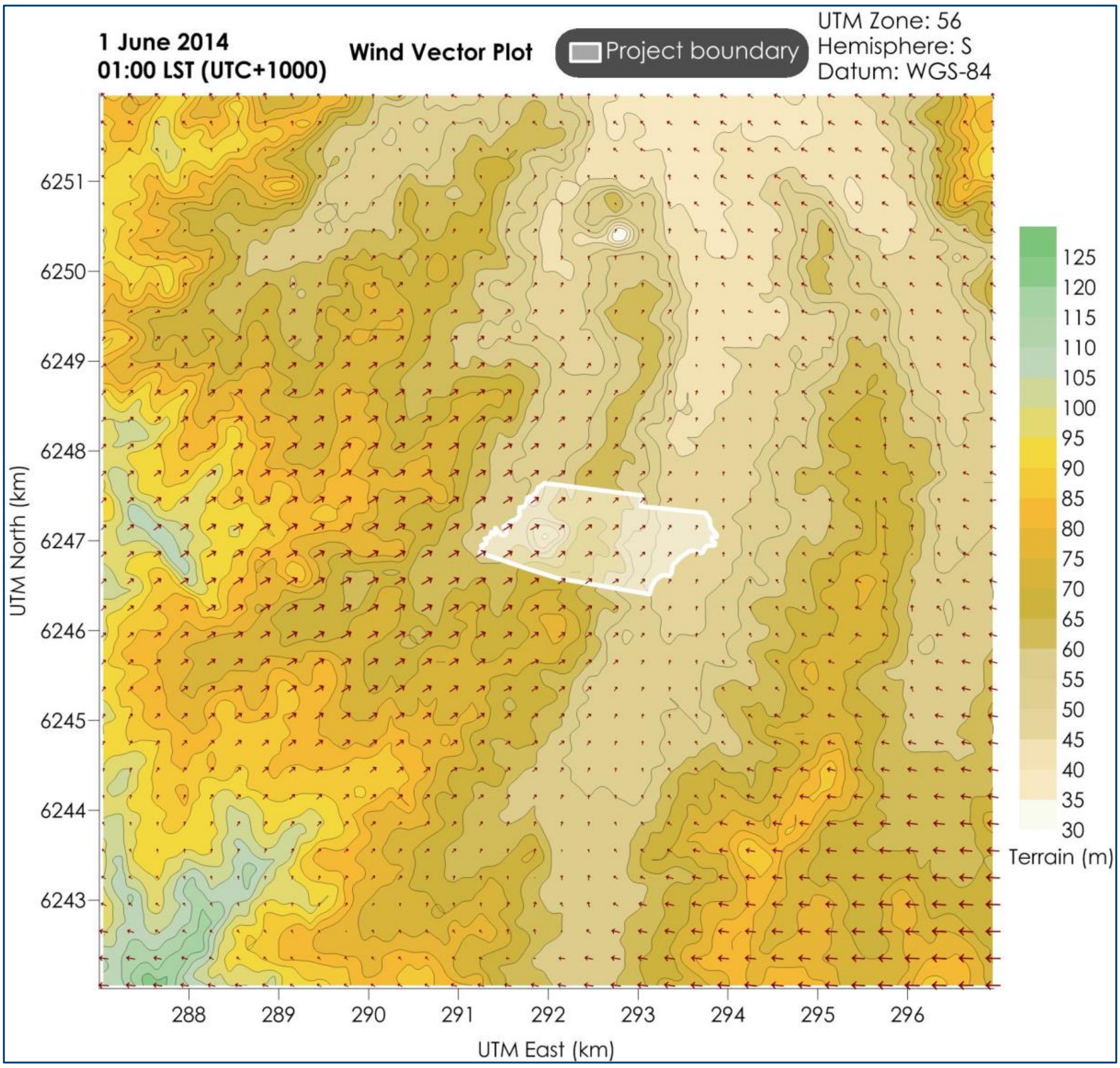

Figure 8-1: Example of the wind field for one of the 8,760 hours of the year that are modelled

CALMET generated meteorological data were extracted from a point within the CALMET domain and are represented in **Figure 8-2** and **Figure 8-3**.

Figure 8-2 presents the annual and seasonal windroses from the CALMET data. The CALMET modelling results reflect the expected wind distribution patterns of the area based on consideration of the measured data and the expected terrain effects on the prevailing winds.

Figure 8-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and is consistent with the conditions expected to occur in the area.

It is considered that the CALMET modelling reflects 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.

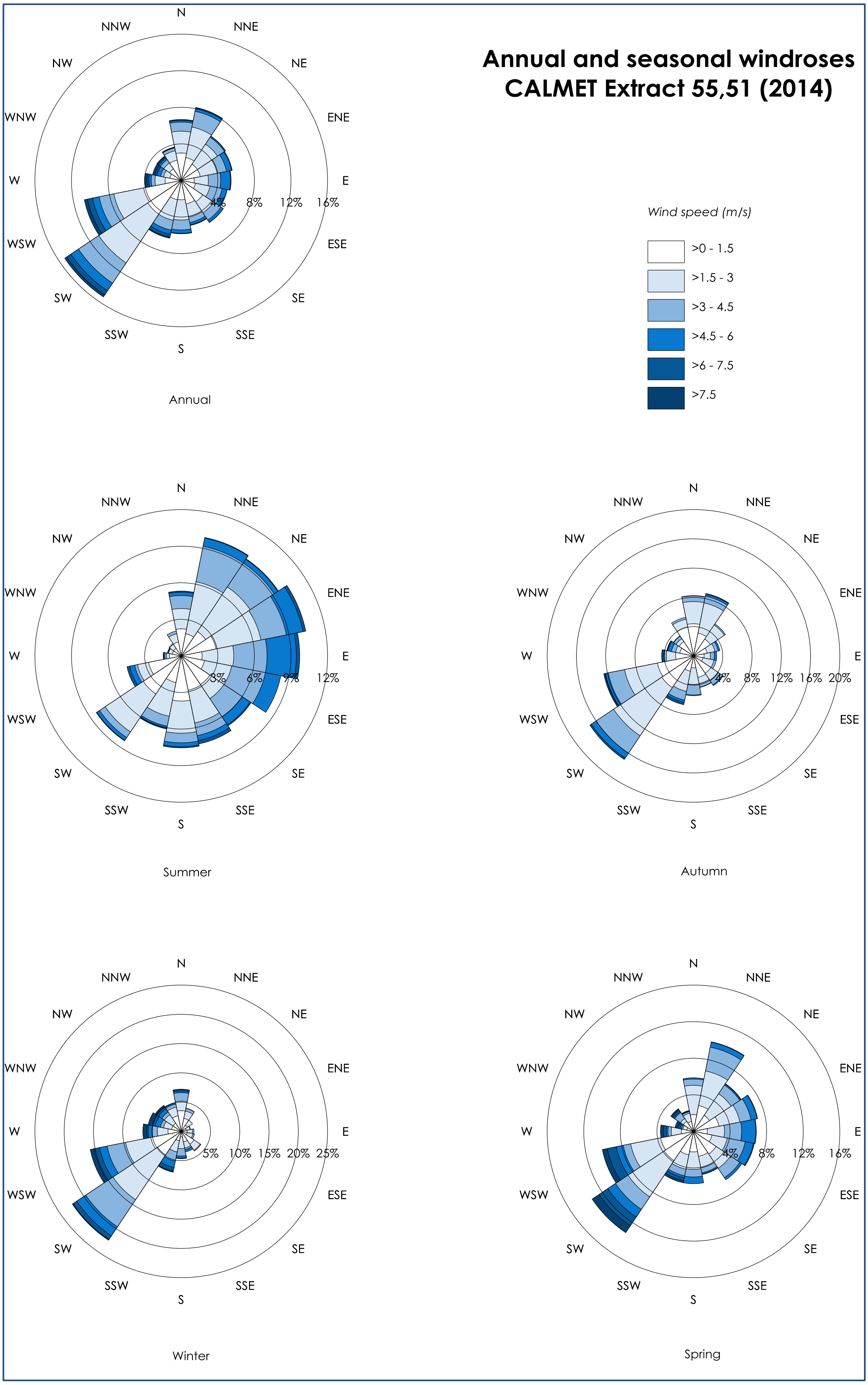

Figure 8-2: Windroses from CALMET extract (cell ref 5551)

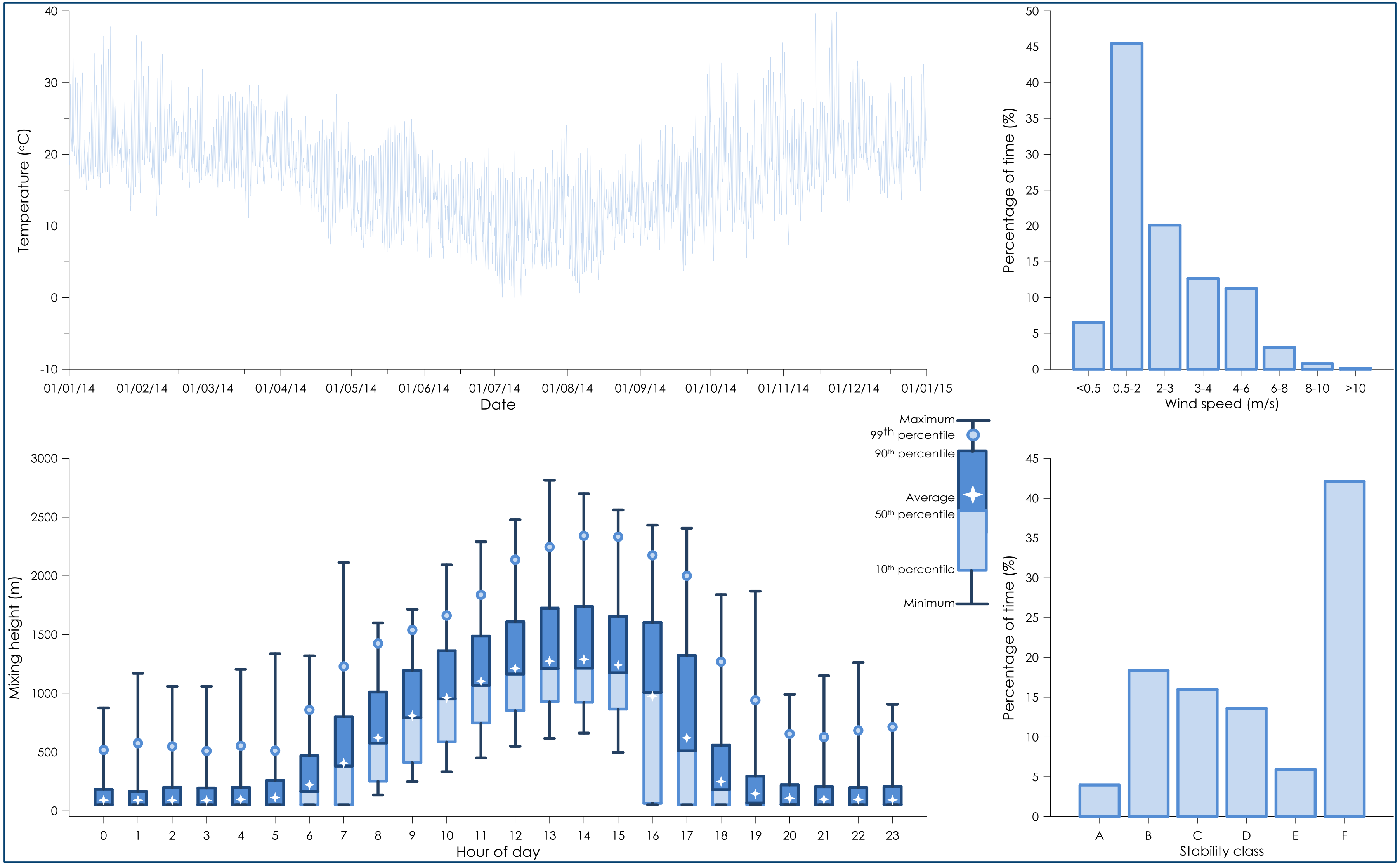

Figure 8-3: Meteorological analysis of CALMET extract (cell ref 5551)

8.2.2 Air dispersion modelling

The CALPUFF dispersion model, in conjunction with a CALMET generated meteorological data file, was applied to provide predictions of the ground level concentrations of pollutants based on the estimated emissions from the activities.

8.3 Modelling scenarios

This assessment considers two operational scenarios to represent the activities at the Project. The scenarios selected were chosen to represent potential worst-case impacts in regard to the quantity of material extracted in each year, the location of the operations occurring on-site and the potential to generate dust at the surrounding sensitive receptors.

The key activities at the Project can be separated into the extraction activities, brick making operations and roof products manufacturing operations.

The extraction activities at the Project are the same as the approved production rate of 420,000 tonnes of clay per calendar year. Activity would be limited to one pit at a time to occur as a campaign basis over a period of approximately 132 days per year.

Figure 8-4 indicates the location of each of the pits relative to sensitive receptors. As the production rate of clay is limited in each calendar year, the potential worst-case operating scenarios from a dust generation perspective, have been identified based on the proximity to the nearest receptors. The worst case scenarios arise for activity occurring in Pit 3 for receptors located to the east of the Project and for activity in Pit 5 for receptors located to the north.

In the Pit 3 scenario burden is removed from Pit 3 and used to fill Pit 2, clay is extracted from Pit 3 and taken to the clay/ raw materials stockpile area and Pit 2 and Pit 3 are active wind erosion sources.

In the Pit 5 scenario burden is removed from Pit 5 and used to fill Pit 4, clay is extracted from Pit 5 and taken to the clay/ raw materials stockpile area and Pit 4 and Pit 5 are active wind erosion sources.

Figure 8-5 and **Figure 8-6** provide the indicative site layouts for the Pit 3 and Pit 5 scenarios respectively.

The modelling assumes the maximum production rate of activity for brick making and roof products manufacturing operations of 300,000 tonnes of bricks and 132,000 tonnes of roof products per calendar year, and that operations occur 24-hours per day, seven days per week.

8.3.1 Alternate Pit 5 haul route

An alternate Pit 5 haul route has been considered as an option to optimise material travel on the Project site. The route is relevant to the Pit 5 scenario only and provides an alternate path of travel to and from the burden emplacement area in Pit 4 and raw material stockpiles.

The alternate Pit 5 haul route, which follows a more direct route between Pit 1 and the brick making facility (rather than travelling around Pit 1) is shorter than the proposed haul route and would significantly reduce dust emissions generated by hauling activities.

Figure 8-7 provides the indicative site layout for the alternative Pit 5 haul route scenario.

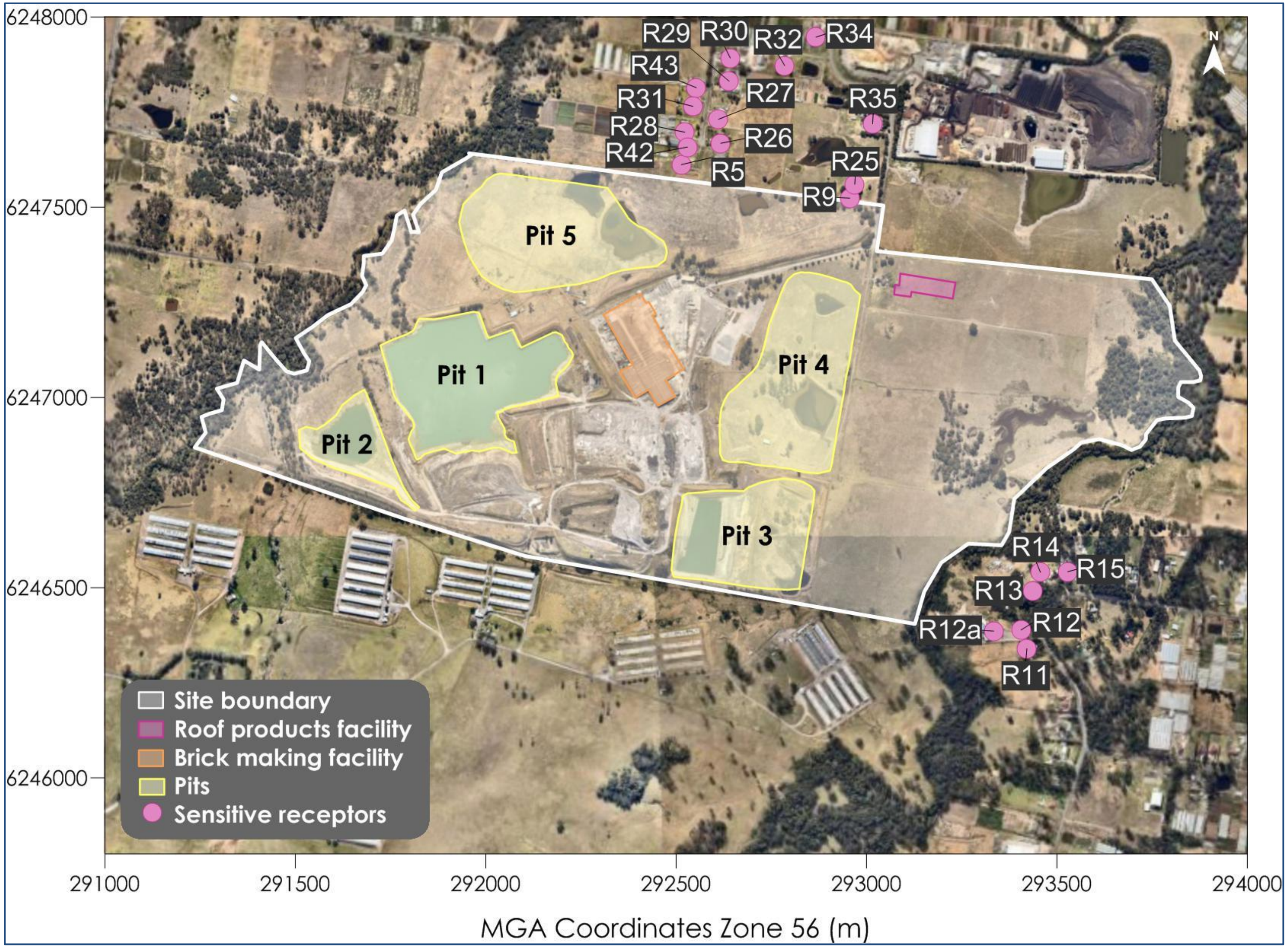

Figure 8-4: Pit locations

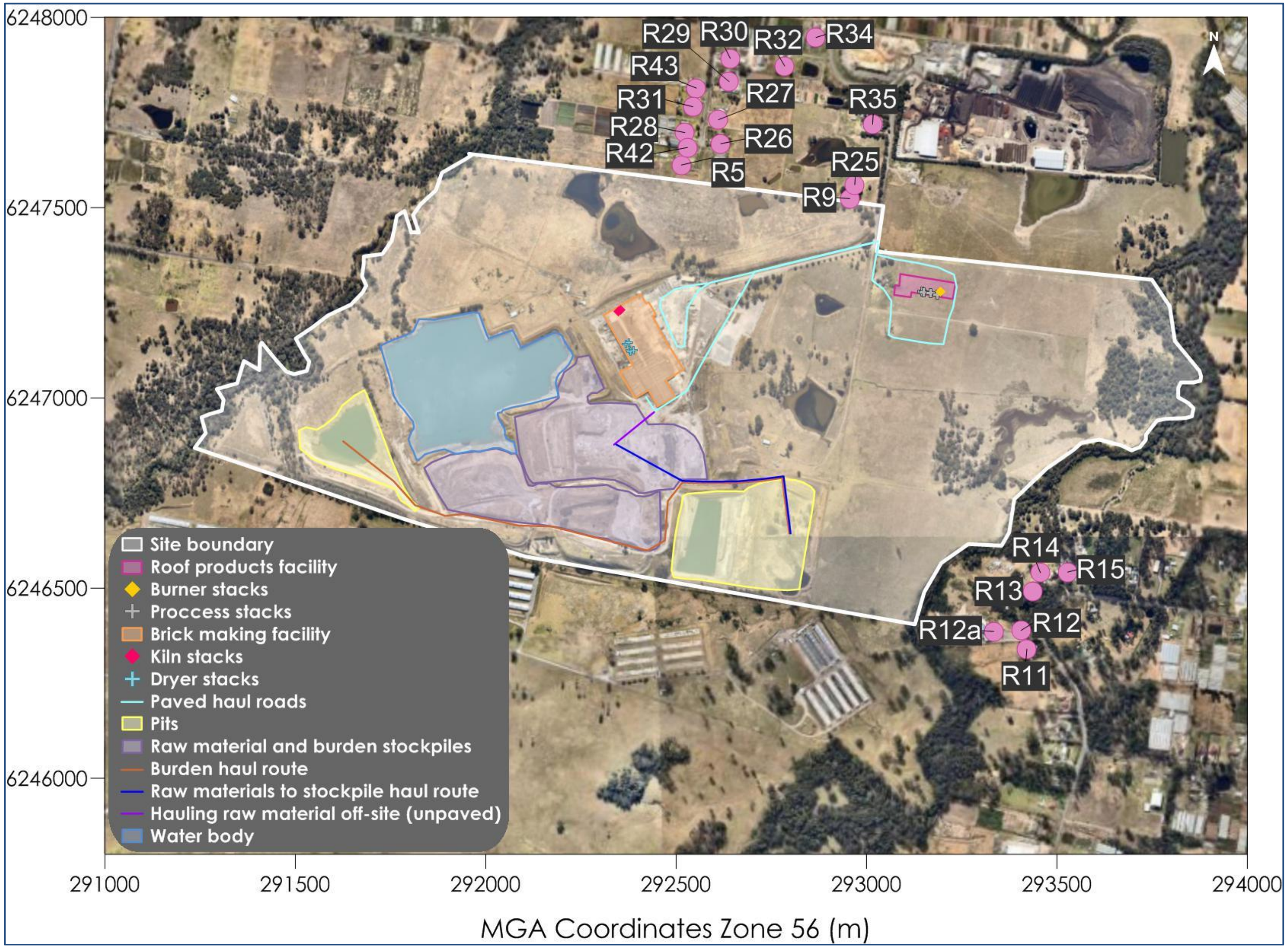

Figure 8-5: Indicative Pit 3 operating scenario

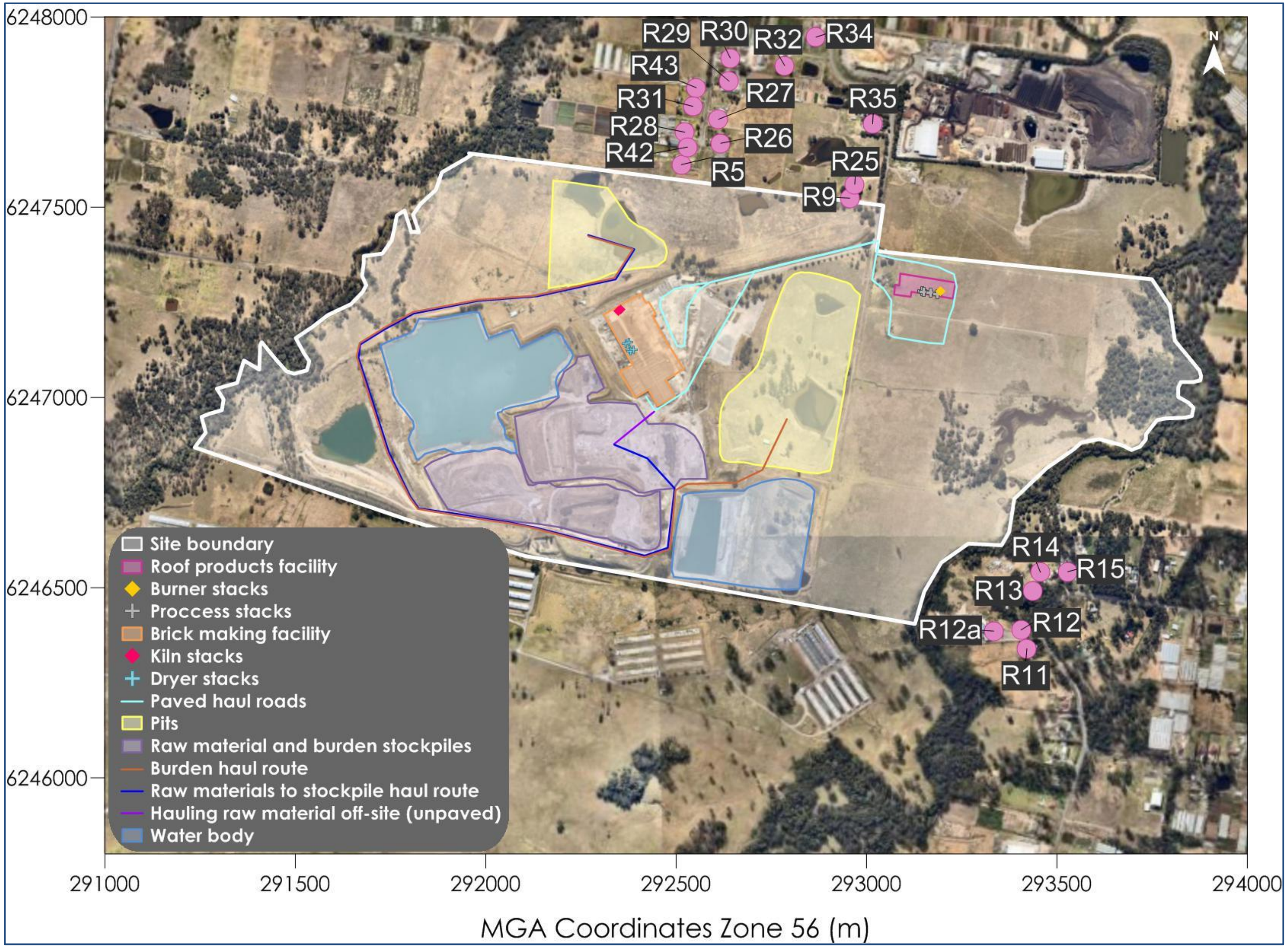

Figure 8-6: Indicative Pit 5 operating scenario

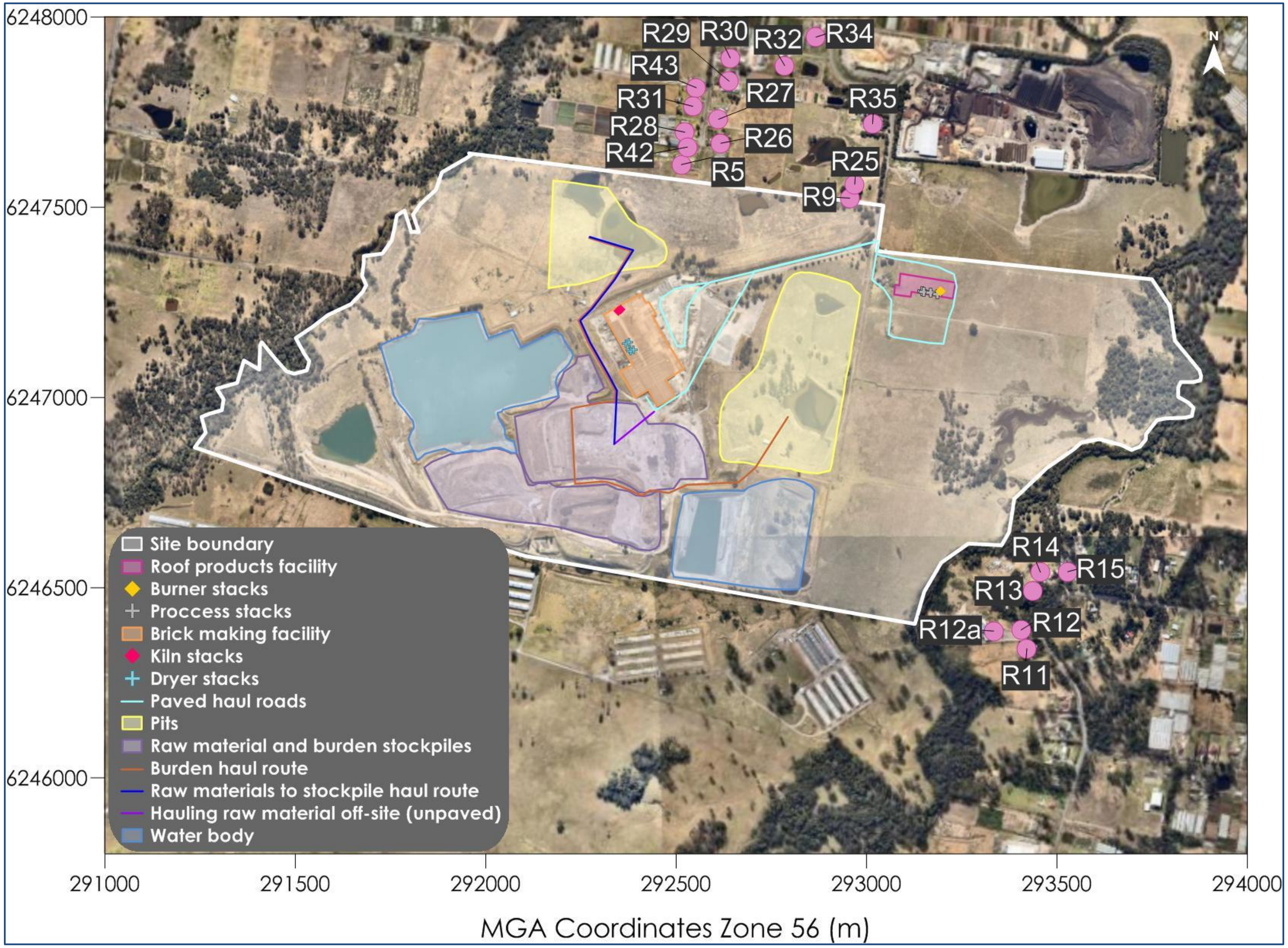

Figure 8-7: Indicative Pit 5 operating scenario – alternate haul route option

8.4 Emissions estimation

For the modelled scenarios, dust emission estimates have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emission factors.

Activities associated with operation of the Project have the potential to generate dust emissions from various activities including; extraction activities, loading/unloading of material, vehicles travelling on-site, and windblown dust generated from stockpiles.

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 both locally developed (**NPI 2012 and 2014**) and US EPA developed documentation (**US EPA 1998**, **US EPA 2006a, US EPA 2006b and US EPA 2011**).

Detailed calculations of the dust emission estimates are provided in **Appendix B**.

8.4.1 Best practice operational dust mitigation measures

The site has considered the possible range of air quality mitigation measures that are feasible and can be applied to achieve a standard of extraction operation consistent with current best practice for the control of dust emissions from mines in NSW, as outlined in the NSW EPA document, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, prepared by Katestone Environmental (**Katestone Environmental, 2010**).

A summary of the key current dust controls, which would continue to be applied for the Project, is shown in **Table 8-3**. A control level of 75% for watering of unpaved haul routes has been applied in the dust emission estimates shown in the following sections.

Table 8-3: Best practice dust mitigation measures

Activity	Dust Control
General	✦ Modify activities during periods of high visible dust ✦ Modify activities during high winds
Hauling on unsealed roads	✦ Watering unpaved roads ✦ Regular cleaning of paved roads with sweeper ✦ Site speed restriction is 15km/h ✦ Shut down engines when vehicles are idle over prolonged periods ✦ Covering of all loads leaving the site
Loading/unloading material	✦ Minimise drop heights ✦ Water spray used where required on unloading activities
Wind erosion on burden emplacements, stockpiles and exposed surfaces	✦ Shaping of stockpiles where practical to avoid strong wind flows and smooth gradients to reduce turbulence at surface

Activity	Dust Control
	✦ Rehabilitation long-term stockpiles and disturbed soil surfaces by revegetation as soon as practical ✦ Watering of active stockpiles when required
Road grading	✦ Watering grader routes during grading

8.4.2 Extraction activities

The estimated dust emissions for activities associated with the extraction activities are presented in **Table 8-4** and **Table 8-5** for the Pit 3 and Pit 5 extraction scenarios respectively.

As the extraction activities occur over a period of approximately 132 days per year, but it is not known which period of the year this may be, the estimated emission rates have been adjusted (up by 365/132) over each day of a full year in order to correctly model the maximum 24-hour average impacts.

Table 8-4: Estimated annual TSP emission rate for extraction activities Pit 3 (kg/year)

Activity	TSP emissions	
	Annual	Modelled emissions for 24-hour impacts
Removal of topsoil / burden in Pit 3 (excavator)	100	277
Loading burden to haul truck	100	277
Hauling burden to Pit 2 (unpaved)	3,520	9,734
Unloading burden at Pit 2	100	277
Compactor in Pit 2 (bulldozer)	1,153	5,259
Bulldozer for breaking up clay/ raw materials in Pit 3	1,153	5,259
Loading clay/ raw material to haul truck	113	313
Haul materials to raw materials stockpile area (unpaved)	7,392	20,441
Unloading clay/ raw materials to stockpile area	113	313
FEL shaping stockpiles	113	516
Grading haul roads	3,326	15,175
Wind erosion Pit 2	2,975	2,975
Wind erosion Pit 3	7,565	7,565
Total emissions	**27,724**	**68,381**

Table 8-5: Estimated annual TSP emission rate for extraction activities Pit 5 (kg/year)

Activity	TSP emissions	
	Annual	Modelled emissions for 24-hour impacts
Removal of topsoil / burden in Pit 5 (excavator)	235	650
Loading burden to haul truck	235	650
Hauling burden to Pit 4 (unpaved)	13,747	38,013
Unloading burden at Pit 4	235	650
Compactor in Pit 4 (bulldozer)	1,153	5,259
Bulldozer for breaking up clay/ raw materials in Pit 5	1,153	5,259
Loading clay/ raw material to haul truck	113	313
Haul materials to raw materials stockpile area (unpaved)	25,257	69,840
Unloading clay/ raw materials to stockpile area	113	313
FEL shaping stockpiles	113	516
Grading haul roads	3,326	15,175

Activity	TSP emissions	
	Annual	Modelled emissions for 24-hour impacts
Wind erosion Pit 4	11,050	11,050
Wind erosion Pit 5	4,760	4,760
Total emissions	**61,491**	**152,448**

8.4.2.1 Alternate haul route option

The estimated dust emissions for activities associated with the extraction activities and alternate haul route are presented in **Table 8-6** for the Pit 5 alternate haul route scenario.

Table 8-6: Estimated annual TSP emission rate for extraction activities Pit 5 – Alternate haul route option (kg/year)

Activity	TSP emissions	
	Annual	Modelled emissions for 24-hour impacts
Removal of topsoil / burden in Pit 5 (excavator)	235	650
Loading burden to haul truck	235	650
Hauling burden to Pit 4 (unpaved)	8,798	24,329
Unloading burden at Pit 4	235	650
Compactor in Pit 2 (bulldozer)	1,153	5,259
Bulldozer for breaking up clay/ raw materials in Pit 5	1,153	5,259
Loading clay/ raw material to haul truck	113	313
Haul materials to raw materials stockpile area (unpaved)	8,624	23,848
Unloading clay/ raw materials to stockpile area	113	313
FEL shaping stockpiles	113	313
Grading haul roads	3,326	15,175
Wind erosion Pit 4	11,050	11,050
Wind erosion Pit 5	4,760	4,760
Total emissions	**39,908**	**92,569**

8.4.3 Brick making facility

The estimated dust emissions for activities associated with the brick making facility are presented in **Table 8-7**.

Raw materials used in the brick making facility are sourced from the on-site stockpiles (145,000 tonnes per annum) and off-site suppliers (up to 215,000 tonnes per annum). Bricks produced from the facility are stored in the existing hardstand area and delivered off-site by trucks travelling on paved roads from the entrance of the site. Up to 330,000 tonnes of bricks are dispatched from the site per calendar year.

Table 8-7: Estimated annual TSP emission rate for the brick making facility (kg/year)

Activity	TSP emissions
Loading clay material from stockpile to box feeder	39
Hauling raw materials from off-site (paved)	2,379
Unloading raw materials from off-site to stockpile	270
Loading raw materials to box feeder	270
Hauling brick products off-site (paved)	3,000
Load clay/ raw material to truck from stockpile for dispatch off-site	74
Truck haulage of clay offsite (unpaved)	1,434
Truck haulage of clay offsite (paved)	3,294

Activity	TSP emissions
Raw material and burden stockpile wind erosion	15,130
Total emissions	**25,890**

8.4.4 Roof products manufacturing facility

The estimated dust emissions for activities associated with roof products manufacturing are presented in **Table 8-8**. The facility makes very low levels of dust per unit of production largely because the facility makes cement tiles, and the material used is deposited into underground hoppers and handled by conveyors or in a sealed system (cement), or has water added to it.

Incoming raw materials include 96,000 tonnes per annum of sand, 24,000 tonnes per annum of cement and flyash, and approximately 4,000 tonnes per annum of liquid products (slurry sand and slurry cement).

It is assumed that five truck loads per week of sand used in the roof product manufacturing is generated from the extraction activities. Reject tiles may either be hauled off-site for recycling or be crushed on site for reuse. It is conservatively assumed in the modelling that reject tiles are both transported off-site and crushed on-site. This double counts the very small emissions from handling the tile rejects.

Table 8-8: Estimated annual TSP emission rate for roof products manufacturing facility (kg/year)

Activity	TSP emissions
Hauling raw materials (paved)	462
Hauling incoming roof products (paved)	31
Crushing sandstone in raw materials stockpile	5
Loading sandstone to truck	10
Hauling sand (unpaved)	49
Hauling sand (paved)	94
Unloading sand to ground bins	106
Unloading cement/flyash to silos	12
Hauling finished roof products (paved)	789
Loading reject tiles to bunker	8
Crushing reject tiles	4
Total emissions	**1,568**

8.4.5 Stack emissions

Air emissions from the Project would also arise from various stack emission points at the brick making facility and roof product manufacturing facility. **Table 8-9** and **Table 8-10** provide the modelling parameters for each stack associated with the brick making facility and roof product manufacturing facility respectively.

The model included consideration of potential "building" wake effects on air dispersion which arise due to the effect of winds passing over the buildings within and around the Project site. The PRIME algorithm is used to model building downwash effects.

Table 8-9: Brick making facility stack modelling parameters

Source	X coordinate (m)	Y coordinate (m)	Height (m)	Diameter (m)	Exit temp (K)	Exit velocity (m/s)
Kiln 1	292349	6247228	41	1.42	385.8	22.3
Kiln 2	292355	6247232	41	1.42	385.8	22.3

Source	X coordinate (m)	Y coordinate (m)	Height (m)	Diameter (m)	Exit temp (K)	Exit velocity (m/s)
Dryer 1	292369	624714	13	0.98	305	6.5
Dryer 2	292379	6247126	13	0.98	305	6.5
Dryer 3	292381	6247122	13	0.98	305	6.5
Dryer 4	292388	6247126	13	0.98	305	6.5
Dryer 5	292376	6247146	13	0.98	305	6.5

Table 8-10: Roof products manufacturing facility stack modelling parameters

Source	X coordinate (m)	Y coordinate (m)	Height (m)	Diameter (m)	Exit temp (K)	Exit velocity (m/s)
Burner 1	293194	6247279	12	0.37	383	2.5
Burner 2	293195	6247279	12	0.31	383	2.5
Process 1	293146	6247280	11	0.56	318	15
Process 2	293146	6247279	11	0.56	318	15
Process 3	293151	6247278	11	0.56	318	15
Process 4	293168	6247275	11	0.56	318	15
Process 5	293186	6247272	11	0.56	318	15

The emission rates for the kiln stacks and dryer stacks at the brick making facility are based on the expected stack concentrations from historical stack emissions testing for other similar facilities provided by the Proponent as well as stack emissions testing conducted for the existing facility (**EML, 2010** & **EML, 2011**).

The estimated stack emission rates used in this assessment for the brick making facility are presented in **Table 8-11**. We note that estimated stack emissions of $PM_{2.5}$ were conservatively assumed to be 100% of PM_{10} for the purpose of this assessment.

Table 8-11: Estimated stack emission rates – Brick making facility

Stack	Pollutant	Emission rate (g/s) or (OU/s)
Kiln 1 & Kiln 2	TSP	0.97
	PM_{10}	0.23
	$PM_{2.5}$	0.23
	SO_2	2.0
	NO_x	2.85
	HF	0.95
	Cl	0.005
	SO_3	0.06
	Odour	29726
Dryers 1- 5	TSP	0.019
	PM_{10}	0.013
	$PM_{2.5}$	0.013
	SO_2	0.0007
	NO_x	0.018
	HF	0.0001
	Cl	0.0002
	SO_3	0.01
	Odour	683

The estimated emission rates for the burner stacks and process stacks at the roof products manufacturing facility are based on NPI emission factors (**NPI, 2011**) and for the process stacks, the estimated concentrations were assumed to be similar to the dryer stack concentrations from the brick making facility and this would be conservative.

The estimated stack emission rates used in this assessment for the roof products manufacturing facility are presented in **Table 8-12**.

Table 8-12: Estimated stack emission rates – Roof products manufacturing facility

Stack	Pollutant	Emission rate (g/s) or (OU/s)
Burner 1 & Burner 2	TSP	0.0034
	PM_{10}	0.0034
	$PM_{2.5}$	0.001
	SO_2	0.0053
	NO_x	0.058
Process 1- 5	TSP	0.014
	PM_{10}	0.01
	$PM_{2.5}$	0.01
	SO_2	0.0005
	NO_x	0.013
	HF	0.0001
	Cl	0.0001
	SO_3	0.0073
	Odour	493

It has been conservatively assumed that all NO_x is converted to NO_2 for all sources.

8.4.6 Emissions from other nearby operations

There are two facilities identified in the vicinity of the site which may contribute to local dust levels; Australian Native Landscapes (ANL) located at 210 Martin Road, Badgerys Creek and a Resource Recovery Facility at 25 Martin Road, Badgerys Creek.

Activities at the ANL facility include processing, handling, movement and storage of compost and garden products. It is noted that compost products have a relatively high moisture content thus would have a low potential for windblown dust emissions and from handling of the material and hence dust emissions from the ANL facility are anticipated to be low.

The Resource Recovery Facility at 25 Martin Road processes 50,000 tonnes per annum of construction and demolition waste and 10,000 tonnes per annum of green waste material. On-site activities include the transfer, sorting, stockpiling and processing (crushing or mulching/chipping) of materials. The Resource Recovery Facility is located over 1km from the Project site and therefore it is unlikely that any dust emissions from the site would have a tangible cumulative impact at the receptors located near the Project.

We note that the local monitoring data presented in **Section 6.3** indicate that the existing air quality levels, which include the contribution from the existing facilities, were generally lower than the levels measured at the NSW OEH monitoring stations located further afield. Thus using the higher levels recorded at the NSW OEH monitoring stations to represent background air quality levels would account for any potential small contribution from the existing facilities nearby.

8.4.7 Comparison with approved project

Table 8-13 presents a comparison of the estimated TSP emission rate for a modelled scenario for the approved project (**AECOM, 2011**) with scenarios for the proposed modification. The Pit 5 scenario for the approved project and the proposed modification have been selected for the comparison.

The values in **Table 8-13** indicate the proposed modification would see an increase in the amount of TSP emissions generated compared to the approved project by approximately 44%. A comparison with the alternate haul route scenario would result in an increase of approximately 7%.

This suggests that the proposed modification would potentially result in more dust generated compared to the approved project, however would not significantly change the with the alternate haul route scenario.

We note there are differences associated with the extraction activity of the approved project compared with the extraction activity for the proposed modifications, such as the location and extent of the extraction area. The period of extraction for the proposed modification would occur over a longer timeframe compared to the approved project and hence the intensity of dust emissions would be reduced.

Table 8-13: Comparison of approved project and proposed modification estimated TSP emissions (kg of TSP)

Aspect	Approved project	Proposed modification	Proposed modification with alternate haul route scenario
Pit 5 scenario	23,207	61,491	39,908
Other activity	39,920	25,890	25,890
Roof products production	-	1,568	1,568
Total TSP emissions	**63,126**	**88,949**	**67,366**
Percent increase in emissions compared to approved project		41%	7%

9 DISPERSION MODELLING RESULTS

The dispersion model predictions for each of the assessed scenarios are presented in this section. The results presented include those for the operation in isolation (incremental impact) and cumulative impacts with background levels.

9.1 Dust modelling predictions

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 $PM_{2.5}$ and PM_{10} concentrations;
- Annual average 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, the predictions are based on the highest predicted 24-hour average concentrations modelled at each grid (or discrete receptor) point in the modelling domain. At each point, this is the worst day (i.e. a 24-hour period) in the annual modelling period. The predictions thus do not represent just one particular day, but a combination of all of the worst case days at every point. Thus the extent of the predicted impacts is a large overestimation of what would actually occur on any single day.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix C**. **Table 9-1** and **Table 9-2** present the predicted incremental particulate dispersion modelling results at each of the assessed sensitive receptor locations for the Pit 3 and Pit 5 modelling scenarios, respectively.

The results in **Table 9-1** and **Table 9-2** indicate the Project would be below the relevant incremental criteria at all the assessed receptor locations for all scenarios.

The predicted maximum incremental 24-hour average $PM_{2.5}$ and PM_{10} levels are based on activity occurring all year round, whereas this would only occur on a campaign basis over 132 days in the year.

Table 9-1: Incremental particulate dispersion modelling results for sensitive receptors – Pit 3 scenario

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
	NSW EPA Air Quality Impact Criteria / VLAMP					
	25	-	50	-	-	2
R5	1.9	0.3	10.8	1.1	3.1	0.1
R9	2.3	0.4	11.6	1.7	5.7	0.2
R11	1.3	0.1	8.1	0.3	0.7	<0.1
R12	1.4	0.1	8.4	0.3	0.7	<0.1
R12a	1.6	0.1	9.7	0.4	0.8	<0.1
R13	1.3	0.1	7.9	0.3	0.8	<0.1
R14	1.2	0.1	7.6	0.3	0.8	<0.1
R15	1.1	0.1	7.0	0.3	0.7	<0.1

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	NSW EPA Air Quality Impact Criteria / VLAMP					
	25	-	50	-	-	2
R25	2.0	0.3	10.0	1.4	4.4	0.1
R26	1.8	0.3	10.0	1.0	2.9	0.1
R27	1.6	0.2	9.0	0.8	2.4	0.1
R28	1.7	0.2	9.4	0.9	2.5	0.1
R29	1.4	0.2	7.7	0.7	1.9	<0.1
R30	1.3	0.2	7.0	0.6	1.6	<0.1
R31	1.5	0.2	8.5	0.8	2.1	0.1
R32	1.3	0.2	6.8	0.7	1.8	<0.1
R34	1.1	0.2	5.8	0.6	1.5	<0.1
R35	1.4	0.2	7.6	0.9	2.4	0.1
R42	1.8	0.3	10.1	1.0	2.8	0.1
R43	1.4	0.2	7.9	0.7	1.9	<0.1
R44	1.0	0.1	5.7	0.5	1.2	<0.1
R45	1.0	0.1	5.7	0.5	1.3	<0.1
R46	1.0	0.1	5.3	0.5	1.3	<0.1

Table 9-2: Incremental particulate dispersion modelling results for sensitive receptors – Pit 5 scenario

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	NSW EPA Air Quality Impact Criteria / VLAMP					
	25	-	50	-	-	2
R5	4.2	0.5	27.5	2.4	6.0	0.3
R9	2.7	0.5	17.8	2.3	7.0	0.3
R11	1.5	0.1	11.1	0.3	0.7	<0.1
R12	1.6	0.1	11.8	0.3	0.8	<0.1
R12a	1.7	0.1	12.9	0.4	0.8	<0.1
R13	1.6	0.1	12.3	0.4	0.8	<0.1
R14	1.6	0.1	12.3	0.4	0.9	<0.1
R15	1.5	0.1	11.1	0.3	0.8	<0.1
R25	2.5	0.4	16.2	2.0	5.6	0.2
R26	3.4	0.4	22.1	1.8	4.6	0.2
R27	3.0	0.3	18.8	1.5	3.8	0.1
R28	3.2	0.4	22.2	1.7	4.3	0.2
R29	2.4	0.3	16.0	1.2	2.9	0.1
R30	2.2	0.2	15.2	1.0	2.4	0.1
R31	2.9	0.3	19.9	1.4	3.4	0.1
R32	2.3	0.2	14.2	1.1	2.6	0.1
R34	2.0	0.2	13.2	0.9	2.2	0.1
R35	2.1	0.3	14.1	1.3	3.2	0.1
R42	3.6	0.4	23.4	2.0	5.0	0.2
R43	2.8	0.3	18.8	1.2	3.0	0.1
R44	2.1	0.2	14.5	0.7	1.8	0.1
R45	1.9	0.2	13.4	0.7	1.8	0.1

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
	NSW EPA Air Quality Impact Criteria / VLAMP					
	25	-	50	-	-	2
R46	1.8	0.2	12.1	0.8	1.8	0.1

The cumulative (total) impact is the impact associated with the operation of the Project combined with the ambient background levels in **Section 5.3.4**. The predicted cumulative annual average PM$_{2.5}$, PM$_{10}$, TSP and dust deposition levels due to the Project for the Pit 3 and Pit 5 modelling scenarios is shown in **Table 9-3** and **Table 9-4**, respectively.

Cumulative 24-hour average PM$_{2.5}$ and PM$_{10}$ impacts need to be assessed differently to annual average values because there are 365 days in the year with different levels of impact and also different background levels on each day. Cumulative 24-hour impacts are considered in detail in **Section 7.2**.

The results in **Table 9-3** and **Table 9-4** indicate that the predicted levels would be below the relevant annual average particulate criteria at the assessed receptor locations for both modelling scenarios.

Table 9-3: Cumulative annual average particulate dispersion modelling results for sensitive receptors – Pit 3 scenario

Receptor ID	PM$_{2.5}$ (µg/m³)	PM$_{10}$ (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	NSW EPA Air Quality Impact Criteria / VLAMP			
	8	25	90	4
R5	7.3	17.7	62.9	2.8
R9	7.4	18.3	65.5	2.9
R11	7.1	16.9	60.5	2.7
R12	7.1	16.9	60.5	2.7
R12a	7.1	17.0	60.6	2.7
R13	7.1	16.9	60.6	2.7
R14	7.1	16.9	60.6	2.7
R15	7.1	16.9	60.5	2.7
R25	7.3	18.0	64.2	2.8
R26	7.3	17.6	62.7	2.8
R27	7.2	17.4	62.2	2.8
R28	7.2	17.5	62.3	2.8
R29	7.2	17.3	61.7	2.7
R30	7.2	17.2	61.4	2.7
R31	7.2	17.4	61.9	2.8
R32	7.2	17.3	61.6	2.7
R34	7.2	17.2	61.3	2.7
R35	7.2	17.5	62.2	2.8
R42	7.3	17.6	62.6	2.8
R43	7.2	17.3	61.7	2.7
R44	7.1	17.1	61.0	2.7
R45	7.1	17.1	61.1	2.7
R46	7.1	17.1	61.1	2.7

Table 9-4: Cumulative annual average particulate dispersion modelling results for sensitive receptors – Pit 5 scenario

Receptor ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	NSW EPA Air Quality Impact Criteria / VLAMP			
	8	25	90	4
R5	7.5	19.0	65.8	3.0
R9	7.5	18.9	66.8	3.0
R11	7.1	16.9	60.5	2.7
R12	7.1	16.9	60.6	2.7
R12a	7.1	17.0	60.6	2.7
R13	7.1	17.0	60.6	2.7
R14	7.1	17.0	60.7	2.7
R15	7.1	16.9	60.6	2.7
R25	7.4	18.6	65.4	2.9
R26	7.4	18.4	64.4	2.9
R27	7.3	18.1	63.6	2.8
R28	7.4	18.3	64.1	2.9
R29	7.3	17.8	62.7	2.8
R30	7.2	17.6	62.2	2.8
R31	7.3	18.0	63.2	2.8
R32	7.2	17.7	62.4	2.8
R34	7.2	17.5	62.0	2.8
R35	7.3	17.9	63.0	2.8
R42	7.4	18.6	64.8	2.9
R43	7.3	17.8	62.8	2.8
R44	7.2	17.3	61.6	2.8
R45	7.2	17.3	61.6	2.8
R46	7.2	17.4	61.6	2.8

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

An assessment of total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in accordance with the methods outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

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 (2014 calendar year) from the NSW OEH monitoring sites at Bringelly and Liverpool respectively have been applied in this case to represent the prevailing background levels in the vicinity of the Project and representative sensitive receptor locations.

Table 9-5 and **Table 9-6** provide a summary of the findings from the Level 2 assessment at representative receptor locations for the Pit 3 and Pit 5 scenarios respectively. Detailed tables of the assessment results are provided in **Appendix D**.

The results in **Table 9-5** indicate that the Project will not increase the number of days above the 24-hour average criterion at the most impacted receptors, and thus meets the EPA cumulative impact assessment criteria at all receptors at all times.

Table 9-5: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion – Pit 3 scenario

Receptor ID	$PM_{2.5}$	PM_{10}
R5	0	0
R9	0	0
R12a	0	0
R26	0	0

Table 9-6: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion – Pit 5 scenario

Receptor ID	$PM_{2.5}$	PM_{10}
R5	0	0
R9	0	0
R12a	0	0
R26	0	0

9.3 Dust impacts on more than 25 per cent of privately-owned land

The potential for dust impacts due to the Project to extend over more than 25 per cent of any privately-owned land, has been evaluated using the tabulated results in **Section 9.1** and predicted pollutant dispersion contours in **Appendix C**.

The results indicate that the relevant assessment criteria in **Table 5-3** would not be exceeded on more than 25 per cent of any parcel(s) of privately-owned land, and thus that the VLAMP criterion is met.

9.4 Other pollutants

A summary of the maximum cumulative impacts of SO_2, NO_2 and HF at sensitive receptors is shown in **Table 9-7**. The modelling predictions indicate they would be below the relevant criteria at all sensitive receptor locations.

Table 9-8 provides a summary of the predicted incremental impacts of chlorine, sulfuric acid and odour from the Project at the site boundary and sensitive receptors. No exceedances of the criteria for these pollutants are predicted at any sensitive receptors or the site boundary due to emissions from the Project.

Pollutant concentration isopleths showing the spatial distribution of the predicted incremental impacts associated with the Project over the modelling domain are presented in **Appendix C**.

Table 9-7: Maximum dispersion modelling results - SO_2, NO_2, and HF

Pollutant	Averaging period	Maximum incremental impact at receptor	Background concentration	Maximum cumulative impact at receptor	Criteria	Units
SO_2	1 hour	56.3	25.7	82	570	µg/m³
	24 hour	4.8	8.6	13.4	228	µg/m³
	Annual	0.8	0.7	1.5	60	µg/m³
NO_2	1 hour	81.0	51.3	132.3	246	µg/m³
	Annual	1.2	8.2	9.4	62	µg/m³
HF	24 hours	2.3	-	-	2.9	µg/m³

-No background data available

Table 9-8: Dispersion modelling results – chlorine, sulfuric acid and odour

Pollutant	Averaging period	Percentile	Maximum incremental impact at boundary	Maximum incremental impact at receptor	Criteria	Units
Cl	1 hour	99.9th	0.00008	0.00008	0.05	mg/m^3
H_2SO_4	1 hour	99.9th	0.0012	0.0012	0.018	mg/m^3
Odour	1 hour peak to mean corrected	99th	<1	<1	2	OU

9.5 Modelling predictions for alternative haul route

This section presents the modelling predictions for the alternative haul route for the Pit 5 scenario with the shorter haul route as described in **Section 8.3.1**. The modelling predictions in this section are presented for the most potentially affected receptors for this scenario.

Table 9-9 and **Table 9-10** present the predicted incremental and cumulative impacts associated with the alternative haul route Pit 5 scenario. The results in **Table 9-9** and **Table 9-10** indicate the Project would be below the relevant air quality impact criteria at the assessed receptor locations.

As expected, relative to the predictions for the proposed haul route (refer to **Table 9-2** and **Table 9-4**), the dust levels arising with the alternative haul route are lower.

Table 9-9: Incremental particulate dispersion modelling results for sensitive receptors – Pit 5 scenario – alternate haul routes

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	DD ($g/m^2/month$)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	Air Quality Impact Criteria					
	-	-	-	-	-	2
R5	3.2	0.4	20.2	2.2	5.4	0.2
R9	2.5	0.5	14.7	2.2	6.7	0.2
R12a	1.2	0.1	8.4	0.3	0.7	<0.1
R26	2.7	0.4	14.8	1.7	4.2	0.2

Table 9-10: Cumulative annual average particulate dispersion modelling results for sensitive receptors – Pit 5 scenario – alternate haul routes

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	DD ($g/m^2/month$)
	Air Quality Impact Criteria			
	8	25	90	4
R5	7.5	19.0	65.8	3.0
R9	7.5	18.9	66.8	3.0
R12a	7.1	17.0	60.6	2.7
R26	7.4	18.4	64.4	2.9

Table 9-11 presents a summary of the findings from the Level 2 assessment of cumulative 24-hour average PM_{10} and $PM_{2.5}$ impacts at the selected receptor locations for the alternative haul route Pit 5 scenario.

The results in **Table 9-11** indicate that the Project will not increase the number of days above the 24-hour average criterion at the assessed receptors.

Overall, the results indicate that implementing the alternate haul route would reduce dust impacts from the Project.

Table 9-11: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion – Pit 5 scenario – alternate haul routes

Receptor ID	$PM_{2.5}$	PM_{10}
R5	0	0
R9	0	0
R12a	0	0
R26	0	0

9.6 CASA plume rise assessment

The Project is located within close proximity to the Western Sydney Airport and has potential to affect the protected airspace known as the Obstacle Limitation Surface (OLS). A plume rise assessment is required where tall structures and exhaust plumes are within the OLS and have the potential to impact aircraft safety.

A form 1247 was submitted to the Civil Aviation Safety Authority (CASA) requesting a plume rise assessment for the Project. CASA assessed all exhaust plumes from the Project and found that:

"there is no infringement of the Obstacle Limitation Surfaces at a critical velocity of 4.3m/sec and CASA considers that there will be an Acceptable Level of Safety. No additional mitigations would be required."

10 MITIGATION AND MANAGEMENT

The site will continue to operate in accordance with the *Badgerys Creek Quarry and Brick Making Facility – Air Quality and Greenhouse Gas Management Plan* (**APP, 2013**).

This management plan is to be updated to include new activities included in the modification such as the roof product manufacturing facility, and to ensure best practice techniques are being applied.

The air quality modelling predictions for the operation of the Project demonstrates compliance with the assessment criteria for all dust metrics at the assessed receptor locations and thus the Reactive Dust Management Program as per the *Badgerys Creek Quarry and Brick Making Facility – Air Quality and Greenhouse Gas Management Plan* (**APP, 2013**) is no longer necessary.

The existing HVAS monitor is recommended to be relocated to a position more representative of the surrounding receptor locations, such as to the northern boundary of the site. The HVAS monitor would measure the environmental performance of the Project and facilitate the management of air quality impacts.

If any exceedances are identified due to the Project through air quality monitoring or from ongoing dust related complaints, a reactive dust management strategy would be recommended to be implemented to assist with the management of dust emissions from the ongoing activity.

11 SUMMARY AND CONCLUSIONS

This report has assessed the potential worst-case air quality impacts associated with the proposed CSR Advanced Manufacturing Hub Modification 3.

Air dispersion modelling using the CALPUFF model was used, with generally conservative assumptions to predict the potential for off-site air quality impacts in the surrounding area due to the Project.

It is predicted that the operation of the Project would comply with all assessment criteria for all air pollutants at all receptors.

The use of an alternative haul route for the Pit 5 stage of the Project would reduce dust impacts, and is an effective means to minimise the overall dust generated whilst optimising the site travel distances.

Given the conservative nature of the modelling assessment, it is anticipated that application of the existing *Air Quality and Greenhouse Gas Management Plan* (**2013**), would result in actual dust levels lower than the levels predicted.

Overall, the assessment demonstrates that the operation of the Project would not cause any unacceptable air quality impact in the surrounding environment.

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Appendix A

Selection of Meteorological Year

Selection of meteorological year

The 2014 calendar year has been selected as the meteorological year for the dispersion modelling based on an analysis of the latest five years of meteorological data and wind patterns which reflect those patterns experienced in latest five years.

A statistical analysis of the latest five years of meteorological data from the nearest BoM weather station with suitable available data, Badgerys Creek AWS, is presented in **Table A-1**. The standard deviation of five years of meteorological data spanning 2013 to 2017 was analysed against the mean measured wind speed, wind direction, temperature and relative humidity.

The analysis indicates that 2014 is closest to the average for wind speed, 2014 is the closest to the average wind direction, 2016 is the closest to the average for temperature and 2013 is closest for relative humidity.

Figure A-1 shows the frequency distributions for wind speed, wind direction, temperature and relative humidity of the 2014 year compared with the mean of the 2013 to 2017 data set. The 2014 year data appears to be well aligned with the mean data for wind speed and wind direction which are the most critical parameters for dispersion.

Therefore, based on this analysis it was determined that 2014 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 of standard deviation from mean five year meteorological data at Badgerys Creek AWS

Year	Wind speed	Wind direction	Temperature	Relative humidity
2013	0.25	0.17	0.13	0.18
2014	0.14	0.15	0.19	0.23
2015	0.38	0.21	0.19	0.28
2016	0.47	0.27	0.09	0.21
2017	0.52	0.24	0.28	0.33

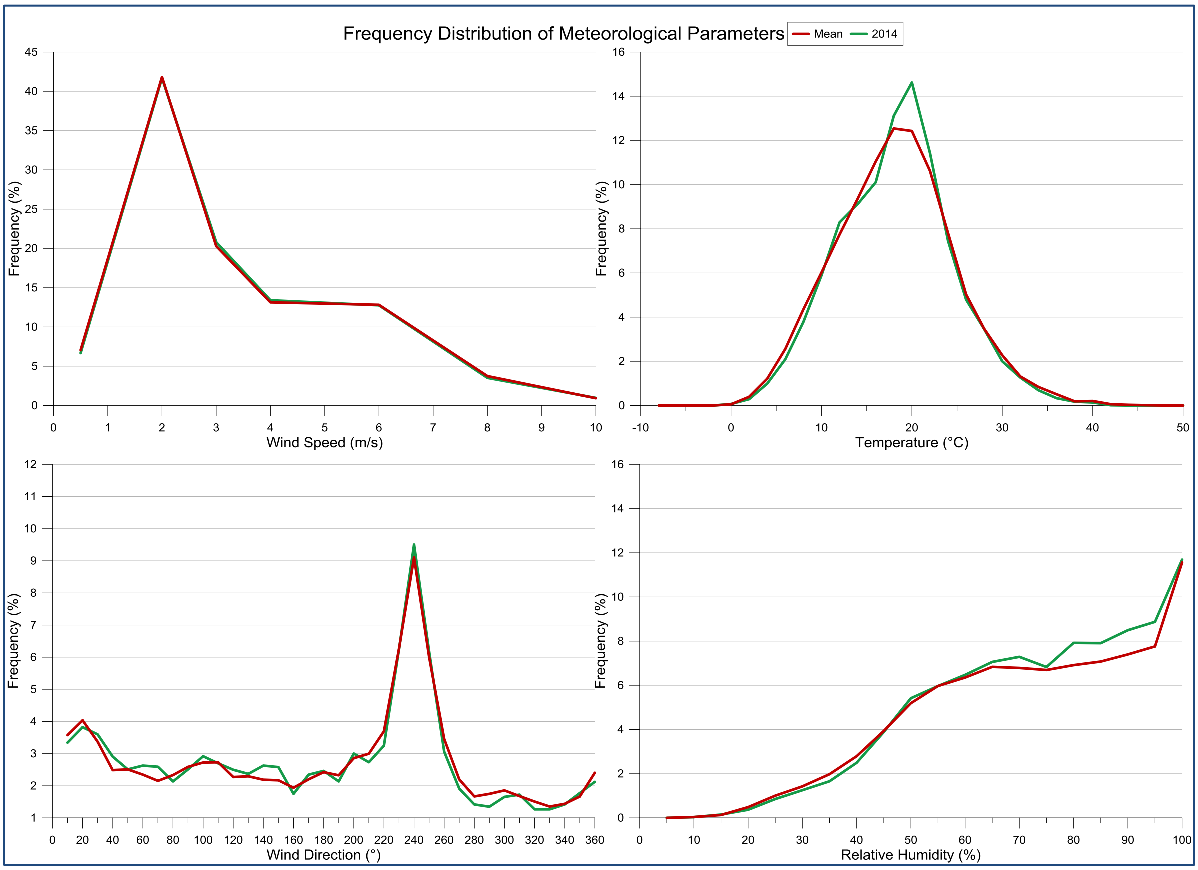

Figure A-1: Frequency distribution of meteorological parameters

Annual and seasonal windroses prepared from data collected for the 2014 calendar year are presented in **Figure A-2**.

A five year annual and seasonal windrose for the Badgerys Creek AWS spanning 2013 to 2017 is presented in **Figure A-3**. The windrose indicates little variation when compared to the individual year presented in **Figure A-2** for the 2014 period. This further suggests that the 2014 calendar year is representative of the available data and is a suitable period for modelling.

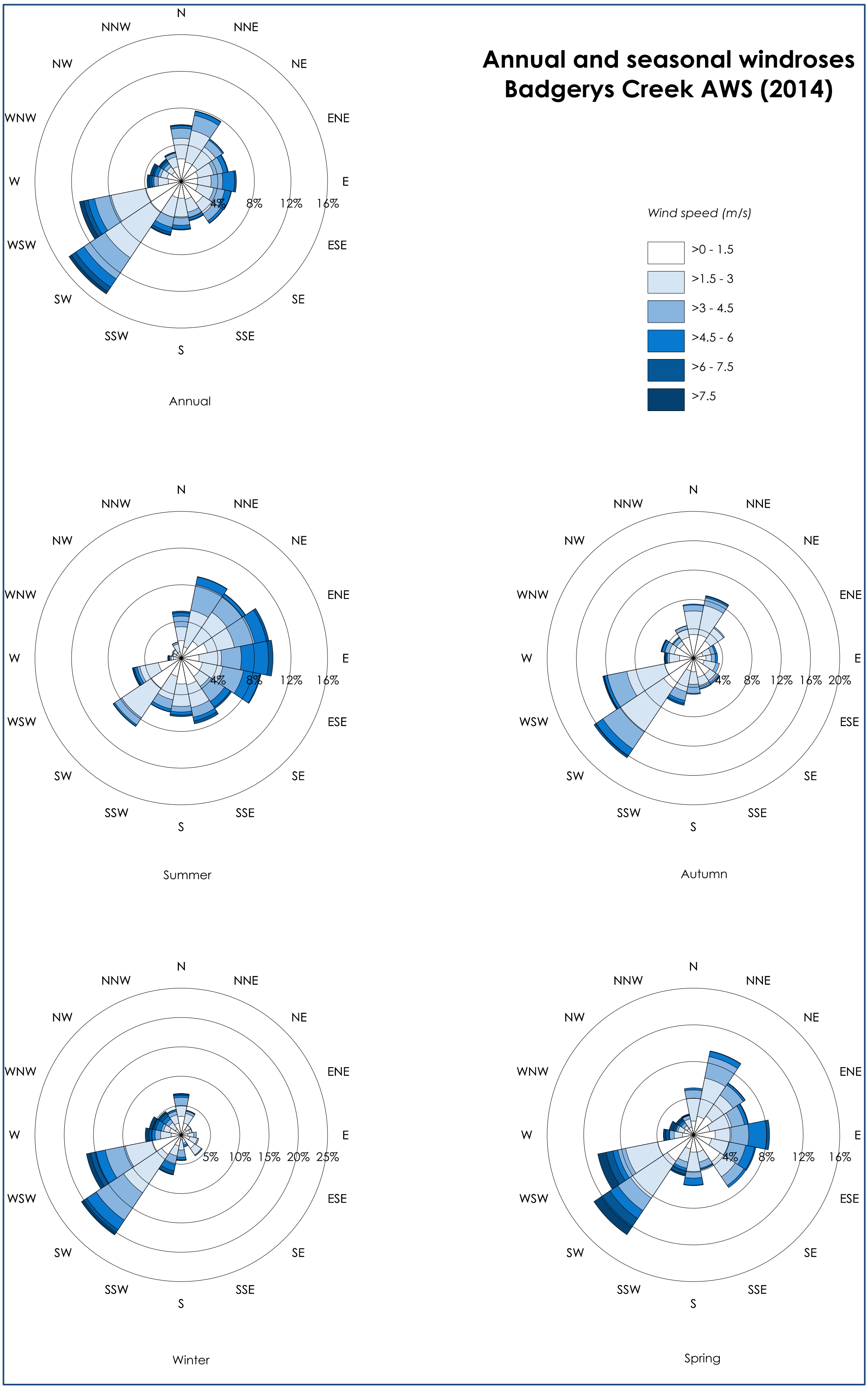

Figure A-2: Annual and seasonal windroses for Badgerys Creek AWS (2014)

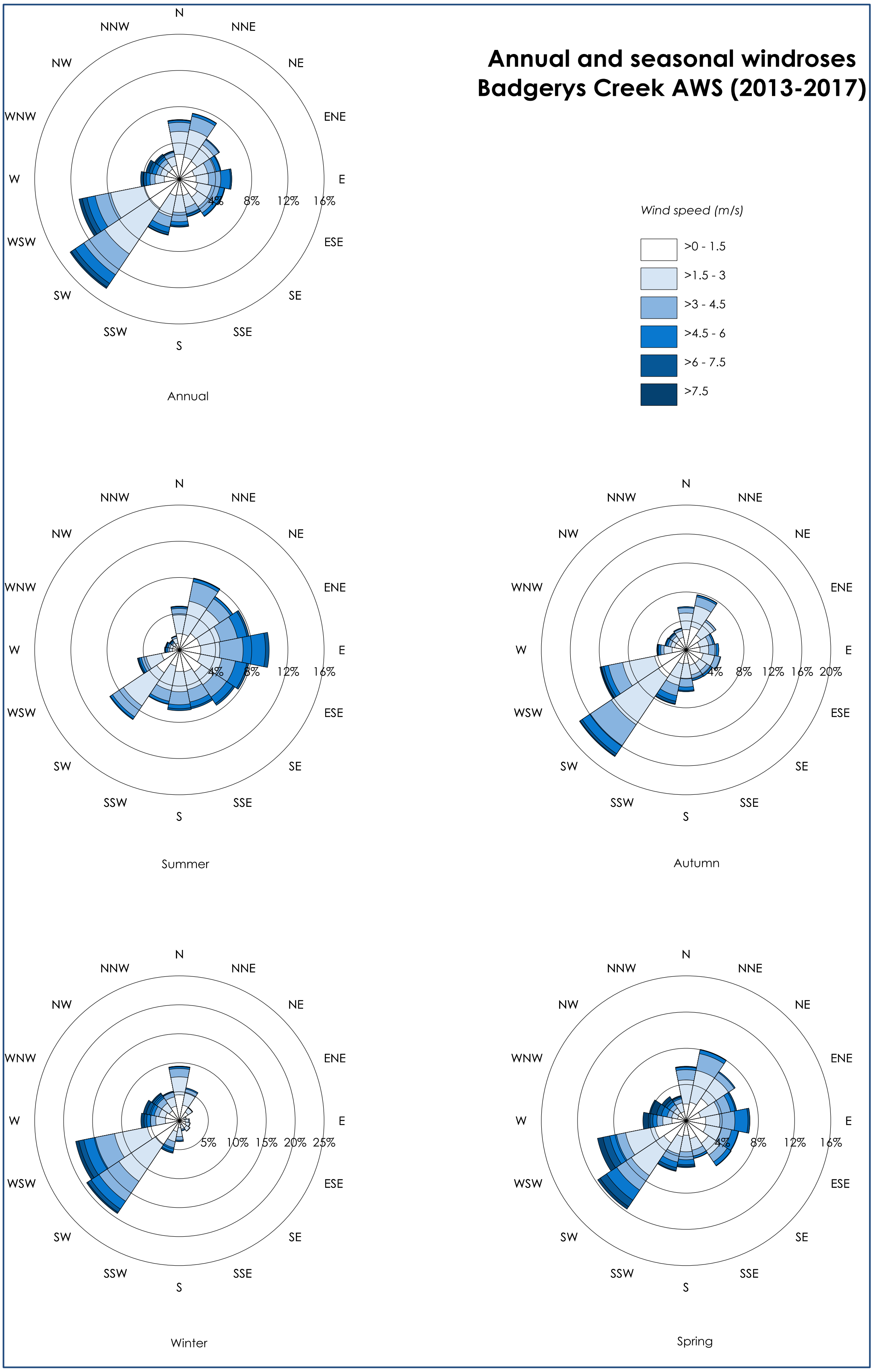

Figure A-3: Annual and seasonal windroses for Badgerys Creek AWS (2013-2017)

Appendix B

Emissions Calculations

Emissions calculations

The dust emissions from the extraction activities have been estimated from the operational pit scenario descriptions 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 and associated controls have been sourced from the National Pollutant Inventory Emission Estimation Technique Manuals (**NPI 2012** and **NPI 2014**) and US EPA AP42 Emission Factors (**US EPA 1998**, **US EPA 2006a, US EPA 2006b,** and **US EPA 2011**).

Table C-1: Emission factor equations

Activity	Emission factor equation	Variable
Bulldozers	$EF_{TSP} = 2.6 \times \left(\frac{s^{1.2}}{M^{1.3}}\right) kg/hr/vehicle$	s = surface material silt content (%) M = moisture content (%)
Material handling/ loading/ unloading	$EF_{TSP} = k \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} \Big/ \frac{M}{2}^{1.4}\right) kg/tonne$	k_{tsp} = 0.74 U = wind speed (m/s) M = moisture content (%)
Hauling on unsealed surfaces	$EF_{TSP} = 0.2819 \times k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{W}{3}\right)^{b} kg/VKT$	k_{TSP} = 4.9 s = surface material silt content (%) W = average weight of vehicles (tonnes) a_{TSP} = 0.7 b_{TSP} = 0.45 75% control factor for watering applied
Hauling on paved surfaces	$EF_{TSP} = \frac{k \times (sL)^{0.91} \times (W)^{1.02}}{1000} kg/VKT$	**k_{tsp}** = 3.23 (g/VKT) sL = road surface silt loading (g/m²) W = average weight of vehicles (tons)
Wind erosion	$EF_{TSP} = 850\, kg/ha/year$	-
Grading	$EF_{TSP} = 0.0034 \times S^{2.5} kg/VKT$	S = vehicle speed (km/hr)
Unload sand to ground bin	$EF_{TSP} = 0.0011\, kg/tonne$	-
Unloading cement/flyash to silos	$EF_{TSP} = 0.0005\, kg/tonne$	-
Crushing reject tiles	$EF_{TSP} = 0.0006\, kg/tonne$	-

Table B-2: Emissions inventory – Roof products manufacturing facility

ACTIVITY	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4 - TSP	Variable 4 - PM10	Variable 4 - PM25	Units	Variable 5	Units	DUST CONTROLS
Hauling raw materials (paved)	462	89	21	124,000	t/yr	0.004	0.001	0.0002	kg/t	28	t/load	0.5	km/trip	2	S.L. (g/m²)	0.205	0.039	0.010	kg/VKT	32	Ave GMV (tonnes)	
Hauling incoming roof products (paved)	31	6	1	8,000	t/yr	0.004	0.001	0.0002	kg/t	20	t/load	0.5	km/trip	2	S.L. (g/m²)	0.157	0.030	0.007	kg/VKT	24	Ave GMV (tonnes)	
Crushing sandstone in raw material stockpile	5	2	0.1	7,800	t/yr	0.00060	0.00027	0.00002	kg/t													
Loading sandstone to truck	10	5	0.5	7,800	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2.0	moisture content %									
Hauling sand to ground bins unpaved	49	10	1	7,800	t/yr	0.025	0.005	0.001	kg/t	31	t/load	0.8	km/trip	5	silt content %	0.968	0.207	0.021	kg/VKT	34	Ave GMV (tonnes)	75
Hauling sand to ground bins paved	94	18	4	7,800	t/yr	0.012	0.002	0.001	kg/t	31	t/load	1.7	km/trip	2	S.L. (g/m²)	0.219	0.042	0.010	kg/VKT	34	Ave GMV (tonnes)	
Unloading sand to ground bins	106	49	8	96,000	t/yr	0.0011	0.00051	0.00008	kg/t													
Unloading cement/flyash to silos	12	4	1	24,000	t/yr	0.00050	0.00017	0.00004	kg/t													
Hauling finished roof products (paved)	789	151	37	132,000	t/yr	0.006	0.001	0.0003	kg/t	22	t/load	0.8	km/trip	2	S.L. (g/m²)	0.162	0.031	0.008	kg/VKT	25	Ave GMV (tonnes)	
Loading reject tiles to bunker	8	4	0.4	6,600	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2.0	moisture content %									
Crushing reject tiles	4	2	0.1	6,600	t/yr	0.00060	0.00027	0.00002	kg/t													
Total	**1,568**	**340**	**75**																			

Table B-3: Emissions inventory – Brick making facility

ACTIVITY	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4 - TSP	Variable 4 - PM10	Variable 4 - PM25	Units	Variable 5	Units	DUST CONTROLS
Loading clay material from stockpile to box feeder	39	18	2	145,000	t/yr	0.0003	0.0001	0.0000	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
Hauling raw materials from off-site (paved)	2,379	457	110	215,000	t/yr	0.011	0.002	0.001	kg/t	33	t/load	1.7	km/trip	2.0	S.L. (g/m²)	0.216	0.041	0.010	kg/VKT	33.167	Ave GMV (tonnes)	
Unloading raw materials from off-site to stockpile	270	128	13	215,000	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Loading raw materials to box feeder	270	128	13	215,000	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Hauling brick products off-site (paved)	3,000	576	139	330,000	t/yr	0.009	0.002	0.0004	kg/t	30	t/load	1.4	km/trip	2.0	S.L. (g/m²)	0.192	0.037	0.009	kg/VKT	29.500	Ave GMV (tonnes)	
Load clay/ raw material to truck from stockpile for dispatch off-site	74	35	4	275,000	t/yr	0.0003	0.0001	0.00001	kg/t	1.1	mean WS m/s/2.2 ^1.3	6.0	moisture content %									
Truck haulage of clay offsite (unpaved)	1,434	368	37	275,000	t/yr	0.021	0.005	0.001	kg/t	30	t/load	0.3	km/trip	5.0	silt content %	2.103	0.540	0.054	kg/VKT	33	Ave GMV (tonnes)	75
Truck haulage of clay offsite (paved)	3,294	632	153	275,000	t/yr	0.011978	0.002	0.001	kg/t	30	t/load	1.7	km/trip	2.0	S.L. (g/m²)	0.213	0.041	0.010	kg/VKT	32.750	Ave GMV (tonnes)	
Raw material and burden stockpile wind erosion	15,130	7,565	1,135	18	ha	850	425	64	kg/ha/yr													
Total	**25,890**	**9,907**	**1,605**																			

Table B-4: Emissions inventory – Extraction activities Pit 3 scenario

ACTIVITY	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4 - TSP	Variable 4 - PM10	Variable 4 - PM25	Units	Variable 5	Units	DUST CONTROLS
Removal of topsoil / burden in Pit 3 (excavator)	100	47	5	80,000	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Loading burden to haul truck	100	47	5	80,000	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Hauling burden to stockpile (unpaved)	3,520	905	90	80,000	t/yr	0.176	0.045	0.005	kg/t	39	t/load	3.0	km/trip	5.0	silt content %	2.288	0.588	0.059	kg/VKT	40	Ave GMV (tonnes)	75
Unloading burden at Pit 2	100	47	5	80,000	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Compactor in Pit 2 (bulldozer)	1,153	204	115	660	hrs/yr	1.75	0.31	0.17	kg/hr	5.0	silt content %	6	moisture content %									
Bulldozer for breaking up clay/ raw materials in Pit 3	1,153	204	115	660	hrs/yr	1.75	0.31	0.17	kg/hr	5.0	silt content %	6	moisture content %									
Loading clay/ raw material to haul truck	113	54	5	420,000	t/yr	0.0003	0.0001	0.00001	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
Haul materials to raw materials stockpile area (unpaved)	7,392	1,899	190	420,000	t/yr	0.070	0.018	0.002	kg/t	39	t/load	1.2	km/trip	5.0	silt content %	2.288	0.588	0.059	kg/VKT	40	Ave GMV (tonnes)	75
Unloading clay/ raw materials to stockpile area	113	54	5	420,000	t/yr	0.0003	0.0001	0.00001	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
FEL shaping stockpiles	113	54	5	420,000	t/yr	0.0003	0.0001	0.0000	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
Grading haul roads	3,326	1,149	106	5,280	km/yr	0.630	0.218	0.020	kg/vkt	8	speed of graders in km/h											
Wind erosion pit 2	2,975	1,488	223	4	ha	850	425	64	kg/ha/yr													
Wind erosion pit 3	7,565	3,783	567	9	ha	850	425	64	kg/ha/yr													
Total	**27,724**	**9,934**	**1,438**																			

Table B-5: Emissions inventory – Extraction activities Pit 5 scenario

ACTIVITY	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4 - TSP	Variable 4 - PM10	Variable 4 - PM25	Units	Variable 5	Units	DUST CONTROLS
Removal of topsoil / burden in Pit 5 (excavator)	235	111	11	187,455	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Loading burden to haul truck	235	111	11	187,455	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Hauling burden to stockpile (unpaved)	13,747	3,532	353	187,455	t/yr	0.293	0.075	0.008	kg/t	39	t/load	5.0	km/trip	5.0	silt content %	2.288	0.588	0.059	kg/VKT	40	Ave GMV (tonnes)	75
Unloading burden at Pit 2	235	111	11	187,455	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Compactor in Pit 2 (bulldozer)	1,153	204	115	660	hrs/yr	1.75	0.31	0.17	kg/hr	5.0	silt content %	6	moisture content %									
Bulldozer for breaking up clay/ raw materials in Pit 5	1,153	204	115	660	hrs/yr	1.75	0.31	0.17	kg/hr	5.0	silt content %	6	moisture content %									
Loading clay/ raw material to haul truck	113	54	5	420,000	t/yr	0.0003	0.0001	0.00001	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
Haul materials to raw materials stockpile area (unpaved)	25,257	6,490	649	420,000	t/yr	0.241	0.062	0.006	kg/t	39	t/load	4.1	km/trip	5.0	silt content %	2.288	0.588	0.059	kg/VKT	40	Ave GMV (tonnes)	75
Unloading clay/ raw materials to stockpile area	113	54	5	420,000	t/yr	0.0003	0.0001	0.00001	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
FEL shaping stockpiles	113	54	5	420,000	t/yr	0.0003	0.0001	0.0000	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
Grading haul roads	3,326	1,149	106	5,280	km/yr	0.630	0.218	0.020	kg/vkt	8	speed of graders in km/h											
Wind erosion pit 4	11,050	5,525	829	13	ha	850	425	64	kg/ha/yr													
Wind erosion pit 5	4,760	2,380	357	6	ha	850	425	64	kg/ha/yr													
Total	**61,491**	**19,979**	**2,574**																			

Table B-6: Emissions inventory – Extraction activities Pit 5 scenario – alternate haul routes

ACTIVITY	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4 - TSP	Variable 4 - PM10	Variable 4 - PM25	Units	Variable 5	Units	DUST CONTROLS
Removal of topsoil / burden in Pit 5 (excavator)	235	111	11	187,455	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Loading burden to haul truck	235	111	11	187,455	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Hauling burden to stockpile (unpaved)	8,798	2,261	226	187,455	t/yr	0.188	0.048	0.005	kg/t	39	t/load	3.2	km/trip	5.0	silt content %	2.288	0.588	0.059	kg/VKT	40	Ave GMV (tonnes)	75
Unloading burden at Pit 2	235	111	11	187,455	t/yr	0.0013	0.0006	0.0001	kg/t	1.1	mean WS m/s/2.2 ^1.3	2	moisture content %									
Compactor in Pit 2 (bulldozer)	1,153	204	115	660	hrs/yr	1.75	0.31	0.17	kg/hr	5.0	silt content %	6	moisture content %									
Bulldozer for breaking up clay/ raw materials in Pit 5	1,153	204	115	660	hrs/yr	1.75	0.31	0.17	kg/hr	5.0	silt content %	6	moisture content %									
Loading clay/ raw material to haul truck	113	54	5	420,000	t/yr	0.0003	0.0001	0.00001	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
Haul materials to raw materials stockpile area (unpaved)	8,624	2,216	222	420,000	t/yr	0.082	0.021	0.002	kg/t	39	t/load	1.4	km/trip	5.0	silt content %	2.288	0.588	0.059	kg/VKT	40	Ave GMV (tonnes)	75
Unloading clay/ raw materials to stockpile area	113	54	5	420,000	t/yr	0.0003	0.0001	0.00001	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
FEL shaping stockpiles	113	54	5	420,000	t/yr	0.0003	0.0001	0.0000	kg/t	1.1	mean WS m/s/2.2 ^1.3	6	moisture content %									
Grading haul roads	3,326	1,149	106	5,280	km/yr	0.630	0.218	0.020	kg/vkt	8	speed of graders in km/h											
Wind erosion pit 4	11,050	5,525	829	13	ha	850	425	64	kg/ha/yr													
Wind erosion pit 5	4,760	2,380	357	6	ha	850	425	64	kg/ha/yr													
Total	**39,909**	**14,433**	**2,020**																			

Appendix C

Isopleth Diagrams

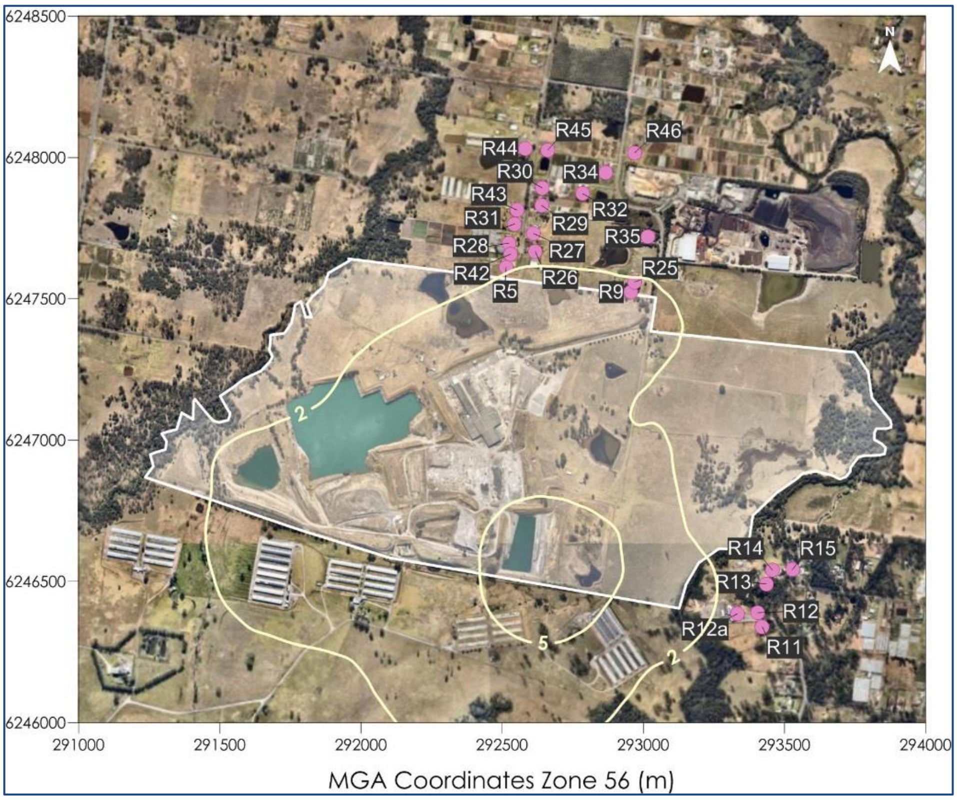

Figure C-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations – Pit 3 scenario (µg/m³)

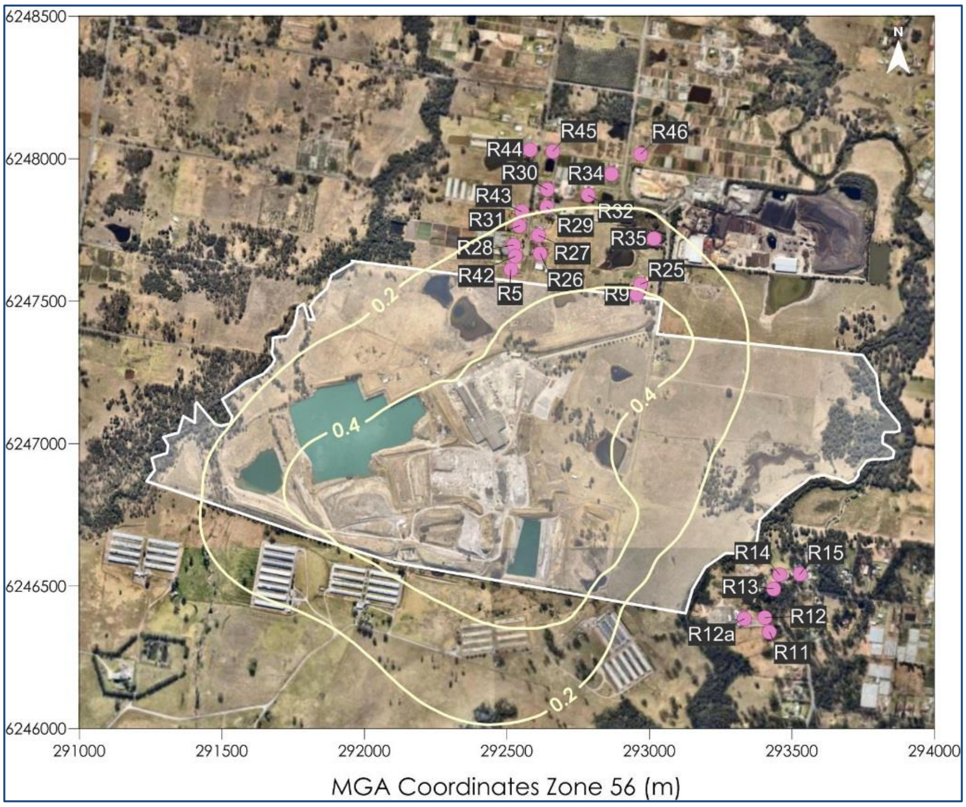

Figure C-2: Predicted incremental annual average $PM_{2.5}$ concentrations – Pit 3 scenario (µg/m³)

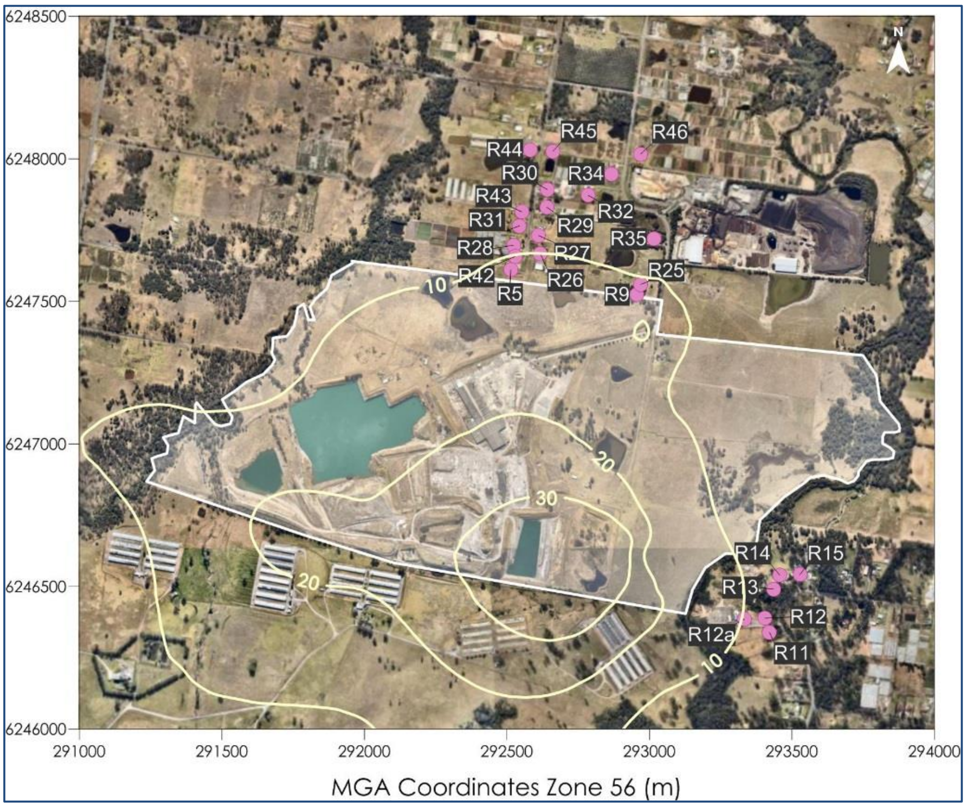

Figure C-3: Predicted incremental maximum 24-hour average PM_{10} concentrations – Pit 3 scenario (µg/m³)

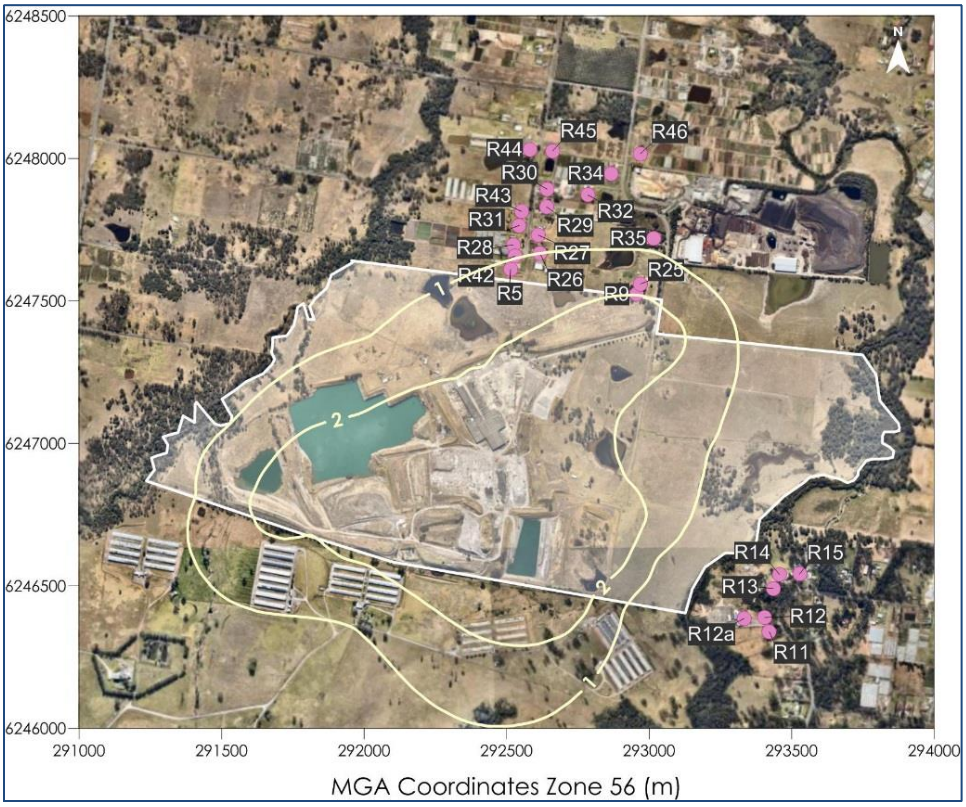

Figure C-4: Predicted incremental annual average PM_{10} concentrations – Pit 3 scenario (µg/m³)

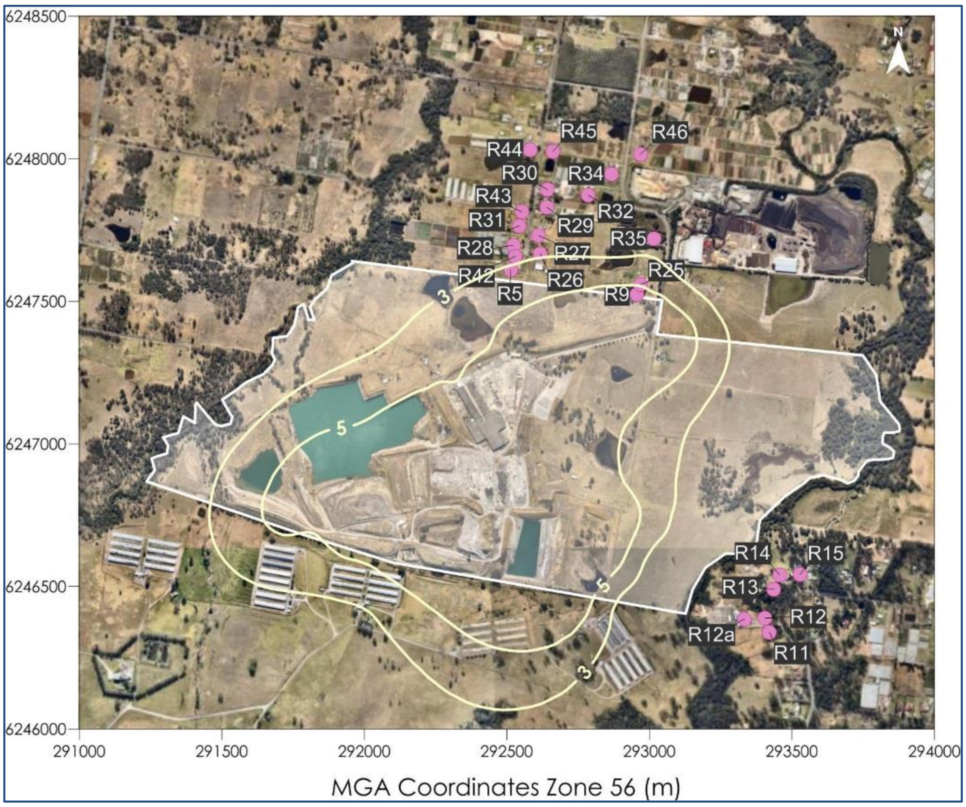

Figure C-5: Predicted incremental annual average TSP concentrations – Pit 3 scenario (µg/m³)

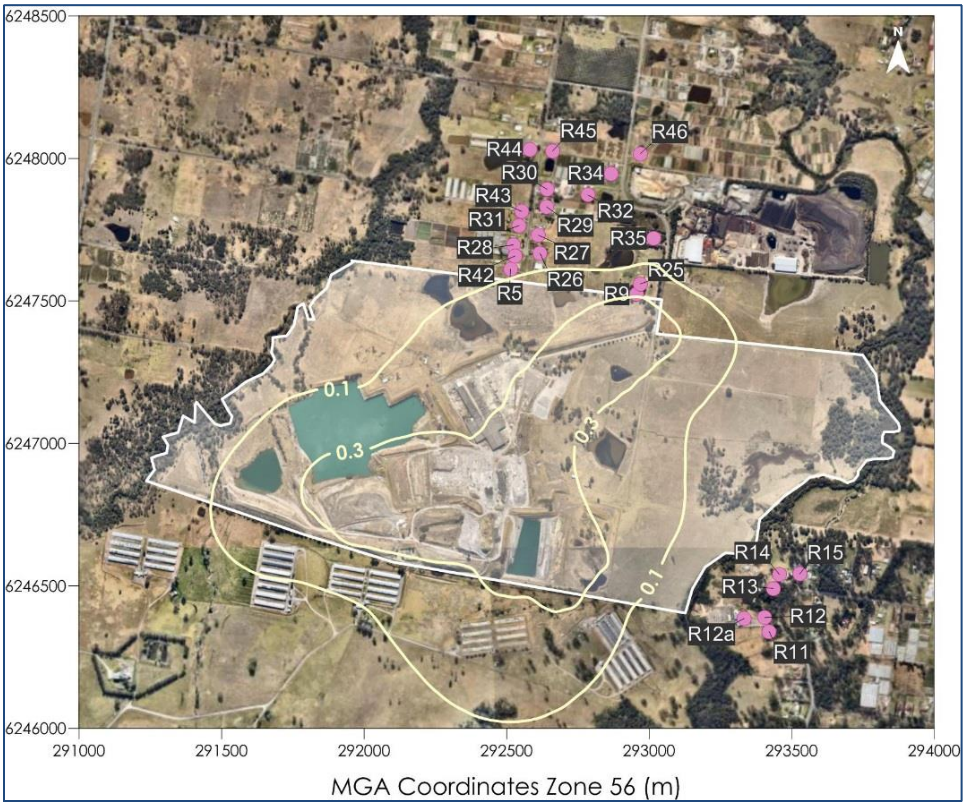

Figure C-6: Predicted incremental annual average dust deposition levels – Pit 3 scenario (g/m²/month)

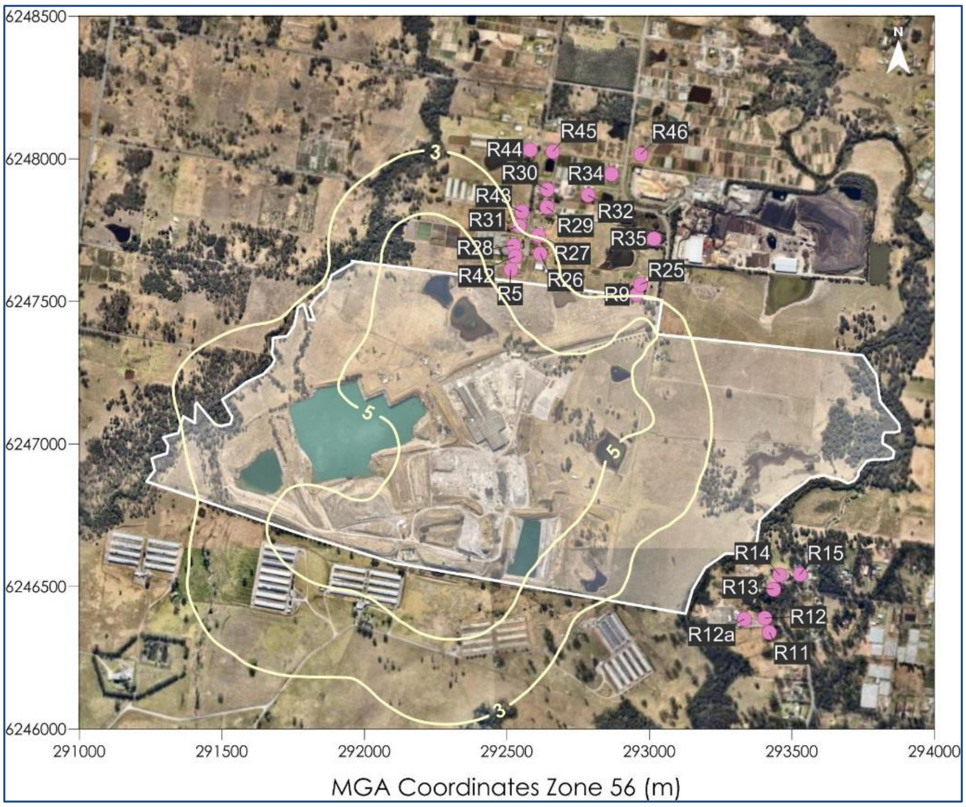

Figure C-7: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations – Pit 5 scenario (µg/m³)

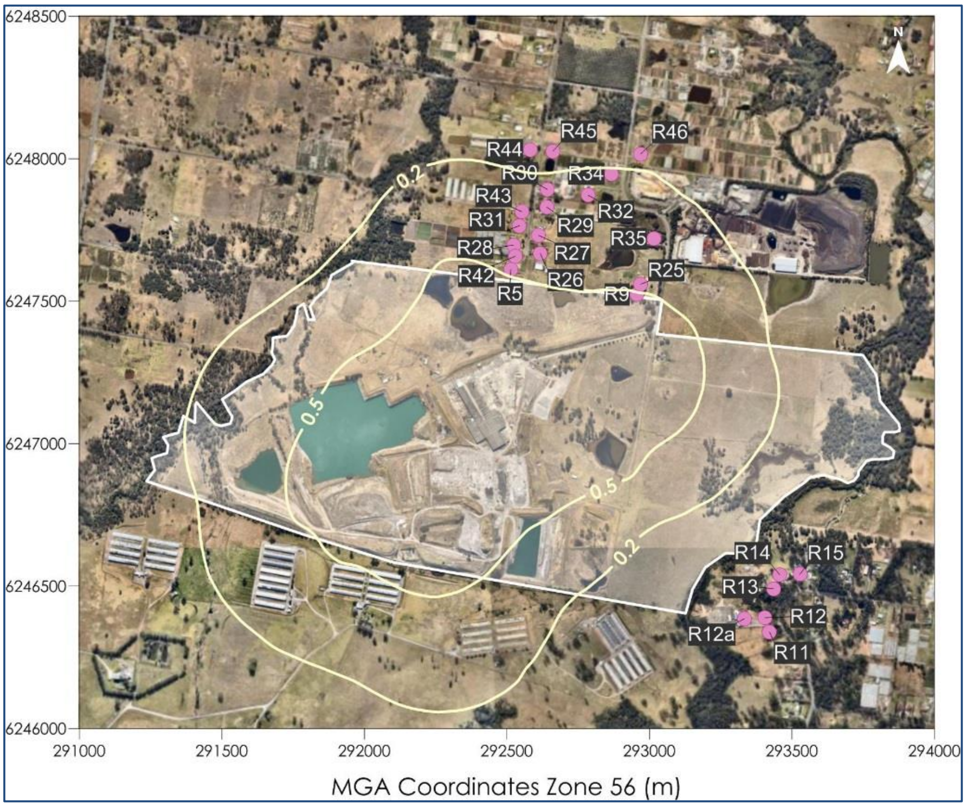

Figure C-8: Predicted incremental annual average $PM_{2.5}$ concentrations – Pit 5 scenario (µg/m³)

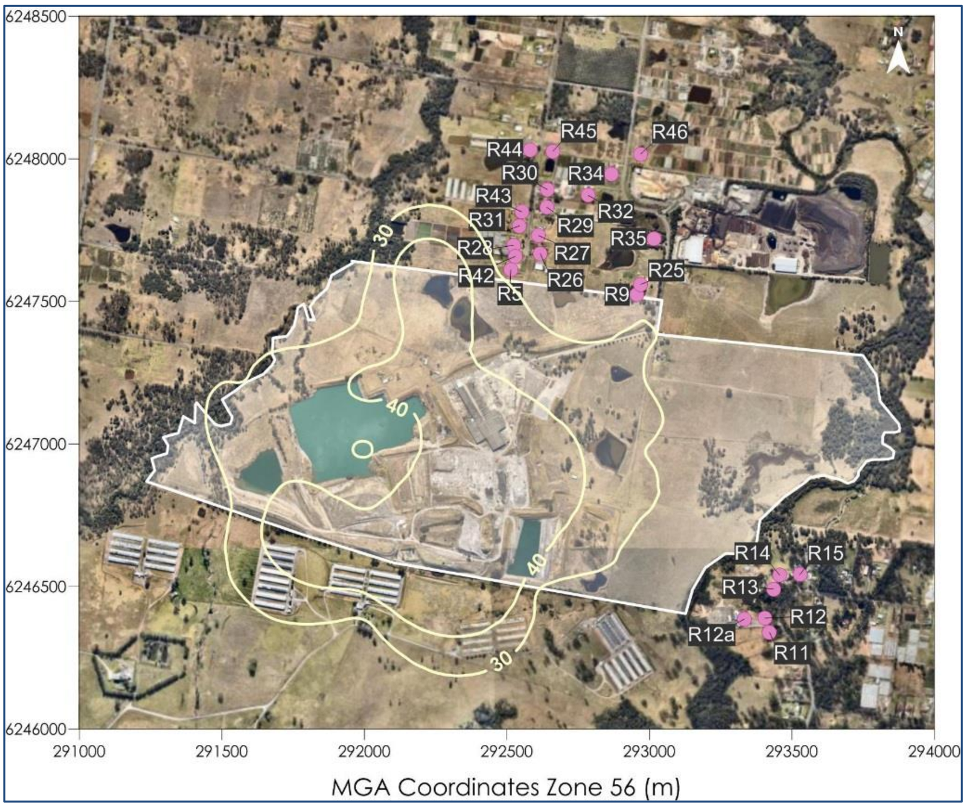

Figure C-9: Predicted incremental maximum 24-hour average PM_{10} concentrations – Pit 5 scenario (µg/m³)

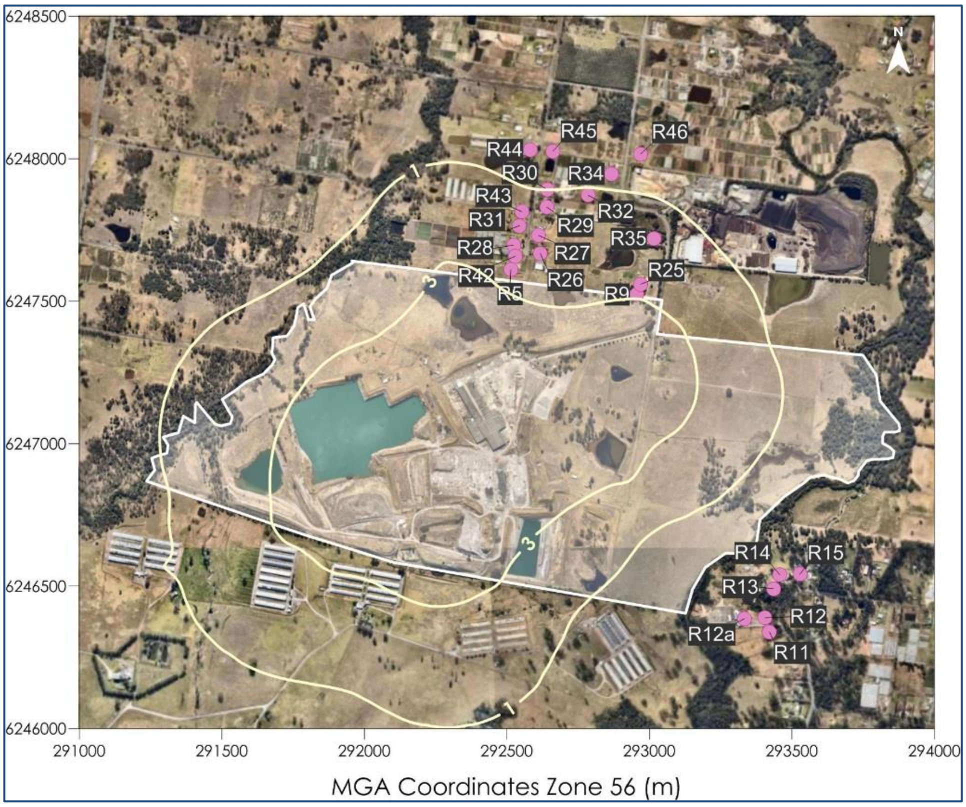

Figure C-10: Predicted incremental annual average PM_{10} concentrations – Pit 5 scenario (µg/m³)

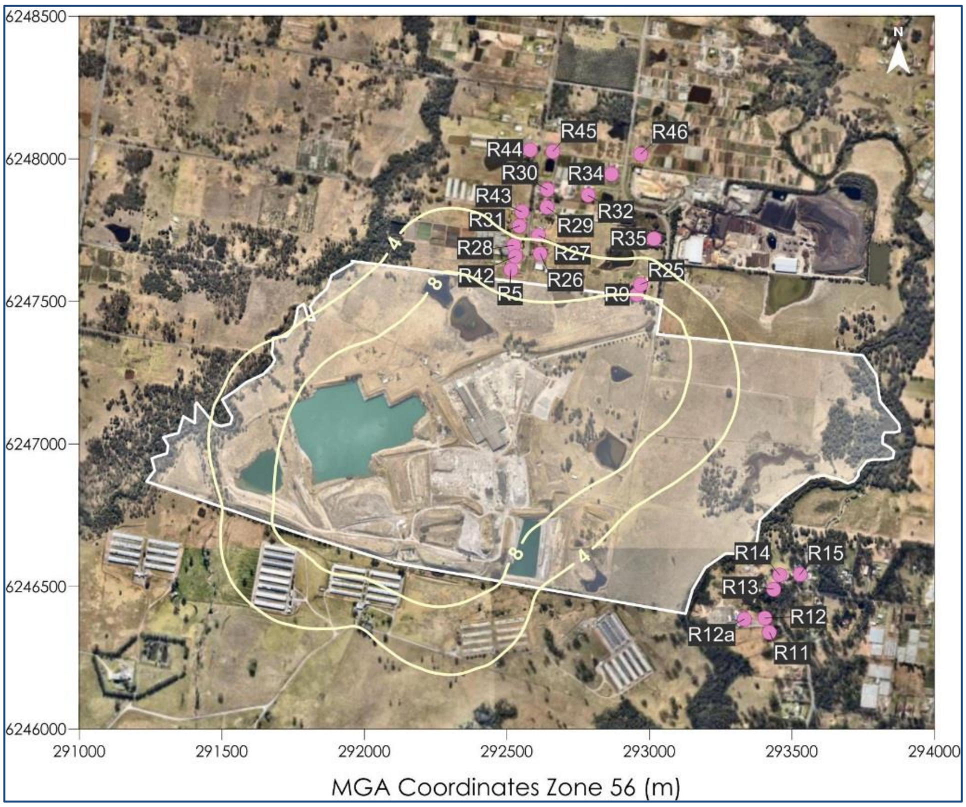

Figure C-11: Predicted incremental annual average TSP concentrations – Pit 5 scenario (µg/m³)

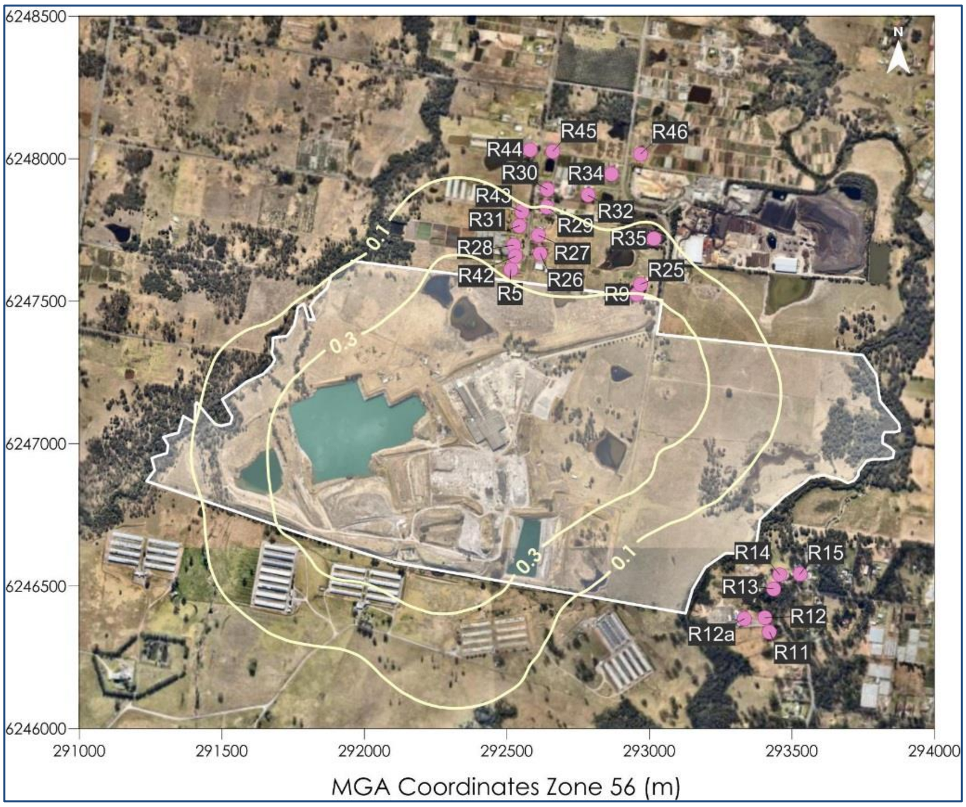

Figure C-12: Predicted incremental annual average dust deposition levels – Pit 5 scenario (g/m²/month)

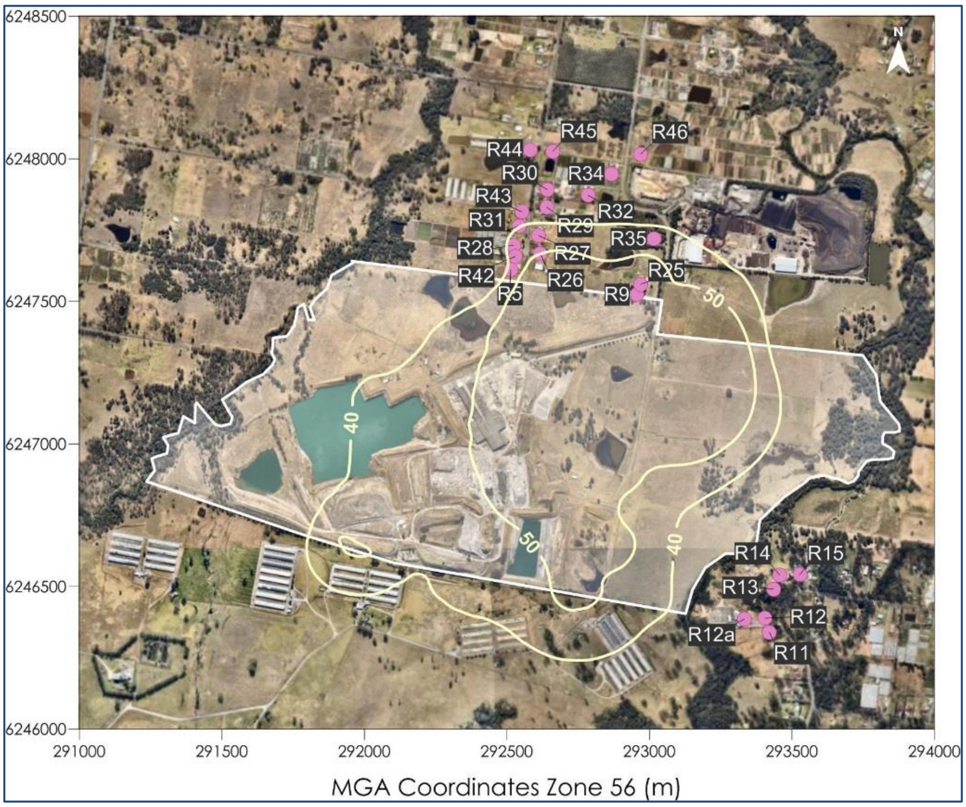

Figure C-13: Predicted incremental maximum 1-hour average SO_2 concentrations (µg/m³)

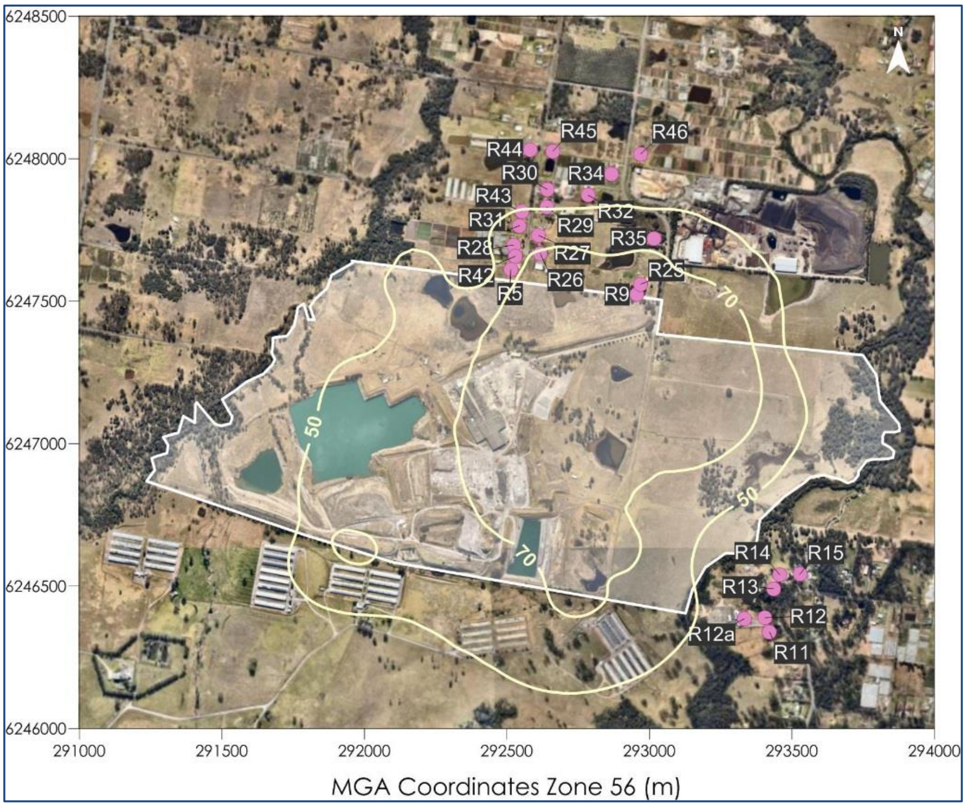

Figure C-14: Predicted incremental maximum 1-hour average NO_2 concentrations (µg/m³)

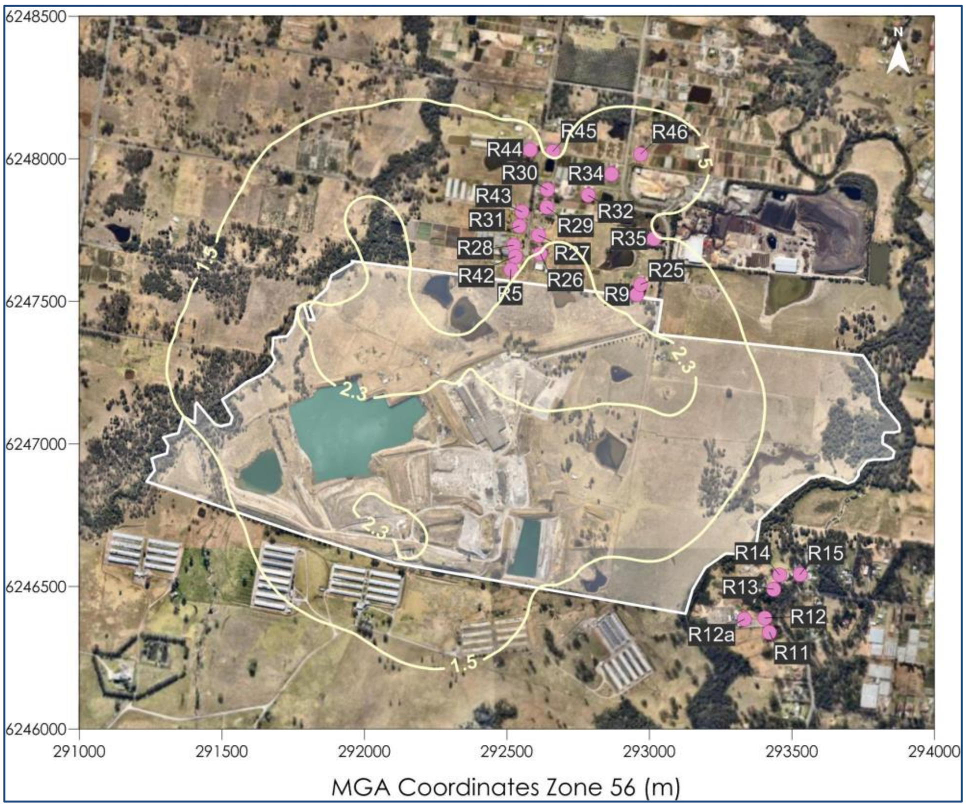

Figure C-15: Predicted incremental maximum 24-hour average hydrogen fluoride concentrations (µg/m³)

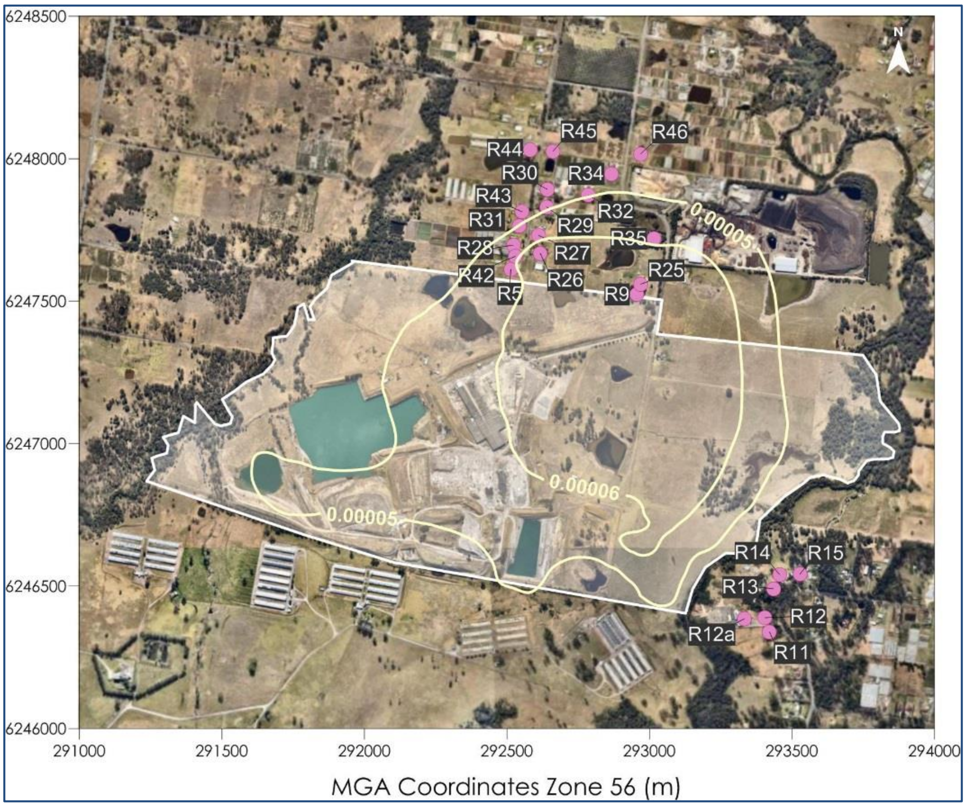

Figure C-16: Predicted incremental 99.9th percentile 1-hour average chlorine concentrations (mg/m³)

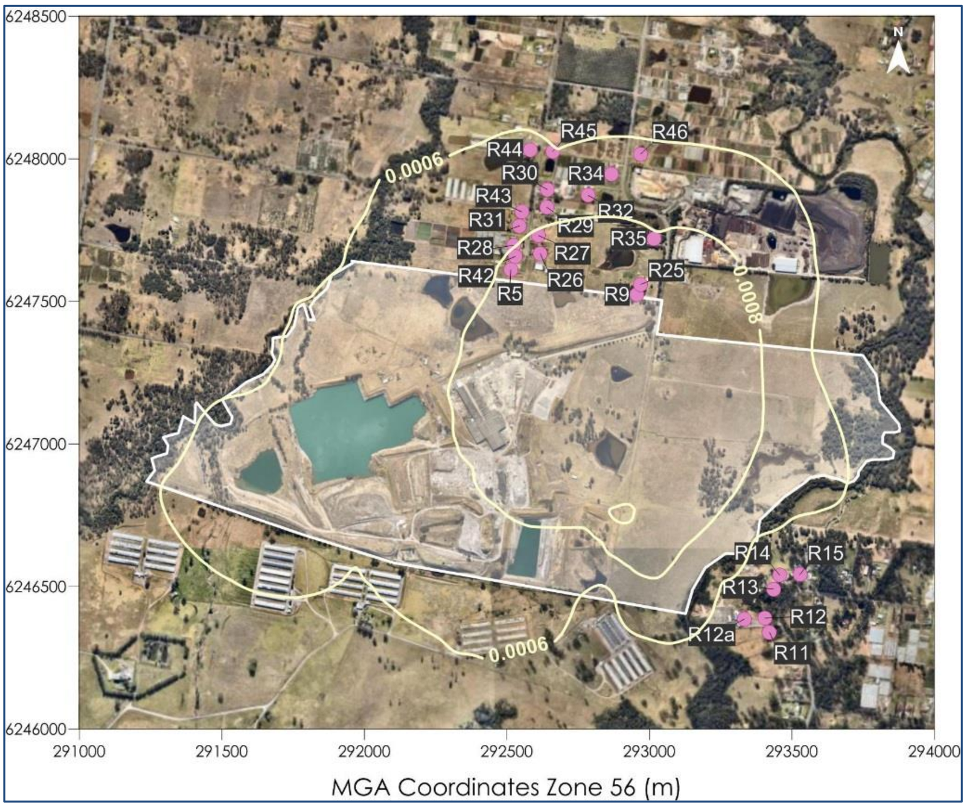

Figure C-17: Predicted incremental 99.9th percentile 1-hour average sulfuric acid concentrations (mg/m³)

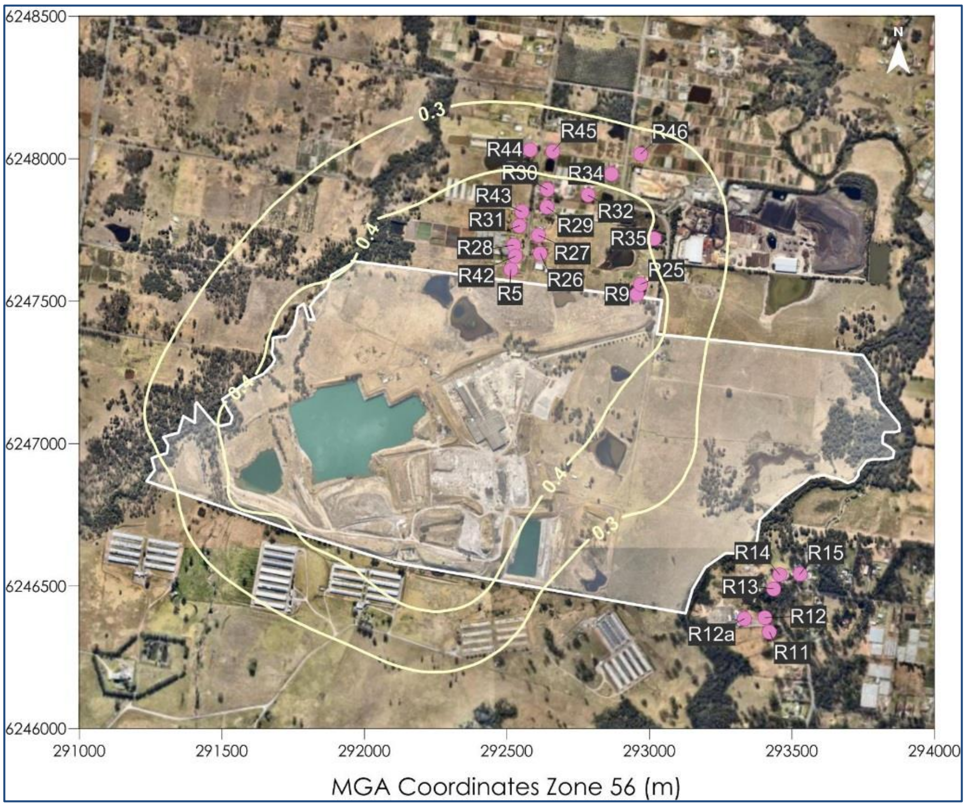

Figure C-18: Predicted incremental 99th percentile 1-hour average odour concentrations (OU)

Appendix D

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

<u>Further detail regarding 24-hour average $PM_{2.5}$ and PM_{10} analysis</u>

The analysis below provides a cumulative 24-hour $PM_{2.5}$ and a 24-hour 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 <u>background</u> level is the ambient level at the OEH Liverpool monitoring station for $PM_{2.5}$ and at the Bringelly monitoring station for PM_{10}.

The <u>predicted increment</u> is the predicted level to occur at the receptor due to the Project.

The <u>total</u> 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-16** show the predicted maximum cumulative levels at the assessed receptor locations surrounding the Project.

Table D-1: 24-hour average PM_{10} concentration (μg/m³) for Pit 3 scenario – R5

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	0.7	43.3	2/07/2014	20.9	5.0	25.9
2/01/2014	41.8	0.6	42.4	13/06/2014	19.0	5.0	24.0
10/02/2014	36.8	1.7	38.5	10/04/2014	15.4	5.0	20.4
31/12/2014	36.1	0.5	36.6	24/05/2014	29.3	4.4	33.7
23/05/2014	34.2	0.0	34.2	11/06/2014	10.6	3.6	14.2
6/08/2014	33.7	0.7	34.4	3/09/2014	7.8	3.6	11.4
17/12/2014	33.4	1.3	34.7	11/05/2014	17.6	3.5	21.1
6/10/2014	33.3	1.0	34.3	13/07/2014	16.0	3.4	19.4
15/11/2014	32.7	0.7	33.4	30/08/2014	6.4	3.3	9.7
26/05/2014	32.4	0.2	32.6	1/06/2014	8.8	3.3	12.1

Table D-2: 24-hour average PM_{10} concentration (μg/m³) for Pit 3 scenario – R9

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	1.0	43.6	13/06/2014	19	7.6	26.6
2/01/2014	41.8	0.7	42.5	28/03/2014	-	7.1	7.1
10/02/2014	36.8	1.2	38.0	2/07/2014	20.9	7.0	27.9
31/12/2014	36.1	0.2	36.3	10/06/2014	8.9	7.0	15.9
23/05/2014	34.2	0.0	34.2	1/06/2014	8.8	6.9	15.7
6/08/2014	33.7	3.5	37.2	11/06/2014	10.6	6.4	17.0
17/12/2014	33.4	1.0	34.4	15/10/2014	8.7	5.6	14.3
6/10/2014	33.3	0.7	34.0	5/06/2014	9.0	5.5	14.5
15/11/2014	32.7	0.8	33.5	24/05/2014	29.3	5.4	34.7
26/05/2014	32.4	2.1	34.5	10/04/2014	15.4	5.0	20.4

- No data

Table D-3: 24-hour average PM_{10} concentration (µg/m³) for Pit 3 scenario – R12a

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	0.8	43.4	24/06/2014	9.6	7.2	16.8
2/01/2014	41.8	0.2	42.0	29/06/2014	7.0	6.7	13.7
10/02/2014	36.8	0.0	36.8	17/07/2014	12.3	3.8	16.1
31/12/2014	36.1	0.0	36.1	3/05/2014	6.5	3.3	9.8
23/05/2014	34.2	1.0	35.2	25/05/2014	23.7	3.2	26.9
6/08/2014	33.7	0.3	34.0	1/08/2014	12.7	3.2	15.9
17/12/2014	33.4	0.0	33.4	30/07/2014	11.9	3.1	15.0
6/10/2014	33.3	0.2	33.5	14/06/2014	11.5	2.8	14.3
15/11/2014	32.7	0.0	32.7	30/09/2014	22.0	2.5	24.5
26/05/2014	32.4	0.3	32.7	28/05/2014	16.7	2.4	19.1

Table D-4: 24-hour average PM_{10} concentration (µg/m³) for Pit 3 scenario – R26

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	0.9	43.5	13/06/2014	19.0	4.9	23.9
2/01/2014	41.8	0.5	42.3	2/07/2014	20.9	4.5	25.4
10/02/2014	36.8	1.4	38.2	10/04/2014	15.4	4.4	19.8
31/12/2014	36.1	0.3	36.4	24/05/2014	29.3	4.0	33.3
23/05/2014	34.2	0.0	34.2	11/06/2014	10.6	3.4	14.0
6/08/2014	33.7	0.8	34.5	3/09/2014	7.8	3.4	11.2
17/12/2014	33.4	0.9	34.3	1/06/2014	8.8	3.3	12.1
6/10/2014	33.3	0.6	33.9	30/08/2014	6.4	3.3	9.7
15/11/2014	32.7	0.6	33.3	15/10/2014	8.7	3.3	12.0
26/05/2014	32.4	0.3	32.7	23/08/2014	7.4	3.1	10.5

Table D-5: 24-hour average $PM_{2.5}$ concentration (µg/m³) for Pit 3 scenario – R5

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.2	24.5	2/07/2014	15.9	1.2	17.1
12/10/2014	21.3	0.0	21.3	24/05/2014	11.1	1.1	12.2
6/08/2014	20.7	0.1	20.8	3/09/2014	5.0	1.1	6.1
8/07/2014	20.3	0.0	20.3	10/04/2014	8.2	1.0	9.2
18/05/2014	20.1	0.5	20.6	30/08/2014	3.8	0.9	4.7
9/08/2014	19.5	0.0	19.5	13/06/2014	16.4	0.9	17.3
4/07/2014	19.3	0.0	19.3	7/09/2014	4.0	0.9	4.9
26/05/2014	18.9	0.1	19.0	19/08/2014	6.1	0.9	7.0
10/05/2014	18.8	0.0	18.8	11/05/2014	12.4	0.9	13.3
5/08/2014	18.3	0.7	19.0	18/08/2014	3.0	0.8	3.8

Table D-6: 24-hour average $PM_{2.5}$ concentration (µg/m³) for Pit 3 scenario – R9

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.0	24.3	2/07/2014	15.9	1.7	17.6
12/10/2014	21.3	0.4	21.7	13/06/2014	16.4	1.6	18.0
6/08/2014	20.7	0.3	21.0	28/03/2014	4.5	1.5	6.0
8/07/2014	20.3	0.3	20.6	1/06/2014	9.2	1.5	10.7
18/05/2014	20.1	0.3	20.4	11/06/2014	14.0	1.4	15.4
9/08/2014	19.5	0.8	20.3	10/06/2014	5.9	1.4	7.3
4/07/2014	19.3	0.0	19.3	24/05/2014	11.1	1.3	12.4
26/05/2014	18.9	0.2	19.1	5/06/2014	5.7	1.2	6.9
10/05/2014	18.8	0.2	19.0	15/10/2014	5.1	1.2	6.3
5/08/2014	18.3	0.4	18.7	2/11/2014	4.7	1.2	5.9

Table D-7: 24-hour average $PM_{2.5}$ concentration ($\mu g/m^3$) for Pit 3 scenario – R12a

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.1	24.4	24/06/2014	3.1	1.3	4.4
12/10/2014	21.3	0.1	21.4	29/06/2014	4.2	1.2	5.4
6/08/2014	20.7	0.1	20.8	17/07/2014	11.4	0.7	12.1
8/07/2014	20.3	0.1	20.4	1/08/2014	4.9	0.6	5.5
18/05/2014	20.1	0.2	20.3	29/09/2014	8.9	0.5	9.4
9/08/2014	19.5	0.2	19.7	30/07/2014	4.6	0.5	5.1
4/07/2014	19.3	0.2	19.5	25/05/2014	12.9	0.5	13.4
26/05/2014	18.9	0.1	19.0	3/05/2014	6.9	0.5	7.4
10/05/2014	18.8	0.3	19.1	30/09/2014	10.8	0.5	11.3
5/08/2014	18.3	0.0	18.3	27/10/2014	11.5	0.5	12.0

Table D-8: 24-hour average $PM_{2.5}$ concentration ($\mu g/m^3$) for Pit 3 scenario – R26

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.3	24.6	2/07/2014	15.9	1.2	17.1
12/10/2014	21.3	0.1	21.4	15/10/2014	5.1	1.1	6.2
6/08/2014	20.7	0.2	20.9	24/05/2014	11.1	1.1	12.2
8/07/2014	20.3	0.1	20.4	10/04/2014	8.2	0.9	9.1
18/05/2014	20.1	0.6	20.7	30/08/2014	3.8	0.9	4.7
9/08/2014	19.5	0.0	19.5	13/06/2014	16.4	0.9	17.3
4/07/2014	19.3	0.0	19.3	3/09/2014	5.0	0.9	5.9
26/05/2014	18.9	0.1	19.0	12/04/2014	5.6	0.9	6.5
10/05/2014	18.8	0.0	18.8	20/07/2014	7.5	0.8	8.3
5/08/2014	18.3	0.6	18.9	7/09/2014	4.0	0.8	4.8

Table D-9: 24-hour average PM_{10} concentration (µg/m³) for Pit 5 scenario – R5

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	1.9	44.5	10/06/2014	8.9	27.5	36.4
2/01/2014	41.8	2.7	44.5	13/06/2014	19.0	24.1	43.1
10/02/2014	36.8	3.4	40.2	1/06/2014	8.8	22.6	31.4
31/12/2014	36.1	0.3	36.4	28/03/2014	-	21.4	21.4
23/05/2014	34.2	0.0	34.2	2/07/2014	20.9	18.2	39.1
6/08/2014	33.7	10.9	44.6	4/04/2014	8.9	18.1	27.0
17/12/2014	33.4	2.1	35.5	5/06/2014	9.0	17.3	26.3
6/10/2014	33.3	1.3	34.6	24/05/2014	29.3	16.6	45.9
15/11/2014	32.7	1.6	34.3	27/07/2014	13.3	14.7	28.0
26/05/2014	32.4	1.8	34.2	10/04/2014	15.4	13.6	29.0

- No data

Table D-10: 24-hour average PM_{10} concentration (µg/m³) for Pit 5 scenario – R9

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	1.5	44.1	4/04/2014	8.9	17.8	26.7
2/01/2014	41.8	1.6	43.4	10/06/2014	8.9	16.9	25.8
10/02/2014	36.8	2.9	39.7	1/06/2014	8.8	16.7	25.5
31/12/2014	36.1	0.7	36.8	28/03/2014	-	16.2	16.2
23/05/2014	34.2	0.0	34.2	13/06/2014	19.0	16.1	35.1
6/08/2014	33.7	7.5	41.2	2/07/2014	20.9	12.5	33.4
17/12/2014	33.4	1.4	34.8	5/06/2014	9.0	11.6	20.6
6/10/2014	33.3	0.8	34.1	24/05/2014	29.3	10.7	40.0
15/11/2014	32.7	1.0	33.7	3/09/2014	7.8	10.5	18.3
26/05/2014	32.4	3.0	35.4	27/07/2014	13.3	10.1	23.4

- No data

Table D-11: 24-hour average PM_{10} concentration (µg/m³) for Pit 5 scenario – R12a

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	1.6	44.2	25/05/2014	23.7	12.9	36.6
2/01/2014	41.8	0.4	42.2	14/06/2014	11.5	9.4	20.9
10/02/2014	36.8	0.0	36.8	29/06/2014	7.0	5.6	12.6
31/12/2014	36.1	0.0	36.1	2/06/2014	9.1	5.5	14.6
23/05/2014	34.2	2.4	36.6	24/06/2014	9.6	5.0	14.6
6/08/2014	33.7	0.9	34.6	28/07/2014	16.3	4.6	20.9
17/12/2014	33.4	0.0	33.4	20/05/2014	28.1	4.3	32.4
6/10/2014	33.3	0.2	33.5	30/07/2014	11.9	4.0	15.9
15/11/2014	32.7	0.0	32.7	24/01/2014	12.7	4.0	16.7
26/05/2014	32.4	0.5	32.9	2/05/2014	14.1	3.9	18.0

Table D-12: 24-hour average PM_{10} concentration (µg/m³) for Pit 5 scenario – R26

Ranked by Highest to Lowest Background Concentration				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
19/05/2014	42.6	1.4	44.0	10/06/2014	8.9	22.1	31.0
2/01/2014	41.8	1.9	43.7	1/06/2014	8.8	19.2	28.0
10/02/2014	36.8	2.2	39.0	13/06/2014	19.0	18.2	37.2
31/12/2014	36.1	0.2	36.3	28/03/2014	-	17.4	17.4
23/05/2014	34.2	0.0	34.2	4/04/2014	8.9	14.4	23.3
6/08/2014	33.7	8.8	42.5	2/07/2014	20.9	14.4	35.3
17/12/2014	33.4	1.3	34.7	5/06/2014	9.0	13.9	22.9
6/10/2014	33.3	0.8	34.1	24/05/2014	29.3	12.3	41.6
15/11/2014	32.7	1.0	33.7	10/04/2014	15.4	10.2	25.6
26/05/2014	32.4	1.2	33.6	27/07/2014	13.3	10.2	23.5

\- No data

Table D-13: 24-hour average $PM_{2.5}$ concentration (μg/m³) for Pit 5 scenario – R5

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.6	24.9	10/06/2014	5.9	4.2	10.1
12/10/2014	21.3	0.1	21.4	13/06/2014	16.4	3.5	19.9
6/08/2014	20.7	1.6	22.3	1/06/2014	9.2	3.4	12.6
8/07/2014	20.3	0.5	20.8	28/03/2014	4.5	3.2	7.7
18/05/2014	20.1	1.2	21.3	2/07/2014	15.9	2.9	18.8
9/08/2014	19.5	0.5	20.0	4/04/2014	3.9	2.9	6.8
4/07/2014	19.3	0.0	19.3	24/05/2014	11.1	2.7	13.8
26/05/2014	18.9	0.3	19.2	5/06/2014	5.7	2.6	8.3
10/05/2014	18.8	0.3	19.1	3/09/2014	5.0	2.6	7.6
5/08/2014	18.3	1.4	19.7	19/07/2014	6.3	2.4	8.7

Table D-14: 24-hour average $PM_{2.5}$ concentration (μg/m³) for Pit 5 scenario – R9

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.7	25.0	4/04/2014	3.9	2.7	6.6
12/10/2014	21.3	0.3	21.6	1/06/2014	9.2	2.7	11.9
6/08/2014	20.7	1.2	21.9	13/06/2014	16.4	2.6	19.0
8/07/2014	20.3	0.9	21.2	28/03/2014	4.5	2.6	7.1
18/05/2014	20.1	1.3	21.4	10/06/2014	5.9	2.6	8.5
9/08/2014	19.5	0.4	19.9	2/07/2014	15.9	2.3	18.2
4/07/2014	19.3	0.1	19.4	25/05/2014	12.9	2.0	14.9
26/05/2014	18.9	0.9	19.8	5/06/2014	5.7	1.9	7.6
10/05/2014	18.8	0.2	19.0	3/09/2014	5.0	1.9	6.9
5/08/2014	18.3	1.4	19.7	24/05/2014	11.1	1.8	12.9

Table D-15: 24-hour average $PM_{2.5}$ concentration (µg/m³) for Pit 5 scenario – R12a

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.2	24.5	25/05/2014	12.9	1.7	14.6
12/10/2014	21.3	0.1	21.4	14/06/2014	13.1	1.2	14.3
6/08/2014	20.7	0.1	20.8	29/06/2014	4.2	1.0	5.2
8/07/2014	20.3	0.2	20.5	24/06/2014	3.1	0.9	4.0
18/05/2014	20.1	0.4	20.5	28/07/2014	12.6	0.8	13.4
9/08/2014	19.5	0.4	19.9	29/09/2014	8.9	0.7	9.6
4/07/2014	19.3	0.6	19.9	2/06/2014	11.9	0.7	12.6
26/05/2014	18.9	0.1	19.0	20/05/2014	12.9	0.6	13.5
10/05/2014	18.8	0.6	19.4	28/06/2014	4.1	0.6	4.7
5/08/2014	18.3	0.0	18.3	4/07/2014	19.3	0.6	19.9

Table D-16: 24-hour average $PM_{2.5}$ concentration (µg/m³) for Pit 5 scenario – R26

Ranked by Highest to Lowest Background Concentration				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
3/07/2014	24.3	0.5	24.8	10/06/2014	5.9	3.4	9.3
12/10/2014	21.3	0.1	21.4	1/06/2014	9.2	2.9	12.1
6/08/2014	20.7	1.3	22.0	28/03/2014	4.5	2.7	7.2
8/07/2014	20.3	0.4	20.7	13/06/2014	16.4	2.7	19.1
18/05/2014	20.1	1.1	21.2	2/07/2014	15.9	2.4	18.3
9/08/2014	19.5	0.3	19.8	4/04/2014	3.9	2.3	6.2
4/07/2014	19.3	0.0	19.3	24/05/2014	11.1	2.2	13.3
26/05/2014	18.9	0.2	19.1	5/06/2014	5.7	2.1	7.8
10/05/2014	18.8	0.2	19.0	15/10/2014	5.1	2.0	7.1
5/08/2014	18.3	1.0	19.3	12/04/2014	5.6	1.7	7.3