AIR QUALITY AND GREENHOUSE GAS STUDY

Appendix F

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F

AIR QUALITY AND
GREENHOUSE GAS ASSESSMENT
HVO SOUTH
MODIFICATION 5

EMM Consulting

25 January 2017

Job Number 15010400

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Air Quality and Greenhouse Gas Assessment HVO South Modification 5

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DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT – 001	09/11/2015	P Henschke	A Todoroski, L Stewart, D Peake
FINAL - 001	23/02/2016	A Todoroski	
FINAL - 007	02/12/2016	P Henschke/ A Todoroski	A Todoroski
FINAL - 009	25/01/2017	P Henschke/ A Todoroski	A Todoroski

EXECUTIVE SUMMARY

This assessment investigates the potential air quality effects and calculates the greenhouse gas emissions that may arise as a result of the proposed modification to Hunter Valley Operations South (HVO South) coal mine located in the Hunter Valley region of New South Wales.

The proposed modification seeks approval to access the deeper coal seams and additional overburden emplacement space within the current footprint. This assessment is prepared in accordance with the applicable regulatory requirements and guidelines and forms part of the environmental assessment prepared for the modification application.

The existing meteorological conditions in the area surrounding the HVO South coal mine 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.

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

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

The assessment predicts potential dust impacts are likely to occur at four privately-owned assessment locations and at a number of mine-owned assessment locations surrounding HVO South. The three of the four privately-owned assessment locations are all located within Warkworth Village and are already subject to environmental air quality impacts due to other mine operations. Of these, assessment location 77 is within Wambo Mine's current acquisition zone; assessment location 102 is the Warkworth Hall, a non-residential location; and assessment location 264 is St Phillips Church, also a non-residential location. Assessment locations 102 and 264 are uninhabited and may be used very infrequently, and as such unlike a residence, would only be subject to brief periods of potential exposure (less than the minimum period applicable for dust criteria) when occasionally occupied. The other privately-owned assessment location, assessment location 471, is located to the northeast of the HVO South and is currently afforded acquisition rights by other mine operations.

A comparison with the previous air quality modelling predictions for HVO South (**Holmes Air Sciences, 2008**) shows that overall, the predicted dust levels associated with the modification would be of a generally similar extent to the approved operations and therefore would not result in any significant change to that which is already approved for HVO South.

The potential for any adverse air quality impacts associated with coal dust generated during rail transport is found to be low and as the proposed modification is not seeking any change to rail movements, there would not be any change in air quality associated with this activity.

As blasting is currently permitted at HVO South 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. To ensure that blasting activities continue to be managed in a manner that would minimise the risk of impacts arising in the future, suggested improvements to the operational systems that arise from new scientific knowledge and a better understanding of blast management are recommended for the proposed modification.

Using the conservative upper limit of the assumed maximum production for the proposed modification, the estimated annual average greenhouse emission is 0.71 million tonnes of carbon dioxide equivalent (Mt CO_2-e) material (Scope 1 and 2), which is calculated to be approximately 0.13 per cent of the Australian greenhouse emissions for the February 2014 to March 2015 period and approximately 0.5 per cent of the New South Wales greenhouse emissions for the 2013 period.

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1 INTRODUCTION

Coal & Allied Operations Pty Limited and HVO Resources Pty Limited own the Hunter Valley Operations (HVO) mining complex, which is managed by HV Operations Pty Ltd (Coal & Allied). Coal & Allied seeks a modification to its current project approval (PA) (PA 06_0261) for its HVO South mine located approximately 24 kilometres (km) northwest of Singleton in the Singleton local government area.

The mining and processing activities at HVO are geographically divided by the Hunter River into operations north of the Hunter River (HVO North) and operations south of the Hunter River (HVO South), with movements of coal, coarse and fine reject, overburden, topsoil, equipment, water, materials and personnel occurring between the two areas. While HVO North and HVO South each have separate planning approvals, HVO is managed as one operation. Rio Tinto Coal Australia (RTCA) provides management services at HVO for Coal & Allied.

HVO South Modification 5 (proposed modification) seeks approval to access the deeper coal seams and additional overburden emplacement space within the current footprint.

This air quality and greenhouse gas assessment was prepared by Todoroski Air Sciences on behalf of Coal & Allied.

1.1 Existing operations

HVO South operates under Project Approval PA 06_0261. It comprises the active Lemington South, Cheshunt and Riverview pits, inclusive of all related mining activities and infrastructure such as overburden emplacement areas.

Three coal preparation plants (CPPs) are used by HVO South and HVO North, and are the Hunter Valley, Newdell and Howick CPPs. There are two train load out areas; Hunter Valley Load Point and Newdell Load Point, and in addition, Ravensworth Coal Terminal (off-site) is also used. Some items of infrastructure such as the Lemington CPP and the associated rail infrastructure are approved but not yet constructed at HVO South.

HVO South is approved to extract 16 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

A small number of properties are entitled to acquisition upon request under PA 06_0261. Details of the properties are provided in **Table 1-1**.

Table 1-1: Land subject to acquisition upon request

Receptor Number (PA 06_0261)	Assessment location ID	Name
16	118	Algie
32	117	Algie (Curlewis)
38	109	Henderson
Keys (vacant land – Lot 2 DP 770905 and Lot 84 DP 753792) – now consolidated as Lot 84 DP 1124139		

Source: PA 06_0261; EMM (2016)

Three of the properties in **Table 1-1** have been subsequently acquired. Properties 117 and 118 are now owned by Coal & Allied, and property 109 is owned by Glencore.

The only remaining properties entitled to acquisition upon request are the two vacant lots owned by Keys (Lot 2 DP 7709905 and Lot 84 DP 753792). Since approval was granted in 2009, the landowner has consolidated these two lots into a single parcel of land, referenced as Lot 84 DP 1124139. This consolidated does not affect the existing acquisition rights.

1.2 Modification description

The application to modify PA 06_0261 is to allow:

- the progression of mining to the base of the deeper Bayswater seam from Cheshunt Pit into Riverview Pit and mining to the base of the Vaux seam below the Bowfield seam in the South Lemington Pit 2;
- a modification to the currently approved overburden emplacement strategy to enable an increase in height in some areas to approximately 230m AHD and incorporation of micro-relief to provide a more natural final landform;
- an increased rate of extraction from 16Mtpa to 20Mtpa ROM coal at peak production and an increased processing rate of coal extracted from HVO South from 16Mtpa to 20Mtpa of ROM coal across HVO coal preparation plants (CPPs); and
- the update of the Statement of Commitments within PA 06_0261 with removal of commitments that are redundant or inconsistent with measures prescribed in approved management plans. This includes the transition from prescriptive blasting conditions and replacement with contemporary outcome based conditions.

The proposed modification will not change the approved footprint of disturbance, mining method, employee numbers, integrated tailing and water management across HVO or extend the project approval period. The components listed above are taken collectively to form the modification. This is the fifth modification of PA 06_0261 and therefore the proposal is named 'HVO South – Modification 5' which is referred to herein as the 'proposed modification'.

The proposed modification will include consolidation of the above with all the operational and environmental activities approved under PA 06_0261, including all aspects of integration with HVO North.

1.3 Assessment purpose

This air quality impact and greenhouse gas assessment has been prepared in general accordance with the New South Wales (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 modification application for Modification 5.

The assessment investigates the potential for adverse air quality impacts occurring at surrounding assessment locations as a result of the Modification 5. 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.

This assessment comprises:

- A review of the existing environment surrounding the proposed modification;
- A description of the dispersion modelling approach used to assess potential impacts;
- The results of the dispersion modelling;
- A discussion of the potential air quality impacts as a result of the proposed modification;
- An estimation of the greenhouse gas emissions generated; and
- Measures to avoid or mitigate potential air quality impacts.

2 LOCAL SETTING

The general area surrounding HVO South is comprised of various open cut coal mining operations, agriculture, woodland, national park and rural residential areas.

Figure 2-1 presents the location of the HVO South in relation to the 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 the HVO South. The surrounding topography is characterised by the steep escarpment to the southwest which forms part of the Wollemi National Park. To the north and east, the terrain is generally open to form the Hunter Valley. 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.

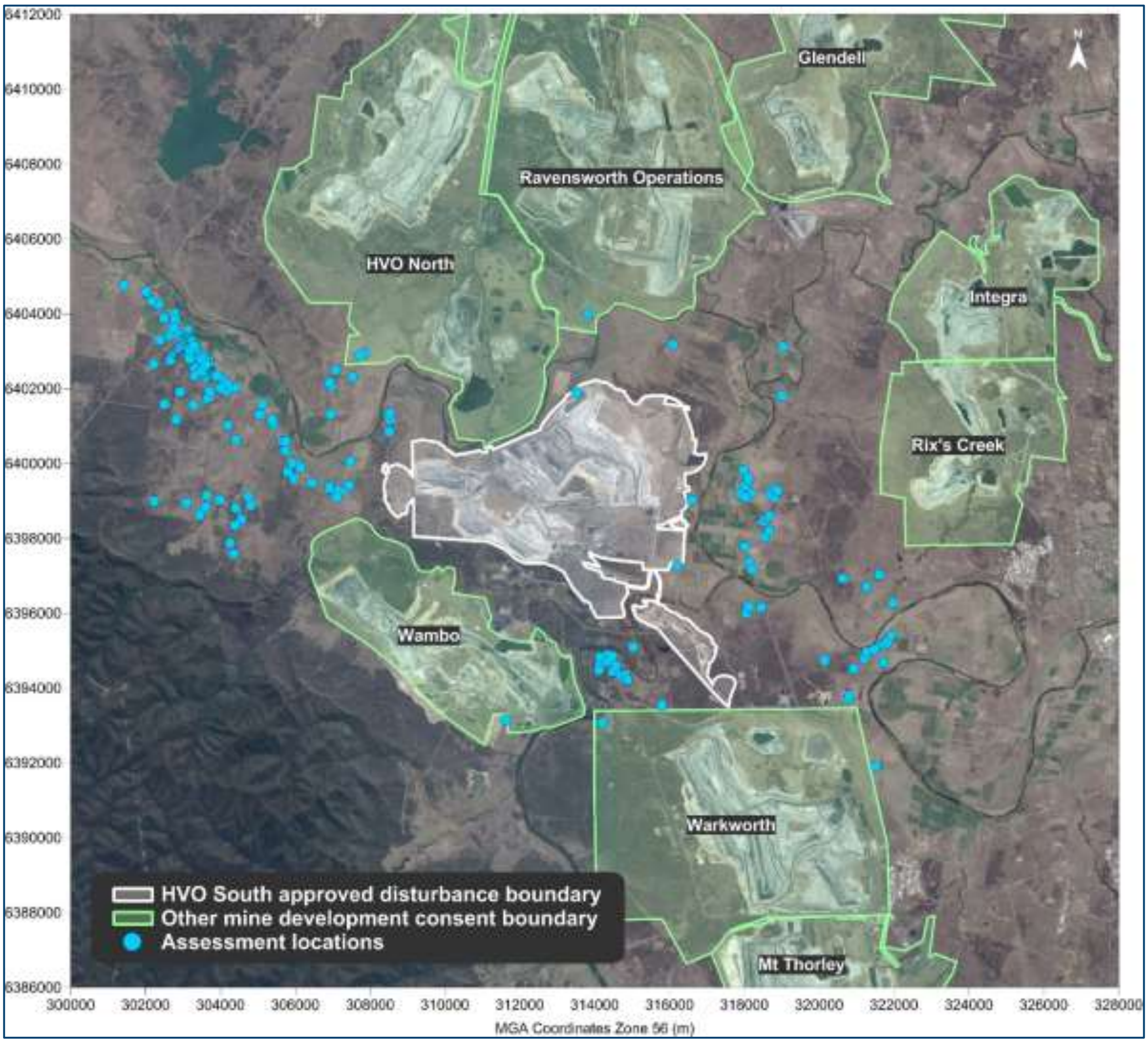


Figure 2-1: Local setting

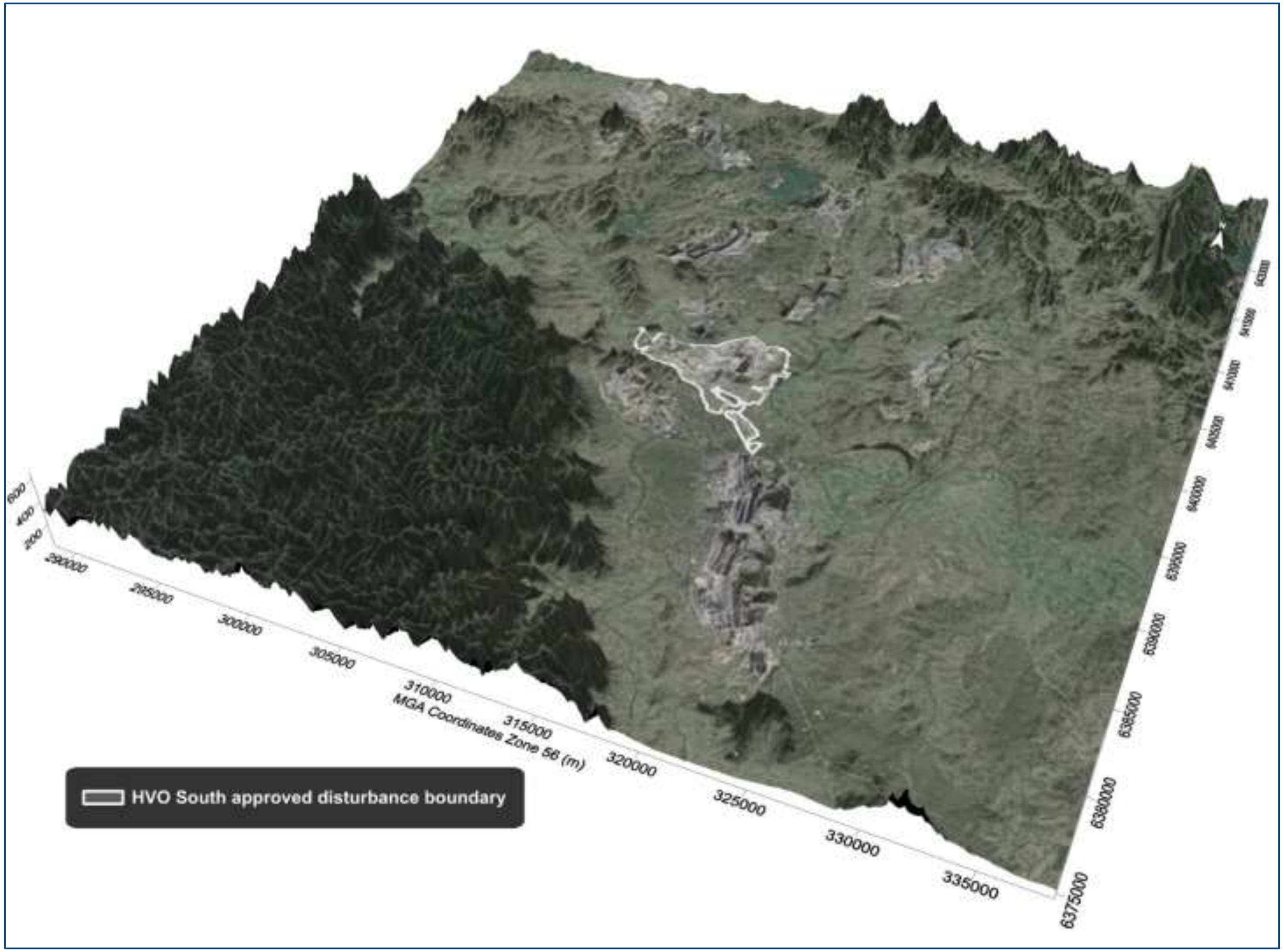


Figure 2-2: Topography surrounding HVO South

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 is due to the abrasion, or crushing of rock and coal, and general disturbance of dusty material. 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 per cent (%) 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 deposit 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

The Mining SEPP non-discretionary standard with respect to cumulative air quality at private dwellings of PM_{10} annual average criterion of 30µg/m³ is equivalent to the NSW EPA annual average PM_{10} criterion.

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.

It is important to note that NEPM air quality standards are not designed to be applied to specific projects. The NEPM standards apply to the average exposure to air pollutants of the general population, in each state. The NEPM requires that the states report to the Commonwealth on the trends in air quality by way of reference to the standards.

The National Environment Protection Council agreed to vary the Ambient Air Quality National Environment Protection Measure by approving an amending instrument on 15 December 2015. The amending instrument took effect on 4 February 2016.

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} and $PM_{2.5}$ is outlined in **Table 3-2**.

Table 3-2: NEPM standards for PM_{10} and $PM_{2.5}$ concentrations

Pollutant	Averaging Period	Maximum concentration
PM_{10}	24 hour	50µg/m³
	Annual	25µg/m³
$PM_{2.5}$	24 hour	25µg/m³
	Annual	8µg/m³

As with each of the NEPM standards, these apply to the average, or general exposure of a population, rather than to "hot spot" locations near industry, where impacts are assessed via impact assessment criteria.

The NSW EPA do not have impact assessment criteria for $PM_{2.5}$ concentrations.

3.1.3 World Health Organization Air Quality Guidelines

The World Health Organization (WHO) publishes air quality guidelines that aim to avert potential health impacts associated with air pollution. The guidelines are based on expert evaluation of scientific evidence and include research from low and middle income countries where air pollution levels are at their highest. The guidelines are predominantly based on $PM_{2.5}$ data from large urban cities.

Table 3-3 outlines the WHO air quality guidelines for particulate matter.

Table 3-3: WHO air quality guidelines

Pollutant	Averaging Period	Guideline level
PM_{10}	24 hour (99th percentile)	$50\mu g/m^3$ *
	Annual	$20\mu g/m^3$ *
$PM_{2.5}$	24 hour (99th percentile)	$25\mu g/m^3$
	Annual	$10\mu g/m^3$

Source: WHO, 2005 * Default level

WHO notes that its air quality guidelines are for $PM_{2.5}$, and that the PM_{10} guideline is only provided as a surrogate offering the same level of protection as the $PM_{2.5}$ guideline. This is done because PM_{10} is more commonly measured and there is often no $PM_{2.5}$ data available. The WHO sets the surrogate PM_{10} level at double the $PM_{2.5}$ guideline level as in most large urban cities the PM_{10} level is in fact approximately 1.25 to 2 times the $PM_{2.5}$ level (**WHO, 2005**).

It is expected that the area around the HVO South would be similar to the Upper Hunter Valley region of NSW which shows that PM_{10} levels are, on average, three times higher than the $PM_{2.5}$ levels (when considering all data on record for Camberwell and Singleton from 2011 to 2014). These data can be sourced from the NSW Office of Environment and Heritage (OEH) website: http://www.environment.nsw.gov.au/AQMS/search.htm.

The WHO guidelines state that in areas where the fraction of $PM_{2.5}$ and PM_{10} is known, the PM_{10} level can be set to offer the same level of protection as the $PM_{2.5}$ guideline. Therefore, in this situation, the WHO guideline for PM_{10} for the area would be set as an annual average of $30\mu g/m^3$.

The WHO guideline levels apply at the 99th percentile for short term, 24-hour average levels, (ie the fourth highest day of a year) permitting three days above the guideline level.

It is noted that the WHO guidelines which could apply in this area are generally equivalent to or less stringent than the NSW guidelines.

3.1.4 NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP)

Part of the NSW Voluntary Land Acquisition and Mitigation Policy dated 15 December 2014 and gazetted on 19 December 2014 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-4** at any residence or workplace. [1]

Table 3-4: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation Criterion	Impact Type
PM_{10}	Annual	$30\mu g/m^3$*	Human health
PM_{10}	24 hour	$50\mu g/m^3$**	Human health

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

Pollutant	Averaging period	Mitigation Criterion		Impact Type
TSP	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: NSW Government (2014)
*Cumulative impact (ie increase in concentration due to the development plus background concentrations due to all other sources).
**Incremental impact (ie increase in concentrations due to the development alone), with zero allowable exceedances of the criteria.

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

Table 3-5: Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition Criterion		Impact Type
PM_{10}	Annual	30µg/m³*		Human health
PM_{10}	24 hour	50µg/m³**		Human health
TSP	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: NSW Government (2014)
*Cumulative impact (ie increase in concentration due to the development plus background concentrations due to all other sources).
**Incremental impact (ie increase in concentrations due to the development alone), with up to 5 allowable exceedances of the criteria over the life of the development.

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 diesel powered equipment are generally considered too low to generate any significant off-site concentrations and have not been assessed in detail in this assessment. The potential NO_X emissions associated with blasting activity have been assessed qualitatively in **Section 8**.

Table 3-6 summarises the NSW EPA air quality goals for NO_2.

Table 3-6: NSW EPA air quality impact assessment criteria of air toxics

Pollutant	Averaging period	Criterion
Nitrogen dioxide (NO_2)	1 hour	246µg/m³
	Annual	62µg/m³

Source: **NSW DEC, 2005**

3.3 Protection of the Environment Operations Act 1997

In accordance with the Environment Protection Licence (No. 640) issued by the NSW EPA, the general obligations of the *Protection of the Environment Operations Act, 1997* and the Regulations made under the Act (namely the Protection of the Environment Operations (Clean Air) Regulation, 2010) are followed at the proposed modification. The proposed modification would continue to operate in accordance with the relevant regulatory framework for air quality to ensure compliance with this legislation.

3.4 NSW State Plan and Action for Air

NSW 2021 replaces the State Plan and is a 10 year plan to rebuild the economy, provide quality services, renovate infrastructure, restore government accountability and strengthen local environment and communities (**NSW Government, 2011**). The goals in *NSW 2021* related to air quality include increasing the number of air quality monitoring stations to provide further information on local air quality, to reduce dust emissions at NSW coal mines and reduce greenhouse gas emissions.

Action for Air began in 1998 and is the NSW Government's 25-year air quality management plan for Sydney, Wollongong and the Lower Hunter (**NSW DECCW, 2009**). Aims of *Action for Air* include reducing emissions such that compliance of the national air quality standards in the Ambient Air Quality NEPM is achieved and in turn reducing population exposure to air pollution.

The proposed modification would include continual improvement of operations at the mine to minimise dust and greenhouse gas emissions through various means and would also provide regular updates of the local air quality from the network of air quality monitoring stations operated in the area to gauge the performance of the operation.

4 EXISTING ENVIRONMENT

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

4.1 Local climate

Long term climatic data collected at the closest Bureau of Meteorology (BoM) weather station at Jerrys Plains Post Office (Station Number 061086) were analysed to characterise the local climate in the proximity of HVO South. The Jerrys Plains Post Office is located approximately 10km west-northwest of HVO South.

Table 4-1 and **Figure 4-1** show climatic parameters which have been collected from the Jerrys Plains Post Office over a 45 to 128 year period. These data assist in characterising the local climatic conditions based on the long term meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 31.8°C and July is the coldest month with a mean minimum temperature of 3.8°C.

Rainfall peaks during the summer months and declines during winter. The data show January is the wettest month with an average rainfall of 77.7mm over 6.4 days and August is the driest month with an average rainfall of 36.1mm over 5.2 days.

Relative humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am relative humidity levels range from 59 per cent in October to 80 per cent in June. Mean 3pm relative humidity levels vary from 42 per cent in October to December to 54 per cent in June.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. The mean 9am wind speeds range from 8.6km/h in April to 11.7km/h in September. The mean 3pm wind speeds vary from 11.0km/h in May to 14.7km/h in September.

Table 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean max. temperature (°C)	31.8	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.3	29.1	31.2
Mean min. temperature (°C)	17.2	17.1	15.0	11.0	7.4	5.3	3.8	4.4	7.0	10.3	13.2	15.7
Rainfall												
Rainfall (mm)	77.7	73.1	59.1	44.0	40.7	48.1	43.4	36.1	41.7	51.9	61.9	67.5
Mean No. of rain days (≥1mm)	6.4	6.0	5.8	4.9	4.9	5.5	5.2	5.2	5.2	5.8	6.2	6.3
9am conditions												
Mean temperature (°C)	23.4	22.7	21.2	18.0	13.6	10.6	9.4	11.4	15.3	19.0	21.1	23.0
Mean relative humidity (%)	67	72	72	72	77	80	78	71	65	59	60	61
Mean wind speed (km/h)	9.6	9.0	8.8	8.6	9.0	9.4	10.6	11.0	11.7	10.9	10.5	9.9
3pm conditions												
Mean temperature (°C)	29.8	28.9	27.2	24.1	20.1	17.1	16.4	18.2	21.2	24.2	26.9	29.0
Mean relative humidity (%)	47	50	49	49	52	54	51	45	43	42	42	42
Mean wind speed (km/h)	13.2	13.0	12.4	11.3	11.0	11.5	13.0	14.3	14.7	14.1	14.2	14.2

Source: **Bureau of Meteorology, 2015 (3 September 2015)**

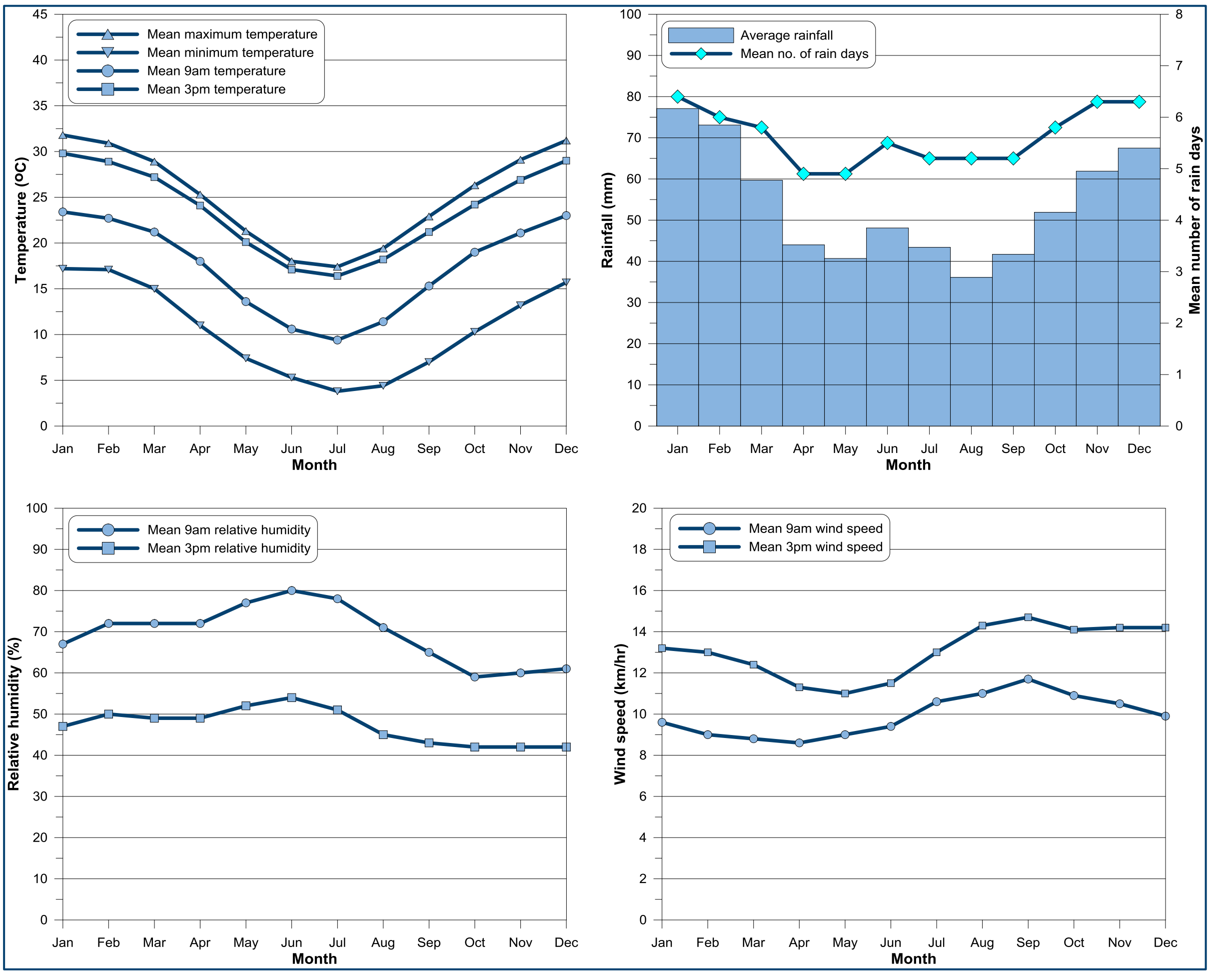


Figure 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

4.2 Local meteorological conditions

HVO South and HVO North operate the Cheshunt and HVO meteorological stations respectively, to assist with environmental management of site operations. 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 both stations are presented in **Figure 4-3** and **Figure 4-4**.

Analysis of the windroses shows that on an annual basis the general wind flows from the Cheshunt station are along the northwest to southeast axis which is typical of the Hunter Valley conditions. Very few winds originate from the northeast and southwest quadrants. The annual wind flow at the HVO station is skewed in an anticlockwise direction with winds along a west to east-southeast axis. This station may be influenced by local terrain features which at this location would skew the winds.

In summer the winds predominately occur from the southeast and east-southeast at both stations. The autumn wind distribution shows dominant winds from the northwest and west-northwest followed by the south-southeast at the Cheshunt station and from the west and east-southeast at the HVO station. During winter, winds are most frequent from the west-northwest and west at the stations. The spring windroses typically share a similar wind distribution pattern to the annual distributions at each station with winds from the northwest, southeast and south-southeast at the Cheshunt station and from the west and east-southeast at the HVO station.

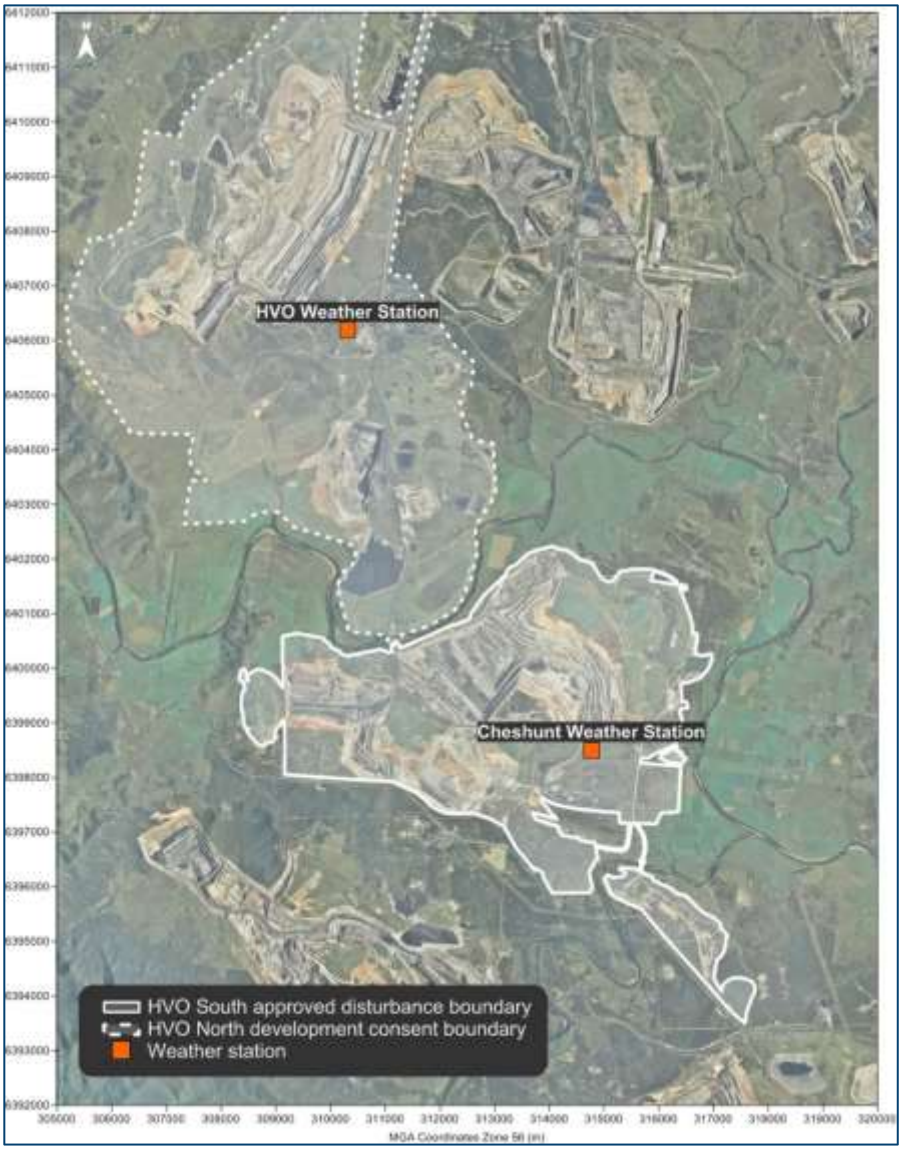


Figure 4-2: Cheshunt and HVO meteorological stations

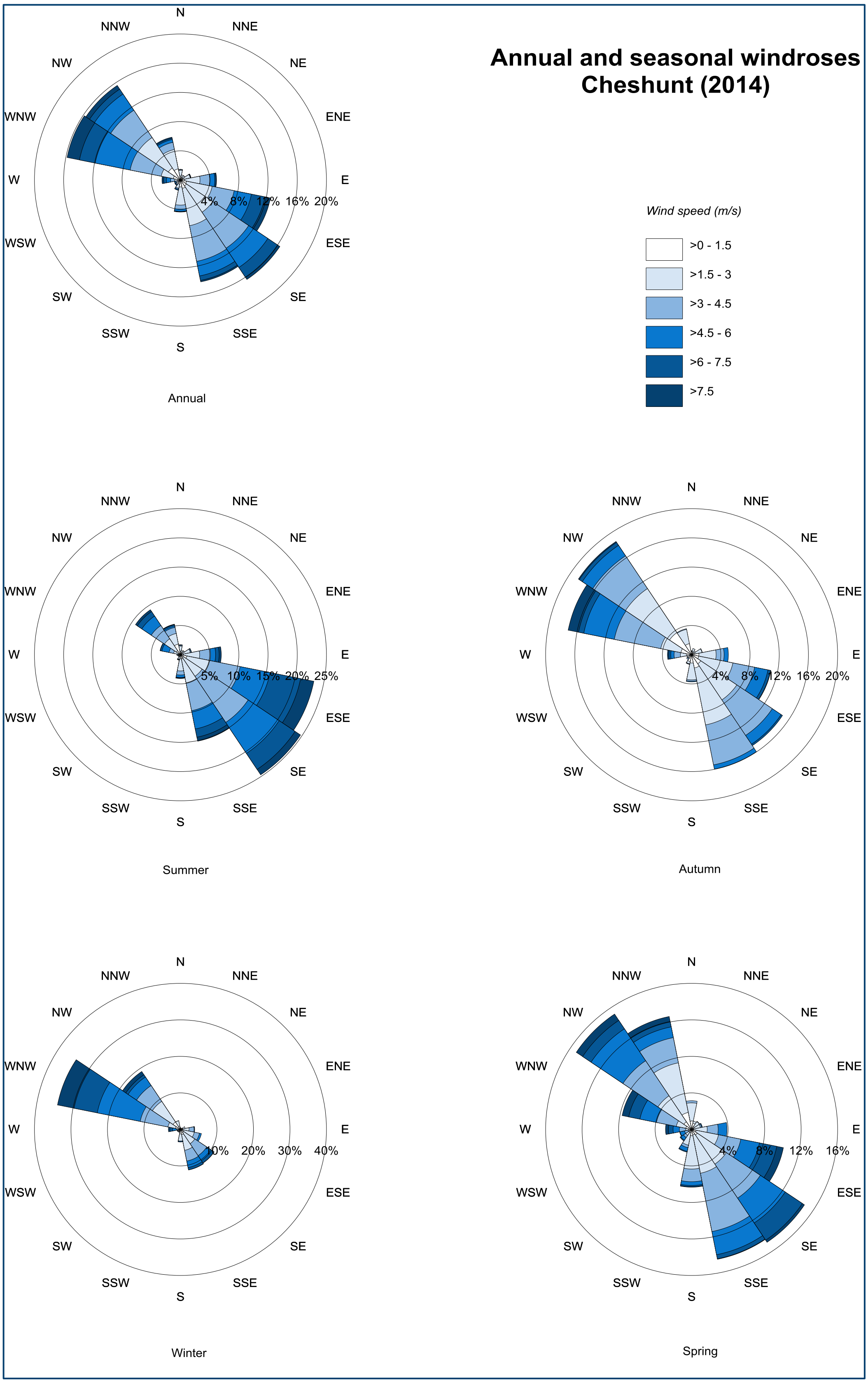


Figure 4-3: Annual and seasonal windroses for Cheshunt weather station (2014)

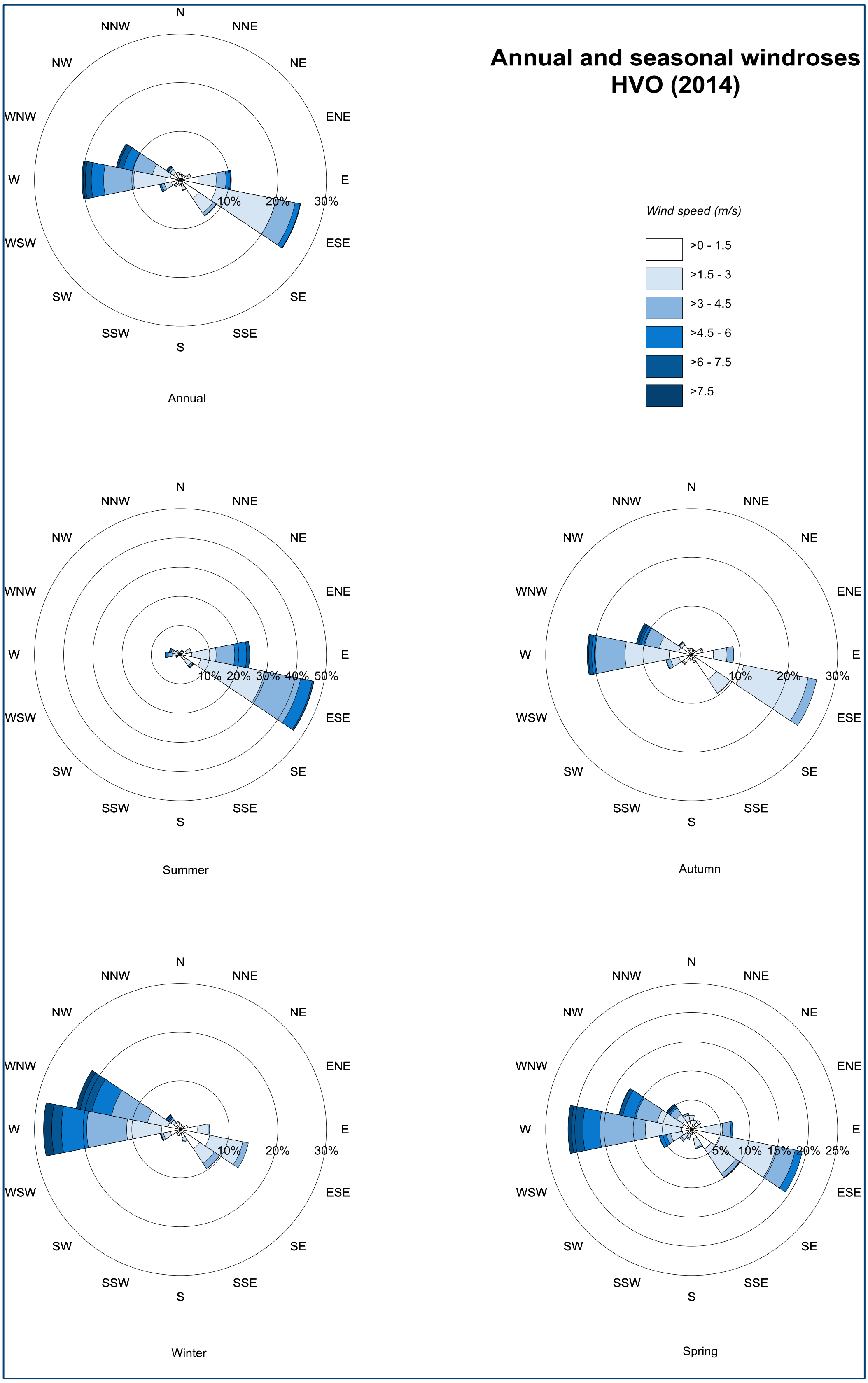


Figure 4-4: Annual and seasonal windroses for HVO weather station (2014)

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 monitoring data collected from a number of ambient monitoring locations in the vicinity of HVO South.

The air quality monitors reviewed in this assessment provide a comprehensive dataset and include eight Tapered Element Oscillating Microbalances (TEOMs), 10 High Volume Air Samplers (HVAS) measuring either TSP or PM_{10}, nine dust deposition gauges, two Beta attenuation monitors (BAM) measuring $PM_{2.5}$ and three NO_2 monitors.

Table 4-2 lists the monitoring stations reviewed in this section which includes data from surrounding mining operations and 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	Monitoring data review period
Maison Dieu	TEOM	January 2012 to December 2014
Knodlers Lane	TEOM	January 2012 to December 2014
Warkworth	TEOM	January 2012 to December 2014
Maison Dieu (NSW OEH)	TEOM	January 2012 to December 2014
Warkworth (NSW OEH)	TEOM	January 2012 to December 2014
Camberwell (NSW OEH)	TEOM	January 2012 to December 2014
Jerrys Plains (NSW OEH)	TEOM	January 2012 to December 2014
Singleton NW (NSW OEH)	TEOM	January 2012 to December 2014
Maison Dieu PM10	HVAS – PM_{10}	January 2012 to December 2014
Knodlers Lane PM10	HVAS – PM_{10}	January 2012 to December 2014
Kilburnie South PM10	HVAS – PM_{10}	January 2012 to December 2014
Warkworth PM10	HVAS – PM_{10}	January 2012 to December 2014
Long Point PM10	HVAS – PM_{10}	January 2012 to December 2014
Maison Dieu TSP	HVAS – TSP	January 2012 to December 2014
Knodlers Lane TSP	HVAS – TSP	January 2012 to December 2014
Kilburnie South TSP	HVAS – TSP	January 2012 to December 2014
Warkworth TSP	HVAS – TSP	January 2012 to December 2014
Long Point TSP	HVAS – TSP	October 2013 to December 2014
DL14	Dust gauge	January 2012 to December 2014
DL21	Dust gauge	January 2012 to December 2014
DL22	Dust gauge	January 2012 to December 2014
DL30	Dust gauge	January 2012 to December 2014
D118	Dust gauge	January 2012 to December 2014
D119	Dust gauge	January 2012 to December 2014
D122	Dust gauge	January 2012 to December 2014
Knodlers Lane	Dust gauge	January 2012 to December 2014
Warkworth	Dust gauge	January 2012 to December 2014
Singleton (NSW OEH)	BAM – $PM_{2.5}$	January 2012 to December 2014

Monitoring site ID	Type	Monitoring data review period
Camberwell (NSW OEH)	BAM – $PM_{2.5}$	January 2012 to December 2014
Beresfield (NSW OEH)	NO_2 monitor	January 2012 to December 2014
Muswellbrook (NSW OEH)	NO_2 monitor	January 2012 to December 2014
Singleton (NSW OEH)	NO_2 monitor	January 2012 to December 2014

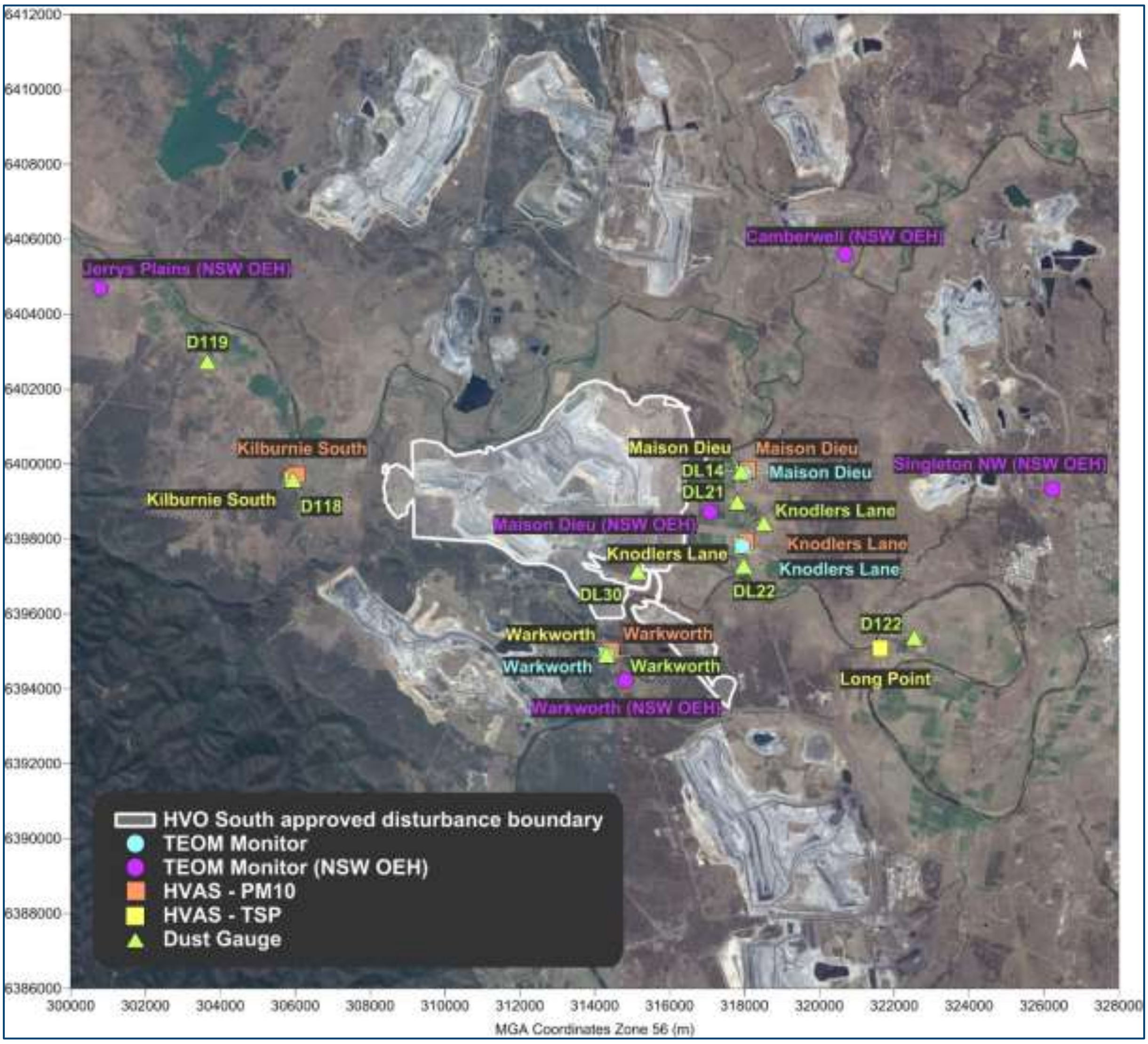


Figure 4-5: Monitoring locations

4.3.1 PM_{10} monitoring - TEOMs

Ambient PM_{10} monitoring using TEOMs is conducted by Coal & Allied at HVO 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 include all emission sources in the vicinity of HVO South.

The TEOMs operated by Coal & Allied at HVO are used for management purposes only and not applied for compliance monitoring. The TEOM monitors provide an indication of the real time air quality conditions surrounding HVO South and are programmed with pre-established real time air quality alarms to notify of increasing dust levels in real time and to trigger additional management action as required.

4.3.1.1 Hunter Valley Operations

A summary of the available data collected from HVO monitors from January 2012 to December 2014 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/m³ for all relevant years, indicating that overall, 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 HVO TEOM monitoring (µg/m³)

	Annual average			Maximum 24-hour average		
	2012	2013	2014	2012	2013	2014
Maison Dieu	21.4	21.5	21.6	76.0	74.7	73.7
Knodlers Lane	18.1	18.9	19.0	56.3	62.1	54.8
Warkworth	16.5	18.2	16.8	41.2	58.0	52.3

With respect to the short-term concentrations, the maximum 24-hour average PM_{10} concentration recorded at the TEOM monitors was on occasion above the 50µg/m³ criterion (see **Figure 4-6**).

An investigation into the potential cause of these elevated PM_{10} levels indicate that they typically coincide with regional dust events which effect a wide area as indicated by other air quality monitoring stations in the surrounding region also recording elevated levels. At other times, potential sources such as local agricultural sources, mining activity and other sources may have contributed to periods of elevated PM_{10} levels.

It can be seen from **Figure 4-6** that PM_{10} concentrations are nominally highest in the spring and summer months with the warmer weather raising the potential for drier ground elevating the occurrence of windblown dust, bushfires and pollen levels.

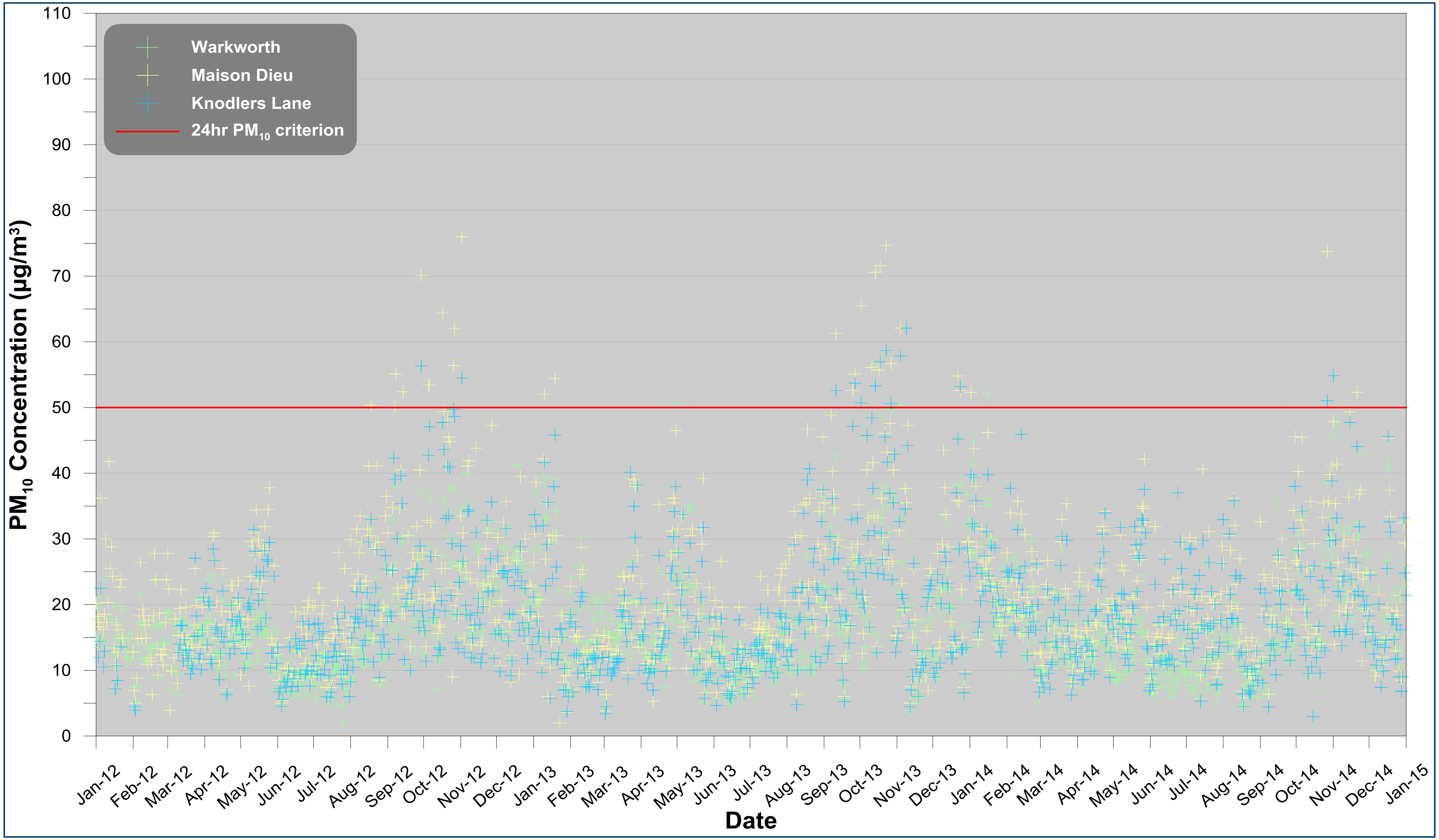


Figure 4-6: TEOM 24-hour average PM_{10} concentrations at HVO monitors

4.3.1.2 NSW EPA

A summary of the available data from the NSW EPA 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/m³. The maximum 24-hour average PM_{10} concentrations recorded at these stations were found to exceed the relevant criterion of 50µg/m³ at times during the review period.

Table 4-4: Summary of PM_{10} levels from NSW EPA TEOM monitoring (µg/m³)

	Annual average			Maximum 24-hour average		
	2012	2013	2014	2012	2013	2014
Maison Dieu (NSW EPA)	25.8	25.8	22.7	87.7	84.2	63.7
Warkworth (NSW EPA)	21.1	21.4	20.6	49.9	65.4	67.9
Camberwell (NSW EPA)	26.4	27.8	24.6	81.6	104.8	79.7
Jerrys Plains (NSW EPA)	10.8	18.6	18.2	43.7	63.3	64.4
Singleton NW (NSW EPA)	25.9	25.9	22.7	85.2	91.7	64.7

The Ambient Air Quality NEPM standard for 24 hour average PM_{10} and $PM_{2.5}$ includes an allowance to remove days on which exceptional events (eg bushfire, dust storm) occur for the purpose of NEPM compliance reporting. 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 non-NEPM compliant 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 HVO TEOM station data (shown in **Figure 4-6**). There is some variation between the measured ambient data at various sites and is expected to be largely attributed to the proximity of these monitors to various local dust sources in the surrounding area.

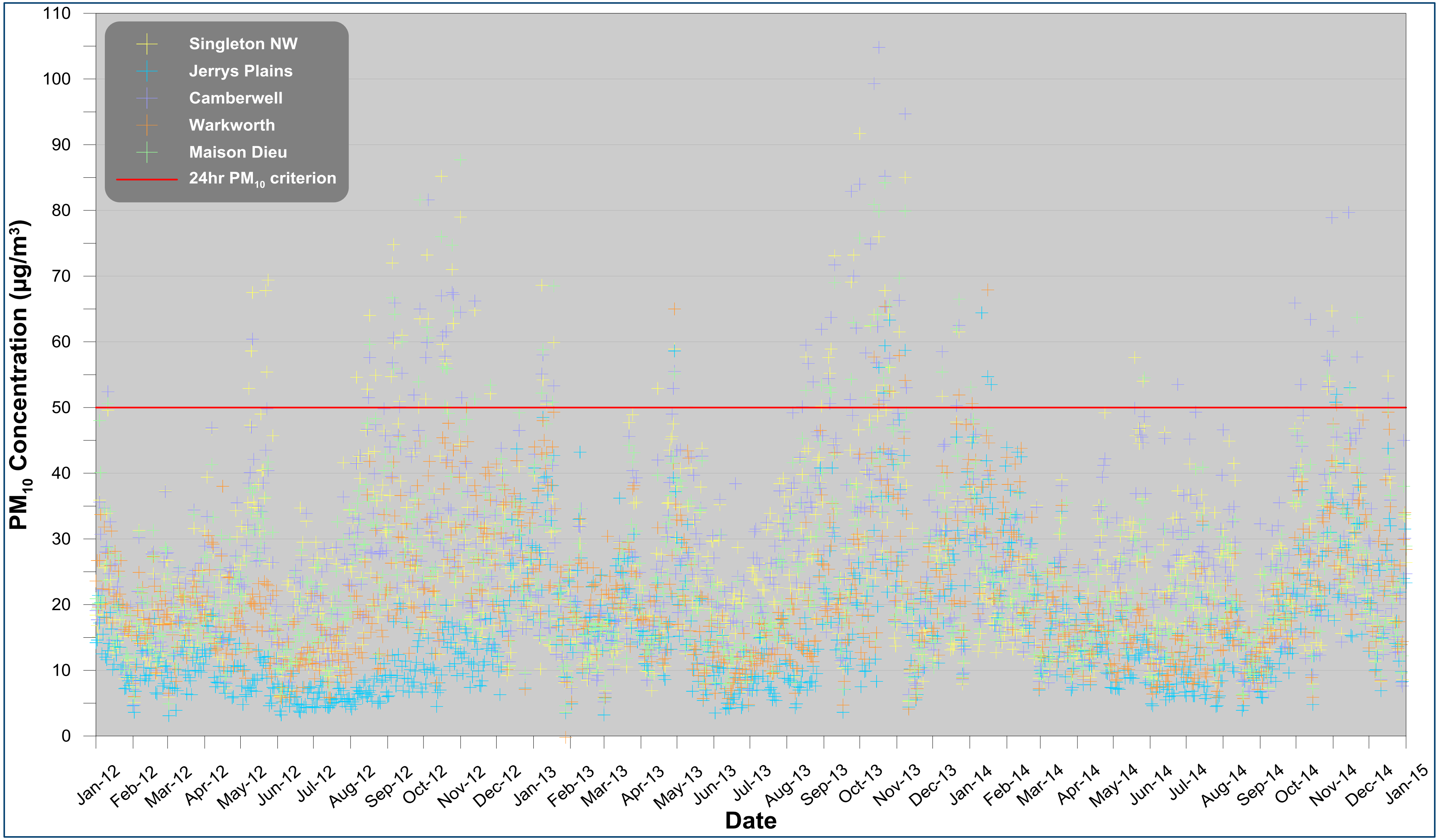


Figure 4-7: TEOM 24-hour average PM_{10} concentrations at NSW OEH monitors

4.3.2 PM_{10} monitoring - HVAS

A summary of the PM_{10} readings from the five HVAS monitoring stations is presented in **Table 4-5**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-8**.

The data in **Table 4-5** indicate that the annual average PM_{10} concentrations for each of the monitoring stations were below the relevant criterion of 30µg/m³ for the years reviewed. The seasonal trends in PM_{10} concentrations can be seen in **Figure 4-8**, with elevated days tending to occur in the warmer months with regional events indicated by most monitors showing elevated levels over the same period.

Table 4-5: Summary of PM_{10} levels from HVAS monitoring (µg/m³)

	Annual average			Maximum 24-hour average		
	2012	**2013**	**2014**	**2012**	**2013**	**2014**
Maison Dieu	14.8	16.4	18.8	45	52	86
Knodlers Lane	20.8	24.9	22.5	59	84	67
Kilburnie South	20.2	19.4	18.8	53	61	58
Warkworth	19.3	21.6	21.8	68	63	75
Long Point(1)	8.7	21.4	19.6	16	45	58

(1)Data available from Jan to Feb 2012 and Oct 2013 to Dec 14

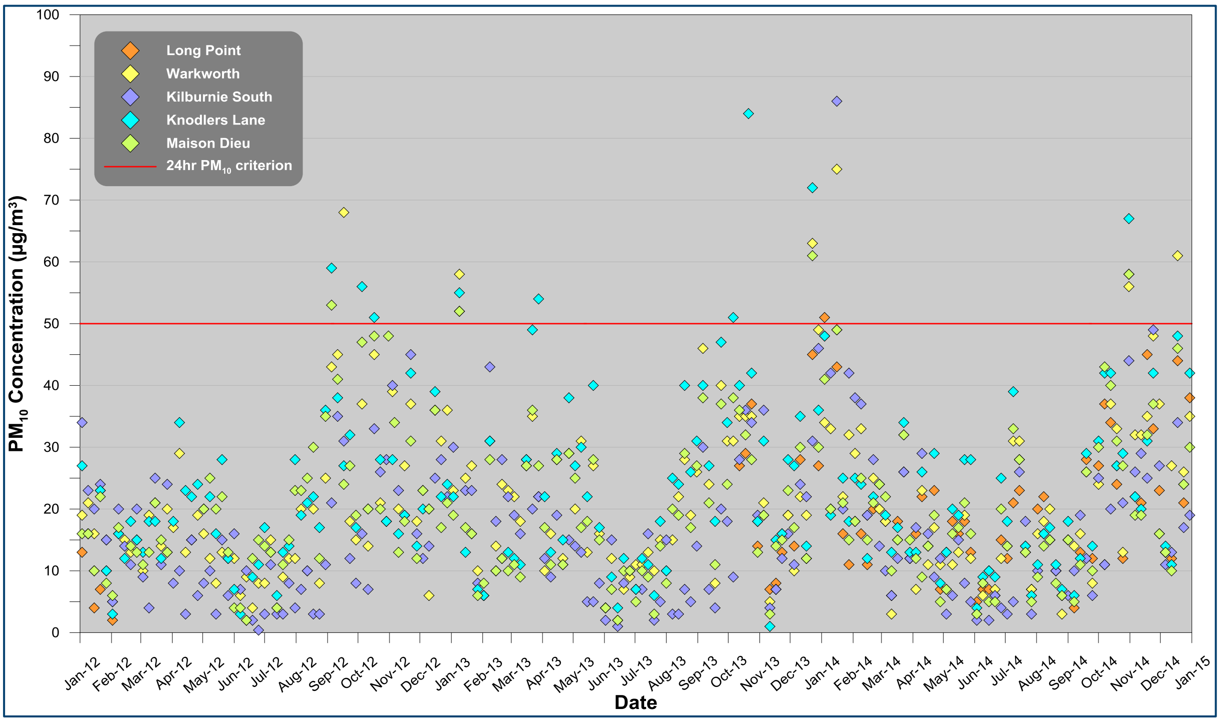


Figure 4-8: HVAS 24-hour average PM_{10} concentrations

As shown in **Figure 4-8**, the maximum 24-hour average PM_{10} concentrations exceed the relevant criterion of 50µg/m³ at times. For the period of review, there were four, five and four days of elevated 24-hour PM_{10} levels recorded at the HVAS stations during 2012, 2013 and 2014 respectively. For each of these events, an investigation was conducted to identify the potential cause of the exceedance.

On the 5 September 2012, the Maison Dieu and Knodlers Lane monitors recorded PM_{10} levels above the criterion. Based the wind conditions during this day the estimated contribution from HVO was found to be less than 10µg/m³. The Warkworth monitor recorded elevated levels on 17 September 2012. An investigation for this day identified lawn mowing activity occurring adjacent to the monitor was the main cause of the recorded exceedance. The Knodlers Lane monitor recorded two day above the criterion on the 5 and 17 October 2012. An analysis of prevailing winds on these days indicates that the contribution from HVO may not have been significant.

On the 9 January 2013 a regional dust event was identified as the cause of recorded exceedance at each of the Maison Dieu, Knodlers Lane, Warkworth and Kilburnie South monitors. On 28 March 2013, an analysis into the recorded elevated level at the Knodlers Lane monitor indicated that based on the wind conditions on the day prevailing east to south-easterly, it is highly unlikely that HVO South would have had a significant contribution. On the 6 October 2013, the Knodlers Lane monitor recorded elevated levels and it was found the HVO may have contributed approximately 45 per cent of the measured level based on an analysis of the wind data and real time PM_{10} data.

The elevated level during 21 October 2013 was likely influenced by bushfire smoke in the regional air column. **Figure 4-9** presents satellite imagery of the area around HVO South showing bushfire smoke on 21 October 2013, noting the red patches in the image indicate the position of the active fire.

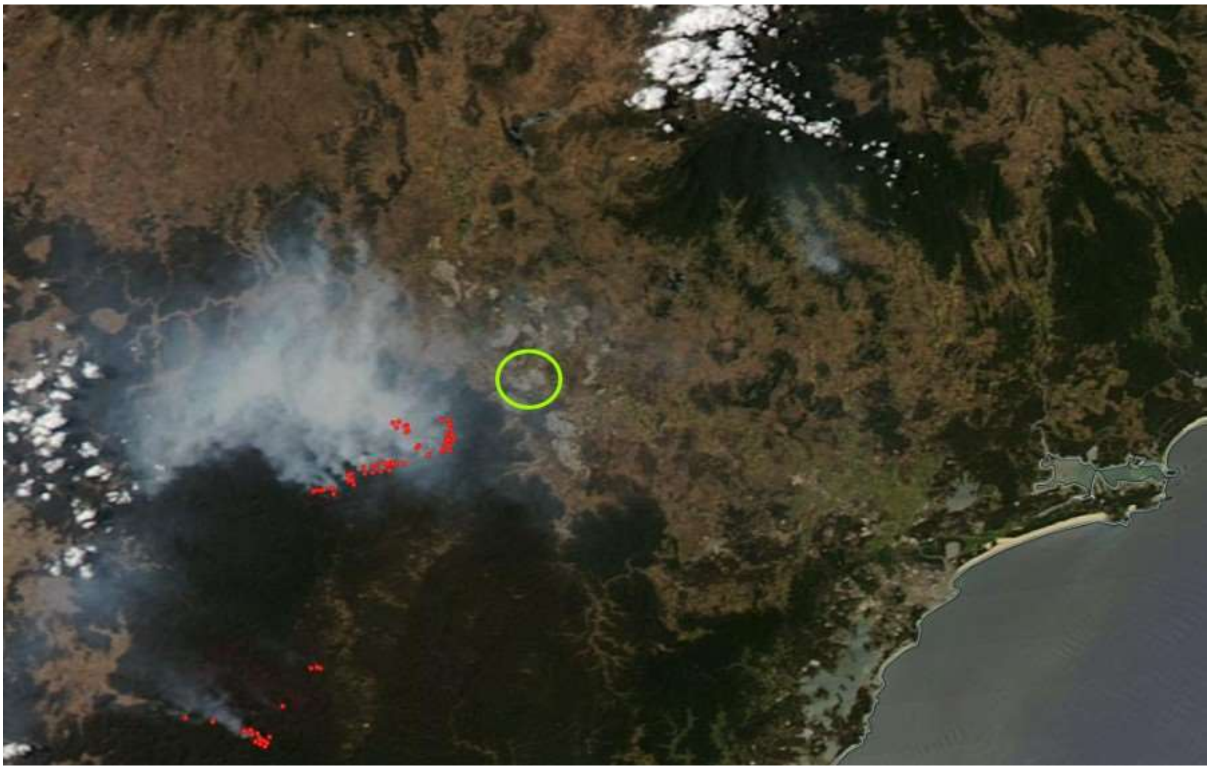
Source: **NASA, 2016**

Figure 4-9: Satellite imagery of the area around HVO South during bushfire event on 21 October 2013

Maison Dieu, Knodlers Lane and Warkworth recorded elevated levels on the 23 December 2013 and coincides with elevated levels at other monitors in the UHAQMN and would suggest a regional event affecting dust levels in the area.

On the 4 January 2014, the Long Point monitor recorded a PM_{10} level above the criterion. An analysis of the wind conditions on the day indicates that HVO may have contributed approximately 32 per cent of the measured dust on this day.

Bushfires occurring in the region on the 16 January 2014 are the likely cause of the elevated levels at the Kilburnie South and Warkworth monitors. **Figure 4-10** presents satellite imagery of the area showing bushfire smoke on 16 January 2014.



Source: **NASA, 2016**

Figure 4-10: Satellite imagery of the area around HVO South during bushfire event on 16 January 2014

Maison Dieu, Knodlers Lane, Warkworth and Long Point all recorded elevated levels on the 31 October 2014 which coincides with elevated levels at other monitors in the UHAQMN. This suggests a regional dust event affecting air quality levels in the area. The Warkworth monitor recorded an elevated level on 18 December 2014, an investigation for this day indicates that based on the prevailing wind conditions, the contribution from HVO would not have been significant.

4.3.3 TSP monitoring

TSP monitoring data are available from the five HVAS monitors surrounding Hunter Valley Operations (see **Figure 4-5**). A summary of the results collected between January 2012 and December 2014 at these stations is shown in **Table 4-6**. Recorded 24-hour average TSP concentrations are presented in **Figure 4-11**.

The monitoring data presented in **Table 4-6** indicate that the annual average TSP concentrations for each monitoring station were less than the criterion of 90µg/m³. **Figure 4-11** 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 are generally attributed to an increased potential of bushfires, dust storms, pollen and other localised sources and dust emissions as a result of mining activity.

Table 4-6: Summary of annul average TSP levels from HVAS monitoring (µg/m³)

	2012	2013	2014
Maison Dieu	63.4	64.6	62.0
Knodlers Lane	66.4	80.5	66.0
Kilburnie South	57.0	49.3	57.0
Warkworth	50.7	55.7	54.4
Long Point(1)	-	61.9	56.9

(1)Data available from October 2013

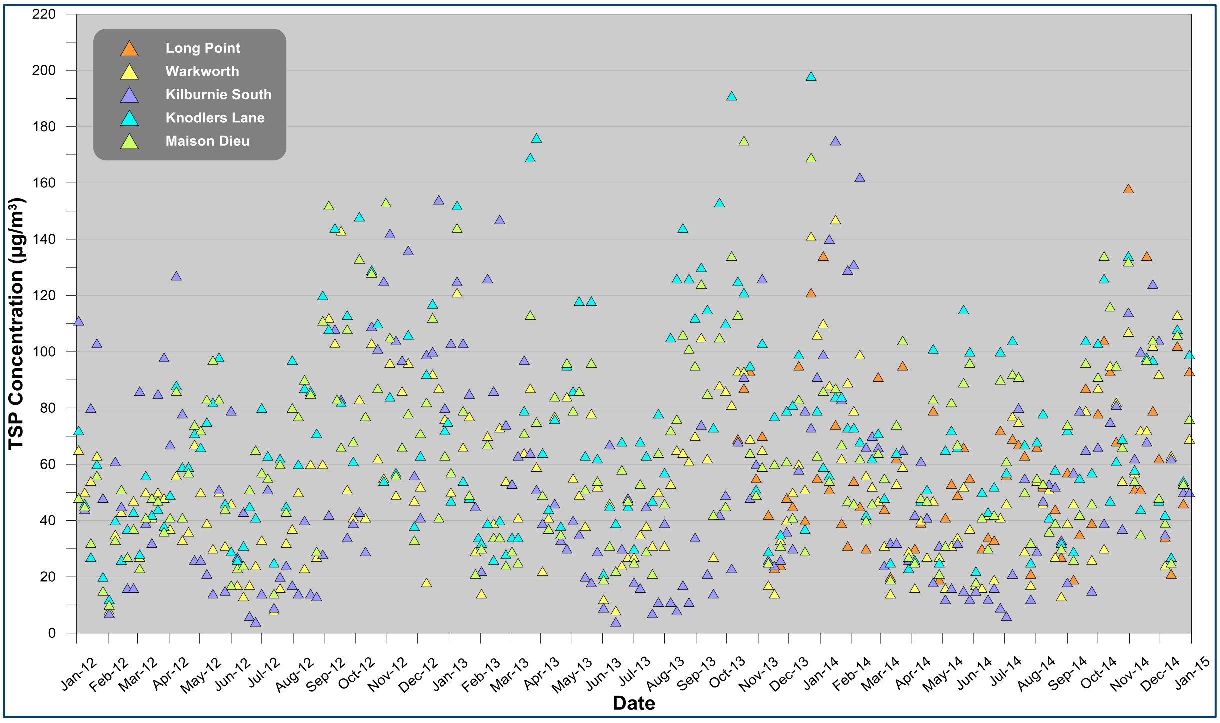


Figure 4-11: HVAS 24-hour average TSP concentrations (criteria is 90 µg/m³ as an annual average)

4.3.4 Dust deposition monitoring

The locations of the dust deposition monitoring sites reviewed in this assessment, are shown in **Figure 4-5**. **Table 4-7** summarises the annual average deposition levels at each gauge during 2012 to 2014.

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.

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

Table 4-7: Annual average dust deposition (g/m^2/month)

	2012	2013	2014
DL14	2.6	1.9	1.6
DL21	3.1	3.3	2.1
DL22	2.8	2.8	1.8
DL30	2.9	2.5	2.8
D118	2.6	2.1	2.9
D119	2.7	2.4	2.5
D122	3.7	3.4	1.9
Knodlers Lane	2.8	2.5	1.3
Warkworth	3.5	3.4	2.8

4.3.5 $PM_{2.5}$ monitoring

A summary of the $PM_{2.5}$ readings from the NSW OEH Singleton and Camberwell monitoring stations is presented in **Table 4-8**. The recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-12**.

Table 4-8 indicates that the annual average $PM_{2.5}$ concentration for the Camberwell monitoring station was 0.2µg/m^3 above the NEPM standard of 8µg/m^3 in 2013. For all other periods the annual average $PM_{2.5}$ concentrations were below the relevant NEPM standard. The Singleton monitoring station indicated levels at or below the NEPM standard for the periods reviewed.

A seasonal trend in $PM_{2.5}$ concentrations can be seen in **Figure 4-12** with higher levels in the cooler months. Ambient $PM_{2.5}$ levels are likely to be governed by many non-mining background sources such as wood heaters and motor vehicles. The wintertime peak in $PM_{2.5}$ levels is expected due to the location of the monitoring sites with respect to urban wood heaters.

Table 4-8: Summary of $PM_{2.5}$ levels from NSW EPA BAM monitoring (µg/m³)

	Annual average			Maximum 24-hour average		
	2012	2013	2014	2012	2013	2014
Singleton	8.0	7.9	7.8	19.5	22.6	28.5
Camberwell	7.5	8.2	7.8	19.6	29.5	31.6

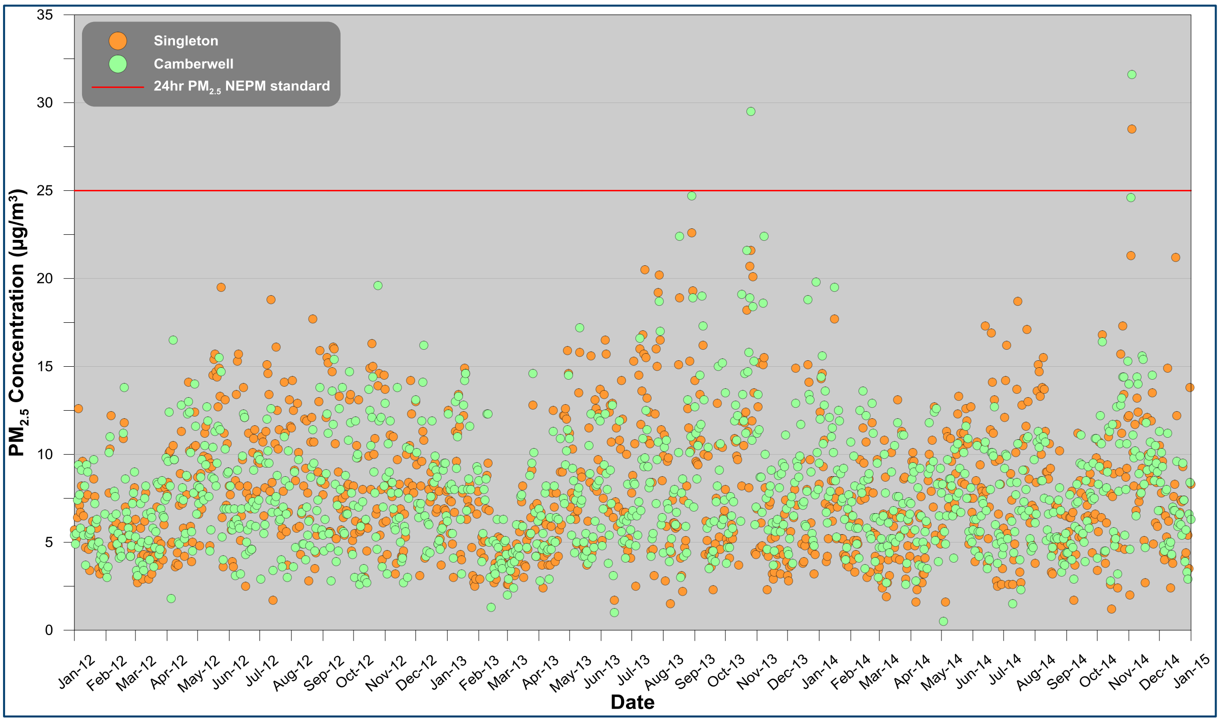


Figure 4-12: 24-hour average $PM_{2.5}$ concentrations at NSW OEH monitors

4.3.6 Nitrogen dioxide

Figure 4-13 presents the maximum daily 1-hour average NO_2 concentrations from the Beresfield, Muswellbrook and Singleton NSW EPA monitoring sites from January 2012 to December 2014.

Ambient air quality monitoring data collected at these locations would include emissions from sources such as the Liddell, Bayswater and Redbank power stations, methane gas flaring operations at mining operations as well as other various combustion sources.

The monitoring data recorded are well below the NSW EPA 1-hour average goal of 246µg/m^3 during this period at all of the monitors. The data in **Figure 4-13** indicate that levels of NO_2 are relatively low compared to the criterion level and show a seasonal fluctuation.

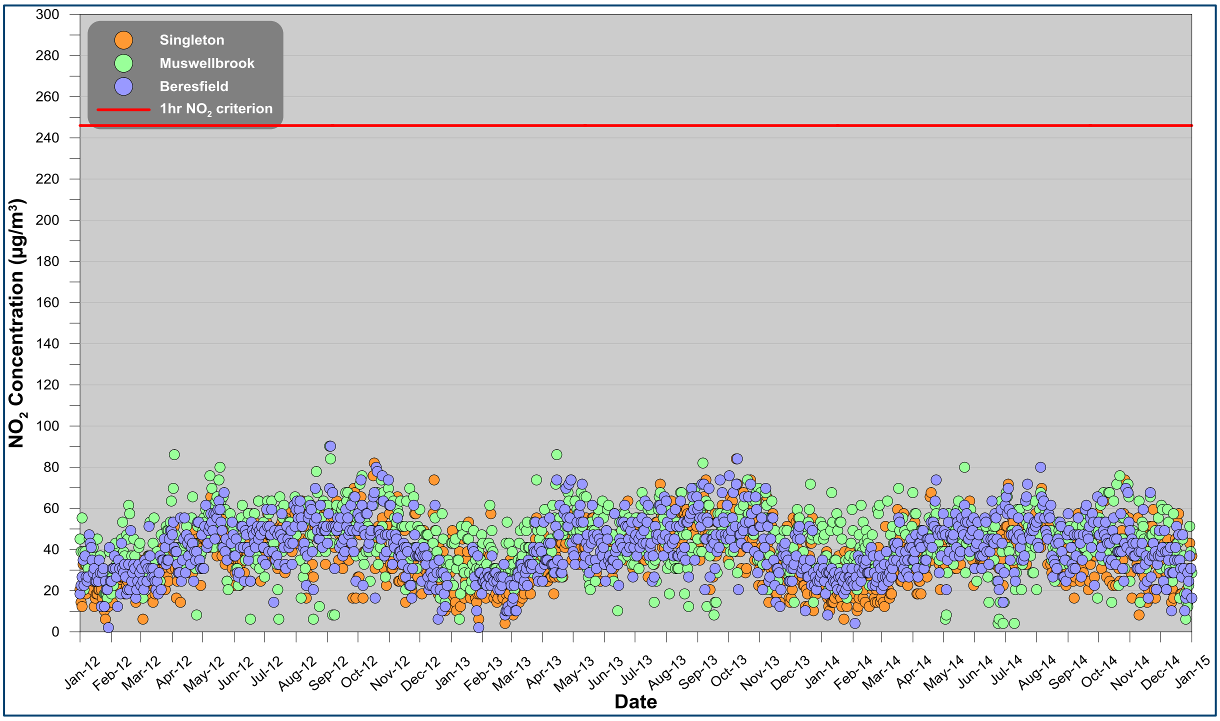


Figure 4-13: Daily 1-hour maximum NO_2 concentrations – Beresfield, Muswellbrook and Singleton

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 that 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**).

The previous air quality impact assessment prepared for HVO South (**Holmes Air Sciences, 2008**) applied a different air dispersion model to predict the potential zone of impacts. The air dispersion model used was a modified version of the United States Environmental Protection Agency (US EPA) Industrial Source Complex (ISC) model.

The ISC model differs from the CALPUFF model in that it is a steady-state Gaussian plume model where CALPUFF is a non-steady-state air dispersion model. The implementation of multi-levelled meteorological data and its transport and dispersion of particles as "puffs" allow CALPUFF to achieve a potentially more accurate prediction of the potential air quality impacts associated with the proposed modification.

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 150 x 150km grid with a 3km 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 done based on a review of the long-term meteorological and ambient air quality conditions which 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
Cheshunt Weather Station (HVO South)	✓	✓			✓	✓	
HVO Weather Station (HVO North)	✓	✓			✓	✓	
Charlton Ridge Weather Station (MTW)	✓	✓			✓	✓	
Cessnock Airport Automatic Weather Station (BoM) (Station No. 061260)	✓	✓			✓	✓	✓
Williamtown RAAF (BoM) (Station No. 061078)	✓	✓	✓	✓	✓	✓	✓
Merriwa (Roscommon) Weather Station (BoM) (Station No, 061287)	✓	✓	✓	✓	✓	✓	✓
Murrurundi Gap Automatic Weather Station (BoM) (Station No. 061392)	✓	✓	✓	✓	✓	✓	✓
Scone Airport Automatic Weather Station (BoM) (Station No. 061363)	✓	✓			✓	✓	✓
Paterson (Tocal) Automatic Weather Station (BoM) (Station No. 061250)	✓	✓			✓	✓	

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

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**.

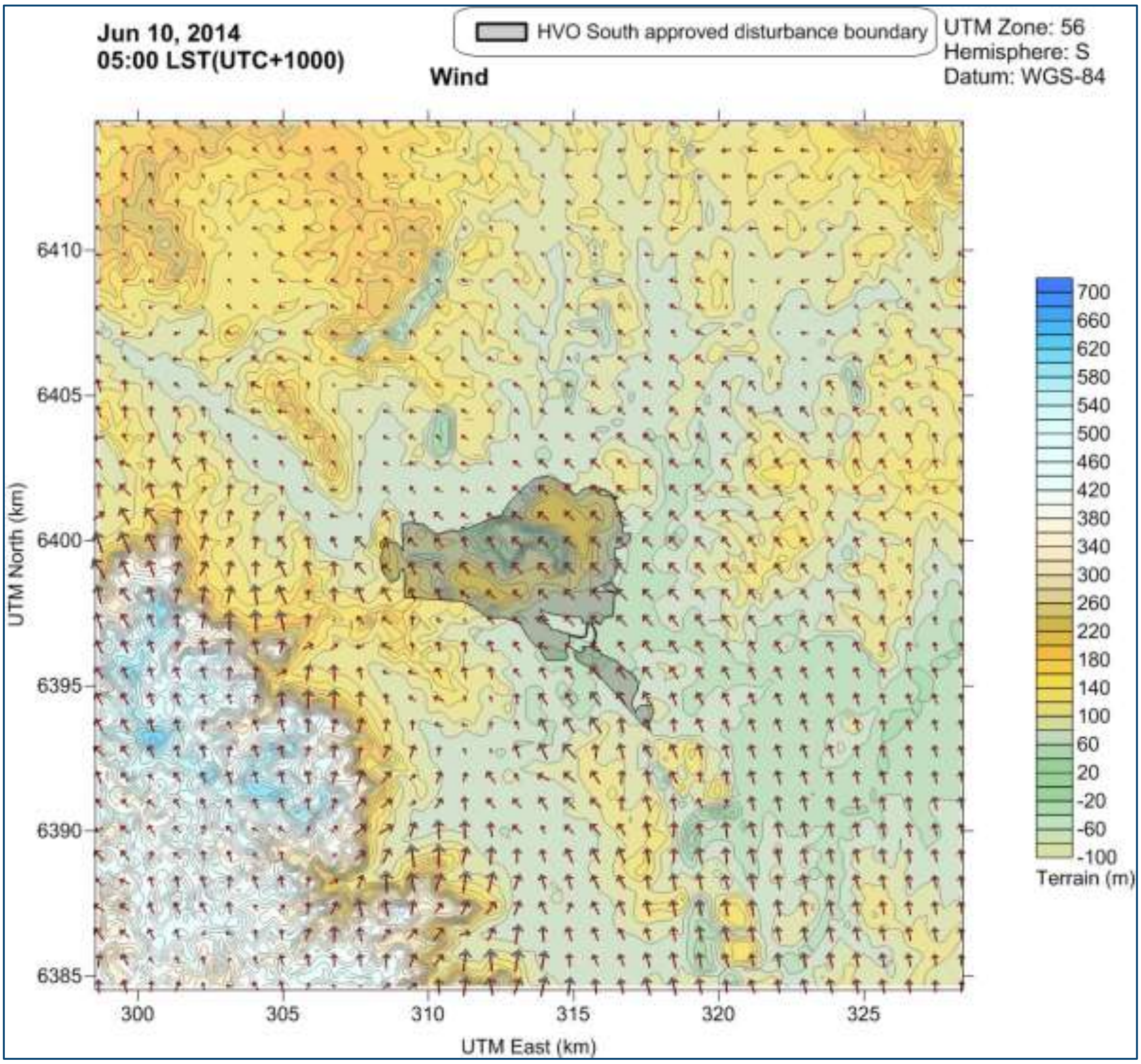


Figure 5-1: Example of the wind field for one of the 8,760 hours of the year that are modelled

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. On an annual basis, winds from the south-southeast are most frequent. During summer, winds from the south-southeast dominate the distribution with fewer winds from the south and northwest. The autumn wind distribution shows the majority of winds originating from the south-southeast and south with some winds from the northwest. In winter, winds from the northwest are the most predominant. In spring, the wind distribution is more varied compared to the other seasons with winds from the northwest and southeast quadrants.

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

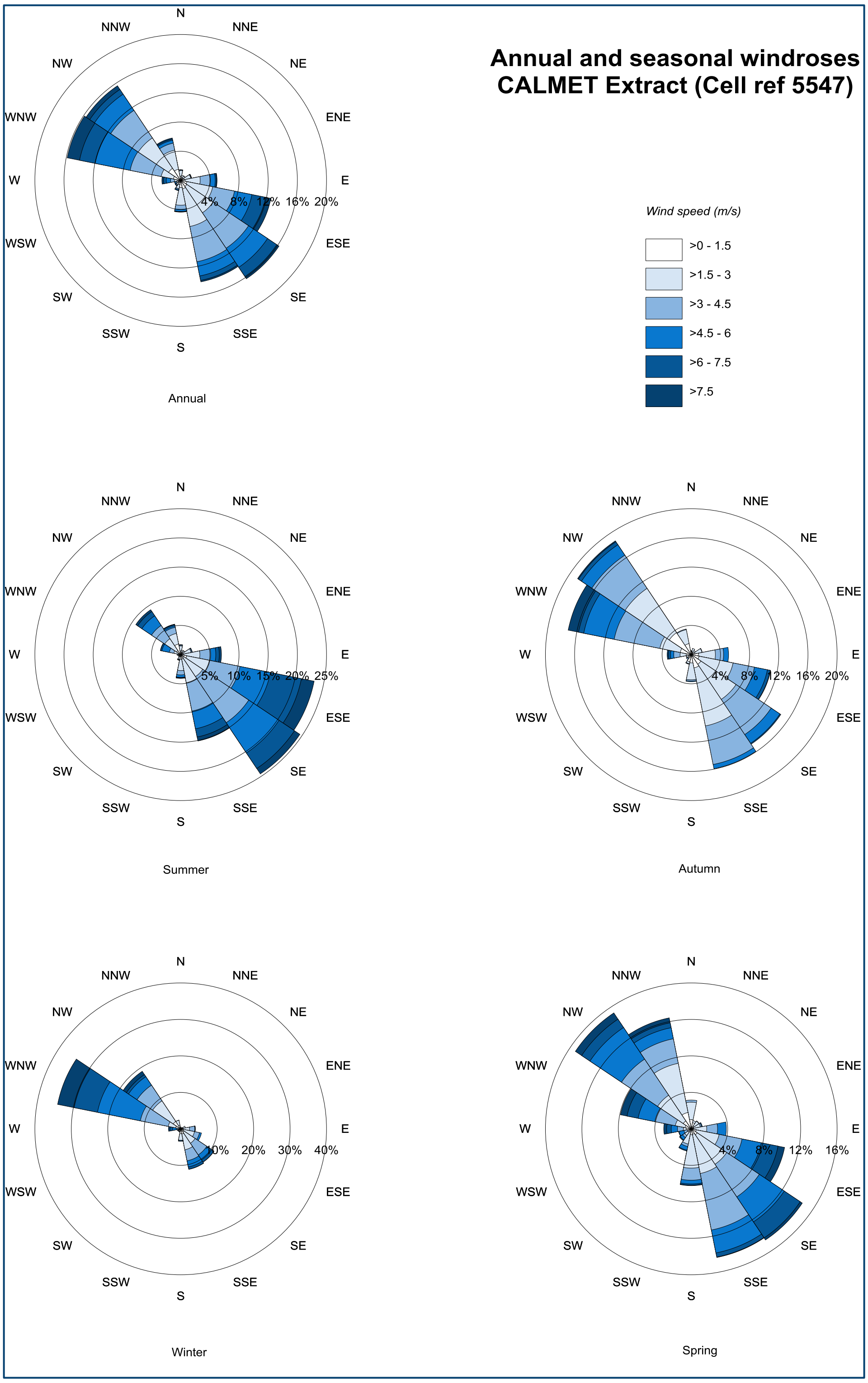


Figure 5-2: Windroses from CALMET extract (Cell ref 5547)

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.

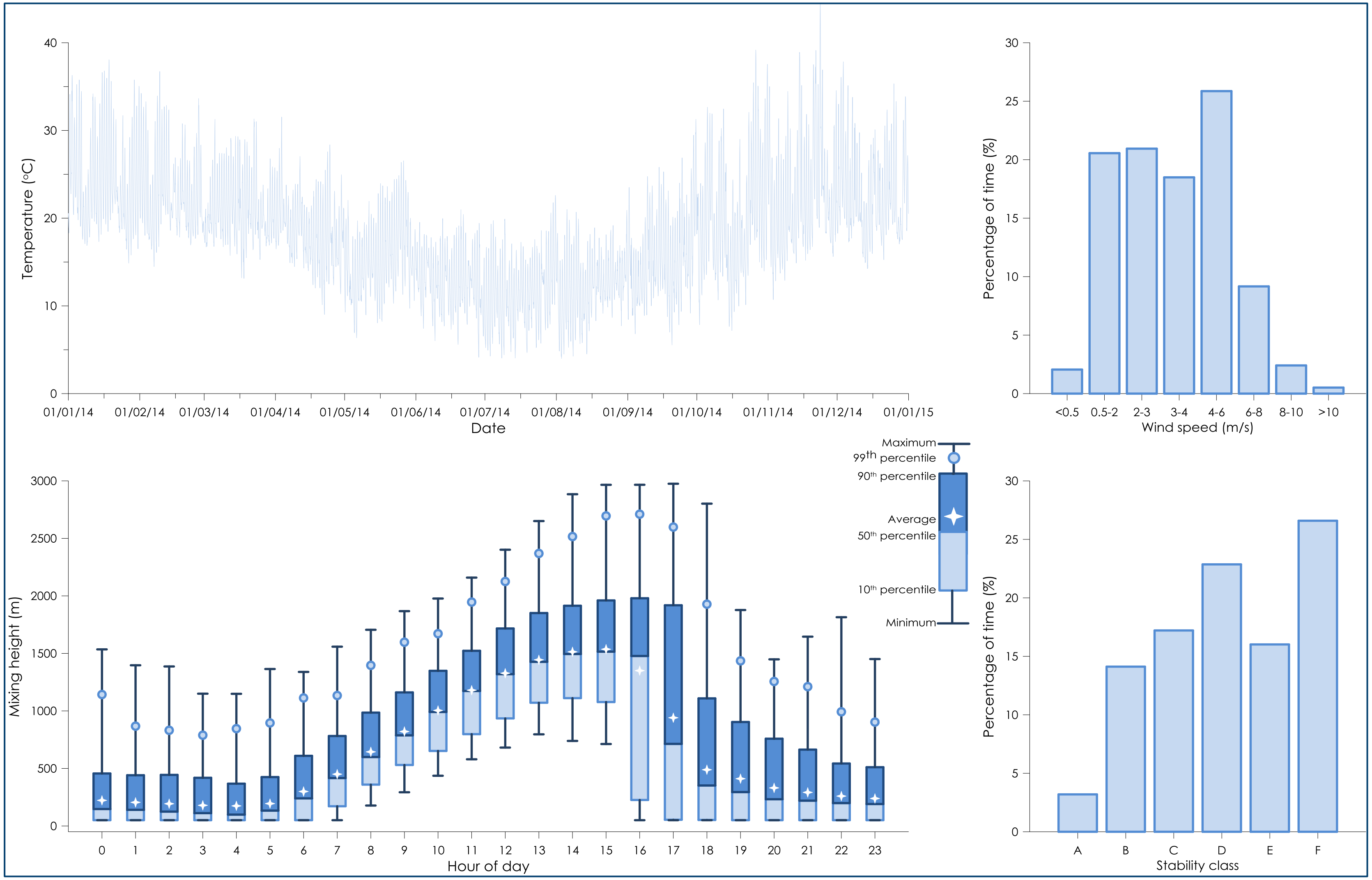


Figure 5-3: Meteorological analysis of CALMET extract (Cell ref 5547)

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 years with above average rainfall.

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 scenarios

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

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

The two scenarios nominally represent the generally highest levels of proposed activity for the modification in future years, with Stage 2 (approximately Year 2022) being closest to the south eastern and eastern receptors and Stage 3 (approximately Year 2026) being closest to the north western and western receptors. Indicative mine plans for each of the respective years are presented in **Figure 5-4** and **Figure 5-5** for Stage 2 and Stage 3, respectively.

The indicative Stage 2 mine plan shows mining activity occurring in four areas of HVO South. The dragline is operating in the Riverview pit with active ROM coal extracted and transported north to the Hunter Valley CPP for processing. Overburden is being removed from the Cheshunt and South Lemington Pit 2 with the material generally being emplaced behind the progression of these pits. The South Lemington Pit 1 sees initial ROM being extracted and emplaced in the vicinity of the Lemington CPP in preparation of its operation which occurs in Stage 3.

The Stage 2 mine plan has the largest active mining and dumping area of all the mine plan scenarios for the proposed modification. This mine plan scenario also appears to align with what appears to be the worst-case year for the United Wambo Open Cut Coal Mine Project. For example, the period between conceptual mine plan Year 5 and 11, as presented in the United Wambo Open Cut Coal Mine Project Preliminary Environmental Assessment (**Umwelt**, **2015**), is identified at the likely worst-case year due to the position of the proposed pit and overburden areas in the western and eastern part of that project. Thus it is important to accurately assess this year with regard to the potential cumulative impacts from the proposed modification in conjunction with the United Wambo Open Cut Coal Mine Project. The cumulative assessment is detailed further in Section 5.3.3.

The indicative Stage 3 mine plan shows that the Cheshunt pit has progressed through the Riverview pit footprint in this scenario. The dragline is operating in this area with active ROM coal extracted being transported to Hunter Valley CPP with some overflow ROM being transported to the Howick CPP. Overburden is emplaced in the areas to the east. The South Lemington Pit 1 is continuing to operate with the South Lemington Pit 2 used for overburden emplacement. ROM from the South Lemington Pit 1 is transported to the operating Lemington CPP.

There are three approved options for the rail loop and train load out point of which one will be operating in Stage 3. As a worst case scenario, the assessment has assumed the rail loop and train load out point is constructed to the south of the South Lemington Pit 1 (see **Figure 5-5**). This would result in the longest haul distances and hence greatest dust emissions of the three options. In Stage 3 we have modelled the hauling of product coal to this location and the loading of the material to trains.

The Stage 3 mine plan has relatively large active mining and dumping areas with significantly long waste hauls and relatively long ROM hauls when compared to the other mine plan scenarios for the proposed modification. In Stage 3, the equipment and sources are concentrated to the east and would likely present a worst-case scenario with regard to the potential impacts for the assessment locations positioned to the east of the proposed modification.

Dust emissions associated with construction activities are typically from a large range of different, short duration activities and arise from a small construction area. The dust emissions can be managed effectively through commonly applied mitigation measures such as water sprays. As such, emissions associated with construction activities would generally be too low relative to the rest of the operational coal mine to generate any significant off-site concentrations and are impractical to model in detail in this study. (Furthermore, the construction period for the LCPP and associated infrastructure would arise between Stage 2 and 3). These emissions would be managed per a construction management plan, as necessary on a day by day basis depending on the activity.

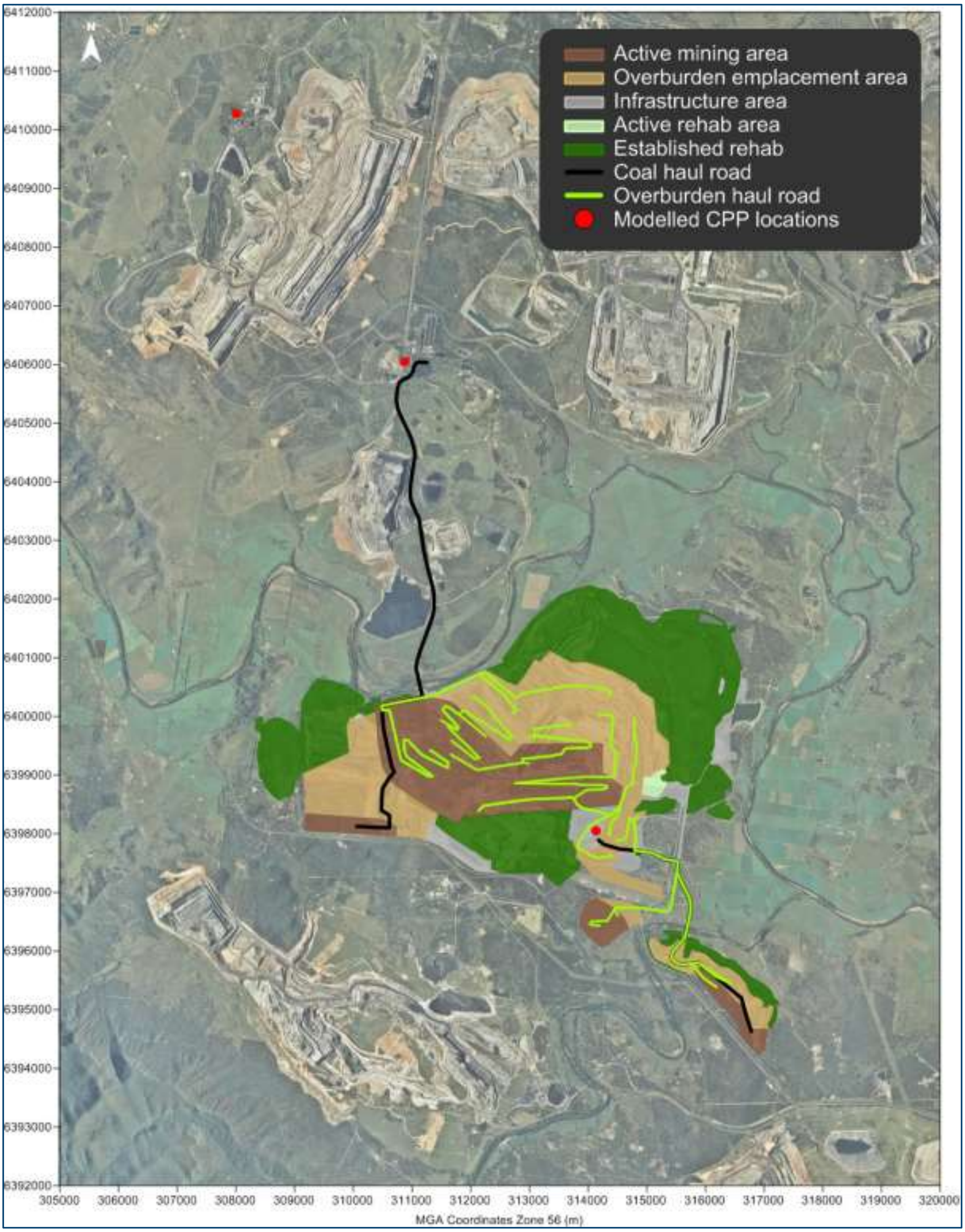


Figure 5-4: Indicative mine plan for Stage 2

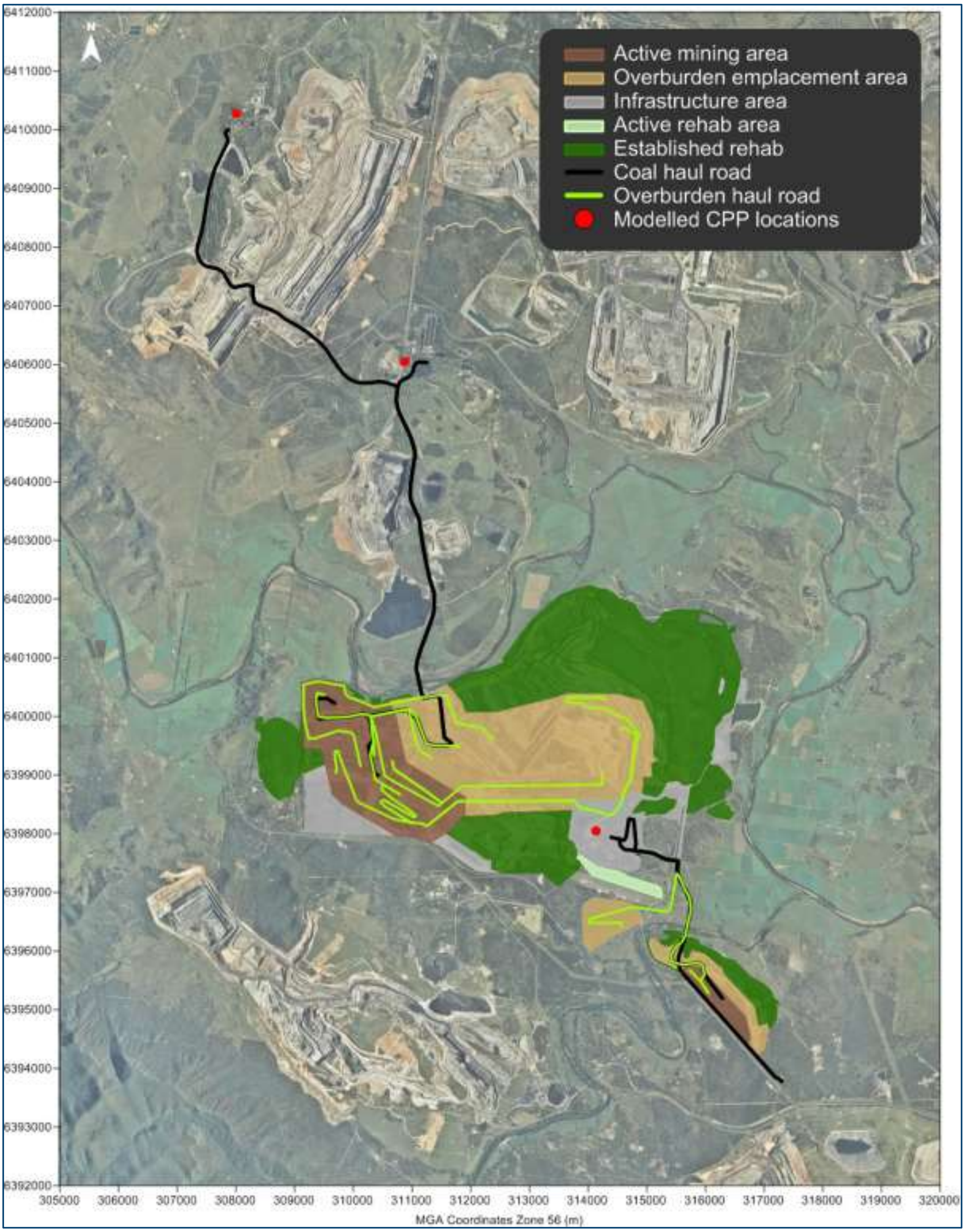


Figure 5-5: Indicative mine plan for Stage 3

5.3.1 Emission estimation

For each of the chosen modelling scenarios, 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 best practice dust mitigation applied where applicable. Further details on the dust control measures applied for the proposed modification are outlined in **Section 5.3.5**.

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

Activity	2014	Stage 2	Stage 3
OB - Topsoil removal (Cheshunt)	2,680	1,322	2,610
OB - Topsoil removal (Riverview)	2,680	-	-
OB - Topsoil removal (South Lemington Pit 2)	-	1,322	-
OB - Topsoil removal (South Lemington Pit 1)	-	-	-
OB - Drilling (Cheshunt)	12,026	17,667	-
OB - Drilling (Riverview)	2,405	-	22,931
OB - Drilling (South Lemington Pit 2)	-	-	-
OB - Drilling (South Lemington Pit 1)	-	3,533	-
OB - Blasting (Cheshunt)	12,251	18,166	-
OB - Blasting (Riverview)	2,450	-	23,603
OB - Blasting (South Lemington Pit 2)	-	-	-
OB - Blasting (South Lemington Pit 1)	-	3,633	-
OB - Dragline (Cheshunt)	-	-	-
OB - Dragline (Riverview)	30,070	826,979	360,702
OB - Dragline (South Lemington Pit 2)	-	-	-
OB - Dragline (South Lemington Pit 1)	-	-	-
OB - Loading OB to haul truck (Cheshunt)	181,081	294,556	-
OB - Loading OB to haul truck (Riverview)	89,189	-	352,077
OB - Loading OB to haul truck (South Lemington Pit 2)	-	49,093	-
OB - Loading OB to haul truck (South Lemington Pit 1)	-	44,183	67,419
OB - Hauling to emplacement area (Cheshunt)	1,517,381	2,526,434	-
OB - Hauling to emplacement area (Riverview)	440,302	-	2,101,289
OB - Hauling to emplacement area (Riverview)	-	-	1,565,178
OB - Hauling to emplacement area (Cheshunt to Riverview)	-	-	-
OB - Hauling to emplacement area (South Lemington Pit 2 to Pit 1)	-	87,725	-
OB - Hauling to emplacement area (Glider to Cheshunt)	-	347,348	-
OB - Hauling to emplacement area (South Lemington Pit 1)	-	40,668	15,392
OB - Hauling to emplacement area (South Lemington to Cheshunt)	-	246,687	-
OB - Hauling to emplacement area (South Lemington Pit 1 to Pit 2)	-	-	574,249
OB - Emplacing at area (Cheshunt)	181,081	363,286	352,077
OB - Emplacing at area (Riverview)	89,189	-	-
OB - Emplacing at area (South Lemington Pit 2)	-	9,819	52,437
OB - Emplacing at area (South Lemington Pit 1)	-	14,728	14,982
OB - Dozers in pit (Cheshunt)	623,909	783,499	-
OB - Dozers in pit (Riverview)	180,895	-	582,974
OB - Dozers in pit (South Lemington Pit 2)	-	97,937	-
OB - Dozers in pit (South Lemington Pit 1)	-	97,937	194,325
OB - Dozers on dump and rehab (Cheshunt)	584,665	979,374	680,136
OB - Dozers on dump and rehab (Riverview)	682,109	-	-

Activity	2014	Stage 2	Stage 3
OB - Dozers on dump and rehab (South Lemington Pit 2)	-	97,937	97,162
OB - Dozers on dump and rehab (South Lemington Pit 1)	-	-	-
CL - Drilling (Cheshunt)	430	631	-
CL - Drilling (Riverview)	86	-	820
CL - Drilling (South Lemington Pit 2)	-	-	-
CL - Drilling (South Lemington Pit 1)	-	126	-
CL - Blasting (Cheshunt)	2,478	3,675	-
CL - Blasting (Riverview)	496	-	4,775
CL - Blasting (South Lemington Pit 2)	-	-	-
CL - Blasting (South Lemington Pit 1)	-	735	-
CL - Dozers ripping/pushing/clean-up (Cheshunt)	83,159	-	-
CL - Dozers ripping/pushing/clean-up (Riverview)	19,995	279,873	258,843
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 2)	-	-	-
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 1)	-	139,937	277,659
CL - Loading ROM coal to haul truck (Cheshunt)	589,943	-	-
CL - Loading ROM coal to haul truck (Riverview)	240,963	1,351,066	1,080,853
CL - Loading ROM coal to haul truck (South Lemington Pit 2)	-	-	-
CL - Loading ROM coal to haul truck (South Lemington Pit 1)	-	6,755	270,213
CL - Hauling ROM to hopper - HVCPP (Cheshunt)	296,850	-	-
CL - Hauling ROM to hopper - HVCPP (Riverview)	63,690	-	-
CL - Hauling ROM to hopper - HVCPP	-	739,325	497,745
CL - Hauling ROM to hopper at LCPP	-	-	76,747
CL - Hauling ROM to stockpile at HCPP	-	-	203,168
CL - Hauling ROM to stockpile at LCPP	-	2,000	-
CHPP - Unloading ROM to hopper - HVCPP	415,453	675,533	432,341
CHPP - Rehandle ROM at hopper - HVCPP	83,091	135,107	86,468
CHPP - Dozer pushing ROM coal - HVCPP	35,868	35,868	35,868
CHPP - Dozer pushing Product coal - HVCPP	14,126	14,126	14,126
CHPP - Loading Product coal to stockpile - HVCPP	1,416	2,263	1,334
CHPP - Loading Product coal to train - HVCPP	1,141	1,824	1,075
CHPP - Loading rejects - HVCPP	321	596	476
CHPP - Hauling rejects - HVCPP	55,024	110,899	93,327
CHPP - Unloading rejects - HVCPP	321	596	476
CHPP - Unloading ROM to stockpile - LCPP	-	3,378	-
CHPP - Rehandle ROM at stockpile - LCPP	-	676	-
CHPP - Dozer pushing ROM coal - LCPP	-	35,868	-
CHPP - Unloading ROM to hopper - LCPP	-	-	135,107
CHPP - Rehandle ROM at hopper - LCPP	-	-	27,021
CHPP - Dozer pushing ROM coal - LCPP	-	-	35,868
CHPP - Dozer pushing Product coal - LCPP	-	-	14,126
CHPP - Loading Product coal to stockpile - LCPP		-	453
CHPP - Loading Product coal to haul truck - LCPP	-	-	111,250
CHPP - Hauling Product to train loadout	-	-	65,672
CHPP - Unloading Product to hopper at train loadout	-	-	55,625
CHPP - Loading Product coal to train - LCPP	-	-	365
CHPP - Loading rejects - LCPP	-	-	119
CHPP - Hauling rejects - LCPP	-	-	11,512
CHPP - Unloading rejects - LCPP	-	-	119
WE - Overburden emplacement areas - Cheshunt	1,022,528	1,574,931	2,010,000
WE - Overburden emplacement areas - Riverview	784,561	608,294	-
WE - Overburden emplacement areas - South Lemington Pit 2	-	41,368	167,979
WE - Overburden emplacement areas - South Lemington Pit 1	-	213,161	186,237
WE - Open pit - Cheshunt	1,244,874	1,908,810	-
WE - Open pit - Riverview	422,460	143,623	1,430,131
WE - Open pit - South Lemington Pit 2	-	152,411	-
WE - Open pit - South Lemington Pit 1	-	147,803	148,430
WE - Active rehab	111,090	13,687	28,671
WE - ROM stockpiles - HVCPP	7,008	7,008	7,008

Activity	2014	Stage 2	Stage 3
WE - ROM stockpiles - LCPP	-	7,008	7,008
WE - Product stockpiles - HVCPP	8,760	8,760	8,760
WE - Product stockpiles - LCPP	-	-	17,520
Grading roads	45,288	45,288	45,288
Total	**10,185,782**	**15,366,841**	**14,910,128**

OB – overburden, CL – coal, CPP – coal preparation plant, WE – wind erosion
HVCPP - Hunter Valley CPP, LCPP – Lemington CPP, HCPP – Howick CPP

5.3.2 Emissions from other mining operations

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

Emissions estimates from these sources were derived from information provided in the air quality assessments available in the public domain at the time of modelling. These estimates are likely to be conservative, as in many cases, mines do not continually operate at the maximum extraction rates assessed in their respective environmental assessments. 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	2014	Stage 2	Stage 3
HVO North(1)	11,783,354	9,483,388	9,004,700
Mount Thorley Warkworth(2)	12,917,315	15,124,600	14,313,814
Wambo Coal Mine(3)	4,186,080	7,033,753	7,033,753
Rix's Creek Coal Mine(4)	1,578,144	2,490,454	1,658,531
Ravensworth Operations(5)	8,749,742	11,582,028	11,510,752
Ashton Coal Mine(6)	-	1,044,064	1,044,064
Integra Coal Mine(7)	4,242,439	2,989,345	2,989,345
Glendell Coal Mine (8)	3,441,315	3,060,737	3,060,737

(1)PAEHolmes (2010b) (2)Todoroski Air Sciences (2014) (3)Holmes Air Sciences (2003) & Umwelt (2015)
(4)Todoroski Air Sciences (2015) (5)PAEHolmes (2010a) (6)PAEHolmes (2009) (7)Holmes Air Sciences (2009)
(8)Holmes Air Sciences (2007)

At the time of preparing the modelling for this assessment, only a Preliminary Environmental Assessment (**Umwelt**, **2015**) had been lodged for the United Wambo Open Cut Coal Mine Project (United Wambo), and not a full environmental assessment. Estimates of the potential dust emissions included in the cumulative assessment (see **Table 5-4**) were thus made based on the indicative production rates for the United Wambo project.
It is also noted that consents for some mining operations would expire at some stage during the proposed modification. However, to assess potential worst case cumulative dust effects, it has been assumed that these operations would continue until the end of the proposed modification. This adds considerable conservatism to the model predictions.

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

5.3.3 United and Wambo Open Cut Coal Mine Project

Since the time of preparing the modelling for this assessment report, the *United Wambo Open Cut Coal Mine Project Air Quality Assessment* (**Jacobs, 2016**) has become publically available. The data in the United Wambo assessment has been compared with the emission estimates included in the cumulative assessment for the proposed modification to determine if there is any potential underestimation in this assessment.

Table 5-5 compares the annual TSP emissions presented in the United Wambo air quality assessment (**Jacobs, 2016**) with the annual TSP emissions assumed in this assessment report.

This assessment assumes significantly higher TSP emissions for the United Wambo project (approx. 70 to 80% higher), therefore the results presented in this report are consider to be conservative and likely to overestimate actual cumulative impacts.

Table 5-5: Comparison of TSP emissions modelled for United Wambo

United Wambo Open Cut Coal Mine Project	Year 2	Year 6	Year 11	Year 16
TSP emissions (kg/year)*	4,256,958	4,094,869	3,878,711	3,869,961
Cumulative assessment - HVO South Modification 5	**-**	**Stage 2**	**Stage 3**	**-**
TSP emissions (kg/year)	-	7,033,753	7,033,753	-
Variation	-	71.8%	81.3%	-

*Source: Jacobs (2016)

5.3.4 Potential coal dust emissions from train wagons

As product coal produced at the proposed modification will be transported off-site via rail to the Port of Newcastle for export to customers, there is potential to generate coal dust emissions from train wagons during transportation. The proposed modification does not seek any increase in product coal transported from HVO South or any change to the approved rail movements and it is not anticipated that there would be any change to air quality levels due to this activity.

However, for the purposes of this assessment, the potential impacts associated with coal dust emissions from train wagons have been assessed to ensure there is no significant impact due to the already approved levels of rail activity for HVO South.

Coal dust emissions from train wagons have the potential to originate from the coal surface of loaded wagons, leakage from wagon doors, re-suspension and wind erosion of coal spilled in the rail corridor, residual coal in unloaded wagons, and parasitic load on sills, shear plates and bogies of wagons.

The surface of loaded wagons provides a significant exposed area which is subject to wind erosion and air movement during transport. The amount of dust potentially generated during transport is related to the inherent dustiness of the coal material and the interactions of the air with the exposed coal surface (**Connell Hatch, 2008**).

Coal dust can potentially leak from the bottom doors of train wagons and fall into the ballast of the train line. This occurs when the doors of the wagon are not completely sealed. The amount of material released will depend on the material properties of the coal, and the vibrational forces experienced by the coal in the wagons that potentially break down the coal material. Dust impacts from this source are considered to be low as the ballast would provide a shielding effect to reduce particle lift-off (**Connell Hatch, 2008**).

During the loading process and in transit, there is potential for coal material to be spilled into the train corridor and cause parasitic loading on the sills, shear plates and bogies. These sources of emissions are easily prevented by careful loading of the material and profiling the shape of the load (**Connell Hatch, 2008**).

Residual coal remaining in an unloaded wagon can dry and become airborne during travel back to the site. This source is dependent on meteorological conditions, the train travel speed and the extent of any turbulent air generated in the unloaded wagon space causing the residual coal particles to become airborne.

5.3.5 Train wagon emission estimation

The scale of the potential emissions would depend on various factors including the material properties of the product coal, meteorological factors and train/wagon specific factors. To determine the potential for dust lift-off during the transportation, dust emissions have been estimated from measurements conducted in other studies.

The study conducted by Katestone Environmental on behalf of Connell Hatch for Queensland Rail Limited (**Connell Hatch, 2008**) completed a review of a study by **Ferreira et al. (2003)** which focused on the release of coal dust from train wagons. The **Ferreira et al. (2003)** study conducted full-scale measurements of coal dust emissions from coal wagons over a 350km journey with an average train speed of between 55 and 60km/hr. The findings of this study concluded that the total emission for an uncovered rail wagon was determined to be 9.6 grams of TSP per kilometre.

The Katestone Environmental study applied this emission factor with dispersion modelling and found that the resulting predicted concentration compared well with actual air quality monitoring conducted. This suggests that the findings of the **Ferreria et al. (2003)** study are sensible and therefore have been applied to estimate emissions for this Project.

It is estimated for this assessment that a peak of six trains (12 movements) per day may occur through Newdell rail loop and a peak of two trains (four movements) may occur through the Lemington rail loop. Each train is estimated to have a capacity of approximately 7,700 tonnes of product coal and consist of 80 wagons per train. This would result in an estimated emission rate of approximately 770g of TSP per km per train.

5.4 Dust mitigation and management

HVO South and HVO North have integrated their management of air quality and operate per an integrated Hunter Valley Operations Air Quality and Greenhouse Gas Management Plan.

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 HVO South.

The measures applied to HVO South 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 HVO South 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 best practice 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.

HVO South utilises meteorological forecast data to guide the day to day planning of mining operations. These systems identify potentially adverse conditions that may arise over the coming day, giving HVO South time to prepare in advance means to mitigate dust appropriately.

The NSW EPA has also placed a PRP on all coal mines environment protection licences (EPLs), including the Hunter Valley Operations EPL which requires identification and assessment of the practicality of implementing further best practice measures. The best practice controls currently implemented were considered in this assessment. Where applicable these controls have been applied in the dust emission estimates as shown in **Appendix C**.

The operation of dust mitigation and management measures commensurate with best practice is a key aspect of HVO South operations. An outline of such measures is set out in the air quality chapter in the main body of the EIS, and the overall approach is detailed in the air quality and greenhouse gas management plan. This is available on the company's website: http://www.riotinto.com/documents/HVO%20Air%20Quality%20and%20Greenhouse%20Gas%20Mgmt%20Plan.pdf

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

5.4.1 Monitoring network

The HVO South air quality monitoring network, is illustrated in **Figure 4-5**. The network of monitors surround the mine operation and are positioned in areas representative of the surrounding assessment locations. This network is augmented by ambient air quality monitoring stations operated by the NSW EPA and provide an extensive network of stations from which to measure ambient air quality.

Air quality monitoring at HVO South is supplemented with visual surveillance to support the reactive air quality management system. The monitors are portable to enable relocation as mining and seasonal conditions change. These monitors are aimed for use as a warning tool for mine operations and provide advance warning of degrading air quality which serves to prompt appropriate actions. Visual surveillance monitoring is also used in the network to assist with identification of problem dust sources, informing a management response and verifying the effectiveness of controls implemented.

5.5 Accounting for background dust levels

All significant dust generating mining operations in the vicinity of HVO South were included in the dispersion model to assess the total potential dust impact. These operations included HVO North, Mount Thorley Warkworth, Wambo, Rix's Creek, Ravensworth, Integra and Glendell coal mines.

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 HVO North, Mount Thorley Warkworth, Wambo, Rix's Creek, Ravensworth, Integra and Glendell 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 $PM_{2.5}$, 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 (ie 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 from 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 5-6**.

Table 5-6: Estimated contribution from other non-modelled dust sources

Dust metric	Averaging period	Unit	Estimated contribution
TSP	Annual	µg/m³	39.5
PM_{10}	Annual	µg/m³	7.0
$PM_{2.5}$	Annual	µg/m³	4.6
Dust deposition	Annual	g/m²/month	1.5

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.

6 DISPERSION MODELLING RESULTS

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

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

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

Each of the 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 each of the assessed years 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

Table 6-1 summarises the assessment locations where impacts are predicted to exceed relevant assessment criteria. The assessment locations highlighted in grey are identified as mine-owned assessment locations, and those highlighted in orange are privately-owned assessment locations already in the acquisition zone for other mine operations.

Cumulative 24-hour $PM_{2.5}$ and PM_{10} impacts are assessed specifically in **Section 6.4**.

As shown, all assessment locations where predicted impacts exceed assessment criteria are mine-owned properties with the exception of assessment locations 77, 102, 246 and 471 which are privately-owned.

In summary:

- the proposed modification satisfies the Mining SEPP non-discretionary standards for private dwellings not already entitled to acquisition from neighbouring mine operations; and,
- under the VLAMP, no additional private dwellings are impacted that are not already afforded acquisition rights from neighbouring mine operations as the VLAMP significant impact criteria corresponds with the Mining SEPP (clause 12AB(4)) non-discretionary standard with respect to cumulative air quality at private dwellings.

The privately-owned assessment locations located in Warkworth Village and are already likely subject to air quality effects due to the various surrounding mine operations. It is noted that assessment location 77 is within Wambo Mine's current acquisition zone and assessment location 102 and 264 are non-residential locations and identified as the Warkworth Hall and the St Phillip's Church, respectively. Assessment locations 102 and 264 are uninhabited and may be used infrequently, and as such unlike a residence, would only be subject to brief periods of potential exposure (less than the minimum period applicable for dust criteria) when occasionally occupied.

Assessment location 471 is located to the northeast of the proposed modification and southwest of Camberwell Village. This assessment location is also already subject to air quality effects due to the various surrounding mine operations.

Table 6-1: Summary of modelled predictions where predicted impacts exceed assessment criteria

Assessment location ID	$PM_{2.5}$	PM_{10}		PM_{10}	TSP	DD	
	Total ann. average	Project 24-hour average		Total ann. average		Project ann. average	Total ann. average
	NEPM 8µg/m³	Criterion 50µg/m³		Criterion 30µg/m³	Criterion 90µg/m³	Criterion 2g/m²/mth	Criterion 4g/m²/mth
	Year of impact (level of impact - µg/m³)		No. of days >50µg/m³	Year of impact (level of impact - µg/m³)		Year of impact (level of impact - g/m²/mth)	
77	Stage 3 (9)	Stage 2 (64) Stage 3 (56)	1 1	Stage 2 (35) Stage 3 (39)	Stage 3 (93)		
78	Stage 3 (9)			Stage 3 (39)	Stage 3 (94)		
79*	Stage 2 (9) Stage 3 (9)	Stage 2 (73) Stage 3 (62)	1 1	Stage 2 (38) Stage 3 (41)	Stage 2 (92) Stage 3 (97)		
83*	Stage 2 (9)	Stage 2 (88)	2	Stage 2 (44)	Stage 2 (103)		

Assessment location ID	$PM_{2.5}$	PM_{10}		PM_{10}	TSP	DD	
	Total ann. average	Project 24-hour average		Total ann. average		Project ann. average	Total ann. average
	NEPM $8\mu g/m^3$	Criterion $50\mu g/m^3$		Criterion $30\mu g/m^3$	Criterion $90\mu g/m^3$	Criterion $2g/m^2/mth$	Criterion $4g/m^2/mth$
	Year of impact (level of impact - $\mu g/m^3$)		No. of days $>50\mu g/m^3$	Year of impact (level of impact - $\mu g/m^3$)		Year of impact (level of impact - $g/m^2/mth$)	
	Stage 3 (10)	Stage 3 (73)	1	Stage 3 (46)	Stage 3 (105)		
90	Stage 2 (10)	Stage 2 (95)	3	Stage 2 (46)	Stage 2 (106)		
	Stage 3 (10)	Stage 3 (79)	2	Stage 3 (47)	Stage 3 (108)		
91*	Stage 2 (9)	Stage 2 (83)	1	Stage 2 (42)	Stage 2 (98)		
	Stage 3 (9)	Stage 3 (72)	1	Stage 3 (44)	Stage 3 (101)		
93		Stage 2 (68)	1	Stage 2 (36)			
	Stage 3 (9)	Stage 3 (64)	1	Stage 3 (40)	Stage 3 (93)		
94*	Stage 2 (10)	Stage 2 (92)	3	Stage 2 (44)	Stage 2 (104)		
	Stage 3 (10)	Stage 3 (79)	4	Stage 3 (46)	Stage 3 (105)		
96*	Stage 2 (9)	Stage 2 (77)	1	Stage 2 (39)	Stage 2 (94)		
	Stage 3 (9)	Stage 3 (72)	2	Stage 3 (41)	Stage 3 (97)		
99*		Stage 2 (66)	1	Stage 2 (36)			
	Stage 3 (9)	Stage 3 (69)	1	Stage 3 (38)	Stage 3 (91)		
102		Stage 2 (67)	1	Stage 2 (36)			
	Stage 3 (9)	Stage 3 (73)	2	Stage 3 (38)			
105	Stage 2 (11)	Stage 2 (123)	20	Stage 2 (53)	Stage 2 (119)		
	Stage 3 (11)	Stage 3 (124)	44	Stage 3 (53)	Stage 3 (119)		
109*	Stage 2 (9)			Stage 2 (43)	Stage 2 (103)		
		Stage 3 (63)	1	Stage 3 (35)			
114	Stage 2 (11)	Stage 2 (149)	126	Stage 2 (55)	Stage 2 (123)	Stage 2 (2.8)	Stage 2 (4.6)
	Stage 3 (11)	Stage 3 (160)	126	Stage 3 (54)	Stage 3 (123)	Stage 3 (2.5)	Stage 3 (4.3)
116		Stage 2 (77)	28	Stage 2 (34)			
		Stage 3 (80)	20	Stage 3 (31)			
117		Stage 2 (58)	7				
		Stage 3 (58)	9				
118		Stage 2 (60)	7				
		Stage 3 (68)	9				
119		Stage 2 (64)	7				
		Stage 3 (67)	7				
121							
		Stage 3 (53)	1				
125							
		Stage 3 (51)	0				
158		Stage 2 (66)	18	Stage 2 (32)			
		Stage 3 (77)	18	Stage 3 (31)			
165		Stage 2 (71)	19	Stage 2 (32)			
		Stage 3 (76)	16				
259		Stage 2 (58)	6				
		Stage 3 (69)	8				
264		Stage 2 (63)	1	Stage 2 (35)			
		Stage 3 (73)	1	Stage 3 (36)			
265		Stage 2 (57)	7				
		Stage 3 (58)	9				
302*	Stage 2 (9)	Stage 2 (56)	4	Stage 2 (43)	Stage 2 (110)		

Assessment location ID	PM2.5	PM10		PM10	TSP	DD	
	Total ann. average	Project 24-hour average		Total ann. average		Project ann. average	Total ann. average
	NEPM 8µg/m³	Criterion 50µg/m³		Criterion 30µg/m³	Criterion 90µg/m³	Criterion 2g/m²/mth	Criterion 4g/m²/mth
	Year of impact (level of impact - µg/m³)		No. of days >50µg/m³	Year of impact (level of impact - µg/m³)		Year of impact (level of impact - g/m²/mth)	
				Stage 3 (33)			
303*	Stage 2 (9)	Stage 2 (52)	2	Stage 2 (44) Stage 3 (33)	Stage 2 (112)		
304*	Stage 2 (10)			Stage 2 (51) Stage 3 (36)	Stage 2 (127) Stage 3 (94)		Stage 2 (4.3)
305*	Stage 2 (9)			Stage 2 (41)	Stage 2 (104)		
306*	Stage 2 (9)			Stage 2 (42) Stage 3 (31)	Stage 2 (107)		
313*		Stage 2 (56)	3	Stage 2 (32)			
314		Stage 3 (78)	6				
315		Stage 3 (66)	7				
316		Stage 3 (83)	5	Stage 3 (31)			
319	Stage 2 (9) Stage 3 (14)	Stage 2 (100) Stage 3 (257)	54 195	Stage 2 (42) Stage 3 (85)	Stage 2 (105) Stage 3 (201)	Stage 3 (4.8)	Stage 3 (6.6)
320	Stage 3 (9)	Stage 2 (51) Stage 3 (113)	1 38	Stage 2 (32) Stage 3 (39)	Stage 3 (98)		
442*				Stage 2 (32)			
443*	Stage 2 (9)	Stage 2 (68)	9	Stage 2 (39) Stage 3 (31)	Stage 2 (103)		
444	Stage 3 (9)	Stage 2 (55) Stage 3 (102)	2 62	Stage 2 (33) Stage 3 (42)	Stage 3 (104)		
446*	Stage 2 (9)			Stage 2 (35) Stage 3 (35)			
447	Stage 2 (9) Stage 3 (9)	Stage 2 (108) Stage 3 (105)	41 38	Stage 2 (38) Stage 3 (37)			
448		Stage 3 (63)	6				
449	Stage 2 (9) Stage 3 (15)	Stage 2 (95) Stage 3 (259)	47 194	Stage 2 (41) Stage 3 (88)	Stage 2 (103) Stage 3 (206)	Stage 3 (4.7)	Stage 3 (6.5)
450	Stage 2 (10) Stage 3 (13)	Stage 2 (114) Stage 3 (219)	69 158	Stage 2 (46) Stage 3 (75)	Stage 2 (114) Stage 3 (180)	Stage 3 (4.3)	Stage 3 (6.4)
467	Stage 3 (9)	Stage 2 (51) Stage 3 (100)	1 52	Stage 2 (32) Stage 3 (41)	Stage 3 (101)		
471	Stage 2 (9) Stage 3 (9)			Stage 2 (42) Stage 3 (40)	Stage 2 (97) Stage 3 (94)		

*Other mine owned property

6.2 Analysis of impacts on vacant land

An assessment was conducted to ascertain as to where potential impacts due to the Project may extend over more than 25 per cent of any privately-owned land. Such an assessment can only be conducted approximately, based on the predicted pollutant dispersion contours.

The assessment considered privately owned vacant land parcels where a dwelling could be built under existing planning controls under the Singleton LEP. The majority of land relevant to this assessment is zoned RU1 and requires a minimum lot size of 40 hectare (ha) for the construction of a dwelling.

The maximum extent of the 6^{th} highest 24-hour average PM_{10} impact predicted to result from the proposed modification (ie accounting for the five allowable exceedances of the criteria over the life of the development) is the most limiting (most stringent) VLAMP acquisition criterion for the proposed modification and was applied to these vacant land parcels.

The assessment found that the maximum extent of the 6^{th} highest 24-hour average PM_{10} level will not exceed the VLAMP 25 per cent criteria at any additional privately owned land parcels. The assessment was also applied to the parcel of vacant land already afforded voluntary acquisition upon request rights within the project approval (PA 06_0261), as shown in **Figure 6-1**. However, this property does not meet the vacant land criteria specified within the VLAMP as construction of a dwelling is not permissible under existing planning controls. The VLAMP is unclear on its application to vacant land parcels with existing voluntary acquisition rights where construction of a dwelling is not permissible under existing planning controls and the extinguishment of those voluntary acquisition rights based on the most recent technical assessment and government policy.

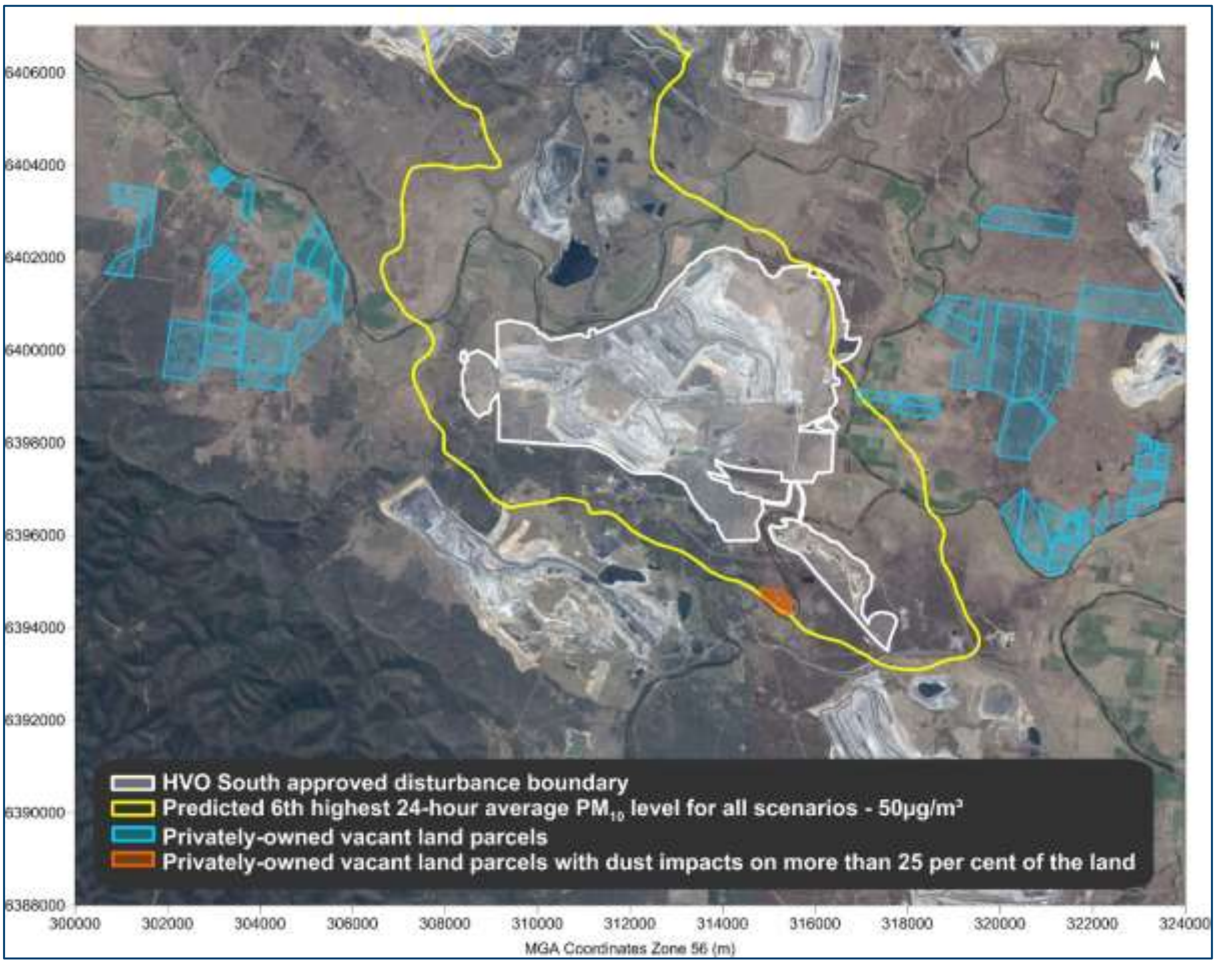


Figure 6-1: Predicted 6th highest 24-hour average PM_{10} levels for all scenarios assessed

6.3 Comparison of modelling predictions

To show the effect of the proposed modifications relative to the approved operations, the key results (maximum 24-hour average and annual average PM_{10}) have been overlayed with results for the maximum year (Scenario B1) from the latest modelling assessment for HVO South (**Holmes Air Sciences, 2008**) in **Figure 6-2** and **Figure 6-3**.

For short term PM_{10} impacts in **Figure 6-2**, the comparison indicates that with the modification there would likely be a reduction of the predicted levels occurring around Maison Dieu. For the areas to the southeast of Jerrys Plains, levels are expected to be generally similar. At Warkworth Village there would be some increase in short term PM_{10} impacts associated with the modification.

The comparison of incremental annual average PM_{10} impacts in **Figure 6-3** shows an increase in areas to the southeast which is associated with operations occurring in the South Lemington Pit 1 and South Lemington Pit 2 and to the north which can be attributed to hauling of ROM coal to the Hunter Valley CPP.

For Stage 2 the incremental annual average PM_{10} impacts also extend slightly to the south and west compared to the previously approved operation, which is most likely due to mining activity located in the Riverview pit. During Stage 3, impacts extend to the northwest and can be associated with activity being focused in the western part of the mine with the dust transported along the predominant wind axis for the area.

Overall, the comparison of incremental 24-hour and annual average PM_{10} levels indicate that the predicted dust levels associated with the modification would be of a generally similar extent to the approved operations.

The proposed modification would therefore not result in any significant change to what is already approved for HVO South.

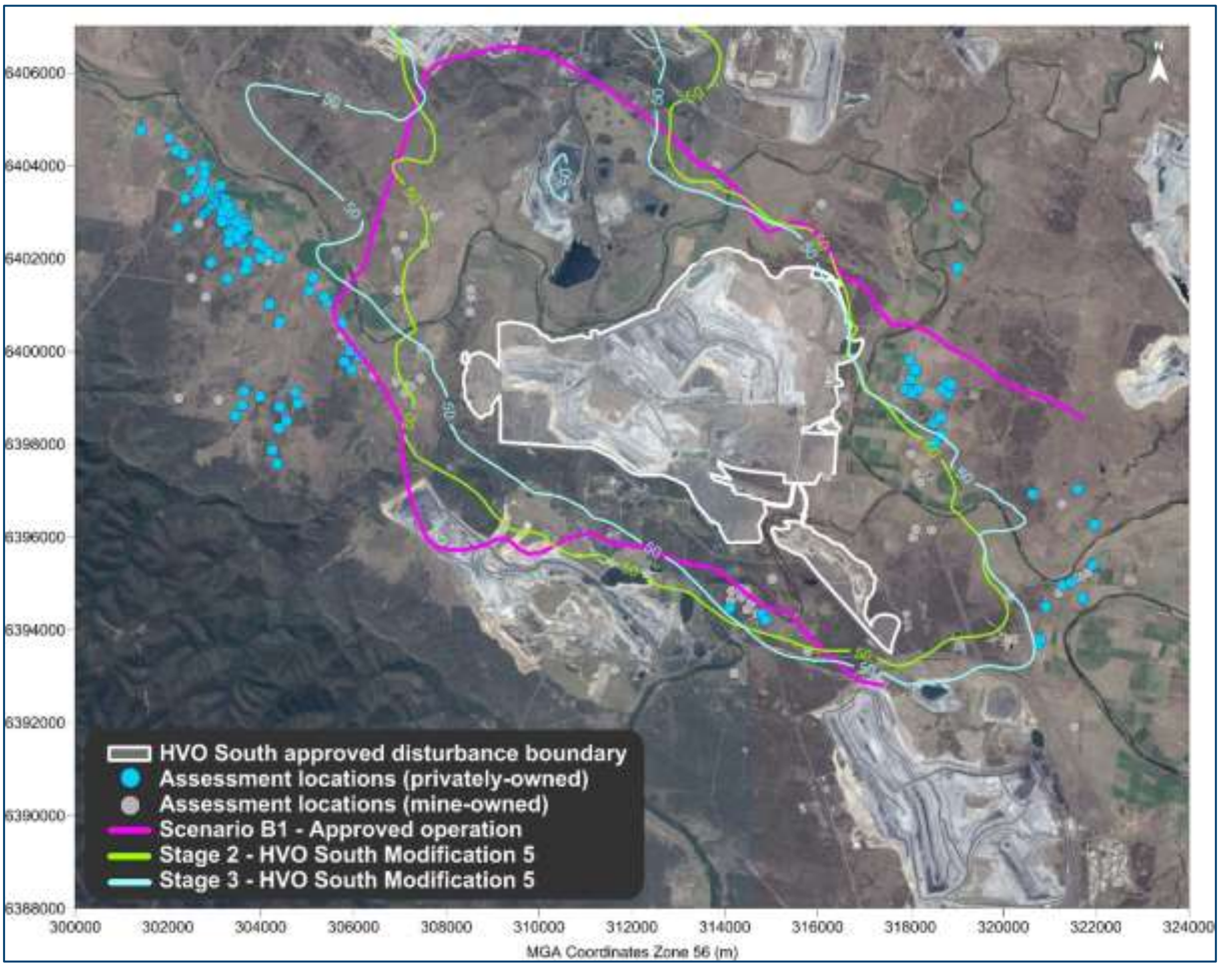


Figure 6-2: Comparison of approved and proposed maximum incremental 24-hour average PM_{10} concentrations (µg/m³)

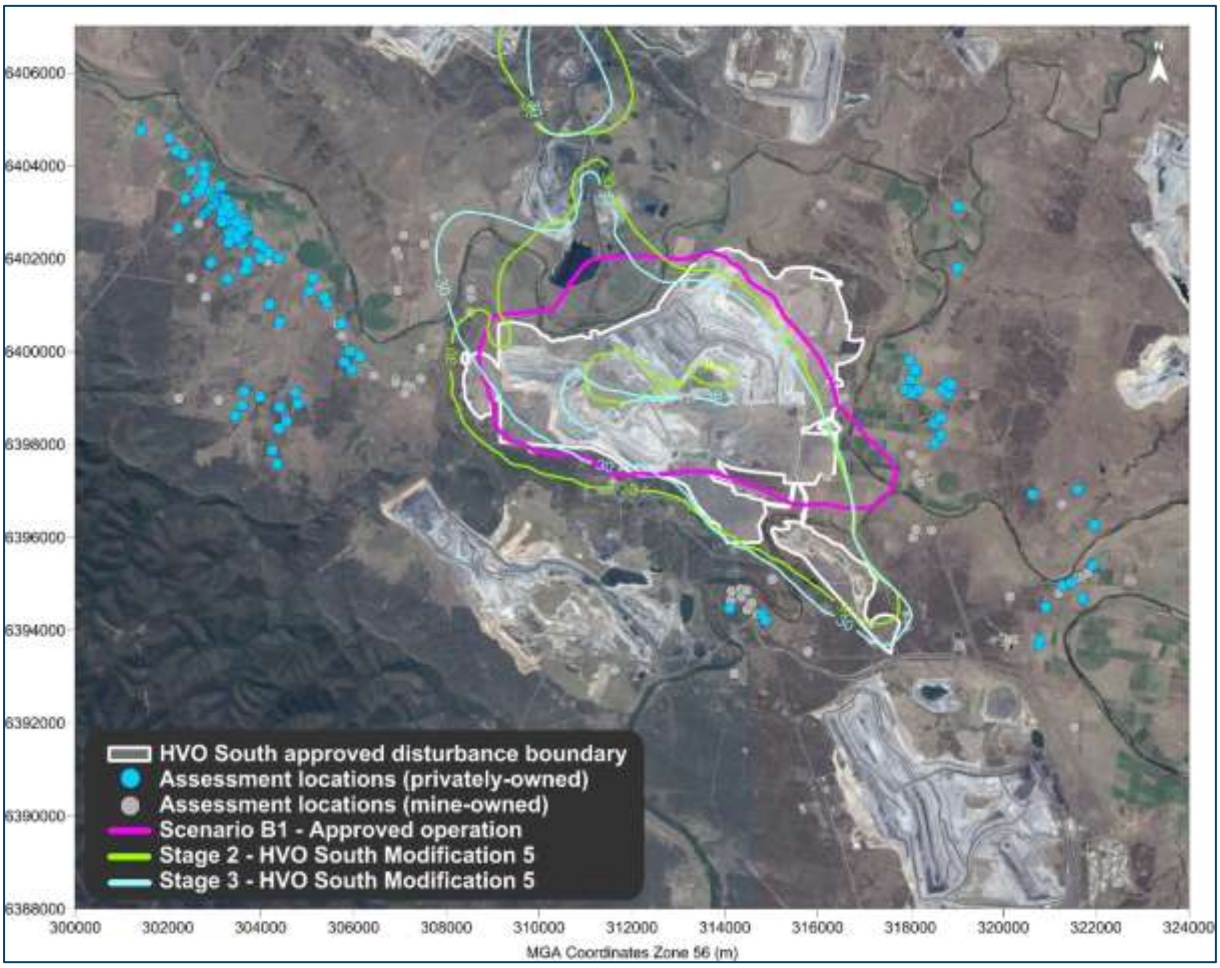


Figure 6-3: Comparison of approved and proposed incremental annual average PM_{10} concentrations (µg/m³)

6.4 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 privately-owned assessment locations at which the data required to conduct this assessment are available and represent the closest and most likely impacted privately-owned assessment locations surrounding HVO South.

There are five 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 6-4 shows the location of each of these monitors in relation to HVO South and surrounding assessment locations.

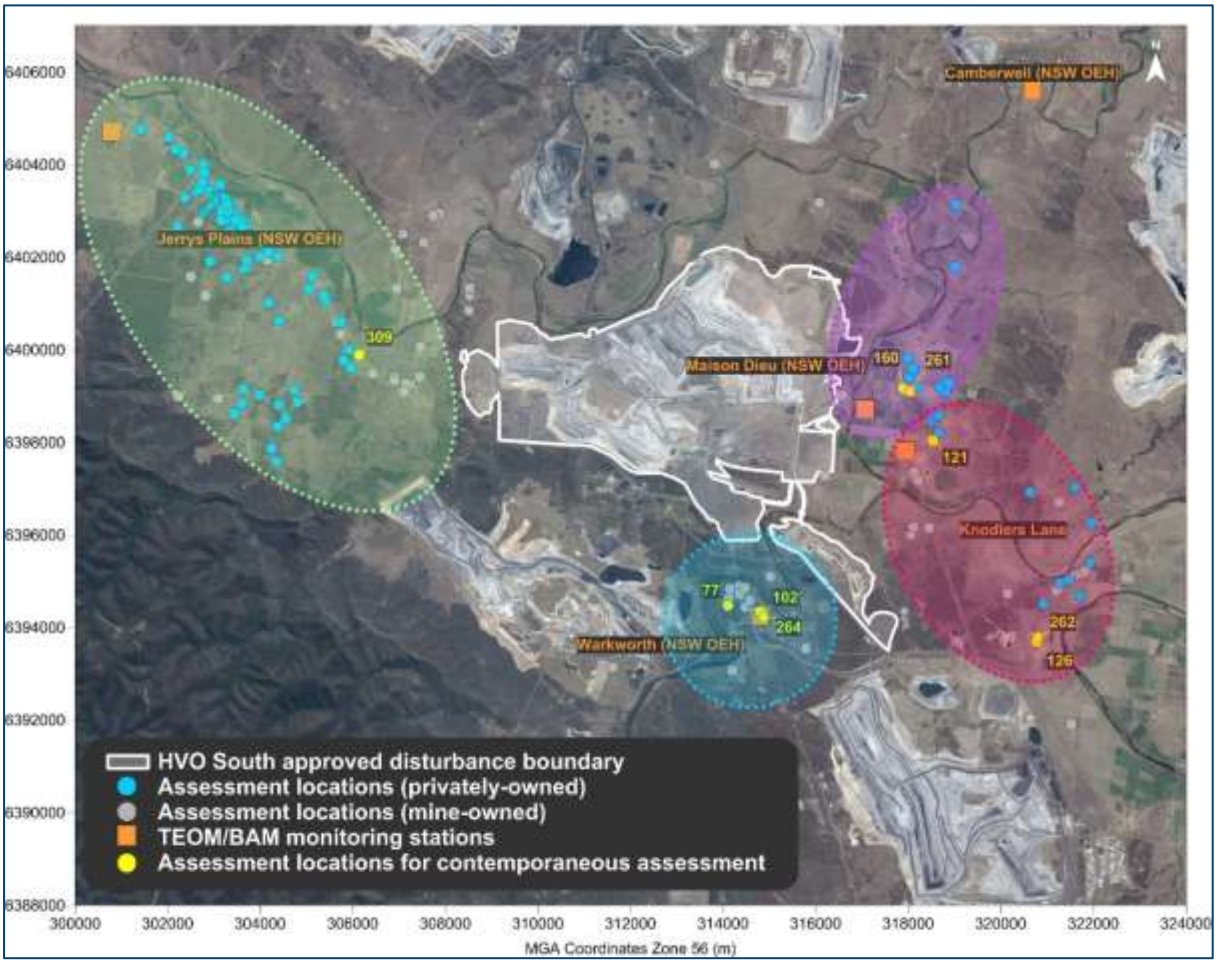


Figure 6-4: Locations available for contemporaneous cumulative impact assessment

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 $PM_{2.5}$ NEPM 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 (as described in **Section 5.5**) 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 HVO South 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. The assessment locations highlighted in orange are already identified in the acquisition zone for other mine operations and are impacted regardless of the Project.

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	
	Stage 2	Stage 3	Stage 2	Stage 3
77	0	0	**9**	**9**
102	0	0	**8**	**13**
121	0	0	0	0
126	0	0	2	4
160	0	0	0	1
261	0	0	0	0
262	0	0	2	3
264	0	0	**7**	**13**
309	0	0	4	1

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 near Warkworth (assessment locations 77, 102 and 264) where it is predicted that there may be 7 to 13 additional days above the criteria. It is clear that acquisition rights should be afforded at these locations (and it is noted that two of these assessment locations – 102 and 264 – are non-residences and assessment location 77 is already afforded such rights by other mining operations).

All other assessed locations would likely experience between zero and four additional days above the criterion. For areas to the east of Jerrys Plains (represented by assessment location 309), the potential cumulative 24-hour average PM_{10} impacts are predicted to decrease for the assessed scenarios, from four additional days to one additional day, due to the relocation of activities from the Riverview pit.

The majority of the Maison Dieu area is not expected to experience any additional days due to the proposed modification. Assessment location 160 is predicted to potentially experience one additional day during Stage 3.

For the Long Point area (represented by assessment locations 126 and 262), these locations are predicted to experience an increase of one to two additional days from Stage 2 to Stage 3. This increase may be attributed to the operation and associated activities of the proposed rail loop located to the south of South Lemington Pit 1.

Further analysis of the predicted cumulative $PM_{2.5}$ and PM_{10} impacts at these locations outside the area near Warkworth, at the likely most impacted of three representative locations, 126, 160 and 309 are presented in **Figure 6-5** to **Figure 6-8**. The figures show time series plots of the 24-hour average $PM_{2.5}$ and PM_{10} concentrations predicted to be experienced as a result of the Project.

The yellow bars in the figures show the predicted additional levels due to the Project above background levels (ie the yellow sections of the bars indicate that 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 Project. There is some potential increase to PM_{10} levels, generally in areas to the southeast of the Project during the winter months and to the northwest of the Project during the summer months.

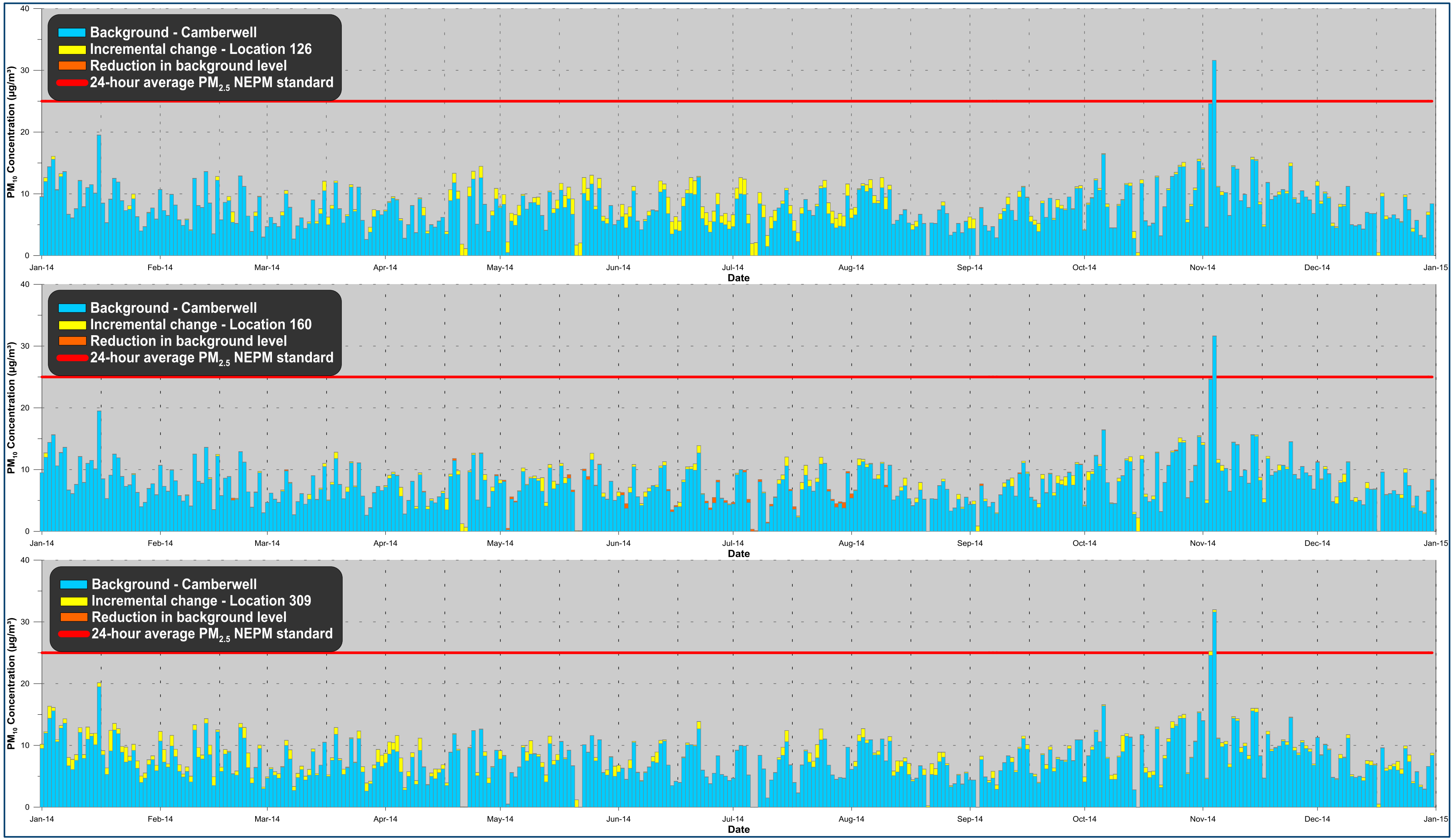


Figure 6-5: Predicted 24-hour average $PM_{2.5}$ concentrations for assessment locations 126, 160 and 309 during Stage 2

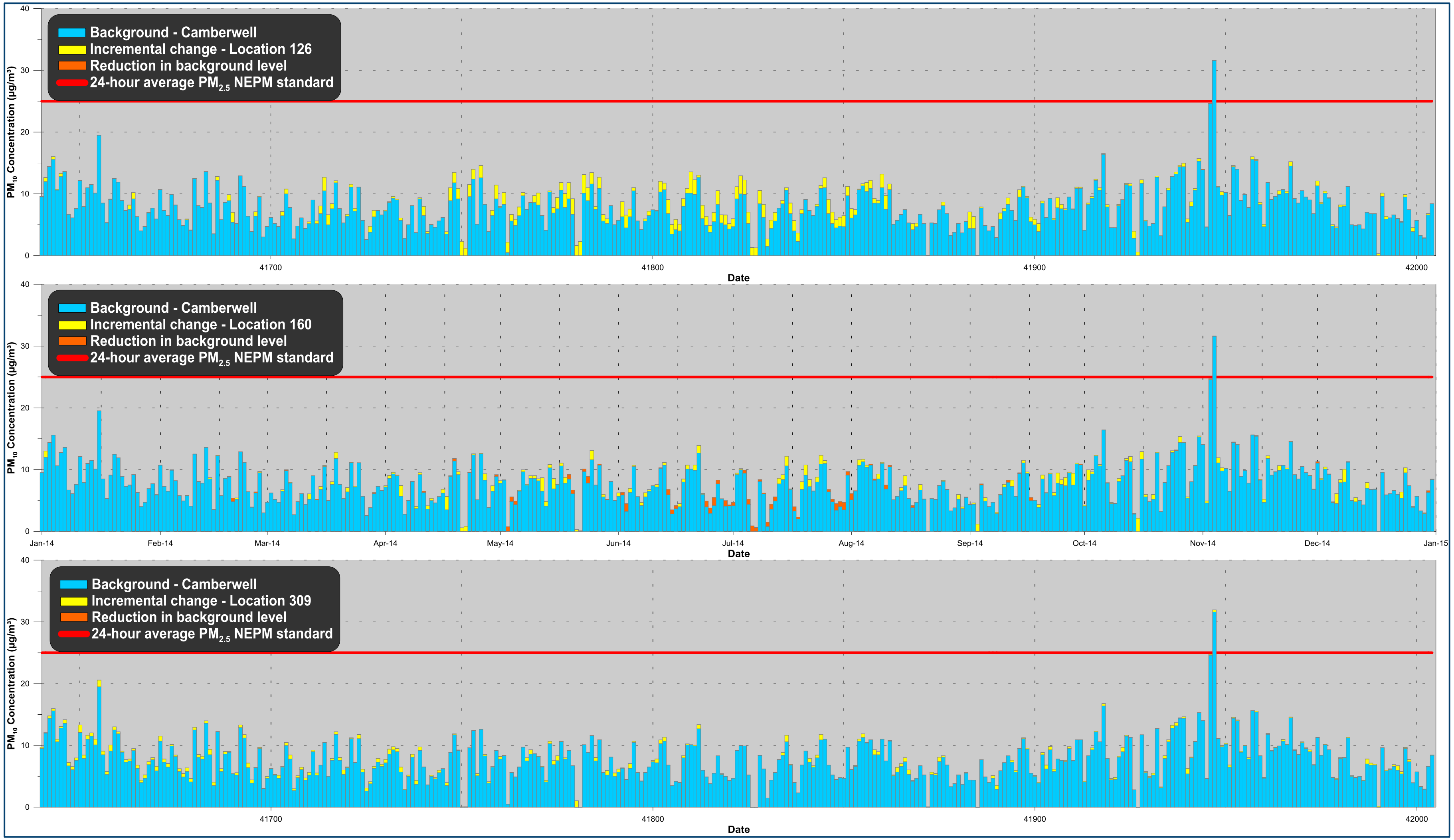


Figure 6-6: Predicted 24-hour average $PM_{2.5}$ concentrations for assessment locations 126, 160 and 309 during Stage 3

Figure 6-7: Predicted 24-hour average PM_{10} concentrations for assessment locations 126, 160 and 309 during Stage 2

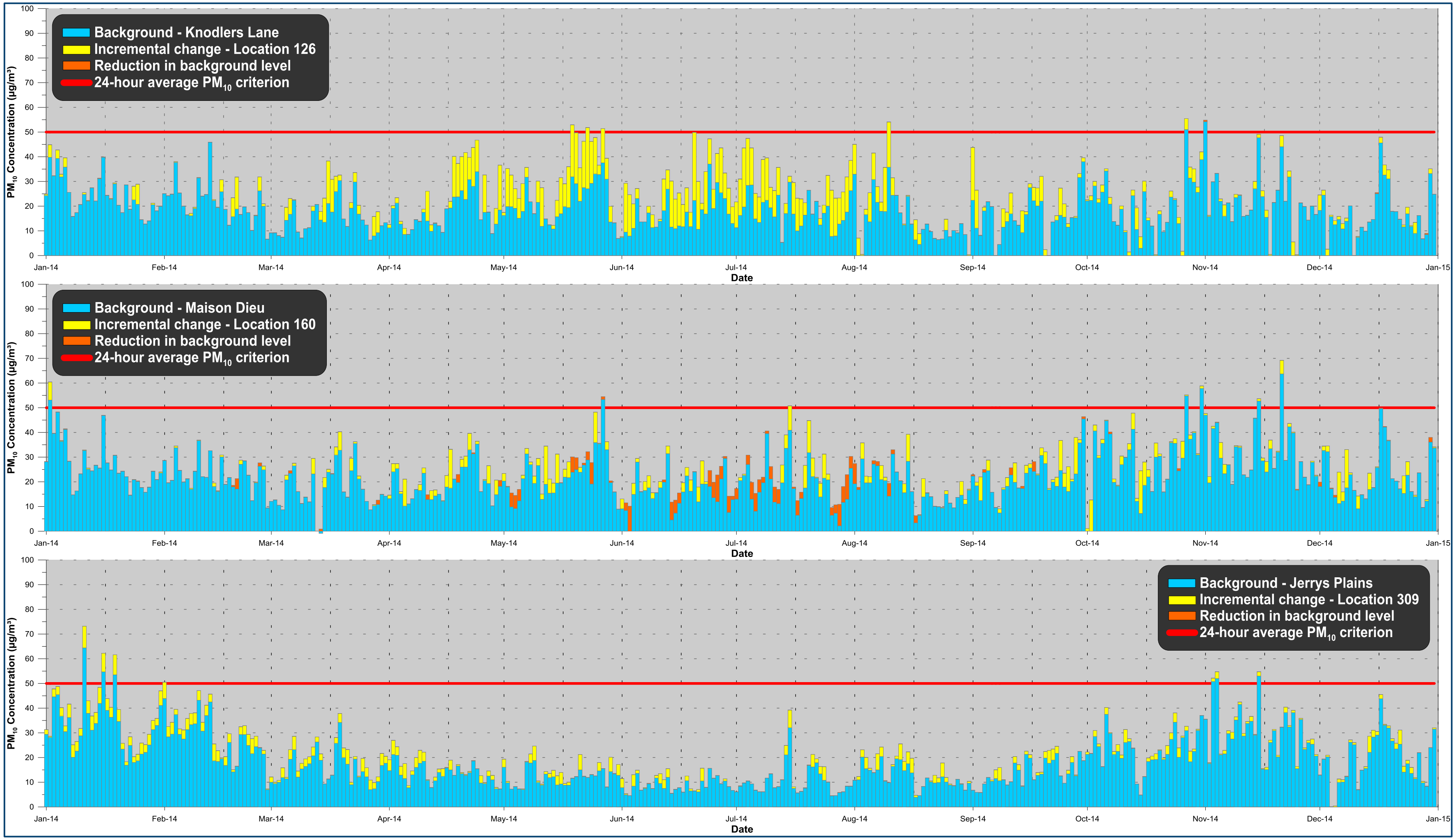


Figure 6-8: Predicted 24-hour average PM_{10} concentrations for assessment locations 126, 160 and 309 during Stage 3

7 ASSESSMENT OF POTENTIAL COAL DUST EMISSIONS FROM TRAIN WAGONS

7.1 Dispersion modelling

The transportation model CAL3QHCR, developed by the US EPA, has been used to assess potential impacts from this source. CAL3QHCR was designed for use in dispersion modelling of road transport emissions, however given the similar linear nature of the potential train wagon emissions compared to road transport emissions it is considered to be a suitable model for this situation also.

To consider the range of varying land use between the Project site and the Port of Newcastle, and the varying orientation of the rail line relative to the prevailing winds, the dispersion model has been set up to assess theoretical sections of the rail line over a distance of 3km with two varying alignments (north/south and east/west) and two different land use categories. Dust level calculation points were applied at a 10 metre (m) spacing, perpendicular from the centre of the rail line source alignment out to a distance to 200m either side of the rail line.

7.2 Modelling predictions

Figure 7-1 and **Figure 7-2** present the model predictions for each scenario through Newdell and Lemington, respectively. The modelling predictions indicate that at distances of 50m and beyond from the rail track centreline, the maximum 24-hour average TSP concentration for the assessed scenarios would be approximately 2.95µg/m^3 for the Project through Newdell, and approximately 1.01µg/m^3 for the Project through Lemington. For urban areas, the predicted the maximum 24-hour average TSP level at 50m from the rail line centre would be approximately 1.71µg/m^3 through Newdell, and approximately 0.58µg/m^3 through Lemington.

By assuming that 40 per cent of the TSP is PM_{10} (**NSW Minerals Council, 2000**), the predicted maximum 24-hour average PM_{10} concentration at 50m from the rail line centre would be approximately 1.18µg/m^3 through Newdell and 0.40µg/m^3 through Lemington. For urban areas the predicted maximum 24-hour average PM_{10} level at 50m from the rail line centre would be approximately 0.68µg/m^3 through Newdell and 0.23µg/m^3 through Lemington.

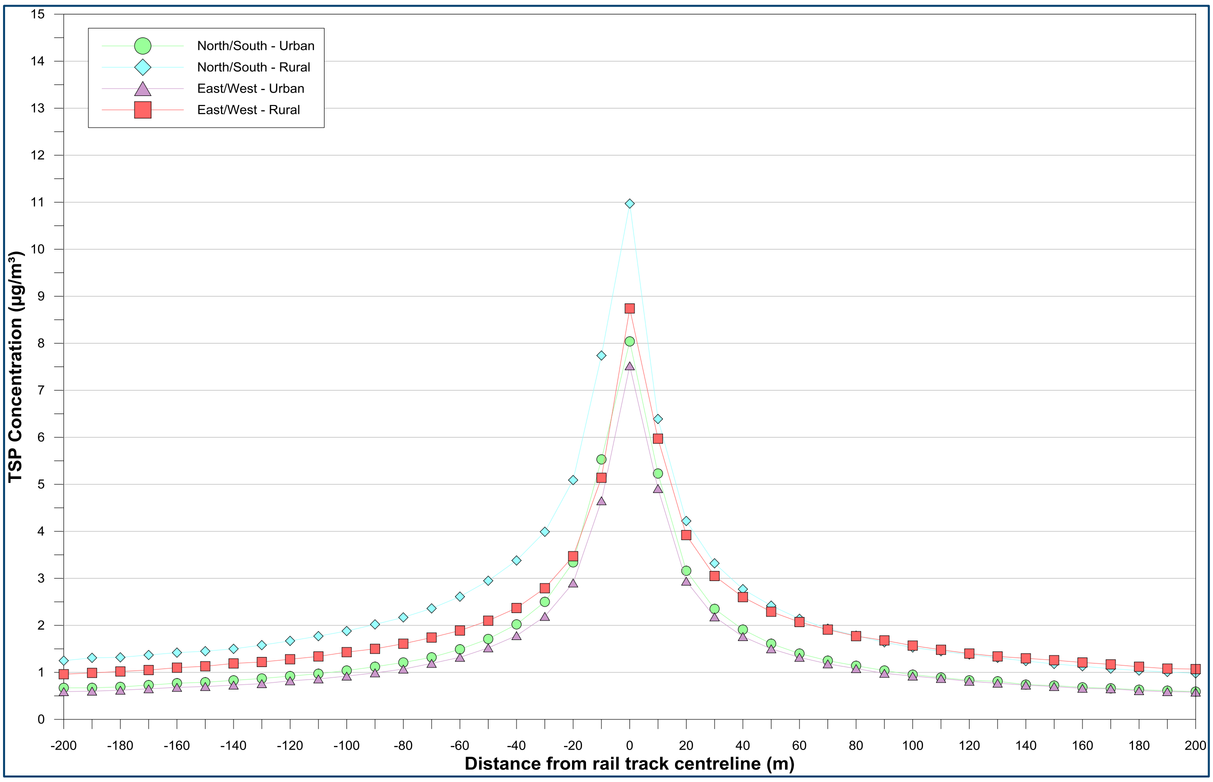


Figure 7-1: Maximum 24-hour TSP concentration based on train wagon emissions from the Project through Newdell

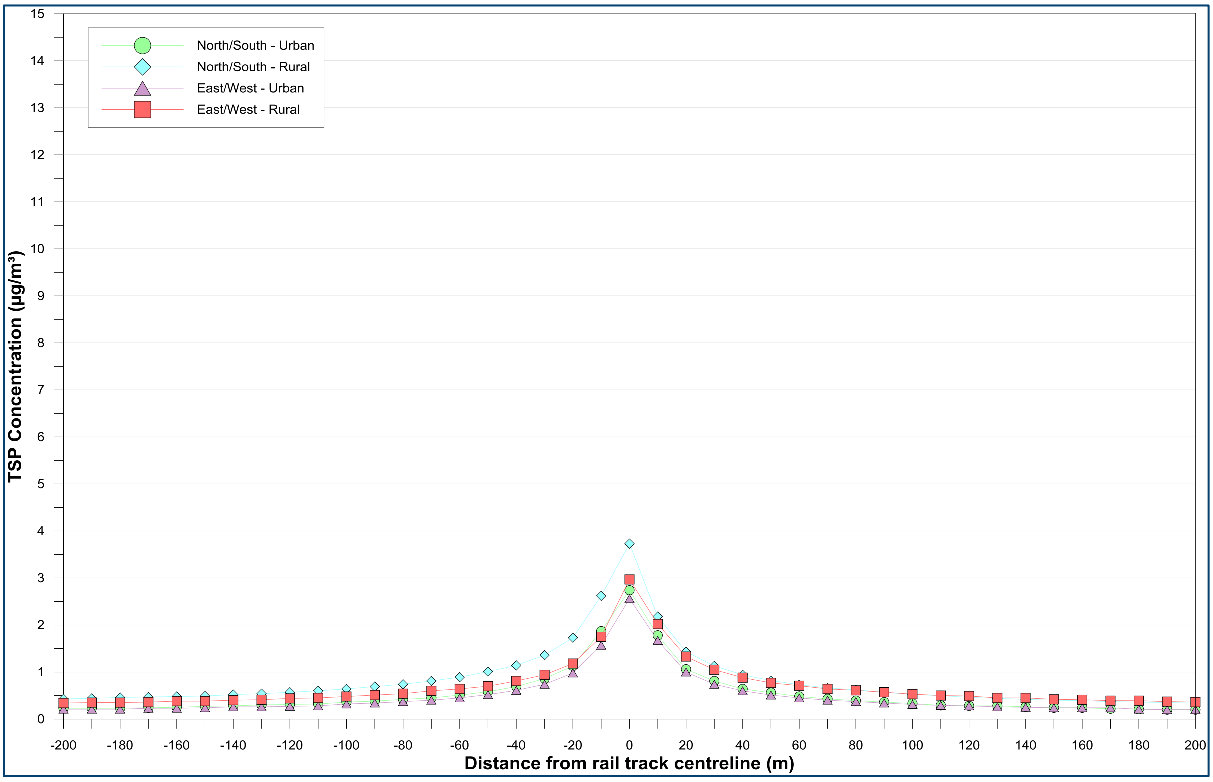


Figure 7-2: Maximum 24-hour TSP concentration based on train wagon emissions from the Project through Lemington

7.3 Summary

The detailed study of dust emissions generated during rail transport of coal conducted by Katestone Environmental for Queensland Rail Limited (**Connell Hatch, 2008**) found that based on monitoring and modelling of the emissions and impacts of coal train wagons, there appears to be a minimal risk of adverse impact on human health. The study found that concentrations of coal dust at the edge of the rail corridor are below levels known to cause adverse impacts on amenity.

A study conducted for the Australian Rail Track Corporation (ARTC) (**Ryan and Wand, 2014**) for trains travelling on the Hunter Valley network found no significant difference in the particulate matter measurements for passing freight and coal trains (loaded and unloaded). The study hypothesised that the significant increase of smaller measured particles ($PM_{2.5}$ and PM_1) associated with rail movements indicates that the elevated particulate matter levels were mostly due to diesel particles associated with locomotive emissions as opposed to coal dust which tends to be in the larger particle range.

Further analysis of this data with additional data in the form of the number of locomotives on each passing train and precipitation data for the general area (**Malecki and Ryan, 2015**) was recently completed. The analysis suggests that the number of locomotives on each passing train has little influence on particulate levels which indicates that diesel particles are not a significant source. The effect of rainfall on a previous day was found to have a significant impact on particulate levels on the following day. This finding would tend to indicate that the key mechanism for the increased particulate levels was due to passing trains stirring up existing dust particles which had previously settled on the tracks and nearby ground and that the influence on particulate levels was the same regardless of the type of train that was passing.

This assessment is consistent with the findings of these studies in indicating that the potential for any adverse air quality impacts associated with coal dust generated during rail transport would be low and would not make any appreciable difference to air quality.

The proposed modification is not seeking any increase in product coal transported from HVO South or change to rail movements, thus there would not be any change in the level of air quality due to this activity.

Nevertheless, HVO South would ensure dust emissions from rail wagons are minimised where possible by streamlining and consistent profiling of coal surface within the rail wagons, minimising spillage and parasitic loading and regular collection and cleaning of any coal spillage.

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 causes 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 that 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 best practice 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.

As such, the only changes that would arise as part of the proposed modification are improvements to the operational systems that arise from new scientific knowledge and a better understanding of blast management.

8.1 General outline of best practice 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.

Specific control measures implemented at HVO, per best practice management procedures, are outlined below.

8.2 Management of potential air quality impacts from blasting

Air quality impacts of blast operations at HVO South are managed under HVO's Blast Management Plan (BMP) HVO-10-ENVMP-SITE-E6-004. The purpose of the BMP is to ensure that blasting operations comply with all relevant requirements particularly noise, overpressure, vibration, blast fume and dust effects.

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

A predictive blast system is also used to schedule blast events to the least-risk time of the day where feasible. This approach minimises the risk of any off-site impact occurring, and is based on hourly forecast weather conditions that may affect the dispersion of blast emissions.

The site operations have not experienced any issues related to air quality impacts from blasting to date.

The current systems in place apply best practice management through the use of a predictive system which models each blast event case specifically.

As the predictive system requires intensive computing effort and may on the rare occasion become unavailable (eg power or internet fault), the fail-safe for this circumstance is to apply a set of conditions related to wind direction and speed. These conditions vary for each blast, and will also vary over time as the mine progresses and blasting locations move relative to sensitive receptors.

To ensure that the HVO BMP is incorporating current best practice, it will be updated prior to commencement of this Project to include the following;

8.2.1 Meteorological considerations

Blasting is scheduled and undertaken in a responsible manner, taking account of best available weather forecast information as follows:

1. *4 – 7 days in advance of blasting – scheduling undertaken in consideration of forecast meteorological conditions (use of publically available forecast information);*
2. *1 – 3 days in advance of blasting - Site specific blast plume predictions and updated weather forecast information is used to refine the blast schedule, taking account of a range of factors such as shot size and location, requirement for closure of public roads, and risk-assessed likelihood of dust / fume associated with the blast;*
3. *Morning of the planned blast – Site specific blast plume predictions are used to determine the optimum time for firing.*
4. *Approaching blast detonation - review of the blasting permissions page for the appropriate Pit area which considers: wind speed and wind direction relative to sensitive receptors and public roads.*

Step 1 aims to ensure that it is likely that there would be favourable air dispersion conditions prevailing after the 4 to 7 days that it may take to load the shot with explosive.

Step 2 aims to define the likely blast window, and to begin planning for the blast to occur within that window.

Step 3 is the final stage of the blast planning and aims to schedule the optimal blast time on the blast day.

Step 4 is the last check immediately before the blast is initiated and is done to ensure that the conditions are as expected, are likely to prevail after the event, are low risk air dispersion conditions (but with that risk being commensurate with the nature of the expected blast), and that the blast may (or may not) proceed.

8.3 Blast impact assessment – concluding comments

As the proposal is moving west, the potential for blast fume impacts to the west increases. This means that potential impacts at assessment locations to the west will need to be managed more stringently in later years of mining.

It is noted that in this regard HVO South have implemented a predictive management system to aid with management of blasting operations. Such a system uses actual conditions for each blast to predict the potential impact which may occur. The prediction is made on the basis of forecast weather data, allowing operators to schedule a blast to the time of least impact over the course of the upcoming day. In effect the system updates the blasting permissions for each individual blast on the basis of predicted impact. The system thus deals with the spatially and time varying weather and terrain influences and is generally more reliable than depending on a fixed set of wind speed and wind direction restrictions.

Overall, it is anticipated that with due care, potential blast impacts would be averted.

9 PARTICULATE MATTER HEALTH EFFECTS

9.1 Introduction

The following section is a summarised excerpt of private correspondence from Environmental Risk Sciences Pty Ltd to Todoroski Air Sciences.

Detailed reviews of the available studies that relate to health effects associated with exposure to particulates are available from various sources (**NEPC 2010, USEPA 2009**, **Anderson et al. 2004, WHO 2003, OEHHA 2002**). Particulate matter is comprised of a diverse range of substances, with varying morphological, chemical, physical and thermodynamic properties, across a large size range. Particulates can be derived from natural sources such as crustal dust, pollen, sea salts and moulds, and anthropogenic (human) activities including combustion and industrial processes. Secondary particulate matter is formed via atmospheric reactions of primary gaseous emissions. The most significant contributors to secondary particulates include nitrogen oxides, ammonia, sulfur oxides, and certain organic gases (emitted from vehicles, combustion, agriculture, industry and biogenic sources).

Particulate matter comprises particles which can remain suspended in the air for extended periods, and is typically classified by particle size.

9.2 Particulate size

The size of particulates is important as it determines how far from an emission source the particulates may be present in air (with larger particulates settling out first and smaller particles remaining airborne for greater distances) and also the potential for adverse effects to occur as a result of exposure.

The common measures of particulate matter that are considered in the assessment of air quality and health risks are previously outlined in **Section 3.1** with more detail in regard to health as follows:

- TSP refers to all particulate with an equivalent aerodynamic particle size below approximately 50µm diameter. Larger particles (termed "inspirable", comprise particles around 10µm and larger) that may cause nuisance and would deposit out of the air (measured as deposited dust) closer to the source. Such particles, if inhaled are mostly trapped in the upper respiratory system[2] and do not reach the lungs. Finer particles (smaller than 10µm, termed "respirable") tend to be of more concern as these particles can penetrate into the lungs. As only a fraction of TSP material is harmful to human health, it is a measure of nuisance impact, not health impact.

- PM_{10}, particulate matter below 10µm in diameter, $PM_{2.5}$, particulate matter below 2.5µm in diameter and PM_1, particulate matter below 1µm in diameter. These particles are small and have the potential to penetrate beyond the nose and upper respiratory system, with the smaller particles able to penetrate into the lower respiratory tract[3] and lungs which may result in adverse health effects (**OEHHA, 2002**).

[2] The upper respiratory tract comprises the mouth, nose, throat and trachea. Larger particles are mostly trapped by the cilia and mucosa and swept to the back of the throat and swallowed.

[3] The lower respiratory tract comprises the smaller bronchioles and alveoli, the area of the lungs where gaseous exchange takes place. The alveoli have a very large surface area and absorption of gases occurs rapidly with subsequent transport to the blood and the rest of the body. Small particles can reach these areas, be dissolved by fluids and absorbed.

Monitoring for PM_{10} is the most commonly applied metric in local and regional air quality monitoring program. Smaller particulates such as $PM_{2.5}$ and PM_1 are generally of most significance with respect to evaluating health effects as a higher proportion of these particles penetrate into the lungs; however, monitoring for such particulate matter is technically challenging and thus is not widely established. Thus PM_{10} monitoring serves as a defacto method of measuring $PM_{2.5}$ (**WHO, 2005**).

Apart from small aerodynamic diameter, factors such as the hygroscopicity, electrostatic charge, and characteristics of the human respiratory system including airway structure and geometry, as well as depth, rate and mode of breathing (eg nasal vs. oral/nasal) affect the extent of particulate penetration and deposition into the lung.

A significant amount of research has been conducted on the health effects of particulates with causal effects relationships identified for exposure to $PM_{2.5}$. A more limited body of evidence suggests an association between exposure to larger particles, PM_{10} and adverse effects (**USEPA, 2009 and WHO, 2003**).

9.3 Particulates composition

Evaluation of size alone in regard to particle health impacts is difficult as particle size may not be independent of chemical composition. Certain particulate size fractions tend to contain certain chemical components, such as crustal materials in the coarse particle fraction (PM_{10} or larger) or metals in fine particulates ($<PM_{2.5}$). In addition, different sources of particulates may emit other pollutants in addition to particulate matter. For example, combustion sources, the dominant particulate source in urban areas, emit predominantly fine particulates as well as gaseous pollutants such as ozone, nitrogen dioxide, carbon monoxide and sulfur dioxide, all of which have independent health effects.

There is strong evidence (**WHO, 2003**) to conclude that fine particles (<2.5µm, $PM_{2.5}$) are more hazardous than coarse particles, primarily on the basis of studies conducted in urban air environments where there is a higher proportion of fine particulates present from fuel combustion sources, rather than from crustal origins. Studies indicate that particles generated from fossil fuel combustion may be a significant contributor to adverse health outcomes. Amongst the characteristics found to be contributing to these outcomes are high organic carbon content, metal content, presence of Poly-cyclic Aromatic Hydrocarbons (PAHs), other organic components, endotoxin and both small (<2.5µm) and extremely small size (<100nm) particulate (**USEPA 2009, WHO 2006a**, **WHO 2003**).

This does not mean that the coarse fraction of PM_{10} is not harmful, however, it appears to be a less critical source (**WHO, 2003 and USEPA, 2009**).

The observed health effects are derived from studies conducted in urban areas, whereas the actual health impacts from particulate matter in a specific location would be affected by the specific characteristics of the mix of particulate matter at the location.

Reviews of the currently available information have not been able to identify any single physical or chemical property of particles that is responsible for the array of adverse health outcomes reported in epidemiological studies (**USEPA, 2009 and WHO, 2003**). Hence, WHO (**WHO, 2006b**) and NEPC (**NEPC, 2010**) concluded that the evidence at present cannot support an indicator for a standard that is more specific than size fraction alone.

As a consequence, the potential for adverse health effects is assumed to apply equally for all sources and composition of particulates at this time.

9.4 Health effects

Adverse health effects associated with exposure to particulate matter have been primarily derived from population-based epidemiological studies. It is difficult to obtain reliable measures of $PM_{2.5}$, hence much of data considered in the studies is based on ambient PM_{10} data measured in urban areas.

Short term exposure (days to weeks) and long term exposure (years) to PM_{10} has been linked to adverse health effects.

Mortality effects relate to the increase in the number of deaths due to existing (underlying) respiratory or cardiovascular diseases that have been associated with exposure to PM_{10} or $PM_{2.5}$ in population-based epidemiological studies.

Morbidity effects relate to a wide range of health indicators used to define illness or the severity of illness associated with exposure to PM_{10} or $PM_{2.5}$, primarily related to the respiratory and cardiovascular system (**USEPA, 2009 and Morawska et al., 2004**) and include:

- Aggravation of existing respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days);
- Changes in cardiovascular risk factors such as blood pressure;
- Changes in lung function and increased respiratory symptoms (including asthma);
- Changes to lung tissues and structure; and
- Altered respiratory defence mechanisms.

These effects are commonly used as measures of population exposure to particulate matter in community epidemiological studies. While there is general agreement on the mortality effects associated with exposure to particulate matter, it is noted that there is less agreement on the wide range of morbidity indicators.

9.5 Summary of health effects

The following table presents a summary of the adverse effects associated with exposure to particulate matter in generally large cities and the susceptible populations identified (relevant to the health endpoint).

Table 9-1: Summary of potential adverse health effects from exposure to particulate matter in cities

Health-effect	Susceptible group	Comments
Short term		
Mortality	Elderly, infants, persons with chronic cardiopulmonary disease, influenza or asthma	Causal relationship has been identified for exposure to PM_{10} and $PM_{2.5}$.
Hospitalisation rates (respiratory and cardiovascular effects)	Elderly, infants, persons with chronic cardiopulmonary disease, pneumonia, influenza or asthma	Reflects substantive health impacts in terms of illness, discomfort, treatment costs, work or school time lost.
Increased respiratory symptoms	Most consistently observed in people with asthma, and children	For most, effects are transient with minimal overall health consequences. May result in some short term absence from work or school due to illness.
Decreased lung function	Observed in both children and adults	For most, effects seem to be small and transient.
Long term		
Increased mortality rates, reduced survival times, chronic cardiopulmonary disease, reduced lung function, lung cancer	Observed in population-wide epidemiological studies, including adults, children and infants. All chronically exposed are potentially affected	Long-term repeated exposure appears to increase the risk of cardiopulmonary disease and mortality. May also result in lower lung function.

9.6 Considerations relevant to mining

Table 9-1 relates to studies of human exposure to particulate matter in generally large cities, where a larger portion of the particulates are in the fine fraction that would penetrate into the lung, and also where a greater portion of the particulate matter is from combustion sources, and thus carries with it other individually toxic substances that are damaging to human health.

It is important to understand that the majority of particulate emissions from mining are dust which originates from the soil. Due to the extreme forces required at the micro level to break down a particle of dust into smaller particles in the fine fraction, mining techniques used at coal mines generally cannot breakdown rock, coal or soil material into these very fine fractions. As a result emissions from mines are predominantly in the coarse size fraction which would not penetrate as deeply into the lung, or carry additional toxic combustion substances. On average it has been measured that approximately 5 per cent of the total dust (TSP) from mining is in the $PM_{2.5}$ size fraction, and approximately 12 per cent of PM_{10} from mining is in the $PM_{2.5}$ fraction (**SPCC, 1986**).

In contrast, in the urban areas in which the majority of the health studies have been conducted, approximately 50 per cent of the PM_{10} is comprised of particles in the $PM_{2.5}$ size range, and most of these are from combustion.

It needs to be understood that rural populations are simply too small for conclusive epidemiological studies to be conducted in those areas, and insufficient alternative data are available for rural areas to identify specific issues that health experts can agree on. Therefore, as a matter of precaution, the findings for urban areas (as shown in **Table 9-1**) are extrapolated to cover rural areas in order to have a basis for managing exposure to particulate matter for rural populations.

This is not to say that particulate emissions from mining are harmless. Mining emissions include a component of particles in the PM_{10} and $PM_{2.5}$ range and this would include fine combustion particles from diesel equipment.

In the context of health impacts in rural areas, it needs to be noted that in many rural areas domestic wood smoke is a key issue of health impact. Wood smoke warrants close attention in any evaluation of health impact as it can be a significant, highly localised source of toxic pollution in the winter period for rural communities and individuals.

The recent studies by CSIRO (**CSIRO, 2013**) into the composition of particulate matter in the Hunter Valley found that a key source of fine particulate is wood smoke. As has occurred in many rural towns, NSW EPA has launched an initiative to target particulates in the Hunter Valley (**NSW EPA, 2013**), and a key action relates to management of wood smoke in the urban areas.

In this regard it is also important to interpret emission inventory data, such as NPI data and data from NSW EPA's air emissions inventory for the Greater Metropolitan Region (GMR) in NSW in the correct context. For example, if one compares mine dust emissions with those from wood heaters based on only the inventory data, one would see that the two produce roughly the same amount of $PM_{2.5}$ emissions. However, it would be wrong to conclude that mines and wood heaters have similar health impacts on the residential population. Unlike coal mines, wood heaters are located inside living rooms and their chimneys are closer to residents than coal mines, which means the air that the population breathes will be affected by wood heater emissions to a much greater degree.

It also needs to be noted that health should be considered in terms of risk of adverse impacts to individuals residing in a specific location, but also in regard to the impacts on the whole community. In the Hunter Valley, the community includes mine workers, and to maintain overall population health it is reasonable to also minimise mine staff exposure to pollutants that may be harmful, or to situations that may be dangerous.

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 proposed modification and to provide a comparison of the direct emissions from the proposed 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 Project defined as:

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

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

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

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 proposed 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 proposed modification occurs from the transportation of the product coal and from the end use of the product coal.

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

10.2.1 Emission sources

Scope 1 and 2 GHG emission sources identified from the operation of the proposed modification are the on-site combustion of diesel fuel, petrol fuel, petroleum based greases and oils, explosives, emissions of methane and carbon dioxide from the exposed coal seams, 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. These estimates are based on a conservative upper limit of the assumed maximum production throughout the life of the proposed modification (up to 2030). The assessment provides a reasonable worst case approximation of the potential GHG emissions for the purpose of this assessment.

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

Period	ROM coal (tonnes)	Diesel (kL)	Fuel Oil (kL)	Petrol (kL)	Grease/oils (kL)	Electricity (MWh)	Explosives (t)	LPG (kL)
Annual	20,000,000	136,344	917	107	1,498	163,370	64,394	1,008
Total	243,231,131	1,658,157	11,157	1,296	18,212	1,986,836	783,134	12,257

Scope 3 emissions for the transport and final use of the coal may have the potential to vary in the future depending on the market situation at the time. These assumptions include emission factors for the transport modes of rail and shipping and the associated average weighted distance travelled for the export coal.

10.2.2 Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the proposed modification, emission factors obtained from the NGA Factors (**Department of the Environment, 2015b**) and other sources as required and are summarised in **Table 10-2**.

Table 10-2: Summary of emission factors

Type	Energy content factor	Emission factor			Units	Scope	Source
		CO_2	CH_4	N_2O			
Diesel	38.6	69.9	0.1	0.5	kg CO_2-e/GJ	1	Table 4 (**DoE, 2015b**)
		3.6				3	Table 39 (**DoE, 2015b**)
Fuel oil	39.7	73.6	0.04	0.2	kg CO_2-e/GJ	1	Table 3 (**DoE, 2015b)**
		3.6				3	Table 39 (**DoE, 2015b**)
Petrol	34.2	67.4	0.5	1.8	kg CO_2-e/GJ	1	Table 4 (**DoE, 2015b**)
		3.6				3	Table 39 (**DoE, 2015b**)
Grease/oils	38.8	3.5			kg CO_2-e/GJ	1	Table 3 (**DoE, 2015b**)
		3.6				3	Table 39 (**DoE, 2015b**)
Electricity		0.84			kg CO_2-e/kWh	2	Table 5 (**DoE, 2015b**)
		0.12				3	Table 41 (**DoE, 2015b**)
Explosives(1)		0.18			t CO2-e/tonne	1	Table 4 (**DCC, 2008**)
LPG	25.7	60.2	0.2	0.2	kg CO_2-e/GJ	1	Table 4 (**DoE, 2015b**)
Fugitive emissions		1.89E-03	6.78E-04		t CO_2-e/m^3	1	Proponent
Rail		16.66			t CO_2-e/Mt-km	3	Proponent
Ship – Handy		5.422			t CO_2-e/Mt-km	3	Proponent
Ship – Panamax		3.459			t CO_2-e/Mt-km	3	Proponent
Ship – Bulk Carrier		2.090			t CO_2-e/Mt-km	3	Proponent
Coking coal	30	91.8	0.02	0.2	kg CO_2-e/GJ	3	Table 1 (**DoE, 2015b**)
Thermal coal(2)	29	90	0.03	0.2	kg CO_2-e/GJ	3	Table 1 (**DoE, 2015b**)

(1)Assumes all explosives considered as Heavy ANFO
(2)Assumes type of coal is anthracite
Department of the Environment (DoE)

Product coal is transported to the Port of Newcastle by rail and then transferred to coal loaders before being shipped to its final destination. The approximate rail distance is taken to be 216km (return distance). The approximate shipping distance of 13,000km (return distance) is based predominately on destinations in the Asian market.

The emissions generated from the end use of coal produced by the Project have been assumed to be used in power generation and steel manufacturing. As it is difficult to estimate emissions based on the consumption in other countries, this assessment has assumed the emissions generated would be equivalent to those generated in NSW. This approach is considered, in the absence of specific data, suitable for this assessment.

10.3 Summary of greenhouse gas emissions

Table 10-3 summarises the estimated annual CO_2-e emissions due to the operation of the proposed modification.

Table 10-3: Summary of CO_2-e emissions for the Project (t CO_2-e)

		Annual	Total
Fugitive emissions	Scope 1	183,466	2,231,237
Diesel	Scope 1	371,033	4,512,343
	Scope 3	18,946	230,417
Fuel oil	Scope 1	2,689	32,707
	Scope 3	131	1,595
Petrol	Scope 1	254	3,088
	Scope 3	13	160
Grease/oil	Scope 1	203	2,473
	Scope 3	209	2,544
Electricity	Scope 2	137,231	1,668,942
	Scope 3	19,604	238,420
Explosives	Scope 1	11,591	140,964
LPG	Scope 1	1,570	19,089
Transport via rail	Scope 3	54,501	662,818
Transport via ship	Scope 3	722,623	8,788,223
Final use of product – coking	Scope 3	7,322,355	89,051,236
Final use of product – thermal	Scope 3	33,180,188	403,522,729

10.4 Contribution of greenhouse gas emissions

Table 10-4 summarises the emissions associated with the proposed modification based on Scopes 1, 2 and 3.

Table 10-4: Summary of CO2-e emissions per scope (t CO_2-e)

Period	Scope 1	Scope 2	Scope 3
Annual	570,807	137,231	41,318,571
Total	**6,941,902**	**1,668,942**	**502,498,142**

The estimated annual greenhouse emissions for Australia for the period February 2014 to March 2015 was 545.1 Mt CO_2-e (**Department of the Environment, 2015c**). In comparison, the conservative estimated annual average greenhouse emission for the proposed modification is 0.71Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of greenhouse emissions from the proposed modification in comparison to the Australian greenhouse emissions for the period February 2014 to March 2015 is conservatively estimated to be approximately 0.13 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, 2015a**). The annual contribution of greenhouse emissions from the proposed modification in comparison to the NSW greenhouse emissions for the 2013 period is conservatively estimated to be approximately 0.50 per cent.

The estimated greenhouse gas emissions generated in all three scopes are based on approximated quantities of materials and where applicable generic emission factors. Therefore, the estimated emissions for the proposed modification are considered conservative.

Due to differences in the GHG estimation methods, a direct comparison with the previous GHG assessment for HVO South (**Rio Tinto, 2007**) cannot be easily demonstrated. In this regard, a comparison using estimates based on the maximum production year (Scenario B1) has been calculated.

On this basis, it is estimated that the annual greenhouse emission (Scope 1 and 2) for approved HVO South for the maximum production year is approximately 0.53 Mt CO_2-e, which in comparison to the estimated annual greenhouse emissions for Australia is approximately 0.1 per cent.

Therefore in this context, as a result of the proposed modification, we may expect to see an increase in GHG emissions of approximately 0.03 per cent over the approved HVO South when compared to the estimated annual greenhouse emissions for Australia.

10.5 Greenhouse gas management

HVO South will continue to utilise various mitigation measures to minimise the overall generation of greenhouse gas emissions. Coal & Allied / RTCA climate change programme has objectives in four key areas delivered through ongoing integration into existing business processes:

- Supporting research and promotion of technologies that reduce carbon dioxide emission from the use of coal;
- The improved use of energy at operations, projects and supply chain;
- Designing future projects with energy efficiency and climate change risks considered; and
- Raising awareness amongst stakeholders that climate change is an issues that requires us all to change how we currently operate.

Research programme funding is provided for the COAL21 Fund, the Australian Coal Association Research Programme (ACARP) and the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) to support and develop the research of low emissions coal technologies.

The bulk consumption of diesel is monitored and reported monthly with the on-site fuel management system monitoring the quantity of fuel dispensed from tanks and service trucks through metering. Vehicles and plant equipment are fitted with identification tags to assist in tracking diesel consumption; the regular maintenance of diesel equipment ensures operational efficiency.

The total site electricity consumption is monitored and reported monthly with significant infrastructure and equipment such as the CPPs, draglines and electric rope shovels fitted with various meters to monitor electricity consumption.

Energy efficiency performance metrics for fuel and electricity consumption which are tracked monthly against internal targets have been developed and implemented at HVO South.

Waste is managed across the site in accordance with an appropriate waste management procedure. Waste management contributes to energy efficiency through measures such as planning when purchasing items to avoid or minimise waste with preference is given to products that are recyclable and reusable over ones that are not; consideration of minimum of packaging or packaging which is reusable or recyclable; and segregating waste to facilitate maximum reuse or recycling.

11 SUMMARY AND CONCLUSIONS

This study has examined potential air quality and greenhouse gas impacts that may arise from the proposed modification to HVO South.

Two indicative mine plan years have been assessed using conservative emission estimation (ie using maximum mine schedule) and dispersion modelling (ie not including the effect of rainfall) has been completed for this assessment.

The results indicate that the proposed modification would lead to an increase in dust levels relative to the current approved operations, however the resulting dust levels at all privately-owned assessment locations would remain within acceptable criteria with the exception of three assessment locations which are within the existing acquisition zone for other mine operations. The proposed modification satisfies the Mining SEPP non-discretionary standards with respect to cumulative air quality at private dwellings not already entitled to acquisition from neighbouring mine operations.

A comparison of the zone of impact for 24-hour and annual average PM_{10} levels between the approved project and proposed modification indicates that the predicted dust levels associated with the modification would have a generally similar extent to the approved operations and would therefore not result in any significant change to that which is already approved for HVO South. The resulting dust levels at all privately-owned assessment locations would remain within acceptable criteria with the exception of four assessment locations which are currently impacted and are within the existing acquisition zone for other mine operations. These locations include two private residences (77 and 471). The two other locations affected by the proposed modification include the Warkworth Town Hall (102) and St Phillip's Church (264). These two locations are uninhabited and may only be exposed to effects from the project briefly, for periods less than the applicable criteria, when occasionally used.

An assessment of impacts on vacant land indicates a parcel of vacant land already afforded voluntary acquisition upon request rights within the project approval (PA 06_0261). However, this property does not meet the vacant land criteria specified within the VLAMP as construction of a dwelling is not permissible under existing planning controls.

The assessment of potential dust emissions associated with the transport of product coal shows that the potential for any adverse air quality impacts is low and would not make any appreciable difference to air quality. As the proposed modification is not seeking an increase in product coal transported from HVO South or any change to rail movements, there would not be any change in air quality levels associated with this activity.

As there has been no significant blasting incident at this site, it is expected that this would remain the case in the future. To ensure that blasting activities continue to be managed in a manner that would minimise the risk of impacts arising in the future, suggested improvements to the operational systems that arise from new scientific knowledge and a better understanding of blast management are recommended for the proposed modification.

The conservative estimated annual average greenhouse emission for the proposed modification based on an upper limit of the assumed maximum production is calculated to be 0.71Mt CO_2-e material (Scope 1 and 2). This is equivalent to approximately 0.13 per cent of the Australian greenhouse emissions for the February 2014 to March 2015 period and approximately 0.5 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	Classification	ID	Easting	Northing	Classification
77	314103	6394482	Privately owned	356	303130	6403214	Privately owned
78	314203	6393069	RTCA	357	303096	6403185	Privately owned
79	314121	6394634	Other mine owned property	358	303138	6403141	Privately owned
83	314144	6394841	Other mine owned property	359	303207	6403190	Privately owned
90	314344	6394886	RTCA	360	303231	6403235	Privately owned
91	314359	6394718	Other mine owned property	361	303253	6403253	Privately owned
93	314481	6394444	RTCA	362	303348	6403156	Privately owned
94	314463	6394855	Other mine owned property	363	303317	6403133	Privately owned
96	314571	6394587	Other mine owned property	364	303257	6403134	Privately owned
99	314699	6394352	Other mine owned property	365	303280	6403102	Privately owned
102	314800	6394348	Privately owned	366	303268	6403081	Privately owned
105	315017	6395104	RTCA	367	303212	6403085	Privately owned
109	315789	6393545	Other mine owned property	368	303224	6403105	Privately owned
114	316208	6397277	RTCA	369	303332	6403032	Privately owned
116	318052	6396001	RTCA	370	303155	6403045	Privately owned
117	317982	6397794	RTCA	371	303239	6402933	Privately owned
118	318128	6397356	RTCA	372	303153	6402874	Privately owned
119	318452	6396156	RTCA	373	303257	6402924	Privately owned
120	318504	6398457	Privately owned	374	303261	6402901	Privately owned
121	318530	6398039	Privately owned	375	303277	6402867	Privately owned
122	318608	6398554	Privately owned	376	303481	6402864	Privately owned
123	318658	6398205	Privately owned	377	303359	6402968	Privately owned
124	318655	6398582	Privately owned	378	303517	6402907	Privately owned
125	320142	6394738	RTCA	379	303559	6402853	Privately owned
126	320764	6393699	Privately owned	380	303466	6402611	Privately owned
127	320624	6396932	Privately owned	381	303443	6402666	Privately owned
128	320916	6394511	Privately owned	382	303423	6402691	Privately owned
129	321192	6394796	RTCA	383	303422	6402758	Privately owned
130	321271	6394970	Privately owned	384	303381	6402774	Privately owned
131	321519	6391910	RTCA	385	303366	6402742	Privately owned
133	321261	6396710	RTCA	386	303327	6402618	Crown owned
134	321472	6395034	Privately owned	387	303681	6402746	Privately owned
137	321617	6395135	RTCA	388	303581	6402686	Privately owned
139	321707	6394686	Privately owned	389	303599	6402669	Privately owned
141	321604	6397030	Privately owned	390	303621	6402636	Privately owned
142	321715	6395167	RTCA	391	303672	6402589	Privately owned
143	321817	6395230	RTCA	392	303683	6402575	Privately owned
158	316576	6399021	RTCA	393	303726	6402547	Privately owned
160	317883	6399178	Privately owned	394	303694	6402565	Privately owned
161	318010	6399448	Privately owned	395	303695	6402648	Privately owned
162	318011	6399407	Privately owned	396	303605	6402326	Privately owned
163	318114	6399572	Privately owned	397	303667	6402504	Privately owned
165	318110	6396180	RTCA	398	303568	6402424	Privately owned
169	321959	6396271	Privately owned	399	303685	6402492	Privately owned
172	321925	6395400	Privately owned	400	303657	6402525	Privately owned
244	318808	6399092	Privately owned	401	303639	6402533	Privately owned
245	318679	6399194	Privately owned	402	303628	6402548	Privately owned
246	318795	6399314	Privately owned	403	303613	6402568	Privately owned
247	318879	6399292	Privately owned	404	303563	6402478	Privately owned
256	317979	6399821	Privately owned	405	303600	6402580	Privately owned
257	318793	6399221	RTCA	406	303585	6402596	Privately owned
258	318104	6399611	Privately owned	407	303460	6402510	Privately owned
259	318211	6397178	RTCA	408	303505	6402438	Privately owned
260	318180	6399198	Privately owned	409	303400	6402544	Privately owned
261	318030	6399106	Privately owned	410	303336	6402606	Crown owned
262	320794	6393794	Privately owned	411	303373	6402579	Privately owned
264	314870	6394227	Privately owned	412	303294	6402543	Crown owned

ID	Easting	Northing	Classification	ID	Easting	Northing	Classification
265	318014	6397793	RTCA	413	303347	6402494	Privately owned
271	311622	6393146	Other mine owned property	414	303335	6402510	Privately owned
302	307247	6399247	Other mine owned property	415	303325	6402527	Privately owned
303	307143	6399273	Other mine owned property	416	302660	6402764	Other mine owned property
304	307102	6399101	Other mine owned property	417	303181	6403016	Privately owned
305	306895	6399401	Other mine owned property	418	303159	6402798	Privately owned
306	306906	6399339	Other mine owned property	419	303309	6402354	Privately owned
307	305955	6399617	Privately owned	420	303492	6402491	Privately owned
308	305926	6400011	Privately owned	421	303575	6402776	Privately owned
309	306139	6399895	Privately owned	422	303481	6402796	Privately owned
310	305791	6399780	Privately owned	423	303613	6402648	Privately owned
311	305416	6401053	Privately owned	424	303289	6403151	Privately owned
312	305739	6400603	Privately owned	425	302915	6401913	Privately owned
313	307457	6400063	Other mine owned property	426	303276	6401566	Privately owned
314	306942	6401324	RTCA	427	303633	6401732	Privately owned
315	306970	6402069	RTCA	428	303677	6401772	Privately owned
316	307078	6402503	RTCA	429	303990	6402021	Privately owned
317	305370	6401180	Privately owned	430	303709	6401932	Privately owned
319	308525	6401179	RTCA	431	304149	6401941	Other mine owned property
320	307528	6402317	RTCA	432	304188	6401020	Privately owned
321	304390	6402028	Privately owned	433	304403	6400637	Privately owned
322	304021	6402284	Privately owned	434	305124	6401584	Privately owned
323	303908	6402342	Privately owned	436	305040	6401316	Privately owned
324	304172	6402127	Privately owned	437	302021	6404598	Privately owned
325	302367	6403296	Privately owned	438	301417	6404773	Privately owned
326	302343	6404253	Privately owned	439	305651	6400601	Other mine owned property
327	302163	6404340	Privately owned	441	305736	6400346	Other mine owned property
328	302773	6404013	Privately owned	442	306435	6399487	Other mine owned property
329	303132	6403565	Privately owned	443	307444	6399419	Other mine owned property
330	302488	6403896	Privately owned	444	307852	6402954	RTCA
331	302791	6403833	Privately owned	445	316079	6403181	Other mine owned property
332	302771	6403528	Privately owned	446	313816	6404015	Other mine owned property
333	302651	6403521	Privately owned	447	313521	6401905	RTCA
334	302624	6403419	Privately owned	448	306912	6402169	RTCA
335	302691	6403468	Privately owned	449	308520	6401336	RTCA
336	302756	6403623	Privately owned	450	308513	6400853	RTCA
337	302914	6403433	Privately owned	451	304800	6398880	Privately owned
338	303027	6403399	Privately owned	452	304734	6399132	Privately owned
339	302768	6402966	Privately owned	453	304404	6398805	Privately owned
340	302799	6402990	Privately owned	454	304553	6398507	Privately owned
341	302829	6403026	Privately owned	455	304381	6398349	Privately owned
342	302863	6403055	Privately owned	456	304246	6397874	Privately owned
343	302879	6403079	Privately owned	457	304350	6397594	Privately owned
344	302914	6403113	Privately owned	458	303444	6398622	Privately owned
345	302944	6403132	Privately owned	459	303986	6399027	Privately owned
346	302975	6403164	Privately owned	460	303638	6399147	Privately owned
347	303058	6403344	Privately owned	461	303092	6398948	Other mine owned property
348	303035	6403315	Privately owned	462	303598	6398842	Privately owned
349	303000	6403289	Privately owned	464	302816	6401177	Other mine owned property
350	303049	6403237	Privately owned	465	302496	6401589	Other mine owned property
351	303082	6403277	Privately owned	466	302212	6402653	Privately owned
352	303116	6403299	Privately owned	467	307733	6402906	RTCA
353	303137	6403310	Privately owned	468	302224	6398995	Other mine owned property
354	303207	6403301	Privately owned	471	319025	6403131	Privately owned
355	303187	6403276	Privately owned	472	319005	6401802	Privately owned

Appendix B

Monitoring Data

Table B-1: TEOM monitoring data

Date	Knodlers Lane	Maison Dieu	Warkworth	Date	Knodlers Lane	Maison Dieu	Warkworth
1/01/2014	24.4	27.8	32.0	3/07/2014	19.7	21.8	13.3
2/01/2014	39.8	52.3	28.0	4/07/2014	28.4	30.2	15.9
3/01/2014	32.3	39.3	41.4	5/07/2014	28.6	19.1	9.7
4/01/2014	39.3	43.7	45.0	6/07/2014	14.9	14.5	7.5
5/01/2014	31.9	35.0	28.1	7/07/2014	13.4	19.1	7.0
6/01/2014	35.8	38.0	32.0	8/07/2014	21.6	21.3	6.5
7/01/2014	25.6	28.8	27.3	9/07/2014	22.4	29.6	9.0
8/01/2014	15.8	14.7	14.0	10/07/2014	19.4	20.7	11.2
9/01/2014	17.4	15.8	15.3	11/07/2014	15.7	17.1	8.3
10/01/2014	20.6	22.6	23.2	12/07/2014	24.4	16.5	9.4
11/01/2014	24.8	31.5	29.4	13/07/2014	5.3	9.3	5.7
12/01/2014	22.0	26.5	25.4	14/07/2014	17.0	21.3	16.3
13/01/2014	27.4	23.5	24.7	15/07/2014	29.7	40.6	26.5
14/01/2014	22.1	26.8	25.4	16/07/2014	16.8	17.0	11.1
15/01/2014	31.1	25.4	36.2	17/07/2014	10.0	11.8	9.2
16/01/2014	39.8	46.2	52.3	18/07/2014	12.0	15.7	7.0
17/01/2014	24.4	27.1	35.2	19/07/2014	16.4	17.9	7.9
18/01/2014	22.8	24.1	30.2	20/07/2014	26.4	31.1	15.7
19/01/2014	29.1	29.9	29.2	21/07/2014	16.7	21.2	12.2
20/01/2014	20.4	22.8	23.0	22/07/2014	22.0	20.2	12.1
21/01/2014	17.4	23.2	16.1	23/07/2014	12.4	13.5	10.9
22/01/2014	28.6	22.3	14.9	24/07/2014	17.1	20.3	16.3
23/01/2014	18.7	14.0	20.1	25/07/2014	20.0	20.8	14.6
24/01/2014	22.6	20.6	17.6	26/07/2014	7.7	8.9	7.5
25/01/2014	20.8	19.1	16.9	27/07/2014	7.9	10.4	5.3
26/01/2014	14.5	17.6	15.5	28/07/2014	12.7	11.0	6.6
27/01/2014	12.8	15.3	17.9	29/07/2014	14.2	17.5	8.5
28/01/2014	14.0	16.8	22.4	30/07/2014	17.6	21.6	12.0
29/01/2014	20.6	23.6	25.4	31/07/2014	26.3	28.9	15.4
30/01/2014	18.1	20.4	18.7	1/08/2014	32.9	26.4	12.0
31/01/2014	19.9	22.8	21.9	2/08/2014	-	-	-
1/02/2014	25.1	27.9	27.1	3/08/2014	-	-	-
2/02/2014	24.2	19.3	23.8	4/08/2014	16.5	22.0	14.7
3/02/2014	24.9	19.6	16.9	5/08/2014	13.7	18.9	14.1
4/02/2014	37.7	33.9	19.0	6/08/2014	30.7	30.5	12.9
5/02/2014	25.3	24.0	19.3	7/08/2014	21.5	28.3	14.5
6/02/2014	20.0	19.4	9.1	8/08/2014	17.9	19.8	15.6
7/02/2014	16.5	20.7	19.7	9/08/2014	17.9	12.4	12.5
8/02/2014	16.1	17.5	27.3	10/08/2014	35.8	36.2	17.2
9/02/2014	19.1	23.6	19.3	11/08/2014	24.4	32.1	20.4
10/02/2014	31.4	35.7	25.8	12/08/2014	24.4	23.1	14.3
11/02/2014	24.1	21.9	18.5	13/08/2014	17.3	19.4	10.0
12/02/2014	24.8	15.6	25.4	14/08/2014	12.3	14.3	14.1
13/02/2014	45.9	33.8	32.5	15/08/2014	24.0	27.0	16.7
14/02/2014	22.3	18.4	15.6	16/08/2014	12.8	16.4	11.4
15/02/2014	19.4	15.3	11.7	17/08/2014	6.4	6.8	4.7
16/02/2014	25.8	30.7	18.0	18/08/2014	4.5	5.8	4.6
17/02/2014	18.7	18.2	12.5	19/08/2014	10.6	12.8	7.2
18/02/2014	12.3	21.1	17.1	20/08/2014	12.7	14.5	10.1
19/02/2014	15.8	19.5	14.4	21/08/2014	9.7	13.2	8.0
20/02/2014	18.9	19.8	19.5	22/08/2014	6.9	9.6	9.0
21/02/2014	16.6	25.2	29.8	23/08/2014	6.4	9.7	8.9
22/02/2014	19.7	28.1	22.6	24/08/2014	6.7	9.4	7.7
23/02/2014	17.4	22.8	21.9	25/08/2014	10.3	15.0	10.0
24/02/2014	10.2	12.6	10.7	26/08/2014	7.6	11.6	5.9
25/02/2014	16.1	18.8	15.0	27/08/2014	10.1	9.3	6.9
26/02/2014	26.2	26.6	17.2	28/08/2014	9.2	12.9	8.1
27/02/2014	20.0	25.4	18.6	29/08/2014	12.9	13.7	9.9
28/02/2014	6.7	8.5	5.2	30/08/2014	8.5	10.6	5.9
1/03/2014	9.2	12.7	10.2	31/08/2014	-	-	-
2/03/2014	9.2	12.4	9.9	1/09/2014	22.4	32.6	14.3
3/03/2014	8.1	10.7	10.0	2/09/2014	11.1	18.5	9.1
4/03/2014	7.4	9.2	9.7	3/09/2014	8.1	12.0	7.6
5/03/2014	14.3	21.1	13.0	4/09/2014	18.1	24.6	11.2

Date	Knodlers Lane	Maison Dieu	Warkworth	Date	Knodlers Lane	Maison Dieu	Warkworth
6/03/2014	16.7	23.1	16.2	5/09/2014	21.8	23.6	11.7
7/03/2014	22.4	26.7	-	6/09/2014	19.8	19.3	6.4
8/03/2014	9.5	16.8	-	7/09/2014	-	-	-
9/03/2014	7.1	12.0	14.3	8/09/2014	4.4	6.3	7.0
10/03/2014	10.9	13.9	13.6	9/09/2014	11.5	16.2	13.4
11/03/2014	11.3	12.7	14.3	10/09/2014	13.8	18.4	14.4
12/03/2014	18.0	21.8	17.2	11/09/2014	16.9	24.1	12.5
13/03/2014	20.7	16.4	21.9	12/09/2014	14.0	16.9	18.5
14/03/2014	14.4	-	19.0	13/09/2014	12.3	17.3	13.6
15/03/2014	13.5	-	11.1	14/09/2014	9.3	-	-
16/03/2014	21.1	-	15.8	15/09/2014	16.6	26.6	35.3
17/03/2014	17.6	14.8	13.0	16/09/2014	27.5	22.9	14.6
18/03/2014	26.0	29.6	21.4	17/09/2014	22.2	27.2	13.2
19/03/2014	30.4	33.0	28.2	18/09/2014	20.1	22.2	13.9
20/03/2014	14.8	15.6	16.8	19/09/2014	22.0	30.0	19.5
21/03/2014	11.7	13.7	12.2	20/09/2014	-	-	-
22/03/2014	19.2	22.4	13.2	21/09/2014	-	-	-
23/03/2014	29.8	35.4	19.1	22/09/2014	13.6	25.6	17.8
24/03/2014	16.8	21.6	10.5	23/09/2014	14.3	17.4	16.4
25/03/2014	14.4	16.3	11.7	24/09/2014	16.3	23.8	17.2
26/03/2014	12.3	12.3	12.0	25/09/2014	15.5	17.2	11.8
27/03/2014	6.2	8.3	7.6	26/09/2014	11.5	15.0	12.5
28/03/2014	7.9	10.0	8.6	27/09/2014	15.3	19.3	14.2
29/03/2014	9.3	11.3	10.6	28/09/2014	15.3	22.1	13.6
30/03/2014	12.1	15.3	14.8	29/09/2014	31.6	34.3	21.8
31/03/2014	13.3	16.1	17.0	30/09/2014	38.0	45.6	28.0
1/04/2014	11.3	12.8	12.6	1/10/2014	22.1	26.7	16.7
2/04/2014	19.1	23.5	20.6	2/10/2014	22.3	26.2	22.0
3/04/2014	21.3	24.9	22.9	3/10/2014	28.2	40.3	30.6
4/04/2014	12.7	15.1	12.8	4/10/2014	21.4	28.6	24.7
5/04/2014	8.5	9.9	9.8	5/10/2014	25.7	32.9	23.0
6/04/2014	8.6	10.6	7.4	6/10/2014	34.2	45.5	33.5
7/04/2014	10.5	12.6	11.3	7/10/2014	20.8	31.4	29.1
8/04/2014	14.5	16.5	15.0	8/10/2014	13.8	19.3	14.6
9/04/2014	13.7	16.0	14.6	9/10/2014	12.3	17.0	13.7
10/04/2014	17.5	22.8	17.2	10/10/2014	18.8	25.7	19.4
11/04/2014	14.0	14.4	12.3	11/10/2014	9.5	15.0	16.9
12/04/2014	9.8	12.6	9.2	12/10/2014	-	-	-
13/04/2014	13.0	13.9	11.6	13/10/2014	24.3	35.7	25.2
14/04/2014	12.0	14.5	10.5	14/10/2014	10.5	12.6	9.3
15/04/2014	9.4	11.9	10.5	15/10/2014	3.0	-	1.6
16/04/2014	19.0	17.3	12.9	16/10/2014	25.9	29.3	22.0
17/04/2014	19.3	16.9	14.1	17/10/2014	14.2	15.5	14.0
18/04/2014	23.7	20.1	16.1	18/10/2014	11.9	16.5	14.2
19/04/2014	23.8	22.6	18.1	19/10/2014	-	-	-
20/04/2014	26.3	25.1	15.8	20/10/2014	16.7	13.9	13.5
21/04/2014	22.7	25.4	14.3	21/10/2014	9.6	14.0	14.7
22/04/2014	30.7	31.9	17.2	22/10/2014	13.4	19.9	14.4
23/04/2014	28.0	31.3	15.2	23/10/2014	23.7	33.3	26.1
24/04/2014	33.9	34.2	20.5	24/10/2014	22.6	35.5	28.4
25/04/2014	14.5	16.7	11.7	25/10/2014	12.9	20.7	6.7
26/04/2014	17.5	20.0	13.2	26/10/2014	-	-	-
27/04/2014	17.5	18.9	13.6	27/10/2014	51.0	73.7	38.5
28/04/2014	8.9	10.0	9.6	28/10/2014	31.4	35.8	30.2
29/04/2014	12.7	14.4	10.4	29/10/2014	29.7	39.8	33.4
30/04/2014	18.4	20.9	9.9	30/10/2014	25.6	30.0	28.8
1/05/2014	16.2	19.7	12.9	31/10/2014	38.8	41.1	27.4
2/05/2014	19.8	17.5	11.1	1/11/2014	54.8	47.9	45.5
3/05/2014	19.8	15.3	8.9	2/11/2014	15.8	14.0	17.8
4/05/2014	19.1	13.7	8.4	3/11/2014	29.8	35.4	31.4
5/05/2014	15.1	16.0	8.6	4/11/2014	33.2	41.4	47.7
6/05/2014	17.9	20.5	9.6	5/11/2014	22.0	26.4	25.1
7/05/2014	31.7	30.6	18.4	6/11/2014	16.0	19.1	20.0
8/05/2014	21.7	26.0	17.2	7/11/2014	21.3	24.0	22.7
9/05/2014	17.0	18.7	16.7	8/11/2014	13.8	16.5	15.6

Date	Knodlers Lane	Maison Dieu	Warkworth	Date	Knodlers Lane	Maison Dieu	Warkworth
10/05/2014	21.5	25.2	12.9	9/11/2014	23.5	28.9	32.0
11/05/2014	11.8	13.4	9.3	10/11/2014	24.3	29.9	30.8
12/05/2014	14.8	17.4	13.4	11/11/2014	15.9	18.9	20.7
13/05/2014	12.4	15.0	10.0	12/11/2014	16.3	19.5	-
14/05/2014	10.8	15.2	10.2	13/11/2014	18.4	21.4	22.2
15/05/2014	15.7	18.9	14.4	14/11/2014	27.1	36.3	31.7
16/05/2014	16.9	19.1	14.1	15/11/2014	47.7	49.3	38.5
17/05/2014	19.8	21.1	12.5	16/11/2014	23.9	25.4	18.3
18/05/2014	19.4	20.8	13.0	17/11/2014	15.5	20.4	17.4
19/05/2014	31.9	27.7	11.5	18/11/2014	-	29.9	23.4
20/05/2014	29.1	28.7	21.4	19/11/2014	21.5	22.0	20.8
21/05/2014	22.0	23.6	17.3	20/11/2014	26.5	27.4	26.4
22/05/2014	27.5	26.8	18.1	21/11/2014	44.1	52.3	32.5
23/05/2014	27.1	31.4	15.8	22/11/2014	22.0	24.9	30.2
24/05/2014	29.2	26.8	15.9	23/11/2014	31.8	36.9	30.9
25/05/2014	33.1	35.0	17.8	24/11/2014	-	37.4	-
26/05/2014	32.8	34.6	15.8	25/11/2014	-	11.4	19.0
27/05/2014	37.5	42.1	24.4	26/11/2014	21.3	23.9	42.9
28/05/2014	31.0	32.6	11.7	27/11/2014	19.8	19.4	25.1
29/05/2014	13.6	19.6	13.9	28/11/2014	14.3	16.0	27.7
30/05/2014	13.3	15.1	11.0	29/11/2014	20.0	24.8	27.8
31/05/2014	6.9	8.1	11.0	30/11/2014	16.6	19.0	22.4
1/06/2014	7.4	8.7	9.0	1/12/2014	18.3	17.5	13.7
2/06/2014	9.5	10.8	6.5	2/12/2014	24.5	24.9	16.2
3/06/2014	7.9	7.3	6.4	3/12/2014	-	-	20.0
4/06/2014	11.0	14.0	9.5	4/12/2014	15.8	15.5	15.7
5/06/2014	23.1	31.9	14.1	5/12/2014	12.5		-
6/06/2014	13.6	15.2	7.3	6/12/2014	14.6	9.1	9.8
7/06/2014	13.6	15.6	7.8	7/12/2014	10.8	10.0	-
8/06/2014	17.3	16.9	12.2	8/12/2014	13.9	-	-
9/06/2014	11.3	12.5	8.9	9/12/2014	20.1	21.5	22.6
10/06/2014	11.5	15.0	10.6	10/12/2014	-	-	-
11/06/2014	13.9	16.9	12.5	11/12/2014	7.4	-	-
12/06/2014	18.2	19.8	11.4	12/12/2014	11.5	12.0	18.3
13/06/2014	26.9	27.4	17.1	13/12/2014	9.9	10.9	14.3
14/06/2014	11.5	12.1	7.5	14/12/2014	13.5	14.4	17.5
15/06/2014	10.9	11.6	9.7	15/12/2014	14.6	15.0	26.7
16/06/2014	12.0	15.0	9.2	16/12/2014	25.5	19.5	-
17/06/2014	11.7	14.9	6.9	17/12/2014	45.6	45.3	41.7
18/06/2014	17.6	21.8	9.9	18/12/2014	32.6	37.4	40.7
19/06/2014	11.7	15.5	8.3	19/12/2014	31.1	33.4	27.8
20/06/2014	22.3	23.4	6.0	20/12/2014	17.9	18.5	21.0
21/06/2014	10.6	11.1	7.1	21/12/2014	17.8	18.1	18.1
22/06/2014	18.6	18.4	11.7	22/12/2014	14.7	15.5	21.9
23/06/2014	16.8	18.1	8.1	23/12/2014	11.6	13.0	15.4
24/06/2014	37.0	24.0	15.0	24/12/2014	16.9	19.1	19.1
25/06/2014	19.0	18.8	8.7	25/12/2014	11.8	18.4	12.8
26/06/2014	29.6	22.0	10.2	26/12/2014	9.0	9.9	13.7
27/06/2014	25.5	25.5	11.1	27/12/2014	16.2	21.4	20.4
28/06/2014	23.1	29.7	13.9	28/12/2014	6.8	8.5	10.9
29/06/2014	16.8	13.4	9.9	29/12/2014	9.0	9.0	-
30/06/2014	13.0	13.3	9.2	30/12/2014	33.2	32.4	22.7
1/07/2014	11.3	16.7	7.8	31/12/2014	24.8	29.4	26.0
2/07/2014	16.2	19.7	9.7	-	-	-	-

Appendix C
Emission Calculation

HVO South - 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. Detailed emission inventories for each modelled year are presented in **Table C-2** to **Table C-6**.

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
Blasting (overburden/coal)	$EF = 0.00022 \times A^{1.5}\ kg/blast$	A = area to be blasted (m²)	-	US EPA, 1985
Loading / emplacing overburden	$EF = k \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	Ktsp = 0.74 U = wind speed (m/s) M = moisture content (%)	-	NPI, 2012
Dragline	$EF = 0.0046 \times d^{1.1}/M^{1.3}\ kg/m^3$	d = drop height (m) M = moisture content (%)	-	US EPA, 1985
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
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
Loading product coal to stockpile	$EF = k \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	Ktsp = 0.74 U = wind speed (m/s) M = moisture content (%)	25% - variable height stacker	US EPA, 1985
Wind erosion on exposed areas / stockpiles	$EF = 0.4\ kg/ha/hour$	-	50% - water sprays, 20% - interim stabilisation 70% - active rehabilitation	SPCC, 1983
Grading roads	$EF = 0.0034 \times s^{2.5}\ kg/VKT$	S = speed of grader (km/hr)	-	US EPA, 1985

Table C-2: Emission inventory – 2014

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
OB - Topsoil removal (Cheshunt)	2,680	184,800	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (Riverview)	2,680	184,800	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (South Lemington Pit 2)	-	-	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (South Lemington Pit 1)	-	-	tonnes/year	0.03	kg/t											50	% Control
OB - Drilling (Cheshunt)	12,026	67,944	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (Riverview)	2,405	13,589	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (South Lemington Pit 2)	-	-	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (South Lemington Pit 1)	-	-	holes/year	0.59	kg/hole											70	% Control
OB - Blasting (Cheshunt)	12,251	339	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (Riverview)	2,450	68	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (South Lemington Pit 2)	-	-	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (South Lemington Pit 1)	-	-	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Dragline (Cheshunt)	-	-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (Riverview)	30,070	1,370,297	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (South Lemington Pit 2)	-	-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (South Lemington Pit 1)	-	-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Loading OB to haul truck (Cheshunt)	181,081	95,820,720	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (Riverview)	89,189	47,195,280	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (South Lemington Pit 2)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (South Lemington Pit 1)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Hauling to emplacement area (Cheshunt)	1,517,381	95,820,720	tonnes/year	0.106	kg/t	222	tonnes/load	8.3	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (Riverview)	440,302	47,195,280	tonnes/year	0.062	kg/t	222	tonnes/load	4.9	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (Cheshunt to Riverview)	-	-	tonnes/year	0.101	kg/t	222	tonnes/load	8.0	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Emplacing at area (Cheshunt)	181,081	95,820,720	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (Riverview)	89,189	47,195,280	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (South Lemington Pit 2)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (South Lemington Pit 1)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Dozers in pit (Cheshunt)	623,909	37,281	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (Riverview)	180,895	10,809	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (South Lemington Pit 2)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (South Lemington Pit 1)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (Cheshunt)	584,665	34,936	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (Riverview)	682,109	40,759	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (South Lemington Pit 2)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (South Lemington Pit 1)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
CL - Drilling (Cheshunt)	430	14,328	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (Riverview)	86	2,866	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (South Lemington Pit 2)	-	-	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (South Lemington Pit 1)	-	-	holes/year	0.10	kg/hole											70	% Control
CL - Blasting (Cheshunt)	2,478	69	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (Riverview)	496	14	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (South Lemington Pit 2)	-	-	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (South Lemington Pit 1)	-	-	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Dozers ripping/pushing/clean-up (Cheshunt)	83,159	3,478	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (Riverview)	19,995	836	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 2)	-	-	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 1)	-	-	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Loading ROM coal to haul truck (Cheshunt)	589,943	8,733,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (Riverview)	240,963	3,567,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (South Lemington Pit 2)	-	-	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (South Lemington Pit 1)	-	-	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Hauling ROM to hopper - HVCPP (Cheshunt)	296,850	8,733,000	tonnes/year	0.227	kg/t	222	tonnes/load	17.9	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CL - Hauling ROM to hopper - HVCPP (Riverview)	63,690	3,567,000	tonnes/year	0.119	kg/t	222	tonnes/load	9.4	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CHPP - Unloading ROM to hopper - HVCPP	415,453	12,300,000	tonnes/year	0.068	kg/t	6	moisture content in %									50	% Control
CHPP - Rehandle ROM at hopper - HVCPP	83,091	1,230,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CHPP - Dozer pushing ROM coal - HVCPP	35,868	1,500	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CHPP - Dozer pushing Product coal - HVCPP	14,126	1,500	hours/year	9.4	kg/h	4	silt content in %	10	moisture content in %								
CHPP - Loading Product coal to stockpile - HVCPP	1,416	9,509,244	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %							25	% Control
CHPP - Loading Product coal to train - HVCPP	1,141	9,509,244	tonnes/year	0.00040	kg/t											70	% Control
CHPP - Loading rejects - HVCPP	321	1,618,750	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
CHPP - Hauling rejects - HVCPP	55,024	1,618,750	tonnes/year	0.227	kg/t	222	tonnes/load	17.9	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control

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
CHPP - Unloading rejects - HVCPP	321	1,618,750	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
WE - Overburden emplacement areas - Cheshunt	1,022,528	364.8	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - Riverview	784,561	279.9	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - South Lemington Pit 2	-	-	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - South Lemington Pit 1	-	-	ha	3,504	kg/ha/year											20	% Control
WE - Open pit - Cheshunt	1,244,874	355.3	ha	3,504	kg/ha/year												
WE - Open pit - Riverview	422,460	120.6	ha	3,504	kg/ha/year												
WE - Open pit - South Lemington Pit 2	-	-	ha	3,504	kg/ha/year												
WE - Open pit - South Lemington Pit 1	-	-	ha	3,504	kg/ha/year												
WE - Active rehab	111,090	105.7	ha	3,504	kg/ha/year											70	% Control
WE - ROM stockpiles - HVCPP	7,008	4.0	ha	3,504	kg/ha/year											50	% Control
WE - Product stockpiles - HVCPP	8,760	5.0	ha	3,504	kg/ha/year											50	% Control
Grading roads	45,288	147,168	km	0.62	kg/VKT	8	speed of graders in km/h									50	% Control
Total TSP emissions (kg/yr)	**10,185,782**																

Table C-3: Emission inventory – Stage 2

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
OB - Topsoil removal (Cheshunt)	1,322	91,200	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (Riverview)	-	-	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (South Lemington Pit 2)	1,322	91,200	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (South Lemington Pit 1)	-	-	tonnes/year	0.03	kg/t											50	% Control
OB - Drilling (Cheshunt)	17,667	99,814	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (Riverview)	-	-	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (South Lemington Pit 2)	-	-	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (South Lemington Pit 1)	3,533	19,963	holes/year	0.59	kg/hole											70	% Control
OB - Blasting (Cheshunt)	18,166	503	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (Riverview)	-	-	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (South Lemington Pit 2)	-	-	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (South Lemington Pit 1)	3,633	101	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Dragline (Cheshunt)		-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (Riverview)	826,979	37,685,874	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (South Lemington Pit 2)		-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (South Lemington Pit 1)		-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Loading OB to haul truck (Cheshunt)	294,556	155,900,796	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (Riverview)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (South Lemington Pit 2)	49,093	25,983,466	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (South Lemington Pit 1)	44,183	23,385,119	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Hauling to emplacement area (Cheshunt)	2,526,434	155,900,796	tonnes/year	0.108	kg/t	222	tonnes/load	8.5	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (Riverview)	-	-	tonnes/year	0.000	kg/t	222	tonnes/load	0.0	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (South Lemington Pit 2 to Pit 1)	87,725	5,196,693	tonnes/year	0.113	kg/t	222	tonnes/load	8.9	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (South Lemington Pit 2 to Cheshur	347,348	20,786,773	tonnes/year	0.111	kg/t	222	tonnes/load	8.8	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (South Lemington Pit 1)	40,668	7,795,040	tonnes/year	0.035	kg/t	222	tonnes/load	2.7	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (South Lemington Pit 1 to Cheshur	246,687	15,590,080	tonnes/year	0.105	kg/t	222	tonnes/load	8.3	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Emplacing at area (Cheshunt)	363,286	192,277,649	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (Riverview)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (South Lemington Pit 2)	9,819	5,196,693	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (South Lemington Pit 1)	14,728	7,795,040	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Dozers in pit (Cheshunt)	783,499	46,817	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (Riverview)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (South Lemington Pit 2)	97,937	5,852	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (South Lemington Pit 1)	97,937	5,852	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (Cheshunt)	979,374	58,521	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (Riverview)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (South Lemington Pit 2)	97,937	5,852	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (South Lemington Pit 1)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
CL - Drilling (Cheshunt)	631	21,049	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (Riverview)	-	-	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (South Lemington Pit 2)	-	-	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (South Lemington Pit 1)	126	4,210	holes/year	0.10	kg/hole											70	% Control
CL - Blasting (Cheshunt)	3,675	102	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (Riverview)	-	-	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (South Lemington Pit 2)	-	-	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (South Lemington Pit 1)	735	20	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Dozers ripping/pushing/clean-up (Cheshunt)	-	-	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (Riverview)	279,873	11,704	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 2)	-	-	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 1)	139,937	5,852	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Loading ROM coal to haul truck (Cheshunt)	-	-	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (Riverview)	1,351,066	20,000,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (South Lemington Pit 2)	-	-	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (South Lemington Pit 1)	6,755	100,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Hauling ROM to hopper - HVCPP	739,325	20,000,000	tonnes/year	0.246	kg/t	222	tonnes/load	19.5	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CL - Hauling ROM to stockpile at LCPP	2,000	100,000	tonnes/year	0.133	kg/t	222	tonnes/load	10.5	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CHPP - Unloading ROM to hopper - HVCPP	675,533	20,000,000	tonnes/year	0.068	kg/t	6	moisture content in %									50	% Control
CHPP - Rehandle ROM at hopper - HVCPP	135,107	2,000,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CHPP - Dozer pushing ROM coal - HVCPP	35,868	1,500	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CHPP - Dozer pushing Product coal - HVCPP	14,126	1,500	hours/year	9.4	kg/h	4	silt content in %	10	moisture content in %								
CHPP - Loading Product coal to stockpile - HVCPP	2,263	15,200,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %							25	% Control

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
CHPP - Loading Product coal to train - HVCPP	1,824	15,200,000	tonnes/year	0.00040	kg/t											70	% Control
CHPP - Loading rejects - HVCPP	596	3,000,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
CHPP - Hauling rejects - HVCPP	110,899	3,000,000	tonnes/year	0.246	kg/t	222	tonnes/load	19.5	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CHPP - Unloading rejects - HVCPP	596	3,000,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
CHPP - Unloading ROM to stockpile - LCPP	3,378	100,000	tonnes/year	0.068	kg/t	6	moisture content in %									50	% Control
CHPP - Rehandle ROM at stockpile - LCPP	676	10,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CHPP - Dozer pushing ROM coal - LCPP	35,868	1,500	hours/year	23.9	kg/h	5	silt content in %	6.0	moisture content in %								
WE - Overburden emplacement areas - Cheshunt	1,574,931	561.8	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - Riverview	608,294	217.0	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - South Lemington Pit 2	41,368	14.8	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - South Lemington Pit 1	213,161	76.0	ha	3,504	kg/ha/year											20	% Control
WE - Open pit - Cheshunt	1,908,810	544.8	ha	3,504	kg/ha/year												
WE - Open pit - Riverview	143,623	41.0	ha	3,504	kg/ha/year												
WE - Open pit - South Lemington Pit 2	152,411	43.5	ha	3,504	kg/ha/year												
WE - Open pit - South Lemington Pit 1	147,803	42.2	ha	3,504	kg/ha/year												
WE - Active rehab	13,687	13.0	ha	3,504	kg/ha/year											70	% Control
WE - ROM stockpiles - HVCPP	7,008	4.0	ha	3,504	kg/ha/year											50	% Control
WE - ROM stockpiles - LCPP	7,008	4.0	ha	3,504	kg/ha/year											50	% Control
WE - Product stockpiles - HVCPP	8,760	5.0	ha	3,504	kg/ha/year											50	% Control
Grading roads	45,288	147,168	km	0.62	kg/VKT	8	speed of graders in km/h									50	% Control
Total TSP emissions (kg/yr)	**15,366,841**																

Table C-3: Emission inventory – Stage 3

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
OB - Topsoil removal (Cheshunt)	2,610	180,000	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (Riverview)	-	-	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (South Lemington Pit 2)	-	-	tonnes/year	0.03	kg/t											50	% Control
OB - Topsoil removal (South Lemington Pit 1)	-	-	tonnes/year	0.03	kg/t											50	% Control
OB - Drilling (Cheshunt)	-	-	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (Riverview)	22,931	129,556	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (South Lemington Pit 2)	-	-	holes/year	0.59	kg/hole											70	% Control
OB - Drilling (South Lemington Pit 1)	-	-	holes/year	0.59	kg/hole											70	% Control
OB - Blasting (Cheshunt)	-	-	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (Riverview)	23,603	653	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (South Lemington Pit 2)	-	-	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Blasting (South Lemington Pit 1)	-	-	blasts/year	36	kg/blast	3,000	Average area of blast in square metres										
OB - Dragline (Cheshunt)	-	-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (Riverview)	360,702	16,437,402	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (South Lemington Pit 2)	-	-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Dragline (South Lemington Pit 1)		-	bcm/year	0.022	kg/bcm	5	drop height in m	2	moisture content in %								
OB - Loading OB to haul truck (Cheshunt)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (Riverview)	352,077	186,345,330	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (South Lemington Pit 2)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Loading OB to haul truck (South Lemington Pit 1)	67,419	35,683,148	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Hauling to emplacement area (Cheshunt)	-	-	tonnes/year	0.000	kg/t	222	tonnes/load	0.0	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (Riverview)	2,101,289	110,233,760	tonnes/year	0.127	kg/t	222	tonnes/load	10.0	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (Riverview)	1,565,178	76,111,570	tonnes/year	0.137	kg/t	327	tonnes/load	13.3	km/return trip	3.4	kg/VKT	1.7	% silt content	413	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (South Lemington Pit 1)	15,392	7,929,589	tonnes/year	0.013	kg/t	222	tonnes/load	1.0	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Hauling to emplacement area (South Lemington Pit 1 to Pit 2	574,249	27,753,560	tonnes/year	0.138	kg/t	222	tonnes/load	10.9	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
OB - Emplacing at area (Cheshunt)	352,077	186,345,330	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (Riverview)	-	-	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (South Lemington Pit 2)	52,437	27,753,560	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Emplacing at area (South Lemington Pit 1)	14,982	7,929,589	tonnes/year	0.00189	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %								
OB - Dozers in pit (Cheshunt)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (Riverview)	582,974	34,835	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (South Lemington Pit 2)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers in pit (South Lemington Pit 1)	194,325	11,612	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (Cheshunt)	680,136	40,641	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (Riverview)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (South Lemington Pit 2)	97,162	5,806	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab (South Lemington Pit 1)	-	-	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
CL - Drilling (Cheshunt)	-	-	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (Riverview)	820	27,321	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (South Lemington Pit 2)	-	-	holes/year	0.10	kg/hole											70	% Control
CL - Drilling (South Lemington Pit 1)	-	-	holes/year	0.10	kg/hole											70	% Control
CL - Blasting (Cheshunt)	-	-	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (Riverview)	4,775	132	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (South Lemington Pit 2)	-	-	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Blasting (South Lemington Pit 1)	-	-	blasts/year	36	kg/blast	3,000	Area of blast in square metres										
CL - Dozers ripping/pushing/clean-up (Cheshunt)	-	-	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (Riverview)	258,843	10,825	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 2)	-	-	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Dozers ripping/pushing/clean-up (South Lemington Pit 1)	277,659	11,612	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CL - Loading ROM coal to haul truck (Cheshunt)	-	-	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (Riverview)	1,080,853	16,000,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (South Lemington Pit 2)	-	-	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Loading ROM coal to haul truck (South Lemington Pit 1)	270,213	4,000,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CL - Hauling ROM to hopper at HVCPP	497,745	12,800,000	tonnes/year	0.259	kg/t	222	tonnes/load	20.5	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CL - Hauling ROM to hopper at LCPP	76,747	4,000,000	tonnes/year	0.128	kg/t	222	tonnes/load	10.1	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CL - Hauling ROM to stockpile at HCPP	203,168	3,200,000	tonnes/year	0.423	kg/t	222	tonnes/load	33.4	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CHPP - Unloading ROM to hopper at HVCPP	432,341	12,800,000	tonnes/year	0.068	kg/t	6	moisture content in %									50	% Control
CHPP - Rehandle ROM at hopper at HVCPP	86,468	1,280,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CHPP - Dozer pushing ROM coal at HVCPP	35,868	1,500	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CHPP - Dozer pushing Product coal at HVCPP	14,126	1,500	hours/year	9.4	kg/h	4	silt content in %	10	moisture content in %								
CHPP - Loading Product coal to stockpile at HVCPP	1,334	8,960,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %							25	% Control

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
CHPP - Loading Product coal to train at HVCPP	1,075	8,960,000	tonnes/year	0.00040	kg/t											70	% Control
CHPP - Loading rejects - HVCPP	476	2,400,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
CHPP - Hauling rejects - HVCPP	93,327	2,400,000	tonnes/year	0.259	kg/t	222	tonnes/load	20.5	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CHPP - Unloading rejects - HVCPP	476	2,400,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
CHPP - Unloading ROM to hopper - LCPP	135,107	4,000,000	tonnes/year	0.068	kg/t	6	moisture content in %									50	% Control
CHPP - Rehandle ROM at hopper - LCPP	27,021	400,000	tonnes/year	0.068	kg/t	6	moisture content in %										
CHPP - Dozer pushing ROM coal - LCPP	35,868	1,500	hours/year	23.9	kg/h	5	silt content in %	6	moisture content in %								
CHPP - Dozer pushing Product coal - LCPP	14,126	1,500	hours/year	9.4	kg/h	4	silt content in %	10	moisture content in %								
CHPP - Loading Product coal to stockpile - LCPP	453	3,040,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %							25	% Control
CHPP - Loading Product coal to haul truck - LCPP	111,250	3,040,000	tonnes/year	0.037	kg/t	10	moisture content in %										
CHPP - Hauling Product to train loadout	65,672	3,040,000	tonnes/year	0.144	kg/t	222	tonnes/load	11.4	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CHPP - Unloading Product to hopper at train loadout	55,625	3,040,000	tonnes/year	0.037	kg/t	10	moisture content in %									50	% Control
CHPP - Loading Product coal to train - LCPP	365	3,040,000	tonnes/year	0.00040	kg/t											70	% Control
CHPP - Loading rejects - LCP	119	600,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
CHPP - Hauling rejects - LCP	11,512	600,000	tonnes/year	0.128	kg/t	222	tonnes/load	10.1	km/return trip	2.8	kg/VKT	1.7	% silt content	275	Ave GMV (tonnes)	85	% Control
CHPP - Unloading rejects - LCP	119	600,000	tonnes/year	0.00020	kg/t	1.596	average of (wind speed/2.2)^1.3 in m/s	10	moisture content in %								
WE - Overburden emplacement areas - Cheshunt	2,010,000	717.0	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - South Lemington Pit 2	167,979	59.9	ha	3,504	kg/ha/year											20	% Control
WE - Overburden emplacement areas - South Lemington Pit 1	186,237	66.4	ha	3,504	kg/ha/year											20	% Control
WE - Open pit - Riverview	1,430,131	408.1	ha	3,504	kg/ha/year												
WE - Open pit - South Lemington Pit 1	148,430	42.4	ha	3,504	kg/ha/year												
WE - Active rehab	28,671	27.3	ha	3,504	kg/ha/year											70	% Control
WE - ROM stockpiles - HVCPP	7,008	4.0	ha	3,504	kg/ha/year											50	% Control
WE - ROM stockpiles - LCPP	7,008	4.0	ha	3,504	kg/ha/year											50	% Control
WE - Product stockpiles - HVCPP	8,760	5.0	ha	3,504	kg/ha/year											50	% Control
WE - Product stockpiles - LCPP	17,520	5.0	ha	3,504	kg/ha/year												
Grading roads	45,288	147,168	km	0.62	kg/VKT	8	speed of graders in km/h									50	% Control
Total TSP emissions (kg/yr)	**14,910,128**																

Appendix D

Modelling Predictions – Dust emissions

Table D-1: Modelling predictions for Stage 2

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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
77	9	1	64	6	11	0.3	8	35	86	2.8
78	3	0	22	2	4	0.1	7	25	71	2.7
79	10	1	73	7	12	0.3	9	38	92	3.0
83	12	1	88	9	15	0.4	9	44	103	3.3
90	13	1	95	10	17	0.4	10	46	106	3.4
91	11	1	83	8	15	0.4	9	42	98	3.1
93	9	1	68	7	12	0.3	8	36	89	2.9
94	13	1	92	10	17	0.4	10	44	104	3.3
96	11	1	77	8	14	0.3	9	39	94	3.1
99	9	1	66	7	12	0.3	8	36	88	2.9
102	9	1	67	7	12	0.3	8	36	89	3.0
105	17	2	123	16	29	0.8	11	53	119	3.9
109	6	1	46	5	8	0.2	9	43	103	3.2
114	19	5	149	38	68	2.8	11	55	123	4.6
116	10	2	77	17	30	1.1	8	34	85	3.0
117	7	2	58	14	25	1.2	7	28	75	2.9
118	8	2	60	15	26	1.2	8	29	77	2.9
119	8	2	64	15	26	1.1	8	30	78	2.8
120	6	1	43	8	14	0.7	7	23	64	2.4
121	6	1	48	10	17	0.9	7	24	67	2.5
122	5	1	42	8	13	0.6	7	22	63	2.3
123	6	1	46	9	15	0.8	7	23	65	2.4
124	5	1	42	8	13	0.6	7	22	63	2.3
125	6	1	48	10	17	0.7	7	24	69	2.5
126	5	1	44	8	15	0.6	7	23	66	2.5
127	5	1	38	7	12	0.6	7	21	62	2.3
128	5	1	42	8	15	0.6	7	22	65	2.4
129	5	1	39	8	14	0.6	7	22	64	2.3
130	5	1	38	8	14	0.6	6	21	63	2.3
131	3	1	23	5	8	0.3	6	19	59	2.1
133	5	1	34	6	11	0.6	6	19	59	2.2
134	5	1	37	8	13	0.6	6	20	62	2.3
137	4	1	36	7	13	0.6	6	20	61	2.3
139	4	1	34	7	13	0.5	6	20	61	2.3
141	5	1	32	5	9	0.5	6	18	57	2.1
142	4	1	36	7	13	0.5	6	20	61	2.3
143	4	1	36	7	12	0.5	6	20	60	2.2
158	9	2	66	17	29	1.4	8	32	80	3.1
160	5	1	43	8	13	0.6	7	23	64	2.3
161	5	1	37	7	11	0.4	7	22	62	2.1
162	5	1	38	7	11	0.4	7	22	62	2.1
163	5	1	37	6	10	0.3	7	21	61	2.1
165	9	2	71	16	29	1.1	8	32	82	2.9

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
169	4	1	32	6	10	0.5	6	18	57	2.1
172	4	1	35	7	12	0.5	6	19	59	2.2
244	5	1	37	6	10	0.4	7	21	61	2.1
245	5	1	37	6	10	0.4	7	21	61	2.1
246	4	1	34	5	9	0.3	7	21	60	2.0
247	4	1	34	5	9	0.3	7	21	60	2.0
256	5	1	36	6	9	0.3	7	21	60	2.0
257	5	1	36	6	9	0.4	7	21	60	2.1
258	5	1	37	6	10	0.3	7	21	61	2.0
259	7	2	58	15	26	1.2	8	29	77	2.9
260	5	1	40	7	11	0.5	7	22	62	2.2
261	5	1	42	8	13	0.6	7	22	63	2.2
262	6	1	44	8	15	0.6	7	23	66	2.5
264	9	1	63	6	11	0.3	8	35	87	2.9
265	7	2	57	14	24	1.2	7	28	75	2.9
271	2	0	16	1	2	0.0	7	28	77	3.2
302	7	2	56	12	24	1.1	9	43	110	3.8
303	7	1	52	11	22	1.0	9	44	112	3.9
304	6	1	48	10	20	0.8	10	51	127	4.3
305	6	1	47	10	19	0.8	9	41	104	3.8
306	6	1	47	10	19	0.8	9	42	107	3.9
307	4	1	31	6	11	0.5	7	27	76	2.9
308	5	1	36	7	13	0.5	7	28	77	2.8
309	5	1	37	7	14	0.6	7	29	79	2.9
310	4	1	31	6	11	0.5	7	26	74	2.8
311	4	1	28	7	13	0.5	7	24	70	2.4
312	5	1	33	8	14	0.5	7	26	74	2.6
313	7	2	56	14	28	1.3	8	32	87	3.3
314	6	2	44	12	24	0.7	7	27	75	2.5
315	6	2	47	12	23	0.6	7	27	74	2.3
316	5	2	40	13	25	0.6	8	29	77	2.3
317	4	1	26	7	13	0.5	7	24	69	2.4
319	13	3	100	26	52	1.8	9	42	105	3.6
320	7	2	51	17	33	0.8	8	32	84	2.4
321	3	1	22	5	9	0.3	6	19	60	2.1
322	3	1	23	5	9	0.3	6	18	58	2.0
323	3	1	23	5	8	0.3	6	18	57	2.0
324	3	1	22	5	9	0.3	6	18	58	2.1
325	3	0	22	3	6	0.2	6	15	52	1.9
326	2	0	18	3	6	0.2	6	15	52	1.9
327	2	0	18	3	6	0.2	6	15	52	1.9
328	2	0	19	4	6	0.2	6	16	53	1.9
329	3	1	23	4	7	0.2	6	16	54	1.9
330	3	0	20	3	6	0.2	6	15	53	1.9

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
331	3	0	20	4	6	0.2	6	16	53	1.9
332	3	0	23	4	6	0.2	6	16	53	1.9
333	3	0	23	4	6	0.2	6	16	53	1.9
334	3	0	23	4	6	0.2	6	15	53	1.9
335	3	0	23	4	6	0.2	6	16	53	1.9
336	3	0	22	4	6	0.2	6	16	53	1.9
337	3	1	23	4	7	0.2	6	16	54	1.9
338	3	1	24	4	7	0.3	6	16	54	1.9
339	3	0	22	4	6	0.3	6	16	53	1.9
340	3	0	23	4	6	0.3	6	16	53	1.9
341	3	0	23	4	7	0.3	6	16	54	1.9
342	3	1	23	4	7	0.3	6	16	54	1.9
343	3	1	23	4	7	0.3	6	16	54	1.9
344	3	1	23	4	7	0.3	6	16	54	1.9
345	3	1	24	4	7	0.3	6	16	54	1.9
346	3	1	24	4	7	0.3	6	16	54	1.9
347	3	1	24	4	7	0.3	6	16	54	1.9
348	3	1	24	4	7	0.3	6	16	54	1.9
349	3	1	24	4	7	0.3	6	16	54	1.9
350	3	1	24	4	7	0.3	6	16	54	1.9
351	3	1	24	4	7	0.3	6	16	54	1.9
352	3	1	24	4	7	0.3	6	16	54	1.9
353	3	1	24	4	7	0.3	6	16	54	1.9
354	3	1	24	4	7	0.3	6	16	54	1.9
355	3	1	24	4	7	0.3	6	16	54	1.9
356	3	1	24	4	7	0.3	6	16	54	1.9
357	3	1	24	4	7	0.3	6	16	54	1.9
358	3	1	24	4	7	0.3	6	16	54	1.9
359	3	1	24	4	7	0.3	6	16	54	1.9
360	3	1	24	4	7	0.3	6	16	54	1.9
361	3	1	24	4	7	0.3	6	16	54	1.9
362	3	1	25	4	7	0.3	6	16	55	1.9
363	3	1	25	4	7	0.3	6	16	55	1.9
364	3	1	25	4	7	0.3	6	16	54	1.9
365	3	1	25	4	7	0.3	6	16	55	1.9
366	3	1	24	4	7	0.3	6	16	55	1.9
367	3	1	24	4	7	0.3	6	16	54	1.9
368	3	1	24	4	7	0.3	6	16	54	1.9
369	3	1	25	4	7	0.3	6	16	55	1.9
370	3	1	24	4	7	0.3	6	16	54	1.9
371	3	1	24	4	7	0.3	6	16	55	2.0
372	3	1	23	4	7	0.3	6	16	54	2.0
373	3	1	24	4	7	0.3	6	16	55	2.0
374	3	1	24	4	7	0.3	6	16	55	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
375	3	1	24	4	7	0.3	6	16	55	2.0
376	3	1	24	4	8	0.3	6	17	55	2.0
377	3	1	24	4	7	0.3	6	16	55	1.9
378	3	1	25	4	8	0.3	6	17	55	2.0
379	3	1	25	4	8	0.3	6	17	56	2.0
380	3	1	23	4	7	0.3	6	17	55	2.0
381	3	1	23	4	7	0.3	6	17	55	2.0
382	3	1	23	4	7	0.3	6	17	55	2.0
383	3	1	24	4	7	0.3	6	17	55	2.0
384	3	1	24	4	7	0.3	6	17	55	2.0
385	3	1	23	4	7	0.3	6	17	55	2.0
386	3	1	22	4	7	0.3	6	16	55	2.0
387	3	1	25	4	8	0.3	6	17	56	2.0
388	3	1	24	4	8	0.3	6	17	56	2.0
389	3	1	24	4	8	0.3	6	17	56	2.0
390	3	1	24	4	8	0.3	6	17	56	2.0
391	3	1	24	4	8	0.3	6	17	56	2.0
392	3	1	24	4	8	0.3	6	17	56	2.0
393	3	1	24	4	8	0.3	6	17	56	2.0
394	3	1	24	4	8	0.3	6	17	56	2.0
395	3	1	24	4	8	0.3	6	17	56	2.0
396	3	1	21	4	8	0.3	6	17	56	2.0
397	3	1	23	4	8	0.3	6	17	56	2.0
398	3	1	22	4	8	0.3	6	17	56	2.0
399	3	1	23	4	8	0.3	6	17	56	2.0
400	3	1	23	4	8	0.3	6	17	56	2.0
401	3	1	23	4	8	0.3	6	17	56	2.0
402	3	1	23	4	8	0.3	6	17	56	2.0
403	3	1	23	4	8	0.3	6	17	56	2.0
404	3	1	22	4	8	0.3	6	17	56	2.0
405	3	1	23	4	8	0.3	6	17	56	2.0
406	3	1	23	4	8	0.3	6	17	56	2.0
407	3	1	22	4	7	0.3	6	17	55	2.0
408	3	1	22	4	7	0.3	6	17	55	2.0
409	3	1	22	4	7	0.3	6	17	55	2.0
410	3	1	22	4	7	0.3	6	16	55	2.0
411	3	1	22	4	7	0.3	6	17	55	2.0
412	3	1	22	4	7	0.3	6	16	55	2.0
413	3	1	22	4	7	0.3	6	16	55	2.0
414	3	1	22	4	7	0.3	6	16	55	2.0
415	3	1	22	4	7	0.3	6	16	55	2.0
416	3	0	21	3	6	0.3	6	15	53	2.0
417	3	1	24	4	7	0.3	6	16	54	1.9
418	3	1	23	4	7	0.3	6	16	54	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
419	3	1	21	4	7	0.3	6	16	55	2.0
420	3	1	22	4	7	0.3	6	17	55	2.0
421	3	1	24	4	8	0.3	6	17	56	2.0
422	3	1	24	4	8	0.3	6	17	55	2.0
423	3	1	24	4	8	0.3	6	17	56	2.0
424	3	1	25	4	7	0.3	6	16	55	1.9
425	2	0	17	3	6	0.2	6	15	53	2.0
426	2	0	17	4	6	0.3	6	16	54	2.0
427	2	1	19	4	7	0.3	6	17	56	2.0
428	2	1	19	4	7	0.3	6	17	56	2.0
429	3	1	21	5	8	0.3	6	18	58	2.0
430	3	1	20	4	8	0.3	6	17	56	2.0
431	3	1	21	5	9	0.3	6	18	58	2.1
432	2	1	19	4	8	0.3	6	18	58	2.1
433	3	1	18	4	8	0.3	6	18	58	2.2
434	3	1	25	7	12	0.4	7	22	65	2.2
436	3	1	25	6	12	0.4	7	22	66	2.3
437	2	0	17	3	5	0.2	6	15	52	1.8
438	2	0	16	3	5	0.2	6	14	51	1.8
439	5	1	33	7	14	0.5	7	26	73	2.6
441	5	1	34	7	13	0.5	7	26	74	2.7
442	5	1	38	7	14	0.6	8	32	86	3.4
443	8	2	68	14	29	1.4	9	39	103	3.7
444	7	2	55	16	31	0.6	8	33	83	2.3
445	5	1	37	7	10	0.1	8	30	74	2.2
446	7	1	49	11	17	0.2	9	35	82	2.3
447	15	3	108	22	36	0.7	9	38	89	2.5
448	6	2	47	12	22	0.6	7	27	73	2.3
449	12	3	95	25	50	1.7	9	41	103	3.5
450	14	4	114	30	60	2.0	10	46	114	3.8
451	2	0	14	2	4	0.2	6	16	55	2.3
452	2	0	15	3	5	0.2	6	16	55	2.3
453	2	0	12	2	4	0.2	6	15	53	2.2
454	2	0	12	2	3	0.1	6	15	53	2.2
455	2	0	11	2	3	0.1	6	14	51	2.1
456	2	0	10	1	2	0.1	5	13	50	2.0
457	2	0	10	1	2	0.1	5	13	50	2.0
458	1	0	9	1	2	0.1	5	13	50	1.9
459	2	0	11	2	4	0.1	6	14	52	2.0
460	2	0	11	2	3	0.1	6	14	51	2.0
461	1	0	9	1	3	0.1	5	13	49	1.9
462	2	0	10	2	3	0.1	6	14	50	2.0
464	2	0	13	3	5	0.2	6	15	52	1.9
465	2	0	14	3	5	0.2	6	14	52	1.9

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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
466	2	0	18	3	5	0.2	6	15	52	1.9
467	7	2	51	16	31	0.6	8	32	83	2.3
468	1	0	8	1	2	0.1	5	12	48	1.8
471	2	0	15	3	4	0.1	9	42	97	2.8
472	2	0	17	3	4	0.1	7	26	69	2.1

*PM$_{2.5}$ NEPM standard applicable to the population as a whole

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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
77	8	1	56	6	11	0.3	9	39	93	2.8
78	3	0	23	2	4	0.1	9	39	94	3.1
79	9	1	62	7	13	0.3	9	41	97	3.0
83	10	1	73	9	16	0.4	10	46	105	3.2
90	11	1	79	10	18	0.5	10	47	108	3.3
91	10	1	72	9	15	0.4	9	44	101	3.1
93	9	1	64	7	13	0.3	9	40	93	2.9
94	11	1	79	11	19	0.5	10	46	105	3.3
96	10	1	72	9	15	0.4	9	41	97	3.0
99	10	1	69	7	13	0.3	9	38	91	2.8
102	10	1	73	8	13	0.3	9	38	90	2.8
105	17	3	124	21	38	1.0	11	53	119	3.8
109	9	1	63	5	9	0.2	8	35	84	2.6
114	21	5	160	39	71	2.5	11	54	123	4.3
116	10	2	80	16	29	1.0	8	31	80	2.8
117	7	2	58	13	24	1.1	7	27	72	2.7
118	8	2	68	14	25	1.1	7	28	74	2.8
119	8	2	67	14	25	1.0	7	27	74	2.7
120	6	1	46	8	13	0.6	7	21	62	2.3
121	7	1	53	10	16	0.8	7	23	65	2.4
122	6	1	44	7	12	0.6	6	21	61	2.2
123	6	1	50	8	14	0.7	7	22	63	2.3
124	6	1	43	7	12	0.5	6	20	60	2.2
125	6	1	51	9	17	0.6	7	22	65	2.4
126	6	1	49	8	15	0.6	7	22	64	2.4
127	5	1	40	7	12	0.6	6	20	60	2.2
128	6	1	43	8	14	0.5	6	21	63	2.3
129	5	1	39	8	14	0.5	6	20	61	2.3
130	5	1	37	7	13	0.5	6	20	60	2.2
131	4	1	30	5	10	0.3	6	18	58	2.1

Receptor ID	$PM_{2.5}$ (µg/m^3)		PM_{10} (µg/m^3)		TSP (µg/m^3)	DD (g/m^2/mth)	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	TSP (µg/m^3)	DD (g/m^2/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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
133	5	1	36	6	10	0.5	6	18	57	2.2
134	4	1	35	7	13	0.5	6	19	60	2.2
137	5	1	37	7	12	0.5	6	19	59	2.2
139	4	1	34	7	12	0.5	6	19	59	2.2
141	5	1	36	5	9	0.4	6	17	56	2.1
142	5	1	38	7	12	0.5	6	19	59	2.2
143	5	1	39	7	12	0.5	6	19	58	2.2
158	11	2	77	17	29	1.2	8	31	78	2.8
160	5	1	40	8	12	0.5	7	21	61	2.1
161	5	1	37	6	10	0.3	6	21	60	2.0
162	5	1	37	6	10	0.4	7	21	60	2.0
163	5	1	37	6	9	0.3	6	20	59	2.0
165	10	2	76	16	28	1.0	8	29	78	2.8
169	4	1	34	6	10	0.5	6	17	56	2.1
172	5	1	39	6	11	0.5	6	18	58	2.2
244	5	1	32	5	9	0.3	6	20	58	2.0
245	4	1	32	5	9	0.3	6	20	58	2.0
246	4	1	31	5	8	0.3	6	19	58	2.0
247	4	1	30	5	8	0.3	6	19	58	2.0
256	5	1	36	5	8	0.2	6	20	59	1.9
257	4	1	31	5	8	0.3	6	19	58	2.0
258	5	1	37	6	9	0.3	6	20	59	2.0
259	8	2	69	14	25	1.1	7	27	74	2.8
260	5	1	37	7	11	0.4	6	21	60	2.1
261	5	1	39	7	12	0.5	7	21	61	2.1
262	6	1	48	8	15	0.6	7	21	64	2.4
264	10	1	73	7	12	0.3	8	36	88	2.8
265	7	2	58	13	23	1.0	7	27	72	2.7
271	2	0	14	1	2	0.0	7	28	75	3.0
302	4	1	32	5	10	0.5	8	33	89	3.2
303	4	1	32	5	10	0.5	8	33	89	3.2
304	4	1	29	5	9	0.4	8	36	94	3.4
305	4	1	30	5	10	0.4	8	30	83	3.1
306	4	1	30	5	9	0.4	8	31	84	3.1
307	3	1	22	4	7	0.3	7	24	69	2.7
308	3	1	24	5	9	0.4	7	24	70	2.6
309	4	1	25	5	9	0.4	7	24	70	2.7
310	3	1	21	4	8	0.3	7	23	68	2.6
311	4	1	29	6	12	0.6	7	22	66	2.4
312	4	1	29	6	12	0.5	7	24	69	2.5
313	6	1	46	10	20	1.1	7	28	79	3.1
314	10	2	78	13	26	1.0	7	28	77	2.7
315	8	2	66	13	27	0.8	8	29	79	2.5
316	10	2	83	15	29	0.7	8	31	82	2.4

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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
317	4	1	31	6	12	0.5	7	22	66	2.4
319	31	8	257	68	146	4.8	14	85	201	6.6
320	14	3	113	23	46	1.1	9	39	98	2.8
321	5	1	38	5	9	0.4	6	18	59	2.1
322	5	1	37	5	9	0.4	6	18	57	2.1
323	5	1	37	4	8	0.3	6	17	57	2.1
324	5	1	37	5	9	0.4	6	18	58	2.1
325	4	0	31	3	6	0.3	6	15	53	2.0
326	3	0	23	3	6	0.2	6	15	53	1.9
327	3	0	22	3	6	0.2	6	15	52	1.9
328	3	0	25	4	7	0.3	6	16	53	1.9
329	3	1	28	4	7	0.3	6	16	54	1.9
330	3	0	25	3	6	0.3	6	15	53	1.9
331	3	0	26	4	7	0.3	6	16	54	1.9
332	4	0	30	4	7	0.3	6	16	54	2.0
333	4	0	30	4	7	0.3	6	16	54	2.0
334	4	0	31	4	7	0.3	6	16	54	2.0
335	4	0	31	4	7	0.3	6	16	54	2.0
336	4	0	28	4	7	0.3	6	16	54	1.9
337	4	1	31	4	7	0.3	6	16	54	2.0
338	4	1	31	4	7	0.3	6	16	54	2.0
339	4	0	32	4	7	0.3	6	16	54	2.0
340	4	0	33	4	7	0.3	6	16	54	2.0
341	4	0	33	4	7	0.3	6	16	54	2.0
342	4	1	33	4	7	0.3	6	16	54	2.0
343	4	1	33	4	7	0.3	6	16	54	2.0
344	4	1	34	4	7	0.3	6	16	54	2.0
345	4	1	34	4	7	0.3	6	16	54	2.0
346	4	1	34	4	7	0.3	6	16	54	2.0
347	4	1	32	4	7	0.3	6	16	54	2.0
348	4	1	32	4	7	0.3	6	16	54	2.0
349	4	1	33	4	7	0.3	6	16	54	2.0
350	4	1	33	4	7	0.3	6	16	54	2.0
351	4	1	33	4	7	0.3	6	16	54	2.0
352	4	1	33	4	7	0.3	6	16	55	2.0
353	4	1	32	4	7	0.3	6	16	55	2.0
354	4	1	32	4	7	0.3	6	16	55	2.0
355	4	1	33	4	7	0.3	6	16	55	2.0
356	4	1	34	4	7	0.3	6	16	55	2.0
357	4	1	34	4	7	0.3	6	16	55	2.0
358	4	1	34	4	7	0.3	6	16	55	2.0
359	4	1	34	4	7	0.3	6	16	55	2.0
360	4	1	33	4	8	0.3	6	16	55	2.0
361	4	1	33	4	8	0.3	6	16	55	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
362	4	1	34	4	8	0.3	6	16	55	2.0
363	4	1	35	4	8	0.3	6	16	55	2.0
364	4	1	34	4	8	0.3	6	16	55	2.0
365	4	1	35	4	8	0.3	6	16	55	2.0
366	4	1	35	4	8	0.3	6	16	55	2.0
367	4	1	35	4	7	0.3	6	16	55	2.0
368	4	1	35	4	7	0.3	6	16	55	2.0
369	4	1	35	4	8	0.3	6	16	55	2.0
370	4	1	35	4	7	0.3	6	16	55	2.0
371	4	1	35	4	7	0.3	6	16	55	2.0
372	4	1	35	4	7	0.3	6	16	55	2.0
373	4	1	35	4	7	0.3	6	16	55	2.0
374	4	1	35	4	7	0.3	6	16	55	2.0
375	4	1	35	4	7	0.3	6	16	55	2.0
376	5	1	37	4	8	0.3	6	17	56	2.0
377	4	1	36	4	8	0.3	6	16	55	2.0
378	5	1	37	4	8	0.3	6	17	56	2.0
379	5	1	37	4	8	0.3	6	17	56	2.0
380	4	1	35	4	8	0.3	6	17	55	2.0
381	4	1	36	4	8	0.3	6	17	55	2.0
382	4	1	36	4	8	0.3	6	17	55	2.0
383	5	1	36	4	8	0.3	6	17	55	2.0
384	4	1	36	4	8	0.3	6	17	55	2.0
385	4	1	35	4	8	0.3	6	17	55	2.0
386	4	1	34	4	7	0.3	6	16	55	2.0
387	5	1	38	4	8	0.3	6	17	56	2.0
388	5	1	37	4	8	0.3	6	17	56	2.0
389	5	1	37	4	8	0.3	6	17	56	2.0
390	5	1	37	4	8	0.3	6	17	56	2.0
391	5	1	37	4	8	0.3	6	17	56	2.0
392	5	1	37	4	8	0.3	6	17	56	2.0
393	5	1	37	4	8	0.3	6	17	56	2.0
394	5	1	37	4	8	0.3	6	17	56	2.0
395	5	1	38	4	8	0.3	6	17	56	2.0
396	4	1	32	4	8	0.3	6	17	56	2.0
397	5	1	36	4	8	0.3	6	17	56	2.0
398	4	1	34	4	8	0.3	6	17	56	2.0
399	5	1	36	4	8	0.3	6	17	56	2.0
400	5	1	36	4	8	0.3	6	17	56	2.0
401	5	1	36	4	8	0.3	6	17	56	2.0
402	5	1	36	4	8	0.3	6	17	56	2.0
403	5	1	36	4	8	0.3	6	17	56	2.0
404	4	1	35	4	8	0.3	6	17	56	2.0
405	5	1	36	4	8	0.3	6	17	56	2.0

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
406	5	1	36	4	8	0.3	6	17	56	2.0
407	4	1	34	4	8	0.3	6	17	55	2.0
408	4	1	33	4	8	0.3	6	17	55	2.0
409	4	1	34	4	7	0.3	6	16	55	2.0
410	4	1	34	4	7	0.3	6	16	55	2.0
411	4	1	34	4	7	0.3	6	16	55	2.0
412	4	1	32	4	7	0.3	6	16	55	2.0
413	4	1	32	4	7	0.3	6	16	55	2.0
414	4	1	32	4	7	0.3	6	16	55	2.0
415	4	1	32	4	7	0.3	6	16	55	2.0
416	4	0	29	3	6	0.3	6	15	53	2.0
417	4	1	35	4	7	0.3	6	16	55	2.0
418	4	1	34	4	7	0.3	6	16	55	2.0
419	4	1	29	4	7	0.3	6	16	55	2.0
420	4	1	34	4	8	0.3	6	17	55	2.0
421	5	1	37	4	8	0.3	6	17	56	2.0
422	5	1	37	4	8	0.3	6	17	56	2.0
423	5	1	37	4	8	0.3	6	17	56	2.0
424	4	1	34	4	8	0.3	6	16	55	2.0
425	2	0	16	3	6	0.3	6	15	53	2.0
426	2	0	15	3	6	0.3	6	16	54	2.0
427	2	1	19	4	7	0.3	6	17	56	2.0
428	3	1	21	4	7	0.3	6	17	56	2.0
429	4	1	31	4	8	0.3	6	18	57	2.1
430	3	1	25	4	7	0.3	6	17	56	2.0
431	4	1	32	5	9	0.4	6	18	58	2.1
432	2	1	18	4	8	0.3	6	18	58	2.1
433	2	1	17	4	7	0.3	6	18	58	2.2
434	5	1	39	6	12	0.5	7	21	63	2.3
436	4	1	28	6	11	0.5	7	21	64	2.3
437	2	0	20	3	6	0.2	6	15	52	1.9
438	2	0	19	3	5	0.2	6	14	51	1.8
439	4	1	28	6	12	0.5	7	23	68	2.5
441	3	1	27	6	11	0.5	7	23	69	2.5
442	4	1	27	4	8	0.4	7	26	74	2.9
443	5	1	36	7	13	0.6	8	31	84	3.0
444	13	3	102	26	51	1.0	9	42	104	2.6
445	4	1	33	6	9	0.1	8	30	73	2.1
446	5	1	39	9	13	0.2	8	35	80	2.2
447	14	3	105	21	34	0.6	9	37	85	2.3
448	8	2	63	13	26	0.8	8	29	78	2.4
449	32	9	259	71	152	4.7	15	88	206	6.5
450	28	7	219	58	125	4.6	13	75	180	6.4
451	2	0	11	2	3	0.1	6	16	55	2.3

Receptor ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	PM2.5 (µg/m³)	PM10 (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 / NEPM standard*									
	25*	-	50	-	-	2	8*	30	90	4
452	2	0	12	2	4	0.2	6	16	55	2.3
453	2	0	10	2	3	0.1	6	15	53	2.2
454	2	0	10	1	3	0.1	6	15	53	2.2
455	1	0	9	1	2	0.1	6	15	52	2.2
456	1	0	8	1	2	0.1	6	14	51	2.1
457	1	0	8	1	2	0.1	6	14	51	2.1
458	1	0	8	1	2	0.1	5	13	50	2.0
459	1	0	10	2	3	0.1	6	14	52	2.1
460	1	0	9	2	3	0.1	6	14	51	2.0
461	1	0	8	1	2	0.1	5	13	50	1.9
462	1	0	8	1	2	0.1	6	14	51	2.0
464	2	0	14	3	5	0.2	6	15	52	2.0
465	2	0	13	3	5	0.2	6	14	52	1.9
466	3	0	22	3	6	0.3	6	15	52	2.0
467	13	3	100	25	49	0.9	9	41	101	2.6
468	1	0	7	1	2	0.1	5	12	48	1.8
471	2	0	14	2	4	0.1	9	40	94	2.8
472	2	0	17	3	4	0.1	7	25	66	2.0

*$PM_{2.5}$ NEPM 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 proposed modification in Stage 2 (µg/m³)

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

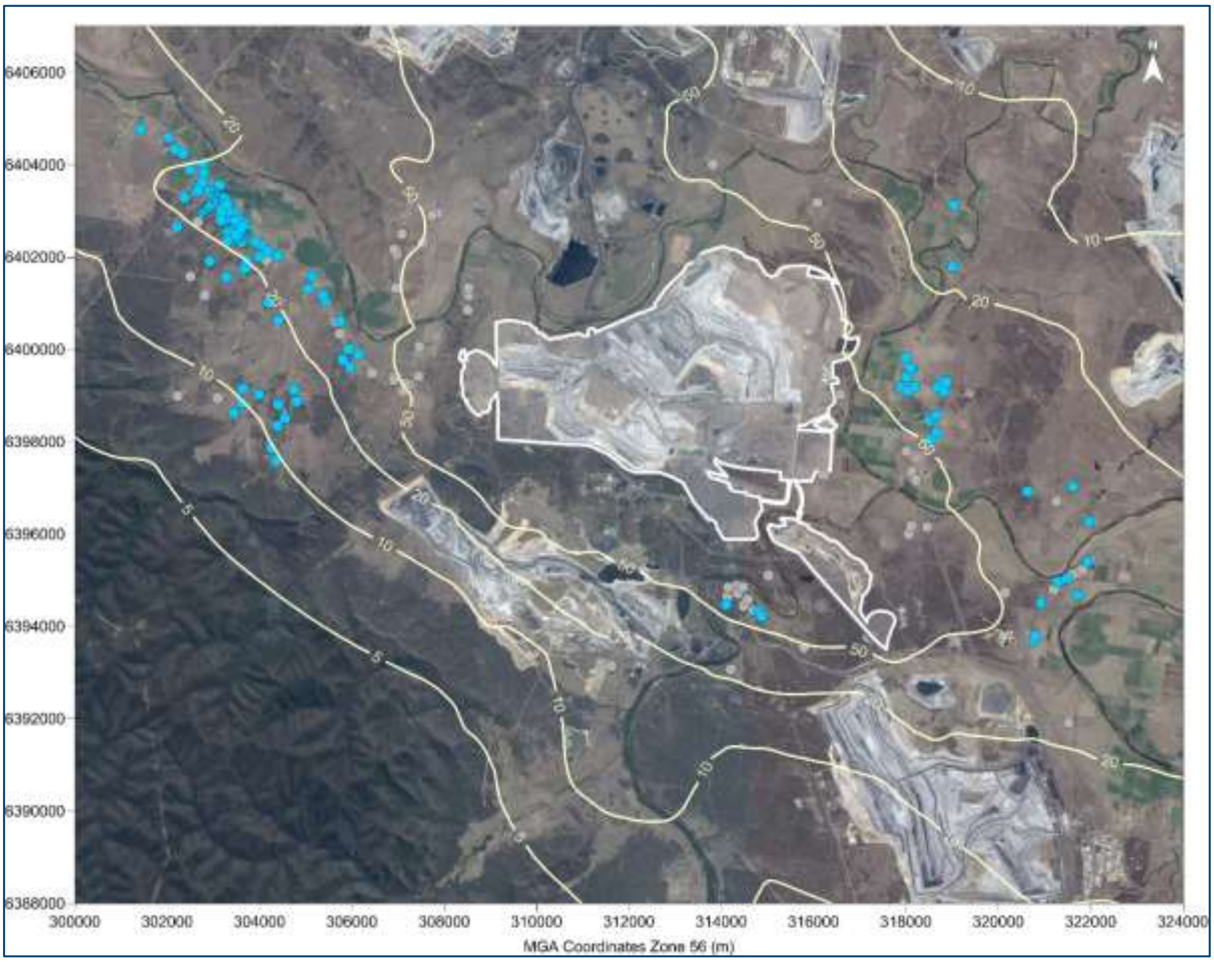

Figure E-3: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the proposed modification in Stage 2 (µg/m³)

Figure E-4: Predicted annual average PM_{10} concentrations due to emissions from the proposed modification in Stage 2 (µg/m³)

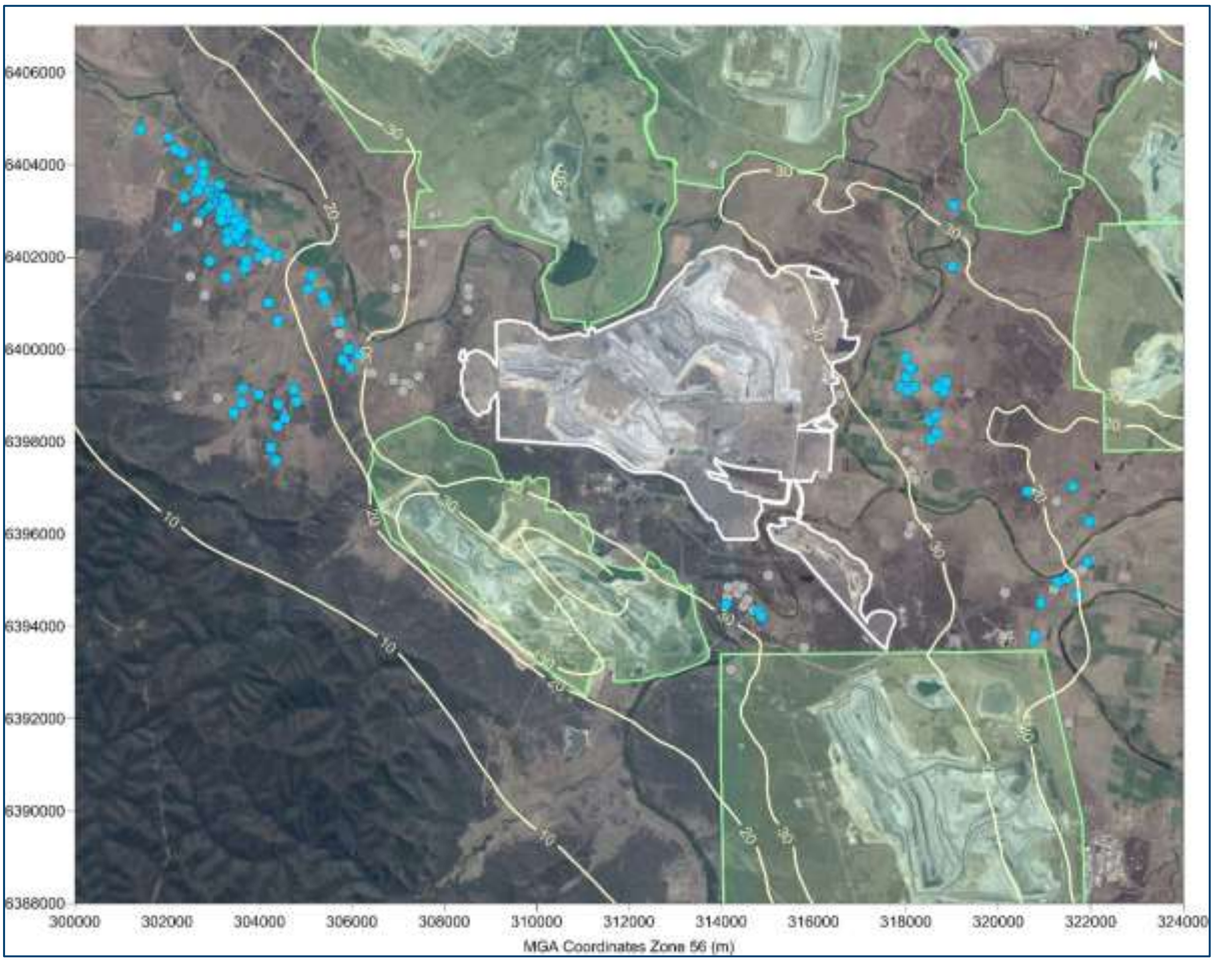

Figure E-5: Predicted annual average PM_{10} concentrations due to emissions from the proposed modification and other sources in Stage 2 (µg/m³)

Figure E-6: Predicted annual average TSP concentrations due to emissions from the proposed modification in Stage 2 (µg/m³)

Figure E-7: Predicted annual average TSP concentrations due to emissions from the proposed modification and other sources in Stage 2 (µg/m³)

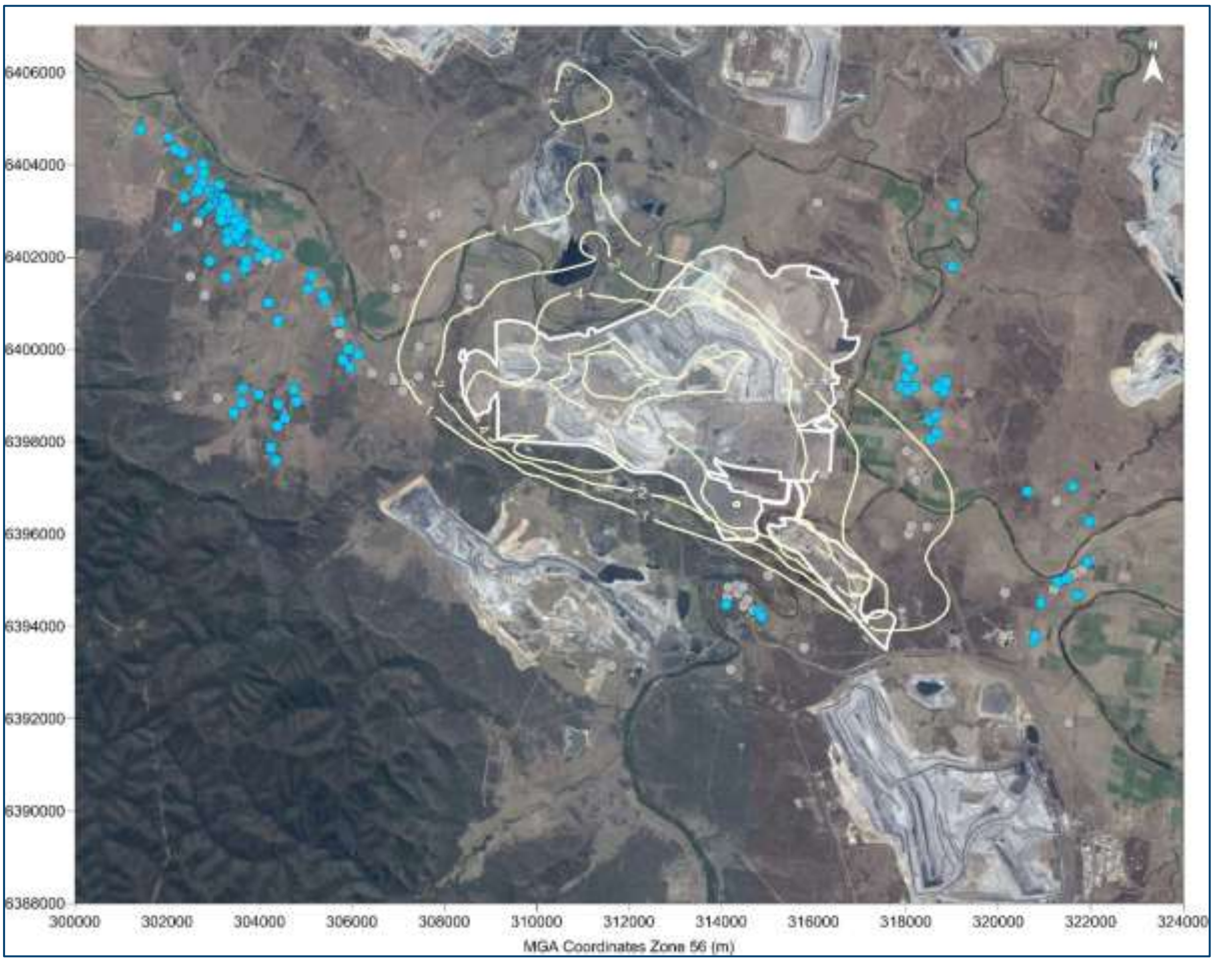

Figure E-8: Predicted annual average dust deposition levels due to emissions from the proposed modification in Stage 2 (g/m²/month)

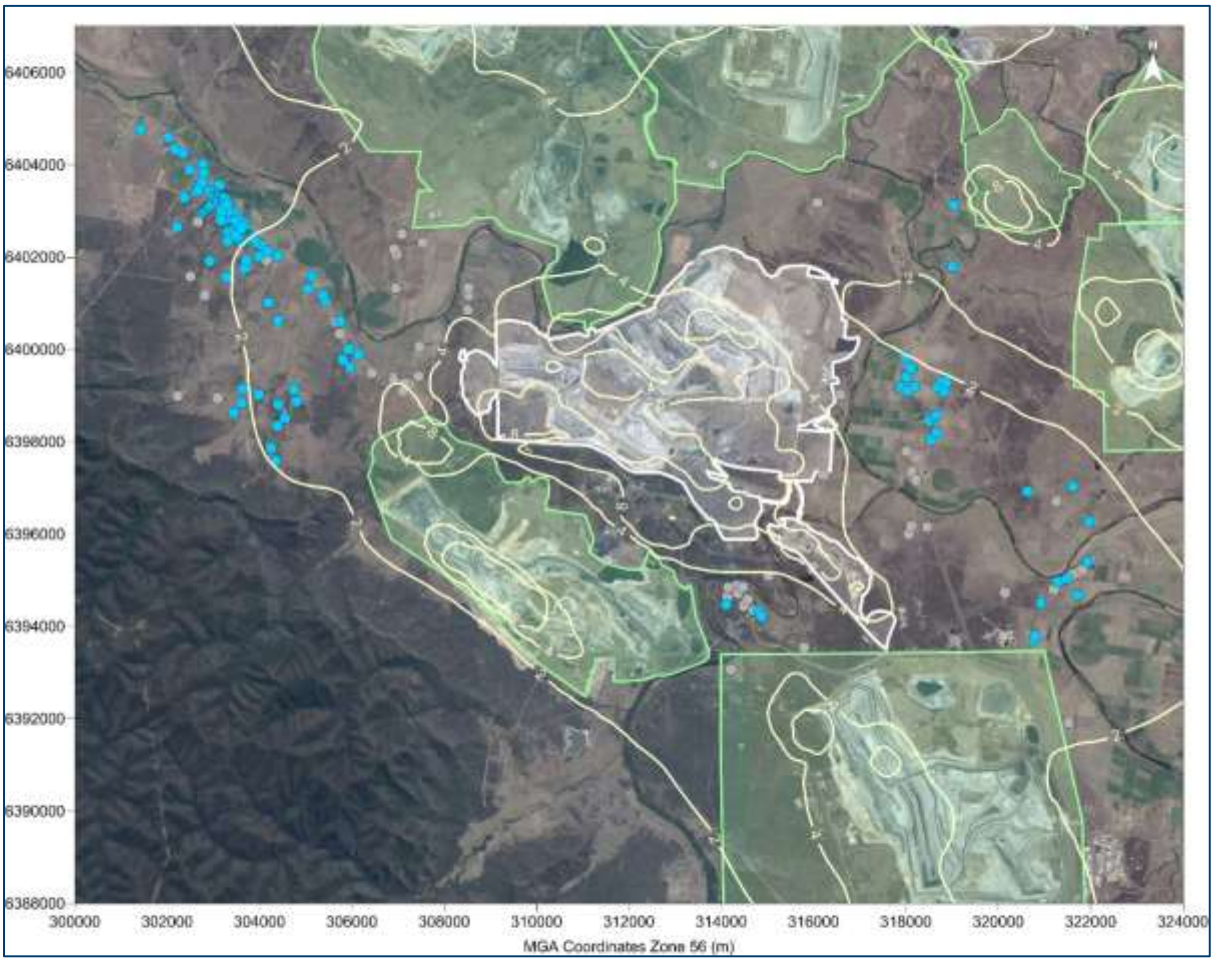

Figure E-9: Predicted annual average dust deposition levels due to emissions from the proposed modification and other sources in Stage 2 (g/m²/month)

Figure E-10: Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the proposed modification in Stage 3 (µg/m³)

Figure E-11: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the proposed modification in Stage 3 (µg/m³)

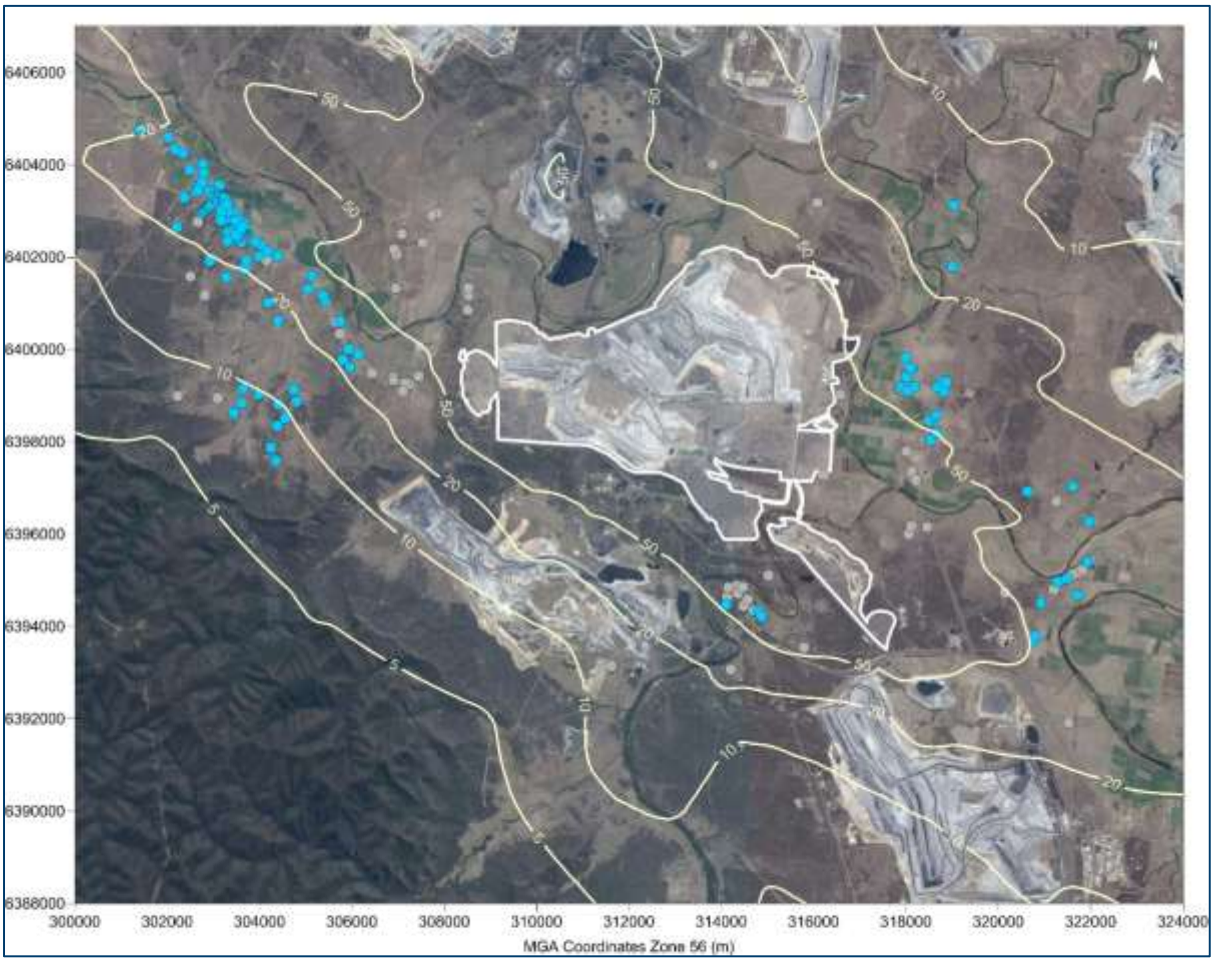

Figure E-12: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the proposed modification in Stage 3 (µg/m³)

Figure E-13: Predicted annual average PM_{10} concentrations due to emissions from the proposed modification in Stage 3 (µg/m³)

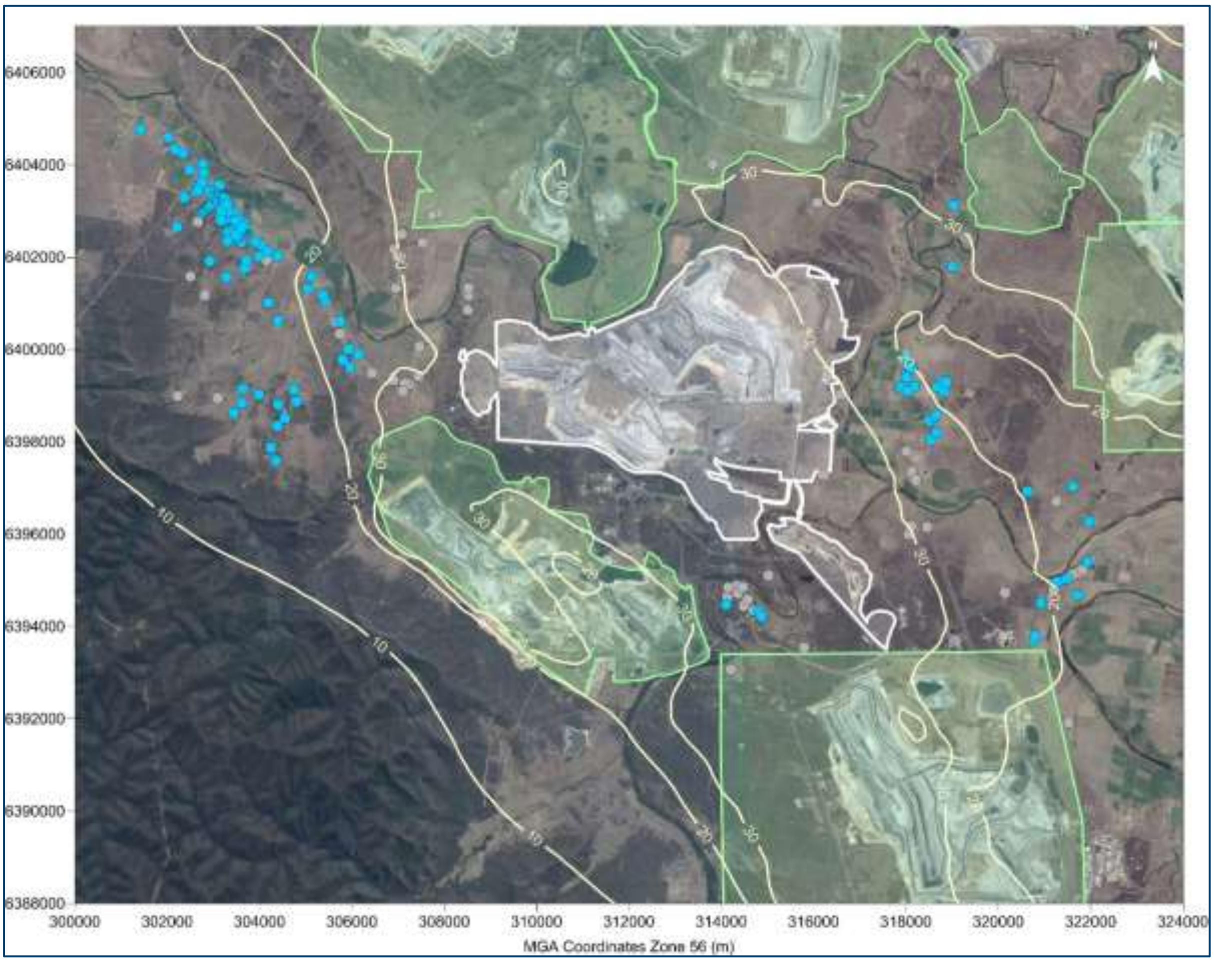

Figure E-14: Predicted annual average PM_{10} concentrations due to emissions from the proposed modification and other sources in Stage 3 (µg/m³)

Figure E-15: Predicted annual average TSP concentrations due to emissions from the proposed modification in Stage 3 (µg/m³)

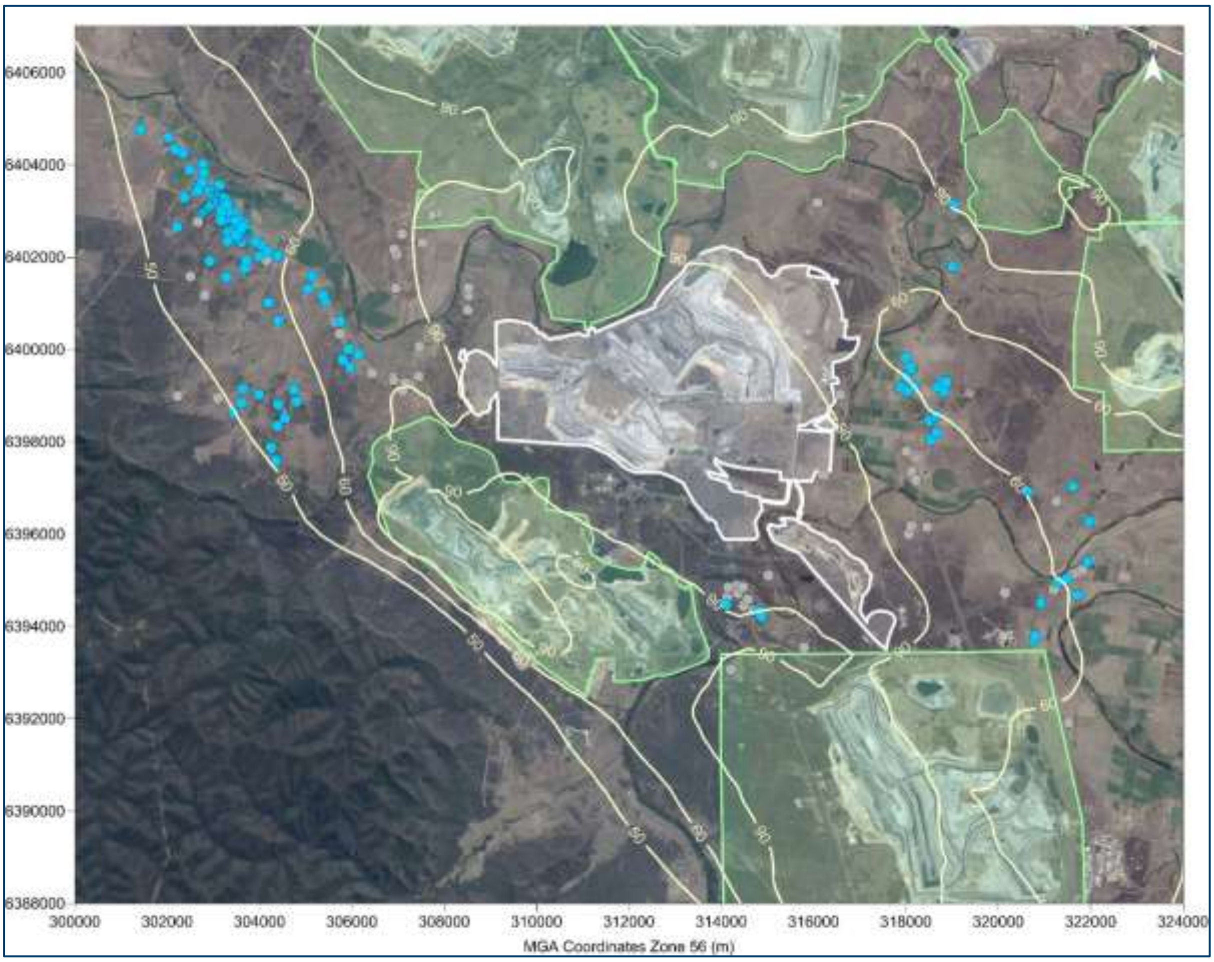

Figure E-16: Predicted annual average TSP concentrations due to emissions from the proposed modification and other sources in Stage 3 (µg/m³)

Figure E-17: Predicted annual average dust deposition levels due to emissions from the proposed modification in Stage 3 (g/m²/month)

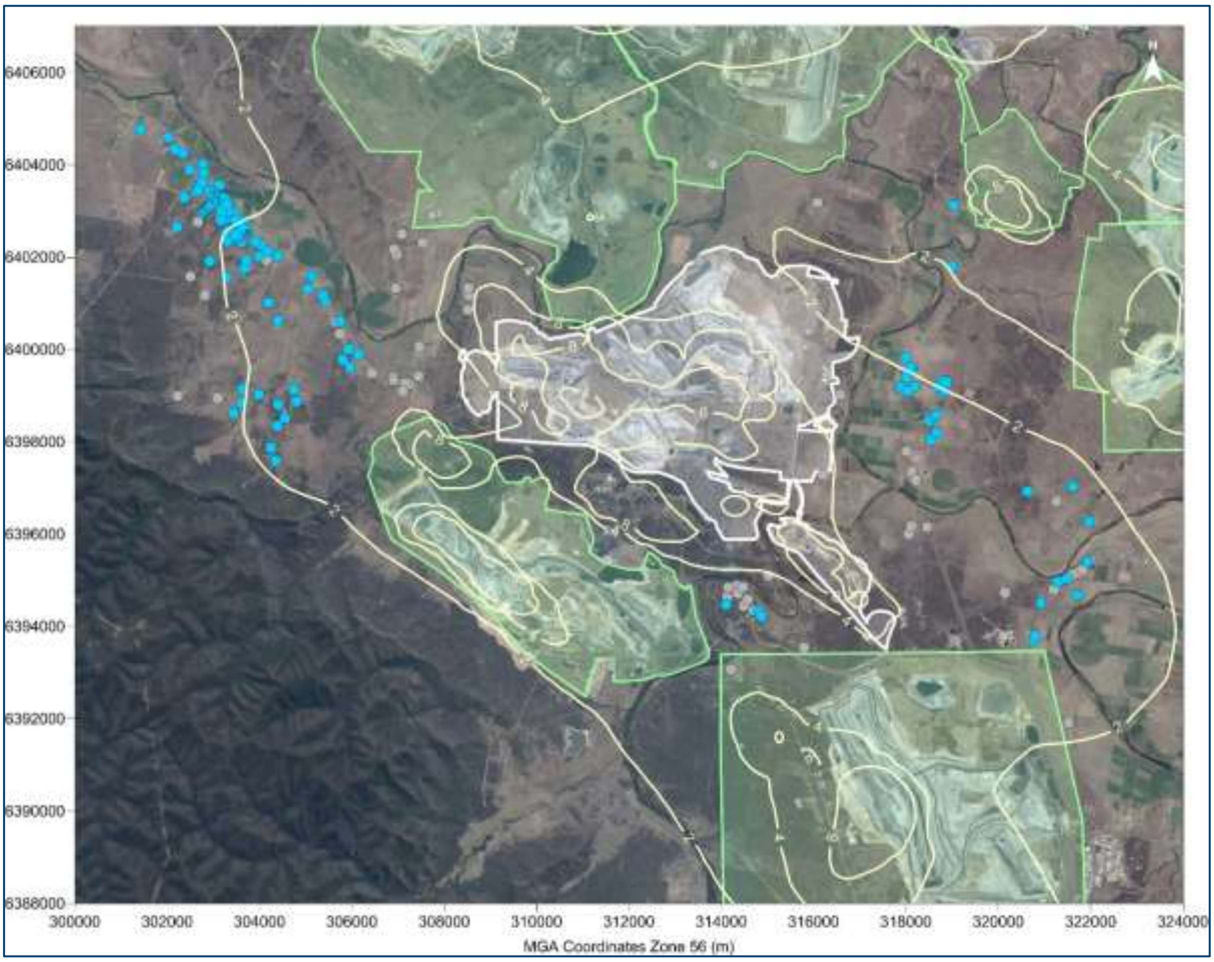

Figure E-18: Predicted annual average dust deposition levels due to emissions from the proposed modification and other sources in Stage 3 (g/m²/month)

Appendix F

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

Table F-1: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 77

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	13/06/2014	11	5	16
16/01/2014	20	0	20	18/06/2014	8	3	11
6/10/2014	16	1	17	19/06/2014	10	3	13
4/01/2014	16	0	16	10/05/2014	9	3	11
14/11/2014	16	1	17	2/07/2014	9	2	12
15/11/2014	15	0	15	9/11/2014	14	2	17
31/10/2014	15	1	16	29/04/2014	7	2	9
24/11/2014	15	1	15	15/07/2014	11	2	13
3/01/2014	14	0	14	16/07/2014	7	2	9
26/10/2014	14	0	15	10/02/2014	13	2	15

Table F-2: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 102

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	13/06/2014	11	6	16
16/01/2014	20	0	20	2/07/2014	9	3	12
6/10/2014	16	1	17	19/06/2014	10	3	13
4/01/2014	16	1	16	13/10/2014	11	3	14
14/11/2014	16	2	17	16/07/2014	7	3	9
15/11/2014	15	0	15	9/11/2014	14	2	17
31/10/2014	15	1	16	15/07/2014	11	2	13
24/11/2014	15	1	16	14/02/2014	9	2	11
3/01/2014	14	0	14	25/07/2014	11	2	13
26/10/2014	14	0	15	18/06/2014	8	2	10

Table F-3: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 121

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	17/04/2014	4	2	5
16/01/2014	20	0	20	28/05/2014	6	2	7
6/10/2014	16	0	16	16/07/2014	7	1	8
4/01/2014	16	0	16	12/05/2014	7	1	8
14/11/2014	16	0	16	3/08/2014	11	1	12
15/11/2014	15	0	16	15/10/2014	ND	1	1
31/10/2014	15	0	16	22/06/2014	13	1	14
24/11/2014	15	0	15	15/07/2014	11	1	12
3/01/2014	14	0	14	4/09/2014	8	1	9
26/10/2014	14	1	15	5/04/2014	6	1	7

ND – No data

Table F-4: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 126

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	14/06/2014	7	3	9
16/01/2014	20	0	20	3/07/2014	10	3	13
6/10/2014	16	0	17	23/05/2014	10	3	13
4/01/2014	16	0	16	20/06/2014	10	3	13
14/11/2014	16	0	16	4/07/2014	10	2	12
15/11/2014	15	0	16	20/05/2014	7	2	9
31/10/2014	15	0	16	3/06/2014	5	2	7
24/11/2014	15	1	15	21/06/2014	10	2	12
3/01/2014	14	0	14	16/06/2014	4	2	6
26/10/2014	14	0	15	7/07/2014	ND	2	2

ND – No data

Table F-5: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 160

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	12/05/2014	7	2	9
16/01/2014	20	0	20	15/10/2014	ND	2	2
6/10/2014	16	0	16	17/04/2014	4	2	5
4/01/2014	16	0	16	20/07/2014	9	2	11
14/11/2014	16	0	16	28/09/2014	8	2	9
15/11/2014	15	0	16	26/09/2014	7	1	9
31/10/2014	15	0	15	15/07/2014	11	1	12
24/11/2014	15	0	15	5/04/2014	6	1	7
3/01/2014	14	0	14	2/10/2014	8	1	10
26/10/2014	14	1	15	12/09/2014	7	1	9

ND – No data

Table F-6: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 261

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	15/10/2014	ND	2	2
16/01/2014	20	0	20	12/05/2014	7	2	9
6/10/2014	16	0	16	17/04/2014	4	2	5
4/01/2014	16	0	16	20/07/2014	9	2	11
14/11/2014	16	0	16	26/09/2014	7	1	9
15/11/2014	15	0	16	15/07/2014	11	1	12
31/10/2014	15	0	15	5/04/2014	6	1	7
24/11/2014	15	0	15	28/09/2014	8	1	9
3/01/2014	14	0	14	2/10/2014	8	1	10
26/10/2014	14	1	15	19/08/2014	7	1	8

ND – No data

Table F-7: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 262

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
4/11/2014	**32**	0	**32**	-	-	-	-
3/11/2014	25	0	25	14/06/2014	7	3	10
16/01/2014	20	0	20	23/05/2014	10	3	13
6/10/2014	16	0	17	3/07/2014	10	2	12
4/01/2014	16	0	16	20/06/2014	10	2	13
14/11/2014	16	0	16	20/05/2014	7	2	9
15/11/2014	15	0	16	4/07/2014	10	2	12
31/10/2014	15	0	16	3/06/2014	5	2	7
24/11/2014	15	1	15	10/08/2014	8	2	10
3/01/2014	14	0	14	21/06/2014	10	2	12
26/10/2014	14	0	15	24/05/2014	9	2	11

Table F-8: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 264

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	13/06/2014	11	5	16
16/01/2014	20	0	20	19/06/2014	10	3	13
6/10/2014	16	1	17	13/10/2014	11	3	14
4/01/2014	16	1	16	2/07/2014	9	3	12
14/11/2014	16	1	17	16/07/2014	7	2	9
15/11/2014	15	0	15	18/06/2014	8	2	10
31/10/2014	15	1	16	9/11/2014	14	2	17
24/11/2014	15	1	16	15/07/2014	11	2	13
3/01/2014	14	0	14	25/07/2014	11	2	13
26/10/2014	14	0	15	26/05/2014	8	2	10

Table F-9: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 309

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	1	25	19/01/2014	9	3	12
16/01/2014	20	1	20	4/04/2014	9	3	12
6/10/2014	16	0	17	11/10/2014	9	3	12
4/01/2014	16	1	16	23/01/2014	7	2	10
14/11/2014	16	0	16	24/02/2014	6	2	9
15/11/2014	15	1	16	5/04/2014	6	2	8
31/10/2014	15	0	15	9/05/2014	9	2	11
24/11/2014	15	0	15	23/07/2014	8	2	10
3/01/2014	14	2	16	30/03/2014	7	2	9
26/10/2014	14	0	15	2/02/2014	7	2	9

Table F-10: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 77

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
4/11/2014	**32**	0	**32**	-	-	-	-
3/11/2014	25	0	25	13/06/2014	11	5	15
16/01/2014	20	1	20	14/02/2014	9	4	12
6/10/2014	16	1	17	4/06/2014	6	4	10
4/01/2014	16	1	16	15/07/2014	11	4	14
14/11/2014	16	1	17	16/05/2014	8	3	11
15/11/2014	15	0	15	27/10/2014	14	3	17
31/10/2014	15	1	17	19/06/2014	10	3	13
24/11/2014	15	1	15	10/02/2014	13	3	15
3/01/2014	14	0	14	24/07/2014	11	2	13
26/10/2014	14	0	15	12/03/2014	5	2	8

Table F-11: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 102

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	13/06/2014	11	7	17
16/01/2014	20	1	20	14/02/2014	9	7	15
6/10/2014	16	1	18	15/07/2014	11	4	15
4/01/2014	16	1	16	10/02/2014	13	4	17
14/11/2014	16	2	18	23/11/2014	10	4	14
15/11/2014	15	0	16	19/06/2014	10	4	14
31/10/2014	15	1	17	9/11/2014	14	4	18
24/11/2014	15	1	16	16/05/2014	8	4	11
3/01/2014	14	0	14	4/06/2014	6	3	10
26/10/2014	14	0	15	23/10/2014	11	3	14

Table F-12: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 121

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	16/07/2014	7	2	9
16/01/2014	20	0	20	17/04/2014	4	2	5
6/10/2014	16	0	16	12/05/2014	7	2	8
4/01/2014	16	0	16	28/05/2014	6	2	7
14/11/2014	16	0	16	26/09/2014	7	2	9
15/11/2014	15	0	16	5/04/2014	6	2	7
31/10/2014	15	0	15	15/07/2014	11	2	12
24/11/2014	15	0	14	26/06/2014	6	1	7
3/01/2014	14	0	14	15/05/2014	7	1	8
26/10/2014	14	1	15	24/07/2014	11	1	12

ND – No data

Table F-13: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 126

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	20/06/2014	10	3	14
16/01/2014	20	0	20	23/05/2014	10	3	13
6/10/2014	16	0	17	3/07/2014	10	3	13
4/01/2014	16	0	16	1/09/2014	4	3	7
14/11/2014	16	0	16	19/05/2014	9	3	12
15/11/2014	15	0	16	20/05/2014	7	3	9
31/10/2014	15	0	16	2/06/2014	6	2	9
24/11/2014	15	1	15	21/06/2014	10	2	12
3/01/2014	14	0	14	4/07/2014	10	2	12
26/10/2014	14	0	15	21/04/2014	ND	2	2

ND – No data

Table F-14: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 160

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	12/05/2014	7	2	9
16/01/2014	20	0	20	17/04/2014	4	2	6
6/10/2014	16	0	16	15/10/2014	ND	2	2
4/01/2014	16	0	16	8/12/2014	8	2	10
14/11/2014	16	0	16	28/09/2014	8	2	9
15/11/2014	15	0	16	5/04/2014	6	2	7
31/10/2014	15	0	15	20/07/2014	9	2	11
24/11/2014	15	0	15	24/09/2014	8	2	9
3/01/2014	14	0	14	2/10/2014	8	2	10
26/10/2014	14	1	15	15/05/2014	7	2	9

ND – No data

Table F-15: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 261

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
4/11/2014	**32**	0	**32**	-	-	-	-
3/11/2014	25	0	25	12/05/2014	7	2	9
16/01/2014	20	0	20	17/04/2014	4	2	6
6/10/2014	16	0	16	15/10/2014	ND	2	2
4/01/2014	16	0	16	8/12/2014	8	2	10
14/11/2014	16	0	16	5/04/2014	6	2	7
15/11/2014	15	0	16	20/07/2014	9	2	11
31/10/2014	15	0	15	28/09/2014	8	2	9
24/11/2014	15	0	15	15/05/2014	7	2	8
3/01/2014	14	0	14	15/07/2014	11	2	12
26/10/2014	14	1	15	25/05/2014	12	2	13

ND – No data

Table F-16: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 262

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
4/11/2014	**32**	0	**32**	-	-	-	-
3/11/2014	25	0	25	20/06/2014	10	3	13
16/01/2014	20	0	20	23/05/2014	10	3	13
6/10/2014	16	0	17	3/07/2014	10	3	13
4/01/2014	16	0	16	1/09/2014	4	3	7
14/11/2014	16	0	16	19/05/2014	9	3	12
15/11/2014	15	0	16	26/07/2014	7	2	9
31/10/2014	15	0	16	10/08/2014	8	2	10
24/11/2014	15	1	15	2/06/2014	6	2	9
3/01/2014	14	0	14	20/05/2014	7	2	9
26/10/2014	14	0	15	21/04/2014	ND	2	2

ND – No data

Table F-17: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 264

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	13/06/2014	11	7	17
16/01/2014	20	1	20	14/02/2014	9	6	14
6/10/2014	16	1	17	10/02/2014	13	4	17
4/01/2014	16	1	16	15/07/2014	11	4	15
14/11/2014	16	2	18	9/11/2014	14	4	18
15/11/2014	15	0	15	23/11/2014	10	4	14
31/10/2014	15	1	17	19/06/2014	10	3	13
24/11/2014	15	2	16	18/06/2014	8	3	11
3/01/2014	14	0	14	23/10/2014	11	3	14
26/10/2014	14	1	15	16/05/2014	8	3	11

Table F-18: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 309

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
4/11/2014	32	0	32	-	-	-	-
3/11/2014	25	0	25	11/01/2014	12	1	13
16/01/2014	20	1	21	16/01/2014	20	1	21
6/10/2014	16	0	17	15/07/2014	11	1	12
4/01/2014	16	0	16	21/05/2014	ND	1	1
14/11/2014	16	0	16	19/01/2014	9	1	10
15/11/2014	15	0	16	15/01/2014	10	1	11
31/10/2014	15	0	15	24/07/2014	11	1	12
24/11/2014	15	0	15	28/10/2014	5	1	6
3/01/2014	14	0	15	14/02/2014	9	1	9
26/10/2014	14	0	14	7/08/2014	9	1	9

ND – No data

Table F-19: Stage 2 (PM_{10} 24-hr average concentration) – Assessment location 77

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
16/01/2014	68	3	71	-	-	-	-
3/01/2014	51	0	51	-	-	-	-
4/11/2014	50	1	52	-	-	-	-
17/12/2014	49	1	51	13/06/2014	21	40	61
26/11/2014	48	0	48	18/06/2014	11	26	37
4/01/2014	48	4	51	19/06/2014	13	23	36
1/11/2014	48	6	53	10/05/2014	14	21	35
18/12/2014	47	5	51	29/04/2014	11	19	30
15/01/2014	46	2	48	9/11/2014	35	19	53
17/01/2014	45	1	45	2/07/2014	12	18	30
13/02/2014	44	0	44	16/07/2014	12	17	29
15/11/2014	44	0	44	26/05/2014	18	17	35
1/02/2014	42	0	43	10/02/2014	37	17	54
6/01/2014	42	9	51	18/03/2014	26	16	42
31/10/2014	42	8	50	15/07/2014	33	16	49
8/02/2014	41	7	48	17/05/2014	14	16	29
3/11/2014	41	0	41	14/02/2014	19	15	34
18/01/2014	40	5	45	2/06/2014	7	15	22
21/11/2014	40	3	43	16/05/2014	14	15	29
15/12/2014	39	0	39	4/10/2014	29	15	44
12/02/2014	39	0	39	23/11/2014	36	15	50
6/10/2014	39	5	44	25/07/2014	15	15	30
1/01/2014	38	1	39	19/02/2014	15	15	30
19/01/2014	38	2	40	13/10/2014	28	14	42
2/02/2014	38	0	38	15/05/2014	15	13	27
11/01/2014	38	3	41	24/09/2014	15	12	27
24/11/2014	38	6	44	5/06/2014	16	12	28
3/10/2014	37	3	40	23/10/2014	33	12	45

Table F-20: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 102

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
16/01/2014	68	3	71	-	-	-	-
3/01/2014	51	0	51	-	-	-	-
4/11/2014	50	1	52	-	-	-	-
17/12/2014	49	2	51	13/06/2014	21	43	64
26/11/2014	48	0	48	13/10/2014	28	23	50
4/01/2014	48	5	52	2/07/2014	12	22	34
1/11/2014	48	2	50	19/06/2014	13	22	34
18/12/2014	47	2	49	9/11/2014	35	19	54
15/01/2014	46	2	48	14/02/2014	19	19	38
17/01/2014	45	1	45	16/07/2014	12	19	31
13/02/2014	44	0	44	18/06/2014	11	18	29
15/11/2014	44	1	44	26/05/2014	18	18	37
1/02/2014	42	0	43	10/05/2014	14	18	32
6/01/2014	42	10	52	4/12/2014	16	17	33
31/10/2014	42	9	51	15/07/2014	33	17	50
8/02/2014	41	6	48	25/07/2014	15	17	32
3/11/2014	41	0	41	10/02/2014	37	17	54
18/01/2014	40	5	45	2/06/2014	7	16	24
21/11/2014	40	5	46	19/02/2014	15	16	31
15/12/2014	39	0	39	23/11/2014	36	15	51
12/02/2014	39	0	39	29/04/2014	11	15	26
6/10/2014	39	5	44	16/05/2014	14	15	29
1/01/2014	38	1	39	4/10/2014	29	15	44
19/01/2014	38	2	40	24/09/2014	15	14	29
2/02/2014	38	0	38	5/06/2014	16	14	30
11/01/2014	38	3	40	24/12/2014	21	14	35
24/11/2014	38	11	49	18/03/2014	26	14	39
3/10/2014	37	5	42	17/05/2014	14	13	27
10/02/2014	37	17	54	15/05/2014	15	13	28
2/01/2014	36	7	43	23/10/2014	33	12	46

Table F-21: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 264

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
16/01/2014	**68**	3	**71**	-	-	-	-
3/01/2014	**51**	0	**51**	-	-	-	-
4/11/2014	**50**	1	**51**	-	-	-	-
17/12/2014	49	2	**51**	13/06/2014	21	40	**61**
26/11/2014	48	0	48	13/10/2014	28	21	49
4/01/2014	48	4	**52**	19/06/2014	13	21	34
1/11/2014	48	3	50	2/07/2014	12	20	32
18/12/2014	47	2	49	18/06/2014	11	19	30
15/01/2014	46	2	48	9/11/2014	35	18	52
17/01/2014	45	1	45	16/07/2014	12	18	30
13/02/2014	44	0	44	26/05/2014	18	17	36
15/11/2014	44	1	44	10/05/2014	14	17	31
1/02/2014	42	0	43	14/02/2014	19	17	36
6/01/2014	42	9	**51**	4/12/2014	16	16	32
31/10/2014	42	9	**51**	25/07/2014	15	16	31
8/02/2014	41	6	47	15/07/2014	33	16	49
3/11/2014	41	0	41	2/06/2014	7	16	23
18/01/2014	40	4	45	10/02/2014	37	15	**52**
21/11/2014	40	5	45	29/04/2014	11	15	25
15/12/2014	39	0	39	23/11/2014	36	14	50
12/02/2014	39	0	39	4/10/2014	29	14	43
6/10/2014	39	5	44	19/02/2014	15	14	29
1/01/2014	38	1	39	24/12/2014	21	14	35
19/01/2014	38	2	40	16/05/2014	14	13	28
2/02/2014	38	0	38	24/09/2014	15	13	28
11/01/2014	38	2	40	18/03/2014	26	13	39
24/11/2014	38	11	48	17/05/2014	14	13	26
3/10/2014	37	4	42	5/06/2014	16	13	28

ND – No data

Table F-22: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 160

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/11/2014	64	6	70	-	-	-	-
31/10/2014	58	1	59	-	-	-	-
27/10/2014	55	2	57	-	-	-	-
27/05/2014	55	-1	54	-	-	-	-
2/01/2014	53	5	58	-	-	-	-
15/11/2014	53	2	54	-	-	-	-
17/12/2014	50	0	50	15/10/2014	7	18	25
4/01/2014	48	0	49	12/05/2014	19	15	34
1/11/2014	47	3	50	17/04/2014	18	14	31
16/01/2014	47	0	47	20/07/2014	32	13	45
30/09/2014	46	-1	46	28/09/2014	23	12	35
14/11/2014	46	0	46	26/09/2014	16	11	27
6/10/2014	45	0	45	12/09/2014	20	11	30
4/11/2014	44	0	44	2/10/2014	ND	10	10
18/12/2014	42	0	42	19/08/2014	14	10	24
23/11/2014	42	2	45	21/04/2014	26	10	36
3/11/2014	42	1	42	8/12/2014	18	9	27
6/01/2014	42	0	41	22/06/2014	19	9	28
13/10/2014	41	6	47	15/07/2014	41	9	50
15/07/2014	41	9	50	5/04/2014	10	9	19
9/07/2014	41	1	42	25/05/2014	36	9	44

ND – No data

Table F-23: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 261

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/11/2014	**64**	6	**70**	-	-	-	-
31/10/2014	**58**	2	**59**	-	-	-	-
27/10/2014	**55**	2	**57**	-	-	-	-
27/05/2014	**55**	0	**54**	-	-	-	-
2/01/2014	**53**	5	**58**	-	-	-	-
15/11/2014	**53**	2	**55**	-	-	-	-
17/12/2014	50	0	50	15/10/2014	7	17	24
4/01/2014	48	0	49	12/05/2014	19	15	34
1/11/2014	47	3	50	17/04/2014	18	13	31
16/01/2014	47	0	47	20/07/2014	32	13	44
30/09/2014	46	-1	46	26/09/2014	16	10	26
14/11/2014	46	0	46	28/09/2014	23	10	33
6/10/2014	45	0	45	19/08/2014	14	10	24
4/11/2014	44	0	44	2/10/2014	ND	10	10
18/12/2014	42	0	42	22/06/2014	19	9	28
23/11/2014	42	2	45	12/09/2014	20	9	29
3/11/2014	42	0	42	15/07/2014	41	9	50
6/01/2014	42	0	41	5/04/2014	10	9	19
13/10/2014	41	6	47	25/05/2014	36	9	45

ND – No data

Table F-24: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 121

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/11/2014	55	3	58	-	-	-	-
27/10/2014	51	2	53	-	-	-	-
15/11/2014	48	2	50	17/04/2014	19	13	33
13/02/2014	46	0	46	28/05/2014	31	12	43
17/12/2014	46	-1	45	16/07/2014	17	11	28
21/11/2014	44	6	50	22/06/2014	19	11	29
2/01/2014	40	3	43	15/10/2014	3	11	14
16/01/2014	40	0	40	4/09/2014	18	11	29
4/01/2014	39	0	40	12/05/2014	15	10	25
31/10/2014	39	2	40	3/08/2014		10	10
30/09/2014	38	-1	37	26/09/2014	12	9	21
4/02/2014	38	1	38	3/09/2014	8	9	17

ND – No data

Table F-25: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 126

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/11/2014	55	1	56	-	-	-	-
27/10/2014	51	5	56	-	-	-	-
15/11/2014	48	1	49	14/06/2014	12	22	33
13/02/2014	46	0	46	3/07/2014	20	21	41
17/12/2014	46	4	49	23/05/2014	27	21	48
21/11/2014	44	3	47	20/05/2014	29	20	49
2/01/2014	40	5	45	4/07/2014	28	20	49
16/01/2014	40	0	40	20/06/2014	22	20	42
4/01/2014	39	4	43	3/06/2014	8	18	26
31/10/2014	39	2	41	21/06/2014	11	18	28
30/09/2014	38	4	42	7/07/2014	13	17	30
4/02/2014	38	0	38	22/05/2014	27	17	44
27/05/2014	38	12	50	16/06/2014	12	16	28
24/06/2014	37	14	51	27/07/2014	8	16	24
6/01/2014	36	3	39	29/07/2014	14	16	31
10/08/2014	36	16	52	2/06/2014	9	16	26
6/10/2014	34	1	35	24/05/2014	29	16	45
24/04/2014	34	10	44	10/08/2014	36	16	52

Table F-26: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 262

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/11/2014	**55**	1	**56**	-	-	-	-
27/10/2014	**51**	5	**56**	-	-	-	-
15/11/2014	48	1	49	14/06/2014	12	22	34
13/02/2014	46	0	46	23/05/2014	27	21	48
17/12/2014	46	3	49	3/07/2014	20	20	40
21/11/2014	44	3	47	20/05/2014	29	20	49
2/01/2014	40	5	44	4/07/2014	28	20	48
16/01/2014	40	0	40	20/06/2014	22	19	42
4/01/2014	39	4	43	3/06/2014	8	19	26
31/10/2014	39	2	41	10/08/2014	36	17	**53**
30/09/2014	38	3	41	24/05/2014	29	17	46
4/02/2014	38	0	38	21/06/2014	11	17	27
27/05/2014	38	11	49	7/07/2014	13	17	30
24/06/2014	37	14	**51**	29/07/2014	14	16	30
6/01/2014	36	3	39	9/07/2014	22	16	39
10/08/2014	36	17	**53**	16/06/2014	12	16	28
6/10/2014	34	1	35	27/07/2014	8	16	24
24/04/2014	34	10	43	22/05/2014	27	16	43

Table F-27: Stage 2 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 309

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
11/01/2014	64	7	72	-	-	-	-
16/01/2014	55	6	61	-	-	-	-
19/01/2014	54	23	77	-	-	-	-
15/11/2014	53	4	57	-	-	-	-
4/11/2014	52	3	55	-	-	-	-
3/11/2014	51	5	56	19/01/2014	54	23	77
4/01/2014	46	5	50	11/10/2014	26	21	47
3/01/2014	45	16	61	23/01/2014	25	20	44
1/02/2014	44	13	57	24/02/2014	22	19	41
17/12/2014	44	4	47	4/04/2014	13	19	32
10/02/2014	43	7	50	5/04/2014	12	18	30
13/02/2014	43	6	49	9/05/2014	19	17	36
15/01/2014	42	12	54	13/01/2014	31	16	48
10/11/2014	42	2	44	23/07/2014	13	16	30
31/01/2014	41	7	48	2/02/2014	28	16	44
17/01/2014	39	5	44	3/01/2014	45	16	61
22/11/2014	38	2	40	30/03/2014	17	15	32
24/11/2014	38	1	39	13/08/2014	19	15	34
12/01/2014	38	5	43	16/08/2014	14	15	28
6/10/2014	38	2	39	31/03/2014	18	15	32
4/02/2014	37	14	51	22/08/2014	10	14	24
12/02/2014	37	5	42	2/04/2014	21	14	35
31/10/2014	37	1	38	23/02/2014	25	14	39
5/01/2014	37	3	40	4/02/2014	37	14	51
18/01/2014	36	8	45	10/04/2014	19	13	32

ND – No data

Table F-28: Stage 3 (PM_{10} 24-hr average concentration) – Assessment location 77

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
16/01/2014	**68**	6	**74**	-	-	-	-
3/01/2014	**51**	0	**51**	-	-	-	-
4/11/2014	**50**	2	**52**	-	-	-	-
17/12/2014	49	0	50	13/06/2014	21	33	**54**
26/11/2014	48	0	48	14/02/2014	19	30	49
4/01/2014	48	4	**52**	4/06/2014	11	28	39
1/11/2014	48	1	49	15/07/2014	33	25	**58**
18/12/2014	47	2	49	16/05/2014	14	24	39
15/01/2014	46	3	49	27/10/2014	35	20	**55**
17/01/2014	45	1	46	10/02/2014	37	20	**57**
13/02/2014	44	0	44	12/03/2014	21	19	41
15/11/2014	44	1	44	15/02/2014	19	19	38
1/02/2014	42	1	43	23/11/2014	36	19	**55**
6/01/2014	42	12	**54**	19/06/2014	13	19	31
31/10/2014	42	11	**53**	24/07/2014	20	18	38
8/02/2014	41	9	50	19/02/2014	15	18	33
3/11/2014	41	0	41	24/10/2014	33	18	**50**
18/01/2014	40	6	46	7/08/2014	19	17	36
21/11/2014	40	4	44	5/04/2014	15	16	31
15/12/2014	39	0	39	15/04/2014	11	16	27
12/02/2014	39	0	39	14/07/2014	26	15	41
6/10/2014	39	8	46	18/06/2014	11	15	26
1/01/2014	38	1	39	23/10/2014	33	15	48
19/01/2014	38	2	41	25/03/2014	16	15	31
2/02/2014	38	0	38	28/06/2014	15	15	30
11/01/2014	38	6	44	8/05/2014	19	15	34
24/11/2014	38	6	44	9/11/2014	35	14	49
3/10/2014	37	2	39	16/07/2014	12	14	26
10/02/2014	37	20	**57**	12/01/2014	35	14	48
2/01/2014	36	3	39	3/04/2014	26	14	40

Table F-29: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 102

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
16/01/2014	68	5	73	-	-	-	-
3/01/2014	51	0	51	-	-	-	-
4/11/2014	50	2	52	-	-	-	-
17/12/2014	49	0	49	14/02/2014	19	51	70
26/11/2014	48	0	48	13/06/2014	21	49	70
4/01/2014	48	6	53	10/02/2014	37	34	71
1/11/2014	48	2	50	15/07/2014	33	32	65
18/12/2014	47	0	47	23/11/2014	36	29	65
15/01/2014	46	3	49	9/11/2014	35	28	62
17/01/2014	45	1	46	16/05/2014	14	28	42
13/02/2014	44	0	44	4/06/2014	11	27	38
15/11/2014	44	1	45	19/06/2014	13	26	39
1/02/2014	42	1	43	23/10/2014	33	25	58
6/01/2014	42	17	59	15/04/2014	11	24	35
31/10/2014	42	11	53	13/10/2014	28	23	50
8/02/2014	41	9	50	27/10/2014	35	23	58
3/11/2014	41	0	41	12/03/2014	21	22	43
18/01/2014	40	6	46	7/08/2014	19	22	41
21/11/2014	40	6	46	19/02/2014	15	22	37
15/12/2014	39	0	39	24/10/2014	33	21	54
12/02/2014	39	0	39	25/05/2014	22	21	43
6/10/2014	39	10	49	8/05/2014	19	21	40
1/01/2014	38	1	40	28/06/2014	15	21	36
19/01/2014	38	2	41	4/10/2014	29	21	50
2/02/2014	38	0	38	15/02/2014	19	20	39
11/01/2014	38	5	42	18/03/2014	26	20	46
24/11/2014	38	12	50	16/02/2014	25	20	44
3/10/2014	37	5	42	8/12/2014	17	20	36
10/02/2014	37	34	71	5/04/2014	15	20	34
2/01/2014	36	11	47	2/07/2014	12	19	31
23/11/2014	36	29	65	24/07/2014	20	19	39
29/01/2014	36	6	41	16/07/2014	12	19	31
22/11/2014	35	1	37	18/06/2014	11	18	29
19/03/2014	35	4	40	3/04/2014	26	18	44
10/01/2014	35	1	36	14/11/2014	33	18	51
27/10/2014	35	23	58	11/10/2014	25	18	42
19/12/2014	35	0	34	6/01/2014	42	17	59
30/10/2014	35	10	45	20/11/2014	31	16	47
9/11/2014	35	28	62	2/06/2014	7	16	23
10/11/2014	35	0	35	24/09/2014	15	15	30

Table F-30: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 264

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
16/01/2014	68	4	72	-	-	-	-
3/01/2014	51	0	51	-	-	-	-
4/11/2014	50	2	52	-	-	-	-
17/12/2014	49	0	49	13/06/2014	21	50	71
26/11/2014	48	0	48	14/02/2014	19	47	66
4/01/2014	48	5	52	10/02/2014	37	33	71
1/11/2014	48	2	50	9/11/2014	35	29	63
18/12/2014	47	0	47	15/07/2014	33	29	61
15/01/2014	46	3	49	23/11/2014	36	28	64
17/01/2014	45	1	46	19/06/2014	13	25	38
13/02/2014	44	0	44	23/10/2014	33	24	57
15/11/2014	44	1	44	16/05/2014	14	24	38
1/02/2014	42	1	43	18/06/2014	11	24	35
6/01/2014	42	16	58	4/10/2014	29	23	52
31/10/2014	42	10	52	25/05/2014	22	23	44
8/02/2014	41	8	49	13/10/2014	28	22	50
3/11/2014	41	0	41	4/06/2014	11	21	32
18/01/2014	40	5	46	18/03/2014	26	21	46
21/11/2014	40	5	45	16/02/2014	25	21	45
15/12/2014	39	0	39	7/08/2014	19	21	39
12/02/2014	39	0	39	8/12/2014	17	20	37
6/10/2014	39	8	47	19/02/2014	15	19	34
1/01/2014	38	1	40	15/04/2014	11	19	30
19/01/2014	38	2	41	27/10/2014	35	19	54
2/02/2014	38	0	38	5/04/2014	15	18	33
11/01/2014	38	4	42	16/07/2014	12	18	31
24/11/2014	38	13	51	28/06/2014	15	18	33
3/10/2014	37	4	41	12/03/2014	21	18	39
10/02/2014	37	33	71	24/10/2014	33	17	50
2/01/2014	36	10	47	2/07/2014	12	17	30
23/11/2014	36	28	64	8/05/2014	19	17	36
29/01/2014	36	5	41	2/06/2014	7	17	24
22/11/2014	35	1	37	15/02/2014	19	17	36
19/03/2014	35	4	39	14/11/2014	33	16	50
10/01/2014	35	1	36	24/07/2014	20	16	36
27/10/2014	35	19	54	6/01/2014	42	16	58
19/12/2014	35	0	35	3/04/2014	26	16	42
30/10/2014	35	9	44	11/10/2014	25	16	41
9/11/2014	35	29	63	24/12/2014	21	16	37
10/11/2014	35	0	35	24/09/2014	15	15	30

ND – No data

Table F-31: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 160

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/11/2014	64	5	69	-	-	-	-
31/10/2014	58	1	59	-	-	-	-
27/10/2014	55	0	55	-	-	-	-
27/05/2014	55	-1	53	-	-	-	-
2/01/2014	53	7	60	-	-	-	-
15/11/2014	53	1	54	-	-	-	-
17/12/2014	50	0	50	15/10/2014	7	17	25
4/01/2014	48	0	48	17/04/2014	18	16	33
1/11/2014	47	1	48	12/05/2014	19	15	34
16/01/2014	47	0	47	8/12/2014	18	15	33
30/09/2014	46	-1	45	28/09/2014	23	15	38
14/11/2014	46	0	46	20/07/2014	32	13	45
6/10/2014	45	0	45	6/12/2014	11	13	24
4/11/2014	44	0	44	2/10/2014	ND	13	13
18/12/2014	42	0	42	25/05/2014	36	12	48
23/11/2014	42	1	44	24/09/2014	25	12	37
3/11/2014	42	1	42	15/05/2014	20	12	31
6/01/2014	42	0	41	15/08/2014	28	11	39
13/10/2014	41	6	48	5/04/2014	10	11	21
15/07/2014	41	10	51	26/09/2014	16	10	26
9/07/2014	41	-1	40	15/07/2014	41	10	51
3/10/2014	41	2	43	24/07/2014	22	10	31
7/10/2014	40	-1	39	3/09/2014	12	10	22

ND – No data

Table F-32: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 261

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
21/11/2014	64	5	69	-	-	-	-
31/10/2014	58	1	59	-	-	-	-
27/10/2014	55	0	55	-	-	-	-
27/05/2014	55	-1	54	-	-	-	-
2/01/2014	53	7	60	-	-	-	-
15/11/2014	53	1	54	-	-	-	-
17/12/2014	50	0	50	15/10/2014	7	16	23
4/01/2014	48	0	48	17/04/2014	18	15	33
1/11/2014	47	1	48	12/05/2014	19	15	34
16/01/2014	47	0	47	8/12/2014	18	14	31
30/09/2014	46	-1	46	20/07/2014	32	13	45

14/11/2014	46	0	46	28/09/2014	23	12	35
6/10/2014	45	0	45	25/05/2014	36	12	48
4/11/2014	44	0	44	2/10/2014	ND	11	11
18/12/2014	42	0	42	6/12/2014	11	11	22
23/11/2014	42	1	44	15/05/2014	20	11	30
3/11/2014	42	1	42	24/09/2014	25	11	35
6/01/2014	42	0	41	5/04/2014	10	10	21
13/10/2014	41	6	47	26/09/2014	16	10	26
15/07/2014	41	10	50	15/08/2014	28	10	38
9/07/2014	41	-1	40	3/09/2014	12	10	22
3/10/2014	41	2	43	15/07/2014	41	10	50
7/10/2014	40	-1	39	24/07/2014	22	9	31

ND – No data

Table F-33: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 121

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/11/2014	**55**	1	**56**	-	-	-	-
27/10/2014	**51**	1	**52**	-	-	-	-
15/11/2014	48	1	49	16/07/2014	17	18	35
13/02/2014	46	0	46	17/04/2014	19	15	34
17/12/2014	46	-1	45	28/05/2014	31	13	44
21/11/2014	44	6	50	12/05/2014	15	12	27
2/01/2014	40	6	45	26/09/2014	12	12	24
16/01/2014	40	0	40	26/06/2014	30	12	41
4/01/2014	39	0	39	5/04/2014	9	10	19
31/10/2014	39	1	39	15/07/2014	30	10	40
30/09/2014	38	-2	36	15/10/2014	3	9	12
4/02/2014	38	1	38	30/07/2014	18	9	27

ND – No data

Table F-34: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 126

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/11/2014	55	-1	54	-	-	-	-
27/10/2014	51	4	55	-	-	-	-
15/11/2014	48	1	49	20/06/2014	22	28	50
13/02/2014	46	0	46	23/05/2014	27	25	52
17/12/2014	46	2	48	3/07/2014	20	24	44
21/11/2014	44	4	49	1/09/2014	22	21	44
2/01/2014	40	5	45	19/05/2014	32	21	53
16/01/2014	40	0	40	20/05/2014	29	21	50
4/01/2014	39	3	43	2/06/2014	9	20	29
31/10/2014	39	3	42	21/06/2014	11	19	30
30/09/2014	38	2	40	4/07/2014	28	19	47
4/02/2014	38	0	38	21/04/2014	23	19	42
27/05/2014	38	14	51	22/05/2014	27	19	46
24/06/2014	37	10	47	26/07/2014	8	19	26
6/01/2014	36	4	40	14/06/2014	12	19	30
10/08/2014	36	18	54	10/08/2014	36	18	54
6/10/2014	34	1	35	30/04/2014	18	18	37
24/04/2014	34	13	47	27/06/2014	26	18	44
30/12/2014	33	2	35	9/08/2014	18	18	36
4/11/2014	33	0	33	8/07/2014	22	17	39
25/05/2014	33	15	48	16/03/2014	21	17	38
1/08/2014	33	12	45	23/06/2014	17	17	34
26/05/2014	33	4	37	9/07/2014	22	17	40

Table F-35: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 262

Ranked by Highest to Lowest Background Concentration				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment due to Project	Total cumulative 24-hr average level
1/11/2014	55	-1	54	-	-	-	-
27/10/2014	51	4	55	-	-	-	-
15/11/2014	48	1	49	20/06/2014	22	26	48
13/02/2014	46	0	46	23/05/2014	27	24	51
17/12/2014	46	2	48	3/07/2014	20	22	42
21/11/2014	44	4	48	1/09/2014	22	21	43
2/01/2014	40	5	44	19/05/2014	32	21	52
16/01/2014	40	0	40	26/07/2014	8	19	27
4/01/2014	39	3	42	2/06/2014	9	18	28
31/10/2014	39	3	42	10/08/2014	36	18	54
30/09/2014	38	1	39	20/05/2014	29	18	47
4/02/2014	38	0	38	21/04/2014	23	18	41

27/05/2014	38	13	50	21/06/2014	11	18	28
24/06/2014	37	10	47	4/07/2014	28	18	46
6/01/2014	36	4	40	30/04/2014	18	18	36
10/08/2014	36	18	**54**	14/06/2014	12	17	29
6/10/2014	34	1	35	22/05/2014	27	17	45
24/04/2014	34	12	46	27/06/2014	26	17	43
30/12/2014	33	1	34	16/03/2014	21	17	38
4/11/2014	33	0	33	24/05/2014	29	17	46
25/05/2014	33	15	48	8/07/2014	22	17	39
1/08/2014	33	12	45	9/07/2014	22	16	39

Table F-36: Stage 3 ($PM_{2.5}$ 24-hr average concentration) – Assessment location 309

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**
11/01/2014	**64**	9	**73**	-	-	-	-
16/01/2014	**55**	8	**62**	-	-	-	-
19/01/2014	**54**	8	**62**	-	-	-	-
15/11/2014	**53**	2	**55**	11/01/2014	**64**	9	**73**
4/11/2014	**52**	3	**55**	19/01/2014	**54**	8	**62**
3/11/2014	**51**	1	**52**	16/01/2014	**55**	8	**62**
4/01/2014	46	3	49	15/07/2014	32	7	39
3/01/2014	45	3	48	14/02/2014	19	7	26
1/02/2014	44	7	**51**	1/02/2014	44	7	**51**
17/12/2014	44	2	45	14/12/2014	22	7	29
10/02/2014	43	4	47	7/08/2014	15	7	22
13/02/2014	43	3	46	15/01/2014	42	7	48
15/01/2014	42	7	48	13/08/2014	19	6	26
10/11/2014	42	1	42	21/05/2014	15	6	21
31/01/2014	41	6	47	24/02/2014	22	6	28
17/01/2014	39	5	44	5/04/2014	12	6	18

ND – No data