Appendix F

Air Quality Impact Assessment

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AIR QUALITY IMPACT ASSESSMENT
BLOOMFIELD COLLIERY
MODIFICATION

The Bloomfield Group

20 September 2017

Job Number 17020662

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EXECUTIVE SUMMARY

This assessment investigates the potential air quality effects which may arise as a result of the proposed modification to the Bloomfield Colliery located in East Maitland in the Newcastle Coalfield, New South Wales.

The proposed modification seeks approval to access the deeper coal seams and a change in the boundary of the active operation by approximately 200 metres. Overall, as there is no significant change in the rate of emissions generated or in the operating areas, only small changes in the existing effects are likely to arise due to the Project.

This assessment aims to quantify the potential effects of the Project and to provide an assessment per the more stringent new EPA criteria. The assessment is prepared per the applicable regulatory guidelines and forms part of the environmental assessment prepared for the modification application.

The existing meteorological conditions in the area surrounding the Bloomfield Colliery are governed by the local terrain features and vegetation with the overall prevailing wind flows along a west-northwest and east-southeast axis, characteristic of the area. The ambient air quality levels that are monitored at various locations surrounding the Bloomfield Colliery indicate that air quality in the area is generally good and is typically below the relevant New South Wales Environment Protection Authority goals.

To assess the potential for air quality impacts associated with the proposed modification, one indicative mine plan year was selected to represent the range of potential worst-case impacts over the life of the proposed mining operation. The mine plan year was selected with reference to the scale and location of activities occurring at the operations which would likely contribute to the highest dust levels at sensitive receptor locations in each year.

Air dispersion modelling with the CALPUFF modelling suite is utilised in conjunction with estimated emission rates for the air pollutants generated by the various mining activities. All reasonable and feasible best practice mitigation and management measures are considered to ameliorate any potential adverse air quality impacts and to address government and community concerns regarding the contribution to air quality due to the mining activity.

The assessment predicts potential dust impacts would be below the relevant criteria for all of the assessed dust metrics, with the exception of cumulative 24-hour average $PM_{2.5}$ and PM_{10}. Generally minor and occasional potential short-term dust impacts at four privately-owned receptor locations surrounding Bloomfield Colliery were predicted to occur without the application of reactive and predictive measures in place. An analysis of these impacts indicate they are only marginally exceeding the criteria and would be easily mitigated through day-to-day management of the operations, (or may not occur at all in reality, given that the assessment conservatively double counts the existing and future mine emissions in the added background monitoring data). Overall, it is considered that with the nominated mitigation measures, no unacceptable impacts on air quality would arise due to the Project.

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for the Bloomfield Group (hereafter referred to as the Proponent). It provides an assessment of the potential air quality impacts associated with a proposed modification to the Bloomfield Colliery (hereafter referred to as the Project)

1.1 Overview of the Bloomfield Colliery

The Bloomfield Colliery is an existing open cut mining operation located in East Maitland in the Newcastle Coalfield. Coal has been mined on the property for over 100 years. Underground mining by the current owner commenced in 1937 and the last coal extracted from underground operations was in 1992. The open cut commenced operations in 1964.

Bloomfield Colliery operates per its current Project Approval (07_0087) which permits extraction of up to 1.3 million tonnes of run-of-mine (ROM) coal per year. ROM coal is transported via an internal road to the Bloomfield Coal Handling and Preparation Plant (CHPP) for processing and dispatch via rail. The Bloomfield CHPP is also approved to receive coal from other mining operations, including the Abel Underground and the now completed Tasman Underground Mine and Donaldson Open Cut Coal Mine.

1.2 Overview of the Modification

The Project is seeking approval to access the deeper coal seams previously thought to be inaccessible. Extraction of these resources would require an increase in the depth of the excavation and the overburden emplacement area and would result in an approximate 200 metre (m) change in the boundary of the active operational area.

All of the proposed activities are within the existing approved project boundary and there are no changes being sought to the extent or intensity of mining, mining equipment fleet or mining method.

In terms of air quality, there would be reduced off site effects from the key dust generating activities which occur in the pits as these would be deeper in the pit and more shielded from wind. However, the overburden dumps may be higher and thus more exposed to wind. This may release more emissions from the dumps, but the wind generating the emissions will also tend to better disperse these emissions and the overall effect may be relatively similar. Similarly, there may be a somewhat longer haul length, parts of which would be more shielded and parts more exposed. Overall, in such a case no major decrease or increase in off-site dust effects would be expected, however this assessment has been conducted to objectively evaluate the case and quantify the change.

2 LOCAL SETTING

The Bloomfield Colliery is located approximately 24 kilometres (km) northwest of Newcastle and approximately 9km south of Maitland. Other nearby regional centres include Beresfield, located approximately 9km to the northeast and Kurri Kurri located approximately 7km to southwest.

The general area surrounding the Bloomfield Colliery is comprised of coal mining operations, agricultural activities and woodland. Suburban residential areas are located in relatively close proximity to the north of the Project. The Bloomfield Colliery is surrounded by dense forest (which would have a positive effect in limiting the transport of dust off-site).

Figure 2-1 presents the location of the Bloomfield Colliery and the relevant sensitive receptor locations to this study. **Appendix A** provides a detailed list of all the sensitive receptor locations considered in this assessment.

Figure 2-2 presents a three-dimensional visualisation of the topography in the vicinity of the Bloomfield Colliery. To the southwest of the Bloomfield Colliery, the terrain is undulating and gradually forms well-defined steep slopes as the elevation increases. To the east, the terrain is generally open and is essentially flat along the river flood plain towards the coast. To the northwest the terrain opens into the Hunter Valley region.

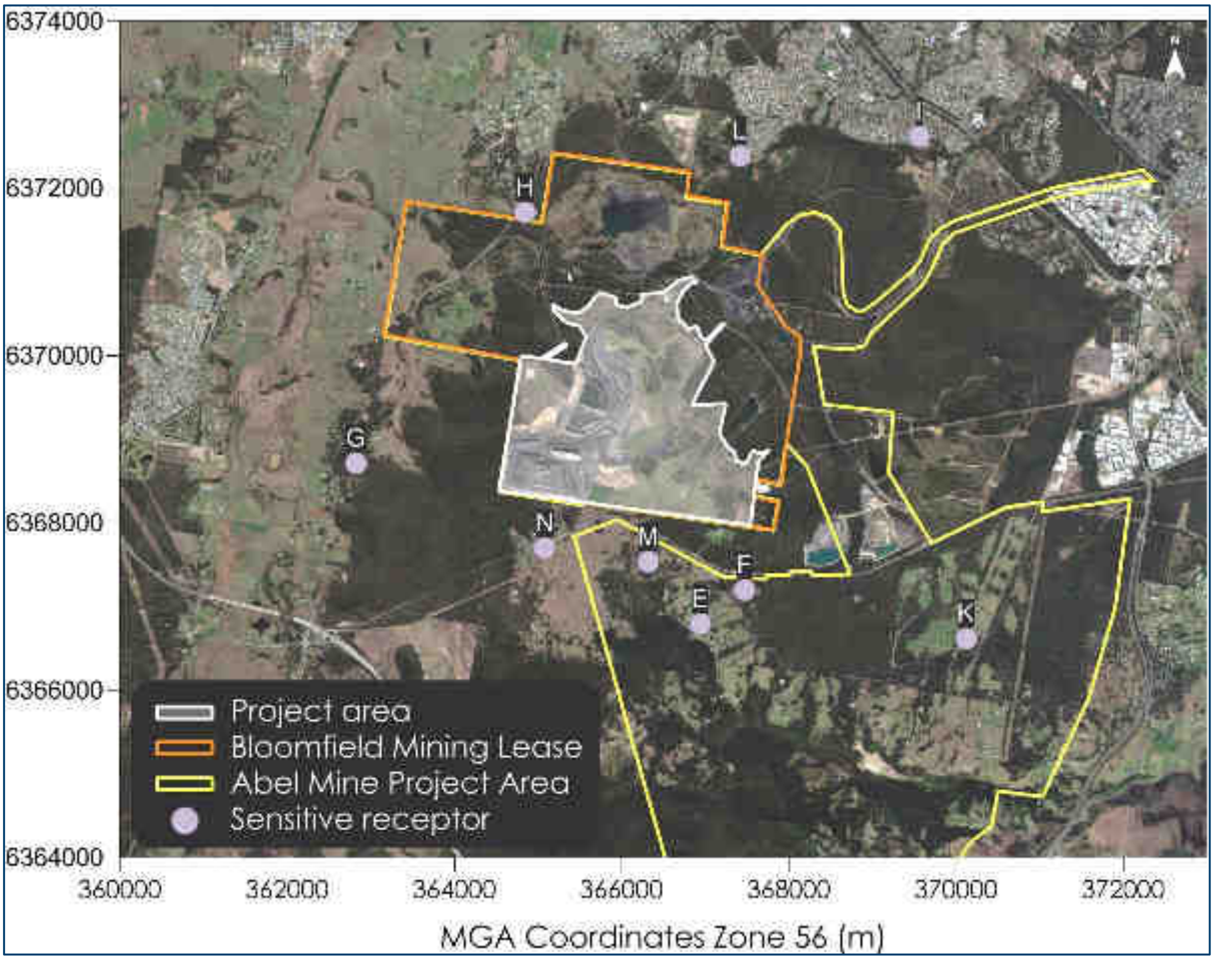

Figure 2-1: Local setting

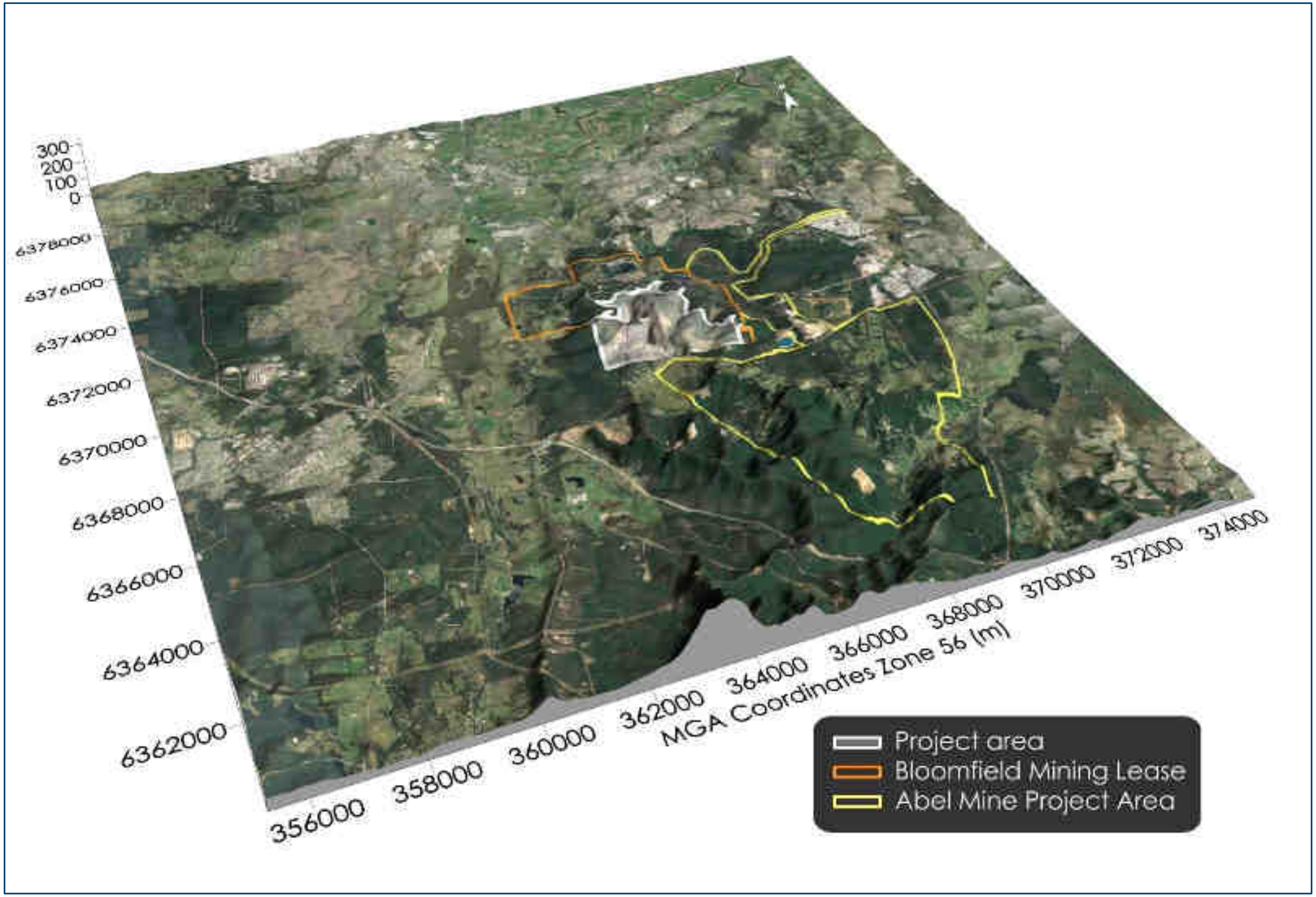

Figure 2-2: Topography surrounding the Project

3 AIR QUALITY ASSESSMENT CRITERIA

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

3.1 NSW EPA impact assessment criteria

Table 3-1 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 burden in the air and not just from the Project. Consideration of background levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
Total suspended particulates (TSP)	Annual	Total	90µg/m³
Particulate matter ≤10µm (PM_{10})	Annual	Total	25µg/m³
	24 hour	Total	50µg/m³
Particulate matter ≤2.5µm ($PM_{2.5}$)	Annual	Total	8µg/m³
	24 hour	Total	25µg/m³
Deposited dust	Annual	Incremental	2g/m²/month
		Total	4g/m²/month
Nitrogen dioxide (NO_2)	1 hour	Total	246µg/m³
	Annual	Total	62µg/m³

Source: NSW EPA (2017)
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

3.2 NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP)

Part of the NSW Voluntary Land Acquisition and Mitigation Policy dated 15 December 2014 and gazetted on 19 December 2014 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 where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-2** at any residence or workplace. [1]

Table 3-2: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation Criterion		Impact Type
PM_{10}	Annual	30µg/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 (2014)
*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.

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

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-3** at any residence, 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 3-3: Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition Criterion		Impact Type
PM_{10}	Annual	30µg/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 (2014)

*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 5 allowable exceedances of the criteria over the life of the development.

4 EXISTING ENVIRONMENT

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

4.1 Local climate

Long term climatic data collected at the Bureau of Meteorology (BoM) weather station at Cessnock Airport Automatic Weather Station (AWS) were analysed to characterise the local climate in the proximity of the Project. The Cessnock Airport AWS is located approximately 21km west of the Bloomfield Colliery.

Table 4-1 and **Figure 4-1** show climatic parameters which have been collected from the Cessnock Airport AWS over a 13 to 26 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 peaks during the summer months and declines during winter. The data show February is the wettest month with an average rainfall of 97.8 millimetres (mm) over 7.8 days and July is the driest month with an average rainfall of 29.0mm over 4.1 days.

Relative humidity levels exhibit variability over the day. Mean 9am relative humidity levels range from 60 per cent in October to 80 per cent in March and June. Mean 3pm relative humidity levels vary from 42 per cent in August and September to 55 per cent in June.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. The mean 9am wind speeds range from 8.7 kilometres per hour (km/h) in March to 14.0km/h in September. The mean 3pm wind speeds vary from 14.2km/h in May to 19.1km/h in September.

Table 4-1: Monthly climate statistics summary – Cessnock Airport AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temperature (°C)	30.1	29.2	27.3	24.2	20.7	17.8	17.3	19.4	22.5	25.3	26.9	28.9	24.1
Mean min. temperature (°C)	16.9	16.9	14.6	10.5	7.5	5.8	4.1	4.5	7.0	9.7	13.0	15.0	10.5
Rainfall													
Rainfall (mm)	81.2	97.8	70.0	58.0	41.7	58.5	29.0	34.6	45.4	51.1	74.4	80.3	743.3
Mean No. of rain days (≥1mm)	6.4	7.8	7.4	5.7	5.2	5.4	4.1	4.5	5.7	6.4	7.4	7.1	73.1
9am conditions													
Mean temperature (°C)	23.2	22.2	20.2	17.8	14.1	11.0	10.1	12.2	16.2	19.1	20.2	22.2	17.4
Mean relative humidity (%)	68	76	80	76	79	80	76	69	63	60	65	65	71
Mean wind speed (km/h)	11.5	10.2	8.7	10.1	10.4	11.5	11.5	13.0	14.0	13.7	12.7	11.8	11.6
3pm conditions													
Mean temperature (°C)	28.7	27.3	25.7	23.0	19.6	16.8	16.4	18.6	21.2	23.4	25.0	27.3	22.8
Mean relative humidity (%)	46	53	53	52	54	55	49	42	42	44	47	46	49
Mean wind speed (km/h)	18.5	17.3	15.7	14.6	14.2	15.1	15.3	17.3	19.1	18.7	18.6	18.3	16.9

Source: **Bureau of Meteorology (2017), accessed March 2017**

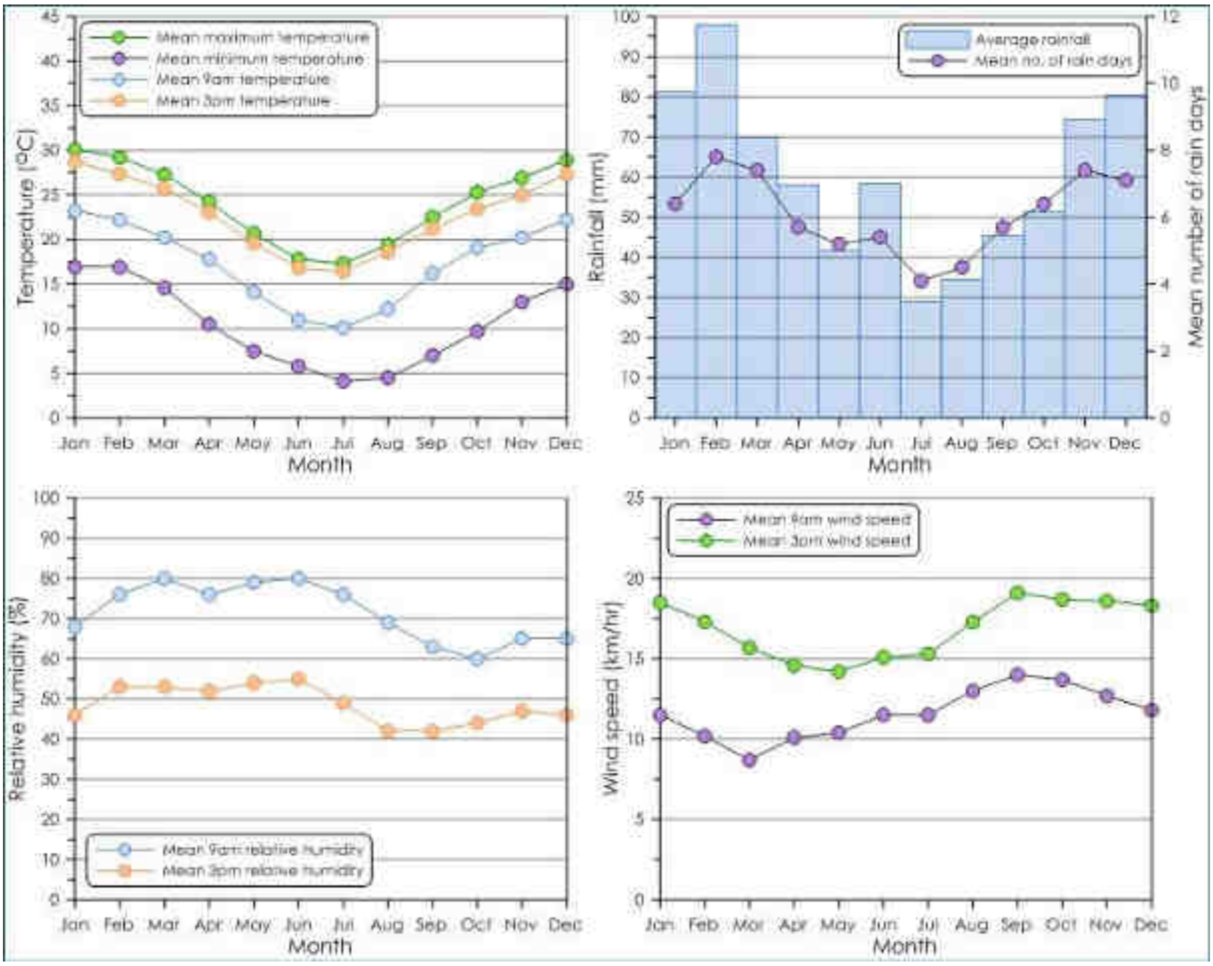

Figure 4-1: Monthly climate statistics summary – Cessnock Airport AWS

4.2 Local meteorological conditions

The Bloomfield Colliery operates a meteorological station to assist with environmental management of site operations. The location of this station is shown in **Figure 4-2**.

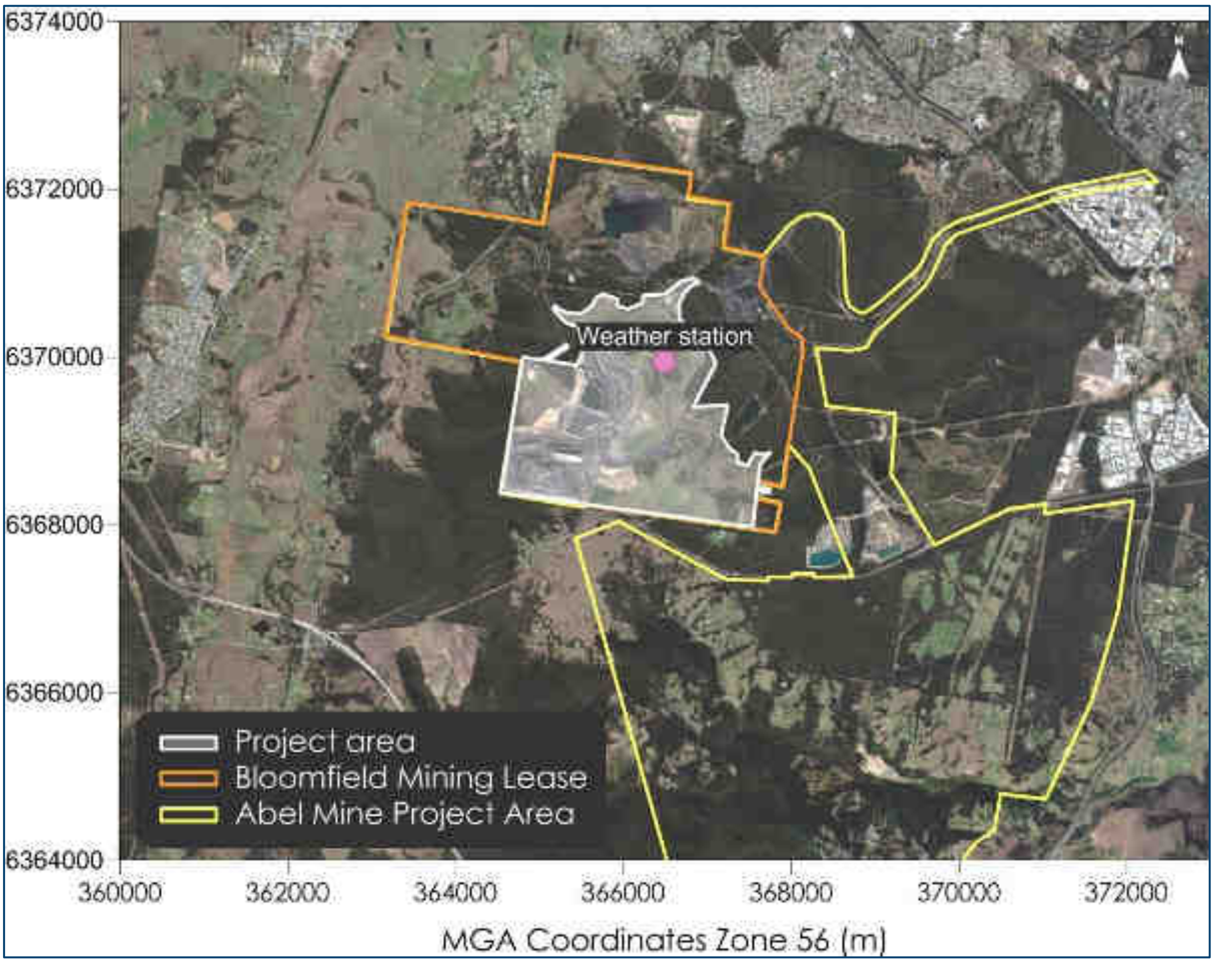

Figure 4-2: Bloomfield Colliery weather station location

Annual and seasonal windroses prepared from the available data collected for the 2015 calendar period for the station are presented in **Figure 4-3**.

Analysis of the windroses shows that winds are generally light. On an annual basis the general winds at the Bloomfield weather station are along the west-northwest to east-southeast axis. Very few, almost non-existent winds originate from the northeast quadrant throughout the year.

In summer the winds predominately occur from the southeast and east-southeast and are typically light. Winds from all other quadrants are almost absent. The autumn wind distribution shows dominance of light winds from the east-southeast followed by relatively stronger winds from the west-northwest. The autumn wind distribution is similar to the annual distribution. During winter, relatively stronger winds from the west-northwest are most frequent, followed by a few winds from the southwest quadrant. Winds from all other quadrants are almost absent. The spring windrose typically shares a similar wind distribution pattern to the annual distribution but with fewer and lighter winds from the west-northwest.

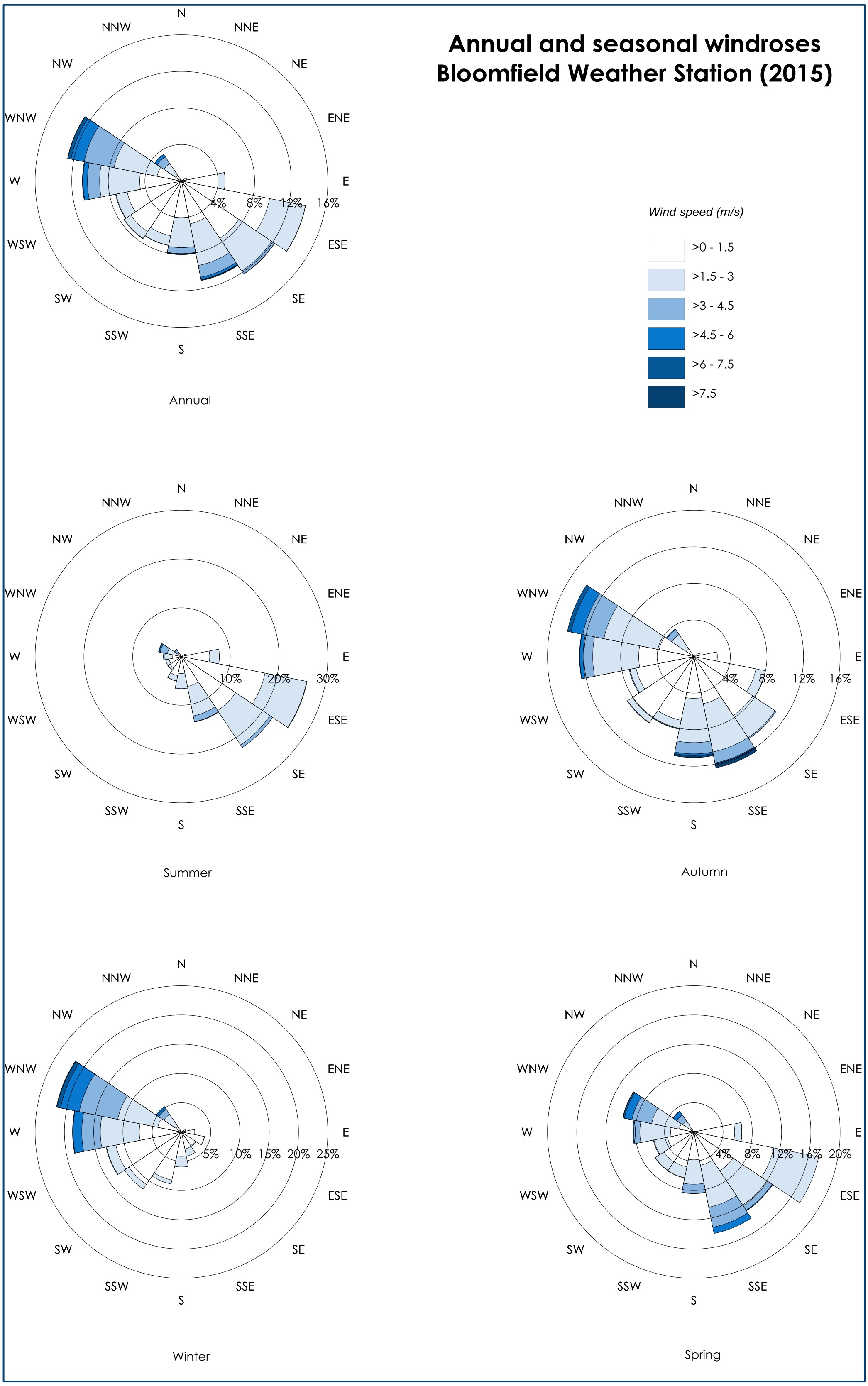

Figure 4-3: Annual and seasonal windroses for the Bloomfield Colliery weather station (2015)

4.3 Local air quality monitoring

The main sources of particulate matter in the wider area include active mining, agricultural activities, emissions from local anthropogenic activities such as motor vehicle exhaust and domestic wood heaters, urban activity and various other commercial and industrial activities.

This section reviews the ambient monitoring data collected from a number of ambient monitoring locations in the vicinity of the Project. The monitoring data reviewed in this assessment include data collected at High Volume Air Samplers (HVAS) measuring TSP and PM_{10}, ten dust deposition gauges measuring dust fallout, a Tapered Element Oscillating Microbalance (TEOM) measuring PM_{10} and a Beta Attenuation Monitor (BAM) measuring $PM_{2.5}$ and a monitor to measure NO_2.

Figure 4-4 shows the approximate location of each of the monitoring stations reviewed in this assessment.

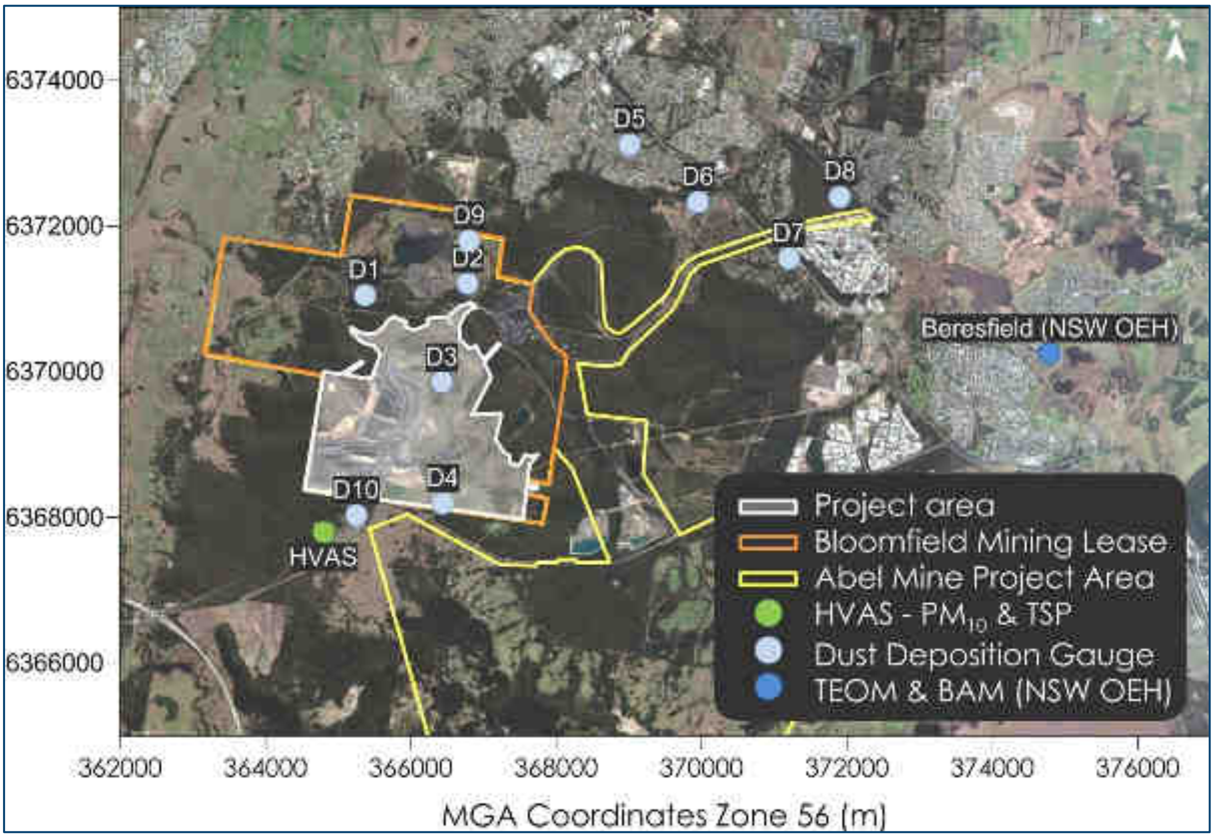

Figure 4-4: Monitoring locations

4.3.1 PM_{10} monitoring

A summary of the available ambient PM_{10} monitoring data from the Bloomfield Colliery HVAS and NSW OEH Beresfield TEOM monitoring station is presented in **Table 4-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-5**.

The monitoring data in **Table 4-2** include all emission sources in the general vicinity and indicate that the annual average PM_{10} concentrations for the monitoring stations were below the relevant criterion of 25µg/m³ for the period reviewed.

Table 4-2: Summary of PM_{10} levels from Bloomfield Colliery HVAS and NSW OEH Beresfield monitoring station (µg/m³)

Year	2012	2013	2014	2015	2016
Annual average					
Bloomfield	15.8	16.8	14.8	13.9	15.9
Beresfield	21.3	21.4	19.4	18.8	19.1
Maximum 24-hour average					
Bloomfield	33.0	46.0	36.0	48.0	45.0
Beresfield	50.8	55.3	45.4	64.9	48.0
Number of days >50µg/m³					
Bloomfield	0	0	0	0	0
Beresfield	1	5	0	2	0

The maximum 24-hour average PM_{10} concentrations (see **Figure 4-5**) recorded at the Bloomfield Colliery monitor were below the relevant criterion of 50µg/m³ for the review period. In contrast, the Beresfield monitoring station was found on occasion to exceed the maximum 24-hour average PM_{10} criterion.

It is noteworthy that on the days when both stations recorded 24-hour PM_{10} levels, the Beresfield monitor recorded levels that on average were 39 per cent higher than the levels at the Bloomfield monitor which is located in the vicinity of the existing mine.

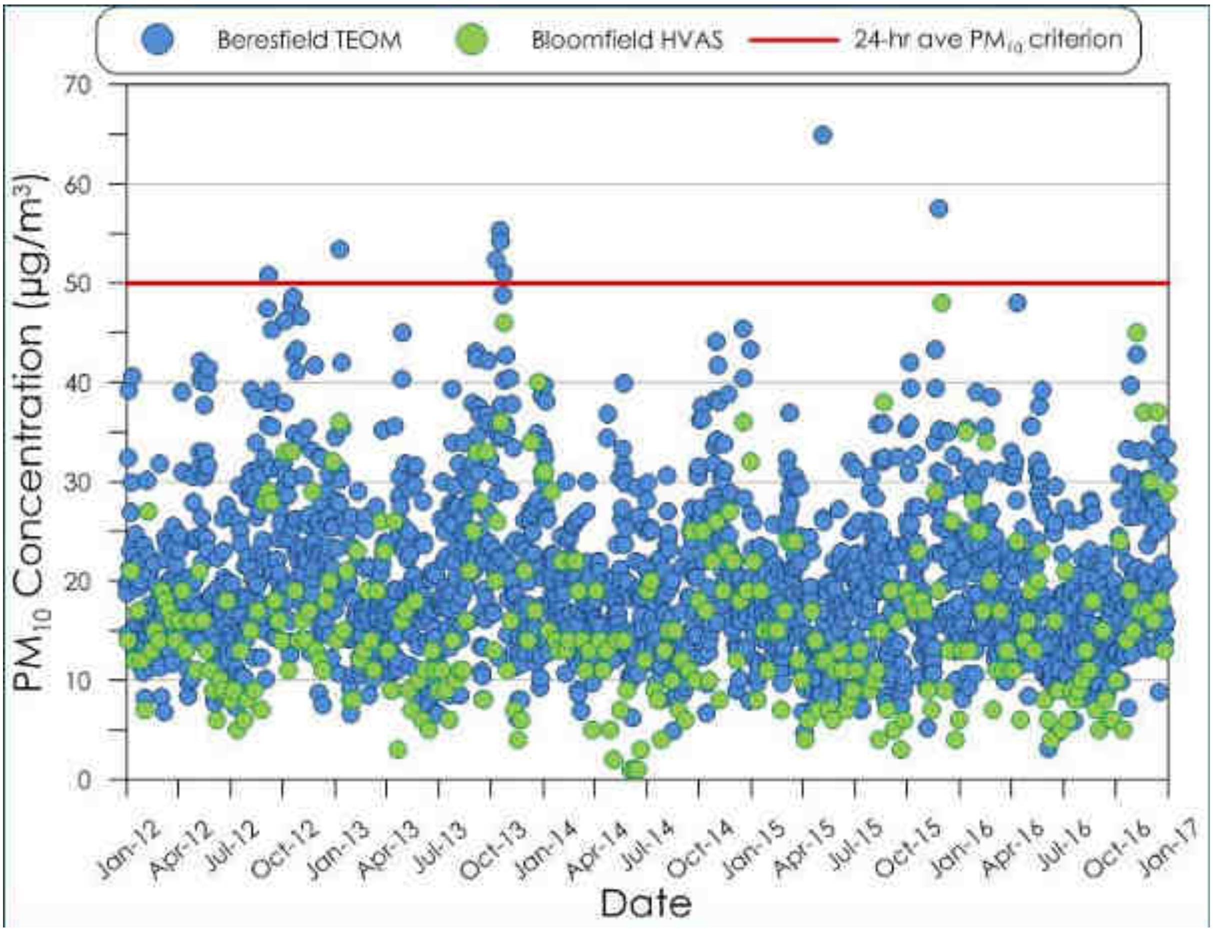

Figure 4-5: TEOM 24-hour average PM_{10} concentrations at NSW OEH Beresfield monitor

4.3.2 TSP monitoring

A summary of the available TSP monitoring data from the Bloomfield Collier HVAS collected between January 2012 and December 2016 is shown in **Table 4-3**. Recorded 24-hour average TSP concentrations are presented in **Figure 4-6**.

The monitoring data presented in **Table 4-3** indicate that the annual average TSP concentrations for the monitoring station are less than half the criterion of 90µg/m^3. **Figure 4-6** shows that the recorded 24-hour average TSP concentrations follow a similar trend to the PM_{10} HVAS monitoring data as expected.

Table 4-3: Summary of annul average TSP levels from Bloomfield Colliery HVAS monitoring (µg/m³)

Year	Annual average
2012	38.0
2013	38.2
2014	31.1
2015	29.0
2016	34.5

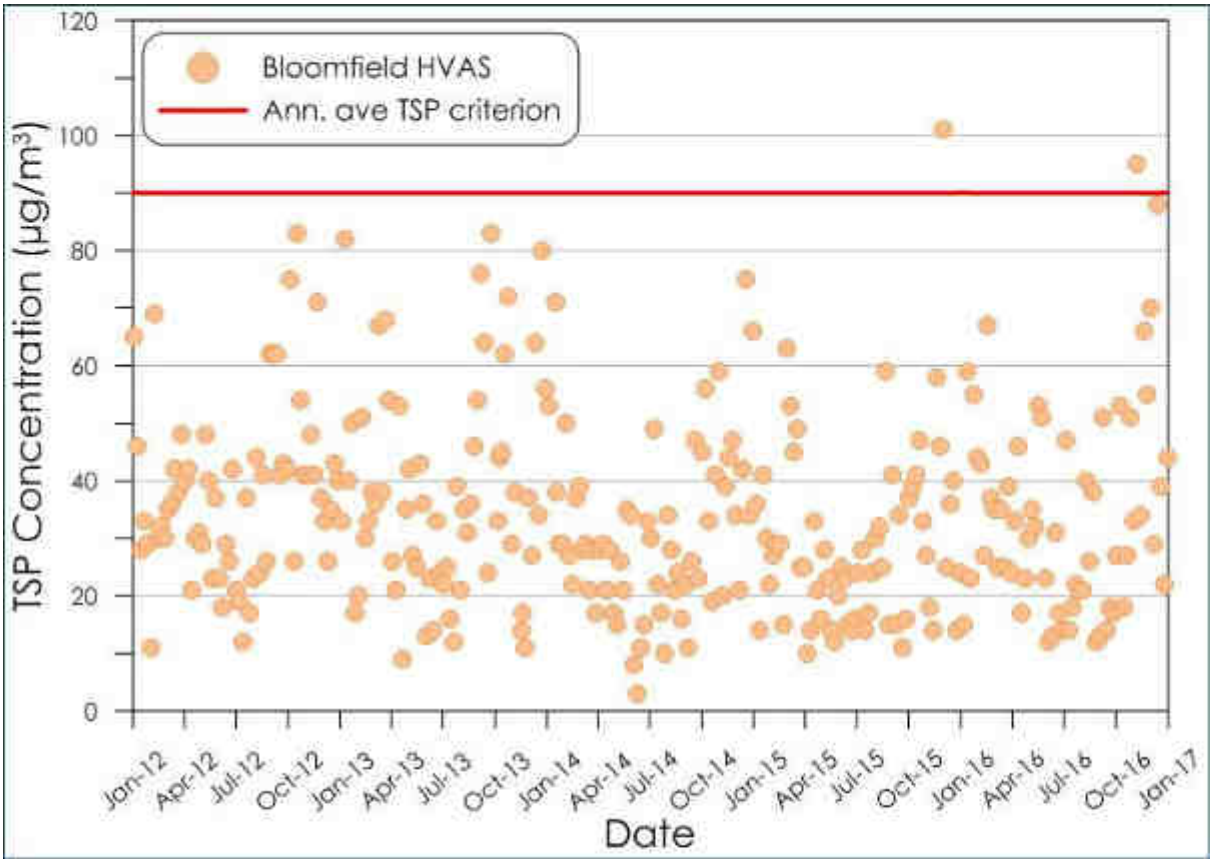

Figure 4-6: HVAS 24-hour average TSP concentrations (criteria is 90 µg/m³ as an annual average)

4.3.3 Dust deposition monitoring

Table 4-4 summarises the annual average deposition levels at each gauge during 2012 to 2016.

The monitoring data indicate that some of the samples were contaminated possibly with materials such as bird droppings, insects or plant matter. This is a relatively common occurrence for this type of monitoring, and accordingly, contaminated samples have been excluded from the reported annual average results.

All gauges recorded an annual average insoluble deposition level below the criterion of 4g/m^2/month and in general, the air quality in terms of dust deposition is considered good.

Table 4-4: Annual average dust deposition (g/m²/month)

Dust gauge	2012	2013	2014	2015	2016
D1	1.5	1.7	1.2	1.3	0.7
D2	1.7	1.6	1.4	1.3	1.3
D3	1.9	2.5	1.6	1.5	1.1
D4	3.1	1.3	1.5	1.4	1.3
D5	1.4	1.5	1.5	1.3	1.3
D6	3.4	2.5	2.5	1.3	1.5
D7	1.8	1.7	1.4	1.1	1.1
D8	1.6	1.7	1.7	1.3	1.4
D9	1.1	1.3	1.1	0.9	0.8
D10	2.2	1.5	1.5	1.5	2.2

4.3.4 $PM_{2.5}$ monitoring

A summary of the $PM_{2.5}$ readings from the NSW OEH Beresfield monitoring station is presented in **Table 4-5**. The recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-7**.

Table 4-5 indicates that the annual average $PM_{2.5}$ concentration was above the relevant criterion of 8µg/m³ in 2013. For all other periods the annual average $PM_{2.5}$ concentrations were below the relevant criterion.

On occasion, the 24-hour average $PM_{2.5}$ levels were also found to be above the relevant criterion of 25µg/m³ during the review period (see **Figure 4-7**). Ambient $PM_{2.5}$ levels are likely to be governed by many non-mining background sources such as wood heaters and motor vehicles.

Table 4-5: Summary of $PM_{2.5}$ levels from NSW OEH Beresfield monitoring station (µg/m³)

Year	Annual average	Maximum 24-hour average	Number of days >25µg/m³
2012	7.9	22.4	0
2013	8.2	40.8	2
2014	7.5	19.0	0
2015	7.3	25.9	1
2016	7.4	27.9	1

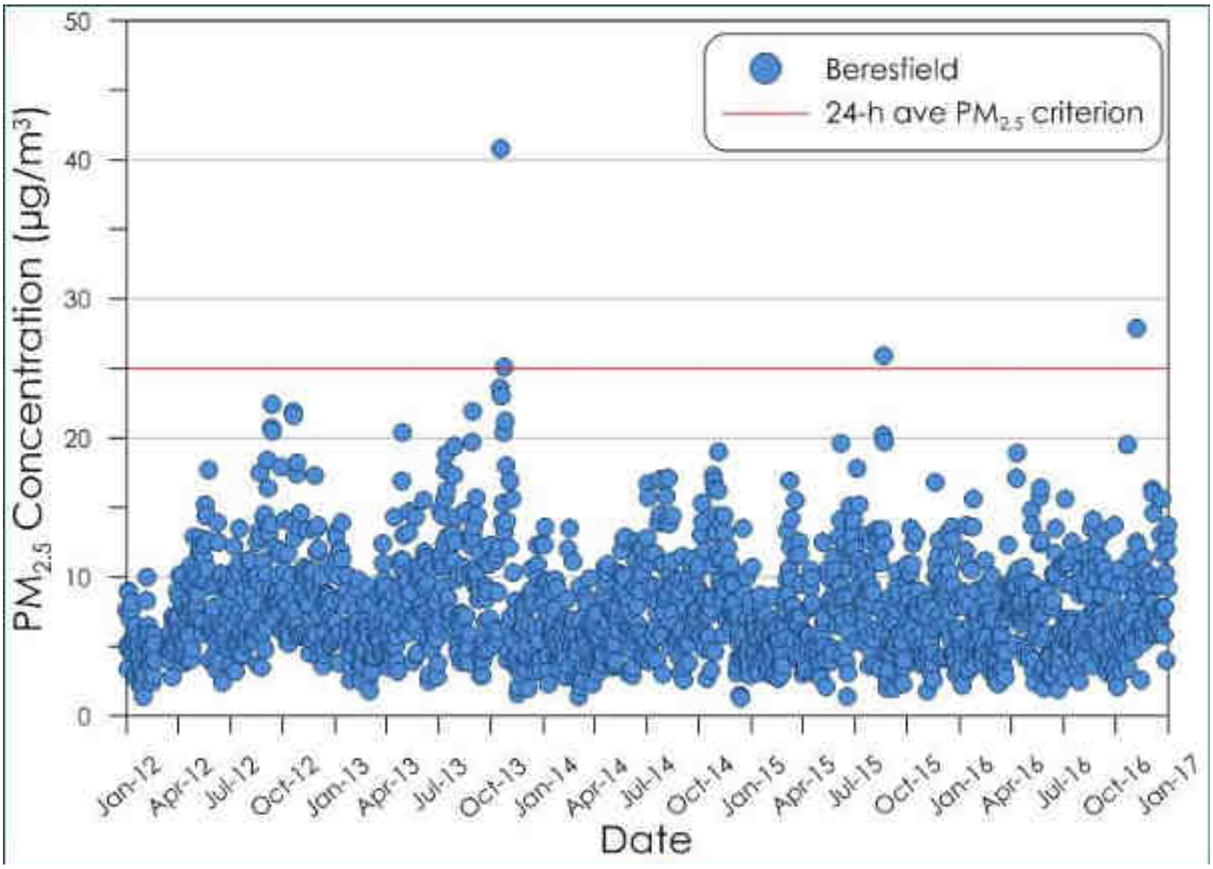

Figure 4-7: 24-hour average $PM_{2.5}$ concentrations at NSW OEH Beresfield monitoring station

4.3.5 Nitrogen dioxide

Figure 4-8 presents the maximum daily 1-hour average NO_2 concentrations from the NSW OEH Beresfield monitoring site from January 2012 to December 2016.

The monitoring data recorded are well below the NSW EPA 1-hour average goal of 246µg/m³ during this period at all of the monitors. The data in **Figure 4-8** indicate that levels of NO_2 are relatively low compared to the criterion level and show a seasonal fluctuation.

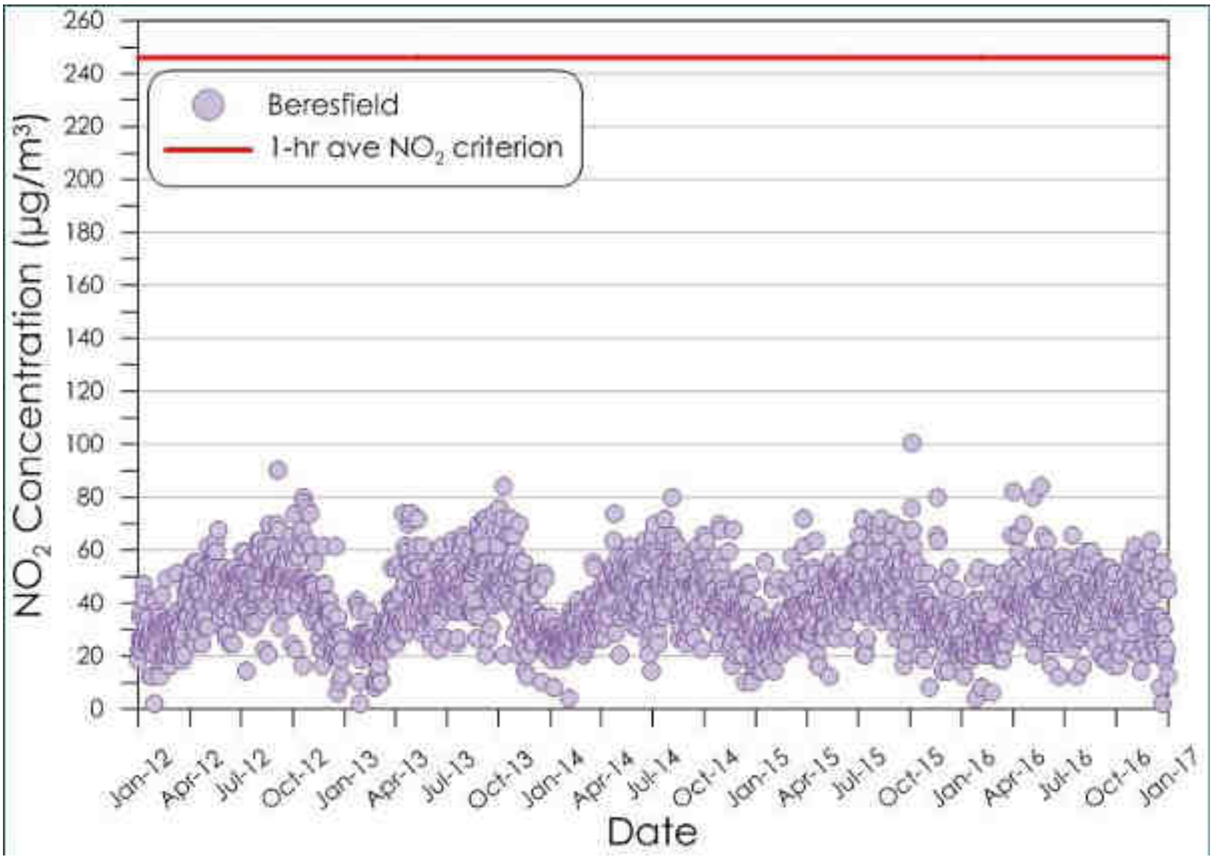

Figure 4-8: Daily 1-hour maximum NO_2 concentrations at NSW OEH Beresfield monitoring station

5 DISPERSION MODELLING APPROACH

5.1 Introduction

For this assessment the CALPUFF modelling suite is applied to dispersion modelling. The model was setup in general accordance with methods provided in the NSW EPA document *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 Environmental Corporation, 2011**).

5.2 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 in the CALMET model.

The centre of analysis for the TAPM modelling used is 32deg48.5min south and 151deg33.5min east. The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels. The CALMET domain was run on a 20 x 20km grid with a 0.2km grid resolution.

The 2015 calendar year was selected as the period for modelling the Project. This period was selected based on a review of the long-term meteorological and ambient air quality conditions which are representative of the prevailing conditions. Accordingly, the available meteorological data for January 2015 to December 2015 from five nearby meteorological monitoring sites were included in the simulation. **Table 5-1** outlines the parameters used from each station.

Table 5-1: Surface observation stations

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Bloomfield Colliery Weather Station	✓	✓			✓	✓	
Williamtown RAAF (BoM) (Station No. 061078)	✓	✓	✓	✓	✓	✓	✓
Newcastle Nobbys Signal Station AWS (BoM) (Station No. 61055)							
Cessnock Airport AWS (BoM) (Station No. 061260)	✓	✓			✓	✓	✓
Paterson (Tocal) AWS (BoM) (Station No. 061250)	✓	✓			✓	✓	

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 **Figure 5-2**.

Table 5-2: Seven critical parameters used in CALMET

Parameter	Value
TERRAD	5
IEXTRP	-4
BIAS (NZ)	-1, -0.5, -0.25, 0, 0, 0, 0, 0
R1 and R2	8, 8
RMAX1 and RMAX2	15, 15

5.2.1 Evaluation of meteorological data

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

Figure 5-1 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.

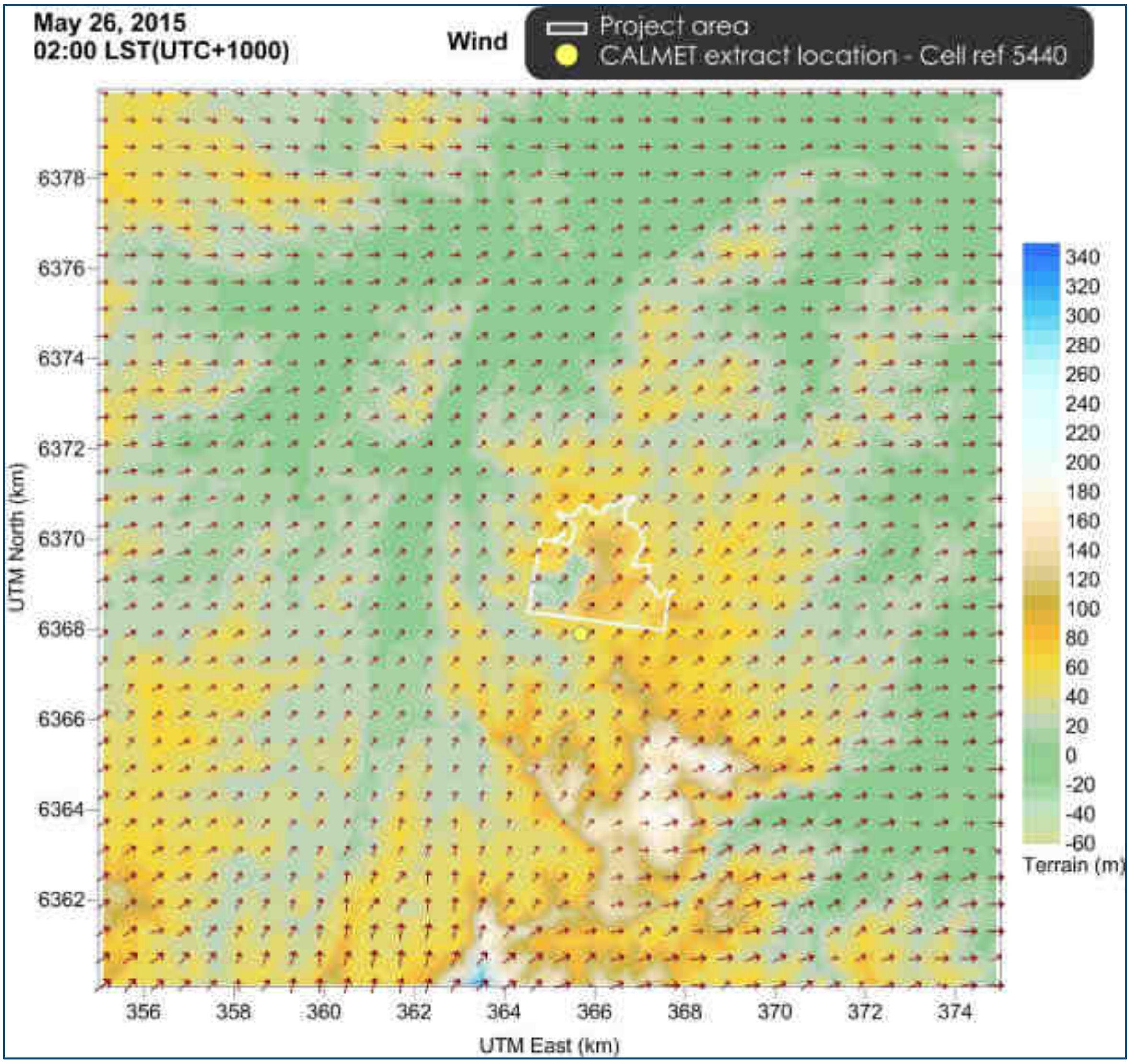

Figure 5-1: Example of the wind field for one of the 8,760 hours of the year that are modelled

CALMET generated meteorological data were extracted from a central point within the CALMET domain and are graphically represented in **Figure 5-2** and **Figure 5-3**.

Figure 5-2 presents annual and seasonal windroses extracted from one central point in the CALMET domain. As expected, the windroses show similar distributions at the Bloomfield weather station (see **Figure 4-3**).

Overall the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. This is evident as the windroses based on the CALMET data also compare well with the windroses generated with the measured data, as presented in **Figure 4-3**.

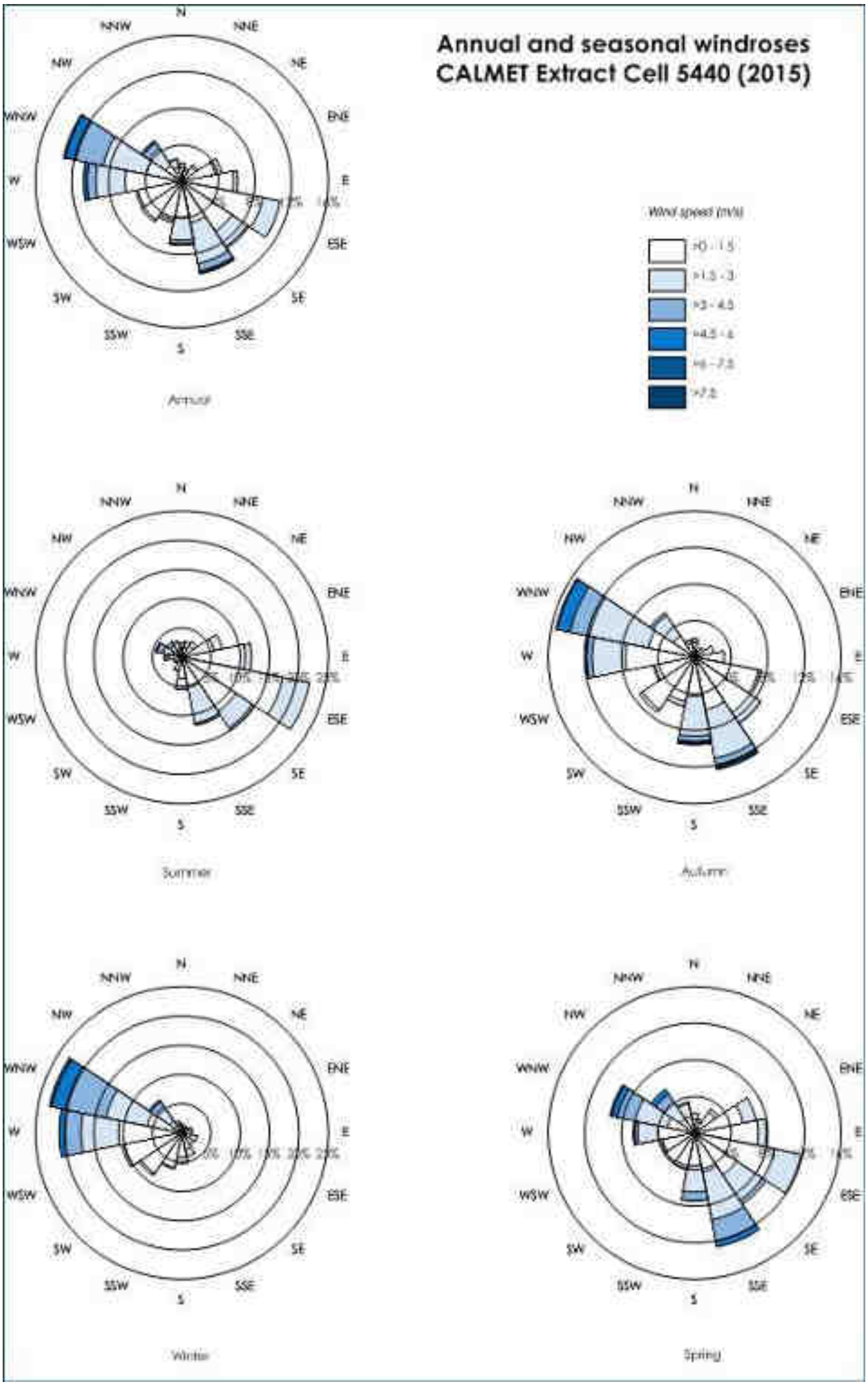

Figure 5-2: Windroses from CALMET extract (Cell ref 5440)

Figure 5-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

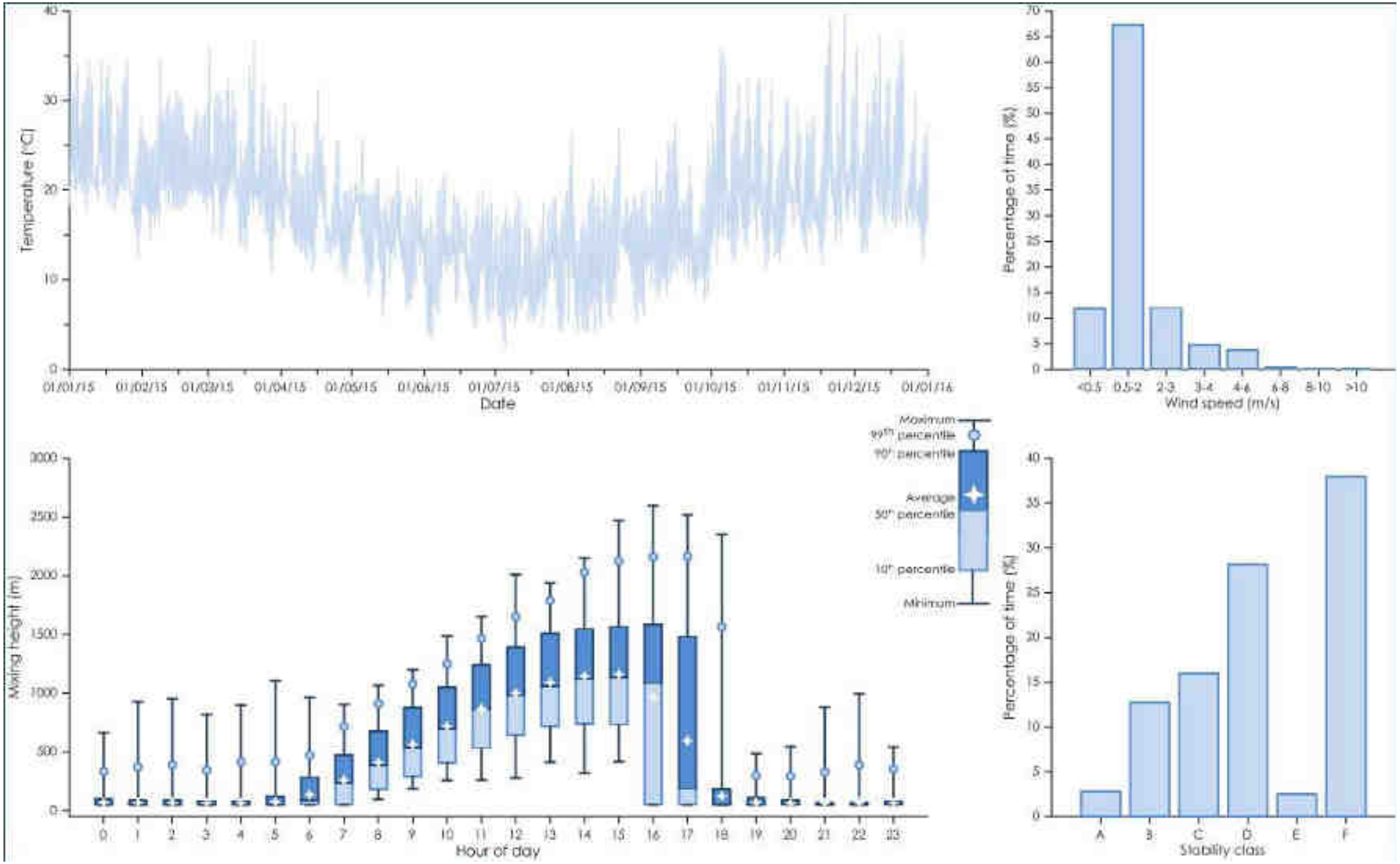

Figure 5-3: Meteorological analysis of CALMET extract (Cell ref 5440)

5.2.2 Dispersion modelling

CALPUFF modelling of dust emissions is based on the distribution of particles for each particle size category derived from the applied emission factor equations. Emissions from each activity were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in removing dust emissions from the atmosphere has not been considered in this assessment. As a result, the predicted impact can be expected to be elevated when examined against a typical year, especially for years with above average rainfall.

Dispersion modelling of the diesel powered equipment was conducted as point sources and impacts due to the Project were added to the ambient background level to assess potential impacts. Complete conversion of NO_X to NO_2 is conservatively assumed for these sources.

5.3 Modelling scenario

The assessment considers a single indicative mine plan year (scenario) to represent the proposed modification. The scenario is chosen to represent potential worst-case impacts in regard to the quantity of material extracted in each year, the location of the operations and the potential to generate dust at the receptor locations.

Mining operations at the Bloomfield Colliery consist of a truck and shovel operation to remove overburden material and extract the coal resources. Overburden emplacement typically occurs behind the progression of the mine extraction with rehabilitation of emplacement areas progressing as they are completed. The active mining areas and exposed areas are kept to a minimum for the efficiency of the operation and this also has a positive effect in minimising the potential amount of dust levels generated from the operations.

The scenario chosen for assessment (Year 2021) nominally represents the highest level of proposed activity for the modification in future years with a target of 1.3 million tonnes of ROM coal extracted. An indicative mine plan for the modelling scenario is presented in **Figure 5-4**.

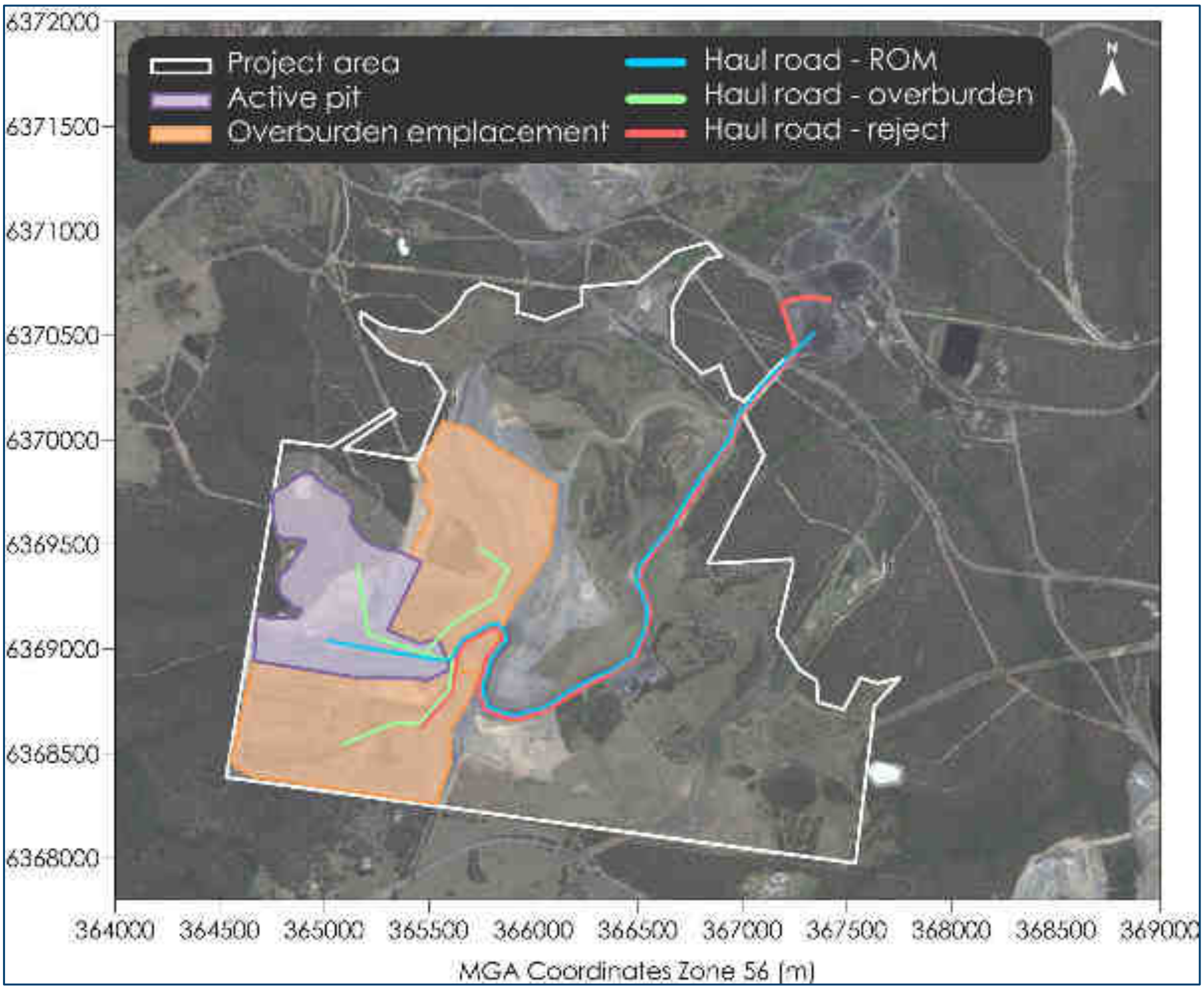

Figure 5-4: Indicative mine plan for modelling scenario

5.3.1 Emission estimation

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

The emission factors were sourced from both locally developed and United States EPA (US EPA) developed documentation. Total dust emissions from all significant dust generating activities for the project are presented in **Table 5-3**. Estimated $PM_{2.5}$ emissions from diesel powered equipment are presented in **Table 5-4**. Detailed emission inventories and emission estimation calculations are presented in **Appendix B**.

The estimated emissions presented in **Table 5-3** are commensurate with a mining operation utilising reasonable and feasible best practice dust mitigation applied where applicable. Further details on the dust control measures applied for the Bloomfield Colliery are outlined in **Section 5.4**.

Table 5-3: Estimated emission for the proposed modification

Activity	TSP emission (kg/yr.)	PM_{10} emission (kg/yr.)	$PM_{2.5}$ emission (kg/yr.)
TS - Excavator loading topsoil from stockpile to haul truck	72	34	5
TS - Hauling topsoil to rehab area	889	195	21
TS - Emplacing topsoil at rehab area	72	34	5
TS - Rehandle topsoil at rehab area	7	3	1
OB - Drilling	6,018	3,129	181
OB - Blasting	24,871	12,933	746
OB - Excavator loading OB to haul truck	11,476	5,428	822
OB - Hauling to dump - to Creek cut	65,996	14,513	1,588
OB - Hauling to dump - to S cut	76,257	16,750	1,811
OB - Emplacing at dump - Creek cut	5,733	2,711	411
OB - Emplacing at dump - S cut	5,743	2,716	411
OB - Rehandle OB	1,148	543	82
OB - Dozers on OB in pit	19,632	4,744	2,061
OB - Dozers on OB working on dump + rehab	43,876	10,603	4,607
CL - Dozers ripping/pushing/clean-up	267	27	6
CL - Loading ROM coal to haul truck	5,688	818	108
CL - Hauling ROM to ROM Pad	43,516	9,969	1,532
CHPP - Unloading ROM to ROM Pad - Bloomfield	5,688	818	108
CHPP - Unloading ROM to ROM Pad - Abel	26,688	3,838	507
CHPP - Loading ROM to hopper	9,713	1,397	185
CHPP - Rehandle ROM at hopper	6,475	931	123
CHPP - Plant feed conveyor	14	7	1
CHPP - Crushing	4,440	1,998	370
CHPP - Screening	11,100	4,440	259
CHPP - No. 2 Conveying to CHPP	8	4	1
CHPP - Transfer	8,339	3,944	597
CHPP - Conveying to Product stockpile	17	8	1
CHPP - Unloading to Product stockpile	731	346	52
CHPP - Conveying to train load out	33	16	2
CHPP - Transfer	219	104	16
CHPP - Loading coal to train	731	346	52
CHPP - Dozers on Product stockpiles	1,926	252	42
OB - Loading Reject to haul truck	151	71	11
OB - Hauling Reject to dump	38,114	8,363	895
OB - Emplacing Reject at dump	151	71	11
WE - Overburden emplacement areas	97,835	48,918	7,338
WE - Open pit	43,775	21,888	3,283
WE - ROM stockpiles	23	12	2

Activity	TSP emission (kg/yr.)	PM_{10} emission (kg/yr.)	$PM_{2.5}$ emission (kg/yr.)
WE - Product stockpiles	185	93	14
OB - Grading roads	14,771	5,161	458
Locomotive idling	515	515	499
Total	**582,386**	**188,690**	**29,225**

TS – topsoil, OB – overburden, CL – coal, CHPP – coal preparation plant, WE – wind erosion

Table 5-4: Estimated $PM_{2.5}$ emissions from diesel powered equipment

Type	Plant detail	$PM_{2.5}$ emission (kg/yr.)
Excavator	EX500-5	580
Shovel	P&H 5700	71
Loader	994A	61
Dozer (Open Cut)	D11N	72
Dozer (Open Cut)	D10T	64
Dozer (Open Cut)	D10N	10
Dozer (Washed Coal)	D11R	47
Truck	793 C	850
Truck	789A	325
Truck	789C	81
Water Cart	777B WC	79
Water Cart	773-B	3
Grader	24H	69
Grader	16G	4
Drill	SK75	79
Drill	SK50	24
Loader	992C	118

5.3.2 Emissions from other mining operations

In addition to the estimated dust emissions from the proposed modification, emissions from all nearby approved mining operations were also modelled, in accordance with their current consent (or current proposed project), to assess potential cumulative dust effects.

Emissions estimates from these sources were derived from information provided in the air quality assessments available in the public domain at the time of modelling. These estimates are likely to be conservative, as in many cases, mines do not continually operate at the maximum extraction rates assessed in their respective environmental assessments. **Table 5-5** summarises the emissions adopted in this assessment for each of the nearby mining operations.

Table 5-5: Estimated emissions from nearby mining operations

Mining operation	TSP emission (kg/yr.)
Abel Underground*	51,064

*Source: Todoroski Air Sciences, 2012

Emissions from nearby mining operations would contribute to the background level of dust in the area surrounding the proposed modification, and these emissions were explicitly included in the modelling assessment. Additionally, there would be numerous smaller or very distant sources that contribute to the total background dust level. Modelling these sources explicitly is impractical; however, the residual level of dust due to all other such non-modelled sources has been included in the cumulative results, and the method for doing this is discussed further in **Section 5.5**.

5.3.3 Emissions from diesel powered equipment

The assessment of diesel emissions from the Project is focused on the potential emissions of oxides of nitrogen (NO_X), generally assessed as NO_2, arising from diesel powered equipment.

The ambient air quality goals for CO are set at higher concentration levels than the NO_2 goals. Based on the NO_2 monitoring data which are low compared to the goals, and consideration of the typical mix of ambient pollutant levels and associated emissions of CO, the indication is that predictions of CO would be well below the air quality goals and do not require further consideration.

Emissions from diesel powered equipment were estimated on the basis of manufacturer's data. It is noted that manufacturer's equipment performance specifications were typically categorised on the basis of the US EPA federal tier standards of emissions for diesel equipment (**Dieselnet**, **2017**).

Emissions for certain plant included non-methane-hydrocarbon (NMHC) and NO_X emissions as a single value. For the purpose of this assessment it has been conservatively assumed that the total emission (NHMC and NO_X) comprises NO_2.

The various types of diesel powered mining equipment operated at the Project is outlined in **Table 5-6**. The equipment are assumed to be equivalent to Tier 2 and plant hours of operation were based on assumed plant availability and utilisation rates for the specific equipment type. The emission rates used in the modelling are considered conservative and likely to overestimate actual emissions from mining equipment.

Table 5-6: Estimated NO_X emissions from diesel powered equipment

Type	Plant detail	NO_X emission (kg/yr.)
Excavator	EX500-5	26,579
Shovel	P&H 5700	3,241
Loader	994A	2,818
Dozer (Open Cut)	D11N	3,283
Dozer (Open Cut)	D10T	2,928
Dozer (Open Cut)	D10N	442
Dozer (Washed Coal)	D11R	2,155
Truck	793 C	38,952
Truck	789A	11,173
Truck	789C	3,724
Water Cart	777B WC	3,724
Water Cart	773-B	3,625
Grader	24H	145
Grader	16G	3,174
Drill	SK75	192
Drill	SK50	4,996
Loader	992C	1,499

5.4 Dust mitigation and management

A range of air quality mitigation measures are applied at Bloomfield Colliery to achieve a standard of mine operation consistent with current best practice for the control of dust emissions from coal mines in NSW.

The measures applied to the Project reflect those 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, 2010**), and also imposed on mines in the current NSW EPA PRP's that relate to haul road emissions, and dust mitigation in response to adverse weather conditions.

Where applicable these controls have been applied in the dust emission estimates as shown in **Appendix B**. A summary of key dust controls applied to current operations at the Project are shown in **Table 5-7**.

Table 5-7: Summary of best practice dust mitigation measures

Activity	Dust mitigation measure
Drilling	✦ Dust suppression system. ✦ Prevent disturbance of drill cuttings. ✦ Application of water on dusty areas prior to drilling. ✦ Ceasing operations when visible dust generated.
Blasting	✦ Watering blast areas to suppress dispersion of drill cuttings. ✦ Review meteorological and blast forecast prior to blasting.
Hauling on unsealed roads	✦ Watering of haul road surfaces. ✦ Prevent material being deposited / spilled on haul roads. ✦ Restrict general vehicle speed. ✦ Trafficable areas clearly marked, vehicle movements restricted to these areas. ✦ Trafficable areas and vehicle manoeuvring areas maintained. ✦ Fleet optimisation to reduce vehicle kilometres travelled.
Material extraction/unloading	✦ Application of water on dusty areas prior to extraction. ✦ Sheltered dumping during periods of adverse weather. ✦ Minimise the fall distance of materials during loading and unloading. ✦ Ceasing operation during high dust periods.
Dozer operation	✦ Avoid use during unfavourable conditions. ✦ Minimise travel speed in dusty conditions. ✦ Travel on water watered routes between work areas.
Graders	✦ Travel on watered routes. ✦ Water haul roads immediately after grading, where possible.
Exposed areas	✦ Minimise area of disturbance, rehabilitate areas as soon as feasible. ✦ Apply interim stabilisation on areas inactive for long periods.
Rehabilitation	✦ Rehabilitation expedited to achieve maximum coverage rate. ✦ Vegetation is actively managed.

It should be noted that attainment of best practice requires ongoing improvement and thus the current best practice mitigation and dust management measures are likely to improve over time, as they are regularly reviewed and updated through the management plan framework.

5.5 Accounting for background air quality levels

All significant dust generating mining operations in the vicinity of Bloomfield Colliery were included in the dispersion model to assess the total potential dust impact. The total predicted effects from the Project (including any existing effects) were added with the measured background levels (which also include any existing effects from the colliery). This approach is conservative, (would lead to overestimation of impacts) as the existing colliery emissions are double counted in this assessment.

Ambient air quality monitoring data collected from the Bloomfield air quality monitoring network during 2015 have been applied to represent the prevailing background dust levels. For $PM_{2.5}$, the ratio of the measured PM_{10} levels at the Bloomfield and Beresfield monitors was applied to the Beresfield $PM_{2.5}$ level to estimate the potential $PM_{2.5}$ level in the vicinity of the Bloomfield Colliery.

The background dust levels applied in the assessment are presented in **Table 5-8**.

Table 5-8: Estimated contribution from other non-modelled dust sources

Dust metric	Averaging period	Unit	Estimated contribution
TSP	Annual	µg/m³	29.0
PM_{10}	Annual	µg/m³	13.9
$PM_{2.5}$	Annual	µg/m³	5.3
Dust deposition	Annual	g/m²/month	1.5

The NO_2 monitoring data presented in **Section 4.3.5** shows that the annual average NO_2 background level at the Beresfield monitor during 2015 was 39.1µg/m^3, and the maximum measured 1-hour average NO_2 background level was 100.5µg/m^3. In lieu of any data for the site, the annual average level at Beresfield was used and per the Victorian EPA approach[2], the 70th percentile level of 45.1µg/m^3 obtained from the Beresfield data was used as the background level contributed to each of the 365 total cumulative 24 hour impact predictions.

[2]The Victorian Government's State Environment Protection Policy (Air Quality Management), **SEPP (2001)** states at Part B, 3(b) *"Proponents required to include background data where no appropriate hourly background data exists must add the 70th percentile of one year's observed hourly concentrations as a constant value to the predicted maximum concentration from the model simulation. In cases where a 24-hour averaging time is used in the model, the background data must be based on 24-hour averages. "*.

6 DISPERSION MODELLING RESULTS

The dispersion model predictions for the assessed scenario are presented in this section and include predictions for the operation in isolation (incremental impact) and the operation with other sources (total (cumulative) impact). The results show the estimated:

- 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 $PM_{2.5}$ and PM_{10} criterion the predictions show the highest predicted 24-hour average concentrations that were modelled at each point within the modelling domain for the worst day (a 24-hour period) in the one year long modelling period. When assessing the total (cumulative) 24-hour average impacts based on model predictions, challenges arise with identification and quantification of emissions from non-modelled sources over the 24-hour period. Due to these factors, the 24-hour average impacts need to be calculated differently to annual averages and as such, the predicted total (cumulative) impacts for maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations have been addressed specifically in **Section 6.4.**

Each of the sensitive receptor locations (residences) shown in **Figure 2-1** and detailed in **Appendix A** were assessed individually as discrete receptors with the predicted results presented in tabular form in the following section. Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix C**.

6.1 Predicted dust concentrations

Table 6-1 presents the predicted particulate dispersion modelling results at each of the assessed sensitive receptor locations. The predicted cumulative $PM_{2.5}$, PM_{10}, TSP and dust deposition levels due to the Project with the estimated background levels are presented in **Table 6-2**.

The results indicate the predicted levels would be below the relevant criteria at the assessed sensitive receptor locations.

Table 6-1: Dispersion modelling results for sensitive receptors – Incremental impact

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)
	Incremental impact					
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	-	-	-	-	-	2
E	3	<1	17	2	3	<0.1
F	4	1	21	3	5	0.1
G	7	1	38	4	7	0.1
H	7	1	35	7	10	0.1
I	2	<1	9	1	2	<0.1
K	3	<1	16	1	2	<0.1
L	3	1	13	3	5	0.1
M	6	1	29	3	5	0.1
N	4	<1	18	2	4	<0.1

Table 6-2: Dispersion modelling results for sensitive receptors – Cumulative impact

Receptor ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Cumulative impact			
	Annual average			
	8	25	90	4
E	6	16	32	1.5
F	6	17	34	1.6
G	6	18	36	1.6
H	7	21	39	1.6
I	6	15	31	1.5
K	6	15	31	1.5
L	6	17	34	1.6
M	6	17	34	1.6
N	6	16	33	1.5

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

The potential impacts due to the Project, extending over more than 25 per cent of any privately-owned land, have been evaluated using the predicted pollutant dispersion contours.

Figure 6-1 presents the extent of the maximum 24-hour average PM_{10} level (50µg/m^3) due to the Project in isolation. The maximum 24-hour average PM_{10} level was found to have the greatest extent of any of the other assessed dust metrics and hence represents the most impacting parameter.

The isopleth in **Figure 6-1** indicates there is only one privately-owned land parcel (vacant land within the mining lease) which would be impacted more than 25 per cent.

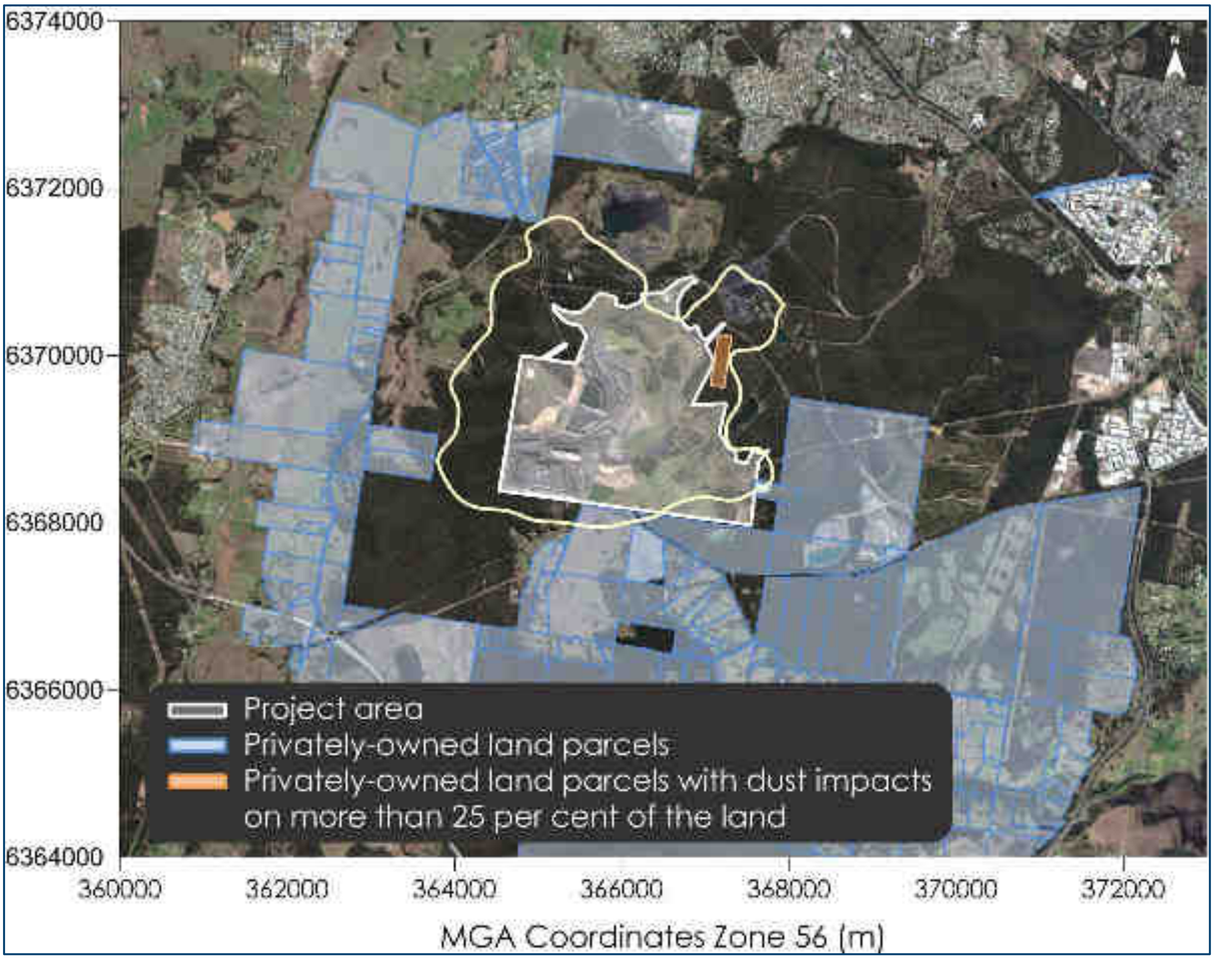

Figure 6-1: Predicted maximum 24-hour average PM_{10} level

6.3 Assessment of total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} concentrations

An assessment of cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in accordance with the methods outlined in Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA 2017**).

As shown in **Section 4.3**, maximum background levels have in the past reached levels near to the 24-hour average $PM_{2.5}$ and PM_{10} criterion level. Due to these elevated levels in the monitoring data, the screening Level 1 NSW EPA approach of adding maximum background levels to maximum predicted Project only levels would not be appropriate for assessing the potential 24-hour average impacts on these elevated days.

In such situations, the NSW EPA approach applies a more thorough Level 2 assessment whereby the measured background level on a given day is added contemporaneously with the corresponding Project only level predicted using the same day's weather data. This method factors into the assessment the spatial and temporal variation in background levels affected by the weather and existing sources of dust in the area on a given day. However, even with a detailed Level 2 approach, any air dispersion modelling has limitations in predicting short term impacts which may arise many years into the future, and these limitations need to be understood when interpreting the results.

Ambient (background) dust concentration data for January 2015 to December 2015 from the Bloomfield HVAS were used for the days on which the data are available, and data from the TEOM and BAM monitors at Beresfield were otherwise applied to complete the Level 2 contemporaneous 24-hour average assessment. The Beresfield monitoring station is the closest monitoring station where suitable data for a Level 2 assessment are available.

The data used for the background levels would already include emissions from various natural and anthropogenic sources including the existing Bloomfield Colliery and thus would provide a conservative estimate of the prevailing measured background levels in the vicinity. The assessment has thus double counted the existing emissions from the colliery, and will overestimate the actual levels by some margin.

Table 6-3 provides a summary of the findings of the contemporaneous assessment at each sensitive receptor location. Detailed tables of the full assessment results are provided in **Appendix D**.

Table 6-3: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion without implementation of predictive measures

Receptor ID	$PM_{2.5}$ analysis	PM_{10} analysis
E	0	1
F	0	1
G	0	0
H	0	0
I	0	0
K	0	0
L	0	0
M	0	3
N	0	2

The results in **Table 6-3** indicate that there is potential for cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts to occur at the assessed locations without the use of reactive or predictive management systems to control short term dust levels.

Further analysis of the predicted cumulative PM_{10} impacts at Receptor M and N are presented in **Figure 6-2** and **Figure 6-3**. The figures show time series plots of the 24-hour average $PM_{2.5}$ and PM_{10} concentrations predicted to be experienced as a result of the Project. The orange bars represent the existing ambient background level at the monitoring location and the blue bars represent the predicted incremental contribution due to the Project.

The predicted exceedances of the PM_{10} 24-hour average at these locations only marginally exceed the criteria (see **Figure 6-2** and **Figure 6-3**). Given the conservatism in the assessment due to double counting the existing colliery emissions, etc., these effects may not actually occur, however the small reductions needed could be easily achieved through predictive and reactive dust control strategies, which would be operated at the site to mitigate such potential impacts.

Current predictive and reactive dust control measures applied at the Bloomfield Colliery include the use of predictive meteorological modelling software which incorporates regional weather station data and forecasts to predict daily weather events which may exacerbate dust impacts from planned operations. This forward planning is coupled with the use of real-time on-site weather station data to assist with planning decisions.

Bloomfield Colliery also operate a network of portable real-time dust monitors. These monitors are nominally positioned upwind and downwind of mining activity with the measured levels providing an estimate of the potential amount of dust generated from the operations which can signal if excessive dust is being generated and further dust control is required.

Visual inspections of dust plumes are also used to identify those activities which require further controls to be applied at times such as watering, or activities which may need to be modified to reduce the amount of dust being generated, such as temporarily ceasing a particular activity.

To evaluate the effectiveness of the implementation of such predictive and reactive measures at the Project, the dispersion modelling was re-run to consider the effects of applying additional control measures and temporarily pausing activities in the pit and overburden areas during periods of elevated dust.

Only the activities that can be controlled in the pit and overburden areas were ceased in the model, and dust from other sources such as wind erosion remained as a source of dust in the modelling representing the implementation of mitigation measures.

Table 6-4 outlines the maximum number of additional days in a year predicted to exceed the 24-hour criterion with the implementation of reactive measures.

Table 6-4: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion with implementation of predictive measures

Receptor ID	PM_{10} analysis
E	0
F	0
G	0
H	0
I	0
K	0
L	0
M	0
N	0

While the modelling methodology will inherently over predict impacts, the results nevertheless indicate that all of the predicted additional exceedance days due to the Project would be prevented using the reactive controls that the mine would operate.

We note that as the Project is not seeking changes to the intensity or general extent of mining, or any changes in the mining equipment fleet or mining method, it is anticipated that the Project will not result in any significant change in the existing level of impact.

As observed in the monitoring data, the actual 24-hour PM_{10} levels in the vicinity of the receptor near the colliery are significantly lower than the levels measured in the urban areas nearby at Beresfield where the 24-hour PM_{10} levels are on average 39 per cent higher.

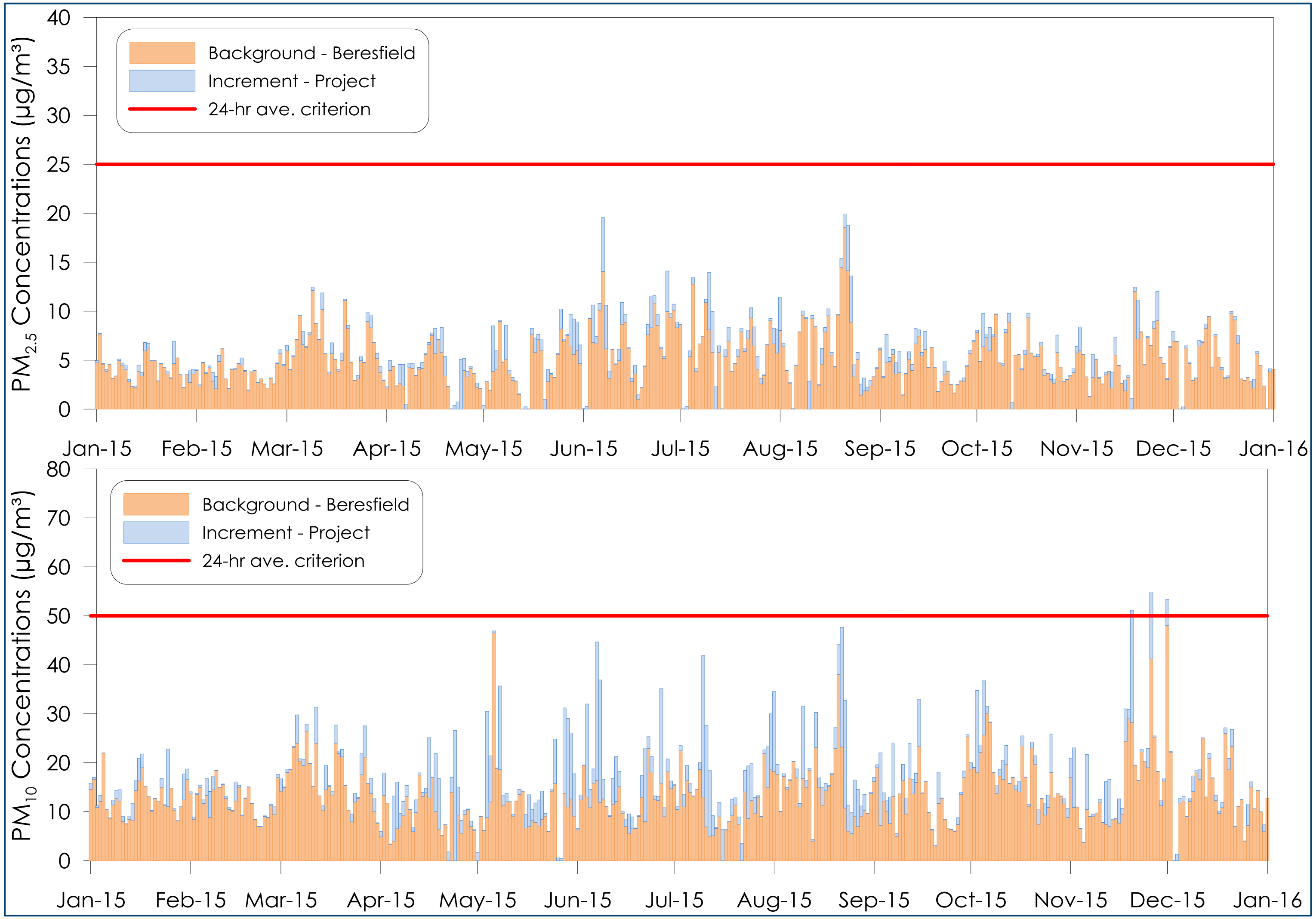

Figure 6-2: Predicted 24-hour average $PM_{2.5}$ and PM_{10} concentrations for sensitive receptor location M (unmitigated)

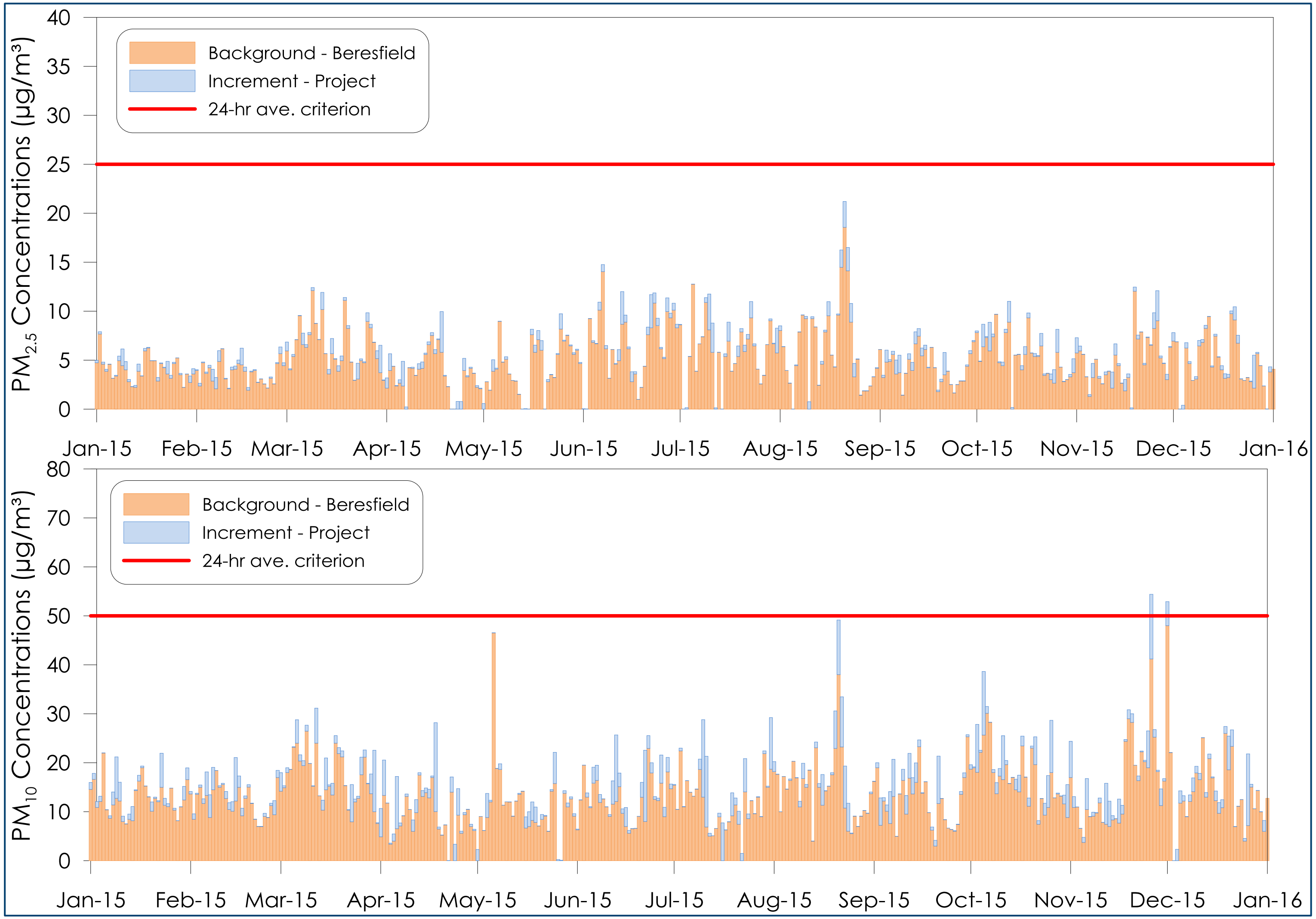

Figure 6-3: Predicted 24-hour average $PM_{2.5}$ and PM_{10} concentrations for sensitive receptor location N (unmitigated)

6.4 Predicted NO_2 concentrations

Table 6-5 presents the predicted NO_2 dispersion modelling results at each of the assessed sensitive receptor locations. Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix C**.

The results in **Table 6-5** indicate the predicted 1-hour and annual average NO_2 concentrations would be below the relevant criteria at the assessed sensitive receptor locations.

Table 6-5: Dispersion modelling results for sensitive receptors – NO_2 concentrations (µg/m³)

Receptor ID	Incremental impact		Cumulative impact	
	24-hour average	Annual average	24-hour average	Annual average
	-	-	246	62
E	60	0.8	105	40
F	65	1.0	110	40
G	60	2.0	105	41
H	70	2.2	115	41
I	26	0.4	71	40
K	27	0.5	72	40
L	35	0.6	80	40
M	102	1.4	147	40
N	118	1.2	164	40

7 SUMMARY AND CONCLUSIONS

This study has examined potential air quality impacts that may arise from the proposed modifications to the Bloomfield Colliery per the current NSW EPA Approved Methods guidelines.

The approach taken in this study is conservative, and would significantly overestimate the likely impacts. For example, conservative emission estimation is applied using maximum mining rates, the dispersion modelling has not included the effect of rainfall, or in-pit dust retention, and the background levels used mean that the existing dust from the colliery is double counted in the cumulative assessment.

The modelling methodology uses recent and comprehensive weather and dust monitoring data and incorporates inventories for TSP, PM_{10} and $PM_{2.5}$ emissions from dust generating activity and diesel exhaust.

As the Project is not seeking changes to the intensity or general extent of mining, or any changes in the mining equipment fleet or mining method, it is anticipated that the Project will not result in any significant change in the existing level of impact.

As observed in the monitoring data, the actual 24-hour PM_{10} levels in the vicinity of the receptor near the colliery are significantly lower than the levels measured in the urban areas nearby at Beresfield, where the 24-hour PM_{10} levels are on average 39 per cent higher.

Thus, as expected, the results show that the dust levels would be below all relevant criteria at the privately-owned receptor locations for the proposed Project.

It is noted that the results also indicate that without reactive or predictive mitigation measures there is some limited potential for cumulative 24-hour average PM_{10} levels to marginally exceed the NSW EPA impact assessment criteria, but with the use of the now routine day-to-day reactive and predictive systems at the operations, no unacceptable levels of impact would be expected to arise.

Overall, the potential air quality impacts associated with the proposed modifications to the Bloomfield Colliery are not expected to be significantly different from the existing approved operations, and the results of the assessment demonstrate that if approved, the Project would not lead to any unacceptable impacts on air quality.

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TRC (2011)

"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", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

US EPA (1985 and updates)
"Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

Appendix A

Sensitive receptor locations

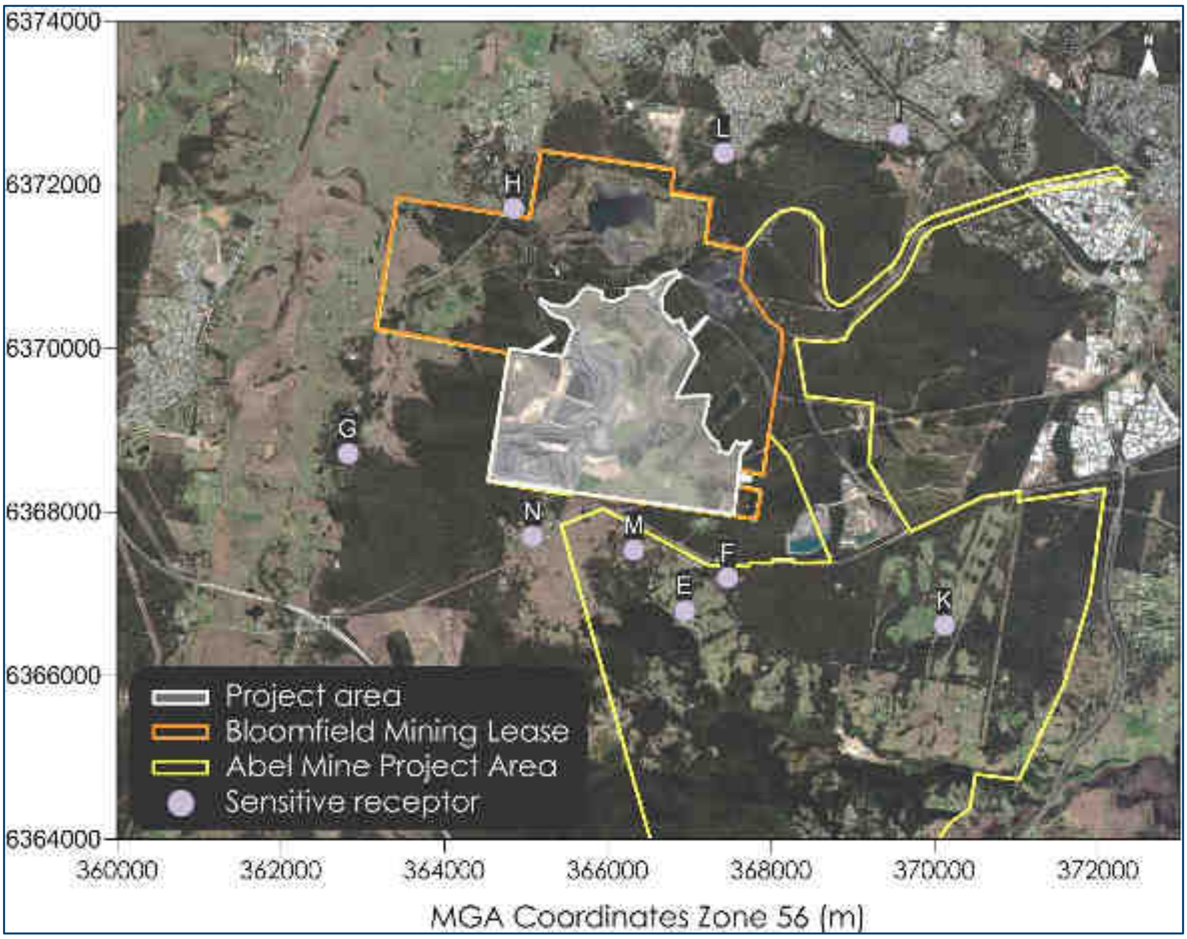

Figure A-1: Location of sensitive receptors assessed in this study

Table A-1: List of sensitive receptors assessed in this study

ID	Easting	Northing
E	366938	6366795
F	367471	6367197
G	362820	6368716
H	364843	6371713
I	369556	6372623
K	370119	6366617
L	367414	6372389
M	366319	6367539
N	365080	6367704

Appendix B

Emission Calculation

Emission Calculation

The mining schedule and mine plan designs provided by the Proponent 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 US EPA AP42 Emission Factors (**US EPA, 1985 and Updates**), the National Pollutant Inventory document *Emission Estimation Technique Manual for Mining, Version 3.1* (**NPI, 2012**) and 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**).

The emission factor equations used for each dust generating activity are outlined in **Table C-1** below. A detailed emission inventory for the modelled year is presented in **Table C-2**.

Control factors include the following:

- Hauling on unpaved surfaces – 80% control for watering of trafficked areas. Note the control factor is only applied to the mechanically generated emissions and not the contributions from the diesel exhaust emissions.
- Drilling overburden material – 70% control for use of dust suppression.
- Unloading ROM to hopper at CHPP – 70% control for use of enclosure.
- Conveyor transfer points – 70% control enclosures.
- Conveyor – 70% control for enclosed conveyors.
- Coal stockpiles – 50% for watering stockpile surface.

Potential air emissions associated with locomotives idling at the rail loop have been included in the emissions inventory. Emission estimates assume three locomotives idling continuously with emission based on Class 81 locomotive emission rates (**Parsons Brinckerhoff, 2012**).

Air emissions associated with the operation of the diesel powered equipment have been estimated based on the number of equipment, power rating, hours of operation and emission factors sourced from the NSW EPA document *NSW Coal Mining Benchmarking Study Best-practice measures for reducing non-road diesel exhaust emissions* (**NSW EPA, 2014**). Emission factors are based on Tier 2 equipment. A detailed emission inventory for diesel emissions is presented in **Table C-3**.

Table C-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Drilling (overburden)	$EF = 0.59\ kg/hole$	$0.52\ \times TSP$	$0.03\ \times TSP$
Blasting (overburden)	$EF = 0.00022\ \times A^{1.5}\ kg/blast$	$0.52\ \times TSP$	$0.03\ \times TSP$
Loading / emplacing overburden & loading product coal to stockpile & conveyor transfer	$EF = 0.74\ \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.35\ \times 0.0016\ \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.053\ \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times\ 4.9\ \times\ (s/12)^{0.7} \times\ (1.1023\ \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times\ 1.5 \times\ (s/12)^{0.9} \times\ (1.1023\ \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times\ 0.15\ \times\ (s/12)^{0.9} \times\ (1.1023 \times M/3)^{0.45}\ kg/VKT$
Dozers on overburden	$EF = 2.6\ \times \frac{s^{1.2}}{M^{1.3}}\ kg/hour$	$EF = 0.45\ \times \frac{s^{1.5}}{M^{1.4}} \times 0.75\ kg/hour$	$EF = 2.6\ \times \frac{s^{1.2}}{M^{1.3}} \times 0.105\ kg/hour$
Dozers on coal	$EF = 35.6\ \times \frac{s^{1.2}}{M^{1.4}}\ kg/hour$	$EF = 8.44\ \times \frac{s^{1.5}}{M^{1.4}} \times 0.75\ kg/hour$	$EF = 35.6\ \times \frac{s^{1.2}}{M^{1.4}} \times 0.022\ kg/hour$
Loading / emplacing coal	$EF = \frac{\left(0.58 \times \left(\frac{s}{2}\right)^{1.2} \times \left(\frac{U}{2}\right)^{1.3}\right)}{M^{1.2}}\ kg/tonne$	$EF = \frac{\left(0.596\ \times \left(\frac{s}{2}\right)^{0.9} \times \left(\frac{U}{2}\right)^{1.3}\right)}{M^{1.2}} \times 0.75\ kg/tonne$	$EF =\ TSP\ \times 0.019\ kg/tonne$
Wind erosion on exposed areas & conveyors	$EF = 850\ kg/ha\ /year$	$0.5\ \times TSP$	$0.075\ \times TSP$
Wind erosion on stockpiles	$EF = 1.9\ \times \left(\frac{s}{1.5}\right) \times 365\ \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) kg/ha\ /year$	$0.5\ \times TSP$	$0.075\ \times TSP$
Grading roads	$EF = 0.0034\ \times\ sp^{2.5}\ kg/VKT$	$EF = 0.0056\ \times\ sp^{2.0}\ \times 0.6\ kg/VKT$	$EF = 0.0034\ \times\ sp^{2.5}\ \times 0.031\ kg/VKT$

EF = emission factor, A = area of blast (m^2), U = wind speed (m/s), M = moisture content (%), s = silt content (%), VKT = vehicle kilometres travelled (km), p = number of days per year when rainfall is greater than 0.25mm (days), f = percentage of time that wind speed is greater than 5.4m/s (%), sp = speed of grader (km/h).

Table C-2: Emission inventory

ACTIVITY	TSP emission	PM10 emission	PM25 emission	Intensity	Units	Emission Factor - TSP	Emission Factor - PM10	Emission Factor - PM25	Units	Variable 1	Units	Variable 2	Units	Variable 3 - TSP	Variable 3 - PM10	Variable 3 - PM25	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
TS - Excavator loading topsoil from stockpile to hau	72	34	5	96,000	t/yr	0.00075	0.00035	0.00005	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	2	MC in %										
TS - Hauling topsoil to rehab area	889	195	21	96,000	t/yr	0.046	0.010	0.001	kg/t	195	tonnes/load	2.8	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	% silt c	249	Ave weight (t	80	% Control
TS - Emplacing topsoil at rehab area	72	34	5	96,000	t/yr	0.00075	0.00035	0.00005	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	2	MC in %										
TS - Rehandle topsoil at rehab area	7	3	1	9,600	t/yr	0.00075	0.00035	0.00005	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	2	MC in %										
OB - Drilling	6,018	3,129	181	34,000	holes/yr	0.59	0.31	0.02	kg/hole													70	% Control
OB - Blasting	24,871	12,933	746	86	blasts/yr	289	150.4	8.7	kg/blast	12,000	Area of blast in m^2												
OB - Excavator loading OB to haul truck	11,476	5,428	822	15,360,000	t/yr	0.00075	0.00035	0.00005	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	2	MC in %										
OB - Hauling to dump - to Creek cut	65,996	14,513	1,588	7,673,328	t/yr	0.043	0.009	0.001	kg/t	195	tonnes/load	2.6	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	% silt c	249	Ave weight (t	80	% Control
OB - Hauling to dump - to S cut	76,257	16,750	1,811	7,686,672	t/yr	0.050	0.011	0.001	kg/t	195	tonnes/load	3.0	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	% silt c	249	Ave weight (t	80	% Control
OB - Emplacing at dump - Creek cut	5,733	2,711	411	7,673,328	t/yr	0.00075	0.00035	0.00005	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	2	MC in %										
OB - Emplacing at dump - S cut	5,743	2,716	411	7,686,672	t/yr	0.00075	0.00035	0.00005	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	2	MC in %										
OB - Rehandle OB	1,148	543	82	1,536,000	t/yr	0.00075	0.00035	0.00005	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	2	MC in %										
OB - Dozers on OB in pit	19,632	4,744	2,061	1,173	hrs/yr	16.7	4.0	1.8	kg/h	10	silt content in %	2	MC in %										
OB - Dozers on OB working on dump + rehab	43,876	10,603	4,607	2,622	hrs/yr	16.7	4.0	1.8	kg/h	10	silt content in %	2	MC in %										
CL - Dozers ripping/pushing/clean-up	267	27	6	321	hrs/yr	0.8	0.1	0.0	kg/h	0.25	silt content in %	5	MC in %										
CL - Loading ROM coal to haul truck	5,688	818	108	1,300,000	t/yr	0.004	0.001	0.0001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	5	MC in %					0.25	silt content in %				
CL - Hauling ROM to ROM Pad	43,516	9,969	1,532	1,300,000	t/yr	0.165	0.036	0.004	kg/t	195	tonnes/load	10.0	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	% silt c	249	Ave weight (t	80	% Control
CHPP - Unloading ROM to ROM Pad - Bloomfield	5,688	818	108	1,300,000	t/yr	0.004	0.001	0.0001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	5	MC in %					0.25	silt content in %				
CHPP - Unloading ROM to ROM Pad - Abel	26,688	3,838	507	6,100,000	t/yr	0.004	0.001	0.0001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	5	MC in %					0.25	silt content in %				
CHPP - Loading ROM to hopper	9,713	1,397	185	7,400,000	t/yr	0.004	0.001	0.0001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	5	MC in %					0.25	silt content in %			70	% Control
CHPP - Rehandle ROM at hopper	6,475	931	123	1,480,000	t/yr	0.004	0.001	0.0001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	5	MC in %					0.25	silt content in %				
CHPP - Plant feed conveyor	14	7	1	0.054	ha	850	425	64	kg/ha/yr													70	% Control
CHPP - Crushing	4,440	1,998	370	7,400,000	t/yr	0.0006	0.00027	0.00005	kg/t														
CHPP - Screening	11,100	4,440	259	7,400,000	t/yr	0.0015	0.0006	0.000035	kg/t														
CHPP - No. 2 Conveying to CHPP	8	4	1	0.031	ha	850	425	64	kg/ha/yr													70	% Control
CHPP - Transfer	8,339	3,944	597	7,400,000	t/yr	0.00376	0.00178	0.00027	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	0.631	MC in %									70	% Control
CHPP - Conveying to Product stockpile	17	8	1	0.067	ha	850	425	64	kg/ha/yr													70	% Control
CHPP - Unloading to Product stockpile	731	346	52	5,994,000	t/yr	0.00012	0.00006	0.00001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	7.3	MC in %										
CHPP - Conveying to train load out	33	16	2	0.128	ha	850	425	64	kg/ha/yr													70	% Control
CHPP - Transfer	219	104	16	5,994,000	t/yr	0.00012	0.00006	0.00001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	7.3	MC in %									70	% Control
CHPP - Loading coal to train	731	346	52	5,994,000	t/yr	0.00012	0.00006	0.00001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	7	MC in %										
CHPP - Dozers on Product stockpiles	1,926	252	42	1,100	hrs/yr	1.8	0.2	0.0	kg/h	0.7	silt content in %	7	MC in %										
OB - Loading Reject to haul truck	151	71	11	1,406,000	t/yr	0.00011	0.00005	0.00001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	8	MC in %										
OB - Hauling Reject to dump	38,114	8,363	895	1,406,000	t/yr	0.135	0.030	0.003	kg/t	195	tonnes/load	8.2	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	% silt c	249	Ave weight (t	80	% Control
OB - Emplacing Reject at dump	151	71	11	1,406,000	t/yr	0.00011	0.00005	0.00001	kg/t	0.631	(WS/2.2)$^{1.3}$ in m/s	8	MC in %										
WE - Overburden emplacement areas	97,835	48,918	7,338	115.1	ha	850	425	64	kg/ha/yr														
WE - Open pit	43,775	21,888	3,283	51.5	ha	850	425	64	kg/ha/yr														
WE - ROM stockpiles	23	12	2	6.1	ha	8	4	1	kg/ha/yr	0.25	silt content (%)	73	No. of rain days (>0.25mm)					0.8	% of time wind speed >5.4m/s			50	% Control
WE - Product stockpiles	185	93	14	17.3	ha	21	11	2	kg/ha/yr	0.70	silt content (%)	73	No. of rain days (>0.25mm)					0.8	% of time wind speed >5.4m/s			50	% Control
OB - Grading roads	14,771	5,161	458	24,000	km	0.62	0.22	0.02	kg/VKT	8	speed of graders in km/h												
Locomotive idling	515	515	499	8,760	hrs/yr																		
Total TSP emissions (kg/yr.)	**582,386**	**188,690**	**29,225**																				
TSP/ROM Ratio	**0.448**																						

Table C-3: Emissions inventory – Diesel emissions

Plant Category	Plant Detail	Likely Total Yearly Hours	Number of Equip	Power (hp)	LF	Tier 2	Summary of $PM_{2.5}$ emissions (kg/year)	Summary of PM_{10} emissions (kg/year)
Excavator	Hitachi EX500-5	4100	1	3,001	0.45	0.1047	580	598
Shovel	P&H 5700	500	1	3,001	0.45	0.1047	71	73
Loader	994A	750	1	1,739	0.45	0.1047	61	63
Dozers (Open Cut)	D11N	1676	2	850	0.48	0.1047	72	74
Dozers (Open Cut)	D10T	2120	2	599	0.48	0.1047	64	66
Dozers (Open Cut)	D10N	320	1	599	0.48	0.1047	10	10
Dozers (Washed Coal)	D11R	1100	1	850	0.48	0.1047	47	48
Trucks (Open Cut)	793 C	10500	3	2,415	0.32	0.1047	850	876
Trucks (Open Cut)	789A	5013	3	1,451	0.32	0.1047	244	251
Trucks (Open Cut)	789A	1671	1	1,451	0.32	0.1047	81	84
Trucks (Open Cut)	789C	1671	1	1,451	0.32	0.1047	81	84
Water Carts	777B WC	2500	2	944	0.32	0.1046	79	81
Water Carts	773-B	100	1	944	0.32	0.1046	3	3
Graders	24H	2700	1	532	0.46	0.1047	69	71
Graders	16G	300	1	290	0.46	0.1047	4	4
Drills	Sk75	2500	1	801	0.52	0.0755	79	81
Drills	Sk50	750	1	801	0.52	0.0755	24	24
Loaders	992C	3084	4	814	0.45	0.1046	118	122

Appendix C

Isopleth Diagrams

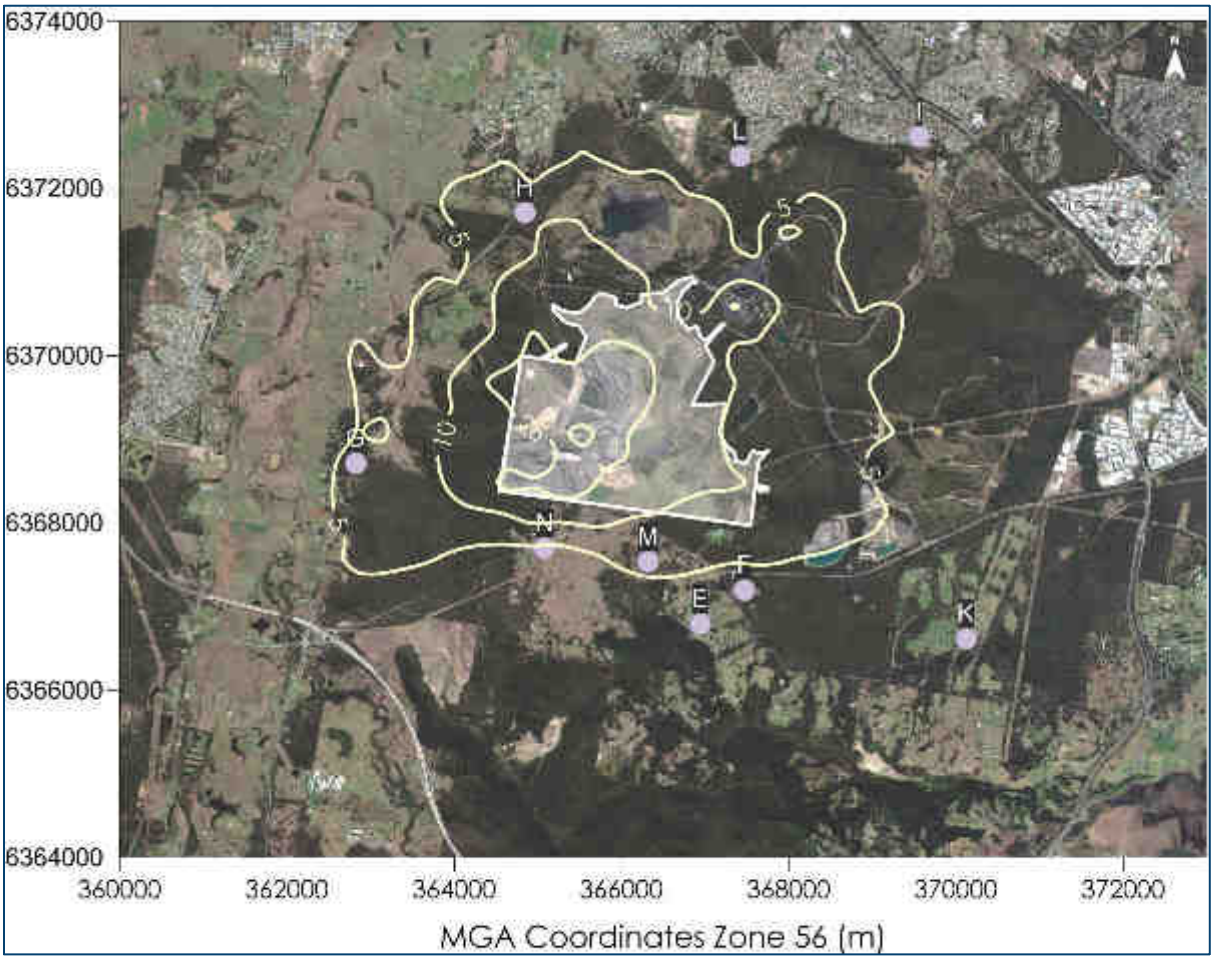

Figure C-1: Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project (µg/m³)

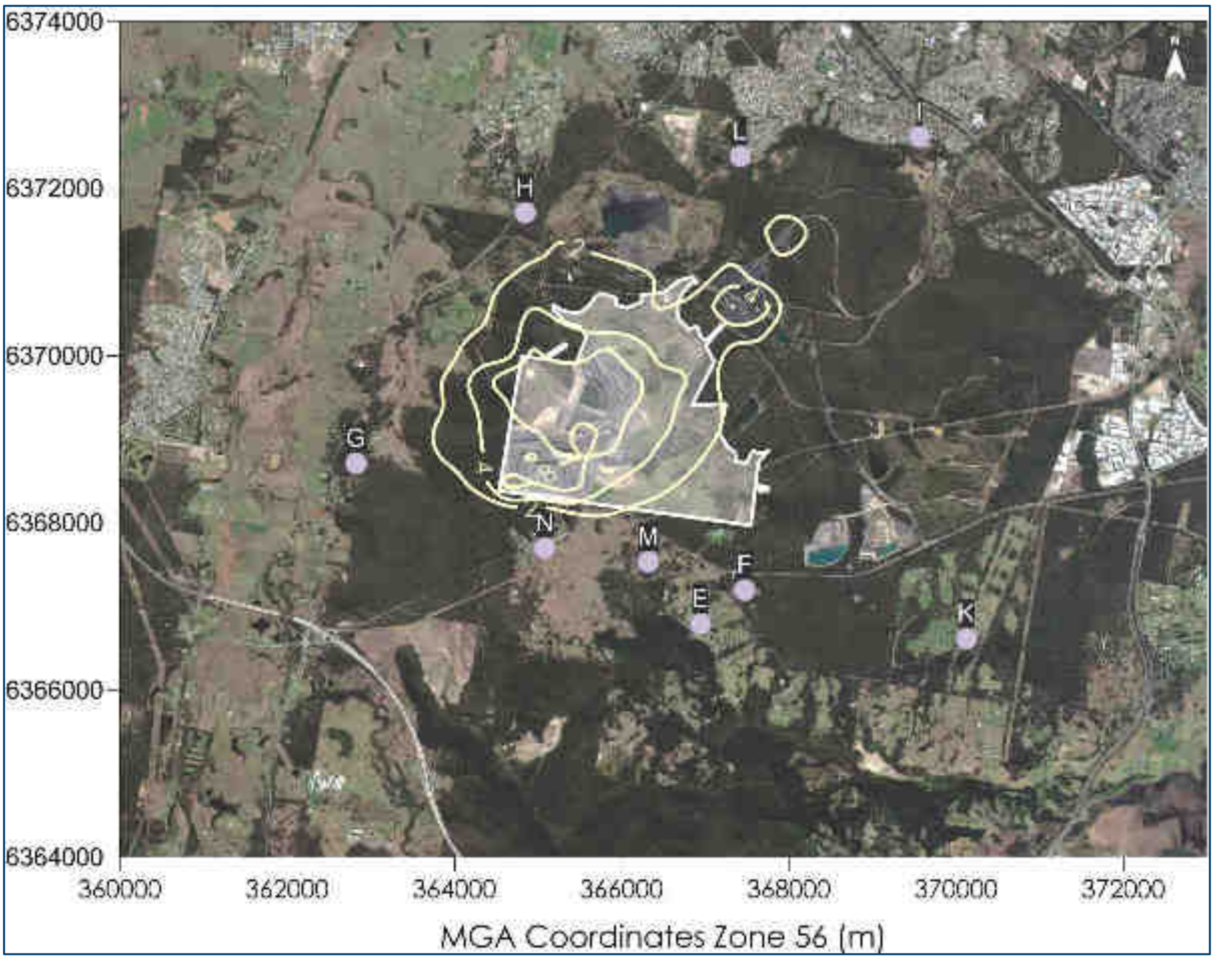

Figure C-2: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project (µg/m³)

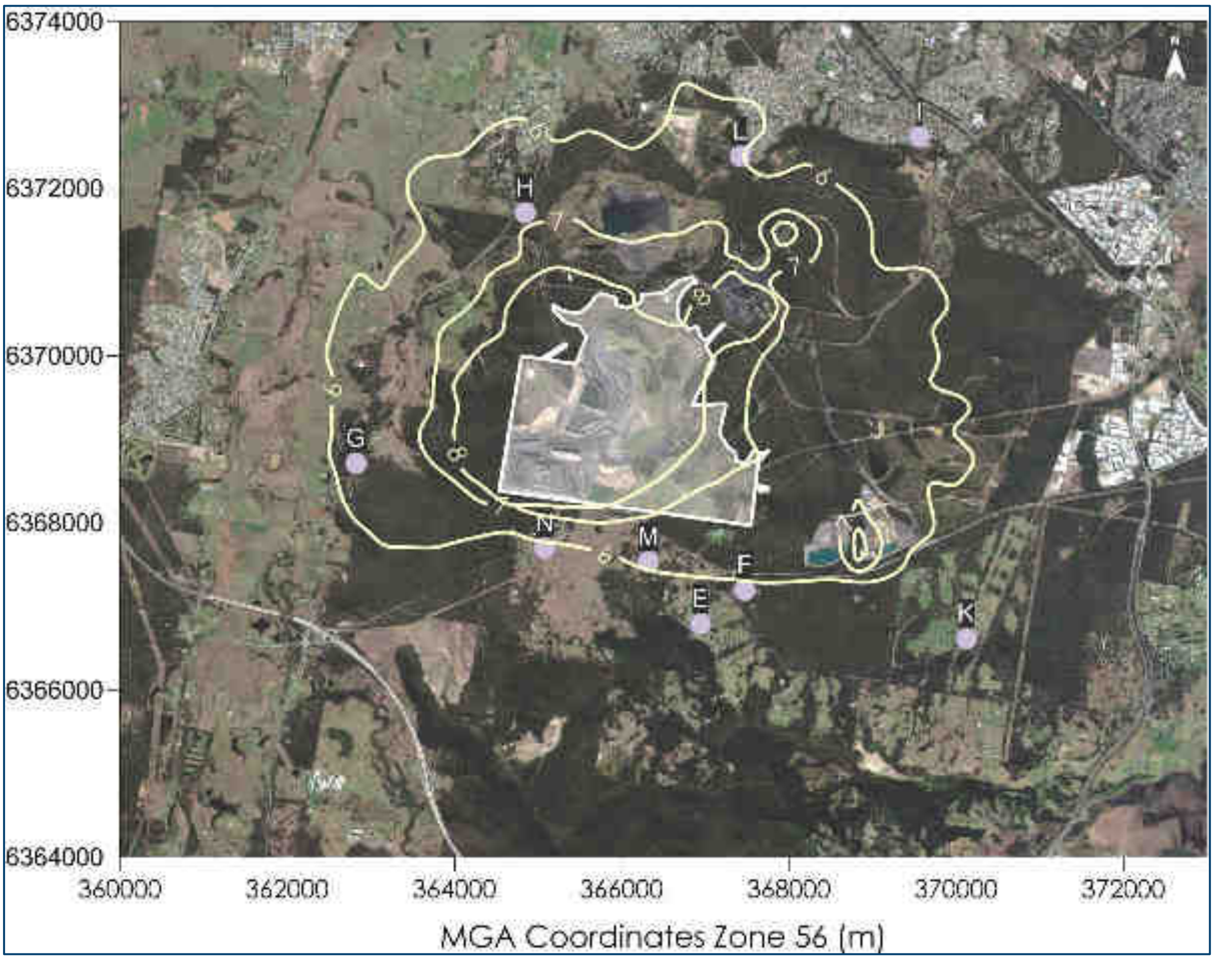

Figure C-3: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project and other sources (µg/m³)

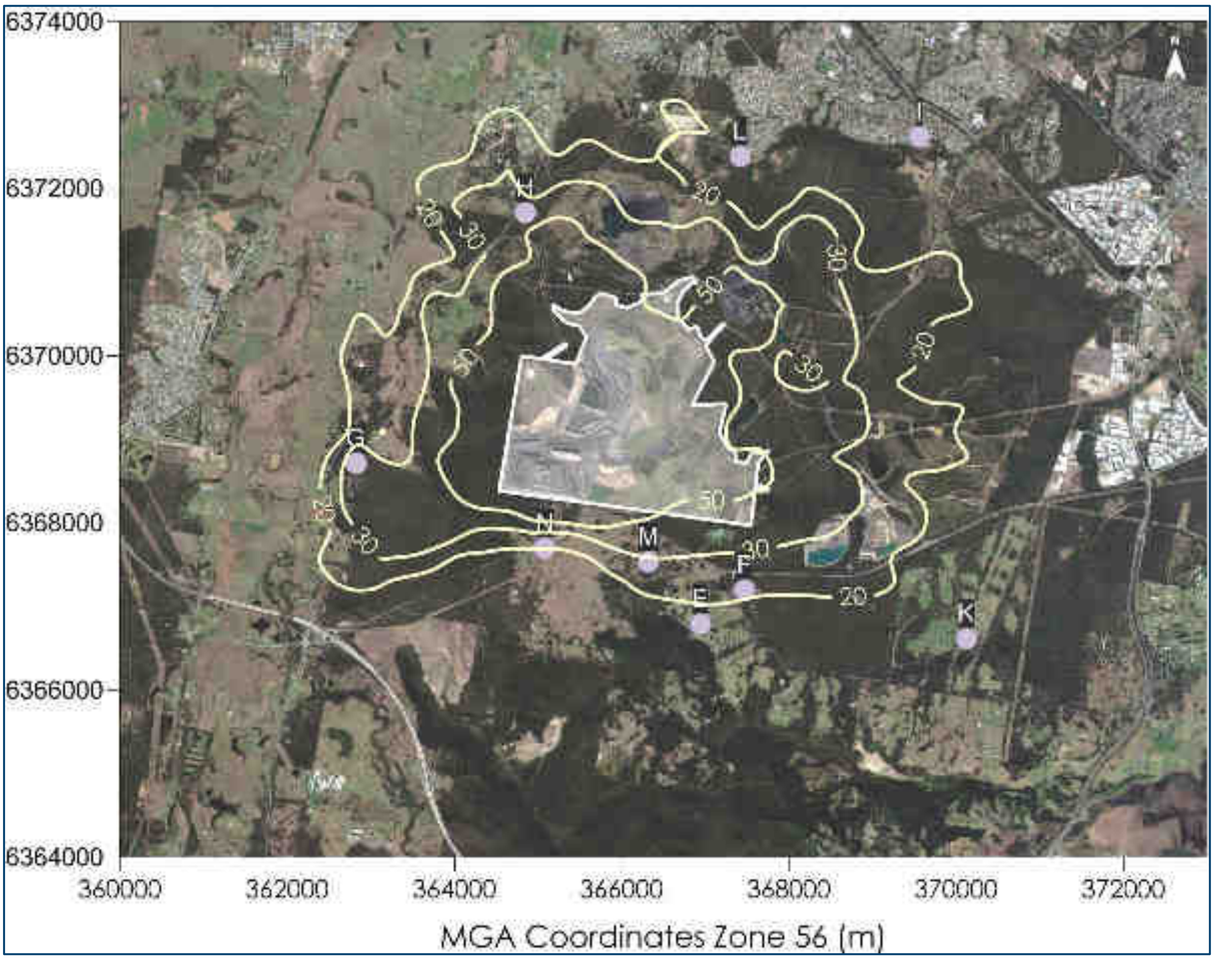

Figure C-4: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project (µg/m³)

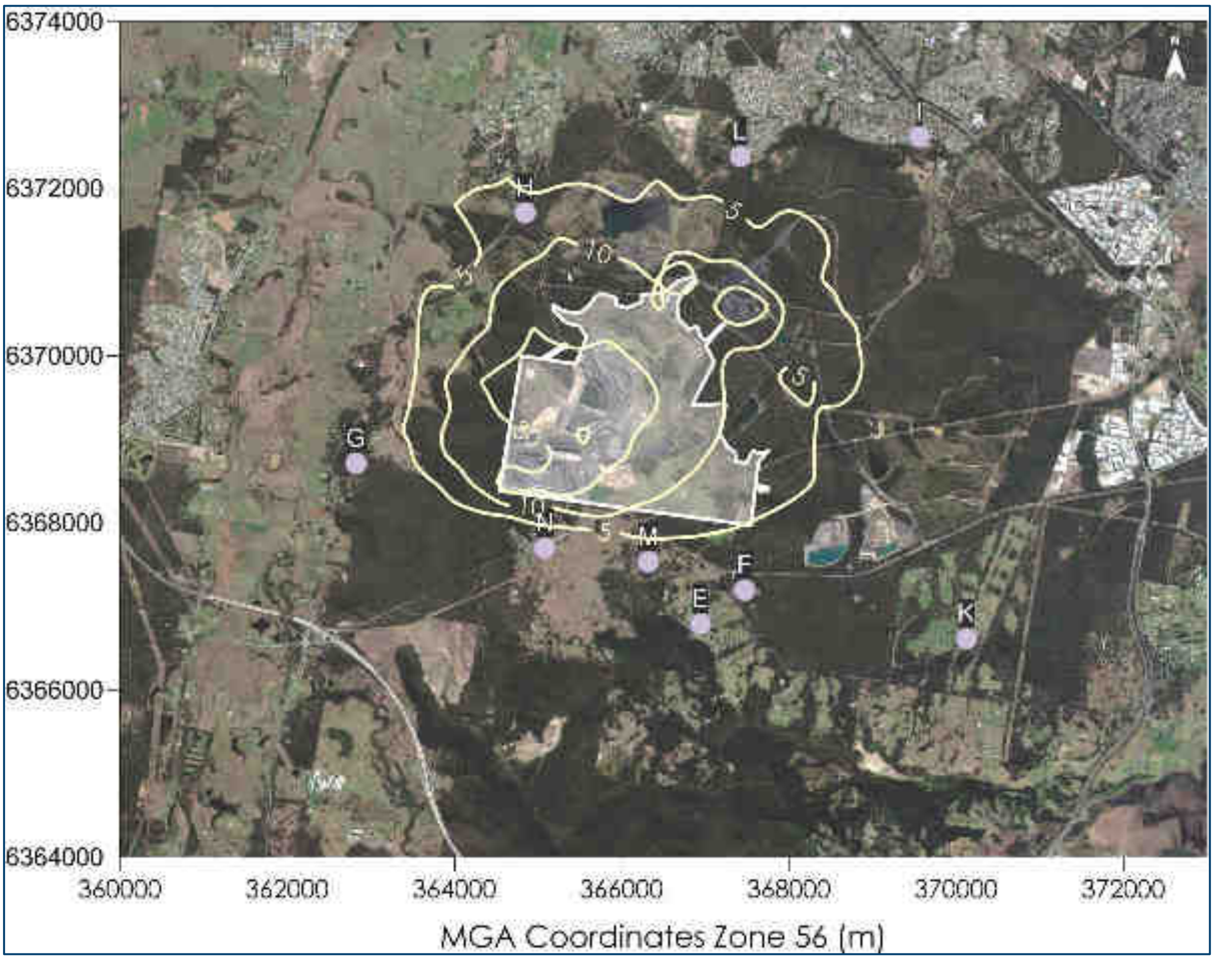

Figure C-5: Predicted annual average PM_{10} concentrations due to emissions from the Project (µg/m³)

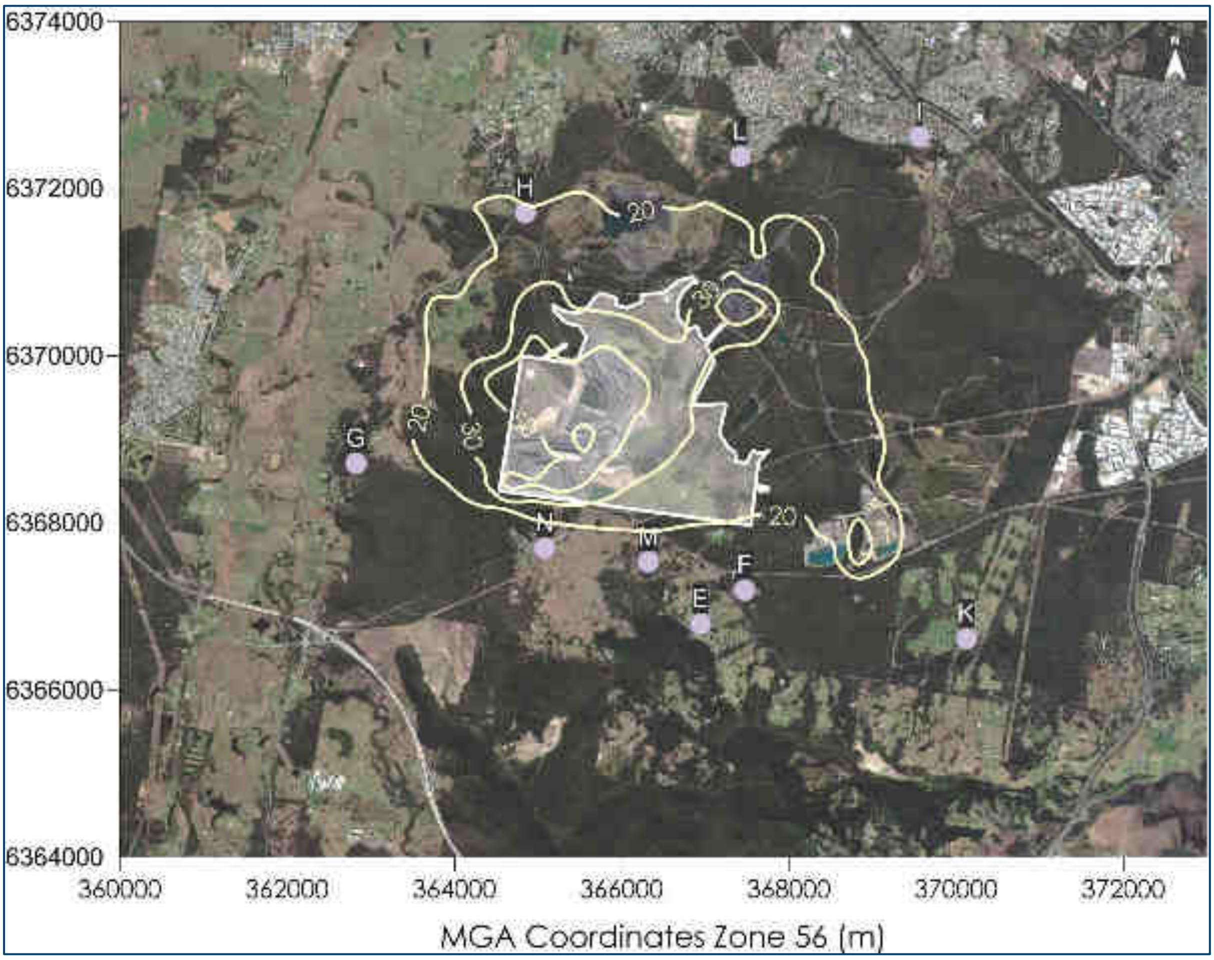

Figure C-6: Predicted annual average PM_{10} concentrations due to emissions from the Project and other sources (µg/m³)

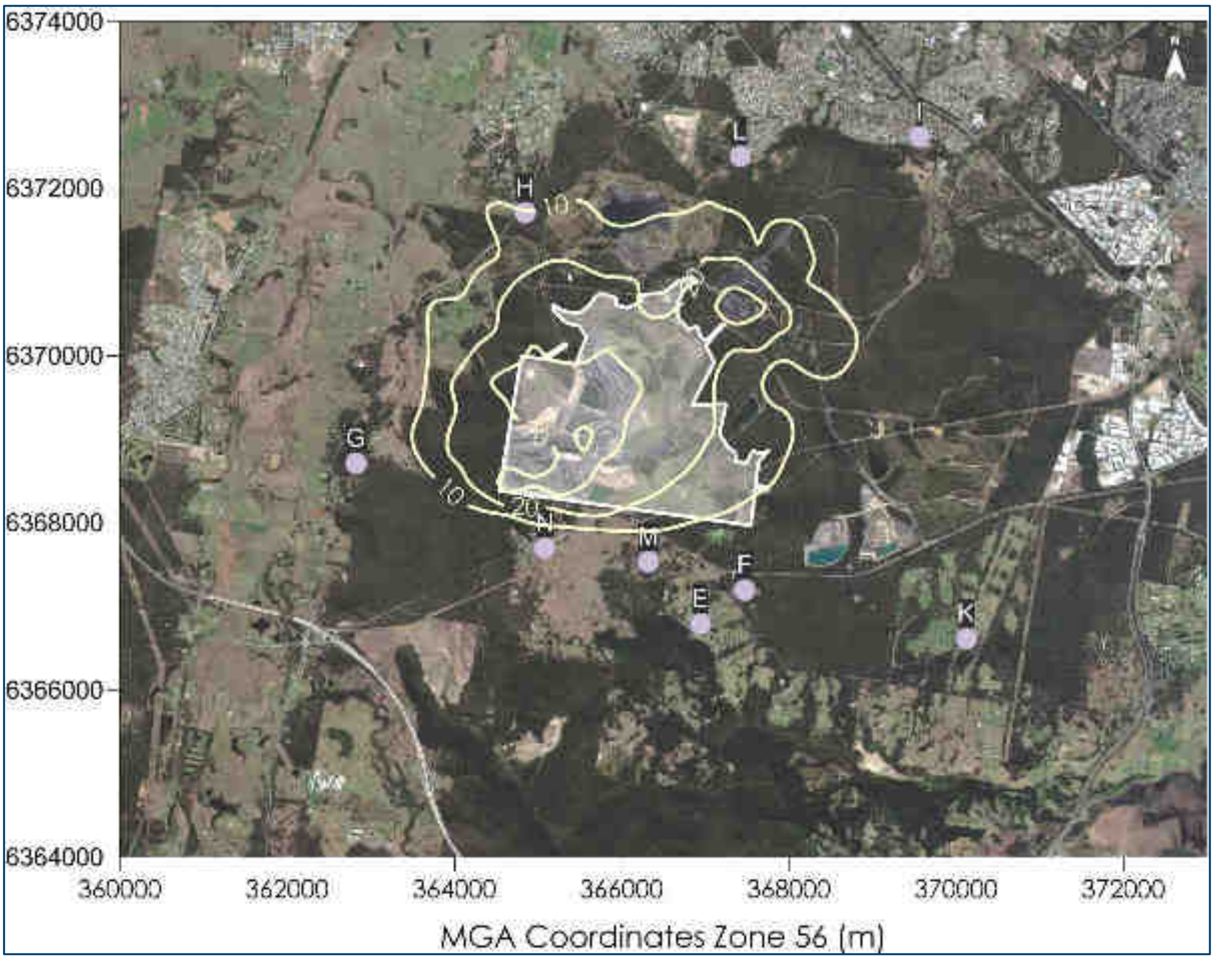

Figure C-7: Predicted annual average TSP concentrations due to emissions from the Project (µg/m³)

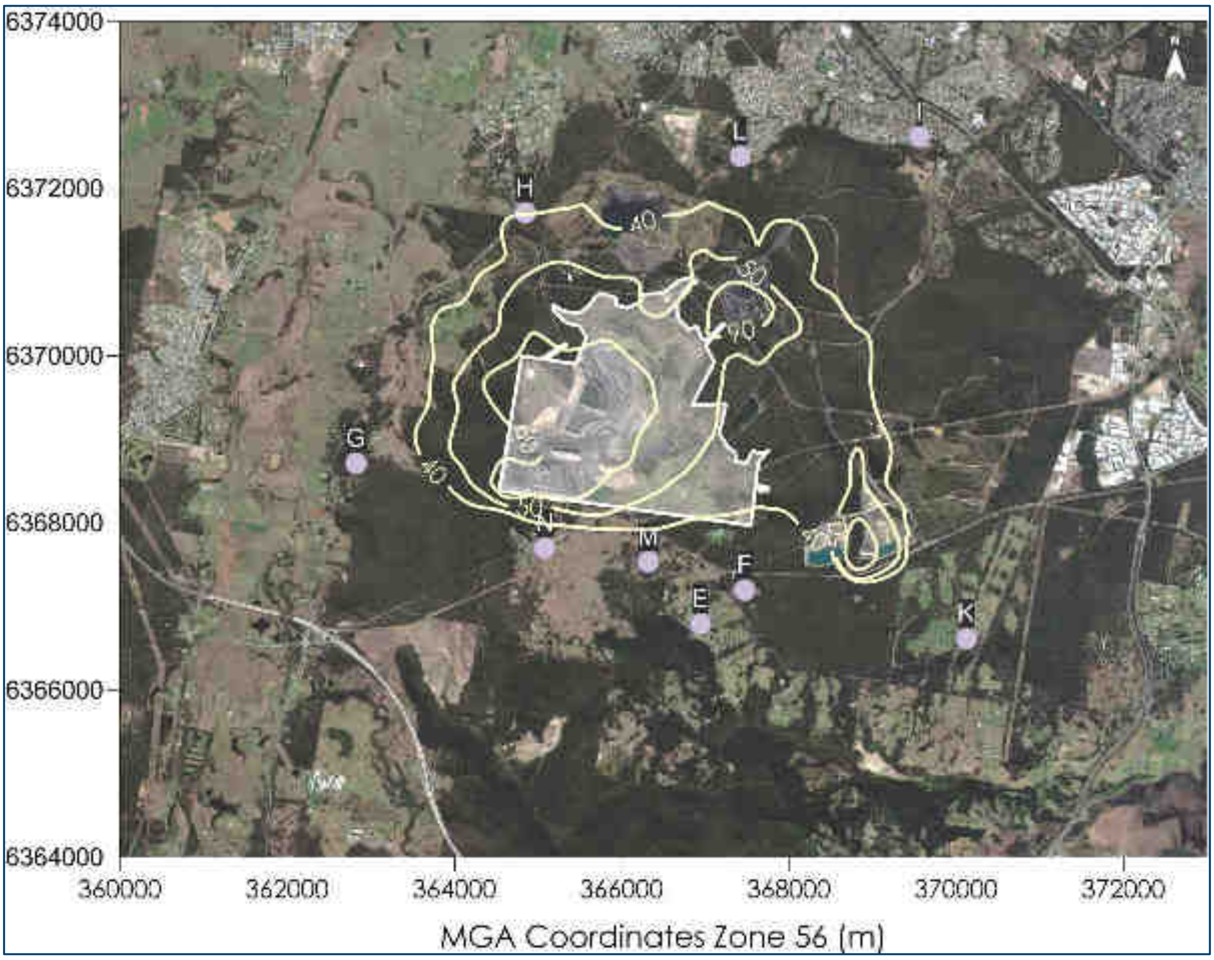

Figure C-8: Predicted annual average TSP concentrations due to emissions from the Project and other sources (µg/m³)

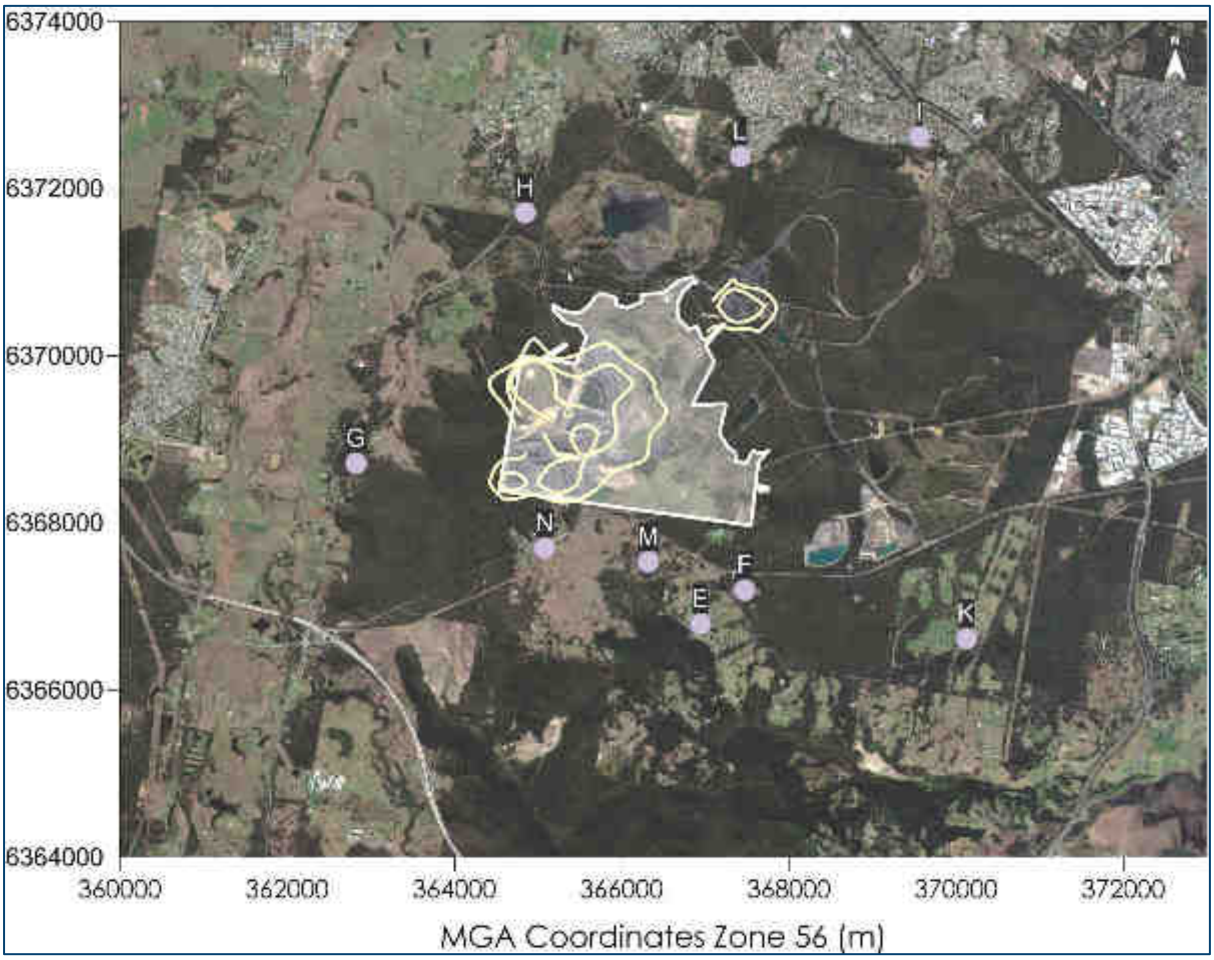

Figure C-9: Predicted annual average dust deposition levels due to emissions from the Project (g/m²/month)

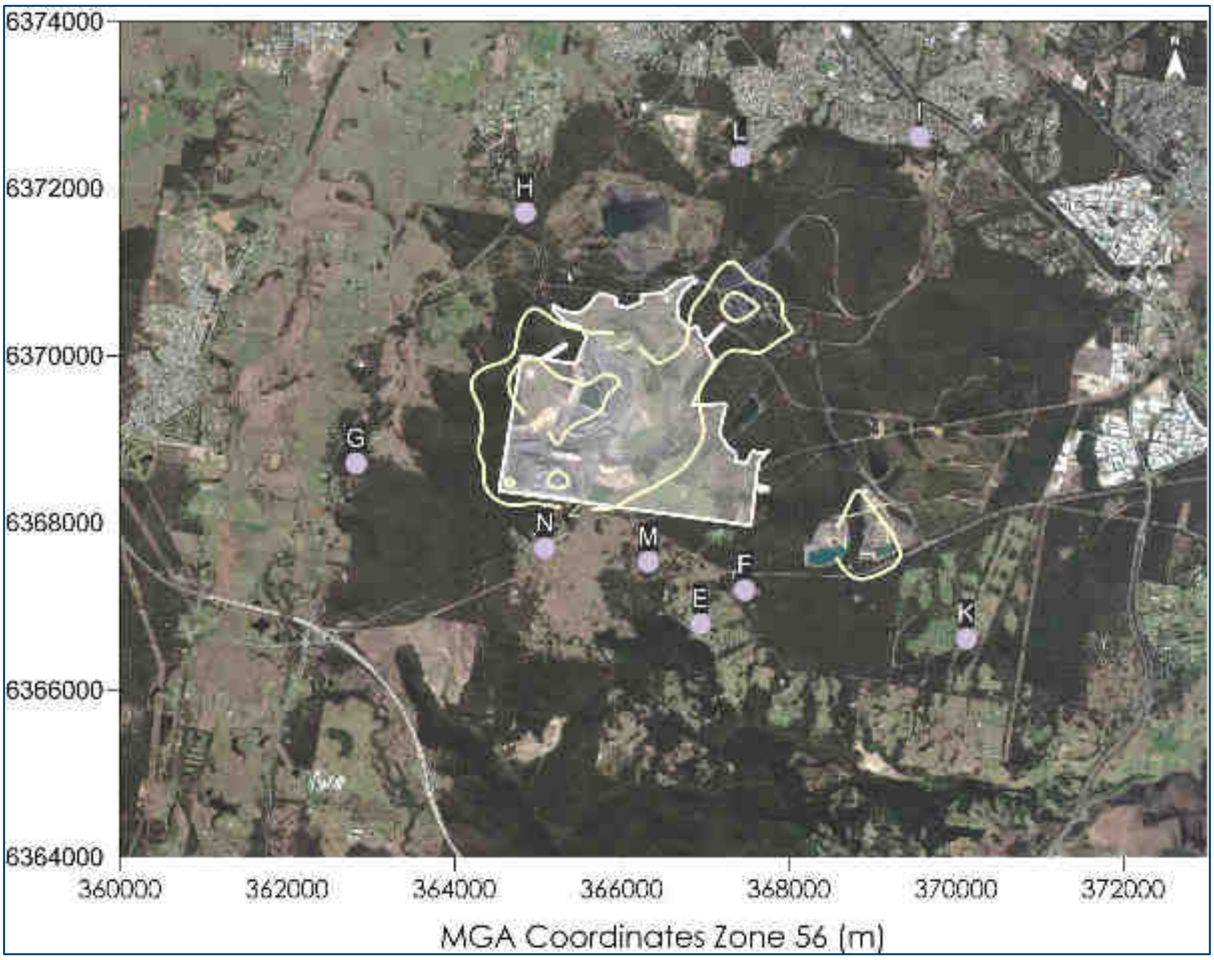

Figure C-10: Predicted annual average dust deposition levels due to emissions from the Project and other sources (g/m²/month)

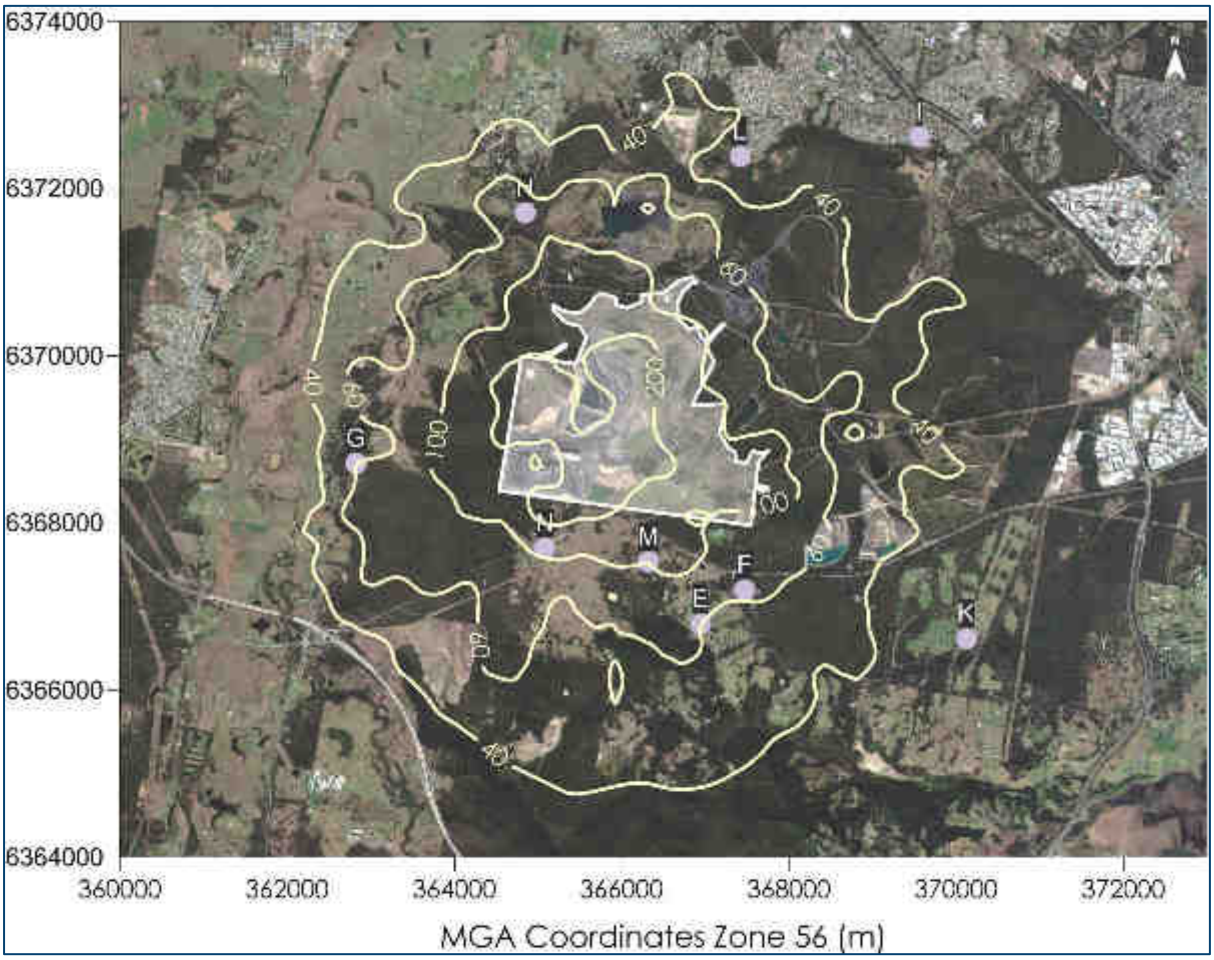

Figure C-11: Predicted 1-hour average NO_2 concentrations due to emissions from the Project (µg/m³)

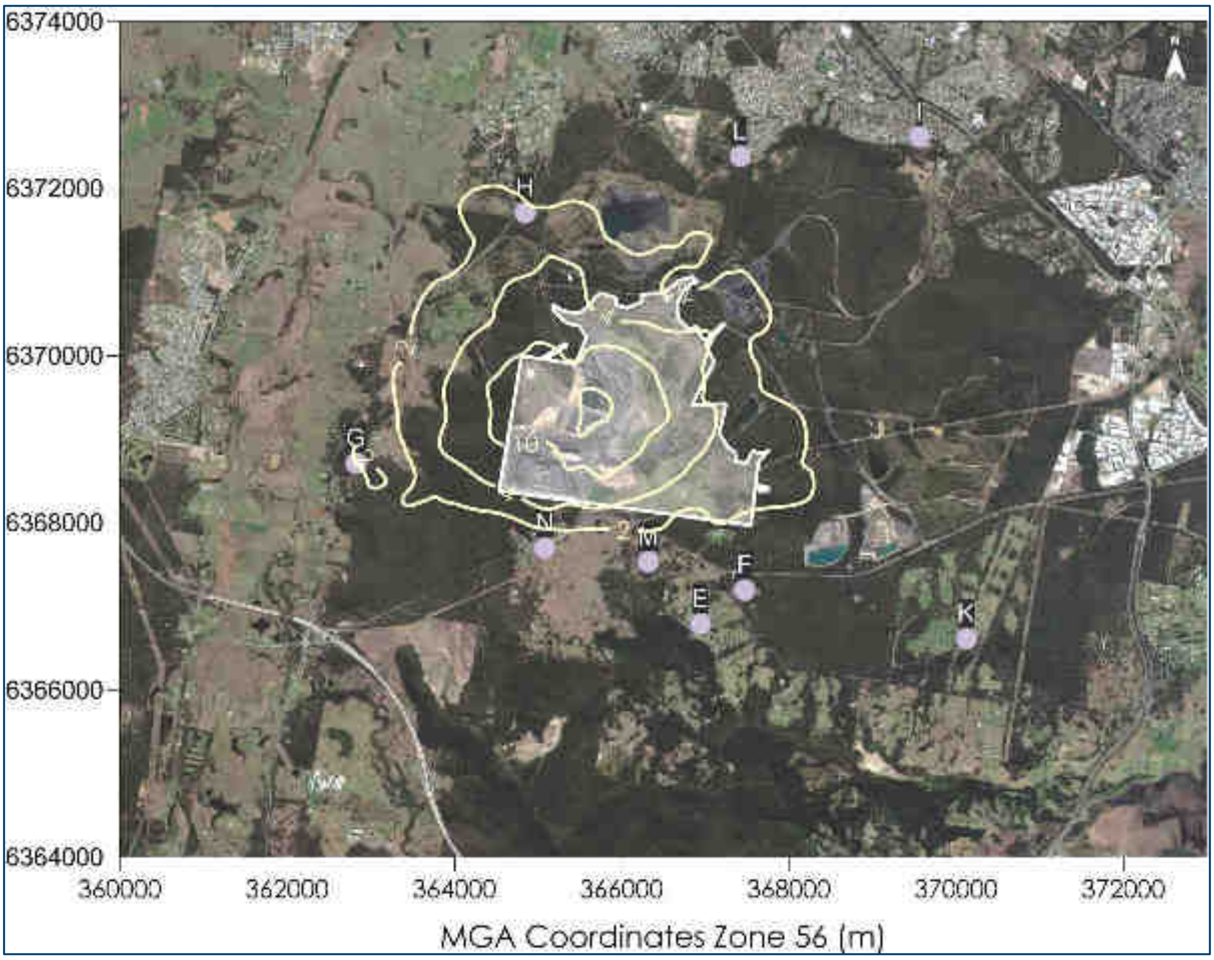

Figure C-12: Predicted annual average NO_2 concentrations due to emissions from the Project (µg/m³)

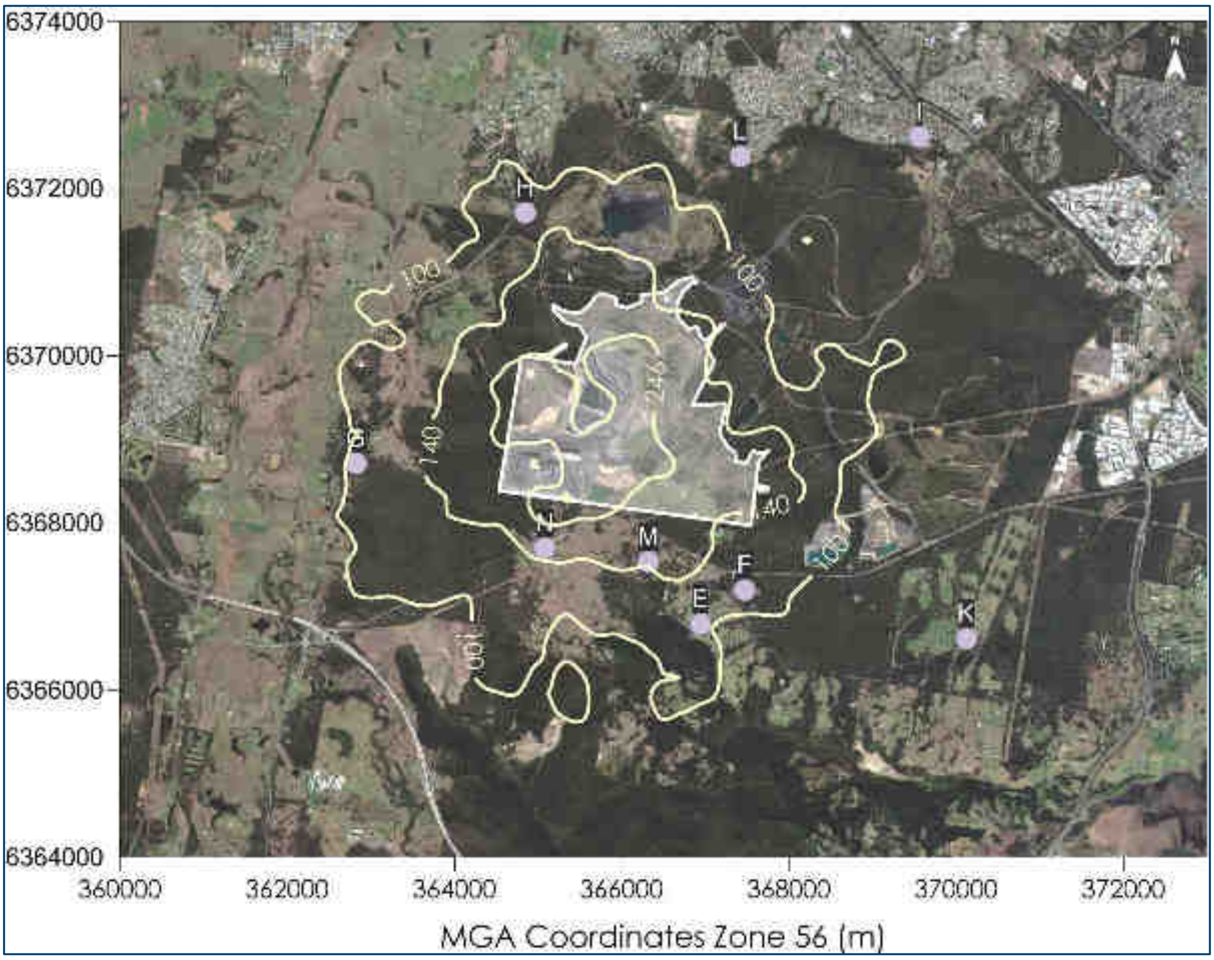

Figure C-13: Predicted 1-hour average NO_2 concentrations due to emissions from the Project and other sources (μg/m³)

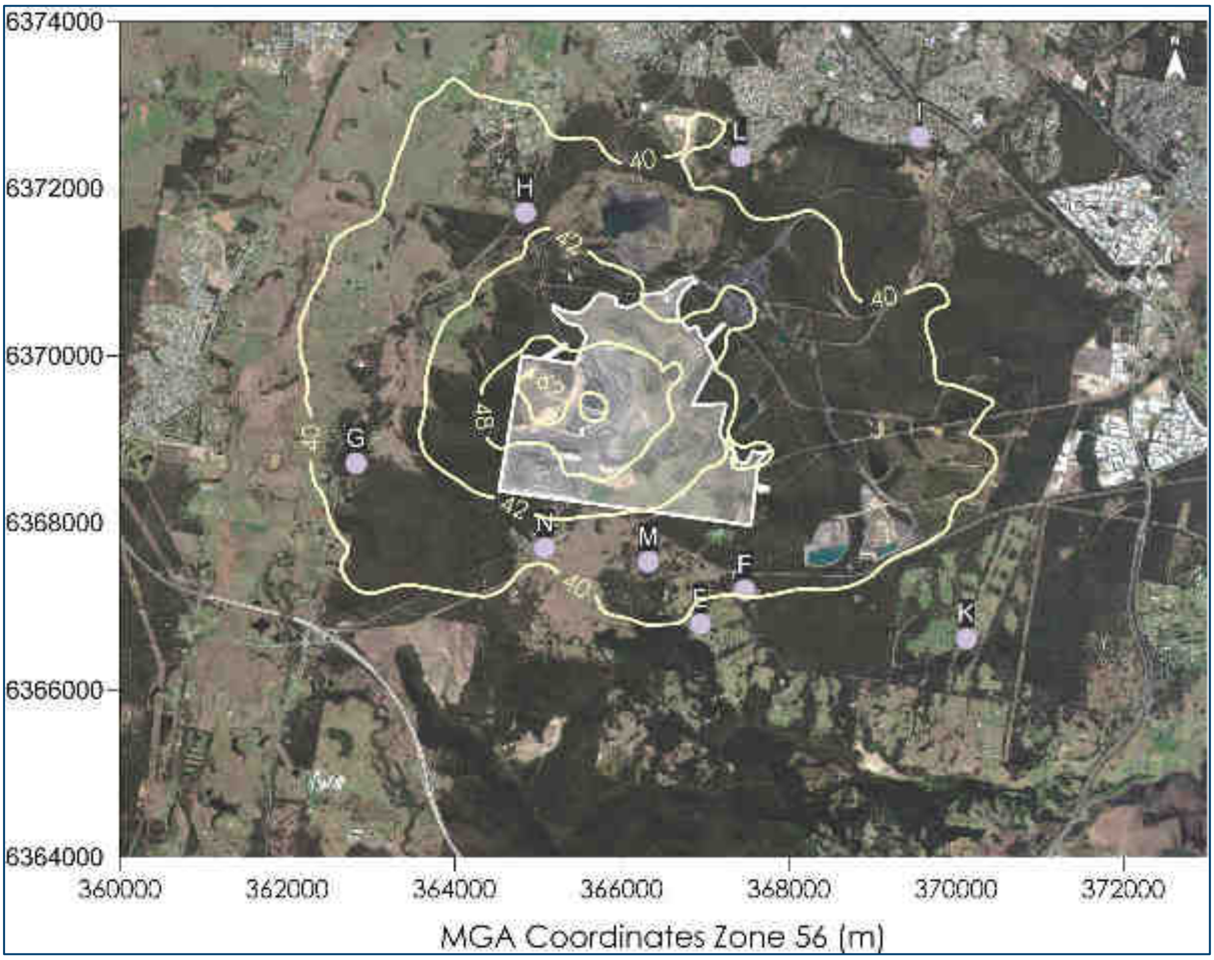

Figure C-14: Predicted annual average NO_2 concentrations due to emissions from the Project and other sources (µg/m³)

Appendix D

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

Table D-1: $PM_{2.5}$ 24-hr average concentration – Receptor location E

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	0.6	19.2	10/07/2015	8.1	3.2	11.3
20/08/2015	14.5	0.4	14.9	24/04/2015	ND	3.2	3.2
22/08/2015	14.1	2.4	16.6	7/06/2015	14.0	3.2	17.2
7/06/2015	14.0	3.2	17.2	20/11/2015	7.2	2.7	9.8
5/07/2015	12.8	0.1	12.8	8/06/2015	6.2	2.6	8.7
9/03/2015	12.1	0.2	12.3	22/08/2015	14.1	2.4	16.6
19/11/2015	12.0	0.2	12.2	4/05/2015	3.9	2.3	6.1
19/03/2015	11.1	0.0	11.2	28/05/2015	6.4	2.3	8.7
9/07/2015	10.9	0.2	11.1	27/06/2015	10.0	2.2	12.2
23/06/2015	10.8	0.4	11.2	4/06/2015	6.8	2.0	8.8

ND – No Data

Table D-2: $PM_{2.5}$ 24-hr average concentration – Receptor location F

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	0.7	19.3	7/06/2015	14.0	4.0	18.1
20/08/2015	14.5	0.3	14.8	11/07/2015	5.8	3.8	9.6
22/08/2015	14.1	3.0	17.2	4/06/2015	6.8	3.8	10.6
7/06/2015	14.0	4.0	18.1	30/05/2015	6.0	3.7	9.7
5/07/2015	12.8	1.1	13.9	10/07/2015	8.1	3.6	11.7
9/03/2015	12.1	0.2	12.3	8/06/2015	6.2	3.6	9.8
19/11/2015	12.0	0.2	12.2	24/04/2015	ND	3.6	3.6
19/03/2015	11.1	0.1	11.2	28/05/2015	6.4	3.3	9.8
9/07/2015	10.9	0.3	11.2	29/05/2015	5.6	3.3	8.9
23/06/2015	10.8	0.4	11.2	8/05/2015	5.1	3.1	8.2

ND – No Data

Table D-3: $PM_{2.5}$ 24-hr average concentration – Receptor location G

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	2.5	21.1	5/11/2015	1.3	7.2	8.5
20/08/2015	14.5	3.7	18.2	9/10/2015	4.4	5.5	9.9
22/08/2015	14.1	0.6	14.7	4/01/2015	3.9	5.1	9.0
7/06/2015	14.0	0.0	14.1	1/01/2015	4.7	5.0	9.8
5/07/2015	12.8	0.0	12.8	16/02/2015	3.9	4.9	8.7
9/03/2015	12.1	1.0	13.1	15/10/2015	4.0	4.8	8.8
19/11/2015	12.0	1.3	13.4	18/12/2015	3.2	4.5	7.7
19/03/2015	11.1	2.0	13.1	16/10/2015	5.6	4.5	10.1
9/07/2015	10.9	1.1	12.0	13/09/2015	7.5	4.4	11.8
23/06/2015	10.8	0.1	10.9	19/10/2015	5.4	4.4	9.7

Table D-4: $PM_{2.5}$ 24-hr average concentration – Receptor location H

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	0.6	19.1	30/04/2015	2.1	6.7	8.8
20/08/2015	14.5	0.7	15.2	26/06/2015	5.2	6.7	11.8
22/08/2015	14.1	0.1	14.2	11/06/2015	4.6	6.5	11.0
7/06/2015	14.0	0.1	14.2	3/05/2015	1.9	5.9	7.9
5/07/2015	12.8	0.0	12.8	17/09/2015	6.3	5.6	11.9
9/03/2015	12.1	2.8	14.9	16/03/2015	5.1	5.5	10.6
19/11/2015	12.0	2.9	14.9	18/09/2015	4.2	5.4	9.6
19/03/2015	11.1	0.9	12.0	17/04/2015	7.1	4.7	11.8
9/07/2015	10.9	2.1	13.0	26/02/2015	4.7	4.5	9.2
23/06/2015	10.8	0.1	10.9	9/11/2015	2.6	4.4	7.0

Table D-5: $PM_{2.5}$ 24-hr average concentration – Receptor location I

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	0.1	18.7	20/06/2015	4.4	1.8	6.2
20/08/2015	14.5	0.1	14.5	31/08/2015	4.2	1.8	6.0
22/08/2015	14.1	0.3	14.4	2/08/2015	6.4	1.8	8.2
7/06/2015	14.0	0.9	15.0	28/06/2015	9.3	1.7	11.1
5/07/2015	12.8	1.1	13.9	27/06/2015	10.0	1.7	11.6
9/03/2015	12.1	0.3	12.4	4/06/2015	6.8	1.7	8.5
19/11/2015	12.0	0.2	12.3	15/08/2015	7.9	1.6	9.5
19/03/2015	11.1	0.6	11.7	25/05/2015	8.2	1.4	9.6
9/07/2015	10.9	0.7	11.6	9/08/2015	9.2	1.4	10.6
23/06/2015	10.8	0.1	10.9	21/06/2015	7.6	1.4	9.0

Table D-6: $PM_{2.5}$ 24-hr average concentration – Receptor location K

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	0.2	18.8	12/07/2015	ND	2.4	2.4
20/08/2015	14.5	0.1	14.6	13/07/2015	5.8	1.9	7.7
22/08/2015	14.1	1.0	15.1	27/08/2015	1.9	1.6	3.5
7/06/2015	14.0	0.9	14.9	25/07/2015	4.1	1.6	5.7
5/07/2015	12.8	1.1	13.9	1/08/2015	8.0	1.6	9.7
9/03/2015	12.1	0.1	12.2	8/06/2015	6.2	1.6	7.8
19/11/2015	12.0	0.1	12.1	11/07/2015	5.8	1.6	7.4
19/03/2015	11.1	0.1	11.2	8/05/2015	5.1	1.4	6.5
9/07/2015	10.9	0.2	11.1	26/07/2015	2.6	1.4	4.0
23/06/2015	10.8	0.2	11.0	10/05/2015	2.9	1.4	4.3

ND – No Data

Table D-7: $PM_{2.5}$ 24-hr average concentration – Receptor location L

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	0.2	18.8	13/04/2015	5.6	2.7	8.3
20/08/2015	14.5	0.2	14.7	10/04/2015	3.4	2.6	6.1
22/08/2015	14.1	0.2	14.3	23/05/2015	3.2	2.6	5.8
7/06/2015	14.0	1.0	15.0	28/06/2015	9.3	2.3	11.6
5/07/2015	12.8	1.0	13.8	20/06/2015	4.4	2.2	6.6
9/03/2015	12.1	1.0	13.1	3/07/2015	ND	2.2	2.2
19/11/2015	12.0	0.7	12.7	10/09/2015	5.1	2.2	7.3
19/03/2015	11.1	1.2	12.3	20/07/2015	7.9	2.1	10.0
9/07/2015	10.9	1.4	12.3	15/08/2015	7.9	2.1	10.0
23/06/2015	10.8	0.1	11.0	11/06/2015	4.6	2.0	6.6

ND – No Data

Table D-8: $PM_{2.5}$ 24-hr average concentration – Receptor location M

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	1.4	19.9	10/07/2015	8.1	5.8	13.9
20/08/2015	14.5	0.9	15.4	7/06/2015	14.0	5.5	19.6
22/08/2015	14.1	4.7	18.8	24/04/2015	ND	5.1	5.1
7/06/2015	14.0	5.5	19.6	23/08/2015	8.9	4.7	13.6
5/07/2015	12.8	0.7	13.4	22/08/2015	14.1	4.7	18.8
9/03/2015	12.1	0.3	12.4	4/05/2015	3.9	4.6	8.5
19/11/2015	12.0	0.4	12.4	8/06/2015	6.2	4.4	10.6
19/03/2015	11.1	0.1	11.2	11/07/2015	5.8	4.2	10.0
9/07/2015	10.9	0.3	11.2	27/06/2015	10.0	4.2	14.1
23/06/2015	10.8	0.8	11.6	20/11/2015	7.2	4.0	11.1

ND – No Data

Table D-9: $PM_{2.5}$ 24-hr average concentration – Receptor location N

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/08/2015	18.6	2.6	21.2	18/04/2015	5.8	4.1	10.0
20/08/2015	14.5	1.8	16.3	10/07/2015	8.1	3.7	11.7
22/08/2015	14.1	2.4	16.5	22/06/2015	8.3	3.4	11.7
7/06/2015	14.0	0.7	14.8	26/12/2015	2.1	3.4	5.5
5/07/2015	12.8	0.0	12.8	13/06/2015	8.7	3.3	12.0
9/03/2015	12.1	0.3	12.4	26/11/2015	9.0	3.1	12.1
19/11/2015	12.0	0.4	12.5	11/07/2015	5.8	3.0	8.8
19/03/2015	11.1	0.3	11.4	5/10/2015	5.9	2.9	8.9
9/07/2015	10.9	0.5	11.4	30/03/2015	3.7	2.8	6.5
23/06/2015	10.8	1.0	11.9	21/08/2015	18.6	2.6	21.2

Table D-10: PM_{10} 24-hr average concentration – Receptor location E

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	2.8	**50.8**	24/04/2015	ND	16.6	16.6
6/05/2015	46.5	0.1	46.7	7/06/2015	16.4	16.0	32.4
26/11/2015	41.2	5.8	47.0	10/07/2015	13.0	15.6	28.6
21/08/2015	38.0	2.8	40.8	20/11/2015	28.2	15.0	43.2
6/10/2015	30.1	0.7	30.8	8/06/2015	11.9	14.6	26.5
19/11/2015	29.0	0.8	29.8	22/08/2015	23.2	12.7	35.9
7/10/2015	28.2	0.1	28.3	28/05/2015	13.8	12.3	26.0
20/11/2015	28.2	15.0	43.2	27/06/2015	15.8	10.3	26.1
9/03/2015	26.4	0.7	27.1	4/05/2015	8.8	10.1	18.9
19/12/2015	26.0	0.7	26.7	4/06/2015	13.0	9.8	22.8

ND – No Data

Table D-11: PM_{10} 24-hr average concentration – Receptor location F

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	2.6	**50.6**	7/06/2015	16.4	20.8	37.2
6/05/2015	46.5	0.6	47.1	8/06/2015	11.9	19.8	31.7
26/11/2015	41.2	6.8	48.0	11/07/2015	6.9	19.6	26.5
21/08/2015	38.0	3.3	41.3	28/05/2015	13.8	19.0	32.8
6/10/2015	30.1	0.7	30.8	4/06/2015	13.0	18.8	31.8
19/11/2015	29.0	0.9	29.9	30/05/2015	12.6	18.2	30.8
7/10/2015	28.2	0.1	28.3	24/04/2015	ND	18.1	18.1
20/11/2015	28.2	13.9	42.1	10/07/2015	13.0	18.1	31.1
9/03/2015	26.4	0.9	27.3	29/05/2015	11.0	16.7	27.7
19/12/2015	26.0	0.7	26.7	22/08/2015	23.2	16.2	39.4

ND – No Data

Table D-12: PM_{10} 24-hr average concentration – Receptor location G

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	0.1	48.1	5/11/2015	3.7	37.7	41.4
6/05/2015	46.5	0.0	46.5	9/10/2015	13.7	27.2	40.9
26/11/2015	41.2	0.2	41.4	4/01/2015	12.1	24.2	36.3
21/08/2015	38.0	11.9	49.9	1/01/2015	14.5	24.1	38.7
6/10/2015	30.1	0.7	30.8	16/02/2015	15.0	22.6	37.6
19/11/2015	29.0	6.1	35.1	15/10/2015	14.5	22.5	37.0
7/10/2015	28.2	0.0	28.3	18/12/2015	10.8	22.4	33.3
20/11/2015	28.2	0.3	28.6	16/10/2015	14.0	21.8	35.9
9/03/2015	26.4	4.3	30.7	19/12/2015	26.0	21.3	47.3
19/12/2015	26.0	21.3	47.3	14/02/2015	10.1	20.9	31.0

Table D-13: PM_{10} 24-hr average concentration – Receptor location H

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	0.9	48.9	3/05/2015	6.2	35.1	41.2
6/05/2015	46.5	0.1	46.6	26/06/2015	12.3	34.3	46.5
26/11/2015	41.2	2.5	43.7	11/06/2015	9.0	32.7	41.8
21/08/2015	38.0	2.6	40.6	30/04/2015	6.2	32.4	38.6
6/10/2015	30.1	0.3	30.4	17/09/2015	16.1	28.4	44.5
19/11/2015	29.0	14.3	43.3	18/09/2015	9.8	28.2	38.0
7/10/2015	28.2	3.4	31.7	16/03/2015	15.2	27.4	42.6
20/11/2015	28.2	2.2	30.5	21/04/2015	7.3	25.7	33.0
9/03/2015	26.4	13.7	40.1	17/04/2015	17.0	25.2	42.2
19/12/2015	26.0	3.8	29.8	26/09/2015	6.0	23.1	29.1

Table D-14: PM_{10} 24-hr average concentration – Receptor location I

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	0.2	48.2	2/08/2015	17.6	8.5	26.2
6/05/2015	46.5	0.3	46.8	28/06/2015	9.0	7.8	16.8
26/11/2015	41.2	0.1	41.3	31/08/2015	13.7	7.8	21.5
21/08/2015	38.0	0.6	38.6	9/08/2015	11.0	7.5	18.5
6/10/2015	30.1	1.6	31.7	4/06/2015	13.0	7.5	20.5
19/11/2015	29.0	1.0	30.0	27/06/2015	15.8	7.2	23.1
7/10/2015	28.2	1.9	30.2	20/06/2015	9.0	7.2	16.3
20/11/2015	28.2	3.6	31.8	15/08/2015	15.0	6.8	21.8
9/03/2015	26.4	1.4	27.8	14/06/2015	15.1	6.1	21.2
19/12/2015	26.0	0.1	26.1	25/05/2015	15.8	5.9	21.6

Table D-15 PM_{10} 24-hr average concentration – Receptor location K

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	0.9	48.9	12/07/2015	5.0	15.1	20.1
6/05/2015	46.5	0.5	47.0	13/07/2015	5.1	11.9	17.0
26/11/2015	41.2	1.9	43.1	25/07/2015	12.3	9.8	22.1
21/08/2015	38.0	1.2	39.2	27/08/2015	7.0	9.3	16.3
6/10/2015	30.1	0.3	30.4	8/06/2015	11.9	8.7	20.6
19/11/2015	29.0	0.3	29.3	1/08/2015	18.2	8.4	26.6
7/10/2015	28.2	0.0	28.3	26/07/2015	9.6	8.4	18.0
20/11/2015	28.2	3.6	31.8	10/05/2015	12.0	8.2	20.2
9/03/2015	26.4	0.4	26.8	11/07/2015	6.9	7.9	14.8
19/12/2015	26.0	0.3	26.3	30/07/2015	15.0	7.5	22.5

Table D-16: PM_{10} 24-hr average concentration – Receptor location L

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	0.4	48.4	23/05/2015	6.0	12.3	18.3
6/05/2015	46.5	0.1	46.6	10/04/2015	10.5	11.2	21.7
26/11/2015	41.2	0.5	41.7	13/04/2015	17.5	10.7	28.2
21/08/2015	38.0	0.8	38.8	26/06/2015	12.3	10.2	22.5
6/10/2015	30.1	0.6	30.7	11/06/2015	9.0	10.1	19.2
19/11/2015	29.0	3.2	32.2	4/09/2015	12.2	9.8	22.0
7/10/2015	28.2	2.0	30.3	28/06/2015	9.0	9.6	18.6
20/11/2015	28.2	5.6	33.8	10/09/2015	16.4	9.4	25.8
9/03/2015	26.4	4.4	30.9	20/06/2015	9.0	9.2	18.3
19/12/2015	26.0	0.5	26.5	3/07/2015	22.4	9.2	31.6

Table D-17: PM_{10} 24-hr average concentration – Receptor location M

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	5.4	53.4	10/07/2015	13.0	28.9	41.9
6/05/2015	46.5	0.4	46.9	7/06/2015	16.4	28.3	44.7
26/11/2015	41.2	13.7	54.9	24/04/2015	ND	26.6	26.6
21/08/2015	38.0	6.1	44.1	8/06/2015	11.9	25.0	36.9
6/10/2015	30.1	1.4	31.5	22/08/2015	23.2	24.4	47.6
19/11/2015	29.0	1.9	30.9	20/11/2015	28.2	22.9	51.1
7/10/2015	28.2	0.1	28.4	23/08/2015	10.7	22.0	32.7
20/11/2015	28.2	22.9	51.1	4/05/2015	8.8	21.7	30.5
9/03/2015	26.4	1.4	27.9	11/07/2015	6.9	20.8	27.7
19/12/2015	26.0	1.2	27.2	27/06/2015	15.8	19.3	35.1

ND – No Data

Table D-18: PM_{10} 24-hr average concentration – Receptor location N

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/12/2015	48.0	4.9	52.9	18/04/2015	10.0	18.2	28.2
6/05/2015	46.5	0.1	46.6	10/07/2015	13.0	15.8	28.8
26/11/2015	41.2	13.2	54.4	26/12/2015	7.2	14.6	21.8
21/08/2015	38.0	11.1	49.1	22/06/2015	8.0	14.6	22.6
6/10/2015	30.1	1.4	31.5	11/07/2015	6.9	14.5	21.3
19/11/2015	29.0	1.8	30.8	13/06/2015	12.1	13.6	25.7
7/10/2015	28.2	0.1	28.3	26/11/2015	41.2	13.2	54.4
20/11/2015	28.2	1.8	30.0	5/10/2015	25.7	13.0	38.6
9/03/2015	26.4	1.2	27.7	30/03/2015	10.0	12.6	22.6
19/12/2015	26.0	1.4	27.4	21/08/2015	38.0	11.1	49.1