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AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT MUSWELLBROOK COAL CONTINUATION PROJECT

EMM Consulting

22 April 2016

Job Number 15120520

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Air Quality Impact and Greenhouse Gas Assessment Muswellbrook Coal Continuation Project

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DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT – 001	29/03/2016	P Henschke, M Yu	A Todoroski
DRAFT – 002	01/04/2016	P Henschke	
DRAFT – 003	18/04/2016	P Henschke, A Todoroski	A Todoroski
FINAL – 001	22/04/2016	P Henschke, A Todoroski	

EXECUTIVE SUMMARY

This report assesses the potential air quality effects of the proposed continuation of the Muswellbrook Coal Mine (MCM) located in the Hunter Valley region of New South Wales, and calculates the greenhouse gas emissions that may arise as a result of the project.

The MCM seeks approval to mine additional coal resources and extend the mine life. This assessment is prepared in accordance with the applicable regulatory requirements and guidelines and forms part of the statement of environmental effects prepared for the modification application.

The existing meteorological conditions in the area around the MCM are governed by the local terrain features with the overall prevailing wind flows being directed along valleys and ridges that are characteristic of the area. The ambient air quality levels that are monitored at various locations surrounding the mining operation indicate that air quality in the area is generally good and is typically below the relevant New South Wales Environment Protection Authority goals, apart from some days of elevated 24-hour PM_{10}.

To assess the potential for air quality impacts associated with project, a mine plan year representing the potential worst-case impacts of the proposed mining operation was selected by reference to the location of the proposed activities likely to contribute to the highest dust levels at sensitive receptor locations in each year.

The emission rates for the air pollutants generated by project were calculated and applied in the CALPUFF model to assess potential off-site pollutant impacts. All reasonable and feasible dust mitigation and management measures that represent best practice for this specific project were considered and applied as appropriate to minimise potential impacts.

The assessment predicted that potential dust impacts are likely to occur at one privately-owned assessment location positioned to the north of the operation. The privately-owned assessment location is predicted to experience up to three days above the 24-hour average PM_{10} criterion.

The potential air quality impacts associated with diesel emissions due to the operation are expected to be negligible. As there are no additional equipment or change to operational hours proposed, there would not be any increase in diesel emissions. As blasting is currently permitted at MCM, and there has been no significant air quality incident in this regard at this site, it is expected that this would remain the case in the future.

Using the upper limit of the assumed maximum production for the proposed continuation of the MCM, the estimated annual average greenhouse emission is 0.015 million tonnes of carbon dioxide equivalent material (Scope 1 and 2), which is calculated to be approximately 0.003 per cent of the Australian greenhouse emissions for the February 2014 to March 2015 period and approximately 0.01 per cent of the New South Wales greenhouse emissions for the 2013 period.

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1 INTRODUCTION

Muswellbrook coal mine (MCM) is an open cut coal mine operated by Muswellbrook Coal Company Limited (MCC). MCM is located on Muscle Creek Road, three kilometres (km) north-east of the township of Muswellbrook, in the Muswellbrook local government area (LGA) in New South Wales (NSW).

MCC has a long history of mining in the Muswellbrook area, with underground operations commencing at MCM in 1907. Underground operations ceased in the late 1990s; however open cut mining continues. MCC has approval from Muswellbrook Shire Council (MSC) to mine within the No. 1 Open Cut Extension Area (Open Cut 1) (DA 205/2002, as modified), with operations approved to be complete by 2020.

Additional coal resources have been identified within a previously rehabilitated area adjacent to Open Cut 1. While this area is within the development consent boundary, a modification to the existing development consent is required to modify the conceptual mine plan to allow mining of these additional resources, as well as extending the approved mine life and modifying the conceptual final landform (the modification).

The modification would maximise the recovery of coal resources within ML 1562, ML 1304 and CCL 713 and would enable the recovery of approximately 4.2 million tonnes (Mt) of additional coal resources.

In summary the modification involves:

- extension of open cut mining operations in Open Cut 1;
- extension of the mine life, with operations proposed to cease by the end of 2025;
- changes to the conceptual final landform within the modification area; and,
- overburden emplacement in both Open Cut 1 and Open Cut 2, so as to achieve the conceptual final landform.

As the modification involves mining of a previously disturbed area that was used as an overburden dump, there would be no direct impact to previously undisturbed land.

No changes are proposed to the maximum production rate of 2 million tonnes per annum (Mtpa), mining methods, coal processing, blasting activities, water management, waste management and handling, coal transport, access to site, employee numbers, hazardous substances and dangerous goods management and environmental management.

1.1 Assessment purpose

This air quality impact and greenhouse gas 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 NSW* (**NSW DEC, 2005**). The assessment forms part of the environmental impact assessment prepared to accompany the application for the modification.

The assessment investigates the potential for adverse air quality impacts occurring at surrounding assessment locations as a result of the modifications. Air dispersion modelling is utilised in conjunction with estimated emission rates of air pollutants and the consideration of mitigation measures in ameliorating any potential air quality impacts. The greenhouse gas assessment is based on the projected quantities of materials consumed and likely emissions generated at the site and is compared with estimates at a national and state level.

2 LOCAL SETTING

Land uses surrounding the mine include agricultural activities, light industrial land uses and residential areas. Agricultural activities are located on properties surrounding MCM and primarily include grazing of beef cattle. Light industrial land uses include Muswellbrook Quarry to the northwest, St Heliers correctional centre to the northwest and Muswellbrook waste management facility to the south. Muswellbrook township is to the southwest, with other notable rural-residential areas along Sandy Creek Road to the northwest, Woodlands Ridge Estate to the south and along Muscle Creek Road to the south.

Other significant features surrounding MCM include the Main Northern Rail Line and the New England Highway, which run to the west through Muswellbrook township and to the south towards Singleton. Numerous other mining operations and power-generating facilities exist between Muswellbrook and Singleton.

Figure 2-1 presents the location of MCM in relation to the other neighbouring coal mining operations and the assessment locations of relevance to this study. **Appendix A** provides a detailed list of all the assessment locations considered in this assessment.

Figure 2-2 presents a three-dimensional (3D) visualisation of the topography in the vicinity of MCM. The surrounding topography is characterised by elevated terrain to the northeast and east of the site which continues to form the Barrington Tops National Park. To the south and east, the terrain is generally more open creating the Hunter Valley region. The terrain features of the surrounding area which form the Hunter Valley region have a significant effect on the local wind distribution patterns and flows.

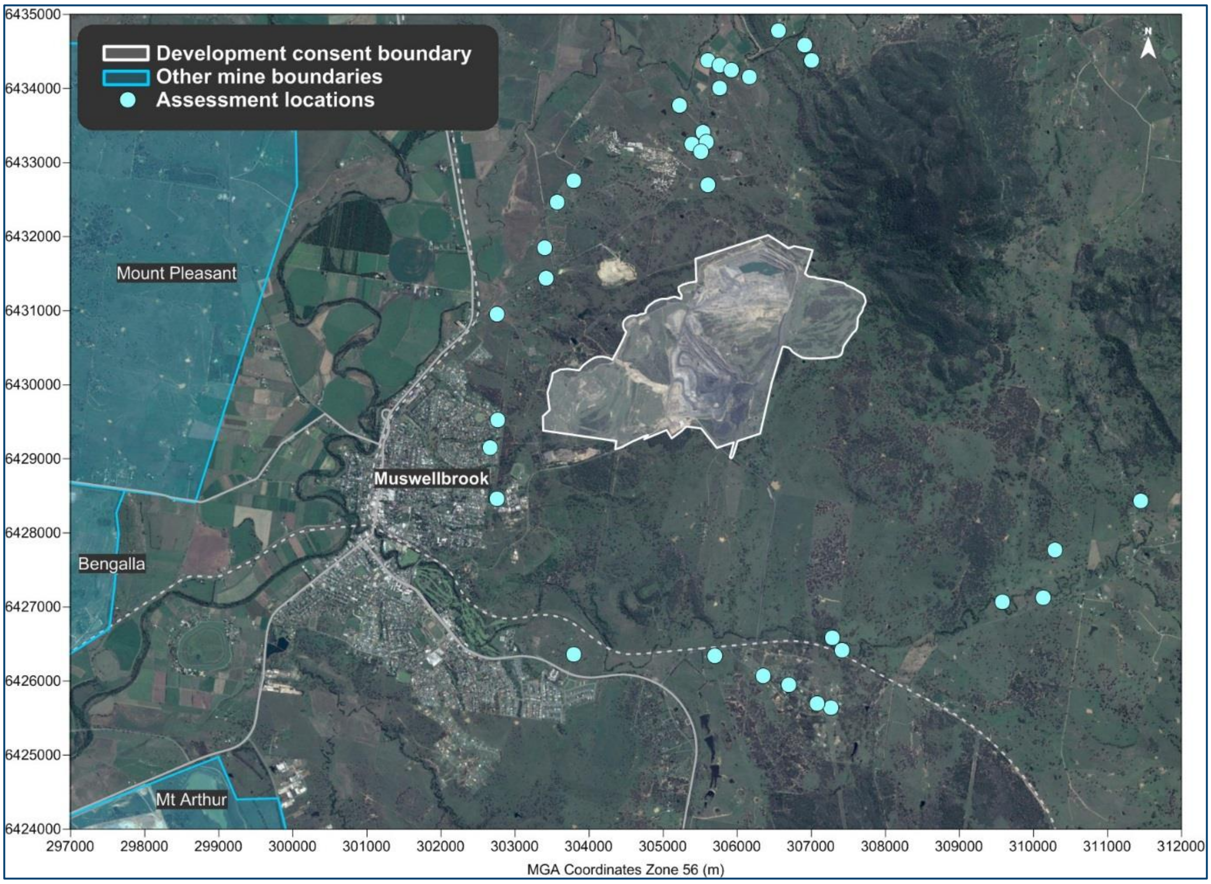

Figure 2-1: Local setting

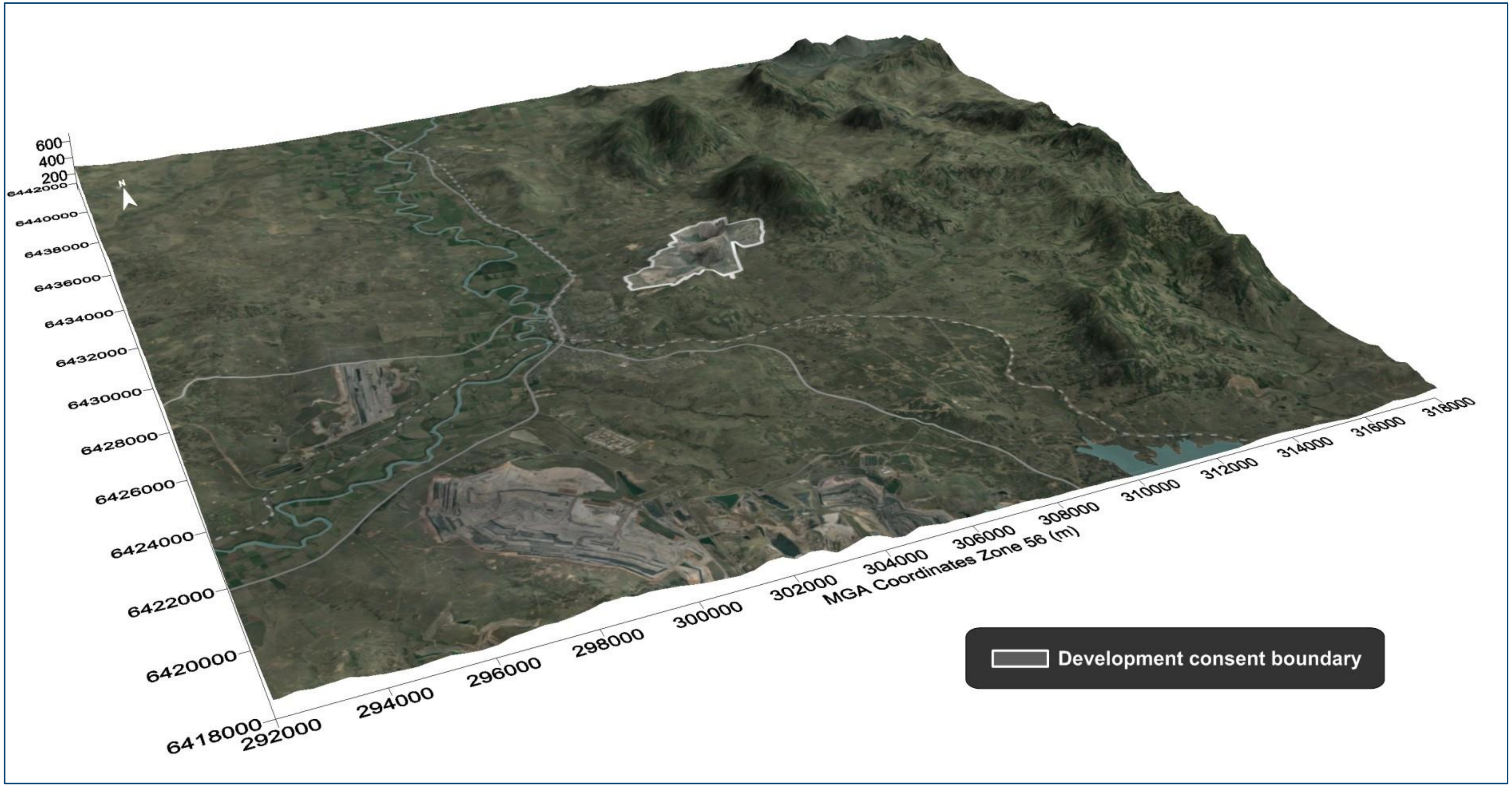

Figure 2-2: Topography surrounding MCC mine

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 proposed modification and the applicable air quality criteria.

3.1 Particulate matter

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

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

Mining activities generate particles in all the aforementioned size categories. The great majority of the mass of particles generated by handling crustal materials, wind erosion and the abrasion, or crushing of rock and coal. . These particulate emissions will generally be larger than 2.5µm, as sub-2.5µm particles are usually generated through combustion processes or as secondary particles formed from chemical reactions rather than through mechanical processes that dominate emissions on mine sites.

Combustion particulate matter can be more harmful to human health as the particles have the ability to penetrate deep into the human respiratory system, due to their size and can be comprised of acidic and carcinogenic substances.

A study of the particle size distribution from mine dust sources in 1986 conducted by the State Pollution Control Commission (SPCC) of 120 samples found that $PM_{2.5}$ comprised approximately 4.7 percent (%) of the TSP, and PM_{10} comprised approximately 39.1% of the TSP in the samples (**SPCC, 1986**). The emissions of $PM_{2.5}$ occurring from mining activities are small in comparison to the total dust emissions and in practice, the concentrations of $PM_{2.5}$ in the vicinity of mining dust sources are likely to be low.

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

3.1.1 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 NSW* (**NSW DEC, 2005**).

The air quality goals for total impact relate to the total dust burden in the air and not just the dust from the proposed modification. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

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

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90µg/m³
PM_{10}	Annual	Total	30µg/m³
	24 hour	Total	50µg/m³
Deposited dust	Annual	Incremental	2g/m²/month
		Total	4g/m²/month

Source: NSW DEC, 2005
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

3.1.2 National Environment Protection (Ambient Air Quality) Measure

The *National Environment Protection Council (NEPC) Act 1994* and subsequent amendments define the National Environment Protection Measures (NEPMs) as instruments for setting environmental objectives in Australia.

The Ambient Air Quality NEPM specifies national ambient air quality standards for air pollutants including PM_{10} and $PM_{2.5}$. The standard for PM_{10} is outlined in **Table 3-2**. It is noted that the NEPM permits five days annually above the 24 hour average PM_{10} criterion to allow for bush fires and similar events.

Table 3-2: Standard for PM_{10} concentrations

Pollutant	Averaging Period	Maximum concentration	Maximum allowable exceedences
PM_{10}	24 hour	50µg/m³	5 days a year

Source: NEPC, 2003

The NSW EPA currently do not have impact assessment criteria for $PM_{2.5}$ concentrations. The Ambient Air Quality NEPM applies advisory reporting standards for $PM_{2.5}$ to gather sufficient data nationally to facilitate a review. The advisory reporting standards for $PM_{2.5}$ are outlined in **Table 3-3**.

As with each of the NEPM standards, these apply to the average, or general exposure of a population, rather than to "hot spot" locations.

Table 3-3: Advisory reporting standards for $PM_{2.5}$ concentrations

Pollutant	Averaging Period	Advisory Reporting Standard
$PM_{2.5}$	24 hour	25µg/m³
	Annual	8µg/m³

Source: NEPC, 2003

3.2 Other air pollutants

Emissions of carbon monoxide (CO), nitrogen dioxide (NO_2) and other pollutants, such as sulfur dioxide (SO_2), will also arise due to the mining activities from the diesel powered equipment.

CO is colourless, odourless and tasteless and is generated from the incomplete combustion of fuels when carbon molecules are only partially oxidised. It can reduce the capacity of blood to transport oxygen in humans resulting in symptoms of headache, nausea and fatigue.

NO_2 is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called oxides of nitrogen (NO_X). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**US EPA, 2011**). NO_X may also be generated by blasting activities. It is important to note that when formed, NO_2 is generally a small fraction of the total NO_X generated.

Sulphur dioxide (SO_2) is a colourless, toxic gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulfur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to have any widespread impact in NSW, and is generally only associated with large industrial activities. Due to its potential to impact on human health, sulfur is actively removed from fuel to prevent the release and formation of SO_2. The sulfur content of Australian diesel is controlled to a low level by national fuel standards.

Overall, these emissions associated with blasting activity and diesel powered equipment are generally considered low and unlikely to generate any significant off-site concentrations. The potential emissions associated with diesel powered equipment and blasting fume emissions have been discussed in **Section 7** and **Section 8**, respectively.

4 EXISTING ENVIRONMENT

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

4.1 Local climate

Long term climatic data collected at the nearby Bureau of Meteorology (BoM) weather station at Scone Airport Automatic Weather Station (AWS) (Station Number 061363) were analysed to characterise the local climate in the proximity of MCM. The Scone Airport AWS is located approximately 26km north-northwest of MCM.

Table 4-1 and **Figure 4-1** present a summary of the climatic parameters collected from the Scone Airport AWS over an approximate 19 to 25-year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 31.3 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 3.4°C.

Rainfall peaks during the warmer months and declines during the cooler months. The data show December is the wettest month with an average rainfall of 78.9 millimetres (mm) over 6.7 days and September is the driest month with an average rainfall of 34.7mm over 4.7 days.

Relative humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am relative humidity levels range from 62 per cent in October to 86 per cent in June. Mean 3pm relative humidity levels vary from 41 per cent in January to 58 per cent in June.

Wind speeds also exhibit little variability between the hours of 9am and 3pm over the seasons. The mean 9am wind speeds range from 7.0 kilometres per hour (km/h) in May and July to 12.7km/h in October and November. The mean 3pm wind speeds vary from 16.0km/h in June to 20.6km/h in November.

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

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temperature (ºC)	31.3	30.3	27.8	24.4	20.3	17.0	16.4	18.7	22.1	25.1	27.9	29.8	24.3
Mean min. temperature (ºC)	16.8	16.5	14.1	9.9	6.6	4.7	3.4	3.6	6.7	9.4	13.2	15.2	10.0
Rainfall													
Rainfall (mm)	65.0	62.0	53.3	37.4	36.8	46.3	39.7	35.9	34.7	46.9	78.0	78.9	615.7
Mean no. of rain days (≥1mm)	6.1	5.7	6.0	4.1	4.4	6.1	5.1	4.2	4.7	5.3	7.1	6.7	65.5
9am conditions													
Mean temperature (ºC)	22.3	21.3	19.0	17.0	13.0	10.0	9.4	11.3	15.3	18.3	19.7	21.6	16.5
Mean relative humidity (%)	70	77	82	77	81	86	83	73	66	62	66	67	74
Mean wind speed (km/h)	11.3	10.0	8.9	8.2	7.0	7.5	7.0	9.9	11.4	12.7	12.7	11.9	9.9
3pm conditions													
Mean temperature (ºC)	29.9	28.9	26.7	23.4	19.4	16.1	15.6	17.7	20.8	23.6	26.0	28.4	23.0
Mean relative humidity (%)	41	47	47	49	51	58	55	47	44	42	43	42	47
Mean wind speed (km/h)	19.2	18.7	18.6	18.0	16.1	16.0	16.5	18.7	18.9	19.1	20.6	20.0	18.4

Source: **Bureau of Meteorology, 2016 (accessed 17 February 2016)**

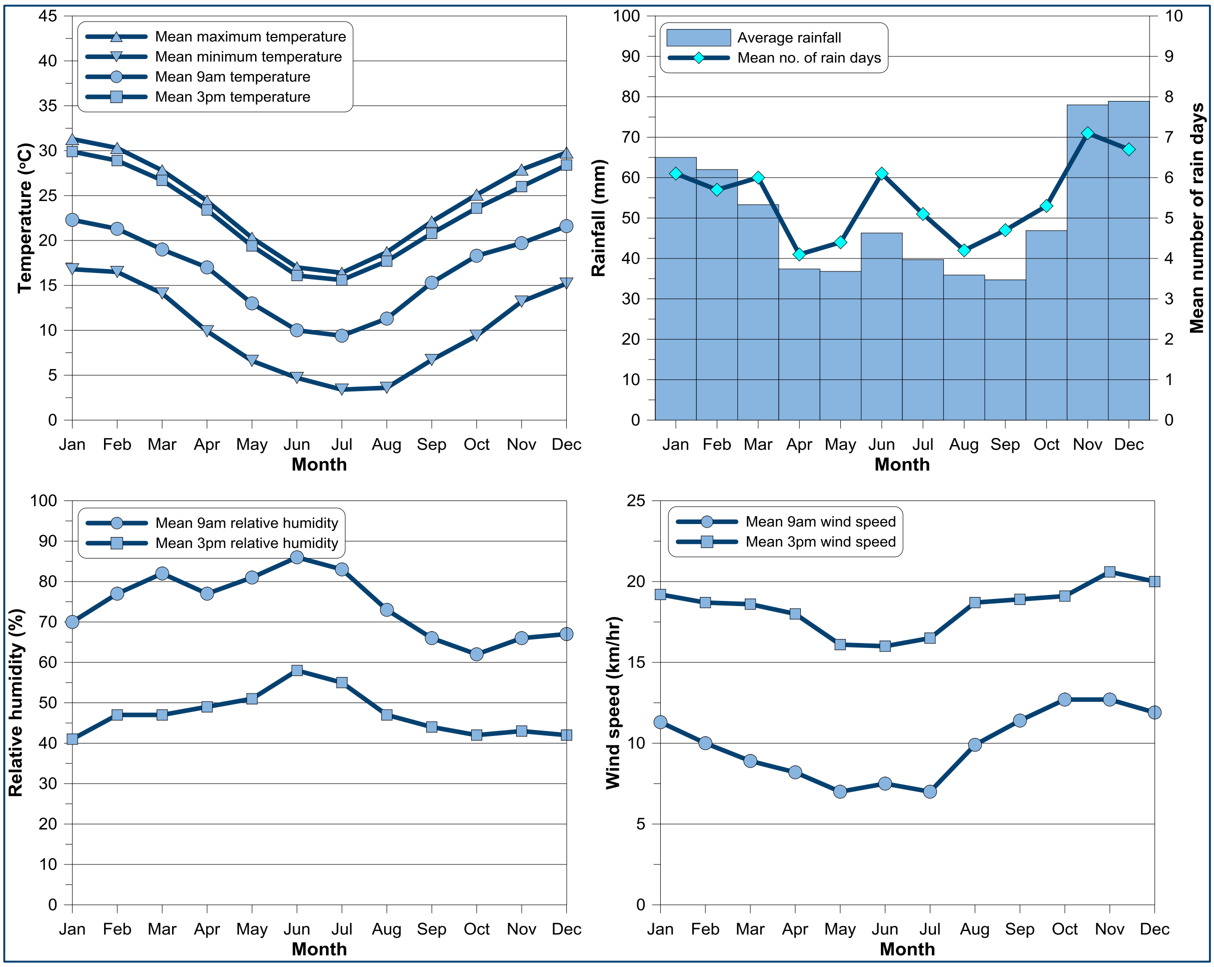

Figure 4-1: Monthly climate statistics summary – Scone Airport AWS

4.2 Local meteorological conditions

MCM operate an on-site weather station to assist with environmental management of site operations. The NSW Office of Environment and Heritage (OEH) operate a weather station in Muswellbrook. The location of these stations is shown in **Figure 4-2**.

Annual and seasonal windroses prepared from the available data collected for the 2014 period for the MCM station and Muswellbrook OEH station are presented in **Figure 4-3** and **Figure 4-4**, respectively.

Both weather stations recorded similar wind distribution patterns during the period reviewed. An analysis of the windroses indicates that on an annual basis dominant winds are from the southeast with few winds from the northwest quadrants.

In summer the winds are similar to the annual distribution with winds typically from the southeast. The autumn and winter distributions are relatively similar with winds from the southeast most frequent and a higher portion of winds from the northwest quadrant compared to other seasons. The spring distribution is similar to that of the other distributions with dominant wind from the southeast and varied winds from the northwest quadrant.

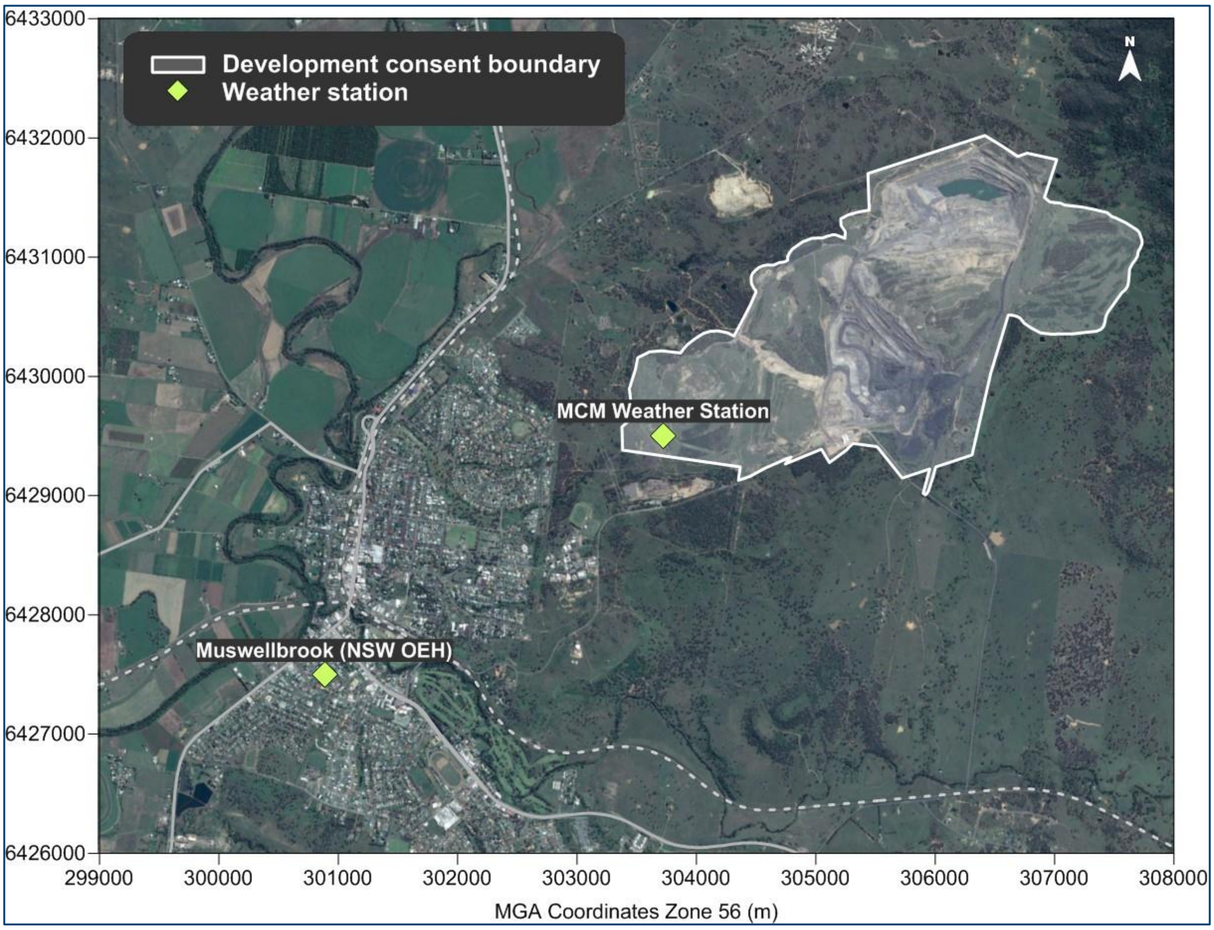

Figure 4-2: Weather station locations

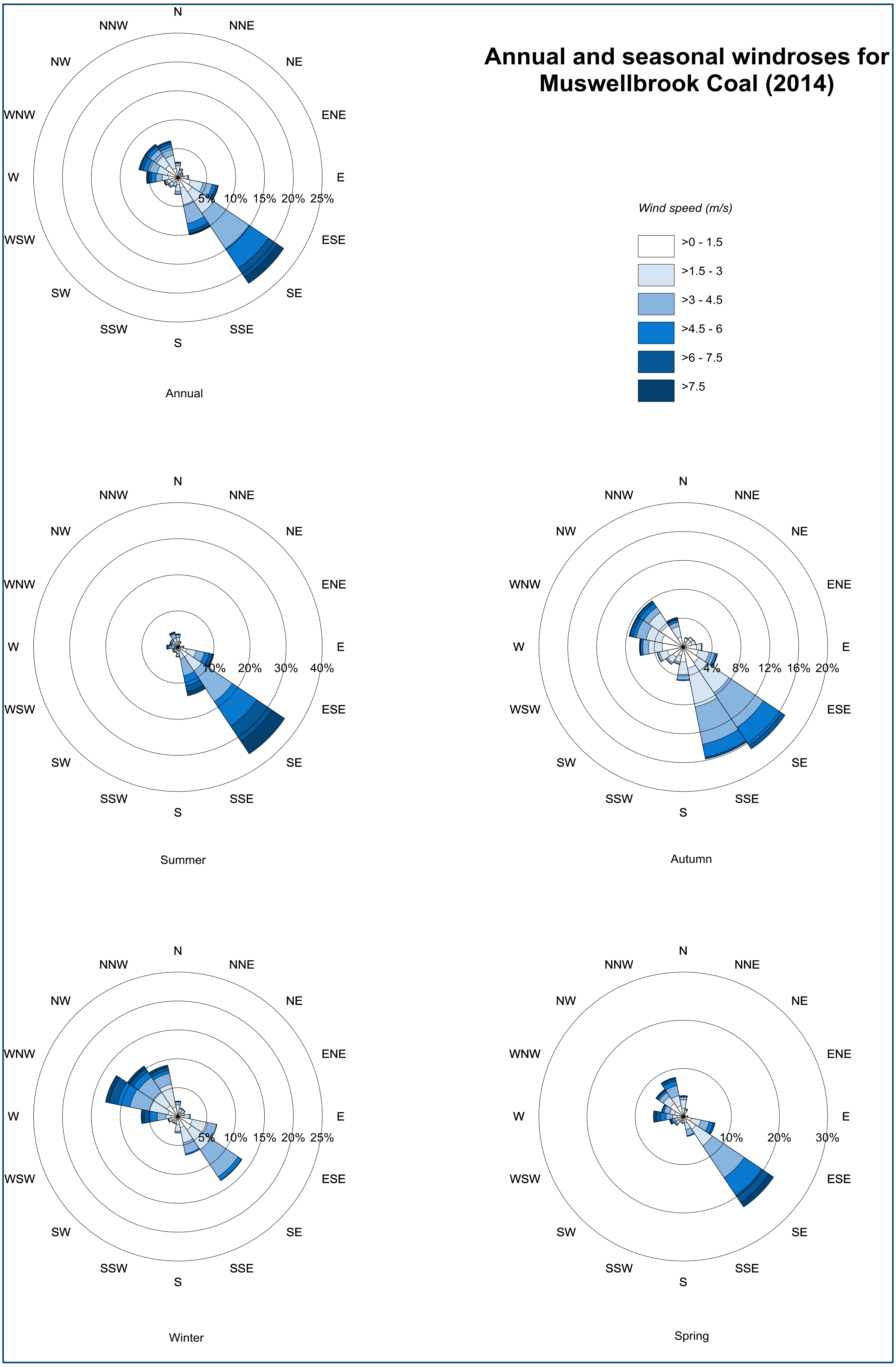

Figure 4-3: Annual and seasonal windroses for MCM weather station (2014)

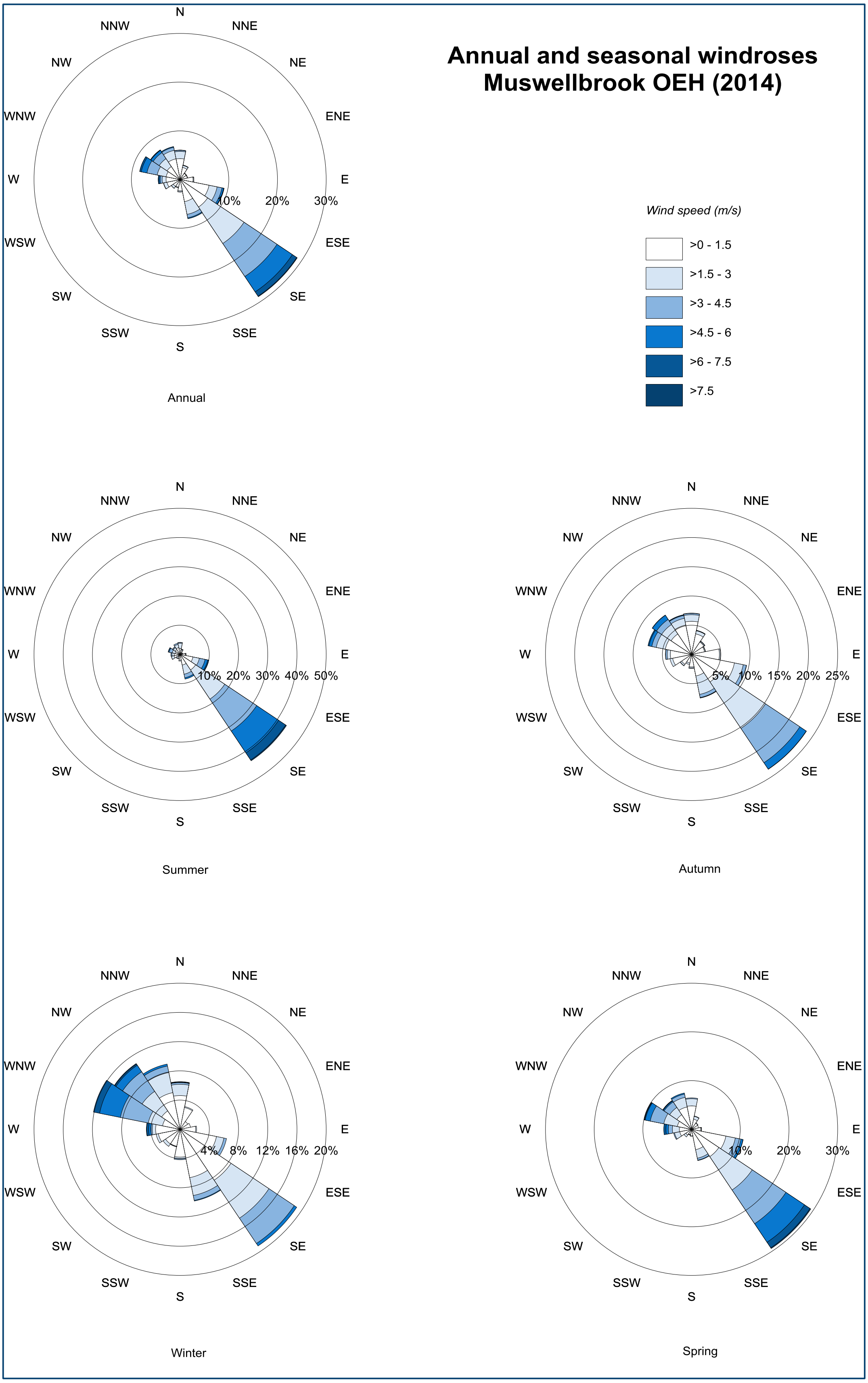

Figure 4-4: Annual and seasonal windrose for Muswellbrook OEH (2014)

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 including power generation associated with the Liddell, Bayswater and Redbank power stations.

This section reviews the ambient air quality monitoring data collected from a number of ambient monitoring locations in the vicinity of MCM.

The air quality monitors reviewed in this assessment provide a comprehensive dataset and include six Tapered Element Oscillating Microbalances (TEOMs), one of which was replaced with a Beta attenuation monitors (BAM), measuring PM_{10}, three High Volume Air Samplers (HVAS) measuring TSP, 17 dust deposition gauges, and one BAM measuring $PM_{2.5}$.

Table 4-2 lists the monitoring stations reviewed in this section and includes data from the NSW OEH Upper Hunter Air Quality Monitoring Network (UHAQMN) stations. **Figure 4-5** shows the approximate location of each of the monitoring stations reviewed in this assessment.

Appendix B provides a summary of selected monitoring data reviewed in this assessment.

Table 4-2: Summary of ambient monitoring stations

Monitoring site ID	Type	Parameter	Period reviewed
Site 1	TEOM	PM_{10}	Jan 2013 to Dec 2015
Site 2	TEOM	PM_{10}	Jan 2013 to Dec 2015
Site 3	TEOM/BAM*	PM_{10}	Jan 2013 to Dec 2015
Muswellbrook NW (NSW OEH)	TEOM	PM_{10}	Jan 2013 to Dec 2015
Muswellbrook (NSW OEH)	TEOM	PM_{10}	Jan 2013 to Dec 2015
Aberdeen (NSW OEH)	TEOM	PM_{10}	Jan 2013 to Dec 2015
Site 1	HVAS	TSP	Jan 2013 to Dec 2015
Site 2	HVAS	TSP	Jan 2013 to Dec 2015
Site 3	HVAS	TSP	Jan 2013 to Dec 2015
DM2, DM7, DM10, DM14-20, DM22-24, DM26, DM29-30	Dust gauge	Deposited dust	Jan 2013 to Nov 2015
DM28	Dust gauge	Deposited dust	Jan 2013 to Aug 2015
Muswellbrook (NSW OEH)	BAM	$PM_{2.5}$	Jan 2013 to Dec 2015

*The TEOM at Site 3 failed and was replaced with a BAM in November 2013

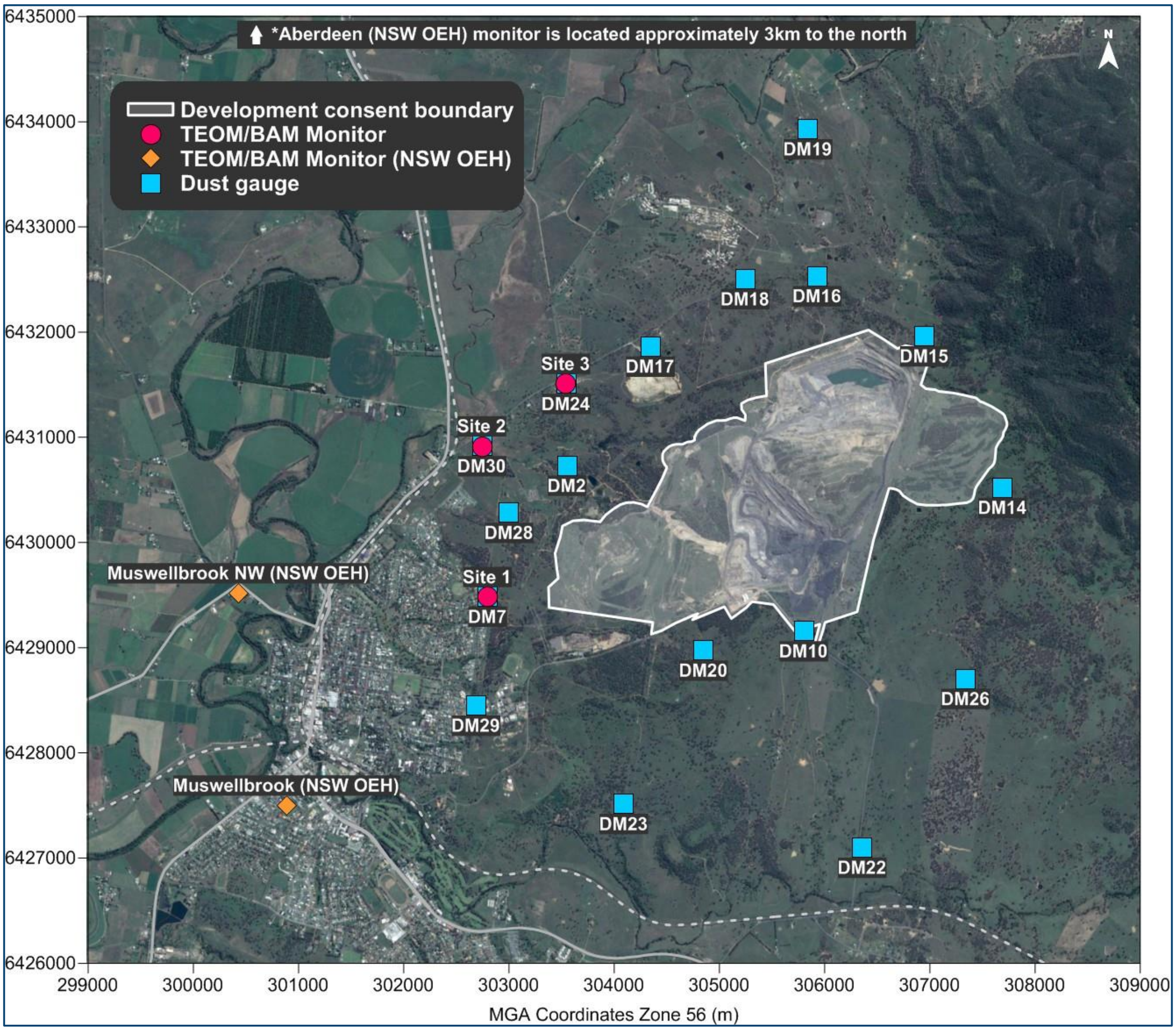

Figure 4-5: Monitoring locations

4.3.1 PM_{10} monitoring – TEOMs and BAM

Ambient PM_{10} monitoring using TEOMs and BAM is conducted by MCM and NSW OEH at various locations surrounding the mine. The location of each of these monitors is shown in **Figure 4-5**. The monitoring data includes all emission sources in the vicinity of MCM.

4.3.1.1 MCM

A summary of the available data collected from MCM monitors from January 2013 to December 2015 is presented in **Table 4-3**. Recorded 24-hour average PM_{10} concentrations are presented graphically in **Figure 4-6**.

A review of **Table 4-3** indicates that the annual average PM_{10} concentrations for each of the monitoring stations were below the relevant criterion of 30µg/m^3 for all relevant years. The levels are less than two thirds of the criteria, indicating that overall, per the NSW OEH pollution index that air quality in the area is good in relation to long term PM_{10} dust levels.

Table 4-3: Summary of PM_{10} levels from MCM TEOMs and BAM monitoring (µg/m³)

Location	Annual average			Maximum 24-hour average		
	2013	2014	2015	2013	2014	2015
Site 1	16.6	17.2	14.9	48.2	43.8	65.3
Site 2	17.3	17.6	14.9	120.7	50.9	61.7
Site 3	18.6	15.3	13.7	55.6	48.2	59.9

With respect to the short-term concentrations, the maximum 24-hour average PM_{10} concentrations recorded at the monitors were on occasion above the 50µg/m^3 criterion (see **Figure 4-6**). It can be seen from **Figure 4-6** that PM_{10} concentrations follow a seasonal trend and are nominally highest in the spring and summer months. The warmer weather at these times may raise the potential for drier ground conditions that increase the occurrence of windblown dust, bushfires and pollen levels.

For the period of review, the Site 1 monitor recorded one day where the measured 24-hour average PM_{10} concentration was above 50µg/m^3, occurring on 6 May 2015. On this day, elevated levels were also recorded at the Site 2 and Site 3 monitors and other surrounding monitoring stations. The elevated dust levels was a result of a state-wide dust storm that originated from the Victorian Mallee and southern NSW regions (**NSW OEH, 2015**).

The Site 2 monitor recorded seven days of elevated 24-hour average PM_{10} levels during August to November 2013, one day in November 2014 and one day in May 2015 (see above). This monitor is located in the Sandy Creek area where road work activities conducted by the Muswellbrook Shire Council were undertaken in 2013-2014 (**MCC, 2014**) and earthworks were stockpiled next to the monitor between August and September 2014 (**MCC, 2015a**). The effect of these activities were identified as the likely cause of the measured PM_{10} results at the monitor.

The Site 3 monitor recorded three days of elevated 24-hour average PM_{10} levels in August and October 2013 and in May 2015 (see above). The likely cause of the recorded elevated levels was found to be associated with crushing activities taking place at the Muswellbrook quarry in 2013-2014 (**MCC, 2014**), located to the east of the monitoring location.

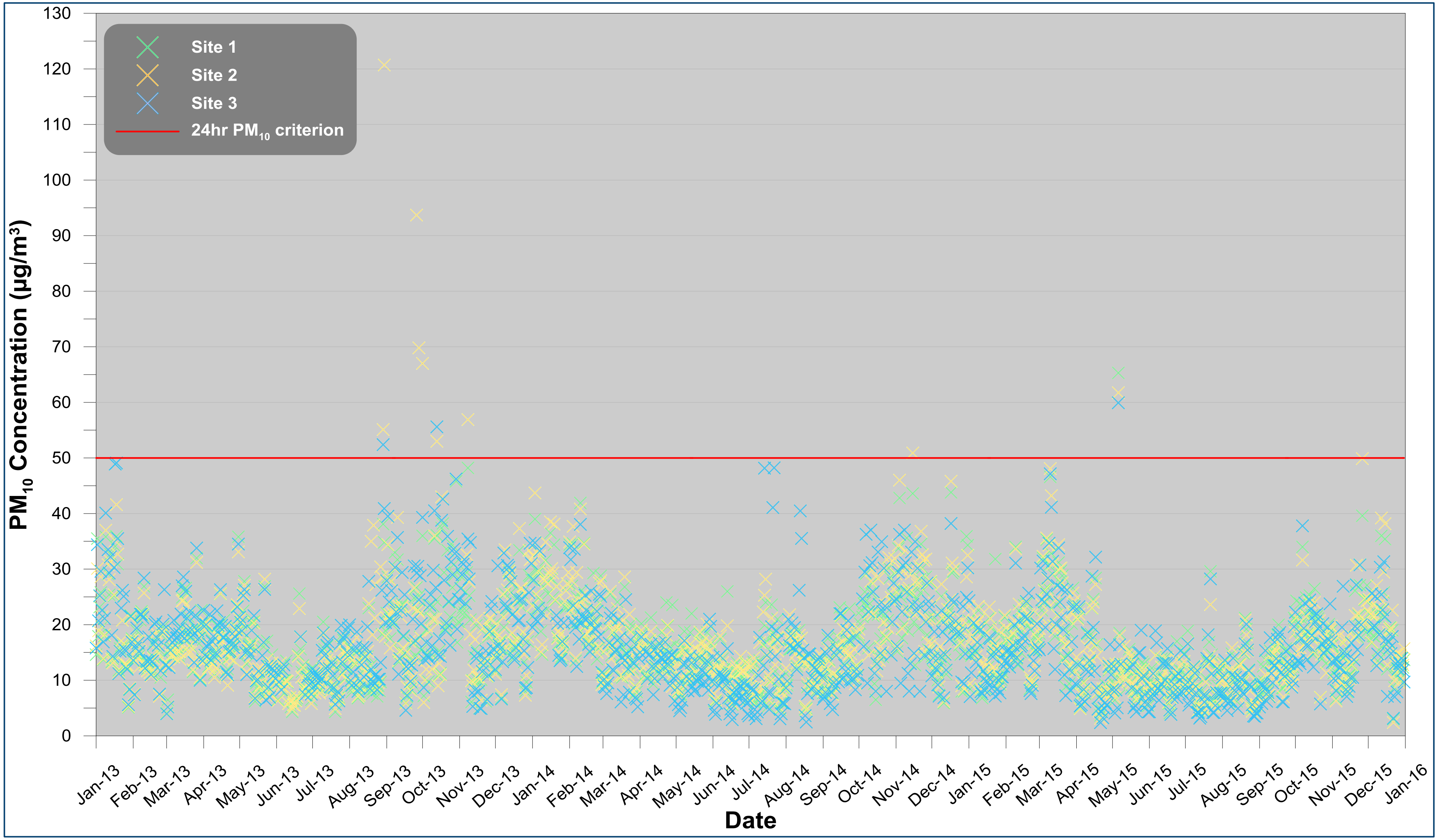

Figure 4-6: TEOMs and BAM 24-hour average PM_{10} concentrations at MCC monitors

4.3.1.2 NSW OEH

A summary of the available data from the NSW OEH monitoring stations is presented in **Table 4-4**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-7**.

A review of **Table 4-4** indicates that the annual average PM_{10} concentrations for each monitoring station were below the relevant criterion of 30µg/m^3. The maximum 24-hour average PM_{10} concentrations recorded at these stations were found to exceed the relevant criterion of 50µg/m^3 at times during the review period.

Table 4-4: Summary of PM_{10} levels from NSW OEH TEOM monitoring (µg/m^3)

Location	Annual average			Maximum 24-hour average		
	2013	2014	2015	2013	2014	2015
Muswellbrook NW (NSW OEH)	18.9	19.2	16.7	52.4	50.8	72.9
Muswellbrook (NSW OEH)	22.6	21.4	19.1	55.6	53.0	72.6
Aberdeen (NSW OEH)	17.3	17.9	15.2	42.7	50.4	64.8

The Ambient Air Quality NEPM standard for 24-hour average PM_{10} is a level of 50µg/m^3 with an allowance for five days above the standard in one year (refer to **Table 3-2**). The NEPM standards only apply to the larger population centres in the region and are not generally applicable for the smaller communities and the diagnostic sites of the UHAQMN. The ambient air quality monitoring data at these sites provide an indication of the potential local exposure and the effects of the local sources.

Figure 4-7 shows a relatively similar seasonal trend to the MCM monitors (shown in **Figure 4-6**). It is noted that there is some variation between the measured ambient data at the various sites and this is expected to be largely attributed to the proximity of these monitors to various local dust sources in the surrounding area.

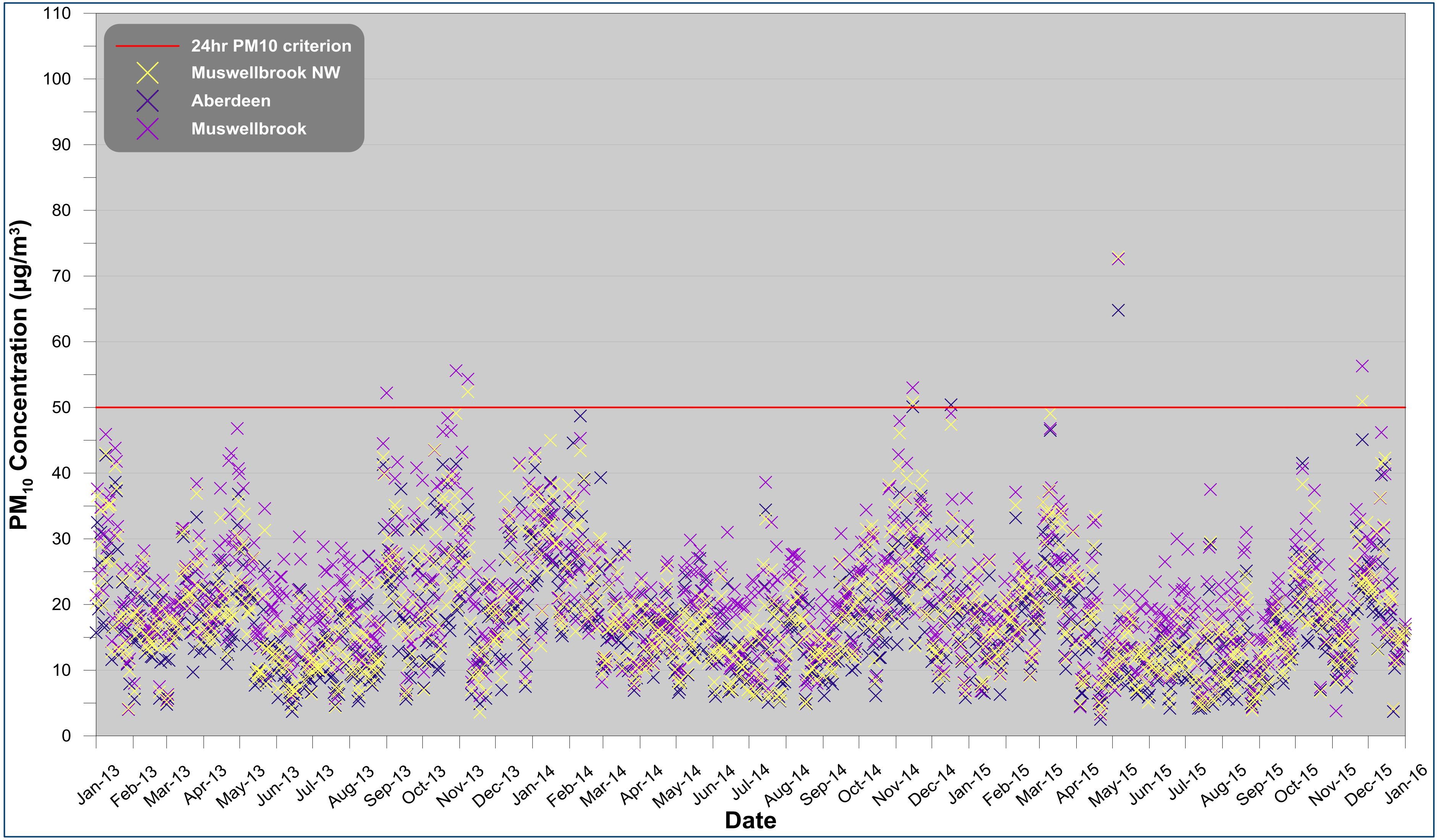

Figure 4-7: TEOM 24-hour average PM$_{10}$ concentrations at NSW OEH monitors

4.3.2 TSP monitoring

TSP monitoring data are available from the three HVAS monitors surrounding MCM (see **Figure 4-5**). A summary of the results collected between January 2013 and December 2015 at these stations is shown in **Table 4-5**. Recorded 24-hour average TSP concentrations are presented in **Figure 4-8**.

The monitoring data presented in **Table 4-5** indicate that the annual average TSP concentrations for each monitoring station were less than the criterion of 90µg/m³.

Figure 4-8 shows that the recorded 24-hour average TSP concentrations at each monitor are generally consistent and follow a similar seasonal trend to the PM_{10} concentrations with nominally highest levels during spring and summer periods which can be generally attributed to an increased potential of bushfires, dust storms, pollen and other localised sources and dust emissions as a result of mining activity. It should be noted that unlike PM_{10}, there is no applicable air quality criterion for 24-hour average TSP concentrations. The TSP dust metric is only assessed on an annual basis.

Table 4-5: Summary of annual average TSP levels from HVAS monitoring (µg/m³)

Location	2013	2014	2015
Site 1	33.0	39.5	29.8
Site 2	37.5	39.4	29.7
Site 3	38.2	51.4	32.9

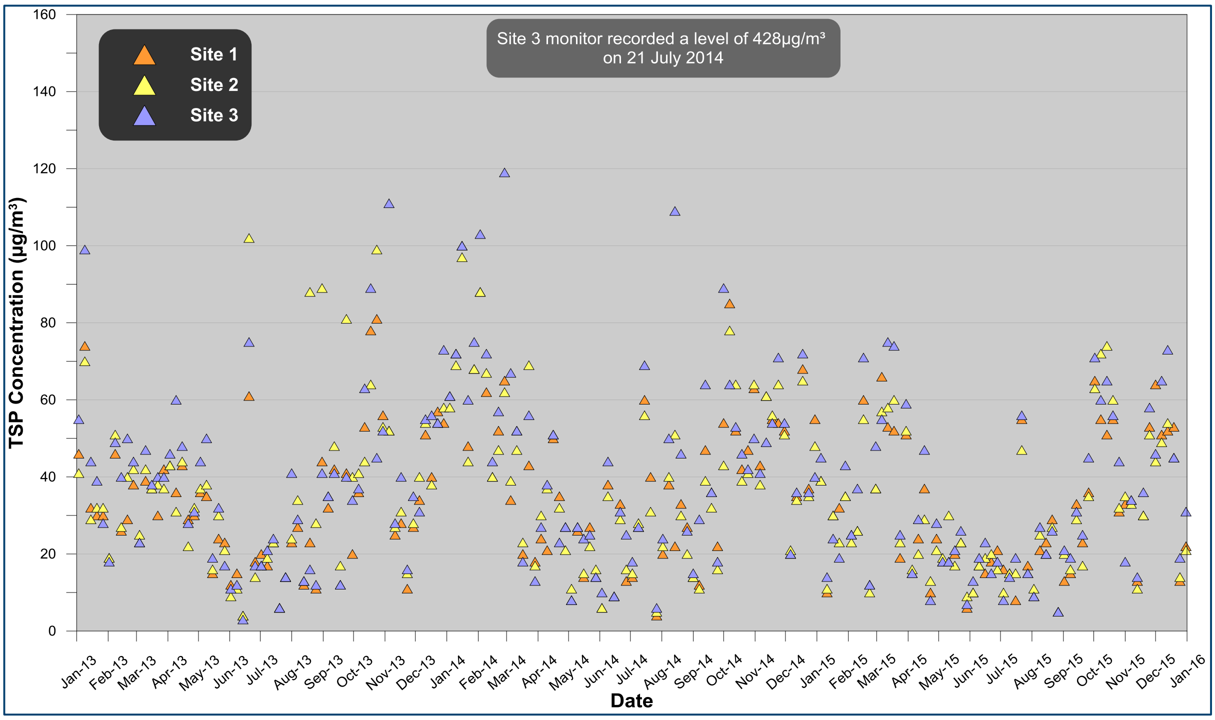

Figure 4-8: HVAS 24-hour average TSP concentrations (criteria is 90 µg/m³ as an annual average)

4.3.3 Dust deposition monitoring

The locations of the dust deposition monitoring sites reviewed in this assessment, are shown in **Figure 4-5**. **Table 4-6** summarises the annual average deposition levels at each gauge during 2013 to 2015.

Field notes accompanying the monitoring indicate that some of the samples were contaminated 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.

DM10 recorded an annual average insoluble deposition level above the criterion of 4g/m^2/month during 2013. All other gauges recorded an annual average insoluble deposition level below the criterion and in general, the air quality in terms of dust deposition is considered good.

There were no records of contamination of samples at DM10 during 2013 but the majority of the recovered samples at DM10 in 2014 and 2015 were contaminated. The high levels recorded at DM10 would occur because the monitor is located closest to the MCM mining operations. As shown in **Figure 4-5**, DM10 is located approximately 200 metres (m) from the coal stockpiles and likely influenced by activity at this location.

Table 4-6: Annual average dust deposition (g/m^2/month)

Location	2013	2014	2015
DM2	2.3	1.8	1.8
DM7	1.1	1.3	1.2
DM10	6.6	NR	NR
DM14	1.4	1.7	NR
DM15	1.6	1.0	1.1
DM16	1.5	1.2	1.4
DM17	2.5	2.9	2.5
DM18	1.5	1.6	1.6
DM19	2.1	1.9	1.5
DM20	1.7	NR	1.2
DM22	1.8	2.7	2.3
DM23	1.2	1.5	1.6
DM24	2.2	3.0	2.0
DM26	1.6	NR	1.7
DM28	NR	1.9	NR
DM29	2.1	1.5	1.4
DM30	1.3	1.3	1.2

NR = No result recorded as less than 75% of the data are available. Mostly due to contamination however some were for other reasons such as unrecovered samples due to wet weather conditions or inaccessibility of the sample, stolen/broken dust gauge, and/or decommissioning.

4.3.4 $PM_{2.5}$ monitoring

A summary of the $PM_{2.5}$ readings from the NSW OEH Muswellbrook monitoring station is presented in **Table 4-7**. The recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-9**.

Table 4-7 indicates that the annual average $PM_{2.5}$ concentrations for the Muswellbrook monitoring station were consistently above the NEPM advisory reporting standard of 8µg/m³ in 2013 to 2015. **Figure 4-9** also indicates that the 24-hour average $PM_{2.5}$ concentrations at Muswellbrook monitoring station were at times above the 24-hour advisory reporting standard of 25µg/m³ in 2013 to 2015.

A seasonal trend in $PM_{2.5}$ concentrations can be seen in **Figure 4-9**. The ambient $PM_{2.5}$ levels are likely to be governed by many non-mining background sources. A CSIRO study (**CSIRO, 2013**) that characterised fine particulate matter in the Hunter Valley region found that wood burning activities in the winter period make up an average of 62 per cent of the $PM_{2.5}$ levels recorded in Muswellbrook.

This indicates that urban wood heaters are the main contributor to the seasonal trend in the $PM_{2.5}$ levels observed in the data and that it is unlikely that the trends are due to mining activity as mining produces a relatively steady level of $PM_{2.5}$ particulate emissions over the entire year.

Table 4-7: Summary of $PM_{2.5}$ levels from NSW OEH BAM monitoring (µg/m³)

Location	Annual average			Maximum 24-hour average		
	2013	2014	2015	2013	2014	2015
Muswellbrook	9.4	9.7	8.7	36.6	27.4	31.2

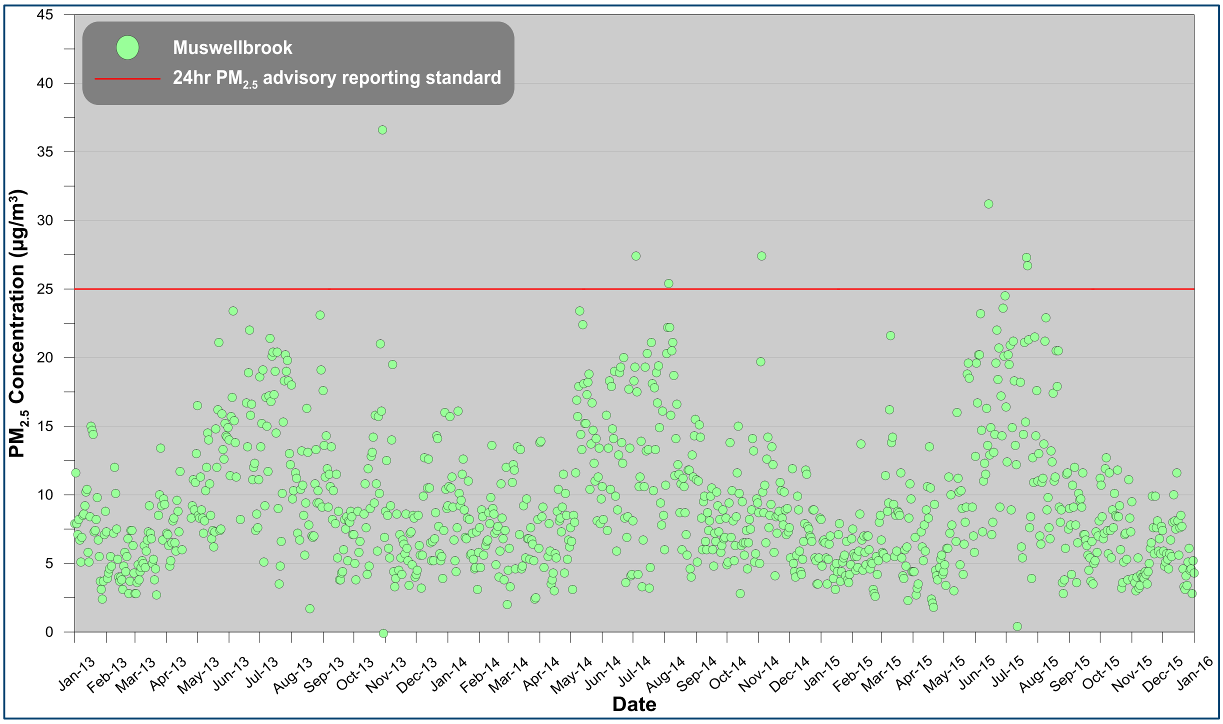

Figure 4-9: 24-hour average $PM_{2.5}$ concentrations at NSW OEH monitors

5 DISPERSION MODELLING APPROACH

5.1 Introduction

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

For this assessment the CALPUFF modelling suite is applied to dispersion modelling. 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 Environmental Corporation [TRC]**, **2011**).

5.2 Modelling methodology

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

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for 3D simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a three-dimensional gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the 3D meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

5.2.1 Meteorological modelling

TAPM was applied to the available data to generate a 3D upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 32deg26.5min south and 151deg1min east. The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

CALMET modelling used a nested approach where the 3D wind field from the coarser grid outer domain is used as the initial (or starting) field for the finer grid inner domains. 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 initial domain was run on a 100 x 100km grid with a 2km grid resolution and refined for a second domain on a 50 x 50km grid with a 1km grid resolution and further refined for a final domain on a 30 x 30km grid with a 0.3km grid resolution.

The 2014 calendar year was selected as the period for modelling the project. This was chosen based on a review of the long-term meteorological and ambient air quality conditions that found this period contains meteorological data representative of the prevailing conditions. Accordingly, the available meteorological data for January 2014 to December 2014 from nine nearby meteorological monitoring sites were included in the simulation.

Table 5-1 outlines the parameters used from each station. The 3D upper air data were sourced from TAPM output.

Table 5-1: Surface observation stations

Weather Stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
MCM weather station	✓	✓			✓	✓	✓
Muswellbrook NW (NSW OEH)	✓	✓					
Muswellbrook (NSW OEH)	✓	✓					
Aberdeen (NSW OEH)	✓	✓					
Scone Airport Automatic Weather Station (BoM) (Station No. 061363)	✓	✓			✓	✓	✓
Murrurundi Gap Automatic Weather Station (BoM) (Station No. 061392)	✓	✓	✓	✓	✓	✓	✓
Merriwa (Roscommon) Weather Station (BoM) (Station No, 061287)	✓	✓	✓	✓	✓	✓	✓
Paterson (Tocal) Automatic Weather Station (BoM) (Station No. 061250)	✓	✓			✓	✓	
Cessnock Airport Automatic Weather Station (BoM) (Station No. 061260)	✓	✓			✓	✓	✓

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

Local land use and detailed topographical information including local mine topography was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 5-1**.

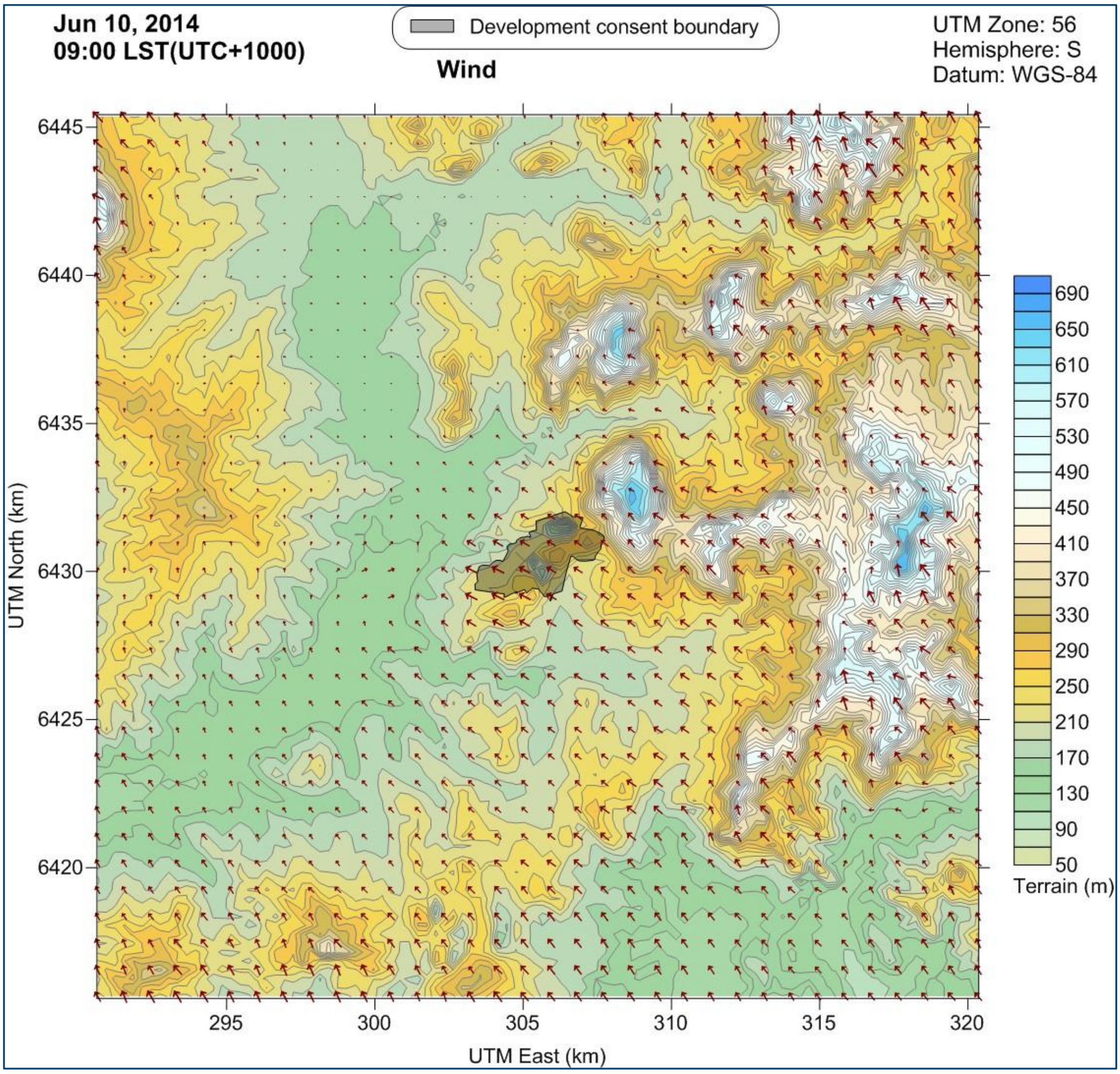

Figure 5-1: Example of the wind field for one of the 8,760 hours of the year that are modelled

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.

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** and **Figure 4-4**.

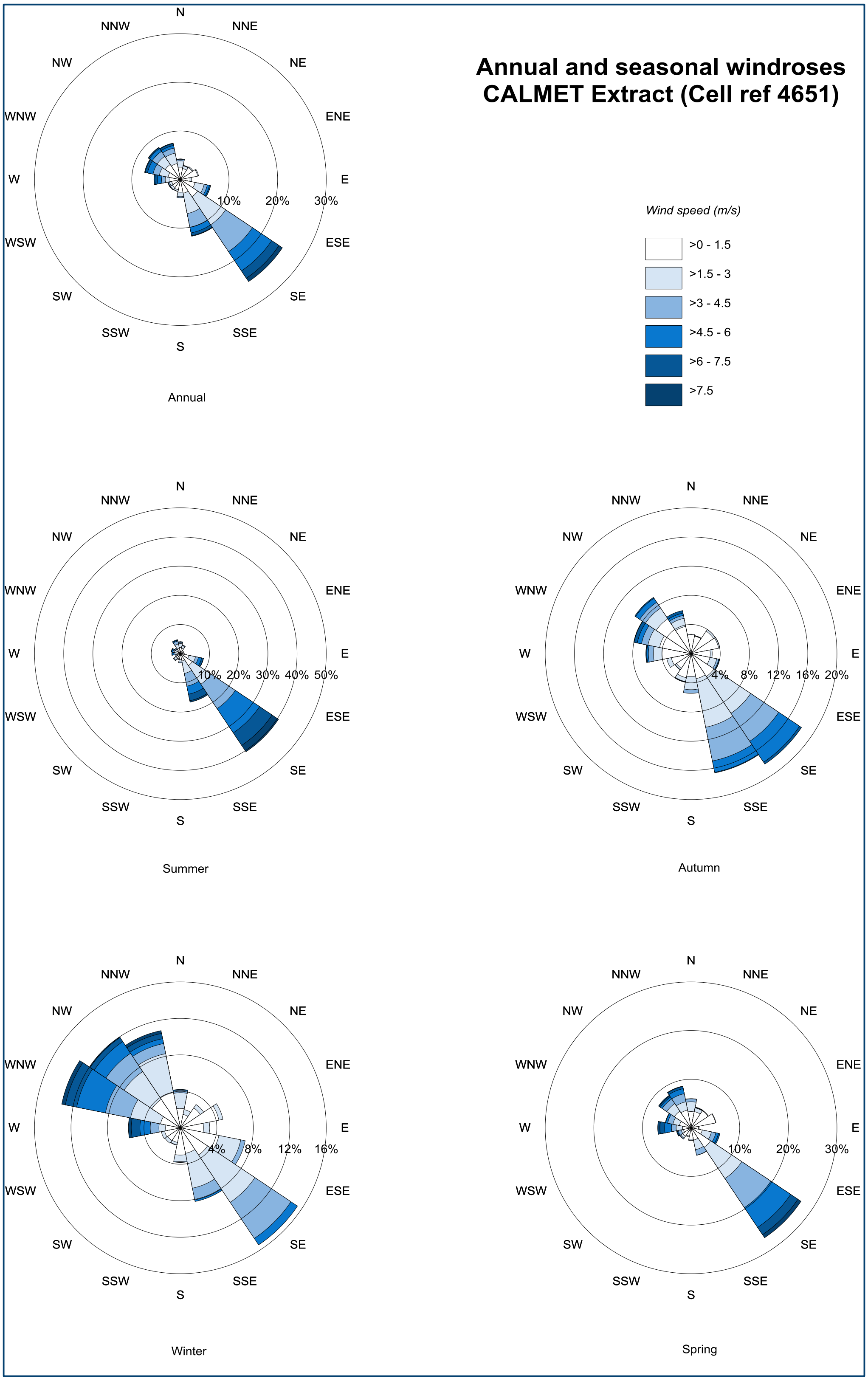

Figure 5-2: Windroses from CALMET extract (Cell ref 4651)

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.

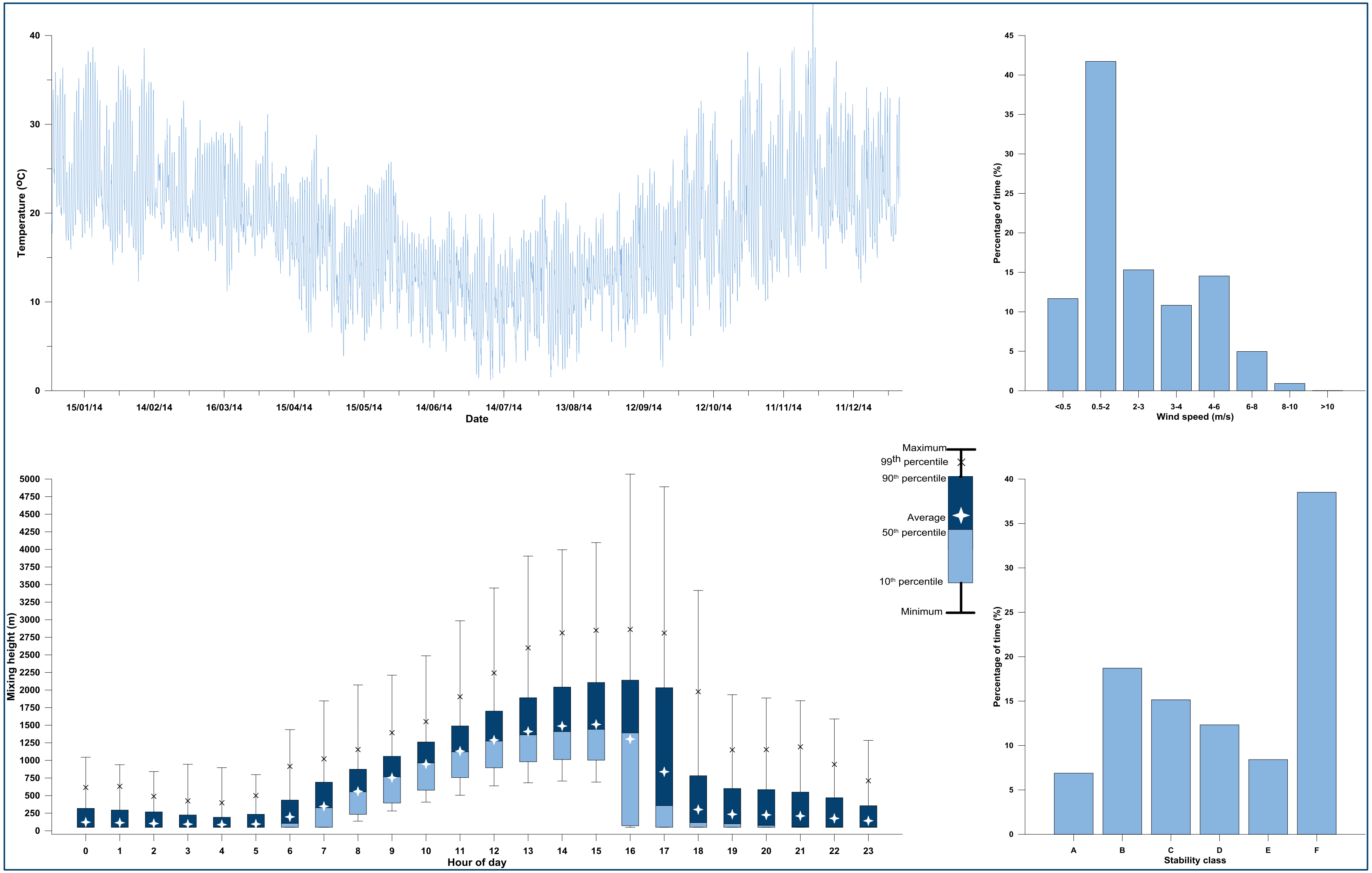

Figure 5-3: Meteorological analysis of CALMET extract (Cell ref 4651)

5.2.2 Dispersion modelling

CALPUFF modelling is based on the application of three particle size categories: fine particulates, coarse matter and the rest. The distribution of particles for each particle size category was derived from measurements in the **SPCC (1986)** study conducted for Hunter Valley mines and is presented in **Table 5-2**.

Table 5-2: Distribution of particles

Particle category	Size range	Distribution [1]
Fine particulates	0 to 2.5 µm	4.68% of TSP
Coarse matter	2.5 to 10 µm	34.4% of TSP
Rest	10 to 30 µm	60.92% of TSP

[1] Particle distribution sourced from **SPCC (1986)**

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 particularly wet years.

Each particle size category is modelled separately and later combined to predict short-term and long-term average concentrations for $PM_{2.5}$, PM_{10}, and TSP. Dust deposition was predicted using the proven dry deposition algorithm within the CALPUFF model. Particle deposition is expressed in terms of atmospheric resistance through the surface layer, deposition layer resistance and gravitational settling (**Slinn and Slinn, 1980** and **Pleim *et al.,* 1984**). Gravitational settling is a function of the particle size and density, simulated for spheres by the Stokes equation (**Gregory, 1973**).

CALPUFF is capable of tracking the mass balance of particles emitted into the modelling domain. For each hour CALPUFF tracks the mass emitted, the amount deposited, the amounts remaining in the surface mixed layer or the air above the mixed layer and the amount advected out of the modelling domain. The versatility to address both dispersion and deposition algorithms in CALPUFF, combined with the 3D meteorological and land use field, generally results in a more accurate model prediction compared to other Gaussian plume models (**Pfender *et al.*, 2006**).

5.3 Modelling scenario

The assessment considers a single conceptual mine plan year (scenario) to represent the modification. The scenario was chosen to represent potential worst-case air quality impacts in regard to the quantity of material handled in each year, the location of the operations and the potential to generate dust at the assessment locations.

The modelled scenario nominally represents year 2017. A visualisation of the conceptual mine plan is presented in **Figure 5-4**. Active mining occurs in the Open Cut 1 with overburden emplacement occurring in the Open Cut 2 void and behind the progression of mining in Open Cut 1. Run-of-mine (ROM) coal is hauled to the coal handling and preparation plant (CHPP) where it is processed as bypass or washed product and stockpiled. The final product is exported off-site via road haul trucks.

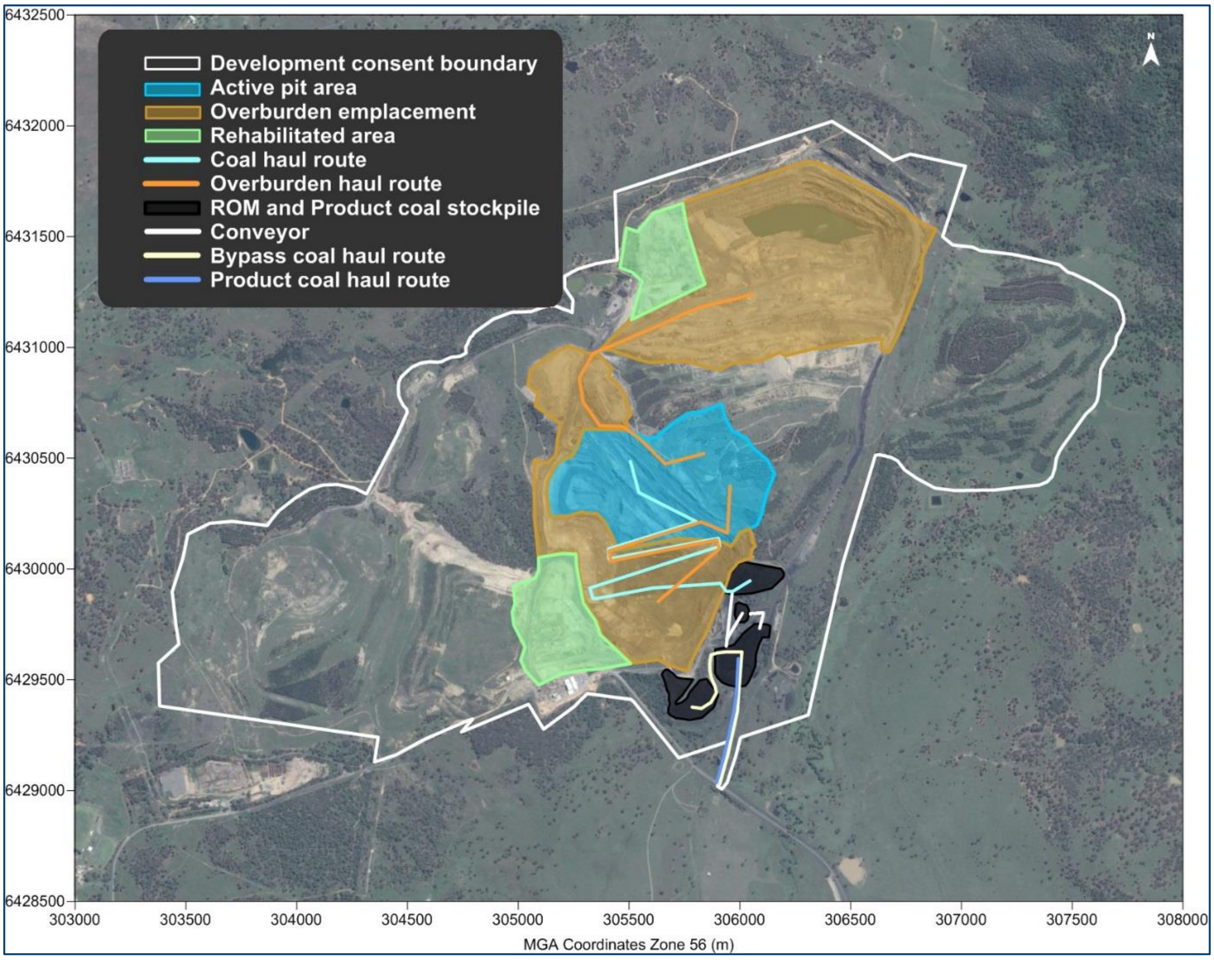

Figure 5-4: Conceptual mine plan for Year 2017

5.3.1 Emission estimation

For the chosen modelling 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 applied are considered the most applicable and representative for determining dust generation rates for the proposed activities. 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**. Detailed emission inventories and emission estimation calculations are presented in **Appendix C**.

The estimated dust emissions presented in **Table 5-3** are commensurate with a mining operation utilising reasonable and feasible dust mitigation where applicable representing best practice management for this project. Further details on the dust control measures applied for the proposed modification are outlined in **Section 9.1**.

Table 5-3: Estimated emission for the proposed modification (kg of TSP)

Activity	Year 2017
TS - Topsoil removal	145
TS - Loading topsoil to haul truck	3
TS - Hauling topsoil to emplacement area	53
TS - Emplacing topsoil at emplacement area	3
OB - Drilling	821
OB - Blasting	1,634
OB - Loading OB to haul truck	12,619
OB - Hauling to emplacement area	197,882
OB - Emplacing at area	12,619
OB - Dozers in pit	66,835
OB - Dozers on dump and rehab	66,835
CL - Dozers ripping/pushing/clean-up	17,388
CL - Loading ROM coal to haul truck	111,663
CL - Hauling ROM to CHPP	30,050
CHPP - Unloading ROM to hopper	33,499
CHPP - Rehandle ROM at hopper	22,333
CHPP - Crushing	992
CHPP - Screening	1,818
CHPP - Loading Bypass to trucks at bin	196
CHPP - Hauling Bypass to stockpile	1,649
CHPP - Unloading Bypass at stockpile	44,741
CHPP - Loading Bypass to trucks for dispatch	44,741
CHPP - Hauling Bypass off-site	8,036
CHPP - Unloading at CHPP stockpile	209
CHPP - Loading Product to trucks	79
CHPP - Hauling Product to stockpile	1,446
CHPP - Unloading Product at stockpile	18,448
CHPP - Loading Product to trucks for dispatch	18,448
CHPP - Hauling Product off-site	7,006
CHPP - Dozer pushing ROM coal	3,109
CHPP - Dozer pushing Product coal	1,536
CHPP - Loading rejects	17
CHPP - Hauling rejects	3,460
CHPP - Unloading rejects	17
WE - Overburden emplacement areas	131,304
WE - Open pit	39,135
WE - ROM stockpiles	3,072
WE – Stabilised emplacement area	1,430
WE - Product stockpiles	3,256
Grading roads	60,385
Total	**968,910**

OB – overburden, CL – coal, CHPP – coal handling and preparation plant, WE – wind erosion

5.3.2 Emissions from other mining operations

In addition to the estimated dust emissions from the 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. This is evident when examining Annual Reviews for coal mines in the Hunter Valley which show in some cases that the mine's actual rate of activity is below the approved level of activity. **Table 5-4** summarises the emissions adopted in this assessment for each of the nearby mining operations.

Table 5-4: Estimated emissions from nearby mining operations (kg of TSP)

Mining operation	Year 2017
Mt Arthur (1)	23,329,928
Bengalla(2)	7,114,703
Drayton(3)	6,463,546
Mt Pleasant Project(2)	6,361,500

(1)PAEHolmes (2013)
(2)Todoroski Air Sciences (2013)
(3)Holmes Air Sciences (2007)

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 5.4**.

5.4 Accounting for background dust levels

All significant dust generating mining operations in the vicinity of MCM were included in the dispersion model to assess the total potential dust impact.

Many other, non-mining sources of particulate matter in the wider area would also contribute to existing ambient dust levels. These sources have not been individually accounted for in the dispersion modelling as it is impractical to do so; however an allowance for their contribution to total dust levels is required to fully assess the total potential impact.

For annual average predictions, the contribution to the prevailing background dust level of other non-modelled dust sources was estimated by modelling the past (known) mining activities (including Mt Arthur, Bengalla and Drayton coal mines) during January 2014 to December 2014 and comparing model predictions with the actual measured data from the corresponding monitoring stations. The average difference between the measured and predicted PM_{10}, TSP and deposited dust levels from each of the monitoring points was considered to be the contribution from other non-modelled dust sources, and was added to the future predicted values to account for the background dust levels (not explicitly in the model and arising from the numerous small or distant, non-modelled dust sources).

This approach is preferable to modelling the proposed modification alone and adding a single constant background level at all points across the modelling domain to estimate cumulative impacts. This is because the approach includes modelling of other major sources (i.e. mines) that more reliably represent the higher dust levels near such sources, and also accounts for the seasonal and time varying changes in the background levels that arise from these major dust sources. In addition, to account for any underestimation due to not including every source (as it is not possible to reasonably do so), the relatively smaller contribution arising from the other non-modelled dust sources, as determined above, was added to the results to obtain the most accurate predictions of future cumulative impacts across the modelled domain.

Using the approach described above, the estimated annual average contribution from other non-modelled dust sources is presented in **Table 5-5**.

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

Dust metric	Averaging period	Unit	Estimated contribution
TSP	Annual	µg/m³	31.7
PM_{10}	Annual	µg/m³	10.3
Dust deposition	Annual	g/m²/month	1.6

It is important that the above values are not confused with measured background levels, background levels excluding only the proposed modification, or the change in existing levels as a result of the proposed modification. The values above are not background levels in that sense, but are the residual amount of the background dust that is not accounted for directly in the air dispersion modelling.

Due to the elevated $PM_{2.5}$ levels at the Muswellbrook OEH monitor which appear to be significantly influenced by local anthropogenic sources occurring during the colder months, i.e. wood heater emissions (**Todoroski Air Sciences, 2014**), a different approach is applied. The $PM_{2.5}$ contribution from non-modelled dust sources is taken from the estimated non-modelled sources contribution for the cumulative impact assessment of Mt Arthur, Bengalla and Mangoola Coal Mines using monitoring data from other stations (**Todoroski Air Sciences, 2014**) not influenced by wood heater emissions. The annual average $PM_{2.5}$ level to account for non-modelled other sources applied in this assessment is 2.9µg/m³.

6 DISPERSION MODELLING RESULTS

The dispersion model predictions for the assessed scenario are presented in this section. The results presented include those 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 6.2.**

Each of the assessment 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 for the assessed year in **Appendix D**.

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

To account for sources not explicitly included in the model, and to fully account for all cumulative dust levels, the unaccounted fractions of background dust levels (which arise from the other non-modelled sources), were added to the annual average model predictions as described in **Section 5.4**.

6.1 Summary of modelling predictions

The air dispersion modelling predictions indicate that only one assessment location is predicted to exceed relevant assessment criteria. **Table 6-1** summarises the modelled predictions for the assessment location.

Table 6-1: Summary of modelled predictions

Assessment location	Incremental - maximum 24-hour average PM_{10} concentration (µg/m³)	Number of days predicted to exceed 50µg/m³
R25	61	3

Based on guidance provided in the NSW Government's Voluntary Land Acquisition and Mitigation Policy (**NSW Government, 2014**), assessment location R25 would be afforded voluntary mitigation rights. Mitigation measures afforded may include the installation of air conditioning, insulation, first flush water systems and cleaning of rainwater tanks.

All other assessment locations are predicted to experience air quality levels below the relevant criterion for each of the assessed dust metrics.

Cumulative 24-hour $PM_{2.5}$ and PM_{10} impacts are assessed specifically in **Section 6.2**.

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

The NSW EPA contemporaneous assessment method was applied to examine the potential maximum total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} impacts for the Project.

The analysis has focussed on the assessment locations which are identified as the closest and most likely impacted assessment locations surrounding the modification.

There are three surrounding monitoring stations where suitable ambient monitoring data are available. The monitoring data collected at these sites cover the contemporaneous modelling period. The assessment of cumulative impacts uses the monitoring data from the closest monitor.

Figure 6-1 shows the location of each of these monitors in relation to MCM and surrounding assessment locations.

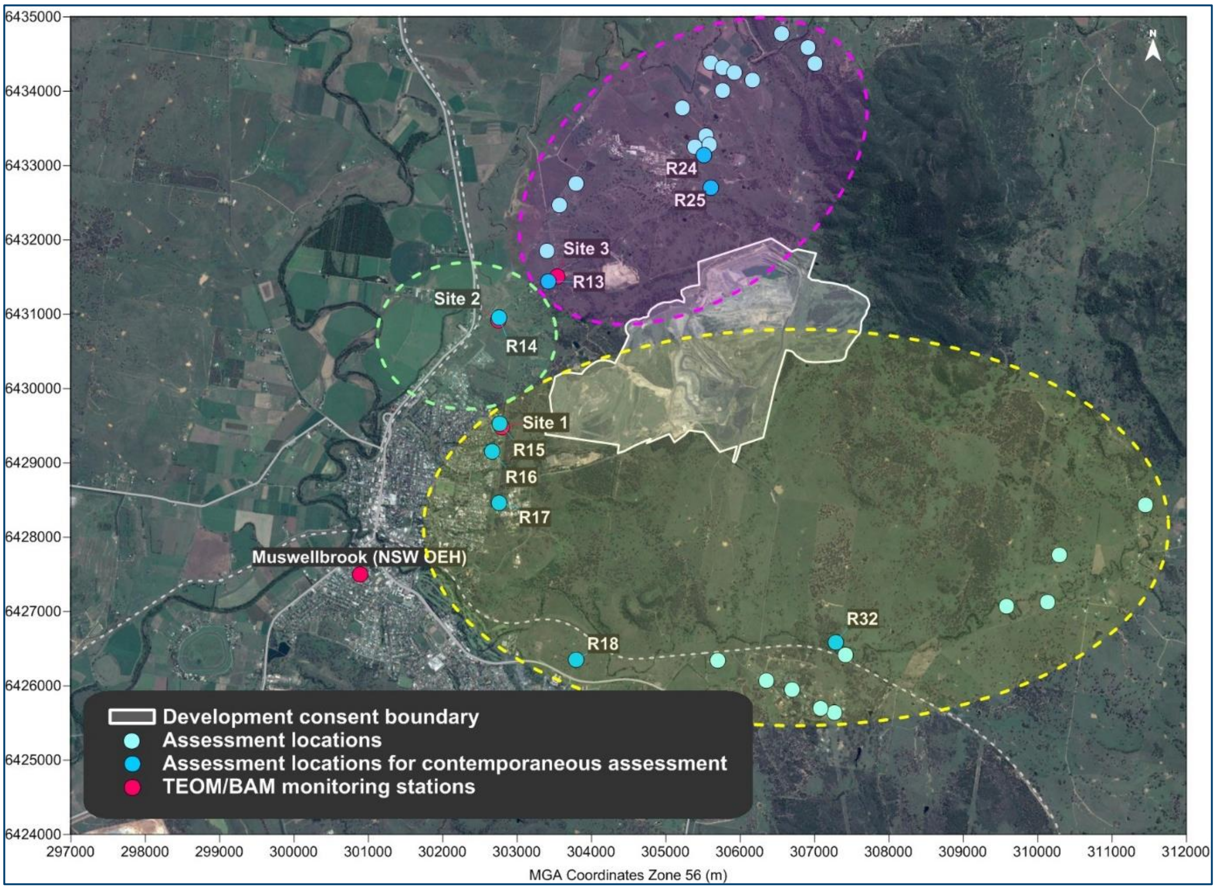

Figure 6-1: Locations available for contemporaneous cumulative impact assessment

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 DEC**, **2005**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts.

As shown in **Section 4**, maximum background levels have in the past reached levels near to the 24-hour average PM_{10} criterion level and the $PM_{2.5}$ advisory reporting standard. 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 2014 to December 2014 from the TEOM and BAM stations have been applied in the Level 2 contemporaneous 24-hour average $PM_{2.5}$ PM_{10} assessment and represent the prevailing measured background levels in the vicinity of MCM and surrounding assessment locations.

As the existing mine was operational during 2014, it would have contributed to the measured levels of dust in the area on some occasions. Due to this it is important to account for these existing activities in the cumulative assessment. Modelling of the actual mining scenario for the 2014 period (in which the weather and background dust data were collected) was conducted to determine the existing contribution to the measured levels of dust. The results were applied in the cumulative assessment to minimise potential double counting of existing mine emissions (as they would occur in both the measured data and in the predicted levels), and thus to make a more reliable prediction of the likely cumulative total dust level.

Table 6-2 provides a summary of the findings of the contemporaneous assessment at each assessment location. Detailed tables of the full assessment results are provided in **Appendix F**.

Table 6-2: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion depending on background level at monitoring sites

Assessment location	$PM_{2.5}$ analysis	PM_{10} analysis
R14	0	0
R15	0	0
R16	0	0
R17	0	0
R18	0	0
R24	0	2
R25	0	3
R32	0	0

The results in **Table 6-2** indicate that there is no likely potential for cumulative 24-hour average $PM_{2.5}$ impacts to occur, however there is some potential for cumulative 24-hour average PM_{10} impacts at the assessed locations.

Potential cumulative PM_{10} impacts are likely to be significant in the area immediately north of MCM (assessment locations 24 and 25) where it is predicted that there may be two to three additional days above the criterion.

All other assessed locations would be likely to experience no additional days above the criterion.

Further analysis of the predicted cumulative $PM_{2.5}$ and PM_{10} impacts at assessment locations R14, R15 and R25 are presented in **Figure 6-2** to **Figure 6-4**. 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 modification.

The yellow bars in the figures show the predicted additional levels due to the modification above background levels (i.e. the yellow sections of the bars indicate the amount of increased dust). The blue bars show the existing background levels, however the orange sections overlap the blue bars and these orange coloured bars indicate the reductions relative to the existing background levels that are predicted to occur. The top of the yellow (or bottom of the orange) bar indicates the predicted future cumulative level associated with the Project and background combined.

The results indicate that $PM_{2.5}$ levels would remain relatively similar as a result of the modification.

There is some potential increase to PM_{10} levels generally in the areas to the north of MCM with the area to the west and south remaining relatively similar. The predicted additional exceedance days occur when the background level is elevated and may have been influenced by activity occurring at the Muswellbrook Quarry (see **Section 4.3.1**).

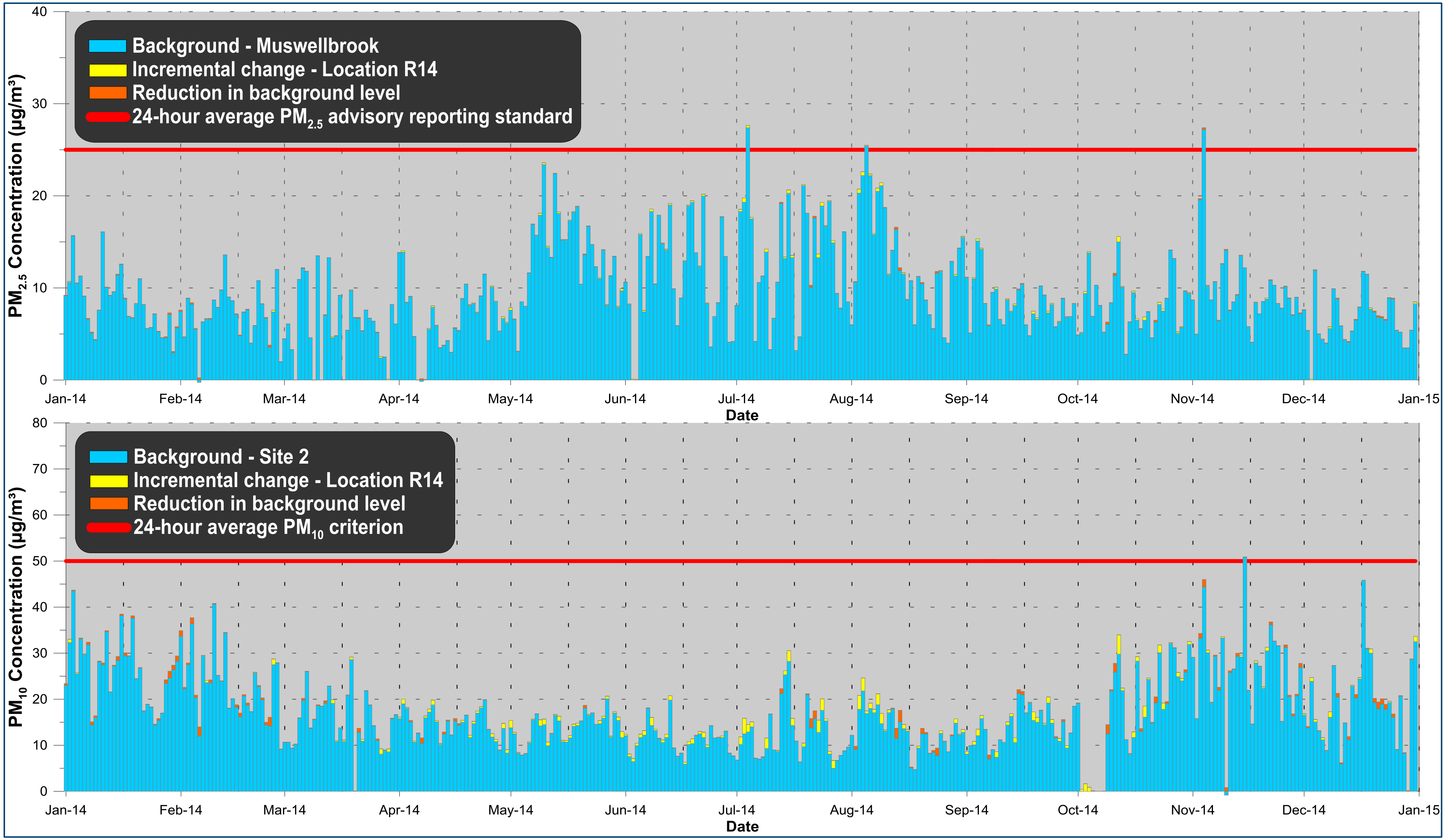

Figure 6-2: Predicted 24-hour average $PM_{2.5}$ and PM_{10} concentrations for assessment location R14 during 2017

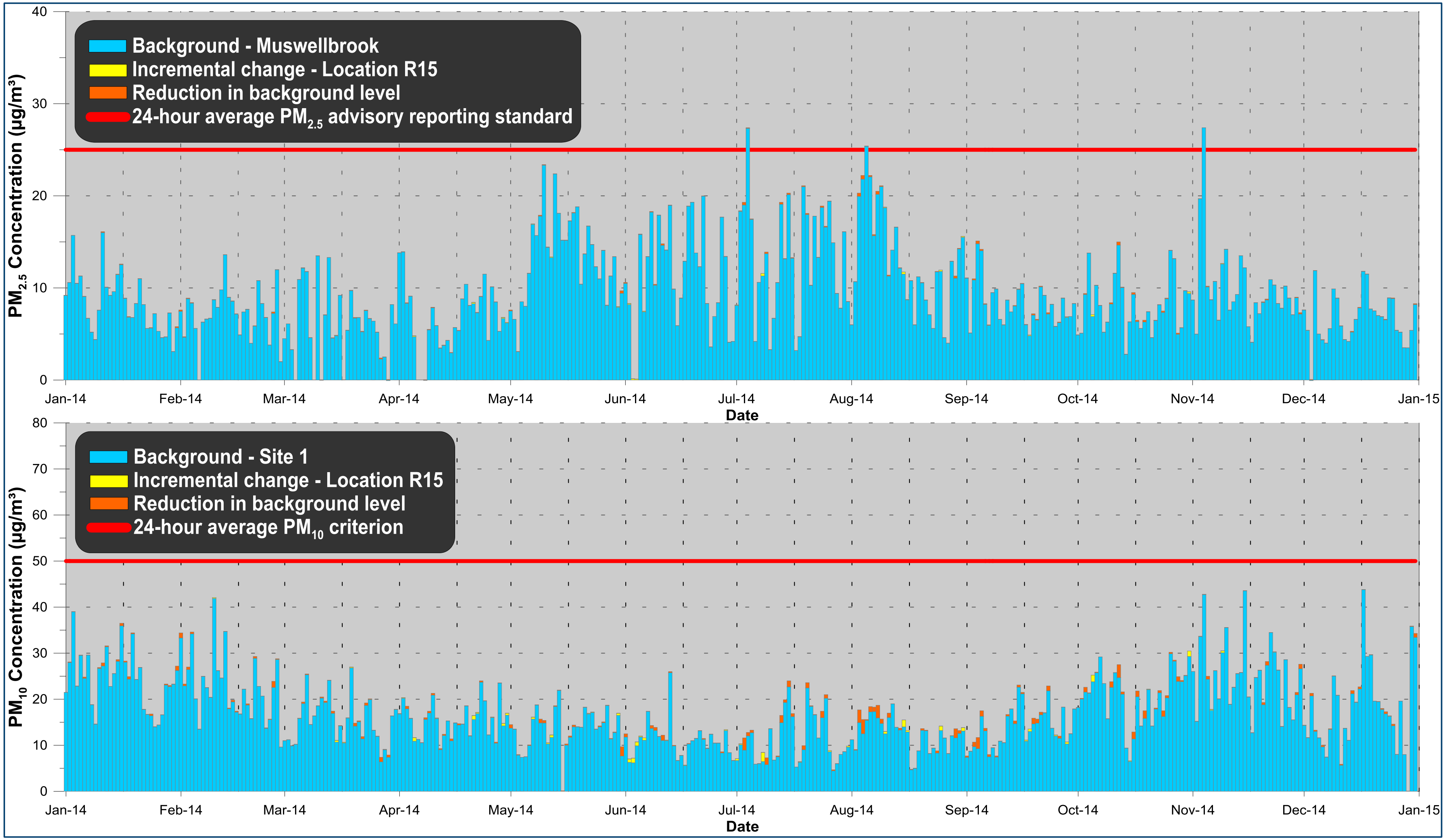

Figure 6-3: Predicted 24-hour average $PM_{2.5}$ and PM_{10} concentrations for assessment locations R15 during 2017

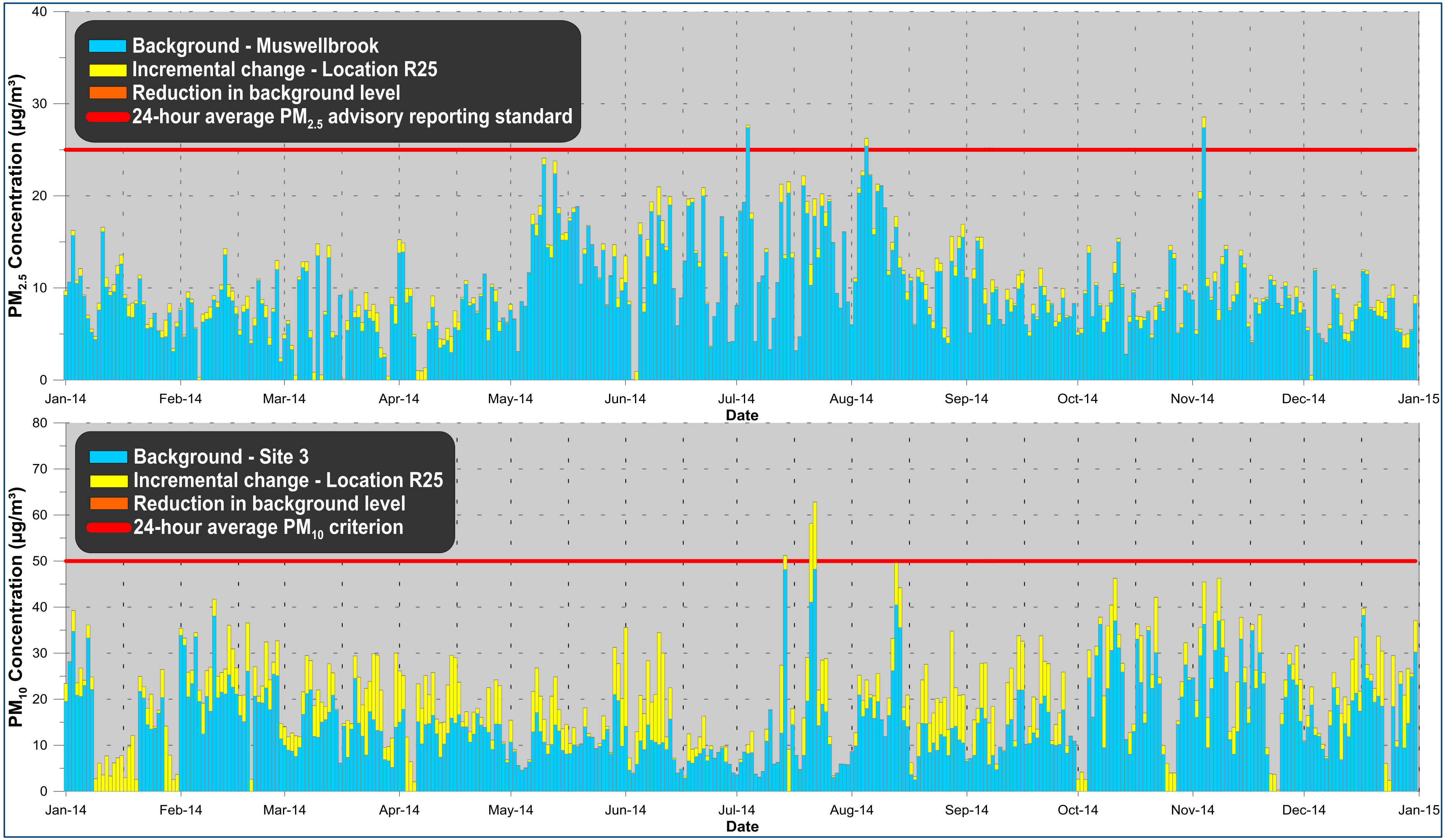

Figure 6-4: Predicted 24-hour average $PM_{2.5}$ and PM_{10} concentrations for assessment locations R25 during 2017

7 ASSESSMENT OF DIESEL EMISSIONS

Recent analysis by NSW EPA indicates that a large amount of diesel fuel is used in mining and, consequently, that there may be potential for impacts to arise due to the emissions from diesel powered equipment used during operations.

It is generally considered that the quantity of emissions generated from diesel powered equipment used for mining activity is too low to generate any significant off-site concentrations. This is due to consideration of the relatively small individual sources, the generally large distance between the sources and assessment locations, and the generally widely spread distribution of sources across the mine site.

It is noted that the available data do not indicate any likely issues in this regard. For example, NO_2 is a significant pollutant emitted from the combustion of diesel, yet NO_2 levels at the monitoring stations in the Hunter Valley are low relative to the criteria.

Figure 7-1 presents the maximum daily 1-hour average NO_2 concentrations from the Singleton, Muswellbrook, Beresfield and Randwick NSW OEH monitoring sites from January 2013 to December 2015. As shown, measured levels of NO_2 are relatively low compared to the criterion level and show a similar trend between stations. This would suggest that diesel emissions from coal mining operations are not a significant source of NO_2 as similar levels are experienced at other locations outside the Hunter Valley region.

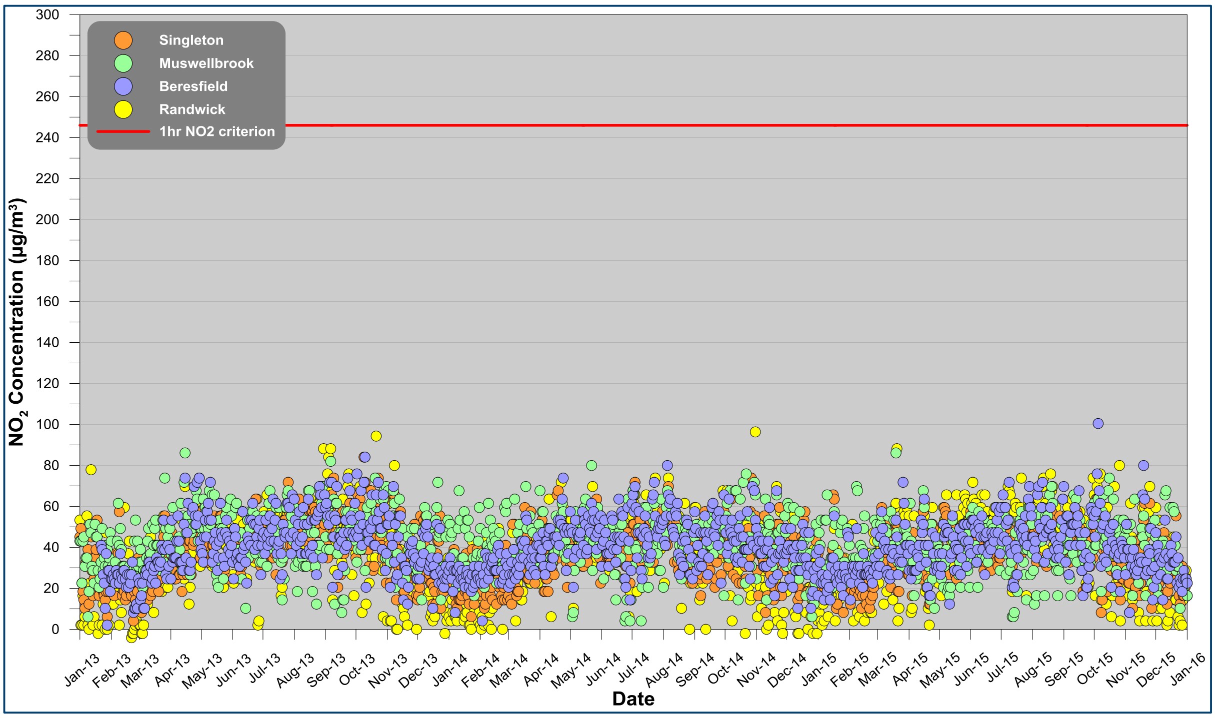

Figure 7-1: Daily 1-hour maximum NO_2 concentrations for NSW OEH monitoring stations

In addition, fine particulate (ie $PM_{2.5}$) is a significant pollutant emitted from diesel combustion. The *Upper Hunter Fine Particle Characterisation Study* (**CSIRO, 2013**) found that wood burning in winter made up an average of 62 per cent of the measured $PM_{2.5}$ in Muswellbrook and 38 per cent in Singleton.

Secondary sulphate and industry aged sea salt made the highest contribution during summer months and the sulphate levels were found to be comparable to other Australian locations. Vehicle and industry sources made up approximately 8 per cent and 17 percent in Muswellbrook and Singleton, respectively.

These data indicate that diesel emissions at the monitoring locations are not likely to be a major issue, however it is recognised that the locations at which these data were collected are some distance away from coal mines.

It should be noted that the contribution of emissions of fine particulate from diesel combustion in mining equipment is already included within the assessment of mine dust presented in **Section 6**.

The key issue to note is that the amount of diesel emissions (NO_2 and fine particulate) due to the modification is not likely to significantly change as the diesel powered equipment and its hours of operations would essentially remain the same. The diesel emissions would generally move away from the majority of sensitive receptors located in the Muswellbrook township area with the proposed activity progressing in a north-easterly direction.

8 ASSESSMENT OF BLAST FUME EMISSIONS

NO_2 impacts from blasting are rare, but are possible when there are unforeseeable complications with a blast that cause high levels of NO_2 or dust emission, and when this occurs during unfavourable air dispersion conditions. This is the case for any blast at any mine, and has always been the case for the existing mine.

There is no specific or unusual circumstance that would arise due to the proposed modification that would lead to any changes in this situation or which would alter the current, potential risk of impacts from blasting.

As blasting is currently permitted, and there has been no significant incident in this regard at this site, it is expected that this would remain the case in the future.

However, it is also reasonable to ensure that all reasonable and feasible blast management measures are being applied to ensure that blasting activities continue to be managed in a manner that would minimise the risk of impacts arising in the future.

8.1 General outline of blast management

The potential effects from blasting activities are generally managed by scheduling the blast to times when there would be a low risk of impact, for example, when winds blow away from receptors. Blast operators make the final decision to blast based on the available information, including available forecasts.

The decision of whether to initiate a blast at any given time will generally need to balance many potentially conflicting factors; for example water ingress or a further increase in the sleep time will increase the risk of a high emissions event, thus waiting too long for ideal air dispersion conditions to occur may present an unacceptable level of risk, and thus the blast may be initiated under less than ideal weather conditions.

On the other hand, a dry blast with low scope for any degradation of the explosive over time or low potential to lead to any elevated emissions might be delayed if it appears that air dispersion conditions would soon improve significantly.

Occasionally safety concerns may also arise, and may require a blast to be detonated under less than ideal (environmental) conditions.

A major consideration at MCC is whether the blast is deemed to be a "hot shot". For these types of blasts, special considerations and planning are applied in an effort to minimise the overall risk of the blast.

Specific control measures implemented at MCM, are outlined below.

8.2 Management of potential air quality impacts from blasting

Air quality impacts of blast operations at MCM are managed under MCC Blast-Vibration Management Plan (BVMP) (**MCC, 2015b**). The purpose of the BVMP is to manage blasting operations so they comply with all relevant requirements particularly noise, overpressure, vibration, blast fume and dust effects.

Measures for drill and blast activities are outlined in the BVMP to assist with the prevention of fume and odours generation. This includes a focus on drill-hole placement, management of surface and ground water in the drill holes, loading of explosive material and stemming material to contain the blast.

The BVMP also applies a pre-blast environmental checklist procedure to guide operators on the suitability of various factors including the current weather conditions for blasting. The BVMP takes into consideration meteorological factors such as wind speed and direction which can affect the scale of potential blast impacts at assessment locations.

8.3 Potential for blast fume emissions

As the site operations have not experienced any recent issues related to air quality impacts from blasting, it is anticipated that the modification would not have any issues related to air quality impacts from blasting.

The existing blast management measures have a demonstrated history of being effective in managing the potential for air quality impacts and are expected to continue to be used. As the mining activity generally moves away from Muswellbrook, the potential for impacts would also reduce.

9 AIR QUALITY MANAGEMENT

9.1 Dust mitigation and management

MCC has documented their management of dust in the Dust Management Plan (DMP) (**MCC, 2015c**).

The possible range of air quality mitigation measures that are feasible and can be applied to achieve a standard of mine operation consistent with current best practice for the control of dust emissions from coal mines in NSW has been carefully considered in the implementation of such measures at MCM.

The measures applied to MCC reflect those outlined in the recent 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.

Dust management practices are in place at MCM that respond to government and community concerns regarding the impacts of mining on regional air quality in the Hunter Valley.

These measures include implementation of management techniques to reduce dust, and staff guidance for the visual identification and hence control of dust. Other measures include alarms based on monitoring to manage potentially rising dust levels and to help prevent or reduce potential impacts. Operational measures such as enforcing a cessation of particular operations during periods of high dust provide additional assistance in reducing the potential dust impacts.

The dust controls currently implemented at MCM were considered in this assessment. Where applicable these controls have been applied in the dust emission estimates as shown in **Appendix C**.

9.1.1 Proactive dust mitigation strategies

The proactive operational dust mitigation strategies implemented at MCM are primarily based on forecast weather data and modelling. This information provides an indication the potential extent of air quality impacts into the future and would be primarily used as an alert of possible elevated air quality levels due to MCM.

The forecast air quality predictions, up to 48 hours in advance, are reviewed daily and used to plan ahead for periods of potential impact, allowing time to prepare and better respond to any actual issue based on measured data and to react quickly where conditions or performance deteriorates due to the changing weather conditions.

9.1.2 Reactive dust mitigation strategies

The reactive operational dust mitigation strategies implemented at MCM to minimise the potential for short term dust impacts have not been explicitly included in the dispersion modelling predictions.

These measures are effective in managing short term dust levels by utilising the maximum availability of dust suppression equipment and deferring or cessation of particular activities.

The monitoring data presented in **Section 4.3** indicate that MCM has been generally in compliance with NSW EPA air quality criteria. Where exceedances have occurred, these have typically been associated with external factors and not MCM activities.

The implementation of reactive operational dust mitigation strategies in the dispersion modelling would likely demonstrate that the short term PM_{10} impacts predicted for assessment location R25 could be effectively managed. The predicted 24-hour average PM_{10} concentrations for the modification are conservative in this regard and would overstate the actual impact in reality.

9.1.3 Monitoring network

The current MCM air quality monitoring network is illustrated in **Figure 4-5**. The network of monitors surround the mine operation and are generally positioned in areas representative of the surrounding assessment locations that may have potential effects from the mining operations. This network is augmented by ambient air quality monitoring stations operated by the NSW OEH and provides an extensive network of stations from which to measure ambient air quality.

These monitors are used to assess compliance and also for providing advance warning of degrading air quality which serves to prompt appropriate actions.

On the basis of the predicted modelling results in this assessment, it is recommended that a monitor be located to the north of MCM, near assessment location R25. This monitor would provide an indication of the ambient air quality levels for this location and ensure the performance of the dust mitigation measures being applied at MCM are adequate. Based on the modelling predictions for the 24-hour average PM_{10} concentrations (refer to **Figure E-3** in **Appendix E**), there is little potential for air quality impacts at the Site 2 monitor. It is suggested that this monitor could be relocated to a position near assessment location R25.

To further supplement the MCM air quality monitoring network, it recommended that an air quality monitor be established to the south-southeast of the mine. It is suggested that a monitor near to R32 be considered. R32 represents the most affected location to the south-southeast of the mine. The final location would depend on landowner agreement and power supply options.

A monitor into the south-southeast would be useful to indicate the potential air quality effects arising from MCM when wind is blowing from the northwest and to estimate the air quality contribution due MCM at receptors to the north by acting as an upwind monitor under south-easterly wind flows.

9.2 Management of spontaneous combustion

Spontaneous combustion has been an issue at MCM over a number of years due to the reactive materials generating smoke and odour. To help manage spontaneous combustion, and as part of MCC's statutory requirements, a Spontaneous Combustion Management Plan (SCMP) (**MCC, 2015d**) has been prepared. The SCMP includes management measures to prevent and also control any spontaneous combustion.

MCC has participated in research programs such as the Australian Coal Association Research Program (ACARP) Project 1609 to identify the causes and thus develop prevention and control measures for spontaneous combustion. The research program found that the coal seams contain coal, carbonaceous shale including remnant coal and sulfide as pyrite (reactive overburden), which when exposed to oxygen oxidates in an exothermic reaction producing heat. Once hot enough, the reactive overburden spontaneously combusts. Further, because the spoil emplacement areas have historically been left uncovered rainfall infiltration has been found to move heat deeper into the spoil emplacement areas, acting as a catalyst resulting in widespread heating and spontaneous combustion.

The research program identified four strategies to manage the risk of spontaneous combustion:

- reduce the overall fuel (carbon) content;
- selectively place and rapid burial of spoil with a high carbonaceous content and remnant coal;
- building spoil emplacement areas in low lifts 5 – 15 m to increase compaction from traffic resulting in a smaller air filled void space, noting that air is required for oxidation; and
- cover spoil emplacement area batters with non-reactive spoil and compact wherever possible.

MCC has reduced the potential for spontaneous combustion at the mine by using the following strategies during mining:

- removing fuel by mining the coal and using the coal washery to increase the recovery of carbon shale and remnant coal;
- cooling heated areas with water before mining (water infusion);
- minimising areas of coal exposed to the air prior to mining;
- retaining 5 m of non-reactive overburden above workings to exclude oxygen from areas not immediately required for mining operations;
- sealing of decommissioned underground workings with clay or non-reactive overburden to exclude oxygen;
- rapidly burying of reactive overburden to minimise the time that it is exposed to oxygen and rainfall infiltration;
- selective placement of reactive overburden so that it is in the lower portions of the spoil emplacement areas for deep burial (encapsulation) to exclude oxygen and rainfall infiltration; and
- limiting spoil emplacement area lifts, under normal conditions, to a height of 10 – 15 m to exclude oxygen and rainfall infiltration.

9.2.1 Project measures in managing spontaneous combustion

The modification would enable progression of mining operations in Open Cut 1, and subsequently extend the life-of-mine. Construction of the spoil emplacement areas would continue sequentially in the void of Open Cut 1, as well as into Open Cut 2, with consideration given to reactive overburden identification, management and placement to reduce the potential for future spontaneous combustion risk.

Reactive overburden would be identified during mining of the modification area by:

- examining the surface for any physical effects of spontaneous combustion such as brown or dying vegetation and increased surface temperature;
- using infra-red photography, where appropriate, to show areas of increased temperature;
- measuring borehole temperatures; and
- measuring ground surface temperatures.

If an increased risk of spontaneous combustion is identified during the mining of the modification area, then it would be managed by the following addition management strategies to those already described for the current operation:

- any blast hole which shows signs of spontaneous combustion or is allowing air into areas of spontaneous combustion would be bagged off or backfilled;
- water infusion or water sprays would be used in accordance with the relevant safe work procedure;
- coal subject to active spontaneous combustion would be removed, and spread out on the ground surface to allow it to cool; and
- loose heaps of coal that are subject to spontaneous combustion would be spread out and compacted with a dozer and saturated with water from the water cart.

The modification would not disturb the western spoil emplacement area in Open Cut 1, and therefore would not increase the potential risk of spontaneous combustion being reactivated at this location. After rehabilitation, exposed coal and reactive overburden in Open Cuts 1 and 2 would be encapsulated by the final landform, which is to be formed by partially backfilling the voids and dozing the slope angle down to 14 degrees. Coal and reactive overburden would be encapsulated in the void walls by at least 10m of non-reactive overburden. Open Cut 1 and Open Cut 2 voids would act as groundwater sinks, and as such groundwater recharge in both voids would flood the base of the voids saturating exposed coal and reactive overburden in the walls of the void. Water saturation would fill the voids in the material and reduce oxygen thereby removing the potential for spontaneous combustion.

The risk of spontaneous combustion in the final landform would be further managed by:

- selective placement of reactive overburden so that it is in the lower portions of the spoil emplacement areas for deep burial (encapsulation) to exclude oxygen and rainfall infiltration, noting that some of the reactive overburden will be flooded by groundwater recharge into the void;
- limiting spoil emplacement area lifts, under normal conditions, to a height of 10-15m to exclude oxygen and rainfall infiltration; and
- encapsulating reactive overburden and remnant coal in non-reactive overburden.

10 GREENHOUSE GAS ASSESSMENT

10.1 Introduction

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

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

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

10.2 Greenhouse gas inventory

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

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

"*...from sources within the boundary of an organisation as a result of that organisation's activities*" (**Department of the Environment, 2015a**).

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

"*...emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation*" (**Department of the Environment, 2015a**).

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

Scope 3 emissions can often result in a significant component of the total emissions inventory; however, these emissions are often not directly controlled by the operation. These emissions are understood to be considered in the Scope 1 emissions from other various organisations related to the mine. The primary contribution of the Scope 3 emissions from the modification occurs from the transportation of the product coal and from the end use of the product coal.

There are significant practical difficulties and anomalies in accounting for Scope 3 emissions especially for the downstream use of coal. There is also no legislative or policy requirement that downstream GHG emissions from the combustion of coal should be included in the environmental assessment. Also, the

GHG Protocol (**World Business Council for Sustainable Development** [**WBCSD] & World Resource Institute [WRI], 2004**) considers Scope 3 reporting as optional and can result in double counting of emissions among organisations and/or projects.

Due to the difficulties associated with estimated Scope 3 emissions, it has not been considered in this assessment.

10.2.1 Emission sources

Scope 1 and 2 GHG emission sources identified from the operation of the modification are the on-site combustion of diesel fuel, petrol fuel, petroleum based greases and oils, emissions of methane and carbon dioxide from gaseous fuels and on-site consumption of electricity.

Scope 3 emissions have been identified as resulting from the purchase of diesel, petrol, petroleum based greases and oils, electricity for use on-site, the transport of product to its final destination and the final use of the product.

Estimated quantities of materials that have the potential to emit GHG emissions associated with Scope 1 and 2 emissions for the proposed modification have been summarised in **Table 10-1** below. The estimated quantities of materials for the Year 2017 were chosen to be presented as they represent the maximum ROM coal production for all the years of the modification.

Table 10-1: Summary of annual quantities of materials estimated for the modification

Period	ROM coal (tonnes)	Diesel (Stationary) (kL)	Biodiesel (Stationary) (kL)	Diesel (Transport) (kL)	Gasoline (Transport) (kL)	Petroleum based oils (other than for use as fuel) (kL)	Petroleum based greases (kL)	Electricity (MWh)
2017	1,652,954	2,899	6,720	224	29	74	6	5,422

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the modification, emission factors obtained from the NGA Factors (**Department of the Environment, 2014**) and other sources.

10.3 Summary of greenhouse gas emissions

Table 10-2 summarises the maximum annual emissions associated with the modification based on Scopes 1 and 2.

Table 10-2: Summary of CO2-e emissions per scope (t CO_2-e)

Period	Scope 1	Scope 2	Scopes 1 and 2
2017	9,848	4,663	14,511

The estimated annual greenhouse emissions for Australia for the period February 2014 to March 2015 was 545.1 million tonnes of carbon dioxide equivalent material (Mt CO_2-e) (**Department of the Environment, 2015b**). In comparison, the maximum estimated annual average greenhouse emission for the modification is 0.015Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of greenhouse emissions from the modification in comparison to the Australian greenhouse emissions for the period February 2014 to March 2015 is conservatively estimated to be approximately 0.003 per cent.

At a state level, the estimated greenhouse emissions for NSW in the 2013 period was 141.8 Mt CO_2-e (**Department of the Environment, 2015c**). The maximum estimated annual contribution of greenhouse emissions from the modification in comparison to the NSW greenhouse emissions for the 2013 period is conservatively estimated to be approximately 0.01 per cent.

11 SUMMARY AND CONCLUSIONS

This study has examined potential air quality impacts and greenhouse gas emissions that may arise from the proposed continuation of MCM.

A single conceptual mine plan year has been assessed using conservative dust emission estimation (e.g. using maximum mine schedule) and dispersion modelling (e.g. not including the effect of rainfall).

The results indicate that the modification is predicted to result in 24-hour average PM_{10} impacts at a single assessment location positioned to the north of the site with potential exceedances of the 24-hour average PM_{10} criterion. The modelling predictions indicate up to three days of exceedance of the 24-hour average PM_{10} criterion.

Overall, impacts would tend to change due to the position of mining, which would move towards the northeast into previously mined areas, and away from the township of Muswellbrook.

As the modification is not seeking an increase in equipment numbers, the rate of coal extraction or any significant change to equipment hours, the amount of dust emissions released would be expected to remain relatively similar to present levels.

As there has been no significant blasting incident at this site, it is expected that this would remain the case in the future.

The conservative estimated annual average greenhouse emission for the modification based on an upper limit of the assumed maximum production is calculated to be 0.015Mt CO_2-e material (Scope 1 and 2). This is equivalent to approximately 0.003 per cent of the Australian greenhouse emissions for the February 2014 to March 2015 period and approximately 0.01 per cent of the New South Wales greenhouse emissions for the 2013 period.

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Appendix A

Assessment locations

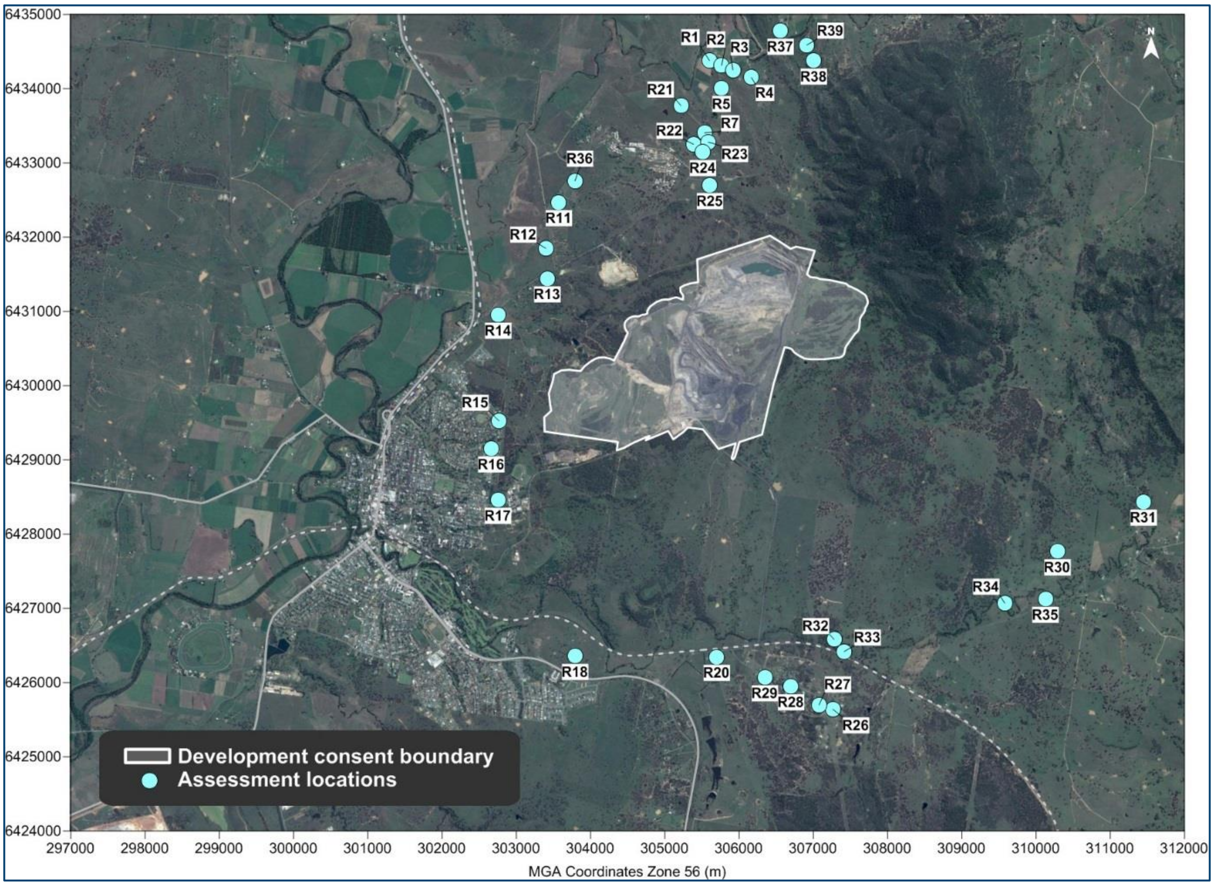

Figure A-1: Location of assessment locations assessed in this study

Table A-1: List of assessment locations assessed in this study

ID	Easting	Northing	ID	Easting	Northing
R1	305602	6434379	R23	305584	6433281
R2	305764	6434314	R24	305513	6433145
R3	305916	6434254	R25	305608	6432700
R4	306165	6434153	R26	307261	6425642
R5	305763	6434008	R27	307076	6425699
R7	305533	6433405	R28	306700	6425948
R11	303573	6432471	R29	306348	6426069
R12	303397	6431849	R30	310289	6427765
R13	303418	6431443	R31	311448	6428437
R14	302757	6430953	R32	307280	6426581
R15	302767	6429524	R33	307416	6426419
R16	302663	6429152	R34	309577	6427069
R17	302753	6428460	R35	310127	6427126
R18	303792	6426355	R36	303789	6432760
R20	305699	6426345	R37	306558	6434778
R21	305216	6433774	R38	307007	6434376
R22	305385	6433252	R39	306912	6434588

Appendix B
Monitoring Data

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Table B-1: TEOM and BAM PM_{10} monitoring data

Date	Site 1	Site 2	Site 3	Date	Site 1	Site 2	Site 3
1/01/2014	21.5	23.4	19.5	3/07/2014	11.6	12.5	8.5
2/01/2014	28.1	32.3	28.0	4/07/2014	12.8	12.9	8.2
3/01/2014	39.0	43.7	34.7	5/07/2014	13.3	14.0	8.4
4/01/2014	22.9	25.5	20.9	6/07/2014	5.9	7.2	3.8
5/01/2014	29.6	33.3	20.6	7/07/2014	6.0	7.0	3.1
6/01/2014	24.8	29.7	23.0	8/07/2014	6.5	7.4	4.3
7/01/2014	29.6	32.4	33.3	9/07/2014	7.3	9.3	10.9
8/01/2014	18.8	15.1	22.1	10/07/2014	13.6	16.8	17.7
9/01/2014	14.6	16.4	-	11/07/2014	6.8	9.0	5.9
10/01/2014	26.9	28.3	-	12/07/2014	7.7	8.7	6.2
11/01/2014	27.9	27.9	-	13/07/2014	16.5	22.3	12.6
12/01/2014	31.6	34.9	-	14/07/2014	19.9	25.3	48.2
13/01/2014	22.8	21.6	-	15/07/2014	24.0	28.2	-
14/01/2014	25.6	27.4	-	16/07/2014	16.9	14.3	14.5
15/01/2014	28.6	29.3	-	17/07/2014	5.3	10.9	7.8
16/01/2014	36.5	38.5	-	18/07/2014	6.3	6.4	4.8
17/01/2014	28.3	30.1	-	19/07/2014	9.9	9.7	7.8
18/01/2014	24.9	29.3	-	20/07/2014	23.6	21.2	19.6
19/01/2014	34.4	38.1	-	21/07/2014	18.6	15.8	41.1
20/01/2014	24.3	24.5	-	22/07/2014	16.7	17.5	48.2
21/01/2014	26.9	26.9	21.7	23/07/2014	11.6	12.8	14.3
22/01/2014	17.8	17.5	20.2	24/07/2014	17.4	17.6	18.9
23/01/2014	16.7	18.9	14.5	25/07/2014	21.0	15.3	17.3
24/01/2014	16.8	18.3	13.5	26/07/2014	8.6	8.1	10.2
25/01/2014	14.0	14.6	13.8	27/07/2014	4.7	5.0	3.1
26/01/2014	14.4	15.8	17.0	28/07/2014	6.0	6.7	4.0
27/01/2014	16.6	17.0	20.3	29/07/2014	8.0	7.8	5.9
28/01/2014	23.3	24.2	-	30/07/2014	8.6	8.8	5.9
29/01/2014	23.0	26.1	-	31/07/2014	9.6	9.6	5.8
30/01/2014	23.3	27.4	-	1/08/2014	11.2	12.2	8.6
31/01/2014	27.2	29.4	-	2/08/2014	9.1	9.8	9.9
1/02/2014	34.4	34.9	33.9	3/08/2014	17.7	17.8	20.9
2/02/2014	23.3	22.6	31.7	4/08/2014	15.6	21.8	16.3
3/02/2014	27.0	27.9	20.5	5/08/2014	15.6	16.9	18.0
4/02/2014	34.6	37.7	23.4	6/08/2014	18.4	18.0	20.3
5/02/2014	20.1	20.9	33.6	7/08/2014	18.3	17.1	15.9
6/02/2014	13.5	14.0	19.5	8/08/2014	18.7	18.8	19.5
7/02/2014	25.0	29.4	12.5	9/08/2014	15.7	14.7	15.5
8/02/2014	22.5	23.6	20.6	10/08/2014	12.5	13.1	12.0
9/02/2014	20.4	24.2	17.4	11/08/2014	17.0	17.1	16.5
10/02/2014	41.9	40.8	38.1	12/08/2014	19.0	18.1	26.2
11/02/2014	26.2	25.2	20.3	13/08/2014	13.9	13.7	40.5
12/02/2014	24.6	24.0	21.5	14/08/2014	13.7	17.6	35.5
13/02/2014	34.7	34.5	21.1	15/08/2014	14.0	13.6	15.4
14/02/2014	18.1	18.0	25.3	16/08/2014	12.9	13.1	14.1
15/02/2014	19.8	20.1	22.6	17/08/2014	4.8	5.3	3.6
16/02/2014	17.4	18.8	21.1	18/08/2014	5.0	4.7	2.5
17/02/2014	16.8	17.0	16.5	19/08/2014	8.8	9.4	7.6
18/02/2014	22.2	21.0	15.1	20/08/2014	13.6	13.7	14.8
19/02/2014	19.0	19.2	26.1	21/08/2014	13.3	12.8	14.7
20/02/2014	15.8	17.3	-	22/08/2014	8.2	8.3	8.4
21/02/2014	29.3	25.7	20.7	23/08/2014	9.4	8.9	10.5
22/02/2014	22.8	23.0	19.3	24/08/2014	8.8	9.4	8.9
23/02/2014	20.7	20.3	19.2	25/08/2014	13.2	12.6	12.4
24/02/2014	13.8	15.0	22.4	26/08/2014	11.6	10.9	11.9
25/02/2014	15.7	16.1	17.7	27/08/2014	8.2	8.6	7.8
26/02/2014	23.9	27.5	25.5	28/08/2014	12.1	12.3	13.7

Date	Site 1	Site 2	Site 3	Date	Site 1	Site 2	Site 3
27/02/2014	28.8	27.9	25.1	29/08/2014	13.6	14.8	14.2
28/02/2014	9.6	9.2	11.4	30/08/2014	13.2	12.3	11.2
1/03/2014	11.0	10.7	10.0	31/08/2014	13.1	12.8	10.5
2/03/2014	11.2	10.7	8.9	1/09/2014	7.7	8.1	6.6
3/03/2014	9.9	9.4	8.7	2/09/2014	8.7	9.9	7.1
4/03/2014	10.2	10.3	7.6	3/09/2014	10.7	10.1	7.8
5/03/2014	15.8	15.9	9.5	4/09/2014	11.7	12.1	14.8
6/03/2014	19.4	20.2	16.7	5/09/2014	17.5	15.8	18.1
7/03/2014	25.5	26.0	21.2	6/09/2014	13.7	13.4	15.8
8/03/2014	14.5	13.8	22.1	7/09/2014	8.0	7.9	5.8
9/03/2014	16.4	15.7	11.9	8/09/2014	9.5	9.0	7.8
10/03/2014	18.6	18.8	11.8	9/09/2014	7.7	7.4	4.7
11/03/2014	20.5	18.5	15.0	10/09/2014	10.9	11.2	9.6
12/03/2014	19.6	19.7	15.6	11/09/2014	10.6	10.6	8.7
13/03/2014	24.1	22.9	17.2	12/09/2014	16.7	14.4	14.5
14/03/2014	17.4	19.1	20.9	13/09/2014	17.9	16.3	15.6
15/03/2014	10.7	10.8	17.6	14/09/2014	15.3	10.6	9.7
16/03/2014	14.2	13.8	6.1	15/09/2014	23.1	22.1	22.0
17/03/2014	10.5	10.9	14.2	16/09/2014	21.5	21.7	22.0
18/03/2014	15.9	20.8	7.4	17/09/2014	10.9	17.0	10.2
19/03/2014	26.8	28.6	13.5	18/09/2014	13.0	19.2	10.4
20/03/2014	14.8	-	24.5	19/09/2014	15.9	15.4	12.7
21/03/2014	15.3	13.7	14.8	20/09/2014	15.7	15.0	11.6
22/03/2014	11.9	10.9	12.0	21/09/2014	17.2	17.5	19.0
23/03/2014	19.2	21.9	7.9	22/09/2014	17.1	14.5	20.7
24/03/2014	20.1	18.7	17.3	23/09/2014	22.9	19.2	17.2
25/03/2014	13.3	14.3	15.6	24/09/2014	13.7	14.8	10.2
26/03/2014	12.0	11.4	13.2	25/09/2014	12.0	11.9	10.0
27/03/2014	7.4	8.1	13.0	26/09/2014	12.0	10.9	10.2
28/03/2014	9.0	8.9	6.9	27/09/2014	18.3	15.6	17.7
29/03/2014	7.9	8.6	6.6	28/09/2014	10.3	9.4	8.3
30/03/2014	16.4	15.9	5.2	29/09/2014	12.5	12.7	12.0
31/03/2014	17.8	16.7	13.9	30/09/2014	17.9	18.5	10.9
1/04/2014	16.8	15.8	15.0	1/10/2014	18.2	19.2	-
2/04/2014	20.2	19.0	17.8	2/10/2014	20.2	-	-
3/04/2014	18.5	18.0	-	3/10/2014	22.6	-	-
4/04/2014	15.8	15.4	-	4/10/2014	21.4	-	-
5/04/2014	10.9	10.7	-	5/10/2014	23.8	-	16.1
6/04/2014	11.3	12.7	15.1	6/10/2014	25.9	-	29.5
7/04/2014	10.6	11.6	10.3	7/10/2014	29.2	-	36.3
8/04/2014	16.0	16.0	14.5	8/10/2014	23.4	-	9.5
9/04/2014	17.4	17.2	14.7	9/10/2014	15.8	14.5	22.3
10/04/2014	21.3	18.8	16.5	10/10/2014	23.8	22.1	30.6
11/04/2014	15.8	15.1	12.5	11/10/2014	25.8	27.8	37.0
12/04/2014	9.3	10.2	7.4	12/10/2014	27.5	29.8	31.2
13/04/2014	12.4	12.9	10.3	13/10/2014	21.6	21.9	25.9
14/04/2014	15.3	15.5	12.6	14/10/2014	9.4	11.2	11.2
15/04/2014	11.4	12.2	15.9	15/10/2014	6.5	8.1	8.1
16/04/2014	14.9	15.8	14.8	16/10/2014	12.9	11.7	13.0
17/04/2014	14.7	14.7	16.7	17/10/2014	21.8	28.3	33.1
18/04/2014	14.6	15.0	14.0	18/10/2014	14.2	13.6	23.6
19/04/2014	18.6	16.5	14.0	19/10/2014	17.5	16.1	14.9
20/04/2014	12.0	11.7	10.7	20/10/2014	22.1	24.3	34.9
21/04/2014	15.6	14.7	12.4	21/10/2014	14.2	15.0	22.4
22/04/2014	16.9	17.0	16.9	22/10/2014	18.1	20.5	30.2
23/04/2014	24.0	18.1	14.4	23/10/2014	21.9	30.1	23.4
24/04/2014	19.7	19.9	13.8	24/10/2014	17.5	17.8	8.0
25/04/2014	12.3	13.5	12.8	25/10/2014	20.8	19.5	-

Date	Site 1	Site 2	Site 3	Date	Site 1	Site 2	Site 3
26/04/2014	16.0	11.8	9.1	26/10/2014	30.2	32.1	-
27/04/2014	10.7	10.8	14.6	27/10/2014	28.5	31.1	-
28/04/2014	23.6	8.9	14.6	28/10/2014	24.9	24.9	14.5
29/04/2014	14.2	13.7	10.4	29/10/2014	24.1	24.0	20.5
30/04/2014	16.5	8.3	6.3	30/10/2014	25.2	26.4	27.5
1/05/2014	14.5	13.8	10.7	31/10/2014	29.3	31.9	24.2
2/05/2014	13.5	12.5	8.7	1/11/2014	26.0	29.1	24.6
3/05/2014	8.0	8.3	5.6	2/11/2014	15.2	15.8	16.1
4/05/2014	7.4	7.9	4.5	3/11/2014	33.7	34.3	29.5
5/05/2014	7.5	8.2	5.1	4/11/2014	42.8	46.0	36.3
6/05/2014	10.1	10.5	6.4	5/11/2014	25.0	30.1	9.5
7/05/2014	15.7	15.5	12.9	6/11/2014	17.6	19.3	22.3
8/05/2014	18.8	16.8	17.1	7/11/2014	26.2	29.6	30.6
9/05/2014	15.7	14.2	13.0	8/11/2014	20.1	22.6	37.0
10/05/2014	15.4	14.5	10.7	9/11/2014	30.1	33.3	31.2
11/05/2014	10.3	9.9	8.1	10/11/2014	35.6	-	25.9
12/05/2014	11.7	12.5	10.2	11/11/2014	18.9	26.2	11.2
13/05/2014	18.6	16.5	14.4	12/11/2014	22.6	26.6	8.1
14/05/2014	22.0	15.3	13.1	13/11/2014	25.6	30.0	13.0
15/05/2014	-	10.8	8.9	14/11/2014	25.8	29.2	33.1
16/05/2014	10.3	10.7	8.1	15/11/2014	43.6	50.9	23.6
17/05/2014	12.0	11.6	8.2	16/11/2014	20.5	21.9	14.9
18/05/2014	14.4	14.1	10.1	17/11/2014	12.7	14.6	34.9
19/05/2014	14.0	14.3	9.8	18/11/2014	24.7	27.9	22.4
20/05/2014	13.9	15.3	10.3	19/11/2014	26.3	27.2	30.2
21/05/2014	18.3	18.7	14.0	20/11/2014	19.3	22.4	23.4
22/05/2014	16.8	16.5	11.9	21/11/2014	28.2	30.5	8.0
23/05/2014	17.1	17.0	11.7	22/11/2014	34.5	36.8	-
24/05/2014	13.5	14.5	9.2	23/11/2014	30.2	32.6	-
25/05/2014	14.2	14.7	9.8	24/11/2014	26.3	31.6	-
26/05/2014	15.1	15.9	11.2	25/11/2014	14.1	15.2	14.5
27/05/2014	18.6	20.1	13.5	26/11/2014	28.6	31.8	20.5
28/05/2014	11.5	11.8	8.2	27/11/2014	18.2	20.9	27.5
29/05/2014	12.9	17.0	21.0	28/11/2014	15.5	16.8	24.2
30/05/2014	16.5	15.4	19.7	29/11/2014	21.5	21.1	23.1
31/05/2014	9.7	11.7	9.8	30/11/2014	27.6	27.8	15.2
1/06/2014	12.5	12.1	14.2	1/12/2014	14.3	16.6	10.8
2/06/2014	6.3	7.6	4.6	2/12/2014	11.7	14.1	14.0
3/06/2014	6.2	6.5	3.9	3/12/2014	21.3	23.9	18.7
4/06/2014	9.9	9.9	5.9	4/12/2014	13.3	15.1	12.2
5/06/2014	11.8	11.7	11.0	5/12/2014	11.6	13.1	11.9
6/06/2014	11.1	12.2	9.1	6/12/2014	10.0	11.2	9.2
7/06/2014	17.4	18.0	14.4	7/12/2014	7.4	8.8	7.2
8/06/2014	14.3	14.3	11.1	8/12/2014	13.6	16.1	14.3
9/06/2014	13.9	13.2	10.7	9/12/2014	25.1	27.3	22.5
10/06/2014	11.9	11.6	10.2	10/12/2014	20.9	21.3	18.7
11/06/2014	12.2	10.6	10.6	11/12/2014	5.9	6.2	6.9
12/06/2014	11.0	11.7	9.1	12/12/2014	13.7	14.9	14.7
13/06/2014	26.0	19.8	15.7	13/12/2014	11.1	11.9	11.9
14/06/2014	10.0	9.4	6.9	14/12/2014	21.9	22.8	19.7
15/06/2014	6.7	7.6	4.0	15/12/2014	19.4	21.0	21.3
16/06/2014	7.8	8.3	4.8	16/12/2014	22.7	24.4	17.4
17/06/2014	5.6	5.9	2.9	17/12/2014	43.8	45.8	38.2
18/06/2014	10.4	10.2	6.6	18/12/2014	29.3	31.1	24.6
19/06/2014	11.0	10.4	6.1	19/12/2014	29.6	30.0	24.0
20/06/2014	11.5	12.1	7.5	20/12/2014	19.6	20.2	19.4
21/06/2014	13.2	12.5	8.2	21/12/2014	19.5	19.4	20.7
22/06/2014	11.5	11.7	9.3	22/12/2014	18.0	20.1	18.5

Date	Site 1	Site 2	Site 3	Date	Site 1	Site 2	Site 3
23/06/2014	9.3	9.6	6.6	23/12/2014	17.3	18.9	-
24/06/2014	12.4	14.3	9.1	24/12/2014	16.3	19.3	-
25/06/2014	10.5	11.6	7.2	25/12/2014	14.6	16.8	18.4
26/06/2014	10.5	11.7	8.4	26/12/2014	8.0	9.0	9.7
27/06/2014	8.6	11.7	9.4	27/12/2014	19.6	20.8	23.3
28/06/2014	13.2	13.0	6.4	28/12/2014	8.0	8.4	9.4
29/06/2014	8.4	8.3	5.9	29/12/2014	-	-	14.8
30/06/2014	6.7	7.7	4.0	30/12/2014	35.9	28.6	25.0
1/07/2014	6.7	6.8	3.6	31/12/2014	34.3	32.5	30.2
2/07/2014	10.1	10.2	6.3	-	-	-	-

Appendix C

Emission Calculation

MCM - 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 State Pollution Control Commission document *Air Pollution from Coal Mining and Related Developments* (**SPCC, 1983**), 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 Practise Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, prepared by Katestone Environmental (**Katestone, 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**.

Table C-1: Emission factor equations

Activity	Emission factor equation	Variables	Control	Source
Drilling (overburden/coal)	$EF = 0.59\ kg/hole$	-	70% - water sprays	US EPA, 1985 NPI, 2012 Katestone, 2010
Blasting (overburden/coal)	$EF = 0.00022 \times A^{1.5}\ kg/blast$	A = area to be blasted (m^2)	-	US EPA, 1985
Loading / emplacing overburden	$EF = k \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M^{1.4}}{2}\right)\ kg/tonne$	Ktsp = 0.74 U = wind speed (m/s) M = moisture content (%)	-	NPI, 2012
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times k \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$	S = silt content (%) M = average vehicle gross mass (tonnes)	85% - watering of trafficked areas	US EPA, 1985 Katestone, 2010
Topsoil removal	$EF = 0.029\ kg/tonne$	-	-	US EPA, 1985
Dozers on overburden	$EF = 2.6 \times \frac{s^{1.2}}{M^{1.3}}\ kg/hour$	S = silt content (%) M = moisture content (%)	-	US EPA, 1985
Dozers on coal	$EF = 35.6 \times \frac{s^{1.2}}{M^{1.4}}\ kg/hour$	S = silt content (%) M = moisture content (%)	-	US EPA, 1985
Loading / emplacing coal	$EF = \frac{0.58}{M^{1.2}}\ kg/tonne$	M = moisture content (%)	50% - water sprays	US EPA, 1985 Katestone, 2010
Loading product coal to stockpile	$EF = k \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M^{1.4}}{2}\right)\ kg/tonne$	Ktsp = 0.74 U = wind speed (m/s) M = moisture content (%)	25% - variable height stacker	US EPA, 1985 Katestone, 2010
Crushing	$EF = 0.0006\ kg/tonne$	-	-	US EPA, 1985
Screening	$EF = 0.0011\ kg/tonne$	-	-	US EPA, 1985
Wind erosion on exposed areas / stockpiles	$EF = 0.4\ kg/ha/hour$	-	80% - stabilised surface 50% - water sprays	SPCC, 1983 Katestone, 2010
Grading roads	$EF = 0.0034 \times s^{2.5}\ kg/VKT$	S = speed of grader (km/hr)	-	US EPA, 1985

Table C-3: Emission inventory – 2017

ACTIVITY	TSP emission (kg/y)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
TS - Topsoil removal	145	5,000	tonnes/year	0.03	kg/t												
TS - Loading topsoil to haul truck	3	5,000	tonnes/year	0.00067	kg/t	1.242	average of (wind spee	3.5	moisture content in %								
TS - Hauling topsoil to emplacement area	53	5,000	tonnes/year	0.053	kg/t	183	tonnes/load	3.3	km/return trip	2.9	kg/VKT	2.0	% silt cont	232	Ave GMV (	80	% Control
TS - Emplacing topsoil at emplacement area	3	5,000	tonnes/year	0.00067	kg/t	1.242	average of (wind spee	3.5	moisture content in %								
OB - Drilling	821	4,640	holes/year	0.59	kg/hole											70	% Control
OB - Blasting	1,634	59	blasts/year	28	kg/blast	2,500	Average blast area (m2)										
OB - Loading OB to haul truck	12,619	18,790,793	tonnes/year	0.00067	kg/t	1.242	average of (wind spee	3.5	moisture content in %								
OB - Hauling to emplacement area	197,882	18,790,793	tonnes/year	0.053	kg/t	183	tonnes/load	3.3	km/return trip	2.9	kg/VKT	2.0	% silt cont	232	Ave GMV (	80	% Control
OB - Emplacing at area	12,619	18,790,793	tonnes/year	0.00067	kg/t	1.242	average of (wind spee	3.5	moisture content in %								
OB - Dozers in pit	66,835	8,266	hours/year	8.1	kg/h	10	silt content in %	3.5	moisture content in %								
OB - Dozers on dump and rehab	66,835	8,266	hours/year	8.1	kg/h	10	silt content in %	3.5	moisture content in %								
CL - Dozers ripping/pushing/clean-up	17,388	727	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Loading ROM coal to haul truck	111,663	1,652,954	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Hauling ROM to CHPP	30,050	1,652,954	tonnes/year	0.091	kg/t	183	tonnes/load	5.7	km/return trip	2.9	kg/VKT	2.0	% silt cont	232	Ave GMV (	80	% Control
CHPP - Unloading ROM to hopper	33,499	1,652,954	tonnes/year	0.068	kg/t	6	moisture content in %									70	% Control
CHPP - Rehandle ROM at hopper	22,333	330,591	tonnes/year	0.068	kg/t	6	moisture content in %										
CHPP - Crushing	992	1,652,954	tonnes/year	0.0006	kg/t												
CHPP - Screening	1,818	1,652,954	tonnes/year	0.0011	kg/t												
CHPP - Loading Bypass to trucks at bin	196	991,773	tonnes/year	0.00020	kg/t	1.242	average of (wind spee	8.4	moisture content in %								
CHPP - Hauling Bypass to stockpile	1,649	991,773	tonnes/year	0.008	kg/t	85	tonnes/load	0.4	km/return trip	2.0	kg/VKT	2.0	% silt cont	99	Ave GMV (	80	% Control
CHPP - Unloading Bypass at stockpile	44,741	991,773	tonnes/year	0.045	kg/t	8.4	moisture content in %										
CHPP - Loading Bypass to trucks for dispatch	44,741	991,773	tonnes/year	0.045	kg/t	8.4	moisture content in %										
CHPP - Hauling Bypass off-site	8,036	991,773	tonnes/year	0.041	kg/t	45	tonnes/load	1.1	km/return trip	1.6	kg/VKT	2.0	% silt cont	61	Ave GMV (	80	% Control
CHPP - Unloading ROM at CHPP stockpile	209	661,182	tonnes/year	0.00032	kg/t	1.242	average of (wind spee	6	moisture content in %								
CHPP - Loading Product to trucks	79	462,063	tonnes/year	0.00017	kg/t	1.242	average of (wind spee	9.3	moisture content in %								
CHPP - Hauling Product to stockpile	1,446	462,063	tonnes/year	0.016	kg/t	85	tonnes/load	0.7	km/return trip	2.0	kg/VKT	2.0	% silt cont	99	Ave GMV (	80	% Control
CHPP - Unloading Product at stockpile	18,448	462,063	tonnes/year	0.040	kg/t	9.3	moisture content in %										
CHPP - Loading Product to trucks for dispatch	18,448	462,063	tonnes/year	0.040	kg/t	9.3	moisture content in %										
CHPP - Hauling Product off-site	7,006	462,063	tonnes/year	0.076	kg/t	45	tonnes/load	2.1	km/return trip	1.6	kg/VKT	2.0	% silt cont	61	Ave GMV (	80	% Control
CHPP - Dozer pushing ROM coal	3,109	130	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CHPP - Dozer pushing Product coal	1,536	130	hours/year	11.8	kg/h	4	silt content in %	8.4	moisture content in %								
CHPP - Loading rejects	17	199,119	tonnes/year	0.00009	kg/t	1.242	average of (wind spee	15	moisture content in %								
CHPP - Hauling rejects	3,460	199,119	tonnes/year	0.087	kg/t	183	tonnes/load	5.4	km/return trip	2.9	kg/VKT	2.0	% silt cont	232	Ave GMV (	80	% Control
CHPP - Unloading rejects	17	199,119	tonnes/year	0.00009	kg/t	1.242	average of (wind spee	15	moisture content in %								
WE - Overburden emplacement areas	131,304	149.9	ha	876	kg/ha/year												
WE - Open pit	39,135	44.7	ha	876	kg/ha/year												
WE - Stabilised emplacement area	3,072	17.5	ha	876	kg/ha/year											80	% Control
WE - ROM stockpiles	1,430	3.3	ha	876	kg/ha/year											50	% Control
WE - Product stockpiles	3,256	7.4	ha	876	kg/ha/year											50	% Control
Grading roads	60,385	98,112	km	0.62	kg/VKT	8	speed of graders in km/h										
Total TSP emissions (kg/yr)	**968,910**																

Appendix D

Modelling Predictions – Dust emissions

Table D-1: Modelling predictions for Stage 3

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project impact						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria / Advisory reporting standard*									
	25*	**-**	**50**	**-**	**-**	**2**	**8***	**30**	**90**	**4**
R1	2	0	17	2	3	0.03	3	14	37	1.7
R2	2	0	17	2	3	0.03	3	14	37	1.7
R3	2	0	18	2	3	0.03	3	14	36	1.7
R4	2	0	18	2	3	0.02	3	14	36	1.7
R5	3	0	21	3	4	0.04	4	15	38	1.7
R7	4	1	31	6	9	0.12	4	18	43	1.8
R11	3	1	22	6	11	0.32	4	20	46	2.0
R12	3	1	22	5	8	0.21	4	19	44	1.9
R13	3	1	24	6	8	0.16	4	20	45	1.9
R14	2	0	10	2	3	0.04	4	17	41	1.8
R15	6	1	45	5	6	0.04	5	23	48	1.9
R16	5	1	35	4	5	0.03	5	22	47	1.9
R17	4	1	29	4	5	0.03	5	23	47	1.9
R18	2	0	14	2	3	0.02	4	20	45	1.8
R20	2	0	16	2	3	0.03	4	17	40	1.8
R21	3	1	23	5	7	0.10	4	17	41	1.8
R22	5	1	35	8	11	0.18	4	20	45	1.8
R23	5	1	36	7	10	0.14	4	19	45	1.8
R24	6	1	42	9	13	0.19	4	21	47	1.9
R25	9	2	**61**	13	20	0.34	5	25	54	2.0
R26	2	0	13	2	3	0.03	4	17	40	1.8
R27	2	0	14	2	3	0.03	4	17	41	1.8
R28	2	0	16	3	4	0.04	4	17	41	1.8
R29	2	0	16	3	4	0.04	4	17	41	1.8
R30	1	0	6	1	1	0.03	3	13	35	1.7
R31	1	0	5	1	1	0.02	3	12	34	1.7
R32	3	0	19	2	3	0.04	4	15	39	1.7
R33	2	0	17	2	3	0.04	4	15	39	1.7
R34	1	0	8	1	1	0.03	3	13	36	1.7
R35	1	0	6	1	1	0.02	3	13	35	1.7
R36	3	1	25	7	11	0.32	4	20	47	2.0
R37	2	0	11	1	1	0.01	3	13	35	1.7
R38	2	0	13	1	2	0.01	3	13	35	1.7
R39	2	0	11	1	1	0.01	3	13	35	1.7

*Advisory NEPM reporting standard applicable to the population as a whole

Appendix E

Isopleth Diagrams – Dust emissions

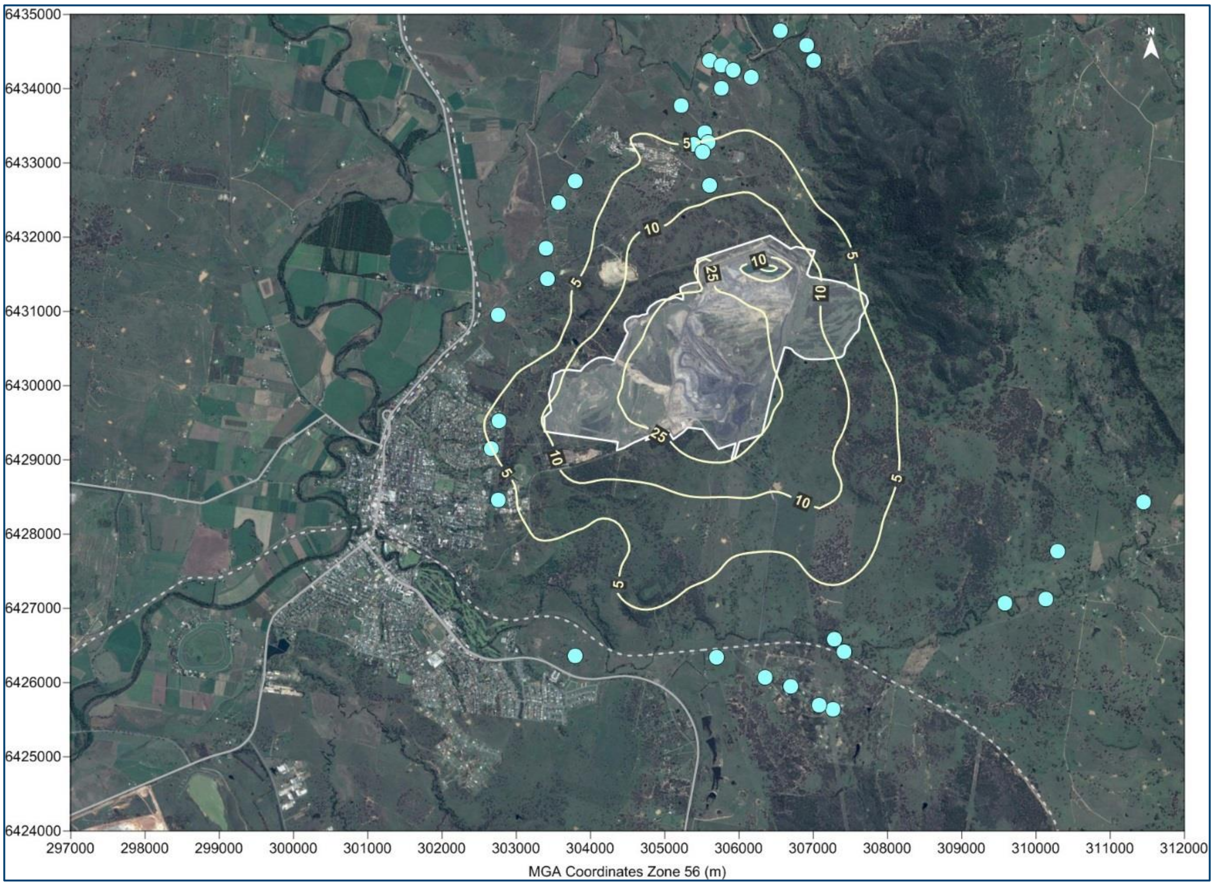

Figure E-1: Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the modification in 2017 (µg/m³)

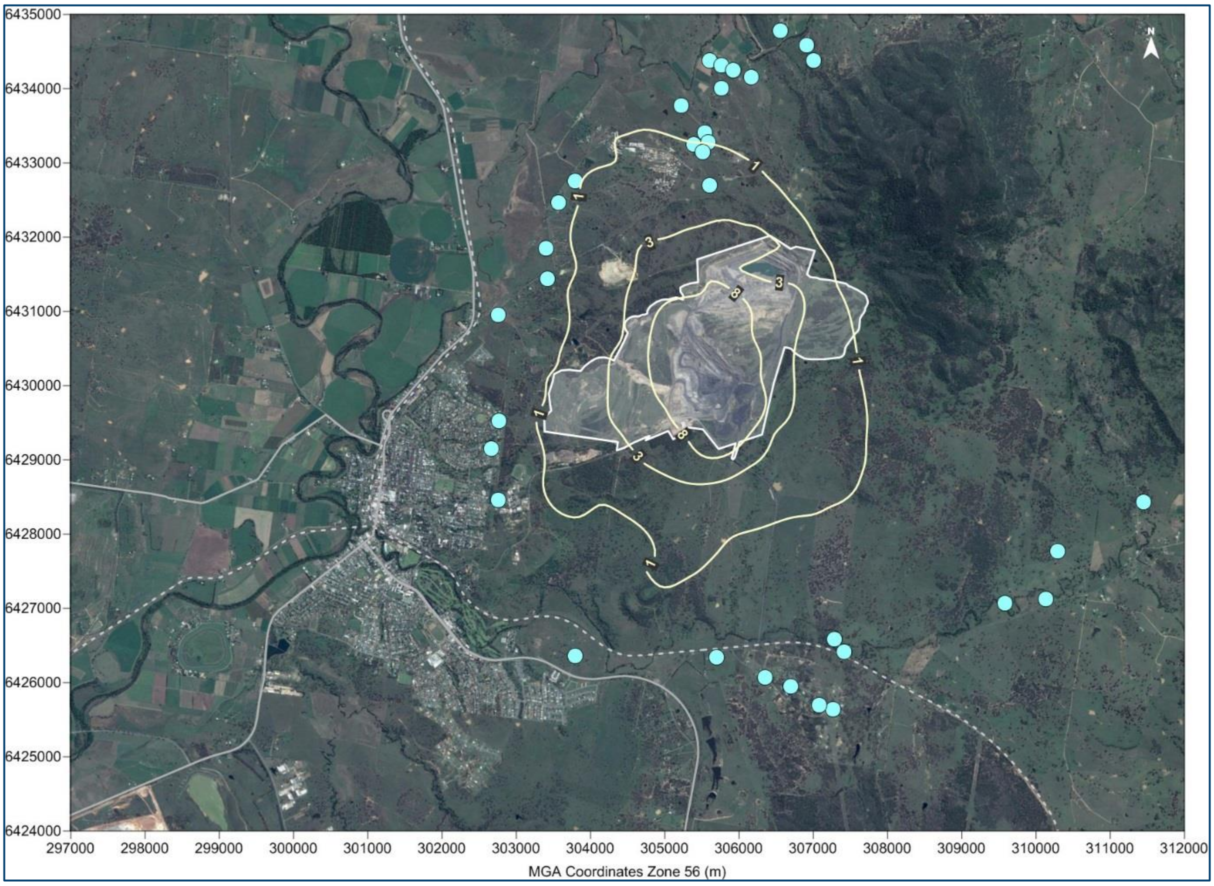

Figure E-2: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the modification in 2017 (µg/m³)

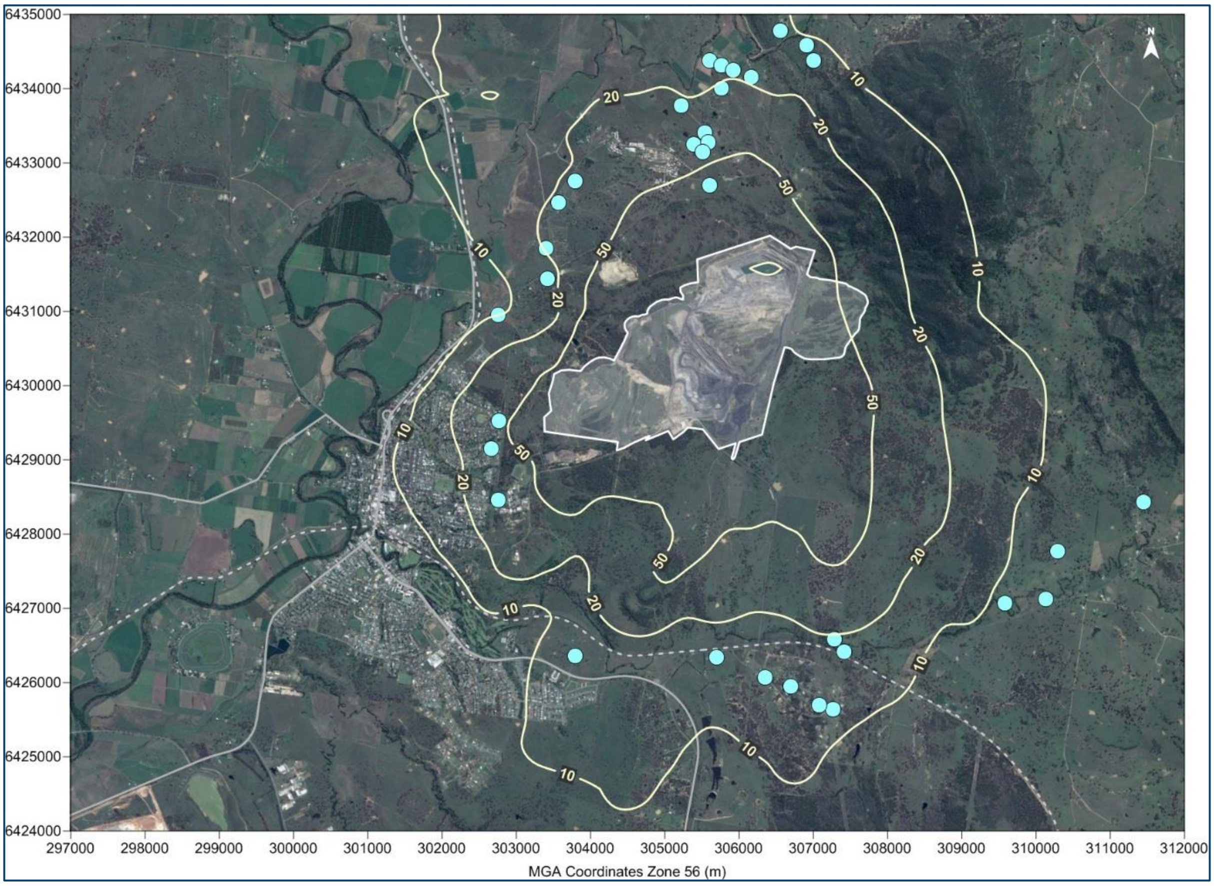

Figure E-3: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the modification in 2017 (µg/m³)

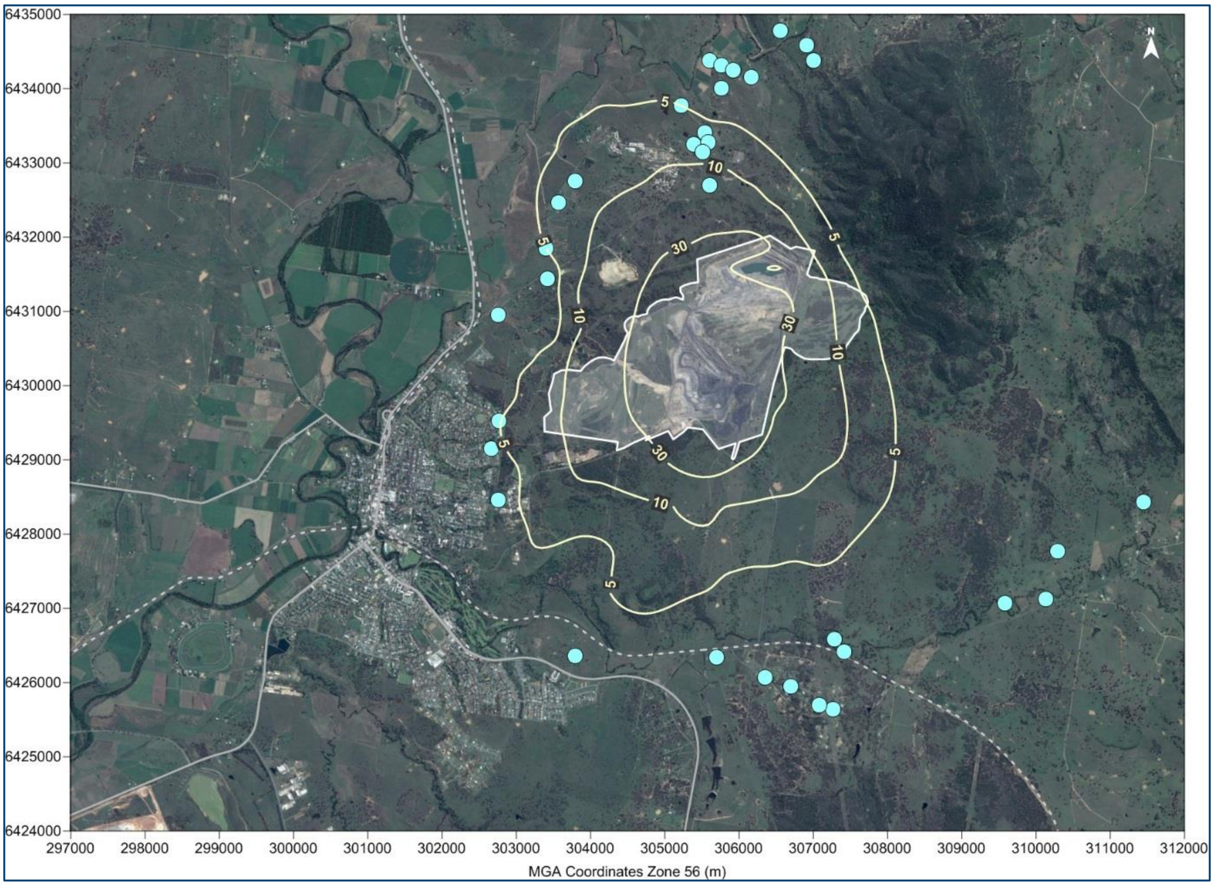

Figure E-4: Predicted annual average PM_{10} concentrations due to emissions from the modification in 2017 (µg/m³)

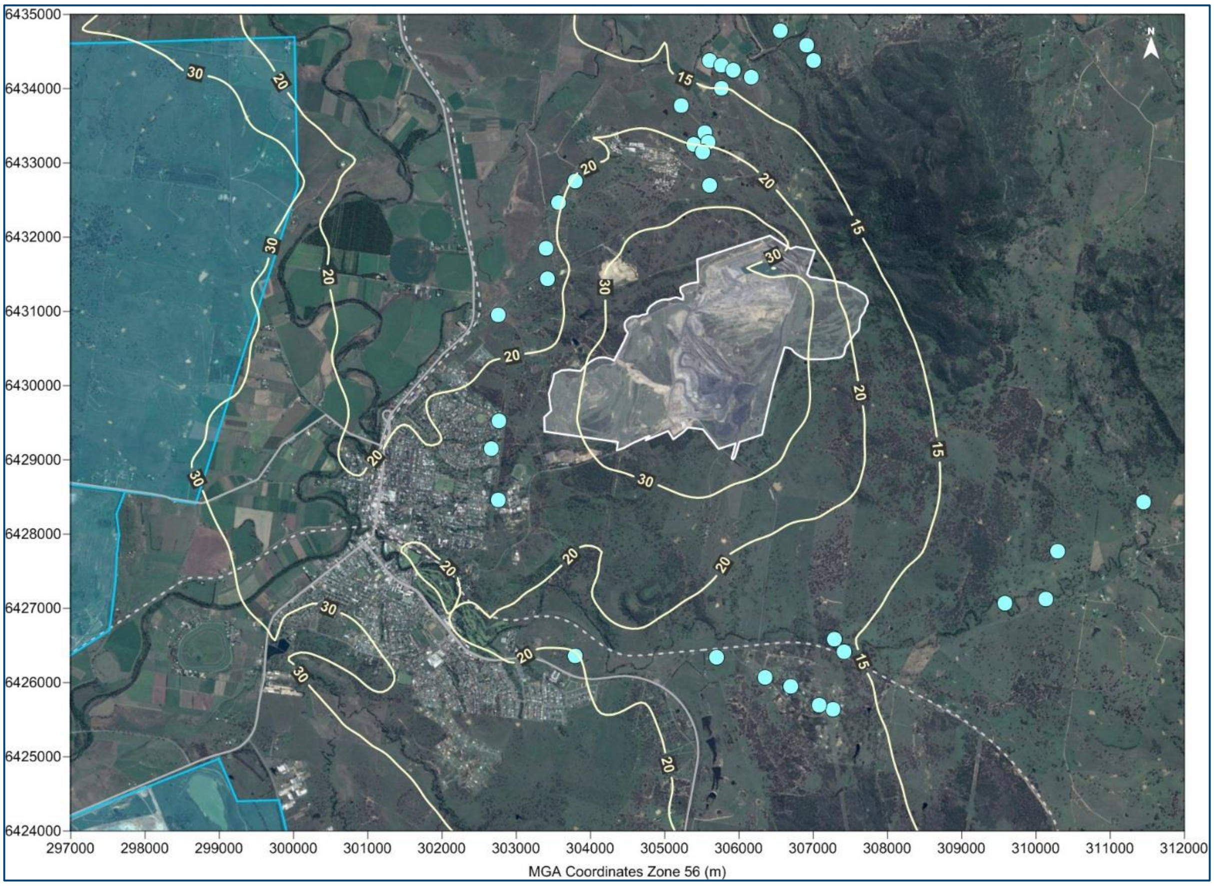

Figure E-5: Predicted annual average PM_{10} concentrations due to emissions from the modification and other sources in 2017 (µg/m³)

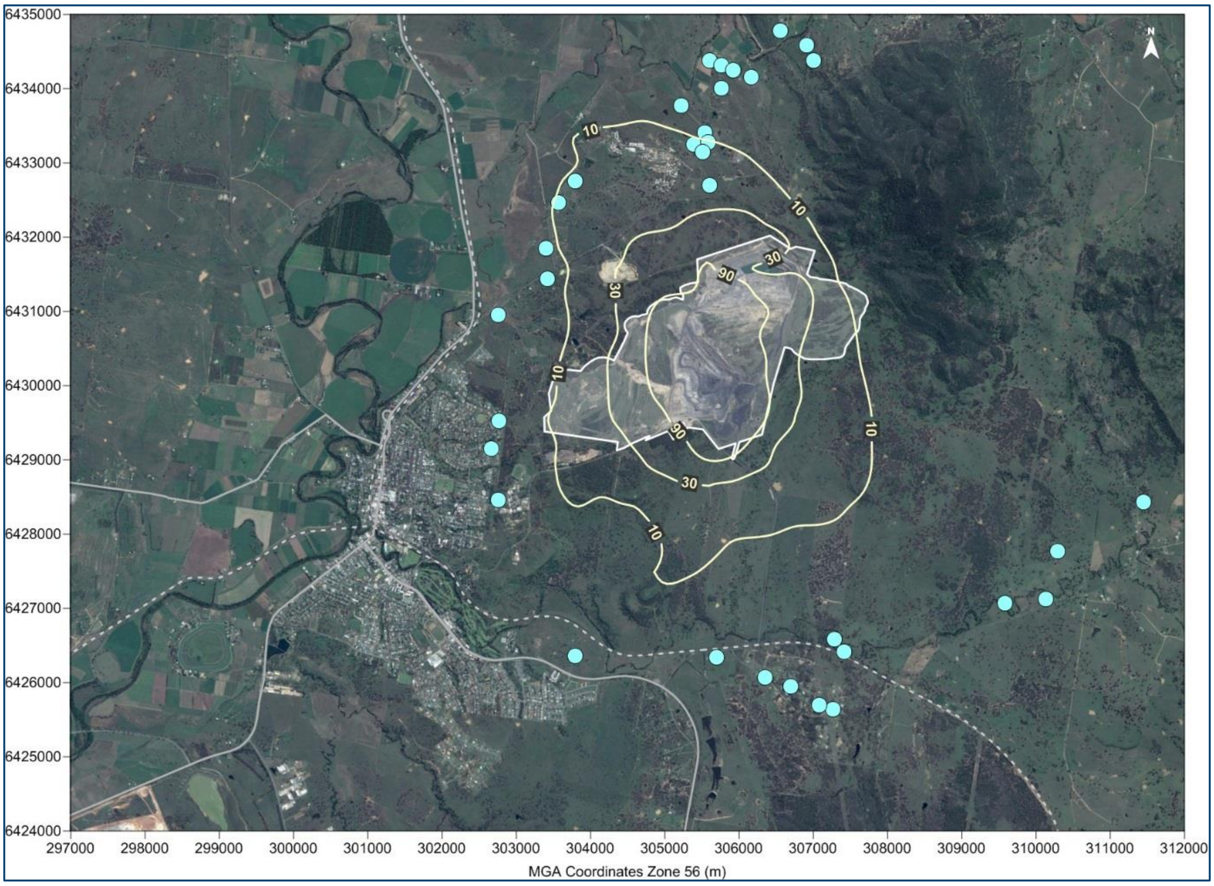

Figure E-6: Predicted annual average TSP concentrations due to emissions from the modification in 2017 (µg/m³)

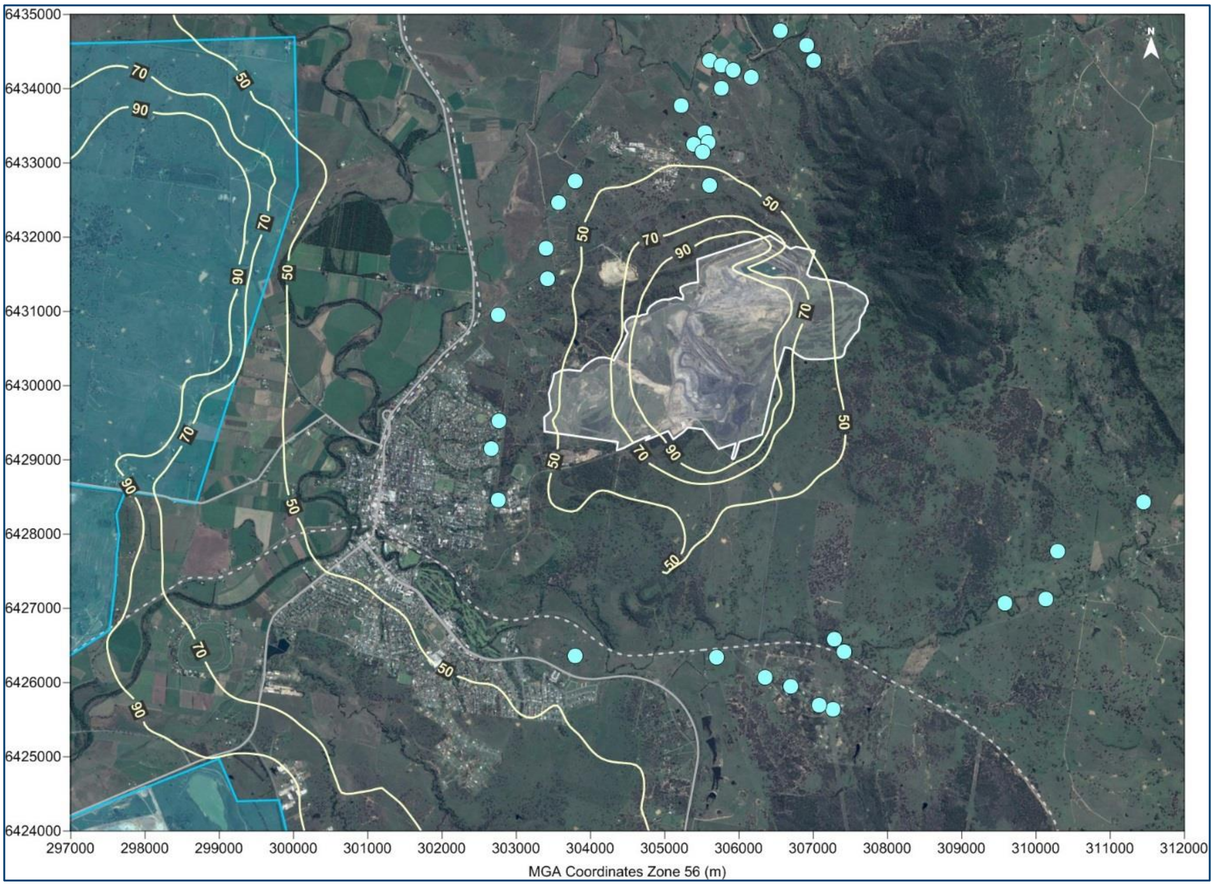

Figure E-7: Predicted annual average TSP concentrations due to emissions from the modification and other sources in 2017 (µg/m³)

Figure E-8: Predicted annual average dust deposition levels due to emissions from the modification in 2017 (g/m²/month)

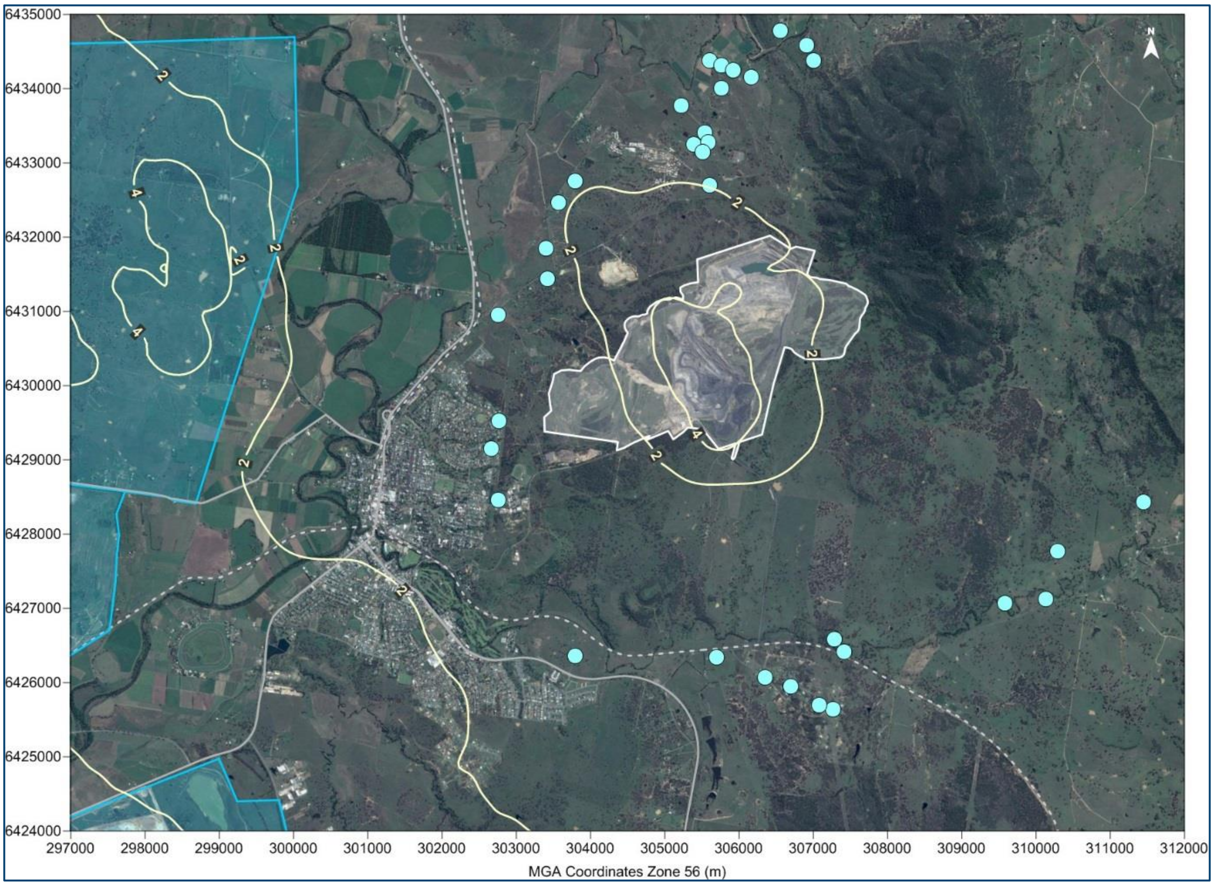

Figure E-9: Predicted annual average dust deposition levels due to emissions from the modification and other sources in 2017 (g/m²/month)

Appendix F

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

Table F-1: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R14

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
4/07/2014	27.4	0.24	27.64	-	-	-	-
4/11/2014	27.4	-0.20	27.20	-	-	-	-
5/08/2014	25.4	0.09	25.49	-	-	-	-
10/05/2014	23.4	0.19	23.59	12/10/2014	15	0.57	15.57
13/05/2014	22.4	0.04	22.44	3/07/2014	19.3	0.48	19.78
4/08/2014	22.2	0.41	22.61	3/08/2014	20.3	0.43	20.73
6/08/2014	22.2	0.17	22.37	4/08/2014	22.2	0.41	22.61
19/07/2014	21.1	0.11	21.21	23/07/2014	13.3	0.38	13.68
9/08/2014	21.1	0.32	21.42	24/07/2014	18.9	0.37	19.27
8/08/2014	20.5	0.34	20.84	19/10/2014	6.5	0.35	6.85
15/07/2014	20.3	0.34	20.64	15/07/2014	20.3	0.34	20.64
3/08/2014	20.3	0.43	20.73	8/08/2014	20.5	0.34	20.84
22/06/2014	20	0.17	20.17	9/07/2014	13.9	0.32	14.22

Table F-2: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R15

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
4/07/2014	27.4	-0.07	27.33	-	-	-	-
4/11/2014	27.4	-0.01	27.39	-	-	-	-
5/08/2014	25.4	-0.01	25.39	-	-	-	-
10/05/2014	23.4	-0.06	23.34	8/07/2014	11.3	0.27	11.57
13/05/2014	22.4	-0.02	22.38	15/08/2014	11.5	0.23	11.73
4/08/2014	22.2	-0.38	21.82	5/10/2014	6.9	0.21	7.11
6/08/2014	22.2	-0.13	22.07	31/10/2014	9.4	0.18	9.58
19/07/2014	21.1	-0.11	20.99	25/08/2014	11.8	0.14	11.94
9/08/2014	21.1	-0.10	21.00	3/06/2014	-	0.14	-
8/08/2014	20.5	-0.34	20.16	21/04/2014	8.3	0.12	8.42
15/07/2014	20.3	-0.16	20.14	2/06/2014	8.2	0.11	8.31
3/08/2014	20.3	-0.34	19.96	4/06/2014	-	0.11	-
22/06/2014	20	-0.03	19.97	31/08/2014	15.5	0.11	15.61

Table F-3: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R16

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
4/07/2014	27.4	-0.01	27.39	-	-	-	-
4/11/2014	27.4	0.00	27.40	-	-	-	-
5/08/2014	25.4	0.02	25.42	-	-	-	-
10/05/2014	23.4	-0.01	23.39	15/08/2014	11.5	0.17	11.67
13/05/2014	22.4	0.00	22.40	31/10/2014	9.4	0.16	9.56
4/08/2014	22.2	-0.26	21.94	5/10/2014	6.9	0.15	7.05
6/08/2014	22.2	-0.13	22.07	4/06/2014	-	0.14	-
19/07/2014	21.1	-0.05	21.05	25/08/2014	11.8	0.13	11.93
9/08/2014	21.1	-0.10	21.00	29/04/2014	6.7	0.13	6.83
8/08/2014	20.5	-0.26	20.24	6/06/2014	7.4	0.13	7.53
15/07/2014	20.3	-0.08	20.22	21/04/2014	8.3	0.11	8.41
3/08/2014	20.3	-0.19	20.11	31/08/2014	15.5	0.11	15.61
22/06/2014	20	0.01	20.01	8/07/2014	11.3	0.11	11.41

Table F-4: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R17

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
4/07/2014	27.4	-0.04	27.36	-	-	-	-
4/11/2014	27.4	0.00	27.40	-	-	-	-
5/08/2014	25.4	0.00	25.40	-	-	-	-
10/05/2014	23.4	-0.02	23.38	26/07/2014	19.4	0.10	19.50
13/05/2014	22.4	-0.02	22.38	25/09/2014	5.8	0.06	5.86
4/08/2014	22.2	-0.16	22.04	2/04/2014	13.9	0.05	13.95
6/08/2014	22.2	-0.17	22.03	14/06/2014	9.9	0.04	9.94
19/07/2014	21.1	-0.12	20.98	24/11/2014	8.3	0.04	8.34
9/08/2014	21.1	-0.18	20.92	16/03/2014	9.2	0.03	9.23
8/08/2014	20.5	-0.11	20.39	15/10/2014	6.3	0.03	6.33
15/07/2014	20.3	-0.13	20.17	23/05/2014	14.7	0.03	14.73
3/08/2014	20.3	-0.11	20.19	6/11/2014	8.7	0.03	8.73
22/06/2014	20	-0.10	19.90	22/05/2014	16.7	0.03	16.73

Table F-5: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R18

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
4/07/2014	27.4	-0.01	27.39	-	-	-	-
4/11/2014	27.4	-0.01	27.39	-	-	-	-
5/08/2014	25.4	0.01	25.41	-	-	-	-
10/05/2014	23.4	0.01	23.41	27/07/2014	14.9	0.08	14.98
13/05/2014	22.4	-0.02	22.38	3/07/2014	19.3	0.07	19.37
4/08/2014	22.2	0.01	22.21	28/07/2014	9.4	0.06	9.46
6/08/2014	22.2	0.01	22.21	6/11/2014	8.7	0.06	8.76
19/07/2014	21.1	-0.06	21.04	1/02/2014	7.6	0.05	7.65
9/08/2014	21.1	0.04	21.14	29/04/2014	6.7	0.05	6.75
8/08/2014	20.5	0.01	20.51	2/09/2014	5.1	0.05	5.15
15/07/2014	20.3	-0.02	20.28	14/07/2014	13.2	0.05	13.25
3/08/2014	20.3	0.01	20.31	16/10/2014	9.5	0.04	9.54
22/06/2014	20	-0.04	19.96	18/09/2014	4.8	0.04	4.84

Table F-6: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R32

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
4/07/2014	27.4	0.02	27.42	-	-	-	-
4/11/2014	27.4	0.00	27.40	-	-	-	-
5/08/2014	25.4	0.02	25.42	-	-	-	-
10/05/2014	23.4	-0.04	23.36	30/09/2014	8.3	0.21	8.51
13/05/2014	22.4	0.00	22.40	31/07/2014	8.5	0.14	8.64
4/08/2014	22.2	0.00	22.20	27/06/2014	17.7	0.12	17.82
6/08/2014	22.2	-0.01	22.19	11/09/2014	6	0.09	6.09
19/07/2014	21.1	-0.01	21.09	28/07/2014	9.4	0.08	9.48
9/08/2014	21.1	0.01	21.11	29/09/2014	6.9	0.08	6.98
8/08/2014	20.5	0.00	20.50	6/05/2014	11.6	0.08	11.68
15/07/2014	20.3	-0.02	20.28	30/07/2014	16.1	0.05	16.15
3/08/2014	20.3	0.00	20.30	4/01/2014	10.5	0.05	10.55
22/06/2014	20	0.00	20.00	24/11/2014	8.3	0.05	8.35

Table F-7: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R13

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
4/07/2014	27.4	0.35	27.75	-	-	-	-
4/11/2014	27.4	-0.22	27.18	-	-	-	-
5/08/2014	25.4	0.06	25.46	-	-	-	-
10/05/2014	23.4	0.29	23.69	4/08/2014	22.2	0.70	22.90
13/05/2014	22.4	0.25	22.65	12/10/2014	15	0.70	15.70
4/08/2014	22.2	0.70	22.90	10/10/2014	8.4	0.63	9.03
6/08/2014	22.2	0.25	22.45	26/02/2014	7.4	0.62	8.02
19/07/2014	21.1	0.19	21.29	24/07/2014	18.9	0.60	19.50
9/08/2014	21.1	0.41	21.51	19/10/2014	6.5	0.49	6.99
8/08/2014	20.5	0.14	20.64	15/07/2014	20.3	0.47	20.77
15/07/2014	20.3	0.47	20.77	19/09/2014	7.2	0.46	7.66
3/08/2014	20.3	0.25	20.55	16/07/2014	13.3	0.44	13.74
22/06/2014	20	0.22	20.22	2/04/2014	13.9	0.44	14.34

Table F-8: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R24

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
4/07/2014	27.4	0.16	27.56	-	-	-	-
4/11/2014	27.4	0.71	28.11	-	-	-	-
5/08/2014	25.4	0.53	25.93	-	-	-	-
10/05/2014	23.4	0.45	23.85	10/06/2014	17.9	2.28	20.18
13/05/2014	22.4	0.98	23.38	1/06/2014	10.6	1.83	12.43
4/08/2014	22.2	0.29	22.49	11/06/2014	14.8	1.81	16.61
6/08/2014	22.2	0.04	22.24	28/08/2014	12.9	1.67	14.57
19/07/2014	21.1	0.66	21.76	21/07/2014	10.3	1.49	11.79
9/08/2014	21.1	0.00	21.10	31/03/2014	6.1	1.41	7.51
8/08/2014	20.5	0.49	20.99	22/07/2014	17.8	1.31	19.11
15/07/2014	20.3	0.84	21.14	26/03/2014	5.2	1.26	6.46
3/08/2014	20.3	0.35	20.65	21/09/2014	10.2	1.25	11.45
22/06/2014	20	0.70	20.70	23/03/2014	7.6	1.23	8.83

Table F-9: 2017 ($PM_{2.5}$ 24-hr average concentration) – Assessment location R25

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
4/07/2014	27.4	0.29	27.69	-	-	-	-
4/11/2014	27.4	1.16	28.56	-	-	-	-
5/08/2014	25.4	0.85	26.25	-	-	-	-
10/05/2014	23.4	0.70	24.10	10/06/2014	17.9	3.07	20.97
13/05/2014	22.4	1.38	23.78	1/06/2014	10.6	2.87	13.47
4/08/2014	22.2	0.48	22.68	28/08/2014	12.9	2.68	15.58
6/08/2014	22.2	0.09	22.29	11/06/2014	14.8	2.52	17.32
19/07/2014	21.1	1.08	22.18	21/07/2014	10.3	2.26	12.56
9/08/2014	21.1	0.00	21.10	26/03/2014	5.2	2.11	7.31
8/08/2014	20.5	0.77	21.27	31/03/2014	6.1	2.01	8.11
15/07/2014	20.3	1.22	21.52	13/07/2014	19.3	1.96	21.26
3/08/2014	20.3	0.54	20.84	21/09/2014	10.2	1.94	12.14
22/06/2014	20	0.90	20.90	23/03/2014	7.6	1.89	9.49

Table F-10: 2017 (PM_{10} 24-hr average concentration) – Assessment location R14

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
15/11/2014	**50.9**	-0.01	51	-	-	-	-
4/11/2014	46.0	-1.61	44	12/10/2014	29.8	4.17	34
17/12/2014	45.8	0.00	46	3/07/2014	12.5	3.38	16
3/01/2014	43.7	-0.18	44	3/08/2014	17.8	3.00	21
10/02/2014	40.8	-0.10	41	4/08/2014	21.8	2.83	25
16/01/2014	38.5	-0.33	38	23/07/2014	12.8	2.67	15
19/01/2014	38.1	-0.52	38	24/07/2014	17.6	2.49	20
4/02/2014	37.7	-1.32	36	19/10/2014	16.1	2.42	19
22/11/2014	36.8	-0.64	36	8/08/2014	18.8	2.37	21
12/01/2014	34.9	-0.24	35	15/07/2014	28.2	2.33	31
1/02/2014	34.9	-1.22	34	9/07/2014	9.3	2.29	12

Table F-11: 2017 (PM_{10} 24-hr average concentration) – Assessment location R15

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
17/12/2014	43.8	0.01	44	8/07/2014	6.5	1.94	8
15/11/2014	43.6	-0.04	44	15/08/2014	14.0	1.50	15
4/11/2014	42.8	-0.07	43	5/10/2014	23.8	1.44	25
10/02/2014	41.9	0.18	42	31/10/2014	29.3	1.17	30
3/01/2014	39.0	0.00	39	3/06/2014	6.2	1.01	7
16/01/2014	36.5	-0.57	36	25/08/2014	13.2	0.96	14
30/12/2014	35.9	-0.10	36	21/04/2014	15.6	0.84	16
10/11/2014	35.6	-0.03	36	4/06/2014	9.9	0.81	11
13/02/2014	34.7	0.00	35	5/04/2014	10.9	0.77	12
4/02/2014	34.6	-0.38	34	2/06/2014	6.3	0.72	7

Table F-12: 2017 (PM_{10} 24-hr average concentration) – Assessment location R16

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
17/12/2014	43.8	0.01	44	15/08/2014	14.0	1.09	15
15/11/2014	43.6	-0.01	44	4/06/2014	9.9	1.06	11
4/11/2014	42.8	-0.03	43	5/10/2014	23.8	1.02	25
10/02/2014	41.9	0.28	42	31/10/2014	29.3	1.02	30
3/01/2014	39.0	-0.01	39	25/08/2014	13.2	0.86	14
16/01/2014	36.5	-0.36	36	6/06/2014	11.1	0.85	12
30/12/2014	35.9	-0.05	36	29/04/2014	14.2	0.74	15
10/11/2014	35.6	-0.02	36	21/04/2014	15.6	0.73	16
13/02/2014	34.7	0.00	35	31/08/2014	13.1	0.72	14
4/02/2014	34.6	-0.21	34	8/07/2014	6.5	0.71	7

Table F-13: 2017 (PM_{10} 24-hr average concentration) – Assessment location R17

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
17/12/2014	43.8	0.01	44	26/07/2014	8.6	0.67	9
15/11/2014	43.6	-0.07	44	25/09/2014	12.0	0.42	12
4/11/2014	42.8	-0.02	43	14/06/2014	10.0	0.29	10
10/02/2014	41.9	-0.01	42	2/04/2014	20.2	0.28	20
3/01/2014	39.0	0.00	39	24/11/2014	26.3	0.26	27
16/01/2014	36.5	-0.23	36	16/03/2014	14.2	0.24	14
30/12/2014	35.9	-0.06	36	23/05/2014	17.1	0.23	17
10/11/2014	35.6	-0.02	36	15/10/2014	6.5	0.23	7
13/02/2014	34.7	0.00	35	6/11/2014	17.6	0.22	18
4/02/2014	34.6	-0.06	35	4/04/2014	15.8	0.19	16

Table F-14: 2017 (PM_{10} 24-hr average concentration) – Assessment location R18

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
17/12/2014	43.8	0.00	44	27/07/2014	4.7	0.60	5
15/11/2014	43.6	-0.01	44	3/07/2014	11.6	0.52	12
4/11/2014	42.8	-0.07	43	28/07/2014	6.0	0.45	6
10/02/2014	41.9	0.06	42	1/02/2014	34.4	0.40	35
3/01/2014	39.0	0.00	39	6/11/2014	17.6	0.39	18
16/01/2014	36.5	-0.02	36	16/10/2014	12.9	0.36	13
30/12/2014	35.9	-0.14	36	2/09/2014	8.7	0.35	9
10/11/2014	35.6	-0.01	36	29/04/2014	14.2	0.31	15
13/02/2014	34.7	0.00	35	18/09/2014	13.0	0.27	13
4/02/2014	34.6	0.03	35	1/09/2014	7.7	0.27	8

Table F-15: 2017 (PM_{10} 24-hr average concentration) – Assessment location R32

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
17/12/2014	43.8	0.08	44	30/09/2014	17.9	1.68	20
15/11/2014	43.6	0.01	44	31/07/2014	9.6	1.09	11
4/11/2014	42.8	-0.01	43	27/06/2014	8.6	0.86	9
10/02/2014	41.9	0.02	42	11/09/2014	10.6	0.66	11
3/01/2014	39.0	0.00	39	29/09/2014	12.5	0.64	13
16/01/2014	36.5	0.03	37	6/05/2014	10.1	0.58	11
30/12/2014	35.9	-0.08	36	28/07/2014	6.0	0.56	7
10/11/2014	35.6	0.00	36	30/07/2014	8.6	0.38	9
13/02/2014	34.7	0.00	35	4/01/2014	22.9	0.38	23
4/02/2014	34.6	0.01	35	7/12/2014	7.4	0.36	8

Table F-16: 2017 (PM_{10} 24-hr average concentration) – Assessment location R13

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
22/07/2014	48.2	-0.42	48	12/10/2014	31.2	5.14	36
14/07/2014	48.2	0.24	48	4/08/2014	16.3	4.85	21
21/07/2014	41.1	-0.54	41	10/10/2014	30.6	4.48	35
13/08/2014	40.5	-5.88	35	26/02/2014	25.5	4.44	30
17/12/2014	38.2	-0.76	37	24/07/2014	18.9	4.10	23
10/02/2014	38.1	-0.22	38	19/10/2014	14.9	3.35	18
11/10/2014	37.0	-1.93	35	15/07/2014	0.0	3.24	3
8/11/2014	37.0	-4.28	33	19/09/2014	12.7	3.16	16
7/10/2014	36.3	-0.45	36	2/04/2014	17.8	3.04	21
4/11/2014	36.3	-1.73	35	16/07/2014	14.5	3.02	18

Table F-17: 2017 (PM_{10} 24-hr average concentration) – Assessment location R24

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
22/07/2014	48.2	10.08	**58**	10/06/2014	10.2	17.82	28
14/07/2014	48.2	1.40	50	11/06/2014	10.6	13.78	24
21/07/2014	41.1	11.01	**52**	1/06/2014	14.2	13.40	28
13/08/2014	40.5	4.27	45	28/08/2014	13.7	13.01	27
17/12/2014	38.2	0.56	39	31/03/2014	13.9	11.17	25
10/02/2014	38.1	1.57	40	21/07/2014	41.1	11.01	**52**
11/10/2014	37.0	6.07	43	22/07/2014	48.2	10.08	**58**
8/11/2014	37.0	6.01	43	26/03/2014	13.2	9.62	23
7/10/2014	36.3	0.83	37	25/03/2014	15.6	9.57	25
4/11/2014	36.3	5.63	42	21/09/2014	19.0	9.38	28

Table F-18: 2017 (PM_{10} 24-hr average concentration) – Assessment location R25

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
22/07/2014	48.2	14.60	**63**	10/06/2014	10.2	24.32	34
14/07/2014	48.2	3.04	**51**	1/06/2014	14.2	21.40	36
21/07/2014	41.1	17.08	**58**	28/08/2014	13.7	21.09	35
13/08/2014	40.5	9.12	50	11/06/2014	10.6	19.44	30
17/12/2014	38.2	1.54	40	21/07/2014	41.1	17.08	**58**
10/02/2014	38.1	3.69	42	26/03/2014	13.2	16.35	30
11/10/2014	37.0	9.24	46	31/03/2014	13.9	16.10	30
8/11/2014	37.0	9.27	46	21/09/2014	19.0	14.78	34
7/10/2014	36.3	1.54	38	13/07/2014	12.6	14.75	27
4/11/2014	36.3	9.18	45	22/07/2014	48.2	14.60	**63**
14/08/2014	35.5	8.67	44	23/03/2014	7.9	14.50	22