BOWDENS SILVER

Part 2
Air Quality Assessment

State Significant Development No. 5765

Prepared by:

Ramboll Australia Pty Ltd

May 2020

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BOWDENS SILVER

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Air Quality Assessment

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COMMONLY USED ACRONYMS, UNITS AND SYMBOLS

$\mu g/m^3$	micrograms per cubic metre
˚C	degrees Celsius
µm	micrometres
AAQ	Ambient Air Quality
AQA	Air Quality and Greenhouse Gas Assessment
AWS	automatic weather station
BMP	Best management practice
BoM	Bureau of Meteorology
CO	carbon monoxide
CO_2	carbon dioxide
DEE	Department of Environment and Energy
EF	Emission factors
EIS	Environmental Impact Statement
EPL	environment protection licence
FEL	Front End Loader
g/m^2/month	grams per square metre per month
GHG	greenhouse gas
GWP	global warming potential
ha	hectare
HCN	hydrogen cyanide
HVAS	high volume air sampler
kg/VKT	kilograms per Vehicle Kilometres Travelled
km	kilometres
m/s	metres per second
m^2	square metres
m^3	cubic metres
NaCN	Sodium cyanide
NAF	non-acid forming
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measures
NGER	National Greenhouse and Energy Reporting
NO_x	nitrogen dioxide
NPI	National Pollutant Inventory
NSW EPA	New South Wales Environment Protection Authority

OEH	NSW Office of Environment and Heritage
PM	particulate matter
PM_{10}	particulate matter less than 10 μm in diameter
$PM_{2.5}$	particulate matter less than 2.5 μm in diameter
POI	places of interest
PRPs	pollution reduction programmes
REL	Reference Exposure Level
ROM	Run-Of-Mine
RWC	R.W. Corkery & Co. Pty. Limited
SEARs	Secretary's Environmental Assessment Requirements
SE&CS	site establishment and construction stage
SO_2	sulphur dioxide
t	tonnes
TAGG	Transport Authorities Greenhouse Group
TAPM	The Air Pollution Model
TEOM	Tapered Element Oscillating Microbalance
tpa	tonnes per annum
TSF	tailings storage facility
TSP	total suspended particulates
US EPA	United States Environment Protection Agency
VLAMP	Voluntary Land Acquisition and Mitigation Policy
VOCs	Volatile Organic Compounds
WRE	waste rock emplacement

EXECUTIVE SUMMARY

OVERVIEW AND ASSESSMENT APPROACH

Bowdens Silver Pty Limited (Bowdens Silver) is proposing to develop and operate an open cut mine to recover mineralised rock (ore) containing silver and small percentages of zinc and lead to depths of approximately 180m. The Mine Site is located approximately 26km east of Mudgee and 2km northeast of Lue in the Central Tablelands of NSW. The mine would be supported by a range of infrastructure including processing plant, waste rock emplacement (WRE), tailings storage facility (TSF) and ancillary components and infrastructure, collectively referred to as the Bowdens Silver Project (the Project). The Project would extract and process approximately 2 million tonnes of ore per year over an anticipated operational Project life of 15 years.

Ramboll Australia Pty Ltd has been commissioned by R.W. Corkery & Co. Pty. Limited, on behalf of the Bowdens Silver, to prepare an Air Quality and Greenhouse Gas Assessment (AQA) for the Project. The AQA forms part of an Environmental Impact Statement, prepared in accordance with the Secretary's Environmental Assessment Requirements.

The AQA presents a quantitative assessment of potential air quality impacts, using a Level 2 assessment approach in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2016).

EXISTING ENVIRONMENT

The land uses of the area surrounding the Mine Site are a mixture of cleared agricultural land and scattered forests and woodlands. The Mine Site and surrounding area is defined by undulating topography, with elevated terrain adjacent to the north and south of a dominant west-northwest to east-southeast aligned valley. An area of elevated terrain separates Lue and the Mine Site.

Analysis of meteorology for the local area is based on two meteorological monitoring stations, one installed within the Mine Site and one within Lue. These local meteorological monitoring sites are strongly influenced by local topography and display significantly different wind direction patterns.

Cumulative impacts are assessed by combining the contribution from the Project with the existing ambient air quality environment. Characterising the existing ambient air quality environment is primarily based on an air quality monitoring network surrounding the Mine Site established by Bowdens Silver.

EMISSIONS AND MODELLING ASSESSMENT

Emissions inventories were developed for four representative mining years, selected to assess the potential air quality impacts of worst-case operational conditions, for example where material movement and equipment use is highest, when extraction or wind erosion areas are largest, or where operations are located closest to receivers. Consistent with the Approved Methods, emission factors developed by the US EPA, have been applied to estimate the amount of dust produced by each activity (soil stripping, waste rock removal and emplacement, TSF earthworks and raises, ore removal and processing, wind erosion and hauling).

The modelling results show that there are no private residences where the cumulative annual average PM_{10} concentration is greater than the NSW EPA's air quality criterion of 25µg/m³ or where the cumulative 24-hour average PM_{10} is above the 50µg/m³ criterion.

There are also no private residences where the cumulative annual average $PM_{2.5}$ concentration is greater than the 8µg/m³ criterion or where the cumulative 24-hour average $PM_{2.5}$ concentration is greater than the 25µg/m³ criterion. The predicted cumulative annual average TSP concentrations and dust deposition levels indicate that no private receivers would experience exceedances of the respective impact assessment criteria.

No exceedances of the impact assessment criteria are predicted at Project-related or private residences for metal dust concentrations, respirable crystalline silica or hydrogen cyanide (HCN).

GREENHOUSE GAS (GHG) ASSESSMENT

Annual average Scope 1 emissions represent approximately 0.02% of total GHG emissions for NSW and 0.004% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2016. When compared to facility average Scope 1 emissions for coal mining and metal ore mining, the Project's emission intensity is significantly lower (11% and 46% respectively).

MANAGEMENT AND MONITORING

A Best Practice Management determination was completed and used to inform the preventative dust management measures proposed for the Project. In addition to these preventative measures, reactive or corrective measures would be employed for the operation of the Project.

The existing air quality monitoring network would be reviewed and augmented (if required) for the operation of the Project and outlined in an Air Quality Management Plan developed for the Project.

1. INTRODUCTION

Bowdens Silver is proposing to develop and operate the Project located approximately 26km east of Mudgee and approximately 2km northeast of Lue (see **Figure A1-1** and **Figure A1-2** of **Annexure 1**).

Ramboll has been commissioned by R.W. Corkery & Co. Pty. Limited (RWC), on behalf of the Bowdens Silver, to prepare an AQA for the Project.

1.1 OVERVIEW OF THE PROJECT

The Project comprises seven principal components, namely:

- i) a main open cut pit and two satellite open cut pits, collectively covering approximately 52ha;
- ii) a processing plant and related infrastructure covering approximately 22ha;
- iii) a WRE covering approximately 77ha;
- iv) a low grade ore stockpile covering approximately 14ha (9ha above WRE)[1];
- v) an oxide ore stockpile covering approximately 8ha;
- vi) a TSF covering approximately 117ha; and
- vii) the southern barrier to provide visual and acoustic protection to properties south of the Mine Site covering approximately 32ha.

The above components would be supported by a range of on-site and off-site infrastructure. The on-site infrastructure comprises haul roads, water management structures, power/water reticulation, workshops, stores, compounds and offices/amenities. The off-site infrastructure comprises a relocated section of Maloneys Road (including a new railway bridge crossing and new crossing of Lawsons Creek), a 132kV power line and a water supply pipeline for the delivery of water from the Ulan and/or Moolarben coal mines to the Mine Site.

Figure A1-3 (**Annexure 1**) displays the indicative locations of the principal Project components.

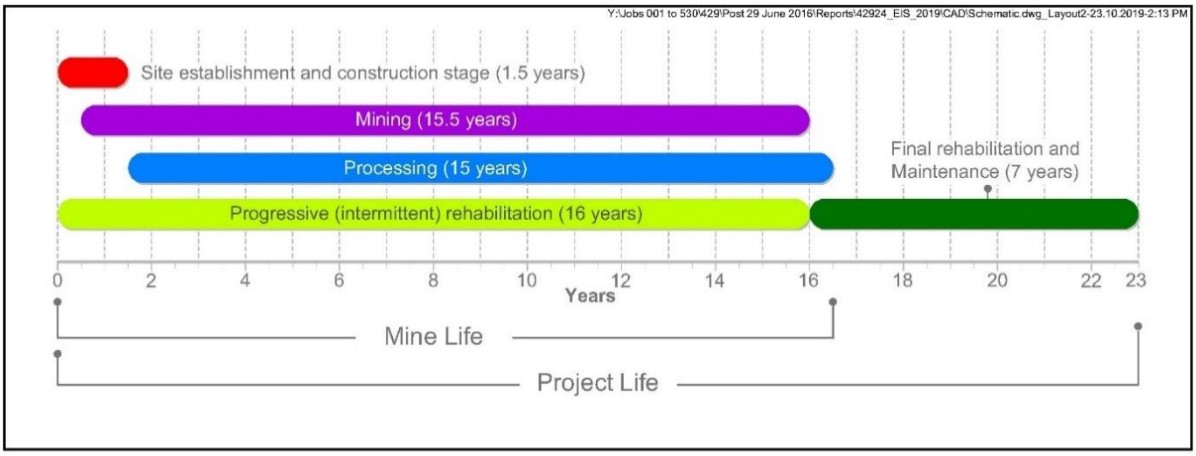
The Project would incorporate conventional open cut pits (one main and two smaller, satellite pits), from which overburden/waste rock would be removed from above and around the silver-zinc-lead ore and either used for on-site construction activities or placed in the out-of-pit WRE or the southern barrier. The mined ore would be transported by haul trucks to the on-site processing plant where it would be crushed, milled and processed to liberate the silver, zinc and lead minerals. These minerals would be collected by conventional froth flotation to produce two concentrates that would be dewatered and transported off site by truck. The residual materials from processing (tailings) would be pumped in the form of a slurry to a TSF located to the west of the main open cut pit.

The Project would require a site establishment and construction period of approximately 18 months during which the processing plant and all related infrastructure and the initial embankment of the TSF would be constructed. Once operational, Bowdens Silver anticipates the mine would produce concentrates for approximately 15 years. In total, it is proposed the mine life would be approximately 16.5 years, i.e. from the commencement of the site establishment

[1] The low grade ore stockpile would be constructed adjacent to but largely upon the northern sections of the WRE.

and construction stage to the completion of concentrate production. It is envisaged rehabilitation activities would be completed over a period of approximately 7 years, i.e. from Year 16 to Year 23. **Figure 1.1** displays the duration of each of the main components throughout the mine life and Project life.

Figure 1.1 Mine Life and Project Life



The estimated annual waste rock removal and ore production is shown in **Table 1.1**, with the mine year scenarios chosen for assessment highlighted in bold. The rationale for selection of the scenario years is discussed further in Section 6.

Table 1.1
Estimated Annual Waste Rock and Ore Production

Operational Year	Ore (t)			Waste Rock (t)		Total
	Ore	Low Grade Ore*	Oxide Ore	Non-Acid Forming[1]	Potentially-Acid Forming[2]	
SE&CS	**113 722**	**27 212**	**94 467**	**3 886 107**	**1 201 545**	**5 323 052**
1	1 744 717	260 511	293 439	927 755	2 773 578	6 000 000
2	1 908 260	228 710	237 645	2 433 037	1 192 348	6 000 000
3	**1 702 839**	**411 050**	**338 161**	**2 057 928**	**1 490 023**	**6 000 000**
4	1 955 782	575 512	96 984	1 712 068	1 659 655	6 000 000
5	2 010 709	505 487	-	1 601 690	1 882 114	6 000 000
6	2 070 259	504 965	1 463	1 109 668	1 313 645	5 000 000
7	2 048 673	435 549	144 594	909 633	1 408 766	4 947 215
8	**1 477 833**	**368 361**	**255 872**	**1 720 556**	**1 177 379**	**5 000 000**
9	**498 246**	**203 257**	**263 882**	**2 381 835**	**1 652 780**	**5 000 000**
10	1 313 773	338 695	56 406	807 046	2 484 080	5 000 000
11	1 377 297	474 018	-	200 188	2 948 498	5 000 000
12	1 679 457	568 307	-	49 706	2 702 531	5 000 000
13	1 661 617	427 979	-	19 573	1 413 339	3 522 508
14	1 501 122	498 878	-	588	1 061 239	3 061 827
15	769 451	230 549	-	-	221 093	1 221 093
Total	*23 833 753*	*6 059 040*	*1 782 913*	*19 817 378*	*26 582 611*	*78 075 696*

* Low grade ore treated in addition to ore when required SE&CS = site establishment and construction stage
1 <0.3% Sulphur content – Fresh, <0.3% Sulphur content – Oxide,
2 >0.3% Sulphur Content
Source: AMC Consultants Pty Ltd

1.2 STUDY OBJECTIVES AND REQUIREMENTS

The AQA forms part of an EIS, prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs). **Table 1.2** provides a summary of the SEARs and other government agency requirements relevant to air quality and where the requirement has been addressed in this report. Issues raised by the Lue and district community relating to air quality and where these issues have been addressed within this report are summarised in **Table 1.3**.

Table 1.2
Coverage of SEARs and Other Government Agency Requirements Relevant to Air Quality

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<table>
<tr><th colspan="2">Relevant Requirement(s)</th><th>Coverage in Report</th></tr>
<tr><td colspan="3">Secretary's Environmental Assessment Requirements</td></tr>
<tr><td colspan="2">The EIS must include an assessment of:
• the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW, having regard to EPA's requirements (see Attachment 2A and 2B); and</td><td>Section 2</td></tr>
<tr><td colspan="2">• the likely greenhouse gas impacts of the development.</td><td>Section 8 (Table 8.4)</td></tr>
<tr><td colspan="3">Requirements Nominated by Other Government Agencies</td></tr>
<tr><td>Environment Protection Authority 14/05/19</td><td>The EA should include a detailed air quality impact assessment (AQIA). The AQIA should:
• Assess the risk associated with potential discharges of fugitive and point source emissions for all stages of the Project. Assessment of risk relates to environmental harm, risk to human health and amenity.</td><td>Table 2,1 for a list of project components and pollutants assessed.</td></tr>
<tr><td></td><td>• Justify the level of assessment undertaken on the basis of risk factors, including but not limited to:
a. proposal location;
b. characteristics of the receiving environment; and
c. type and quantity of pollutants emitted.</td><td>A quantitative Level 2 air quality assessment is prepared in accordance with the Approved Methods.</td></tr>
<tr><td></td><td>• Describe the receiving environment in detail. The Project must be contextualised within the receiving environment…The description must include but need not be limited to:</td><td>Described in Section 3, 4 and 5</td></tr>
<tr><td></td><td>a. meteorology and climate - a minimum of 12 months data obtained from the meteorological station located at the Project site must be provided;</td><td>Section 4</td></tr>
<tr><td></td><td>b. topography;</td><td>Section 3</td></tr>
<tr><td></td><td>c. surrounding land-use;</td><td>Section 3</td></tr>
<tr><td></td><td>d. receivers; and</td><td>Section 3</td></tr>
<tr><td></td><td>e. ambient air quality.</td><td>Section 5</td></tr>
<tr><td></td><td>• Include a detailed description of the Project. All processes that could result in air emissions must be identified and described. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided. Include a detailed process diagram/flowchart of the Project specifying all air inputs, air outputs and air discharge points.</td><td>Detailed emission inventory described in Section 6</td></tr>
</table>

Table 1.2 (Cont'd)
Coverage of SEARs and Other Government Agency Requirements Relevant to Air Quality

Page 2 of 4

Relevant Requirement(s)		**Coverage in Report**
Requirements Nominated by Other Government Agencies (Cont'd)		
Environment Protection Authority 14/05/19 (Cont'd)	• Identification and location of all fixed and mobile sources of dust/air emissions from the development, including rehabilitation, is to be provided. The location of all emission sources should be clearly marked on a plan for key years of the mine development. The EIS must identify all pollutants of concern and estimate emissions by quantity (and size of particles), source(s) and discharge point(s). Note: emissions can be classed as either:	**Annexure 3**
	a. point (e.g. emissions from stack or vent), or	N/A
	b. fugitive (from wind erosion, leakages or spillages, associated with loading or unloading, crushing/screening, conveyors, storage facilities, plant and yard operation, vehicle movements [dust from road, exhausts, loss from load], land clearing and construction works).	Section 6
	• Include air dispersion modelling…Air dispersion modelling must be conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005).This assessment should include the following parameters: a. dust deposition; b. total suspended particles; c. PM_{10} and $PM_{2.5}$ particulate matter.	Quantitative Level 2 assessment is prepared in accordance with the Approved Methods. Modelling results presented in Section 7.
	• Demonstrate the Project's ability to comply with the relevant regulatory framework, specifically the *Protection* of *the Environment Operations Act* 1997 and the *Protection of the Environment Operations (Clean Air) Regulation 2002.*	Section 2.7, **Annexure 4** (BMP)
	• Provide an assessment of the project in terms of the priorities and targets adopted under the NSW State Plan 2010 and its implementation plan Action for Air.	Section 2.8
	• Detail air emission control techniques/practices that will be employed by the Project. a. All emission control techniques/practices must be bench marked against best practice process design and emission control. The Project must be assessed by applying the procedure outlined in in *Coal Mine Particulate Matter Control Best Practice - Site-specific determination guideline* (November 2011). b. Nominated controls must be explicitly linked to calculated emission reductions adopted in the air quality impact assessment emissions inventory, with all assumptions documented and justified	Best management practice determination completed and summarised in **Annexure 4**.
	• Detail emission control techniques/practices that will be employed by the proposal, including the development of real-time monitoring/management procedures, response (adverse weather) trigger levels and predictive meteorological monitoring/modelling for dust management.	Section 9.1.

Table 1.2 (Cont'd)
Coverage of SEARs and Other Government Agency Requirements Relevant to Air Quality

Page 3 of 4

Relevant Requirement(s)		**Coverage in Report**
Requirements Nominated by Other Government Agencies (Cont'd)		
Environment Protection Authority 14/05/19 (Cont'd)	• Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits.	Worst case emission scenarios selected based on maximum production rates and exposed areas.
	• Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment.	Detailed cumulative assessment considered (refer Section 2.6, 5.8 and 7).
Greater Western Area Health Service 24/01/2013	• Consider potential impact of dust suppression process and chemicals used on river catchment and drinking water.	No chemicals proposed for dust suppression
	• Ensure dust control on site and during processing of materials meets appropriate criteria.	Best management practice determination completed and summarised in **Annexure 4**.
Department of Education and Communities 13/02/13	Assess the potential impact of dust and dust toxicity on the school.	Lue Public School included as a sensitive receiver
Department of Education 3/08/2017	The impacts on the quality of school's rooftop rainwater supply from mine pollutants and traffic fumes during construction and operation of the mine.	Assessed in the Human Health Risk Assessment (enRiskS, 2020)
Mid-Western Regional Council 14/02/13	Assess the cumulative impact of mining projects within the catchment and their water demands including impacts of dust to drinking water.	No nearby mining projects considered for cumulative assessment
	Council requires the applicant to undertake a full assessment of the impacts on air quality from dust and particulate matter as a result of the Project including monitoring of background lead levels to ensure there are no adverse impacts on the Lue community and the surrounding area. Council requests that consideration be given to the findings in Port Augusta *[sic]* (Pirie) where unexpected high lead levels were found locally and at sites remote from the mine site *[sic]* (smelter).	A quantitative Level 2 air quality assessment is prepared in accordance with the Approved Methods. Further assessment of lead exposure is provided in the Human Health Risk Assessment (enRiskS, 2020).

Table 1.2 (Cont'd)
Coverage of SEARs and Other Government Agency Requirements Relevant to Air Quality

Page 4 of 4

Relevant Requirement(s)		**Coverage in Report**
Requirements Nominated by Other Government Agencies (Cont'd)		
Mid-Western Regional Council 14/02/13 (Cont'd)	It is requested that the Director-General's Requirements include specific reference to variable wind patterns, including seasonal wind patterns and the need for a detailed air dispersal model. Council also requires specific details on the specific dust suppression measures that will be in place during operations and also on the haulage routes.	Section 4.2 and 7 and **Annexure 4**.
TransGrid 25/03/13	Dust shall be controlled to prevent impact on the insulators.	Section 7.6

Table 1.3
Issues raised by Lue and District Community Relevant to Air Quality

Page 1 of 3

Issue(s)	**Coverage in Report**
How can we be sure dust modelling is sufficiently robust?	Modelling conducted in accordance with EPA's approved methods
Will wind monitoring be conducted at higher levels to accurately determine prevailing wind conditions?	Wind monitoring conducted at two different locations and elevations. Refer Section 4.2
Will peak wind speed, wind frequency and wind direction be considered when assessing air quality?	All measured wind conditions are considered in the modelling
Will adequate meteorological data, including wind roses, be provided in the EIS?	Yes, see Section 4.2
What wind monitoring will be conducted to the east of the mine?	Section 4.2 for monitoring locations
What is the prevailing wind direction? Will this spread dust to Lue?	Section 4.2 for wind roses
What dust monitoring will be conducted close to Lue?	Section 5.2 for overview of monitoring
Will background air quality data include concentrations of lead and other heavy metals?	Section 5.2 for overview of monitoring
Dust will be unbearable even without the lead. How much dust will be generated from the mine (including haul roads)?	Section 6 for estimates of dust produced
Dust is already visible from the road from drilling – will this get worse?	Dust will be generated from a number of sources and on occasion may be visible. Refer Section 7
How much dust will be dispersed during concentrate handling?	None, the high moisture content material would be bagged for transportation.
How much dust will be generated from the transport route?	Some minor wheel generated dust, however, the number of truck movements will be low and concentrate will be bagged.
How much dust will be generated during blasting?	Section 6 (**Table 6.1**)
Would blasting still be allowed on windy days?	Blasting will be scheduled to avoid adverse meteorological conditions

Table 1.3 (Cont'd)
Issues raised by Lue and District Community Relevant to Air Quality

Page 2 of 3

Issue(s)	Coverage in Report
To what extent will dust from the mine disperse?	See **Annexure 6** for contour plots
Is the buffer zone around the mine adequate? Why isn't it 8km like coal mines?	There are no prescribed buffer distances in NSW, for coal mines or other developments. The required separation distances between development and residences is determined through modelling, which demonstrates that the separation distances would be adequate.
What will comprise the dust from the mine and where will it go?	Section 7 and **Annexure 6** for contour plots
Is it likely that dust and contaminants will become re-suspended and spread beyond the current buffer?	Dust that falls onto hard surfaces can become re-suspended by high winds or vehicle movements, however there would be minimal risk of this occurring for the Project.
What are the expected quantities of dust that will be deposited at Lue and other residences?	Section 7 and **Annexure 6** for contour plots
What mitigation measures will be implemented to reduce dust generation?	Section 9.1 for management measures
Will Bowdens Silver use a water cart or seal roads used by mine-related traffic?	Yes, see Section 9.1 for management measures
Will Bowdens Silver use dust blankets during blasts?	No, see Section 9.1 for management measures
Will Bowdens Silver use dust suppression chemicals on haul roads?	No, see Section 9.1 for management measures
Baseline levels of metals and minerals in soils with reference to guidelines including the National Environment Protection Measure (NEPM) soil criteria and the ANZG water and sediment criteria.	Addressed within the Human Health Risk Assessment (enRiskS, 2020)
Potential impacts from dust and any associated metals on drinking water supplies, livestock and aquatic environments.	Addressed within the Human Health Risk Assessment (enRiskS, 2020)
Modelling of dust dispersion from the mine and processing activities.	Refer Sections 4.5, 6 and 7
Potential impacts from dust and any associated metals on human health.	Addressed within the Human Health Risk Assessment (enRiskS, 2020)
Buffer zones with reference to dust dispersion.	Section 7 and **Annexure 6** for contour plots
PM2.5 and PM10 dust monitoring systems surrounding the mine.	Section 5.2 and 9.1 for monitoring
Use of real-time air quality monitoring for on-going management.	Section 5.2 and 9.1 for monitoring
Dust monitoring results and approach to air modelling, measurement and analysis.	Section 2, 7 and **Annexure 6** for contour plots
Concentrations of lead in dust.	Section 6.4 and 7.7

Table 1.3 (Cont'd)
Issues raised by Lue and District Community Relevant to Air Quality

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Issue(s)	**Coverage in Report**
How will blast scheduling occur to avoid adverse weather conditions?	Mine operators would review the forecast for upcoming blasts to schedule a suitable time. Blast will be deferred if the unsuitable conditions exist.
What is in the dust?	Section 6.4 and 7.7
What metals are in the dust?	Section 6.4 and 7.7
How far will the dust travel from the Mine?	**Annexure 6** for contour plots
What distance have you modelled air quality from the Mine Site?	Modelling predictions made across an area of 20km x 20km
Dust issues east of mine: Modelling doesn't fit with local knowledge in our case.	Modelling is based on locally measured meteorology.

2. ASSESSMENT APPROACH

2.1 OVERVIEW

The AQA presents a quantitative assessment of potential air quality impacts, using a Level 2 assessment approach in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales ("the Approved Methods") (NSW EPA, 2016).

An overview of the approach to the assessment is as follows.

- The Project is reviewed for potential emission sources.
- Emissions are estimated for all sources using emission factors and Project activity data.
- Dispersion modelling using a regulatory dispersion model is used to predict ground-level concentrations for key pollutants from the Project, at surrounding sensitive receivers (both private and Project-related residences).
- Cumulative impacts are assessed, taking into account the combined effect of existing baseline air quality and other local sources of emissions.
- Estimates of greenhouse gas emissions are presented and benchmarked against Greenhouse Gas accounts for NSW and Australia.

2.2 PROJECT COMPONENTS AND POLLUTANTS CONSIDERED FOR THE ASSESSMENT

Air quality impacts are modelled in this AQA for the following key Project components.

- Site establishment and construction.
- TSF construction and raises.
- Open cut mining.
- Ore handling and processing.
- Product transportation.

A summary of the potential emissions to air for each Project component are identified and summarised in **Table 2.1**.

Table 2.1
Emissions Sources and Air Quality Indicators for Assessment

Project Component	Emission Source	Air Quality Indicator	Included in this Assessment?
Site establishment and construction	Fugitive dust from material handling and vehicle movements	TSP, PM_{10}, $PM_{2.5}$ and dust deposition	Emissions assessed and modelled.
	Diesel combustion	PM_{10} and $PM_{2.5}$	Emissions assessed and modelled.
		Oxides of nitrogen (NO_x)	Gaseous combustion emissions from mining equipment would not result in significant off-site concentrations and therefore have not been assessed and modelled*.
		Sulphur dioxide (SO_2)	
		Carbon monoxide (CO)	
		Volatile organic compounds (VOCs)	
Open cut mining and TSF raises	Fugitive dust from blasting, material handling and vehicle movements	TSP, PM_{10}, $PM_{2.5}$ and dust deposition	Emissions assessed and modelled.
	Diesel combustion	PM_{10} and $PM_{2.5}$	Emissions assessed and modelled.
		Oxides of nitrogen (NO_x)	Gaseous combustion emissions from mining equipment would not result in significant off-site concentrations and therefore have not been assessed and modelled*.
		Sulphur dioxide (SO_2)	
		Carbon monoxide (CO)	
		Volatile organic compounds (VOCs)	
	Blast fume	Oxides of nitrogen (NO_x)	Emissions would be managed in accordance with the blast management plan developed for the Project. No quantitative assessment of blast fume is presented in this report.
Ore handling and processing	Fugitive dust from material handling and processing	TSP, PM_{10}, $PM_{2.5}$ and dust deposition	Emissions assessed and modelled.
	Diesel combustion	PM_{10} and $PM_{2.5}$	Emissions assessed and modelled.
		Oxides of nitrogen (NO_x)	Gaseous combustion emissions from plant and equipment would not result in significant off-site concentrations and therefore have not been assessed and modelled*.
		Sulphur dioxide (SO_2)	
		Carbon monoxide (CO)	
		Volatile organic compounds (VOCs)	
	Fugitive emissions (volatilisation) from processing tanks and TSF surface	Cyanide as hydrogen cyanide (HCN)	Emissions assessed and modelled.
Product transport	Fugitive dust from vehicle movements	TSP, PM_{10}, $PM_{2.5}$ and dust deposition	Emissions assessed and modelled for site access road only.
	Diesel combustion	PM_{10} and $PM_{2.5}$	Gaseous combustion emissions from product transport would not result in significant off-site concentrations and therefore have not been assessed and modelled*.
		Oxides of nitrogen (NO_x)	
		Sulphur dioxide (SO_2)	
		Carbon monoxide (CO)	
		Volatile organic compounds (VOCs)	
All components	All major sources	Greenhouse gases (GHG)	Emissions quantified.

* See Section 2.3.4.

2.3 ASSESSMENT CRITERIA

2.3.1 Particulate Matter (PM)

When first regulated, airborne PM was assessed based on concentrations of “total suspended particulate matter” (TSP). In practice, this typically referred to PM smaller than 30 to 50 micrometres (µm) in diameter. As air sampling technology has improved and the importance of particle size and chemical composition has become more apparent, ambient air quality standards have been revised to focus on the smaller particle sizes, which are thought to be most dangerous to human health. Contemporary air quality assessment typically focuses on "fine" and "coarse" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$ [2].

Air quality criteria for PM in Australia are given for particle size metrics including TSP, PM_{10} and $PM_{2.5}$. The 2016 update to the ‘Approved Methods’, gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) National reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

The Approved Methods specifies that the impact assessment criteria for ‘criteria pollutants[3]’ are applied at the nearest existing or likely future off-site sensitive receiver and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts must be considered (consideration of existing ambient background concentration is required).

For the purpose of this report, predicted ground level concentrations are assessed against the NSW EPA’s impact assessment criteria presented in **Table 2.2**.

Table 2.2
Impact Assessment Criteria for PM

PM Metric	Averaging period	Concentration (µg/m³)
TSP	Annual	90
PM_{10}	24 hours	50
	Annual	25
$PM_{2.5}$	24 hours	25
	Annual	8

The Approved Methods also prescribes nuisance-based goals for dust deposition, which relate to amenity type impacts such as soiling of exposed surfaces. The NSW EPA impact assessment criteria for dust deposition are summarised in **Table 2.3**, illustrating the maximum increase and total dust deposition rates which would be acceptable so that dust nuisance can be avoided.

[2] Particulate matter with an aerodynamic diameter of less than 10 µm and 2.5 µm respectively
[3] ‘Criteria pollutants’ is used to describe air pollutants that are commonly regulated and typically used as indicators for air quality. In the Approved Methods, the criteria pollutants relevant to this assessment are TSP, PM_{10}, $PM_{2.5}$, deposited dust, and lead. The criterion for lead is presented in Section 2.3.2.

Table 2.3
Impact Assessment Criteria for Dust Deposition

Metric	Maximum Increase in Dust Deposition	Maximum Total Dust Deposition Level
Deposited dust (assessed as insoluble solids)	2 g/m^2/month	4 g/m^2/month

2.3.1.1 Voluntary Land Acquisition and Mitigation Policy

The NSW Government's Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (the Voluntary Land Acquisition and Mitigation Policy (VLAMP))[4] describes the voluntary mitigation and land acquisition policy to address dust (and noise) impacts, and outlines mitigation and acquisition criteria for PM. Essentially, the VLAMP formalises the acquisition criteria that have previously been outlined in conditions of approval for major mining and extractive industries.

Under the VLAMP, if an applicant cannot comply with the relevant impact assessment criteria, or if the mitigation or acquisition criteria may be exceeded, the applicant should consider a negotiated agreement with the affected landowner or acquire the land. In doing so, the land is then no longer subject to the impact assessment, mitigation or acquisition criteria, although provisions do apply to "use of the acquired land", primarily related to informing and protecting existing or prospective tenants.

Voluntary mitigation rights apply when a development contributes to exceedances of the criteria set out in **Table 2.4** and voluntary acquisition rights apply when a development contributes to exceedances of the criteria set out in **Table 2.5**. The criteria for voluntary mitigation and acquisition are the same, with the exception of the number of allowable days above short-term impact assessment criteria for PM_{10}, which is zero for mitigation and five for acquisition.

Table 2.4
VLAMP Mitigation Criteria

Metric	Averaging period	Mitigation Criterion		Impact Type
$PM_{2.5}$	24 hours	25 µg/m^3 *		Human Health
	Annual	8 µg/m^3 **		Human Health
PM_{10}	24 hours	50 µg/m^3 *		Human Health
	Annual	25 µg/m^3 **		Human Health
TSP	Annual	90 µg/m^3 **		Amenity
Deposited Dust	Annual	2 g/m^2/month *	4 g/m^2/month **	Amenity

Notes:
*Incremental increase due to development alone, with zero allowable exceedances over the life of the development.
**Cumulative impact due to the development plus background from other sources.

[4] https://www.planning.nsw.gov.au/-/media/Files/DPE/Reports/Att-E-Revised-VLAMPaccessible-version.pdf?la=en

Table 2.5
VLAMP Acquisition Criteria

Metric	Averaging period	Acquisition Criterion		Impact Type
$PM_{2.5}$	24 hours	25 µg/m³ *		Human Health
	Annual	8 µg/m³ **		Human Health
PM_{10}	24 hours	50 µg/m³ *		Human Health
	Annual	25 µg/m³ **		Human Health
TSP	Annual	90 µg/m³ **		Amenity
Deposited Dust	Annual	2 g/m²/month *	4 g/m²/month **	Amenity

Notes:
*Incremental increase due to development alone, with up to 5 allowable exceedances over the life of the development.
**Cumulative impact due to the development plus background from other sources.

Voluntary mitigation rights apply to any residence on privately-owned land or any workplace on privately-owned land where the consequences of the exceedance, in the opinion of the consent authority, are unreasonably deleterious to worker health or the carrying out of business.

Voluntary acquisition rights also apply when an exceedance occurs across 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.

2.3.2 Metals

Impact assessment criteria for a range of principal and individual toxic air pollutants, including metals, are specified by the NSW EPA in their Approved Methods. Elemental assays for the Bowdens deposit have been provided by Bowdens Silver, including metal composition analysis for 12 key metals, expressed as % or ppm, for both ore and waste rock. The impact assessment criteria for the elements included in the analysis are provided in **Table 2.6.**

Lead is classified as a ‘criteria pollutant’ with the criteria applied at the nearest existing or likely future off-site sensitive receiver and compared against the annual average cumulative concentration (sum of existing ambient background concentration and predicted increase). For the remaining metals, the impact assessment criteria are specified in accordance with toxic air pollutants and must be applied at and beyond the boundary of the emitting source, with the incremental impact (i.e. predicted impacts due to the pollutant source alone) for each pollutant reported as the 99.9^{th} percentile concentration for an averaging period of 1 hour.

Table 2.6
Impact Assessment Criteria for Metals

Substance	Averaging period	Concentration (µg/m³)
Arsenic and compounds	1-hour (99.9th percentile)	0.09
Cadmium and compounds	1-hour (99.9th percentile)	0.018
Copper	1-hour (99.9th percentile)	18
Chromium III and compounds	1-hour (99.9th percentile)	9.0
Chromium VI and compounds	1-hour (99.9th percentile)	0.09
Lead	Annual	0.5*
Manganese and compounds	1-hour (99.9th percentile)	18
Mercury organic	1-hour (99.9th percentile)	0.18
Mercury inorganic	1-hour (99.9th percentile)	1.8
Nickel and compounds	1-hour (99.9th percentile)	0.18
Silver	1-hour (99.9th percentile)	1.8
Zinc (as zinc oxide)	1-hour (99.9th percentile)	0.09
* Cumulative concentration including background and predicted increase.		

2.3.3 Respirable Crystalline Silica

Silica (SiO_2 - silica dioxide) is a naturally occurring mineral which can exist in crystalline or amorphous forms depending on the structural arrangement of the oxygen and silicon atoms. The most common form of crystalline silica is quartz, which is a basic component of sand, stone, granite and many other rocks.

Only the crystalline forms are known to increase scar tissue in the lungs and only the respirable particles (those which are capable of reaching the gas exchange region of the lungs) are considered in determining health effects – i.e. respirable crystalline silica. Depending on the level of exposure, inhalation of respirable crystalline silica particles is known to cause silicosis, an inflammation and scarring in the lungs reducing the capacity to absorb oxygen from air. The International Agency for Research on Cancer has classified crystalline silica as a human carcinogen[5].

Australia has industrial exposure criteria, limiting the allowable concentration of crystalline silica in the workplace environment. However, there are no National or NSW limits for crystalline silica in the ambient air. Several jurisdictions in the US have ambient air quality standards limiting the presence of crystalline silica in ambient air. In 2005, the California Office of Environmental Health Hazard Assessment adopted a chronic Reference Exposure Level (REL) for respirable crystalline silica of 3µg/m^3 (measured as PM_4). A chronic REL is defined as “an airborne level of a chemical at or below which no adverse health effects are anticipated in individuals indefinitely exposed to that level” and is assessed as an annual average.

[5] US Department of Health and Human Services, National Toxicology Program, 12th Report on Carcinogens http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/Silica.pdf

EPA Victoria adopted the assessment criterion of 3 µg/m^3 for mining and extractive industries (EPA Victoria, 2007) based on California REL. Similar to the California REL, the criterion is for chronic exposure and is therefore expressed as an annual average, however, in Victoria it is applied to the $PM_{2.5}$ size fraction.

The EPA Victoria criterion is adopted for this assessment and is considered applicable for evaluating cumulative impacts (Project contribution plus background).

2.3.4 Gaseous Pollutants

Sodium cyanide (NaCN) is proposed to be used as a reagent in the processing plant (as a sphalerite and pyrite depressant), which may lead to fugitive emissions of hydrogen cyanide (HCN) through volatilisation from storage tanks and the TSF. HCN is considered a principal toxic air pollutant and the impact assessment criterion specified by the NSW EPA in the Approved Methods is listed in **Table 2.7**.

Table 2.7
Air Quality Criterion for HCN

Substance	Averaging Period	Concentration (µg/m³)
HCN	1-hour (99.9th percentile)	200

2.4 EMISSIONS FROM THE COMBUSTION OF DIESEL FUEL

The combustion of diesel in mining equipment results in combustion-related emissions, including $PM_{2.5}$, oxides of nitrogen (NO_x), sulphur dioxide (SO_2) carbon monoxide (CO), carbon dioxide (CO_2) and volatile organic compounds (VOCs). Except for PM, combustion emissions have not been quantitatively assessed, as gaseous combustion emissions from mining equipment are not expected to result in significant off-site concentrations and are unlikely to compromise ambient air quality goals.

For example, in an air quality assessment for the Mount Owen Coal mine in the Hunter Valley, the predicted concentrations of CO at the closest receiver were 0.003% of the impact assessment criteria, while the predicted concentrations of SO_2 at the closest receiver were 0.25% of the impact assessment criteria. While the predicted concentrations of NO_2 for the Mount Owen Coal mine were higher (65% of the impact assessment criteria at the worst affected receiver), the background concentrations of NO_2 in the vicinity of the Bowdens Project are expected to very low and therefore unlikely to compromise ambient air quality goals. It is noted that diesel consumption for the Bowdens Project is approximately 20% of diesel consumption for the Mount Owen Coal mine and therefore off-site concentrations would be a fraction of what was predicted.

The US EPA AP-42 emission factors developed for mining do not separate PM emissions from mechanical processes (i.e. crustal material) and diesel exhaust (combustion), and are therefore assumed to include the diesel component of PM. However, the emissions controls (i.e. watering) are often only relevant to the crustal fraction of total PM, for example the watering of haul roads does not control the diesel component of the emissions (US EPA, 1998a). Adjustments to the emission inventories have therefore been made to account for this and are discussed further in Section 6.3. Greenhouse gas emissions from diesel combustion are considered in Section 8.

2.5 BLAST FUME

Blast fume is the result of a less than optimal chemical reaction of ammonium nitrate explosives during the open cut blasting process, resulting in the release of nitric oxide and NO_2. Fume generation can be the result of water and explosives mixing in the hole (geological and/or meteorological influences), the quality of explosive product supplied, and contamination of the explosive product during loading and/or on bench. Potential adverse impacts from blast fume can be effectively managed through good practice blast management.

Bowdens Silver should develop a Blast Management Plan for the Project, which would include blast fume prevention measures, developed in accordance with the Code of Good Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting (Australian Explosives Industry and Safety Group Inc., 2011). The blast management plan should outline the monitoring requirements for blast fume, including identification and rating of visual blast fume, as per Appendices 2 and 3 of the Code of Practice.

Given that it has been demonstrated within the industry that adoption of measures outlined in the Code of Practice effectively controls blast fume, no additional assessment of blast fume is presented in this report. It is noted that PM emissions from blasting are included in the emission inventories presented in Section 6.

2.6 CUMULATIVE IMPACTS

Cumulative impacts are assessed by combining the contribution from the Project with the existing ambient air quality environment, determined using baseline monitoring data for the region (described in Section 5).

2.7 PROTECTION OF THE ENVIRONMENT OPERATIONS LEGISLATION

The statutory framework for managing air emissions in NSW is provided in the *Protection of the Environment Operations Act*[6] *1997* (POEO Act). The primary regulations for air quality made under the POEO Act are:

- Protection of the Environment Operations (Clean Air) Regulation 2010[7]; and
- Protection of the Environment Operations (General) Regulation 2009[8].

As a scheduled activity under Schedule 1 of the POEO Act, the Project would operate under an environment protection licence (EPL) and be required to comply with the associated conditions including emission limits, monitoring, pollution reduction programmes (PRPs) and odour minimisation and control. Best management practice (BMP) is also a guiding principle in the POEO Act and requires that all necessary practicable means are used to prevent or minimise air pollution in NSW. A BMP determination has been made for the Project and is outlined in **Annexure 4**, having regard to all reasonable and feasible avoidance and mitigation measures.

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[6] http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N
[7] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N
[8] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+211+2009+cd+0+N

2.8 NSW STATE PLAN AND ACTION FOR AIR

In March 2010, the NSW Government released the NSW State Plan (DPC, 2010) outlining a number of priorities and targets for NSW, identifying improvements in air quality and progress on reducing GHG emissions as priorities. The NSW State Plan sets goals based largely on community consultation and includes a target to meet the National air quality goals as identified in the Air NEPM.

Mining is not identified specifically in the list of areas to be targeted. Industrial emissions are mentioned in the context of “better managing emissions of ozone-forming substances from new and existing industrial sources”, rather than reducing particulate emissions. Ozone-forming substances, such as oxides of nitrogen, are not quantitatively addressed is this report, however ozone is predominantly an urban air quality issue and not a pollutant of concern in rural regions such as the Central Tablelands.

First published in 1998, the Action for Air is the NSW Government’s 25-year plan for managing air quality in Sydney, the Illawarra and Lower Hunter. This was updated in 2009 (DECCW, 2009) and is a key strategy for implementing the NSW State Plan’s cleaner air goals. The plan is not directly applicable to rural areas of NSW, such as the Central Tablelands. Notwithstanding, the AQA seeks to implement best practice emission controls to ensure the Project would comply with the Ambient Air-NEPM goals.

3. LOCAL SETTING AND ASSESSMENT LOCATIONS

The Mine Site is located approximately 26km east of Mudgee and 2km northeast of Lue in the Central Tablelands of NSW. The land use of the area is a mixture of cleared agricultural land and scattered forests and woodlands.

The Mine Site and surrounding region is defined by undulating topography, with elevated terrain adjacent to the north and south of a dominant west-northwest to east-southeast aligned valley. An area of elevated terrain separates the Lue and the Mine Site. A three-dimensional representation of the topography of the region surrounding the Mine Site is presented in **Figure 3.1**.

In addition to Lue, the local area contains a number of residential properties situated at varying distances from the Mine Site. The general locations of privately-owned and Project-related residences assessed in this report are also shown on **Figure 3.1**. Five ‘places of interest’ (POI), being non-residential receivers, have also been assessed. These include the following.

POI 1. Lue/Havilah Rural Fire Brigade.

POI 2. Lue Pottery

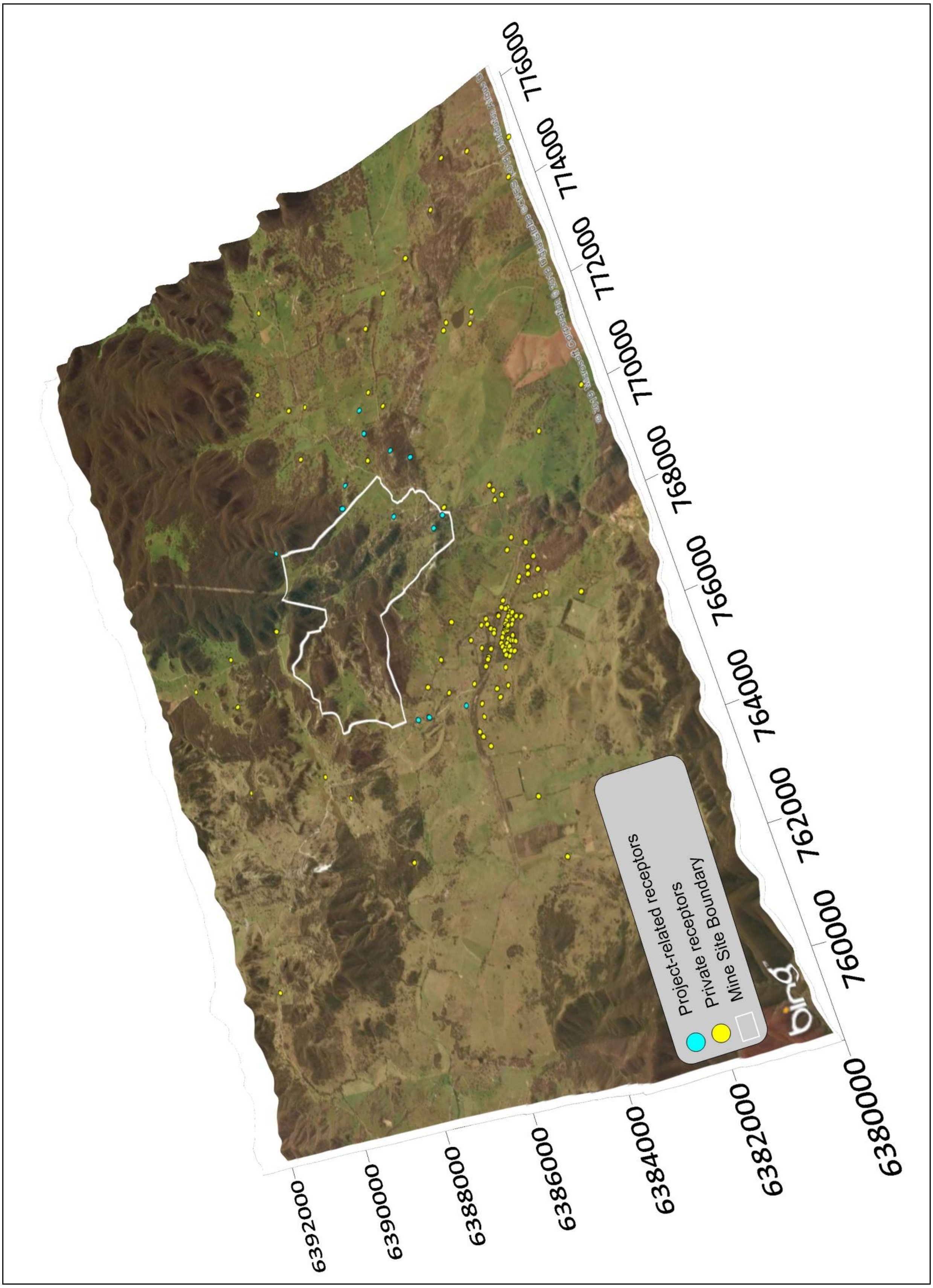
POI 3. Lue Public School

POI 4. Lue Hall

POI 5. Lue Railway Station Buildings

A detailed land ownership map showing all privately-owned and project-related residences is provided in **Figure A1-4** of **Annexure 1**. Residences within Lue have been labelled with a prefix ‘L’, for example L21, whilst rural residences have been labelled with a prefix ‘R’, for example R21.

Figure 3.1 3-Dimensional Topography surrounding the Mine Site



4. OVERVIEW OF LOCAL AND REGIONAL METEOROLOGY

4.1 INTRODUCTION AND DATA SOURCES

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

Analysis of meteorology for the local area is presented based on two meteorological monitoring stations which were installed within the Mine Site in 2012 (Lue Met01) and near Lue in 2013 (Lue Met02) (see **Figure A1.6**).

Analysis of meteorology for the region is supported by the closest Bureau of Meteorology (BoM) automatic weather station (AWS) monitoring sites, as follows.

- Mudgee Airport AWS – located approximately 25km northwest of the Mine Site.
- Nullo Mountain AWS – located approximately 35km east of the Mine Site.
- Merriwa (Roscommon) AWS – located approximately 60km northeast of the Mine Site.
- Bathurst Airport AWS – located approximately 80km southwest of the Mine Site.

4.2 PREVAILING WINDS

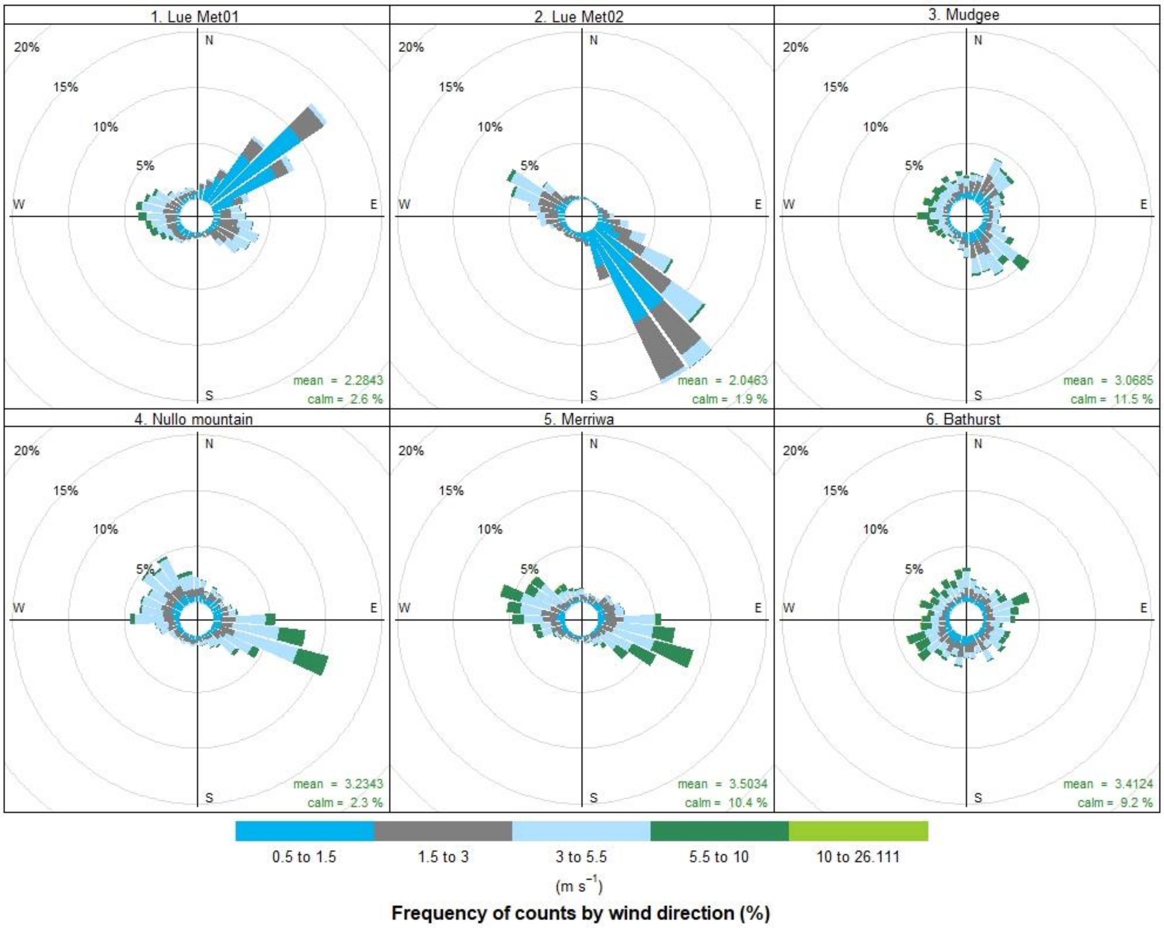
Five years of hourly data from Lue Met01 and Lue Met02[9] were reviewed. The annual wind roses for 2013 to 2017 are presented in **Figure A2-1** and **Figure A2-2** of **Annexure 2**. The analysis shows that both sites display consistency in wind direction, average wind speed and percentage occurrence of calm winds (<= 0.5 m/s), across the five-year period. Based on this analysis, the most recent complete calendar year, at the commencement of modelling (2017), was selected as a representative year for assessment.

The measured wind for 2017 at Lue Met01, Lue Met02 and the regional BoM sites is presented as an annual wind rose in **Figure 4.1**.

Figure 4.1 shows significant regional variation in wind patterns and that the local observation sites, Lue Met01 and Lue Met02, are strongly influenced by local topography and display significantly different wind direction patterns.

[9] It is noted that Lue Met02 was relocated in July 2014 from a position approximately 350m to the north of the original location. The original location was surrounded by denser vegetation and the current location is considered more favourable for the recording of wind conditions in the local area. When the wind rose for 2013 is compared with the following three years, a slight increase in recorded wind speed can be observed following the relocation of the station.

Figure 4.1 Regional Annual Wind Roses for 2017



Lue Met01 exhibits a dominant northeasterly flow whereas Lue Met02 records a defined northwest-southeast aligned air flow. The average recorded wind speed for 2017 was similar at both sites (2.3m/s at Lue Met01 and 2.1m/s at Lue Met02), while the frequency of calm conditions (wind speeds less than 0.5m/s) was slightly higher at Lue Met01 (2.6%) compared to 1.9% at Lue Met02.

Seasonal and diurnal wind roses for 2017 are presented within **Annexure 2**. Seasonal variation in wind speed and direction is evident in the recorded data at both local meteorological stations.

At Lue Met01, the northeasterly flow occurs most frequently during the colder months and is suggestive of drainage flow from the elevated terrain to the east. The western quadrant flow is reasonably consistent across all seasons. Wind speeds are slightly lower during the autumn and winter periods than the remainder of the year. At Lue Met02, the northwest-southeast alignment of the flow is consistent across all seasons. Seasonal variation at Lue Met02 is notable in recorded wind speeds, with the autumn and winter months experiencing lower wind speeds than spring and summer.

Diurnal variation is also notable in both meteorological monitoring datasets. At both sites, the night-time hour wind speeds are lower than daylight hours. Further, the direction of dominant flow during the daylight hours flips, with Lue Met01 showing a change from dominant westerly quadrant flow to dominant northeasterly flow at night and Lue Met02 changing from dominant northwesterly flow to dominant southeasterly flow at night-time. This change in wind direction is suggestive of nocturnal cold air drainage flow from the elevated terrain of the Great Dividing Range to the east. The differences in flow direction between the two monitoring sites illustrates the influence of the local topographical features.

4.3 AMBIENT TEMPERATURE

The inter-annual variation in temperature for Lue Met01 and Lue Met02 is presented as a box and whisker plot in **Figure 4.2** and **Figure 4.3**. The plots show that the monthly minimum, maximum, mean and upper and lower quartile temperatures for the modelled year (2017) are consistent and therefore representative when compared to the most recent five-year period of measurements.

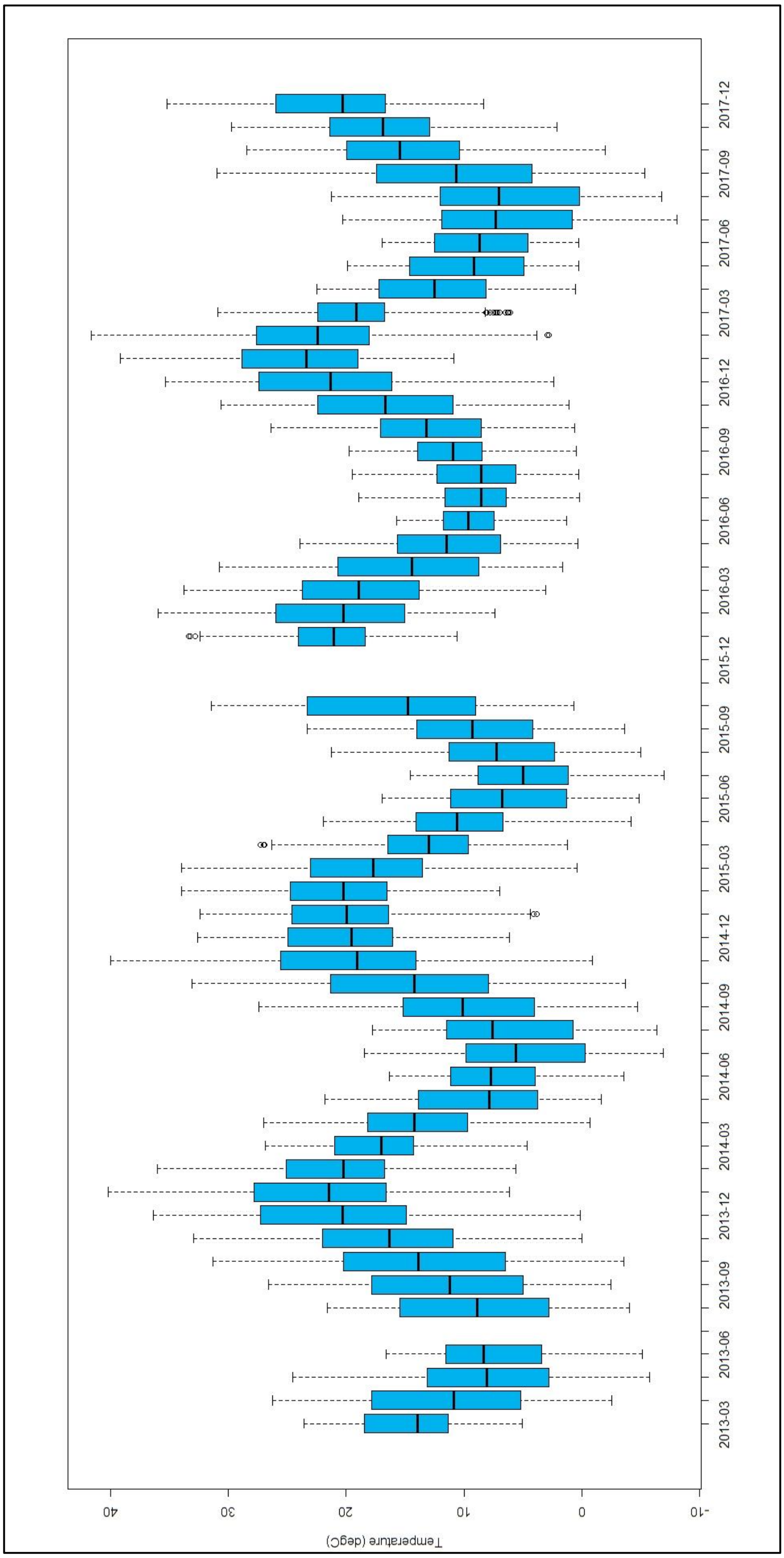
4.4 RAINFALL

Based on historical data recorded at Mudgee Airport, rainfall for the region is considered moderate. Annual rainfall ranges from approximately 350mm to 1,150mm and on average records approximately 675mm. Rainfall is relatively consistent throughout the year, with slightly higher rainfall experienced during the summer months than the remainder of the year. On average 95 rain days occur per year, with 5 to 10 rain days typically experienced each month. Analysis of the on-site data for the five-year period 2013 to 2017 shows that the measured annual rainfall is generally lower than the long-term average for Mudgee. The annual rainfall for the modelling period 2017 is 450mm for Lue Met01 and 483mm for Lue Met02.

To provide a conservative (upper bound) estimate of the PM concentrations, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken for this AQA. Sensitivity analysis completed for the Upper Hunter Particle Model (Kellaghan et al, 2014) indicates that the inclusion of wet deposition may reduce PM_{10} concentrations by 20% to 50% during a period of rainfall, depending on distance from source to receiver. Furthermore, the emission inventories developed for this AQA have not applied a natural mitigation factor[10] for rainfall and are therefore more conservative (higher) than if rainfall was incorporated.

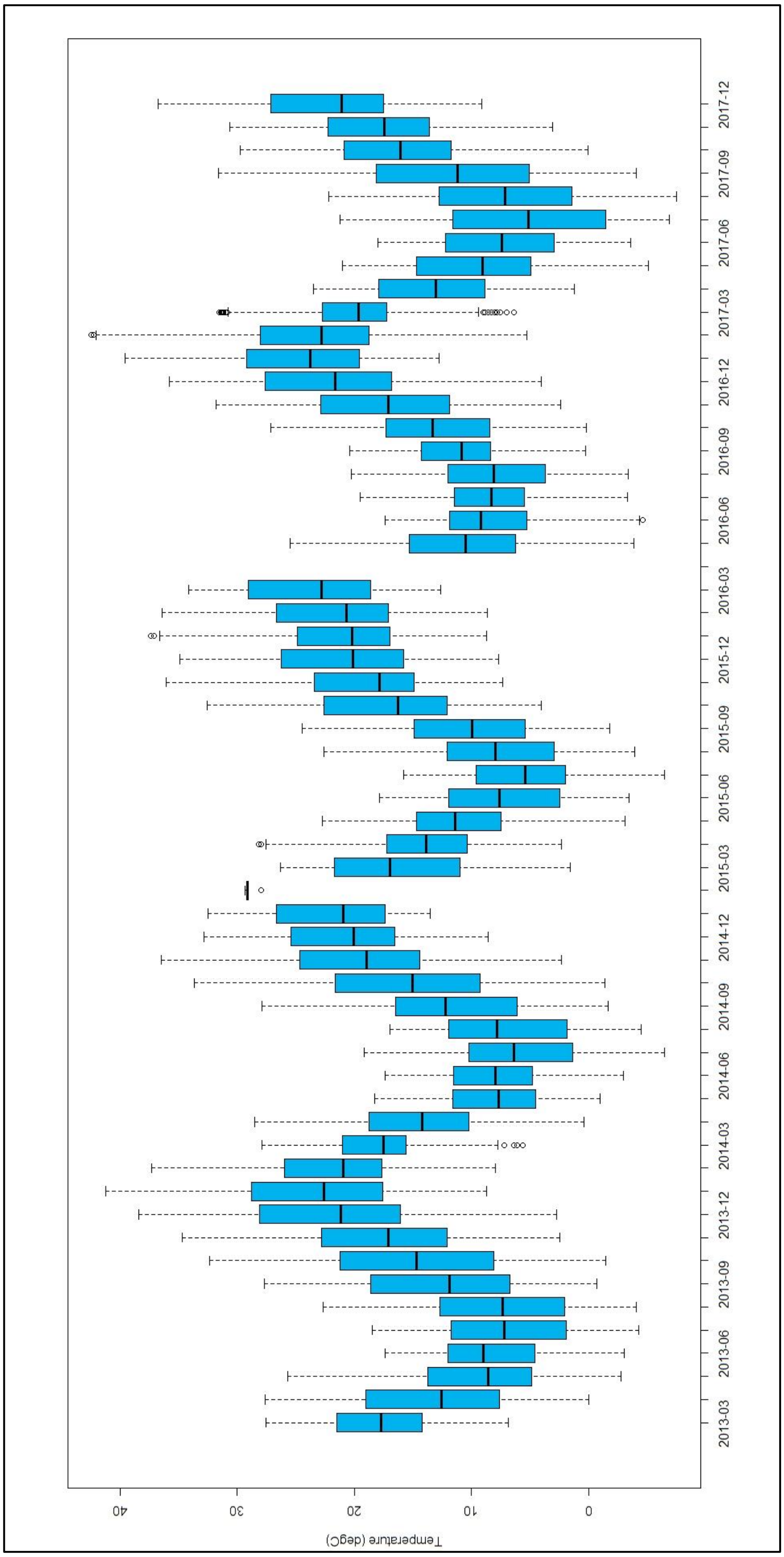
[10] The US EPA AP-42 emission factor documentation for unsealed roads (Chapter 13.2.2) describes a ‘natural mitigation’ factor, which can be applied for rainfall and other precipitation, based on the assumption that annual emissions are inversely proportional to the number of days with measurable rain, defined as the number of days with greater than 0.25 mm recorded.

Figure 4.2 Box and Whisker Plot of Monthly Temperature for Lue Met01 – 2013-2017



Boxes represent the monthly lower to upper quartile (25th, median and 75th percentile) temperature range with the monthly maximum and minimum values shown by the dotted lines.

Figure 4.3 Box and Whisker Plot of Monthly Temperature for Lue Met01 – 2013-2017



Boxes represent the monthly lower to upper quartile (25th, median and 75th percentile) temperature range with the monthly maximum and minimum values shown by the dotted lines.

4.5 METEOROLOGICAL MODELLING

4.5.1 Approach to Meteorological Modelling

In the absence of upper air measurements, CALMET can be run using prognostic upper air data (as a three-dimensional '3D.dat' file), which is used to derive an initial wind field (known as the Step 1 wind field in the CALMET model). The model then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the "hybrid" approach (TRC, 2011) and is adopted for this assessment. The Air Pollution Model (TAPM) was used to generate gridded upper air data for each hour of the model run period, for input into CALMET.

TAPM and CALMET model settings are described in **Annexure 3**, selected in accordance with recommendations in the Approved Methods and in TRC (2011). Surface observations are included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind field. Surface observations are incorporated into both TAPM and CALMET modelling, with the sites included listed **Annexure 3**.

The observations at Lue Met01 and Lue Met02 provide the dominant influence on the derived wind field and the resultant dispersion meteorology within the model. The distance at which the observation influences the model (radius of influence) is determined by the CALMET setting 'RMAX'. The relative importance of the observation in the model (relative weighting of the Step 1 wind field and the observation) is determined by the CALMET setting 'R1'.

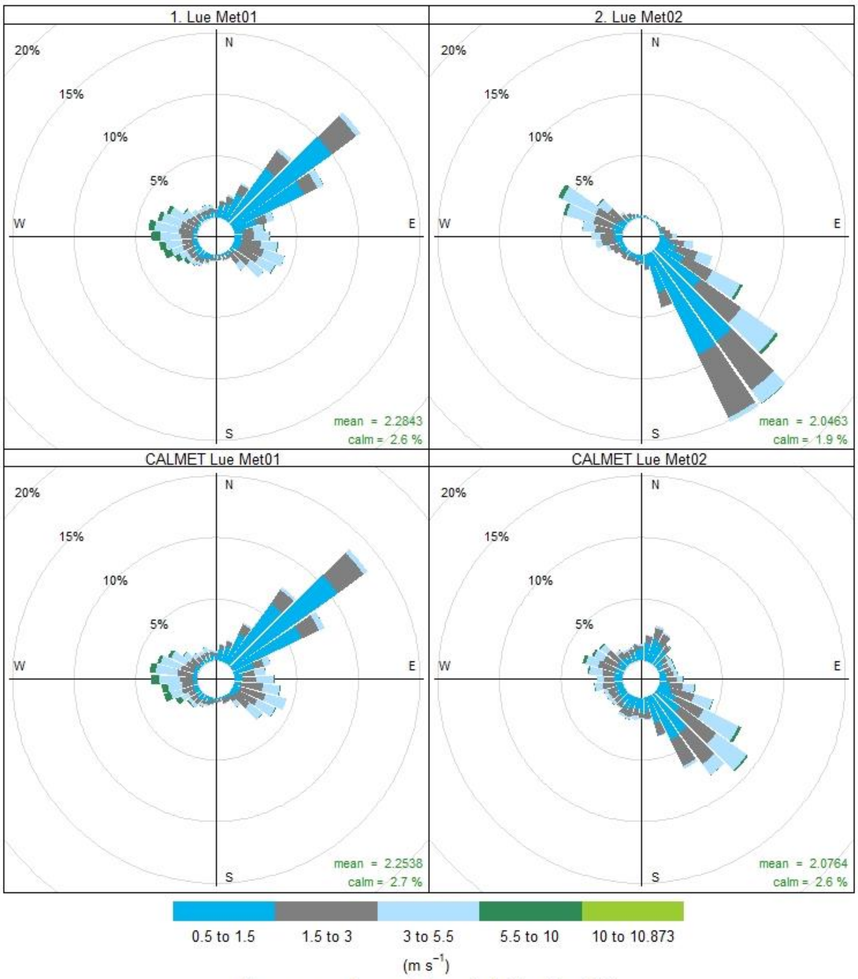
An RMAX of 5km and R1 of 2km is assigned in the model to reflect the local scale topographical influence seen in the observational data. Due to the difference in the winds recorded at the local observation sites, a barrier is added in the model between the two observation sites (such that the influence of the observation is excluded on the other side of the barrier). This also removes any issues associated with overlapping radius of influence (shown in **Figure 4.5**).

Standard practice is to exclude an observation from the model, such that model evaluation can be performed for a site that has not influenced the outcome of the model. However, in this instance, it was not logical to exclude one of the local observation sites for the purpose of model evaluation, as the two sites display very different prevailing wind conditions which were required to be incorporated to ensure robust model performance.

4.5.2 CALMET Predicted Winds

The CALMET predicted winds speeds are compared with observations at the on-site meteorological stations and shown in **Figure 4.4**. At Lue Met01 the observed and predicted wind direction, mean wind speed and frequency of calms are very similar. At Lue Met02, the observed and predicted wind direction are comparable, in terms of dominant direction, although the model predicts a slightly lower frequency of winds from the dominant southeast direction and a higher frequency of winds from the northeast. This northeast component is missing from the observation at Lue Met02 and its presence in the CALMET predicted winds is likely due to the influence of the Lue Met01 observations in the model. At Lue Met02, the observed and predicted mean wind speed are very similar, however, the predicted frequency of calms is slightly higher, again likely due to the influence of the Lue Met01 observation in the model.

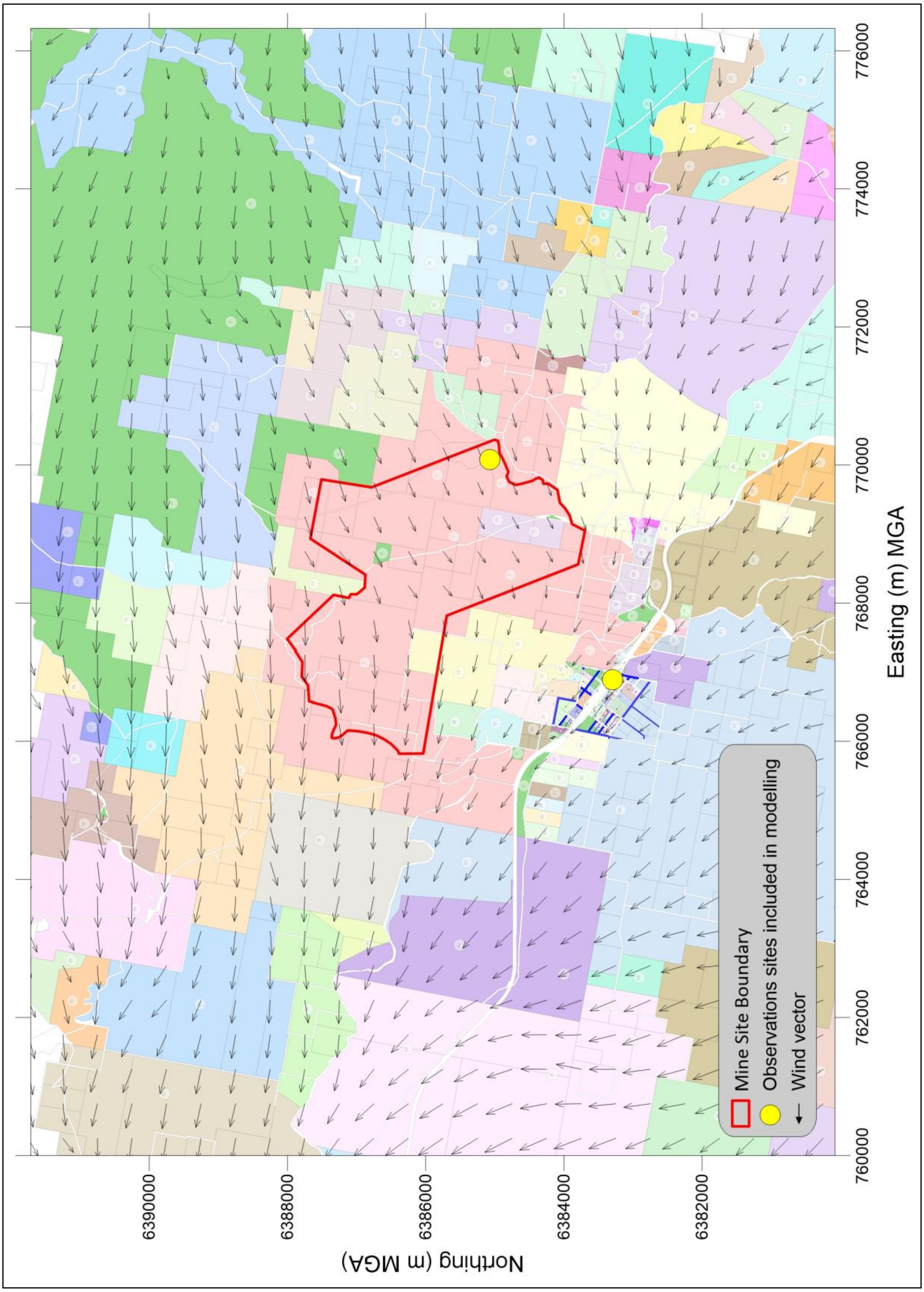
Figure 4.4 Comparison of CALMET Winds with Observations



CALMET is a non-steady state model which generates a temporal and spatial varying wind field across the modelling domain (for any given hour, the wind conditions vary across the modelling domain). The wind roses shown in **Figure 4.4** demonstrate this on an annual basis, showing how the prevailing winds different significantly at two different points in the modelling domain.

Another visual representation of the spatial variation in winds is shown in **Figure 4.5**, showing a snapshot of the wind field for the first hour of the simulation (represented by the arrows). Winds around the Lue Met01 observation site (within the Mine Lease Boundary) follow the northeast flow pattern shown in the annual wind rose, shifting to a southeast flow at the location of Lue Met02 observation site (in Lue).

Figure 4.5 Example of the CALMET Spatially Varying Wind Field for Hour 1 of the Simulation



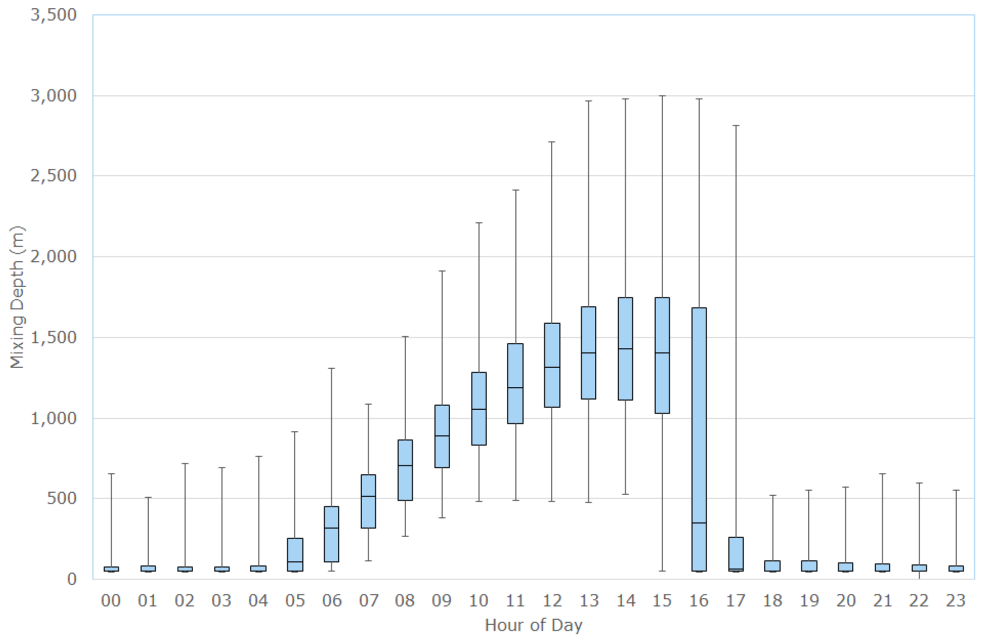
4.5.3 Atmospheric Boundary Layer Heights

The first few hundred metres of the atmosphere constitutes the "atmospheric boundary layer". This layer is directly affected by the earth's surface, either through the retardation of air flow due to the frictional drag of the earth's surface (mechanical mechanisms), or as a result of the heat and moisture exchanges that take place at the surface (convective mixing) (Stull, 1997; Oke, 2003).

During the day-time, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Elevated inversions may occur for a variety of reasons including anticyclonic subsidence and the passage of frontal systems. Due to radiative flux divergence, nights are typically characterised by weak to no vertical mixing and the predominance of stable conditions. These conditions are normally associated with low wind speeds and, hence, lower dilution potentials.

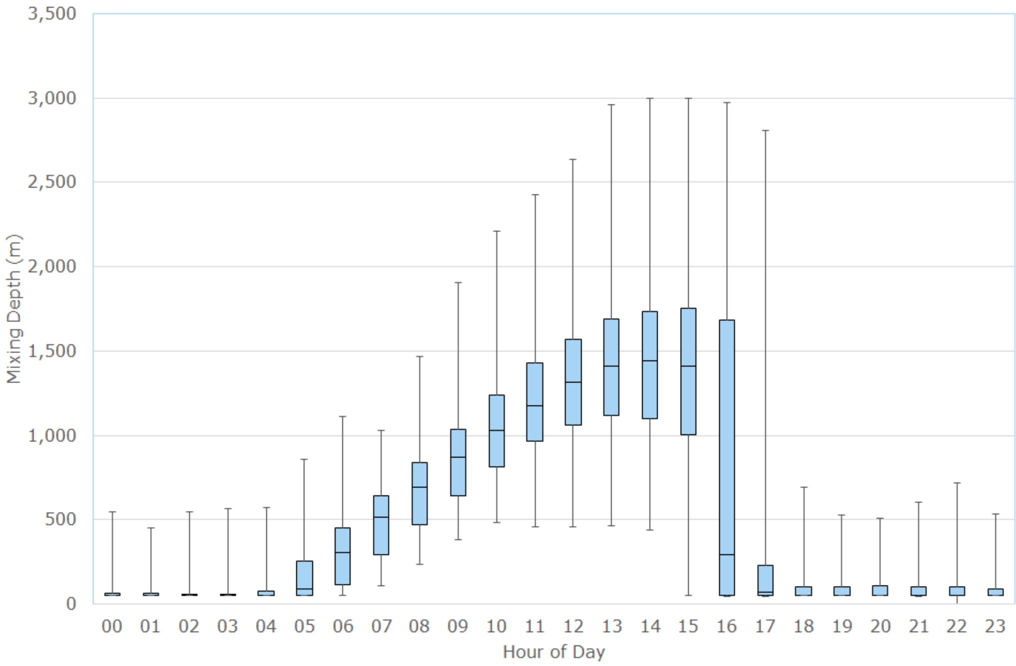
CALMET generated mixing heights are extracted at both the Lue Met01 and Lue Met02 monitoring sites, to provide an indication of the spatial variation in CALMET predicted atmospheric boundary layer heights. The average boundary layer heights by hour of the day are shown in in **Figure 4.6** and **Figure 4.7**. As seen in median and upper and lower quartiles, the highest boundary layer heights are experienced during the day-time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants. There is very little variation in mixing depths between the two sites.

Figure 4.6 Diurnal Variation in CALMET-Generated Mixing Heights – Lue Met01



Lower, middle and upper box markers indicate 25th percentile, median and 75th percentile of mixing height data, respectively, while upper and lower whiskers indicate maximum and minimum values.

Figure 4.7 Diurnal Variation in CALMET-Generated Mixing Heights – Lue Met02



Lower, middle and upper box markers indicate 25th percentile, median and 75th percentile of mixing height data, respectively, while upper and lower whiskers indicate maximum and minimum values.

4.5.4 Atmospheric Stability

Atmospheric stability refers to the degree of turbulence or mixing that occurs in the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants. The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible - typically about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4.8 and **Figure 4.9** illustrate the diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by CALMET, for a single point of the CALMET domain representing the location of the Lue Met01 and Lue Met02 monitoring sites.

The diurnal profile illustrates that atmospheric instability increases during daylight hours as convective energy increases, while stable atmospheric conditions prevail during the night-time. The potential for atmospheric dispersion of emissions is therefore greatest during day-time hours and lowest during evening through to early morning hours.

There is very little variation in atmospheric stability between the two sites, with a marginally lower frequency of occurrence of neutral conditions at Lue Met02.

Figure 4.8 Diurnal Variations in CALMET-Generated Atmospheric Stability – Lue Met01

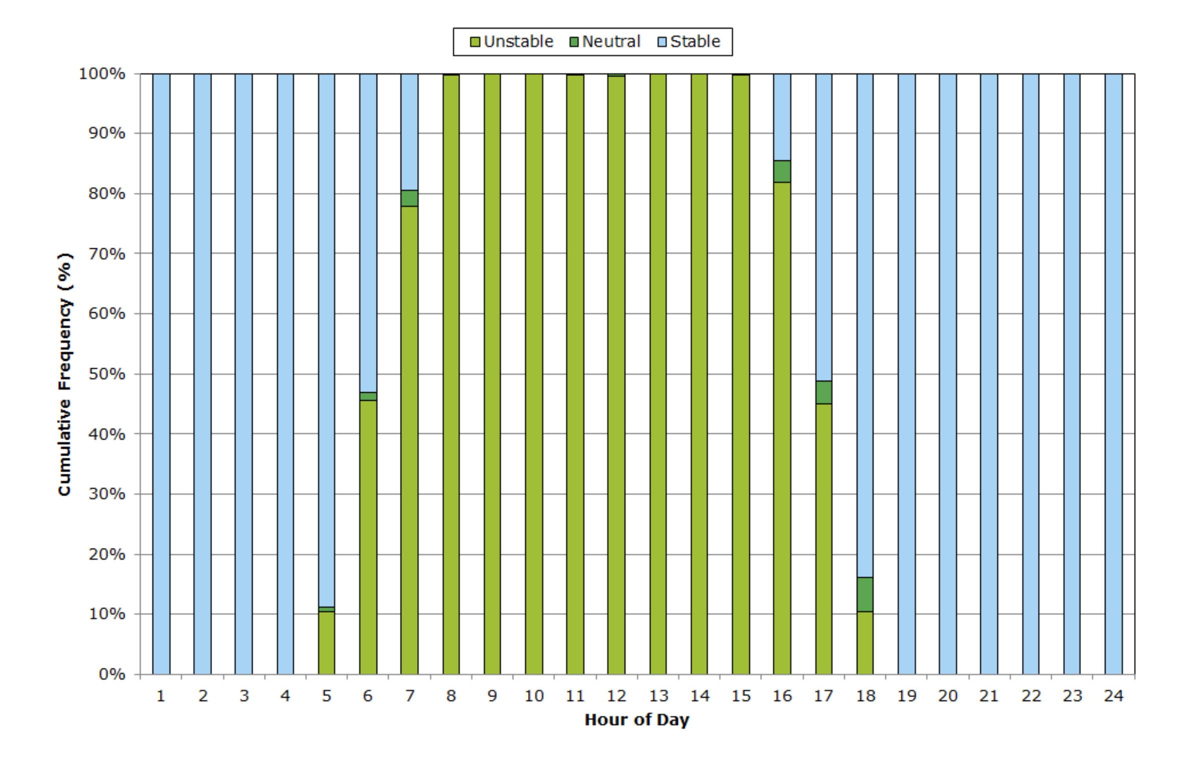
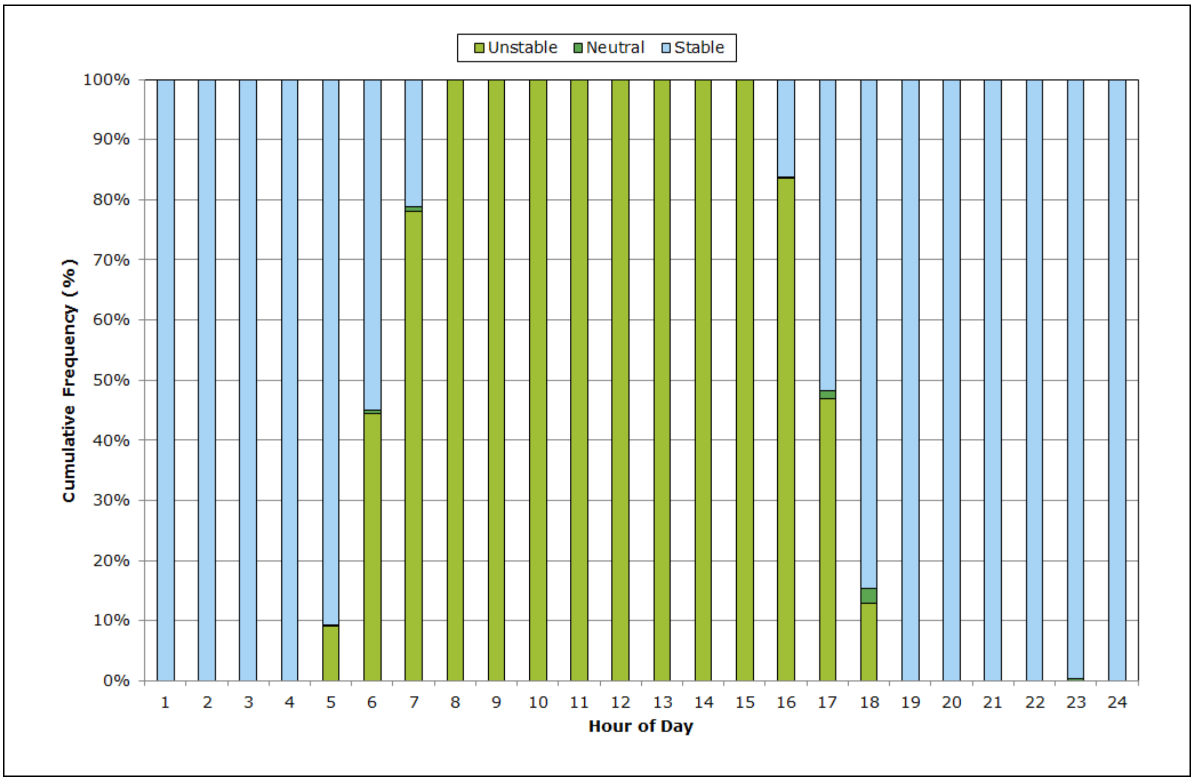


Figure 4.9 Diurnal Variations in CALMET-Generated Atmospheric Stability – Lue Met02



5. EXISTING AIR QUALITY ENVIRONMENT

5.1 INTRODUCTION

There are no known existing or potential future industrial sources of air pollution in the local area, other than those typically associated with rural areas of NSW. For example, a review of the National Pollutant Inventory (NPI) and NSW EPA EPL register identified no reporting or licenced industrial sources of air pollutants within a 10km radius of the Mine Site. There are two small existing quarry operations, located approximately 2.3km to the northwest and 6.7km southeast of the Mine Site boundary and other minor quarrying operations situated approximately 12km and 16km west-northwest of the Mine Site. None of these, however, are expected to contribute significantly to PM concentrations at Lue.

The existing ambient air quality environment in the vicinity of the Mine Site is therefore mostly influenced by:

- wind generated dust from exposed areas;
- fugitive dust emissions from agricultural activities, particularly during dry conditions;
- dust entrainment due to vehicle movements along unsealed and, to a lesser extent, sealed roads;
- seasonal emissions from household wood heaters;
- episodic emissions from vegetation fires; and
- long-range transport of fine particles into the region.

5.2 AIR QUALITY MONITORING NETWORK

Cumulative impacts are assessed by combining the contribution from the Project with the existing ambient air quality environment. Characterising the existing ambient air quality environment is primarily based on an air quality monitoring network established by Bowdens Silver surrounding the Mine Site, which comprises of the following.

- Two tapered element oscillating microbalance (TEOM) monitors for PM_{10} and $PM_{2.5}$, namely:
  - BAM1 – located in the southeastern corner of the Mine Site. Continuous PM_{10} concentrations have been monitored at this location since 2012; and
  - BAM2 – located in Lue. Continuous PM_{10} and $PM_{2.5}$ concentrations have been monitored since 2013.
- Two high volume air samplers (HVAS[11]) measuring TSP and lead concentrations on a one-in-six day run cycle, namely:
  - BHV1 – located in the southeastern corner of the Mine Site; and
  - BHV2 – located in Lue.

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[11] HVAS monitoring was halted in November 2014 and restarted in October 2016

- Twelve dust deposition gauges for recording monthly dust deposition rates and metals (arsenic, lead and zinc) content since 2012.

The locations of the Project air quality monitoring sites are shown in **Figure A1-5** of **Annexure 1.**

5.3 PM_{10} CONCENTRATIONS

Annual average PM_{10} concentrations for the BAM1 and BAM2 monitoring locations are presented in **Table 5.1**. The annual average PM_{10} concentration for the modelled year (2017) is slightly higher, and therefore more conservative, than previous years.

Table 5.1
Annual Average PM_{10} Concentration (µg/m^3)

Site	2014	2015	2016	2017
BAM1	12.5	10.5	10.5	12.9
BAM2	10.1	12.3	9.6	10.1

The 24-hour average PM_{10} concentrations measured at BAM1 and BAM2 during 2017 are presented in **Figure 5.1**. There are two days when the 24-hour average concentrations were at or above the impact assessment criterion during 2017.

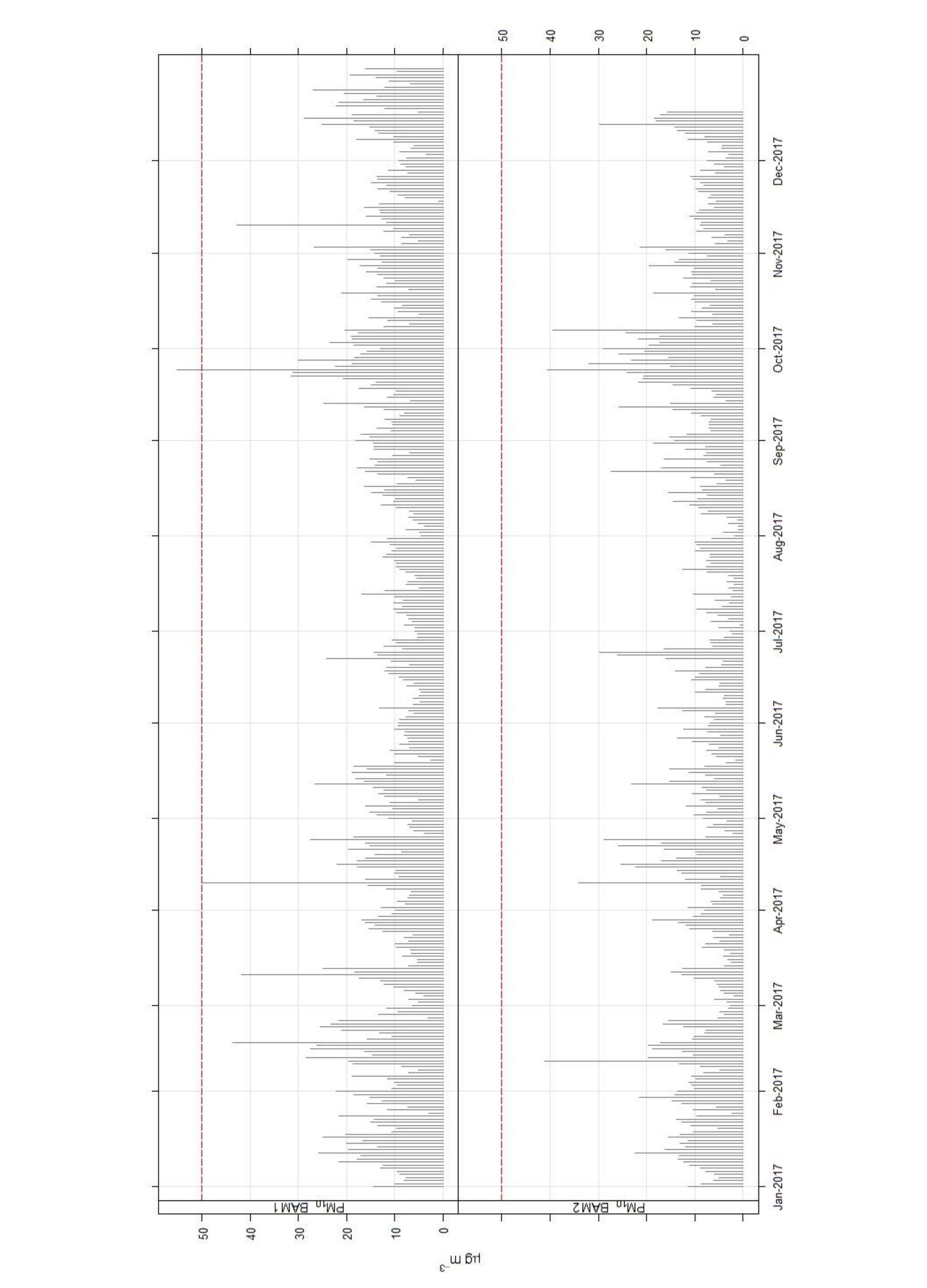
On 24 September 2017, the BAM1 monitoring station measured 55µg/m^3 while the corresponding concentration at BAM2 was 41µg/m^3. According to the (then) NSW Office of Environment and Heritage (OEH) (OEH, 2018), elevated particulate matter concentrations were recorded across NSW on 24 September 2017 due to a combination of a dust storm event from the interior deserts to the northwest and significant hazard reduction burns.

On 10 April 2017, the BAM1 monitoring station measured 50µg/m^3 while the corresponding concentrations at BAM2 was 34µg/m^3. The NSW OEH noted that a dust storm event influenced much of NSW on 10 April 2017 with elevated particulate matter concentrations recorded across the OEH network.

Several other periods of elevated particulate matter, below the impact assessment criteria, were recorded coincident across the monitoring stations. For example, high concentrations in mid-February 2017 coincide with extensive bushfires that occurred in the Central West of NSW.

The daily varying 24-hour PM_{10} concentrations shown in **Figure 5.1** are paired with each daily modelling prediction for cumulative assessment. The highest measured concentration across each site is selected for each day and adopted as the background for all locations. The only exception to this is the two days described above, where the measured concentration at BAM2 is used for background, as the BAM1 measurement is already at or above the impact assessment criterion. This approach is consistent with the guidance provided in Section 5.1.3 of the Approved Methods for dealing with elevated background concentrations.

Figure 5.1 Time-series of 24-hour Average PM_{10} Concentrations for BAM1 and BAM2 - 2017



5.4 $PM_{2.5}$ CONCENTRATIONS

Annual average $PM_{2.5}$ concentrations for BAM2 are presented in **Table 5.2**. Although the annual average $PM_{2.5}$ concentration for the modelled year (2017) is lower than previous years, the selected modelling year remains appropriate, as the key limiting pollutant for the Project is PM_{10}, which, as described above, is higher in 2017 than the other years. It is also noted that, even if the highest background concentration in **Table 5.2** was adopted, it would not change the outcomes of the cumulative assessment described in Section 7.3.

Table 5.2
Annual Average $PM_{2.5}$ Concentration (µg/m^3)

Site	2014	2015	2016	2017
BAM2	5.2	4.3	5.0	3.9

The 24-hour average $PM_{2.5}$ concentrations measured at BAM2 are presented in **Figure 5.2**. There were no days when the 24-hour $PM_{2.5}$ concentration was above the impact assessment criterion of 25µg/m^3.

The daily varying 24-hour $PM_{2.5}$ concentrations shown in **Figure 5.2** are paired with each daily modelling prediction for cumulative assessment. Gaps in the dataset were filled to ensure a full year of combined cumulative 24-hour average predictions. Where the $PM_{2.5}$ concentration was missing for a day but the PM_{10} concentration was available, the gap was filled using a simple linear regression analysis of the available PM_{10} and $PM_{2.5}$ data.

5.5 TSP CONCENTRATION

The annual average TSP concentrations recorded since 2012 at the two HVAS locations is illustrated in **Figure 5.3**. For all years of monitoring at both sites, the annual average concentration is well below the NSW EPA impact assessment criterion (90µg/m^3). The annual average TSP concentrations recorded at BHV1 and BHV2 during 2017 were 23µg/m^3 and 31µg/m^3 respectively.

5.6 DUST DEPOSITION

Annual average dust deposition levels for the period between 2012 and 2017 are presented in **Figure 5.4**. The annual average dust deposition during 2017 ranged from 0.5g/m^2/month (BDG01, BDG10) to 3.1g/m^2/month (BDG05). BDG05 is located 50m from an unsealed section of Pyangle Road and the elevated readings at this location are most likely reflective of wheel generated dust from vehicle movements. The average for 2017 across all sites is 1g/m^2/month.

5.7 OTHER POLLUTANTS

Since 2012, Bowdens Silver has obtained metals analyses of the collected dust deposition gauge samples on a quarterly basis (excluding the period from November 2014 to October 2016), for arsenic, lead and zinc. The analysis shows that, on average, the deposition rate for arsenic, lead and zinc is 0.002g/m^2/month, 0.001g/m^2/month and 0.002g/m^2/month respectively.

Figure 5.2 Time-series of 24-hour Average $PM_{2.5}$ Concentrations for BMA2 - 2017

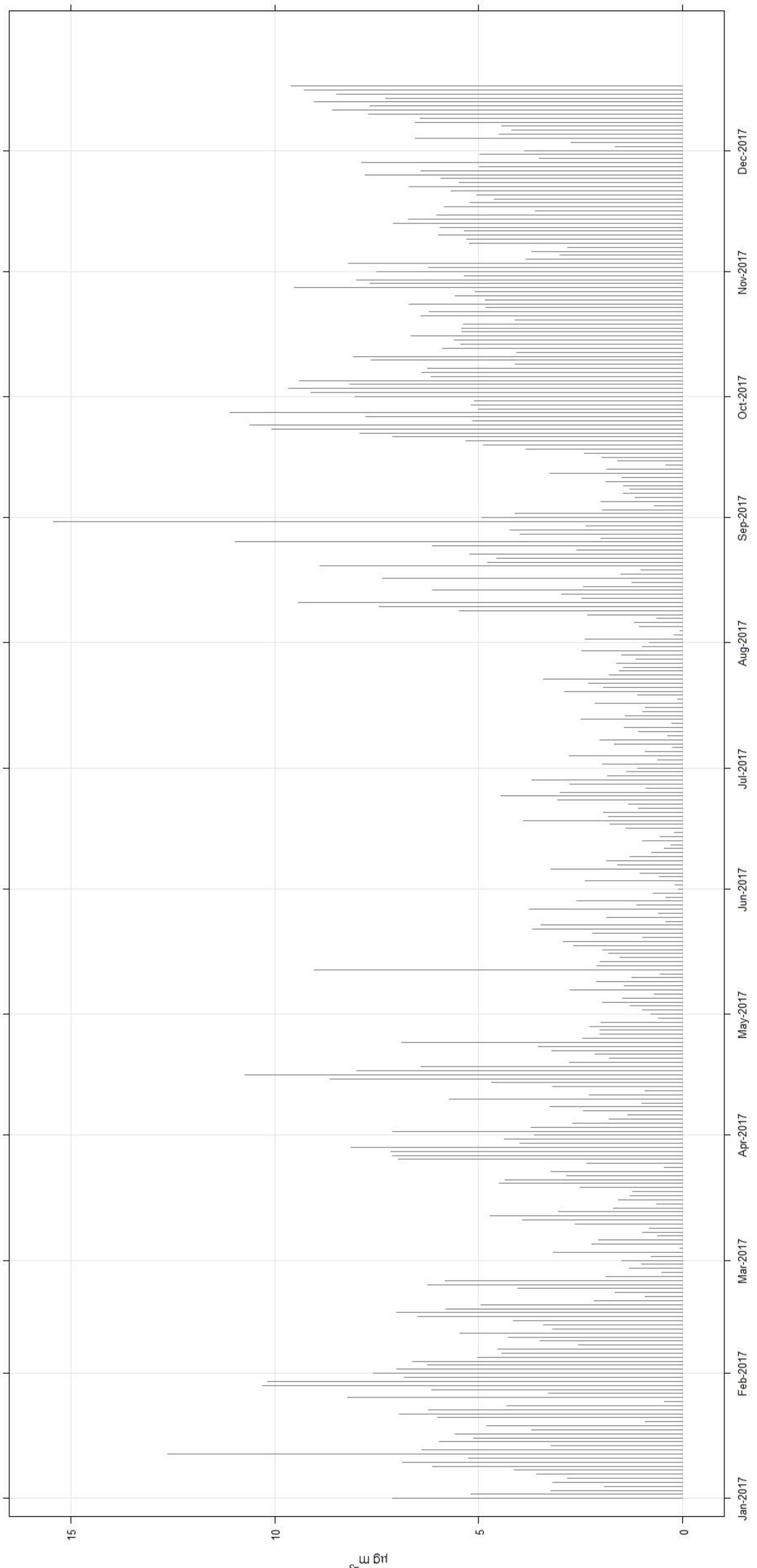


Figure 5.3 Annual Average TSP Concentrations – 2012 to 2017

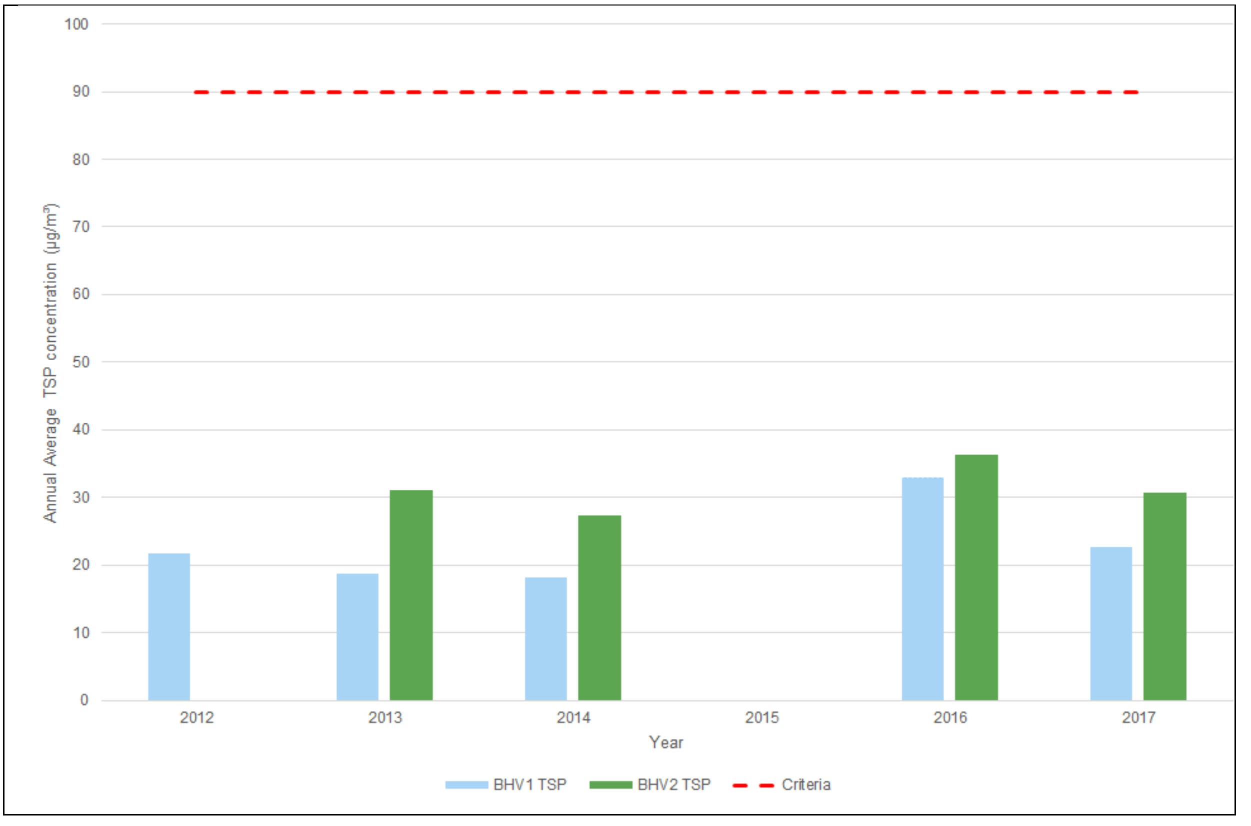
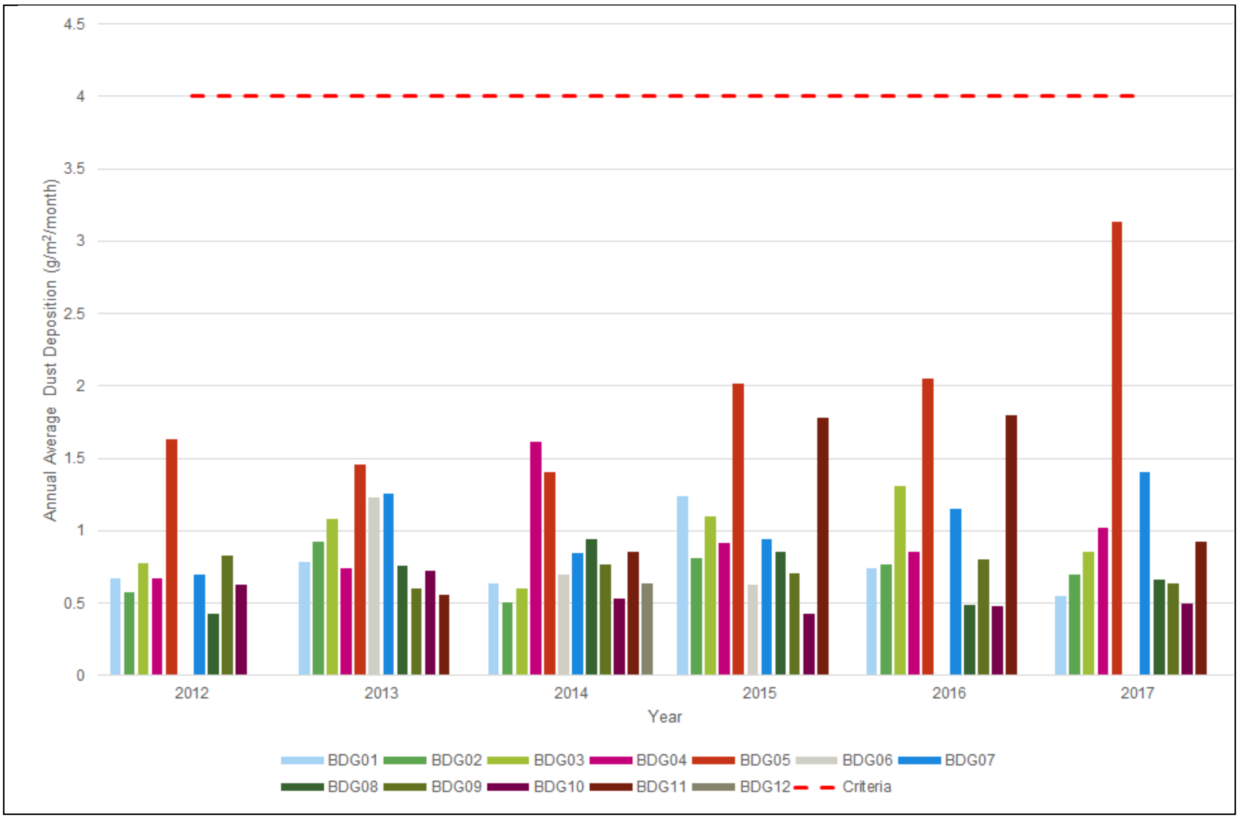


Figure 5.4 Annual Average Dust Deposition Monitoring – 2012 to 2017



Analysis of lead was also undertaken on the collected HVAS TSP samples, and for a short period of time for PM_{10} and $PM_{2.5}$ samples. The maximum measured lead concentration for the period was 0.002µg/m^3 with an average concentration of 0.001µg/m^3. When compared with the NSW EPA's impact assessment criterion of 0.5µg/m^3, the existing ambient levels of lead in the Lue area are negligible (i.e. 0.2% of the impact assessment criteria).

Commencing July 2017, analysis of HVAS samples for concentrations of arsenic, cadmium, chromium, copper, nickel, zinc and selenium was also undertaken. The sample analysis reported ambient concentrations of arsenic, cadmium and selenium below the limit of detection, while average concentrations of chromium, copper, nickel and zinc were 0.001µg/m^3, 0.007µg/m^3, 0.001µg/m^3, and 0.009µg/m^3 respectively. When compared with the NSW EPA's impact assessment criteria listed in **Table 2.6**, these measured concentrations are negligible.

No local monitoring is conducted for ambient concentrations of respirable crystalline silica or other individual toxic air pollutants. Due to the general absence of notable emission sources in the local area, existing ambient concentrations for these pollutants are assumed to be negligible.

Regardless, the impact assessment criteria specified for toxic air pollutants are applied to the incremental impact (i.e. predicted impacts due to the pollutant source alone).

5.8 ADOPTED BACKGROUND FOR CUMULATIVE ASSESSMENT

The background values for cumulative assessment are summarised in **Table 5.3**. For assessment of cumulative 24-hour average concentrations, the daily varying background PM_{10} and $PM_{2.5}$ concentrations from the on-site TEOM locations are paired with modelling predictions for the same period. As a conservative approach, the highest measured PM_{10} concentrations across each site is selected for each day, except for the two days that the BAM1 measurement is already at or above the impact assessment criterion (in which case the measured concentration at BAM2 is used). Selecting the highest daily concentration across each site also results in an annual average background concentration that is higher than the individual measured annual average PM_{10} concentrations presented in **Table 5.1**.

Table 5.3
Adopted Background for Cumulative Assessment

Pollutant	Averaging period	Adopted background value
PM_{10}	24-hour average[1]	Daily varying with a maximum of 43.7µg/m^3
	Annual average[1]	13.6µg/m^3
$PM_{2.5}$	24-hour average	Daily varying with a maximum of 15.4µg/m^3
	Annual average	3.9µg/m^3
TSP	Annual average	30.7µg/m^3
Lead	Annual average	Negligible (i.e. 0.2% of the impact assessment criteria)
Dust deposition	Annual average	1g/m^2/month

Note:[1] Calculated based on the highest measured concentration across each site for each day, except for the two days that the BAM1 measurement was already at or above the impact assessment criterion due to regional dust storms.

6. EMISSIONS INVENTORY

6.1 ASSESSMENT SCENARIOS

Emissions inventories have been developed for four representative years, selected to assess the air quality impacts of worst-case operational conditions, for example where material movement and equipment use is highest, where disturbance or wind erosion areas are largest, or where operations are located closest to receivers.

The following operational scenarios are selected for assessment:

- Scenario 1 - representative of site establishment and construction stage (SE&CS) activities when total extraction of waste rock material is highest and the Stage 1 TSF embankment and impoundment area is being constructed;
- Scenario 2 - mining operations in operational Year 3, representing the year when total extracted material (ore and waste rock) is highest and the Stage 2 TSF embankment raise is undertaken;
- Scenario 3 - mining operations in operational Year 8, representing the year with the maximum extent of the southern barrier construction and the final (Stage 3) TSF embankment raise is undertaken; and
- Scenario 4 - representative of mining operations in operational Year 9, which has the second highest waste rock extraction and where non-acid forming (NAF) waste rock transport to the TSF has ceased.

Consistent with the Approved Methods, emission factors developed by the US EPA[12], have been applied to estimate the amount of dust produced by each activity (soil stripping, waste rock removal and emplacement, TSF earthworks and raises, ore removal and processing, wind erosion and hauling).

6.2 SUMMARY OF ESTIMATED EMISSIONS

A summary of the controlled emission estimates for PM_{10} are presented in **Table 6.1**. The emissions estimates incorporate controls based on a BMP determination undertaken for the Project, incorporating all proposed controls.

Full details on the emission inventory development, including the assumptions, input data, emission factors and the BMP determination are provided in **Annexure 4**. Annual emission inventories for TSP and $PM_{2.5}$ are also shown in **Annexure 4**.

Annual emissions are categorised as: wind-insensitive (where the emission rate is independent of the wind speed); wind-sensitive sources (where there is a relationship between the emission rate and wind speed); and wind erosion sources (where the emission is dependent on the wind speed). Hourly emission files were developed for each source depending on the categorisation; for example, wind-sensitive and wind erosion sources are varied according to the hourly wind speed. Further description of the methodology is provided in **Annexure 4**.

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[12] US EPA AP-42 Compilation of Air Pollutant Emission Factors (US EPA, 1998b; US EPA, 2004; US EPA, 2006).

Table 6.1
Annual PM_{10} Emissions (kg/annum)

Page 1 of 2

Activity	SE&CS	Year 3	Year 8	Year 9
Soil stripping				
Stripping	2 387	806	212	272
Excavator loading haul trucks	457	154	40	52
Hauling soil	13 109	4 339	1 162	1 493
Unloading trucks	457	154	40	52
Processing Plant Earthworks				
Drilling	304	NA	NA	NA
Blasting	429	NA	NA	NA
Landform shaping (cut and fill) by Excavator	22	NA	NA	NA
Landform shaping (cut and fill) by FEL	10 739	NA	NA	NA
Relocating excavated fill by articulated truck	1 291	NA	NA	NA
Relocating excavated fill by semi-tipper	1 009	NA	NA	NA
Shaping / road construction by grader	18 084	NA	NA	NA
Waste rock extraction, loading, hauling and unloading				
Drilling (waste and ore)	2 246	2 531	2 109	2 109
Blasting (waste and ore)	3 172	3 575	2 979	2 979
Bulldozer - open pit	4 001	4 313	4 598	5 504
Excavator loading haul trucks in open cut pit	1 144	1 798	652	907
Hauling to WRE	10 445	6 628	8 542	12 654
Hauling NAF to southern barrier	7 492	6,825	10 473	23 968
Hauling to NAF stockpile area	3 753	1 395	1 171	NA
Excavator loading NAF to B-double trucks	459	171	143	NA
Hauling NAF to TSF embankment or mobile crusher	54 101	20 085	16 860	NA
Unloading haul trucks - WRE	255	234	185	260
Unloading haul trucks - TSF embankment or mobile crusher	321	119	100	NA
Unloading haul trucks - southern barrier	225	205	171	375
Unloading haul trucks - NAF stockpile area	459	171	143	0
Bulldozers - WRE	6 379	6 909	7 181	6 764
Bulldozers - southern barrier	5 623	6 029	6 612	9 748
TSF Earthworks and Raises				
Mobile crusher - TSF	245	91	76	NA
Landform shaping (cut and fill) with FEL	10 739	NA	NA	NA
Landform shaping (cut and fill) with Grader	24 112	NA	NA	NA
Bulldozers - TSF	10 739	3 991	3 351	NA
Loading haul trucks with crushed rock	92	34	29	NA
Transfer (haul) crushed rock to TSF	782	327	244	NA

Table 6.1 (Cont'd)
Annual PM10 Emissions (kg/annum)

Page 2 of 2

Activity	SE&CS	Year 3	Year 8	Year 9
Ore extraction, loading, hauling and processing				
Bulldozer - ripping ore	26	94	71	74
Excavator loading haul trucks	53	551	473	217
Hauling to Run-Of-Mine (ROM) pad	734	10 989	11 907	2 017
Hauling to low grade ore stockpile	121	1 828	3 706	1 312
Hauling to oxide ore stockpile	344	1 233	933	962
Unloading trucks - ROM pad	18	268	233	78
Unloading trucks - low grade ore stockpile	4	65	58	32
Unloading trucks - oxide ore stockpile	15	53	40	42
Bulldozer shaping ROM stockpiles	751	7 826	6 709	3 081
FEL rehandle ore to ROM feed bin	NA	115	100	34
Primary crushing	NA	1 022	887	299
Rehandle crushed ore to milling circuit	NA	383	332	112
Screening (high moisture content)	NA	3 661	3 177	1 071
Product transport (haul on mine access road)	NA	293	293	293
Wind erosion				
Pre-strip	13,855	2 720	2 720	2 720
Soil stockpiles	1 041	89	177	79
Active open cut pit	3 094	6 932	9 609	13 179
WRE - Active areas	4 335	10 285	10,073	10 030
TSF embankment	7 480	7 480	7 480	NA
TSF surface	28 263	7 438	10 413	13 388
NAF stockpiles	1 445	1 445	1 445	NA
Southern barrier	1 615	6 970	6 970	6 970
Rehabilitated area	0	310	344	455
ROM stockpile	1 530	1 530	1 530	1 530
Crushed ore stockpile	0	850	850	850
Low grade ore stockpile	2 083	2 083	7, 353	7 353
Oxide ore stockpiles	638	2 210	2 295	2 295
Miscellaneous				
Grader (road maintenance)	6 028	12 056	12 056	12 056
Total (kg/yr)	**268 531**	**160 657**	**169 305**	**147 664**
Note: FEL = Front End Loader, ROM = Run-of-Mine, NA = Not Applicable (the activity is not applicable to that scenario)				

6.3 DIESEL EMISSIONS

As discussed in Section 2.4, emissions of PM_{10} and $PM_{2.5}$ from diesel combustion in mining equipment are assumed to be included in the total emissions for each relevant source and are not explicitly modelled as a separate emission source. However, adjustments have been made to account for the fact that emission reductions applied to the inventory (i.e. watering) are not relevant to the control of diesel exhaust emissions.

The NSW EPA completed a benchmarking study to evaluate a number of options for reducing diesel emissions for 64 coal mines in NSW (NSW EPA, 2014). The study reported that the majority of mine site diesel (97%) is consumed in haul trucks (62%), excavators (19%) and dozers/loaders (15%). The emissions inventory for the Project applies no controls for dozers/loaders and excavators, therefore the adjustments for diesel emissions are only needed for haul road controls.

Diesel consumption has been estimated for each year of the Project, by Project component and/or equipment type, including specific estimates for all haul trucks and separately for NAF haulage to the TSF.

The estimated diesel consumption for all haul trucks is allocated pro-rata to ore and waste haulage based on the total tonnage hauled for each component.

Emissions are estimated based on diesel consumption using the NSW fleet average $PM_{2.5}$ emission factor of 1.39 kg/kL, as reported in the NSW EPA's benchmarking study[13]. PM_{10} emissions are estimated based on the assumption that $PM_{2.5}$ emissions are 97% of PM_{10} emissions (NSW EPA, 2012). The estimated diesel emissions for hauling are subtracted from the uncontrolled haul road emissions to derive the wheel-generated component of emissions for each haul road. The control for watering is then applied to the wheel-generated component only, and the diesel emissions are then added back to derive the final emission estimate from haul trucks.

The estimated emissions of PM_{10} and $PM_{2.5}$ from diesel combustion for the Project are presented in **Table 6.2**.

Table 6.2
Annual PM_{10} and $PM_{2.5}$ Emissions from Diesel Combustion (kg/annum)

	PM_{10}				$PM_{2.5}$			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Estimated diesel emissions	4 612	3 918	2 265	1 458	4 395	3 771	2 174	1 415
% of total emissions	2.2%	2.5%	1.6%	1.2%	9.9%	11.6%	7.6%	5.3%

[13] Based on total $PM_{2.5}$ emissions (1,298 tonnes per annum) and diesel combustion (936,440 kilolitres per annum)

6.4 METALS

As previously described, elemental assays for the Bowdens deposit have been provided by Bowdens Silver, these include metal composition analysis for 12 key metals, expressed as % and/or ppm, for both ore and waste rock. An extensive soil sampling program was also completed in 2012, with the results reported in the Human Health Risk Assessment (enRiskS, 2020). This metal composition analysis is used to scale the PM emission estimates (TSP, PM_{10} and $PM_{2.5}$) for each activity listed in in **Table 6.1**, based on the type of material being handled or processed (i.e. waste rock, ore and soil). A summary of the metal composition analysis, used to scale the PM emissions and modelling results, is presented in **Table 6.3**. The median of each measurement is selected for use in this assessment.

Table 6.3
Elemental Analysis for the Bowdens Deposit

	Waste Rock		Ore		Soil
Element	**ppm**	**%**	**ppm**	**%**	**%**
Cobalt	2.0	0.0002	3.0	0.0003	0.0006
Chromium	3.0	0.0003	3.0	0.0003	0.0016
Iron	9 800	1.0	15150	1.5	0.0002
Mercury	7.0	0.0007	2.2	0.0002	0.000002
Lithium	33.0	0.003	20.0	0.002	0.0004
Nickel	3.0	0.0003	2.0	0.0002	0.0006
Arsenic	42.0	0.004	196.5	0.020	0.0007
Cadmium	1.0	0.0001	12.9	0.001	0.000004
Copper	0.0008	0.0000001	0.002	0.0000002	0.0008
Manganese	0.2	0.00002	0.6	0.00006	0.06
Lead		0.02	3200	0.32	0.009
Zinc		0.02	4400	0.44	0.0006
Silver		0.000005	69.1	0.0069	0.000005

Source: Bowdens Silver

6.5 SILICA

A review of historic mineralogy data was compiled to identify the silica content within the Bowdens deposit, including the relative amounts of silica in ore and waste rock. A summary of the results of this review is provide in **Table 6.4**. This composition analysis is used to scale the $PM_{2.5}$ emission estimates for each relevant activity, based on the type of material being handled or processed (i.e. waste rock or ore). To be conservative, the higher percentages from within the extent of the pit design are used for the whole of the operational activities.

Emissions of quartz are assumed to occur from those activities in **Table 6.1** where a mechanical grinding / crushing activity might act to liberate emissions of fine silica dust. However, once an activity is determined to result in emissions for fine silica dust, all subsequent downstream handling of that material is assumed to also generate emissions. In effect, all sources / activities except hauling and wind erosion (excluding crushed ore stockpiles) are assumed to liberate fine silica dust.

Table 6.4
Summary of Results for Silica Content in the Bowdens Deposit

Material/sample type	Average silica content, as quartz
Ore (overall)	39%
Waste rock (overall)	36%
Ore (within extent of pit design)	47%
Waste rock (within extent of pit design)	64%

6.6 HYDROGEN CYANIDE

Fugitive emissions of hydrogen cyanide (HCN) by volatilisation[14] are estimated for the processing area and the TSF

The NPI Emission Estimation Technique Manual for Lead Concentrating, Smelting and Refining (1999) reports that 1% of total cyanide is lost through volatilisation as HCN within the processing area of gold operations, which is assumed to also apply to the processing area of the Project. Emissions of HCN from the processing area are therefore derived based on the estimated usage of 190 tonnes of NaCN per annum, which is corrected to total cyanide based on the molecular weight, as follows.

190 tonnes NaCN per annum ÷ (49.0072/26.02) = 101 tonnes CN per annum

101 tonnes CN per annum x 1% x 1000 = 1,009 kg HCN per annum or 0.03 g/s

Cyanide emissions from the TSF were estimated from Section 6.2.2 of the NPI (2006), as follows.

HCN (kg/yr) = free cyanide concentration (kg/m^3) x volume of slurry (m^3/yr) x volatilisation rate

The free cyanide concentration in the TSF return water is estimated as 0.0025 kg/m^3 while the volume of slurry throughput to the TSF is estimated as 2,522,880m^3/yr. Assuming a volatilisation rate of 80% (based on an assumed pH of 8) emissions of HCN from the TSF are estimated as 4,827 kg/annum or 0.15 g/s. Emissions are modelled across the full extent of the TSF.

[14] Emissions by volatilisation refers to evaporation of a substance from the surface of a liquid.

7. ASSESSMENT OF IMPACTS

The predicted Project-only and cumulative modelling results are presented in the following section in tabular form and at each of the assessed private residences. Tabulated modelling results for Project-related residences are shown in **Annexure 5**. The predicted Project-only modelling results are also presented as contour plots in **Annexure 6** showing the extent of predicted Project-only levels across private and Project-related land.

7.1 ANNUAL AVERAGE PM_{10} CONCENTRATION

The predicted Project-only and cumulative annual average PM_{10} concentrations for private residences are presented in **Table 7.1**. The highest predicted increment in annual average PM_{10} at any private residence across all years is 3.3µg/m³ (receiver R7 in Year 9).

There are no private residences where the cumulative annual average PM_{10} concentration is greater than 25µg/m³. The highest predicted cumulative annual average PM_{10} at any private residence across all years is 16.9µg/m³ (receiver R7 in Year 9).

Table 7.1
Predicted Annual Average PM_{10} Concentration (µg/m³)

Page 1 of 4

ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.1**	**1.7**	**2.3**	**3.3**	**15.7**	**15.3**	**15.9**	**16.9**
L1	0.7	0.6	0.6	0.8	14.3	14.2	14.2	14.4
L2	0.6	0.6	0.6	0.7	14.3	14.2	14.2	14.3
L3	0.7	0.6	0.6	0.7	14.3	14.2	14.2	14.3
L4	0.7	0.6	0.6	0.7	14.3	14.2	14.2	14.3
L5	0.7	0.5	0.6	0.7	14.3	14.1	14.2	14.3
L7	0.7	0.6	0.6	0.7	14.3	14.2	14.2	14.3
L8	0.7	0.6	0.6	0.7	14.3	14.2	14.2	14.3
L9	0.6	0.5	0.6	0.7	14.2	14.1	14.2	14.3
L10	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L12	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L13	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L15	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L16	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L17	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L18	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L19	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L20	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L21	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L22	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L23	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2

Table 7.1 (Cont'd)
Predicted Annual Average PM_{10} Concentration (µg/m³)

ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.1**	**1.7**	**2.3**	**3.3**	**15.7**	**15.3**	**15.9**	**16.9**
L24	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L25	0.6	0.5	0.5	0.6	14.2	14.1	14.2	14.2
L26	0.6	0.5	0.5	0.6	14.2	14.1	14.2	14.3
L27	0.6	0.5	0.5	0.6	14.2	14.1	14.2	14.2
L28A	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L28B	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L29	0.6	0.5	0.6	0.7	14.2	14.1	14.2	14.3
L30	0.7	0.5	0.6	0.7	14.3	14.1	14.2	14.3
L31	0.6	0.5	0.6	0.7	14.2	14.1	14.2	14.3
L32	0.7	0.5	0.6	0.7	14.3	14.1	14.2	14.3
L33	0.7	0.5	0.6	0.7	14.3	14.1	14.2	14.3
L34	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L35	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L37	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L38	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L39	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L40	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L41	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L42	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L43	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L44	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L45	0.7	0.5	0.6	0.6	14.3	14.1	14.2	14.3
L46	0.7	0.5	0.6	0.6	14.3	14.1	14.2	14.2
L47	0.7	0.5	0.6	0.6	14.3	14.1	14.2	14.2
L49	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
L50	0.7	0.6	0.6	0.7	14.4	14.2	14.2	14.4
POI1	0.7	0.5	0.6	0.7	14.3	14.2	14.2	14.3
POI2	0.7	0.5	0.6	0.7	14.3	14.1	14.2	14.3
POI3	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
POI4	0.6	0.5	0.6	0.7	14.2	14.1	14.2	14.3
POI5	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
R4	1.5	1.3	1.6	2.0	15.1	14.9	15.2	15.6
R6	0.1	0.1	0.1	0.1	13.7	13.7	13.7	13.7
R7	2.1	1.7	2.3	3.3	15.7	15.3	15.9	16.9
R9	0.1	0.1	0.1	0.1	13.7	13.7	13.7	13.7

Table 7.1 (Cont'd)
Predicted Annual Average PM_{10} Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.1**	**1.7**	**2.3**	**3.3**	**15.7**	**15.3**	**15.9**	**16.9**
R12	1.4	1.3	1.3	1.5	15.0	14.9	14.9	15.1
R13	0.1	0.1	0.1	0.1	13.7	13.7	13.7	13.7
R15	0.1	0.1	0.1	0.1	13.7	13.7	13.7	13.7
R16	0.1	0.1	0.1	0.1	13.7	13.7	13.7	13.7
R17	0.8	0.4	0.4	0.3	14.4	14.0	14.0	13.9
R19	0.2	0.2	0.2	0.2	13.8	13.8	13.8	13.8
R21	0.7	0.6	0.7	0.6	14.3	14.2	14.3	14.2
R22	0.4	0.4	0.4	0.4	14.0	14.0	14.0	14.0
R24	0.5	0.4	0.5	0.6	14.1	14.0	14.1	14.2
R25	0.7	0.6	0.6	0.7	14.3	14.2	14.2	14.3
R27	0.6	0.6	0.6	0.7	14.2	14.2	14.3	14.3
R28A	0.2	0.2	0.2	0.2	13.8	13.8	13.8	13.8
R28B	0.2	0.2	0.2	0.2	13.8	13.8	13.8	13.8
R28C	0.2	0.2	0.2	0.2	13.8	13.8	13.8	13.8
R28D	0.2	0.2	0.2	0.2	13.8	13.8	13.8	13.8
R31	0.3	0.2	0.3	0.3	13.9	13.8	13.9	13.9
R33	0.5	0.4	0.5	0.5	14.1	14.0	14.1	14.1
R34	0.3	0.3	0.3	0.3	13.9	13.9	13.9	13.9
R35	1.1	0.9	0.8	0.9	14.7	14.5	14.4	14.5
R36A	0.9	0.6	0.6	0.6	14.5	14.2	14.2	14.2
R37	0.7	0.6	0.6	0.7	14.3	14.2	14.2	14.3
R39	0.7	0.6	0.7	0.9	14.3	14.2	14.3	14.5
R40	0.7	0.6	0.7	0.8	14.3	14.2	14.3	14.4
R42	0.7	0.6	0.6	0.7	14.3	14.2	14.2	14.3
R43	0.2	0.1	0.2	0.2	13.8	13.8	13.8	13.8
R44	0.5	0.4	0.5	0.6	14.1	14.0	14.1	14.2
R45A	0.5	0.4	0.5	0.6	14.1	14.0	14.1	14.2
R45B	0.5	0.4	0.4	0.5	14.1	14.0	14.0	14.1
R46	0.7	0.6	0.7	0.8	14.3	14.2	14.3	14.5
R47	0.7	0.6	0.7	0.9	14.3	14.2	14.3	14.5
R48	0.3	0.3	0.3	0.3	13.9	13.9	13.9	14.0
R50	0.2	0.2	0.2	0.2	13.8	13.8	13.8	13.8
R58	0.2	0.1	0.1	0.1	13.8	13.7	13.8	13.8
R60	0.6	0.3	0.3	0.3	14.2	13.9	14.0	13.9

Table 7.1 (Cont'd)
Predicted Annual Average PM_{10} Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.1**	**1.7**	**2.3**	**3.3**	**15.7**	**15.3**	**15.9**	**16.9**
R63	0.1	0.1	0.1	0.1	13.7	13.7	13.7	13.7
R68	0.2	0.1	0.1	0.1	13.8	13.7	13.7	13.7
R70	0.1	0.1	0.1	0.1	13.8	13.7	13.7	13.7
R73	0.5	0.2	0.2	0.2	14.2	13.9	13.8	13.8
R74	0.3	0.1	0.1	0.1	13.9	13.8	13.7	13.7
R75	0.3	0.1	0.1	0.1	13.9	13.7	13.7	13.7
R76	0.8	0.4	0.4	0.3	14.4	14.0	14.0	13.9
R80	0.2	0.1	0.1	0.1	13.8	13.7	13.7	13.7
R81	0.9	0.7	0.7	0.8	14.5	14.3	14.3	14.4
R82	0.9	0.7	0.8	0.8	14.5	14.3	14.4	14.4
R83	0.7	0.5	0.6	0.6	14.3	14.1	14.2	14.2
R84A	0.7	0.5	0.6	0.6	14.3	14.1	14.2	14.2
R84B	0.7	0.5	0.6	0.6	14.3	14.1	14.2	14.2
R85	0.7	0.5	0.5	0.6	14.3	14.1	14.1	14.2
R86	0.8	0.6	0.6	0.7	14.4	14.2	14.2	14.3
R87	0.8	0.6	0.6	0.6	14.4	14.2	14.2	14.2
R88	0.6	0.4	0.4	0.5	14.2	14.0	14.0	14.1
R89	0.7	0.5	0.5	0.6	14.3	14.1	14.2	14.2
R90	0.8	0.6	0.6	0.6	14.4	14.2	14.2	14.2
R91	0.3	0.2	0.3	0.3	13.9	13.9	13.9	13.9
R92B	0.5	0.4	0.4	0.5	14.1	14.0	14.0	14.1
R93A	0.6	0.5	0.6	0.7	14.2	14.1	14.2	14.3
R93B	0.6	0.5	0.5	0.7	14.2	14.1	14.1	14.3
R93C	0.5	0.4	0.5	0.6	14.1	14.0	14.1	14.2
R94A	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
R94B	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
R95	0.5	0.4	0.4	0.5	14.1	14.0	14.0	14.1
Note: See EIS Appendix 6 for land ownership details.								

7.2 24-HOUR AVERAGE PM_{10} CONCENTRATION

The predicted Project-only and cumulative 24-hour average PM_{10} concentrations for private residences are presented in **Table 7.2**. The highest predicted increment in 24-hour average PM_{10} at any private residence across all years is 15.6µg/m³ (receiver R21 in Year 9).

There are no private residences where either the predicted increment in 24-hour average PM_{10} or the predicted cumulative 24-hour average PM_{10} is above 50µg/m³. The highest predicted cumulative 24-hour average PM_{10} at any private residence across all years is 48.1µg/m³ (receiver R4 in SE&CS).

Table 7.2
Predicted 24-hour Average PM_{10} Concentration (µg/m³)

Page 1 of 4

ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**11.6**	**10.0**	**14.0**	**15.6**	**48.1**	**46.5**	**47.2**	**47.6**
L1	5.3	4.5	4.3	4.2	44.9	44.4	44.4	44.5
L2	5.0	4.3	4.0	4.0	45.0	44.5	44.5	44.5
L3	5.1	3.5	3.3	3.4	44.1	43.9	43.9	43.9
L4	5.1	3.4	3.2	3.3	44.1	43.9	43.9	43.9
L5	5.2	3.7	3.5	3.4	44.2	44.0	43.9	44.0
L7	5.2	4.3	4.1	4.0	44.7	44.3	44.3	44.3
L8	5.4	4.4	4.3	4.2	44.6	44.3	44.3	44.3
L9	5.1	4.5	4.5	4.6	45.0	44.6	44.7	44.8
L10	4.7	4.2	4.3	4.6	45.0	44.8	44.9	45.0
L12	4.8	4.2	4.4	4.6	44.9	44.7	44.8	44.9
L13	4.9	4.3	4.4	4.6	44.8	44.6	44.7	44.8
L15	5.1	4.3	4.3	4.5	44.7	44.5	44.5	44.6
L16	5.1	4.4	4.6	4.8	44.8	44.6	44.7	44.8
L17	4.9	4.3	4.5	4.8	44.9	44.7	44.8	44.9
L18	5.2	4.3	4.3	4.4	44.6	44.4	44.4	44.5
L19	5.3	4.4	4.4	4.5	44.6	44.3	44.4	44.5
L20	5.3	4.3	4.3	4.3	44.5	44.3	44.3	44.4
L21	5.3	4.3	4.2	4.2	44.5	44.3	44.3	44.3
L22	5.4	4.3	4.3	4.2	44.5	44.2	44.2	44.3
L23	5.3	4.3	4.3	4.3	44.5	44.3	44.3	44.3
L24	5.4	4.4	4.4	4.5	44.5	44.3	44.3	44.4
L25	5.4	4.5	4.5	4.6	44.6	44.3	44.4	44.5
L26	5.4	4.5	4.6	4.7	44.6	44.4	44.4	44.5
L27	5.5	4.2	4.2	4.1	44.4	44.1	44.1	44.2
L28A	5.3	4.0	3.8	3.7	44.3	44.0	44.0	44.1
L28B	5.4	4.0	3.9	3.7	44.2	44.0	44.0	44.0
L29	5.3	4.6	4.8	5.2	44.8	44.6	44.7	44.8
L30	5.2	4.5	4.9	5.3	44.7	44.6	44.7	44.8
L31	5.3	4.6	4.7	5.0	44.7	44.5	44.6	44.7
L32	5.5	4.6	4.8	5.0	44.6	44.4	44.5	44.6
L33	5.6	4.5	4.6	4.7	44.3	44.2	44.2	44.3
L34	5.6	4.3	4.3	4.2	44.3	44.1	44.1	44.2

Table 7.2 (Cont'd)
Predicted 24-hour Average PM_{10} Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**11.6**	**10.0**	**14.0**	**15.6**	**48.1**	**46.5**	**47.2**	**47.6**
L35	5.4	4.0	3.9	3.8	44.2	44.0	44.0	44.1
L37	5.5	4.0	3.9	3.8	44.2	44.0	44.0	44.0
L38	5.5	4.0	4.0	3.8	44.1	44.0	44.0	44.0
L39	5.4	4.0	3.9	3.8	44.2	44.0	44.0	44.0
L40	5.6	4.3	4.3	4.3	44.3	44.1	44.1	44.2
L41	5.5	4.3	4.3	4.3	44.2	44.1	44.1	44.2
L42	5.6	4.0	4.0	3.9	44.1	44.0	44.0	44.0
L43	5.5	4.0	4.0	3.9	44.1	44.0	44.0	44.0
L44	5.5	4.2	4.3	4.3	44.2	44.1	44.1	44.1
L45	5.8	4.0	4.0	3.8	44.1	43.9	43.9	43.9
L46	5.6	4.0	3.9	3.7	44.1	44.0	44.0	44.0
L47	5.7	4.0	3.9	3.7	44.1	43.9	43.9	44.0
L49	4.8	4.3	4.5	4.8	45.2	45.0	45.1	45.2
L50	5.1	3.6	3.4	3.8	44.3	44.0	44.0	44.0
POI1	5.4	4.3	4.1	4.0	44.5	44.2	44.2	44.3
POI2	5.6	4.5	4.6	4.6	44.4	44.2	44.2	44.3
POI3	5.0	4.3	4.4	4.6	44.8	44.6	44.6	44.7
POI4	5.1	4.5	4.5	4.6	45.0	44.6	44.7	44.8
POI5	4.7	4.2	4.3	4.5	45.0	44.8	44.9	45.0
R4	11.6	9.1	11.7	14.1	48.1	46.5	47.2	47.6
R6	2.5	2.1	2.4	2.6	43.8	43.8	43.8	43.8
R7	9.0	8.1	10.1	14.0	46.3	45.6	46.2	47.2
R9	2.0	1.6	1.9	2.0	43.8	43.7	43.7	43.7
R12	5.6	6.6	6.4	7.0	45.4	44.8	44.8	45.6
R13	1.5	1.0	1.1	1.3	43.8	43.8	43.8	43.8
R15	0.9	0.7	0.8	0.8	43.9	43.8	43.8	43.8
R16	0.9	0.6	0.6	0.6	43.8	43.8	43.8	43.8
R17	9.0	4.7	5.3	5.1	43.7	43.7	43.7	43.7
R19	3.2	4.1	5.0	5.4	43.7	43.7	43.7	43.7
R21	8.6	10.0	14.0	15.6	43.7	43.7	43.7	43.7
R22	7.2	7.1	8.5	7.5	43.7	43.7	43.7	43.7
R24	5.9	4.4	5.5	6.1	44.9	44.2	44.3	44.4
R25	4.8	3.0	2.9	3.1	44.1	43.8	43.8	43.8

Table 7.2 (Cont'd)
Predicted 24-hour Average PM_{10} Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**11.6**	**10.0**	**14.0**	**15.6**	**48.1**	**46.5**	**47.2**	**47.6**
R27	7.7	6.6	7.9	9.0	45.6	45.5	46.2	45.2
R28A	2.0	1.6	2.0	2.6	44.1	44.0	44.0	44.0
R28B	2.0	1.5	1.9	2.4	44.1	44.0	44.0	44.0
R28C	2.0	1.8	2.1	2.4	44.1	44.0	44.0	44.0
R28D	1.8	1.6	1.8	2.1	44.1	44.0	44.0	44.0
R31	4.0	3.2	4.0	3.8	43.8	43.8	43.8	43.8
R33	5.9	7.2	9.3	10.0	43.7	43.7	43.7	43.7
R34	5.6	4.4	5.5	5.9	43.7	43.7	43.7	43.7
R35	3.7	3.5	3.4	3.8	44.3	44.2	44.3	44.7
R36A	4.1	2.6	2.5	2.7	44.5	44.1	44.1	44.3
R37	4.1	3.2	3.2	3.7	44.4	44.0	44.0	44.0
R39	4.1	3.7	4.2	5.6	44.7	44.3	44.4	44.6
R40	4.0	3.7	4.4	5.8	44.5	44.2	44.3	44.4
R42	4.8	3.9	3.7	3.9	44.8	44.3	44.3	44.3
R43	3.6	2.7	3.2	3.4	43.8	43.8	43.8	43.8
R44	3.4	2.7	3.1	3.7	45.4	45.1	45.3	45.6
R45A	3.4	2.6	2.9	3.5	45.1	44.9	45.1	45.4
R45B	3.2	2.4	2.7	3.1	45.1	44.8	45.0	45.2
R46	4.3	3.9	4.5	5.8	44.5	44.2	44.3	44.4
R47	4.3	4.0	4.7	6.2	44.5	44.2	44.3	44.3
R48	3.2	2.5	2.9	3.2	44.1	43.9	43.9	43.9
R50	2.3	1.6	1.7	1.7	44.0	43.9	43.9	43.9
R58	1.6	0.7	0.7	0.8	43.7	43.7	43.7	43.7
R60	3.6	1.6	1.8	1.4	44.4	43.7	43.7	43.7
R63	1.1	0.6	0.6	0.5	43.7	43.7	43.7	43.7
R68	3.9	1.5	1.4	0.9	43.7	43.7	43.7	43.7
R70	2.8	1.4	1.4	1.3	43.7	43.7	43.7	43.7
R73	4.9	1.7	1.7	1.5	43.7	43.7	43.7	43.7
R74	4.4	2.2	2.2	2.0	43.7	43.7	43.7	43.7
R75	5.4	1.9	1.6	1.1	43.7	43.7	43.7	43.7
R76	6.3	2.5	2.4	2.1	44.0	43.7	43.7	43.7
R80	2.8	2.2	2.4	2.6	43.8	43.8	43.8	43.8

Table 7.2 (Cont'd)
Predicted 24-hour Average PM_{10} Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
Receiver max	**11.6**	**10.0**	**14.0**	**15.6**	**48.1**	**46.5**	**47.2**	**47.6**
R81	5.9	2.9	3.1	3.5	44.8	43.9	43.9	44.1
R82	5.2	3.0	3.3	3.7	44.6	43.9	43.9	44.2
R83	4.9	2.7	2.7	2.9	44.3	43.8	43.8	43.8
R84A	4.8	2.8	2.7	2.8	44.2	43.8	43.8	43.8
R84B	5.3	3.0	3.0	2.9	44.1	43.8	43.8	43.8
R85	5.4	3.5	3.4	3.2	44.0	43.8	43.8	43.8
R86	3.8	2.8	3.0	3.4	44.1	43.8	43.8	44.1
R87	3.3	2.4	2.5	2.9	44.2	43.9	44.1	44.4
R88	4.2	2.1	2.3	2.5	44.6	44.0	43.9	43.8
R89	5.5	2.6	2.8	3.0	44.9	44.0	43.9	44.0
R90	5.7	2.8	3.0	3.2	44.9	44.0	43.9	44.1
R91	2.9	2.1	2.3	2.4	44.4	44.3	44.4	44.5
R92B	3.5	2.9	3.2	3.6	44.8	44.8	44.9	45.1
R93A	3.9	3.3	3.6	4.3	45.4	45.3	45.5	45.8
R93B	3.7	3.1	3.4	4.0	45.4	45.2	45.5	45.8
R93C	3.6	3.0	3.3	3.8	45.2	45.0	45.3	45.5
R94A	4.2	3.6	4.0	4.7	45.4	45.3	45.5	45.8
R94B	4.0	3.4	3.8	4.4	45.4	45.3	45.5	45.8
R95	3.0	2.3	2.5	3.0	45.2	45.0	45.2	45.4
Note: See EIS Appendix 6 for land ownership details.								

7.3 ANNUAL AVERAGE $PM_{2.5}$ CONCENTRATION

The predicted Project-only and cumulative annual average $PM_{2.5}$ concentrations for private residences are presented in **Table 7.3**. The highest predicted increment in annual average $PM_{2.5}$ at any private residence across all years is 0.8µg/m³ (receiver R7 in Year 9).

There are no private residences where the cumulative annual average $PM_{2.5}$ concentration is greater than 8µg/m³. The highest predicted cumulative annual average $PM_{2.5}$ at any private residence across all years is 4.7µg/m³ (receiver R7 in Year 9). As discussed in Section 5.4, even if a higher background concentration of 5.2µg/m³ was adopted, there would be no private residences where the cumulative annual average $PM_{2.5}$ concentration is greater than 8µg/m³.

Table 7.3
Predicted Annual Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**0.6**	**0.4**	**0.5**	**0.8**	**4.5**	**4.4**	**4.5**	**4.7**
L1	0.2	0.2	0.2	0.2	4.1	4.1	4.1	4.1
L2	0.2	0.2	0.1	0.2	4.1	4.1	4.1	4.1
L3	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L4	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L5	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L7	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L8	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L9	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L10	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
L12	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
L13	0.2	0.1	0.1	0.1	4.1	4.0	4.0	4.1
L15	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L16	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L17	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L18	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L19	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L20	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L21	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L22	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L23	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L24	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L25	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L26	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L27	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L28A	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L28B	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L29	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L30	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L31	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L32	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L33	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L34	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L35	0.2	0.1	0.1	0.1	4.1	4.0	4.0	4.1
L37	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L38	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1

Table 7.3 (Cont'd)
Predicted Annual Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**0.6**	**0.4**	**0.5**	**0.8**	**4.5**	**4.4**	**4.5**	**4.7**
L39	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L40	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L41	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L42	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L43	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L44	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L45	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
L46	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L47	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
L49	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
L50	0.2	0.2	0.2	0.2	4.1	4.1	4.1	4.1
POI1	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
POI2	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
POI3	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
POI4	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
POI5	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
R4	0.4	0.3	0.3	0.4	4.3	4.2	4.3	4.4
R6	0.0	0.0	0.0	0.0	4.0	3.9	3.9	3.9
R7	0.6	0.4	0.5	0.8	4.5	4.4	4.5	4.7
R9	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9
R12	0.4	0.4	0.3	0.4	4.3	4.3	4.2	4.3
R13	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9
R15	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9
R16	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9
R17	0.2	0.1	0.1	0.1	4.1	4.0	4.0	4.0
R19	0.0	0.0	0.0	0.0	4.0	4.0	4.0	4.0
R21	0.2	0.1	0.2	0.1	4.1	4.1	4.1	4.1
R22	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R24	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
R25	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
R27	0.2	0.1	0.2	0.2	4.1	4.1	4.1	4.1
R28A	0.1	0.0	0.0	0.1	4.0	4.0	4.0	4.0
R28B	0.1	0.0	0.0	0.1	4.0	4.0	4.0	4.0
R28C	0.1	0.0	0.0	0.1	4.0	4.0	4.0	4.0
R28D	0.0	0.0	0.0	0.0	4.0	4.0	4.0	4.0

Table 7.3 (Cont'd)
Predicted Annual Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**0.6**	**0.4**	**0.5**	**0.8**	**4.5**	**4.4**	**4.5**	**4.7**
R31	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R33	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R34	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R35	0.3	0.2	0.2	0.2	4.2	4.2	4.1	4.1
R36A	0.2	0.2	0.2	0.2	4.2	4.1	4.1	4.1
R37	0.2	0.2	0.1	0.2	4.1	4.1	4.1	4.1
R39	0.2	0.1	0.2	0.2	4.1	4.1	4.1	4.1
R40	0.2	0.1	0.2	0.2	4.1	4.1	4.1	4.1
R42	0.2	0.2	0.1	0.2	4.1	4.1	4.1	4.1
R43	0.0	0.0	0.0	0.0	4.0	4.0	4.0	4.0
R44	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
R45A	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
R45B	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R46	0.2	0.1	0.2	0.2	4.1	4.1	4.1	4.1
R47	0.2	0.2	0.2	0.2	4.1	4.1	4.1	4.1
R48	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R50	0.0	0.0	0.0	0.0	4.0	4.0	4.0	4.0
R58	0.1	0.0	0.0	0.0	4.0	4.0	4.0	4.0
R60	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.0
R63	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9
R68	0.0	0.0	0.0	0.0	4.0	3.9	3.9	3.9
R70	0.0	0.0	0.0	0.0	4.0	3.9	3.9	3.9
R73	0.1	0.1	0.1	0.0	4.0	4.0	4.0	4.0
R74	0.1	0.0	0.0	0.0	4.0	4.0	3.9	3.9
R75	0.1	0.0	0.0	0.0	4.0	3.9	3.9	3.9
R76	0.2	0.1	0.1	0.1	4.1	4.0	4.0	4.0
R80	0.0	0.0	0.0	0.0	4.0	4.0	4.0	4.0
R81	0.2	0.2	0.2	0.2	4.2	4.1	4.1	4.1
R82	0.2	0.2	0.2	0.2	4.2	4.1	4.1	4.1
R83	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
R84A	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
R84B	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
R85	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
R86	0.2	0.2	0.1	0.2	4.1	4.1	4.1	4.1
R87	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1

Table 7.3 (Cont'd)
Predicted Annual Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**0.6**	**0.4**	**0.5**	**0.8**	**4.5**	**4.4**	**4.5**	**4.7**
R88	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.0
R89	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
R90	0.2	0.1	0.1	0.1	4.1	4.1	4.1	4.1
R91	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R92B	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
R93A	0.2	0.1	0.1	0.2	4.1	4.1	4.1	4.1
R93B	0.2	0.1	0.1	0.2	4.1	4.0	4.1	4.1
R93C	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
R94A	0.2	0.1	0.1	0.2	4.1	4.1	4.0	4.1
R94B	0.1	0.1	0.1	0.1	4.1	4.0	4.0	4.1
R95	0.1	0.1	0.1	0.1	4.0	4.0	4.0	4.0
Note: See EIS Appendix 6 for land ownership details.								

7.4 24-HOUR AVERAGE $PM_{2.5}$ CONCENTRATION

The predicted Project-only and cumulative 24-hour average $PM_{2.5}$ concentrations for private residences are presented in **Table 7.4**. The highest predicted increment in 24-hour average $PM_{2.5}$ at any private residence across all years is 3.6µg/m³ (receiver R7 in Year 9).

There are no private residences where the cumulative 24-hour average $PM_{2.5}$ concentration is greater than 25µg/m³. The highest predicted cumulative 24-hour average $PM_{2.5}$ at any private residence across all years is 16.2µg/m³ (receiver R76 in SE&CS).

Table 7.4
Predicted 24-hour Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.9**	**2.1**	**2.7**	**3.6**	**16.2**	**16.0**	**15.9**	**16.1**
L1	1.4	1.2	1.1	1.2	15.5	15.5	15.5	15.6
L2	1.3	1.2	1.1	1.1	15.5	15.5	15.5	15.5
L3	1.3	1.0	0.9	0.9	15.5	15.6	15.5	15.6
L4	1.2	0.9	0.9	0.8	15.5	15.6	15.5	15.6
L5	1.3	1.0	1.0	0.9	15.5	15.5	15.5	15.6
L7	1.4	1.2	1.1	1.1	15.5	15.5	15.5	15.5
L8	1.4	1.2	1.1	1.2	15.5	15.5	15.5	15.5
L9	1.4	1.2	1.2	1.3	15.5	15.5	15.5	15.5
L10	1.3	1.1	1.1	1.2	15.5	15.5	15.5	15.5

Table 7.4 (Cont'd)
Predicted 24-hour Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.9**	**2.1**	**2.7**	**3.6**	**16.2**	**16.0**	**15.9**	**16.1**
L12	1.3	1.2	1.2	1.3	15.5	15.5	15.5	15.5
L13	1.3	1.2	1.2	1.3	15.5	15.5	15.5	15.5
L15	1.4	1.2	1.2	1.2	15.5	15.5	15.5	15.5
L16	1.4	1.2	1.2	1.3	15.5	15.5	15.5	15.5
L17	1.3	1.2	1.2	1.3	15.5	15.5	15.5	15.5
L18	1.4	1.2	1.2	1.2	15.5	15.5	15.5	15.5
L19	1.4	1.2	1.2	1.2	15.5	15.5	15.5	15.5
L20	1.4	1.2	1.2	1.2	15.5	15.5	15.5	15.5
L21	1.4	1.2	1.1	1.2	15.5	15.5	15.5	15.5
L22	1.4	1.2	1.1	1.2	15.5	15.5	15.5	15.5
L23	1.4	1.2	1.2	1.2	15.5	15.5	15.5	15.5
L24	1.4	1.2	1.2	1.2	15.5	15.5	15.5	15.5
L25	1.4	1.2	1.2	1.3	15.5	15.5	15.5	15.5
L26	1.4	1.2	1.2	1.3	15.5	15.5	15.5	15.5
L27	1.4	1.2	1.1	1.2	15.5	15.5	15.5	15.5
L28A	1.4	1.1	1.0	1.1	15.5	15.5	15.5	15.5
L28B	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.5
L29	1.4	1.3	1.3	1.4	15.5	15.5	15.5	15.6
L30	1.4	1.2	1.3	1.4	15.5	15.5	15.5	15.6
L31	1.4	1.2	1.3	1.4	15.5	15.5	15.5	15.5
L32	1.5	1.3	1.3	1.4	15.5	15.5	15.5	15.6
L33	1.5	1.2	1.2	1.3	15.5	15.5	15.5	15.6
L34	1.5	1.2	1.2	1.2	15.5	15.5	15.5	15.6
L35	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.5
L37	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.6
L38	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.6
L39	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.5
L40	1.5	1.2	1.2	1.2	15.5	15.5	15.5	15.6
L41	1.5	1.2	1.2	1.2	15.5	15.5	15.5	15.6
L42	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.6
L43	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.6
L44	1.4	1.2	1.1	1.2	15.5	15.5	15.5	15.6
L45	1.5	1.1	1.1	1.1	15.6	15.6	15.6	15.6
L46	1.4	1.1	1.1	1.1	15.5	15.5	15.5	15.6
L47	1.4	1.1	1.1	1.1	15.5	15.6	15.5	15.6
L49	1.3	1.2	1.2	1.3	15.5	15.5	15.5	15.5

Table 7.4 (Cont'd)
Predicted 24-hour Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.9**	**2.1**	**2.7**	**3.6**	**16.2**	**16.0**	**15.9**	**16.1**
L50	1.2	1.0	0.9	0.9	15.5	15.6	15.5	15.6
POI1	1.4	1.2	1.1	1.1	15.5	15.5	15.5	15.5
POI2	1.5	1.2	1.2	1.3	15.5	15.5	15.5	15.6
POI3	1.3	1.2	1.2	1.3	15.5	15.5	15.5	15.5
POI4	1.4	1.2	1.2	1.3	15.5	15.5	15.5	15.5
POI5	1.3	1.1	1.1	1.2	15.5	15.5	15.5	15.5
R4	2.9	2.0	2.7	2.9	15.4	15.4	15.4	15.4
R6	0.6	0.5	0.6	0.6	15.4	15.4	15.4	15.4
R7	2.4	2.1	2.7	3.6	15.7	15.6	15.6	15.7
R9	0.5	0.4	0.4	0.5	15.4	15.4	15.4	15.4
R12	1.5	1.7	1.6	1.8	15.9	16.0	15.9	16.1
R13	0.3	0.3	0.3	0.3	15.4	15.4	15.4	15.4
R15	0.2	0.2	0.2	0.2	15.4	15.4	15.4	15.4
R16	0.2	0.1	0.1	0.1	15.4	15.4	15.4	15.4
R17	1.7	1.0	1.0	0.9	15.8	15.6	15.6	15.6
R19	0.7	0.8	1.0	1.1	15.4	15.4	15.4	15.4
R21	1.8	1.9	2.7	3.0	15.4	15.4	15.4	15.4
R22	1.5	1.4	1.7	1.5	15.4	15.4	15.4	15.4
R24	1.4	1.1	1.2	1.2	15.4	15.4	15.4	15.4
R25	1.2	0.8	0.8	0.8	15.5	15.6	15.5	15.6
R27	2.0	1.5	1.8	2.0	15.4	15.4	15.4	15.4
R28A	0.5	0.4	0.4	0.6	15.4	15.4	15.4	15.4
R28B	0.5	0.4	0.4	0.6	15.4	15.4	15.4	15.4
R28C	0.5	0.4	0.5	0.5	15.4	15.4	15.4	15.4
R28D	0.5	0.4	0.4	0.5	15.4	15.4	15.4	15.4
R31	0.9	0.7	0.8	0.8	15.4	15.4	15.4	15.4
R33	1.3	1.4	1.8	2.0	15.4	15.4	15.4	15.4
R34	1.2	0.9	1.1	1.2	15.4	15.4	15.4	15.4
R35	1.1	1.0	0.9	1.1	15.7	15.8	15.8	15.9
R36A	1.2	0.7	0.7	0.7	15.7	15.7	15.7	15.8
R37	1.0	0.9	0.8	0.9	15.5	15.5	15.5	15.6
R39	1.1	1.0	1.1	1.4	15.4	15.4	15.4	15.5
R40	1.1	1.0	1.1	1.5	15.4	15.4	15.4	15.5
R42	1.2	1.1	1.0	1.0	15.5	15.5	15.5	15.5
R43	0.8	0.6	0.7	0.7	15.4	15.4	15.4	15.4
R44	0.9	0.8	0.8	0.9	15.4	15.4	15.4	15.5

Table 7.4 (Cont'd)
Predicted 24-hour Average $PM_{2.5}$ Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**2.9**	**2.1**	**2.7**	**3.6**	**16.2**	**16.0**	**15.9**	**16.1**
R45A	0.9	0.7	0.7	0.9	15.4	15.4	15.4	15.5
R45B	0.8	0.6	0.7	0.8	15.4	15.4	15.4	15.5
R46	1.2	1.1	1.2	1.6	15.4	15.4	15.4	15.5
R47	1.1	1.0	1.2	1.6	15.4	15.4	15.4	15.4
R48	0.7	0.7	0.7	0.8	15.4	15.4	15.4	15.4
R50	0.5	0.4	0.4	0.4	15.4	15.4	15.4	15.4
R58	0.4	0.2	0.2	0.2	15.5	15.5	15.5	15.5
R60	0.9	0.4	0.4	0.4	15.7	15.6	15.6	15.7
R63	0.3	0.1	0.1	0.1	15.5	15.5	15.5	15.5
R68	0.9	0.4	0.3	0.2	15.8	15.6	15.6	15.5
R70	0.6	0.4	0.4	0.4	15.6	15.5	15.5	15.5
R73	1.3	0.5	0.4	0.3	16.0	15.6	15.6	15.5
R74	0.9	0.6	0.6	0.5	15.6	15.5	15.5	15.5
R75	1.2	0.4	0.3	0.3	15.6	15.6	15.5	15.5
R76	1.6	0.6	0.6	0.5	16.2	15.8	15.7	15.6
R80	0.6	0.5	0.5	0.6	15.4	15.4	15.4	15.4
R81	1.6	0.8	0.8	0.8	15.7	15.7	15.7	15.8
R82	1.6	0.8	0.8	0.9	15.7	15.7	15.7	15.8
R83	1.3	0.7	0.7	0.8	15.6	15.6	15.6	15.7
R84A	1.2	0.7	0.7	0.7	15.6	15.6	15.6	15.6
R84B	1.3	0.8	0.8	0.8	15.6	15.6	15.6	15.7
R85	1.4	1.0	0.9	0.9	15.5	15.6	15.5	15.6
R86	1.0	0.7	0.7	0.8	15.6	15.6	15.6	15.6
R87	1.0	0.7	0.7	0.8	15.6	15.6	15.6	15.7
R88	1.2	0.5	0.5	0.6	15.5	15.6	15.5	15.6
R89	1.5	0.7	0.6	0.7	15.6	15.6	15.6	15.6
R90	1.6	0.7	0.7	0.7	15.6	15.6	15.6	15.7
R91	0.8	0.6	0.7	0.8	15.5	15.5	15.5	15.5
R92B	1.0	0.8	0.8	1.0	15.5	15.5	15.5	15.5
R93A	1.0	0.9	1.0	1.3	15.5	15.5	15.5	15.5
R93B	1.0	0.9	1.0	1.3	15.5	15.5	15.5	15.5
R93C	1.0	0.8	1.0	1.2	15.5	15.5	15.5	15.5
R94A	1.1	1.0	1.0	1.2	15.5	15.5	15.5	15.5
R94B	1.1	0.9	1.0	1.1	15.5	15.5	15.5	15.5
R95	0.8	0.6	0.7	0.9	15.4	15.5	15.4	15.5

Note: See EIS Appendix 6 for land ownership details.

7.5 ANNUAL AVERAGE TSP CONCENTRATION

The predicted Project-only and cumulative annual average TSP concentrations for private residences are presented in **Table 7.5**. The highest predicted increment in annual average TSP at any private residence across all years is 7.4µg/m³ (receiver R7 in Year 9).

There are no private residences where the cumulative annual average TSP concentration is greater than 90µg/m³. The highest predicted cumulative annual average TSP at any private residence across all years is 38.4µg/m³ (receiver R7 in Year 9).

Table 7.5
Predicted Annual Average TSP Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**4.4**	**3.7**	**5.0**	**7.4**	**35.4**	**34.7**	**36.0**	**38.4**
L1	1.4	1.2	1.2	1.5	32.4	32.2	32.2	32.5
L2	1.3	1.1	1.1	1.4	32.3	32.1	32.1	32.4
L3	1.4	1.1	1.2	1.3	32.4	32.1	32.2	32.3
L4	1.4	1.1	1.2	1.3	32.4	32.1	32.2	32.3
L5	1.3	1.0	1.1	1.3	32.3	32.0	32.1	32.3
L7	1.3	1.1	1.1	1.3	32.3	32.1	32.1	32.3
L8	1.3	1.1	1.2	1.3	32.3	32.1	32.2	32.3
L9	1.2	1.0	1.1	1.3	32.2	32.0	32.1	32.3
L10	1.1	0.9	1.0	1.1	32.1	31.9	32.0	32.1
L12	1.1	0.9	1.0	1.1	32.1	31.9	32.0	32.1
L13	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
L15	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
L16	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
L17	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
L18	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
L19	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L20	1.2	1.0	1.0	1.2	32.2	32.0	32.0	32.2
L21	1.2	0.9	1.0	1.2	32.2	31.9	32.0	32.2
L22	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L23	1.2	1.0	1.0	1.2	32.2	32.0	32.0	32.2
L24	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L25	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L26	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L27	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L28A	1.2	1.0	1.0	1.2	32.2	32.0	32.0	32.2
L28B	1.2	1.0	1.0	1.2	32.2	32.0	32.0	32.2
L29	1.2	1.0	1.1	1.3	32.2	32.0	32.1	32.3
L30	1.2	1.0	1.1	1.3	32.2	32.0	32.1	32.3
L31	1.2	1.0	1.1	1.3	32.2	32.0	32.1	32.3
L32	1.2	1.0	1.1	1.3	32.2	32.0	32.1	32.3

Table 7.5 (Cont'd)
Predicted Annual Average TSP Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**4.4**	**3.7**	**5.0**	**7.4**	**35.4**	**34.7**	**36.0**	**38.4**
L33	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L34	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L35	1.1	0.9	1.0	1.1	32.1	31.9	32.0	32.1
L37	1.2	1.0	1.0	1.2	32.2	32.0	32.0	32.2
L38	1.2	0.9	1.0	1.2	32.2	31.9	32.0	32.2
L39	1.2	0.9	1.0	1.1	32.2	31.9	32.0	32.1
L40	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L41	1.2	0.9	1.0	1.2	32.2	31.9	32.0	32.2
L42	1.2	0.9	1.0	1.1	32.2	31.9	32.0	32.1
L43	1.2	0.9	1.0	1.1	32.2	31.9	32.0	32.1
L44	1.1	0.9	1.0	1.1	32.1	31.9	32.0	32.1
L45	1.3	1.0	1.1	1.2	32.3	32.0	32.1	32.2
L46	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L47	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
L49	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
L50	1.4	1.2	1.3	1.4	32.4	32.2	32.3	32.4
POI1	1.3	1.1	1.1	1.3	32.3	32.1	32.1	32.3
POI2	1.2	1.0	1.1	1.2	32.2	32.0	32.1	32.2
POI3	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
POI4	1.2	1.0	1.1	1.3	32.2	32.0	32.1	32.3
POI5	1.1	0.9	1.0	1.1	32.1	31.9	32.0	32.1
R4	3.3	2.8	3.6	4.8	34.3	33.8	34.6	35.8
R6	0.2	0.2	0.2	0.2	31.2	31.2	31.2	31.2
R7	4.4	3.7	5.0	7.4	35.4	34.7	36.0	38.4
R9	0.2	0.1	0.2	0.1	31.2	31.1	31.2	31.1
R12	2.6	2.5	2.5	3.0	33.6	33.5	33.5	34.0
R13	0.2	0.1	0.1	0.1	31.2	31.1	31.1	31.1
R15	0.2	0.1	0.1	0.1	31.2	31.1	31.1	31.1
R16	0.1	0.1	0.1	0.1	31.1	31.1	31.1	31.1
R17	1.7	0.8	0.7	0.4	32.7	31.8	31.7	31.4
R19	0.4	0.3	0.3	0.3	31.4	31.3	31.3	31.3
R21	1.4	1.2	1.3	1.2	32.4	32.2	32.3	32.2
R22	0.8	0.7	0.8	0.8	31.8	31.7	31.8	31.8
R24	1.0	0.9	1.0	1.1	32.0	31.9	32.0	32.1
R25	1.4	1.1	1.2	1.3	32.4	32.1	32.2	32.3
R27	1.2	1.2	1.4	1.6	32.2	32.2	32.4	32.6
R28A	0.4	0.3	0.4	0.4	31.4	31.3	31.4	31.4
R28B	0.4	0.3	0.4	0.4	31.4	31.3	31.4	31.4

Table 7.5 (Cont'd)
Predicted Annual Average TSP Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**4.4**	**3.7**	**5.0**	**7.4**	**35.4**	**34.7**	**36.0**	**38.4**
R28C	0.4	0.3	0.4	0.4	31.4	31.3	31.4	31.4
R28D	0.3	0.3	0.3	0.4	31.3	31.3	31.3	31.4
R31	0.5	0.4	0.5	0.5	31.5	31.4	31.5	31.5
R33	0.9	0.8	0.9	1.0	31.9	31.8	31.9	32.0
R34	0.6	0.5	0.6	0.5	31.6	31.5	31.6	31.5
R35	2.1	1.7	1.7	1.8	33.1	32.7	32.7	32.8
R36A	2.0	1.3	1.3	1.2	33.0	32.3	32.3	32.2
R37	1.4	1.2	1.2	1.4	32.4	32.2	32.2	32.4
R39	1.3	1.2	1.4	1.8	32.3	32.2	32.4	32.8
R40	1.3	1.2	1.4	1.7	32.3	32.2	32.4	32.7
R42	1.3	1.1	1.2	1.4	32.3	32.1	32.2	32.4
R43	0.3	0.3	0.3	0.3	31.3	31.3	31.3	31.3
R44	1.0	0.8	0.9	1.2	32.0	31.8	31.9	32.2
R45A	1.0	0.8	1.0	1.2	32.0	31.8	32.0	32.2
R45B	0.9	0.7	0.8	1.0	31.9	31.7	31.8	32.0
R46	1.3	1.2	1.4	1.7	32.3	32.2	32.4	32.7
R47	1.3	1.2	1.5	1.8	32.3	32.2	32.5	32.8
R48	0.6	0.6	0.7	0.7	31.6	31.6	31.7	31.7
R50	0.4	0.3	0.4	0.4	31.4	31.3	31.4	31.4
R58	0.4	0.3	0.3	0.3	31.4	31.3	31.3	31.3
R60	1.2	0.7	0.7	0.6	32.2	31.7	31.7	31.6
R63	0.2	0.1	0.1	0.1	31.2	31.1	31.1	31.1
R68	0.4	0.2	0.2	0.1	31.4	31.2	31.2	31.1
R70	0.3	0.1	0.1	0.1	31.3	31.1	31.1	31.1
R73	1.3	0.6	0.5	0.3	32.3	31.6	31.5	31.3
R74	0.6	0.3	0.3	0.2	31.6	31.3	31.3	31.2
R75	0.6	0.3	0.3	0.2	31.6	31.3	31.3	31.2
R76	1.9	0.9	0.8	0.5	32.9	31.9	31.8	31.5
R80	0.3	0.2	0.3	0.3	31.3	31.2	31.3	31.3
R81	1.7	1.3	1.5	1.5	32.7	32.3	32.5	32.5
R82	1.8	1.4	1.5	1.6	32.8	32.4	32.5	32.6
R83	1.3	1.0	1.2	1.2	32.3	32.0	32.2	32.2
R84A	1.3	1.0	1.1	1.2	32.3	32.0	32.1	32.2
R84B	1.3	1.0	1.1	1.1	32.3	32.0	32.1	32.1
R85	1.2	1.0	1.1	1.1	32.2	32.0	32.1	32.1
R86	1.5	1.2	1.3	1.3	32.5	32.2	32.3	32.3
R87	1.5	1.1	1.2	1.2	32.5	32.1	32.2	32.2
R88	1.1	0.8	0.9	0.9	32.1	31.8	31.9	31.9
R89	1.4	1.0	1.1	1.1	32.4	32.0	32.1	32.1

Table 7.5 (Cont'd)
Predicted Annual Average TSP Concentration (µg/m³)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**4.4**	**3.7**	**5.0**	**7.4**	**35.4**	**34.7**	**36.0**	**38.4**
R90	1.5	1.1	1.2	1.2	32.5	32.1	32.2	32.2
R91	0.6	0.5	0.5	0.6	31.6	31.5	31.5	31.6
R92B	0.9	0.7	0.8	0.9	31.9	31.7	31.8	31.9
R93A	1.1	0.9	1.1	1.3	32.1	31.9	32.1	32.3
R93B	1.1	0.9	1.1	1.3	32.1	31.9	32.1	32.3
R93C	0.9	0.8	0.9	1.1	31.9	31.8	31.9	32.1
R94A	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
R94B	1.0	0.9	1.0	1.2	32.0	31.9	32.0	32.2
R95	0.9	0.7	0.8	1.0	31.9	31.7	31.8	32.0
Note: See EIS Appendix 6 for land ownership details.								

7.6 ANNUAL AVERAGE DUST DEPOSITION

The predicted Project-only and cumulative annual average dust deposition for private residences are presented in **Table 7.6**. The predicted incremental increase in dust deposition is less than 1g/m^2/month at all private residences for all years (less than 50% of the impact assessment criteria of 2g/m^2/month). Similarly, predicted cumulative dust deposition is less than 2g/m^2/month at all private residences for all years (less than 50% of the impact assessment criteria of 4g/m^2/month).

Table 7.6
Predicted Annual Average Dust Deposition (g/m^2/month)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**0.15**	**0.14**	**0.17**	**0.23**	**1.2**	**1.1**	**1.2**	**1.2**
L1	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
L2	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
L3	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
L4	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
L5	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
L7	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
L8	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
L9	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L10	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L12	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L13	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L15	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L16	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L17	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0

Table 7.6 (Cont'd)
Predicted Annual Average Dust Deposition (g/m^2/month)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**0.15**	**0.14**	**0.17**	**0.23**	**1.2**	**1.1**	**1.2**	**1.2**
L18	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L19	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L20	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L21	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L22	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L23	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L24	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L25	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L26	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L27	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L28A	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L28B	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L29	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L30	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L31	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L32	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L33	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L34	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L35	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L37	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L38	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L39	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L40	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L41	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L42	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L43	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L44	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
L45	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L46	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L47	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L49	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
L50	0.04	0.03	0.03	0.03	1.0	1.0	1.0	1.0
POI1	0.03	0.02	0.03	0.03	1.0	1.0	1.0	1.0
POI2	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
POI3	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
POI4	0.03	0.02	0.02	0.03	1.0	1.0	1.0	1.0
POI5	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R4	0.15	0.14	0.17	0.23	1.2	1.1	1.2	1.2
R6	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0

Table 7.6 (Cont'd)
Predicted Annual Average Dust Deposition (g/m^2/month)

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ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
Receiver max	**0.15**	**0.14**	**0.17**	**0.23**	**1.2**	**1.1**	**1.2**	**1.2**
R7	0.10	0.09	0.11	0.16	1.1	1.1	1.1	1.2
R9	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R12	0.07	0.06	0.06	0.07	1.1	1.1	1.1	1.1
R13	0.01	0.00	0.01	0.00	1.0	1.0	1.0	1.0
R15	0.01	0.00	0.01	0.00	1.0	1.0	1.0	1.0
R16	0.01	0.00	0.00	0.00	1.0	1.0	1.0	1.0
R17	0.15	0.06	0.05	0.03	1.1	1.1	1.1	1.0
R19	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R21	0.08	0.07	0.07	0.06	1.1	1.1	1.1	1.1
R22	0.05	0.04	0.05	0.04	1.0	1.0	1.0	1.0
R24	0.04	0.04	0.04	0.05	1.0	1.0	1.0	1.0
R25	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
R27	0.04	0.04	0.05	0.06	1.0	1.0	1.0	1.1
R28A	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R28B	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R28C	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R28D	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R31	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R33	0.05	0.05	0.05	0.05	1.0	1.0	1.1	1.1
R34	0.04	0.03	0.03	0.03	1.0	1.0	1.0	1.0
R35	0.07	0.06	0.05	0.06	1.1	1.1	1.1	1.1
R36A	0.09	0.06	0.05	0.05	1.1	1.1	1.1	1.1
R37	0.04	0.03	0.03	0.04	1.0	1.0	1.0	1.0
R39	0.03	0.03	0.03	0.04	1.0	1.0	1.0	1.0
R40	0.03	0.03	0.03	0.04	1.0	1.0	1.0	1.0
R42	0.03	0.03	0.03	0.03	1.0	1.0	1.0	1.0
R43	0.02	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R44	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R45A	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R45B	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R46	0.03	0.03	0.03	0.04	1.0	1.0	1.0	1.0
R47	0.03	0.03	0.03	0.04	1.0	1.0	1.0	1.0
R48	0.02	0.01	0.02	0.02	1.0	1.0	1.0	1.0
R50	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R58	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R60	0.05	0.03	0.03	0.02	1.1	1.0	1.0	1.0
R63	0.01	0.01	0.01	0.00	1.0	1.0	1.0	1.0
R68	0.02	0.01	0.01	0.00	1.0	1.0	1.0	1.0
R70	0.02	0.01	0.01	0.00	1.0	1.0	1.0	1.0

Table 7.6 (Cont'd)
Predicted Annual Average Dust Deposition (g/m²/month)

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ID	Project-only				Cumulative			
	SE&CS	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
Receiver max	**0.15**	**0.14**	**0.17**	**0.23**	**1.2**	**1.1**	**1.2**	**1.2**
R73	0.08	0.03	0.03	0.01	1.1	1.0	1.0	1.0
R74	0.03	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R75	0.03	0.01	0.01	0.00	1.0	1.0	1.0	1.0
R76	0.11	0.05	0.04	0.02	1.1	1.0	1.0	1.0
R80	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R81	0.04	0.03	0.03	0.03	1.0	1.0	1.0	1.0
R82	0.04	0.03	0.04	0.04	1.0	1.0	1.0	1.0
R83	0.03	0.02	0.03	0.03	1.0	1.0	1.0	1.0
R84A	0.03	0.02	0.03	0.03	1.0	1.0	1.0	1.0
R84B	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R85	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R86	0.04	0.03	0.03	0.03	1.0	1.0	1.0	1.0
R87	0.06	0.04	0.04	0.04	1.1	1.0	1.0	1.0
R88	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R89	0.04	0.03	0.03	0.03	1.0	1.0	1.0	1.0
R90	0.04	0.03	0.03	0.03	1.0	1.0	1.0	1.0
R91	0.01	0.01	0.01	0.01	1.0	1.0	1.0	1.0
R92B	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R93A	0.02	0.02	0.02	0.03	1.0	1.0	1.0	1.0
R93B	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R93C	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R94A	0.02	0.02	0.02	0.03	1.0	1.0	1.0	1.0
R94B	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
R95	0.02	0.02	0.02	0.02	1.0	1.0	1.0	1.0
Note: See EIS Appendix 6 for land ownership details.								

7.7 METALS

The predicted incremental 1-hour average metal dust concentrations are presented in **Table 7.7**. Results are presented as the maximum 1-hour average (100th percentile) across residences located beyond the Mine Site. The predicted maximum incremental increases in metal dust concentrations are well below the applicable impact assessment criteria for all pollutants.

Table 7.7
Predicted 1-hour Average Metal in Dust Concentration (µg/m³)

Pollutant	Size fraction	Goal	SE&CS	Year 3	Year 8	Year 9
Silver (Ag)	$PM_{2.5}$	1.8	0.011	0.006	0.008	0.008
	PM_{10}		0.002	0.001	0.001	0.001
	TSP		0.015	0.010	0.012	0.013
Arsenic (As)	$PM_{2.5}$	0.09	0.031	0.024	0.036	0.031
	PM_{10}		0.005	0.004	0.006	0.005
	TSP		0.045	0.041	0.063	0.052
Cadmium (Cd)	$PM_{2.5}$	0.018	0.002	0.001	0.002	0.002
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.003	0.002	0.003	0.003
Copper (Cu)	$PM_{2.5}$	18	0.011	0.006	0.007	0.008
	PM_{10}		0.002	0.002	0.001	0.001
	TSP		0.015	0.010	0.012	0.013
Manganese (Mn)	$PM_{2.5}$	18	0.007	0.002	0.001	0.002
	PM_{10}		0.001	0.000	0.000	0.000
	TSP		0.016	0.005	0.003	0.003
Zinc (Zn)	$PM_{2.5}$	18	0.402	0.259	0.347	0.332
	PM_{10}		0.076	0.044	0.057	0.055
	TSP		0.567	0.427	0.589	0.542
Cobalt (Co)	$PM_{2.5}$	N/A	0.000	0.001	0.001	0.001
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.001	0.001	0.002	0.001
Chromium (Cr)	$PM_{2.5}$	9	0.011	0.007	0.009	0.008
	PM_{10}		0.002	0.001	0.001	0.001
	TSP		0.015	0.011	0.014	0.014
Iron (Fe)	$PM_{2.5}$	N/A	2.483	2.951	5.111	3.961
	PM_{10}		0.524	0.483	0.814	0.649
	TSP		3.672	5.209	9.229	6.847
Mercury (Hg)	$PM_{2.5}$	0.18	0.000	0.001	0.001	0.001
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.001	0.001	0.002	0.001
Lithium (Li)	$PM_{2.5}$	N/A	0.005	0.006	0.011	0.008
	PM_{10}		0.001	0.001	0.002	0.001
	TSP		0.008	0.011	0.019	0.014
Nickel (Ni)	$PM_{2.5}$	0.18	0.000	0.001	0.001	0.001
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.001	0.001	0.002	0.002
Goal = NSW EPA Impact assessment criteria						

The predicted incremental annual average lead dust concentrations are presented in **Table 7.8**. Considering measured average background concentrations of the order of 0.001µg/m^3, there would be no exceedances of the cumulative impact assessment criteria for lead.

Table 7.8
Predicted Annual Average Lead Dust Concentration (µg/m³)

Pollutant	Size fraction	Goal	SE&CS	Year 3	Year 8	Year 9
Lead (Pb)	$PM_{2.5}$	0.5	0.001	0.001	0.001	0.001
	PM_{10}		0.0003	0.0003	0.0002	0.0002
	TSP		0.001	0.001	0.001	0.001
Goal = NSW EPA Impact assessment criteria						

7.8 RESPIRABLE CRYSTALLINE SILICA

The predicted incremental annual average silica dust concentrations are presented in **Table 7.9**. Results are presented for the $PM_{2.5}$ size fraction and compared against the Victoria EPA's assessment criteria of 3.0µg/m³. No exceedances of the impact assessment criteria are predicted at either Project-related or private residences with the maximum concentration at a private residence predicted at 0.21µg/m³ (at R7 in Year 9), i.e. an order of magnitude below the criteria.

Table 7.9
Predicted Annual Average Silica Dust Concentration (µg/m³)

Pollutant	Receiver type	Goal	SE&CS	Year 3	Year 8	Year 9
Silica	Project-related receivers	3.0	0.05 (R1K) to 0.54 (R1A)	0.02 (R1K) to 0.34 (R10)	0.02 (R1K) to 0.51 (R10)	0.02 (R1K) to 0.76 (R1A)
	Privately-owned rural residences		0.01 (R16) to 0.14 (R7)	0.00 (R16) to 0.12 (R12)	0.00 (R70) to 0.15 (R7)	0.00 (R70) to 0.21 (R7)
	Privately-owned Lue residences		0.05 (L10) to 0.06 (L50)	0.04 (L10) to 0.05 (L50)	0.03 (L10) to 0.04 (L50)	0.04 (L10) to 0.05 (L50)
Goal = EPA Victoria assessment criterion for mining and extractive industries						

7.9 HYDROGEN CYANIDE (HCN)

The predicted incremental 1-hour average HCN concentrations are presented in **Table 7.10** Results are presented as the maximum 1-hour average (i.e. 100th percentile) and compared against the impact assessment criteria of 200µg/m³. No exceedances of the impact assessment criteria are predicted at Project-related or private residences with maximum concentrations two orders of magnitude below the criteria.

Table 7.10
Predicted 1-hour Average HCN Concentration (µg/m³)

Pollutant	Receiver type	Goal	Concentration Range (µg/m³)
HCN	Project-related receivers	200	1.8 (R1I) to 5.9 (R1K)
	Privately-owned rural residences		0.3 (R16) to 4.1 (R82)
	Privately-owned Lue residences		1.6 (L49) to 2.2 (L45)
Goal = NSW EPA Impact assessment criteria			

7.10 VOLUNTARY LAND ACQUISITION ON VACANT LAND

Voluntary land acquisition criteria also apply if the development contributes to an exceedance of the criteria listed in **Table 2.5** on more than 25% of privately-owned land upon which a dwelling could be built under existing planning controls.

Analysis of the contour plots presented in **Annexure 6** indicates that Project-only 24-hour PM_{10} and $PM_{2.5}$ concentrations are unlikely to exceed 50µg/m³ or 25µg/m³ across more than 25% of any privately-owned land.

To assess against voluntary land acquisition criteria for cumulative annual average PM_{10}, $PM_{2.5}$ and TSP, a fixed background value is added to the incremental contour plots presented in **Annexure 6**. Based on this, no additional land would be subject to voluntary land acquisition.

For dust deposition, the Project-only contribution does not exceed 2g/m²/month across more than 25% of any private property and the cumulative contribution does not exceed 4g/m²/month across more than 25% of any private property.

8. GREENHOUSE GAS ASSESSMENT

8.1 INTRODUCTION

The estimation of GHG emissions for the Project is primarily based on the Australian Government Department of Environment and Energy (DEE) *National Greenhouse Accounts Factors (NGAF) workbook* (DEE, 2018)[15]. The only exception to this is vegetation clearing, which is estimated based on a methodology developed by Australian state road authorities and NZ Transport Agency, under the banner of the Transport Authorities Greenhouse Group (TAGG, 2018 (see Section 8.3.2)).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoE, 2015). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream use of products and services or the upstream extraction and production of raw materials.

Scope 3 is an optional reporting category (Bhatia et al, 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations[16].

GHG emissions for individual gases are typically reported as carbon dioxide equivalent emissions (CO_2-e), which are calculated based on each gas' global warming potential (GWP) relative to carbon dioxide.

8.2 EMISSION SOURCES

The GHG emissions sources included in this assessment are listed in **Table 8.1**, representing the most significant sources associated with the Project. Other minor sources of GHG emissions, such as those generated by waste disposal, are anticipated to be negligible in comparison and have not been considered in this assessment.

[15] The methodologies in the NGAF workbook follow a simplified approach, equivalent to the "Method 1" approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (Technical Guidelines) (DoE, 2014). The Technical Guidelines are used for the purpose of reporting under the (National Greenhouse and Energy Reporting Act 2007) (the NGER Act).

[16] Specific Scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels (relating to extraction and transport) and purchased electricity (relating to transmission and distribution losses), making it straightforward for these sources to be included in a GHG inventory even if they are not major sources.

Table 8.1
Scope 1, 2 and 3 Emission Sources from the Bowdens Silver Project

Scope	Source
Scope 1	Direct emissions from fuel combustion (diesel) by on-site plant and equipment during mining and rehabilitation.
	Emissions from explosive usage.
	Emissions associated with vegetation stripping
Scope 2	Indirect emissions associated with the consumption of purchased electricity.
Scope 3	Indirect upstream emissions from the extraction, production and transport of diesel fuel.
	Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.
	Downstream emissions generated from transportation of silver / lead concentrate by road from Mine Site to Parkes.
	Downstream emissions generated from transportation of silver / lead concentrate by rail from Parkes to Port Pirie.
	Downstream emissions generated from transportation of zinc concentrate by road from Mine Site to Port of Newcastle or Port Botany.
	Employee travel
	Downstream emissions generated from international transportation of product by ship

8.3 ACTIVITY DATA

8.3.1 Fuel and Energy Consumption and Assumptions

Fuel based activity data for the emission estimates are presented in **Table 8.2**. The annual on-site diesel consumption for mining and rehabilitation was provided by Bowdens Silver for each year of the Project and used directly for emission estimates.

Diesel consumption from product transportation by road is estimated based on an average articulated truck diesel consumption rate of 55.2 L/100-km[17] and respective travel distance for silver/lead concentrate (Mine Site to Parkes) and lead concentrate (Mine Site to Newcastle or Botany). Based on an average truck load of 44t of concentrate, between 200 and 290 truckloads would be required to transport between 8,800 and 12,760 tonnes of silver/lead concentrate per annum and between 280 and 410 truckloads would be required to transport between 12 320 and 18 040 tonnes of zinc concentrate per annum. To estimate the annual variation in fuel consumption for product transportation by road, these maximum truck movements are scaled pro-rata based on the ratio of ore production for that year to the maximum ore production across all years.

Diesel consumption from silver/lead concentrate transport by rail is based on an NSW fleet average diesel consumption rate of 4.03 L/kilotonne.km (NSW EPA, 2012). The maximum annual tonnes of product and travel distance from Parkes to Port Pirie (1 113km) are combined to estimate the gross-tonne-km travelled for loaded trains. For the return trip, an estimate of the gross-tonne-km for empty trains is made based on a wagon weight of 23 tonnes (t), an average of 88 wagons per train and average train capacity of 8 336t. To estimate the annual variation in

[17] Taken from the ABS Survey of Motor Vehicle Use for Australia for the 12 months ended 30 June 2018

fuel consumption for product transportation by rail, the maximum diesel consumption is scaled pro-rata based on the ratio of ore production for that year to the maximum ore production across all years.

Power consumption is assumed to peak in Year 7 (year of maximum ore production) with the reported maximum power requirement of 84 000 MWhr (megawatt hours) per annum applied for this year. Electricity consumption for all other years is pro-rated from the maximum, based on the ore production for that year. Explosive usage for each year is based on intensity factors provided by Bowdens Silver, as follows: 0.2087 tonnes explosive per tonne of waste rock and 0.2826 tonnes explosive per tonne ore.

Table 8.2
Annual Activity Data

Year	Diesel consumption (kL) - mining	Diesel consumption (kL) – road transport	Diesel consumption (kL) – rail transport	Diesel consumption (kL) - rehabilitation	Explosives usage (t)	Electricity (kWh)
1	12 810	-	-	-	1 128	4 614
2	6 658	189	149	-	1 422	70 791
3	6 658	207	163	-	1,428	77 427
4	8 319	185	146	-	1,433	69 092
5	6 594	212	167	-	1 446	79 355
6	6 594	218	172	-	1 438	81 584
7	6 594	225	177	-	1 234	84 000
8	6 594	222	175	-	1 227	83 124
9	8 667	160	126	-	1 199	59 963
10	6 223	54	43	-	1 115	20 216
11	6 223	143	112	-	1 170	53 306
12	6 223	150	118	-	1 180	55 883
13	6 223	182	144	-	1 210	68 143
14	6 223	180	142	-	890	67 420
15	6 223	163	128	-	787	60 907
16	6 223	84	66	-	329	31 220
17	-	-	-	1 851	-	-
18	-	-	-	1 440	-	-
19	-	-	-	1 391	-	-
20	-	-	-	1 851	-	-
21	-	-	-	467	-	-

8.3.2 Shipping

Emissions from shipping are estimated as follows:

$$Emissions_{t\ CO2-e/annum} = EF_{\ g/kWhr} \times rated\ power\ (kW) \times load\ factor \times hours\ of\ operation$$

The following assumptions are made:

- The likely destination market is South Korea and a one-way travel time of approximately 9.5 days is assumed, based on a cruising speed of 20 knots and travel distance of approximately 4,500 nautical miles.
- Between 280 and 410 loads of zinc concentration would be transported per year, equating to 560 to 820 shipping containers per year (assume 2 shipping containers per truck load). The number of containers shipped each year is estimated by scaling the maximum (820) pro-rata based on the ratio of ore production for that year to the maximum ore production across all years. The number of ships per year is based on a Panamax container ship capacity of 5 000 TEU[18], which equates to a maximum of 0.16 ships per year attributed to the Project.
- The rated engine power (average propulsion engine) for a container ship is assumed as 36 000 kW (DNV GL, 2015) with a load factor of 85% for a nominal cruising speed (Goldsworthy et al, 2013).
- The total kWhr/annum is calculated from the rated power (kW) x load factor x return travel time (hour) x number of ships per annum.
- Emission factors (EF) (g/kWhr) for CO_2, CH_4 and N_2O are taken from DNV GL (2015) and EPA (2012).

8.3.3 Vegetation clearing

Vegetation clearing is not technically a GHG emission source, however, the net impact of vegetation clearing is less carbon dioxide being removed from the atmosphere (through loss of a carbon sink) and therefore an equivalent amount of carbon dioxide would remain. The disposal of cleared vegetation would also result in GHG emissions, depending on the disposal method. If left to decompose naturally on site, the rate at which GHGs are emitted is very slow and considered negligible. However, if vegetation is disposed of to landfill or burnt, the rate is much higher, and emissions are considered more significant.

For the Project, it is assumed that most of the cleared vegetation would be left to decompose naturally on site, either as mulch for use in rehabilitation or set aside for enhancing habitat value. While some wood may be provided for local firewood, it is not possible to accurately estimate the quantity of this for inclusion GHG emission estimates.

The TAFF (2013) workbook methodology for vegetation clearing results in a conservatively high estimate in that it assumes that all carbon pools are removed, all carbon removed is converted to carbon dioxide and released, and sequestration from revegetation is not included.

Emission factors are provided for defined vegetation classes (A to I) corresponding to potential maximum biomass classes (expressed as tonnes dry matter per hectare). The maximum biomass class for the Project site is determined from the map provided in the TAFF (2013) workbook, and the area around Lue is designated as Class 2 or 3, corresponding to a value of between 50 and 150 tonnes dry matter per hectare. The higher value of Class 3 is assumed for this assessment. A summary of the vegetation type and areas to be cleared and the assigned vegetation class and emission factor is provided in **Table 8.3**.

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[18] TEU = Twenty foot equivalent units which is assumed to equate to one 6m container, i.e. 1 container = 1 TEU

Table 8.3
Vegetation Type, Class and Areas to be Cleared for the Project

Vegetation type	Disturbance footprint (ha)	Assigned vegetation class	Corresponding emission factor (t CO_2-e/ha)
CW217 White Box shrubby open forest on fine grained sediments on steep slopes in the Mudgee region of the central western slopes of NSW	21.68	C	307
CW 112 Blakely's Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	21.80	D	307
CW 111 Rough-barked Apple – Red Gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	92.85	D	307
	66.38	D	307
CW 216 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	1.24	D	307
CW 291 Red Stringybark – Inland Scribbly Gum open forest on steep hills in the Mudgee – northern section of the NSW South Western Slopes Bioregion	81.90	C	307
	12.00	C	307
	18.81	C	307
CW 263 Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes	56.65	C	307
CW 242 Blue-leaved Stringybark open forest of the Mudgee region NSW central western slopes	1.04	C	307
CW 270 Mugga Ironbark – Red Box – White Box – Black Cypress Pine tall woodland on rises and hills in the northern NSW South Western Slopes Bioregion	0.77	D	307
CW 249 Derived grassland of the NSW South Western Slopes	5.18	I	110
CW 299 Rough-barked Apple – Blakely's Red Gum – Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	0.76	D	307
CW 272 Narrow-leaved Ironbark – Black Cypress Pine +/- Blakely's Red Gum shrubby open forest on sandstone low hills	0.65	C	307

8.4 EMISSION ESTIMATES

The estimated annual GHG emissions for each source are presented in **Table 8.4**. Estimates for vegetation clearing are life-of-mine (LOM) and therefore emissions are only presented as a LOM total and average annual emissions (assuming clearing occurs evenly across the LOM).

Annual average Scope 1 emissions represent approximately 0.02% of total GHG emissions for NSW and 0.004% of total GHG emissions for Australia, based on the *National Greenhouse Gas Inventory for 2016*[19]. The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions.

[19] http://ageis.climatechange.gov.au/

Table 8.4
Summary of GHG Emission Estimates (tonnes CO_2-e)

Project Year	Scope 1			Scope 2	Scope 3					
							Product Transport			
	Diesel - onsite	Explosives	Vegetation clearing	Electricity	Diesel - onsite (extraction, processing, distribution)	Electricity (T&D loses)	Road	Rail	Shipping	Employee Travel
1	34 711	192		3 876	1 780	554	0	0	0	80.5
2	18 040	242		59 465	925	8 495	540	426	1 205	248.7
3	18 040	243		65 039	925	9 291	590	466	1 318	248.7
4	22 544	244		58 037	1 156	8 291	527	416	1 176	248.7
5	17 869	246		66 658	916	9 523	605	478	1 351	248.7
6	17 869	244		68 530	916	9 790	622	491	1 389	248.7
7	17 869	210		70 560	916	10 080	640	506	1 430	248.7
8	17 869	209		69 824	916	9 975	634	501	1 415	248.7
9	23 484	204		50 369	1 204	7 196	457	361	1 021	248.7
10	16 864	190		16 982	865	2 426	154	122	344	248.7
11	16 864	199		44 777	865	6 397	406	321	907	248.7
12	16 864	201		46 942	865	6 706	426	337	951	248.7
13	16 864	206		57 240	865	8 177	519	410	1 160	248.7
14	16 864	151		56 632	865	8 090	514	406	1 148	248.7
15	16 864	134		51 162	865	7 309	464	367	1 037	248.7
16	16 864	56		26 225	865	3 746	238	188	531	248.7
17	5 015				257					
18	3 902				200					
19	3 769				193					
20	5 015				257					
21	1 266				65					
Max annual	**34 711**	**246**		**70 560**	**1 780**	**10 080**	**640**	**506**	**1 430**	**249**
Average annual	**15 491**	**198**	**7 248**	**50 770**	**794**	**7 253**	**459**	**362**	**1 024**	**238**
LOM total	**325 309**	**3 168**	**115 965**	**812 319**	**16 683**	**116 046**	**7 337**	**5 797**	**16 381**	**3 811**

8.4.1 Emission intensity

The GHG emission intensity for the Project is reviewed by comparing against Australian Scope 1 emissions for relevant ANZSIC categories, as reported in the 2015-2016 National Greenhouse and Energy Reporting (NGER) scheme [20] for 2015-2016.

Table 8.5 presents the Australian total 2015-2016 Scope 1 emissions for coal mining and metal ore mining and the number of facilities that reported for that year. When compared to NGER facility average Scope 1 emissions, the Project's emission intensity is significantly lower than coal mining (13%) and approximately half that of metal ore mining.

Table 8.5
Australian Scope 1 Emissions by ANZSIC Category

ANZSIC category	2015-2016 Scope 1 emission (t CO_2-e)	Number of facilities	NGER facility average Scope 1 emission (t CO_2-e)	Project Scope 1 emissions as % of facility average
Coal Mining	34 450 013	168	205 060	11%
Metal Ore Mining	11 358 788	226	50 260	46%

[20] http://www.cleanenergyregulator.gov.au/NGER/National%20greenhouse%20and%20energy%20reporting%20data/a-closer-look-at-emissions-and-energy-data/australia%E2%80%99s-scope-1-emissions-by-industry-for-nger-reporters

9. MANAGEMENT AND MONITORING

9.1 DUST MANAGEMENT

The proposed dust management measures applied to the emission estimates are outlined in **Annexure 4**. In addition to these preventative measures, reactive or corrective measures would be employed. For example, watering may be increased, or certain activities may be ceased or relocated to more sheltered areas where water application is not sufficient to control dust under those conditions (as determined through monitoring and/or visual inspection).

Full details of the proactive air quality management system would be outlined in the Air Quality Management Plan for the Project, however, it would be based on a combination of the following.

- Meteorological forecasts[21] - to predict when the risk of dust emissions may be high (due to adverse wind conditions) and allow procedures and preparatory measures to be implemented.
- Visual monitoring - to provide an effective mechanism for proactive control of dust at source, before it leaves the Mine Site. For example, using the NSW EPA Dust Assessment Handbook, visual triggers for unacceptable dust at source (i.e. wheel generated dust above tray height) are established to determine the need for action and response.
- Real-time meteorological and air quality monitoring – to provide alerts for appropriate personnel when short-term dust levels increase, to allow management of the location and intensity of activities or increased controls.

An example of how a proactive dust management system could be used to minimise the likelihood of these potential exceedances occurring is outlined in **Table 9.1**.

Table 9.1
Example of Proactive Dust Management for Haul Roads

Aspect	Description	Example of action/response
Meteorological forecast	Daily review of the 3-day forecasts to identify potential for adverse weather for the following day. In the case of waste rock or ore transportation, this might include elevated temperature, high evaporation potential, no rainfall, wind direction aligning with haul roads and towards sensitive receivers.	Prepare for increased water application intensity.
Visual monitoring	Using the dust assessment handbook, identify when triggers are reached. In the case of waste rock or ore transportation, for example, when wheel dust exceeds the height of the wheel or tray.	Call for additional haul road watering.
Real-time monitoring	Air quality triggers identified that take into account wind speed, direction and distance from source to receiver. SMS alarms would be sent when triggers are reached, to notify site personnel that concentrations are increasing and investigation is warranted.	Review operations, meteorological conditions, regional dust levels. Call for additional dust suppression, limit haul distances, shut down non-essential roads, limit grading.

[21] Packaged 3-day Bureau of Meteorology forecasts can be obtained from weatherzone.com.au

The air quality monitoring network described in Section 5.2 provides an existing real-time meteorological and air quality monitoring network. This would be reviewed and augmented (if required) for the operation of the Project and outlined in the Air Quality Management Plan. Monitoring would be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007) (or latest version).

9.2 GHG MANAGEMENT MEASURES

The proposed GHG management measures for the Project include the following.

- Areas cleared of vegetation would be rehabilitated and supplemented with additional biodiversity offset areas which would be improved through ongoing management of the vegetation.
- Energy efficiency would be considered during the design of processing plant with energy efficient systems installed where reasonable and practicable.
- Plant and equipment would be operated and maintained to maximise efficiency and reduce emissions, with mine planning used to minimise vehicle wait times and idling.
- Locally produced goods and services would be procured where feasible and cost effective to reduce transport fuel emissions.
- Cut and fill balances for earthworks would be reviewed to make sure that material is transported the least possible distances.

10. CONCLUSION

Air quality impacts from the Project are assessed using a Level 2 assessment approach in accordance with the Approved Methods for Modelling and Assessment of Air Pollutants in NSW. Emissions inventories have been developed for four representative years of mining operations, selected to assess the air quality impacts of worst-case operational conditions.

Dispersion modelling was used to predict ground-level concentrations for key pollutants from the Project, at surrounding private and Project-related residences. Cumulative impacts were assessed, taking into account the combined effect of existing baseline air quality and other local sources of emissions.

The modelling results incorporate a high level of conservatism through a number of assumptions applied in the model input data and model settings, including:

- the dust emission estimates do not account for natural mitigation due to rainfall; and
- the model does not incorporate wet deposition (removal of particles due to rainfall).

Notwithstanding this approach, there are no private residences where the cumulative annual average PM_{10} concentration is greater than 25µg/m³.

The highest predicted increment in annual average PM_{10} at any private residence across all years is 3.3µg/m³ (receiver R7 in Year 9) whilst the highest predicted increment in 24-hour average PM_{10} at any private residence across all years is 15.6µg/m³ (receiver R21 in Year 9). No private residences exceed NSW EPA's air quality cumulative annual average PM_{10} criterion of 25µg/m³ or the cumulative 24-hour average PM_{10} criterion of 50µg/m³.

The highest predicted increment in annual average $PM_{2.5}$ at any private residence across all years is 0.8µg/m³ (receiver R7 in Year 9) whilst the highest predicted increment in 24-hour average $PM_{2.5}$ at any private residence across all years is 3.6µg/m³ (receiver R7 in Year 9). No private residences exceeded the NSW EPA's air quality cumulative annual average $PM_{2.5}$ criterion of 8µg/m³ or the cumulative 24-hour average $PM_{2.5}$ criterion of 25µg/m³.

The predicted cumulative annual average TSP concentrations and dust deposition levels indicate that no private receivers would experience exceedances of the respective impact assessment criteria.

No exceedances of the impact assessment criteria are predicted at Project-related or private residences for metal dust concentrations, respirable crystalline silica or HCN.

There are no private residences or vacant land requiring acquisition or mitigation on the grounds of air quality, in accordance with the VLAMP policy.

Annual average Scope 1 emissions represent approximately 0.02% of total GHG emissions for NSW and 0.004% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2016. When compared to facility average Scope 1 emissions for coal mining and metal ore mining, the Project's emission intensity is significantly lower (11% and 46% respectively).

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Annexures

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Annexure 1

Project Figures

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Figure A1-1 Locality Plan

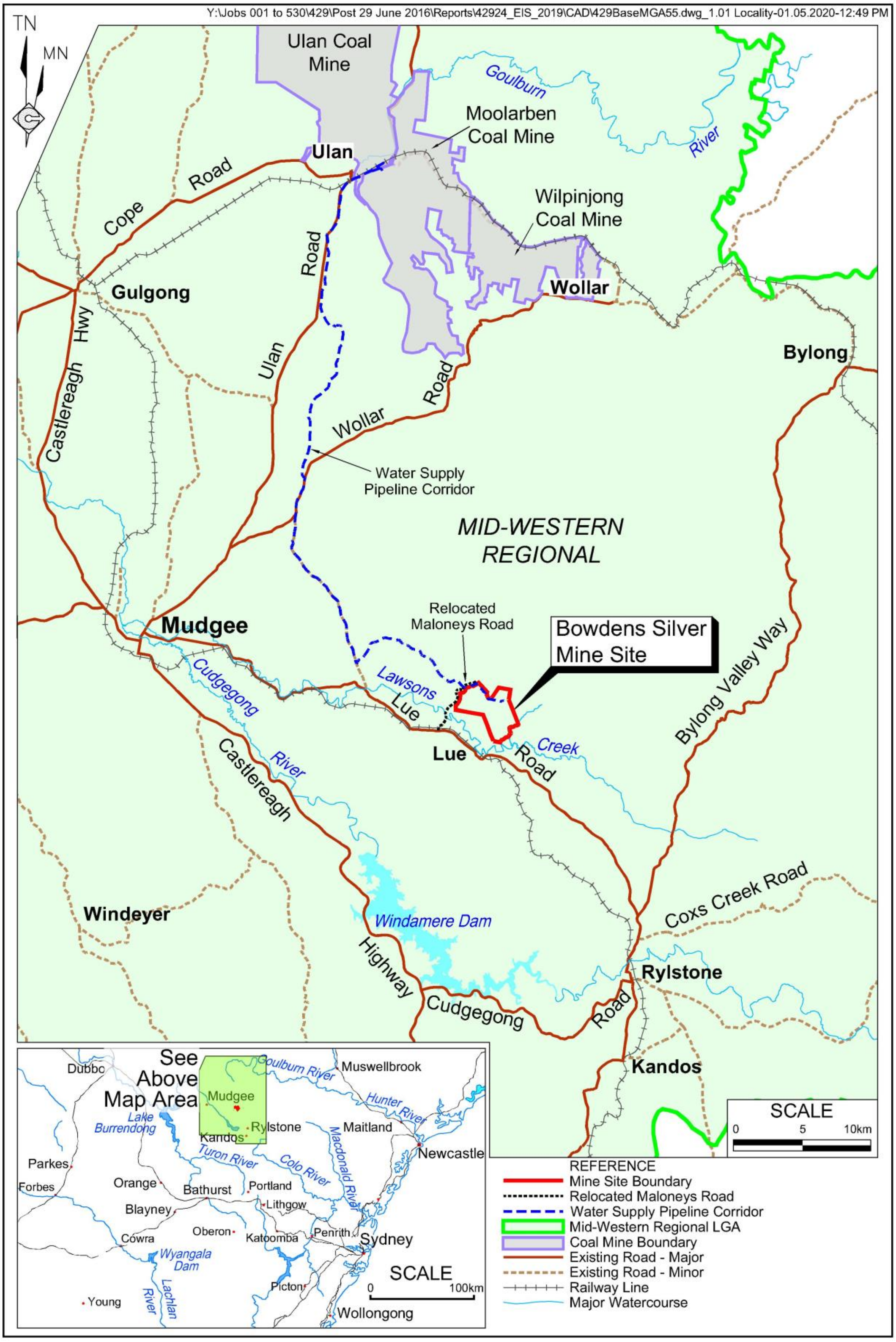


Figure A1-2 Local setting

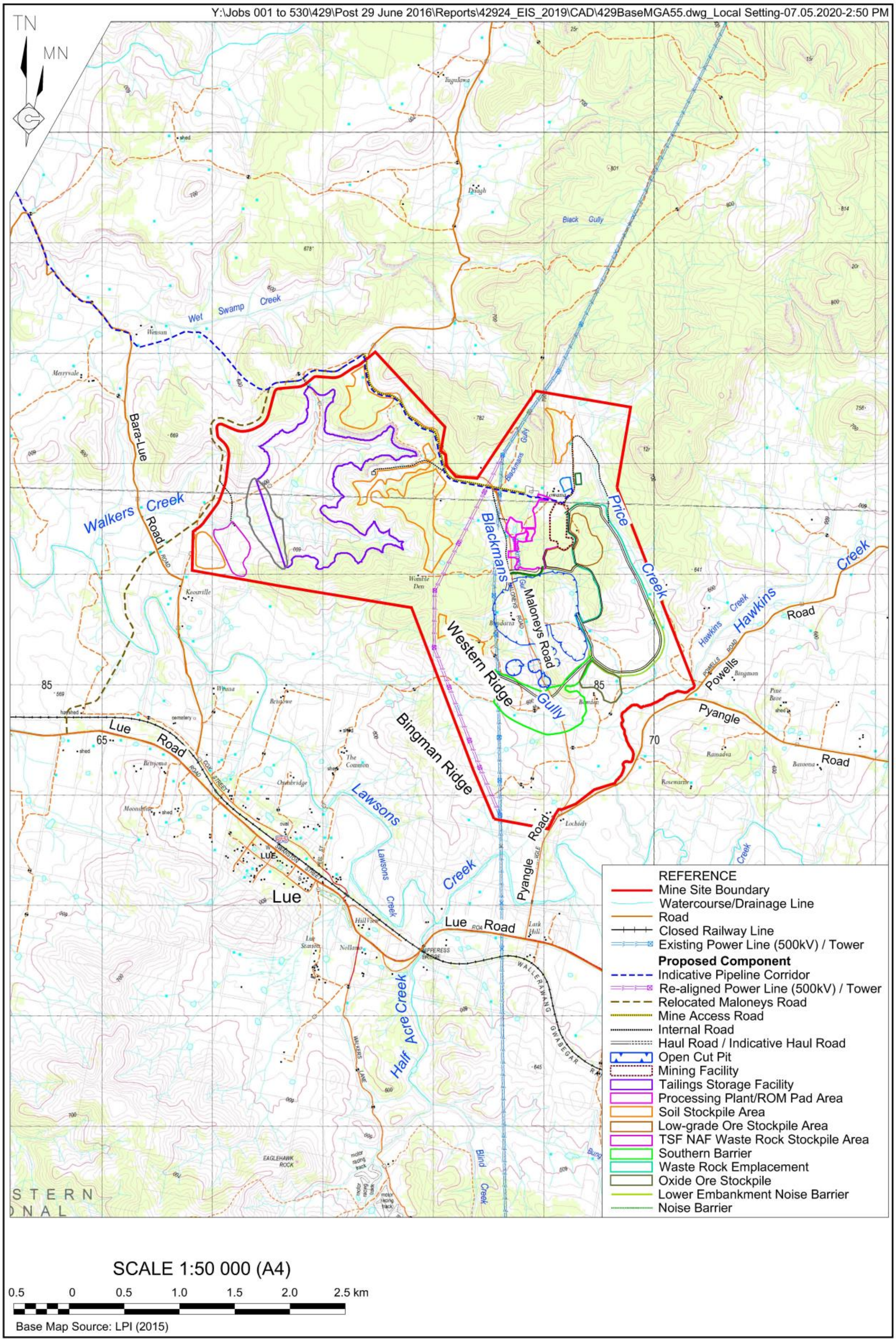


Figure A1-3 Mine Site Layout

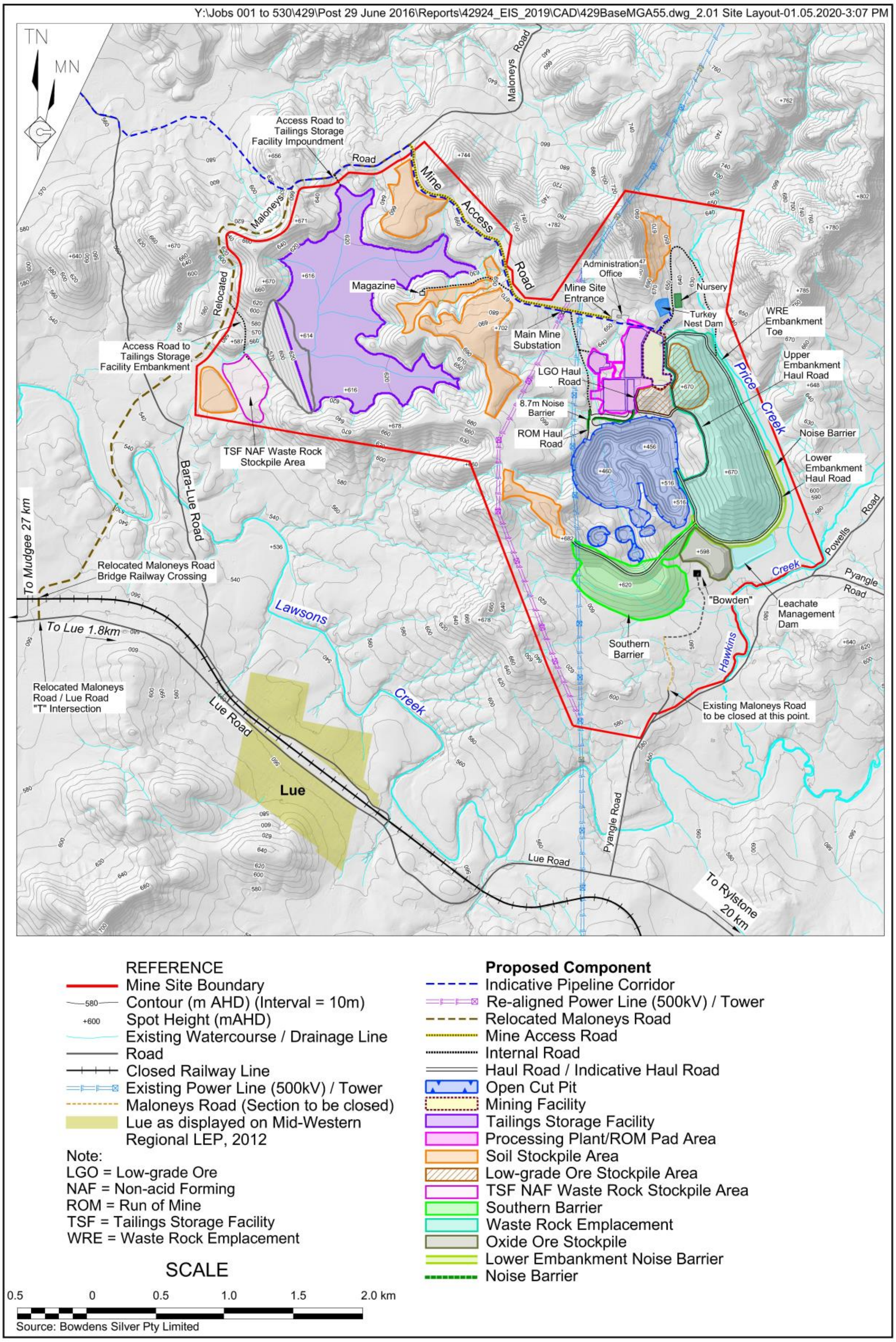


Figure A1-4 Land Ownership and Surrounding Residences

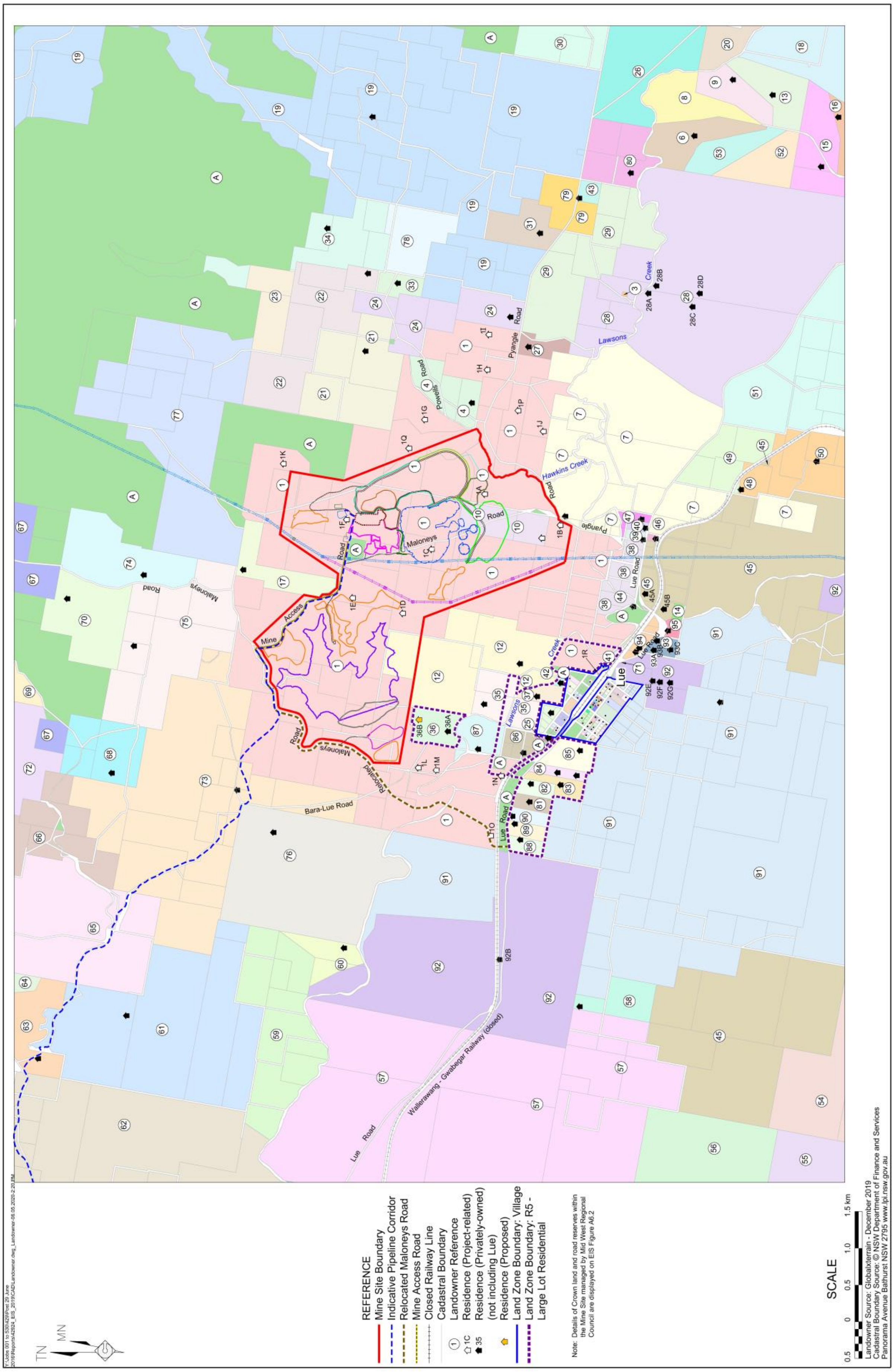
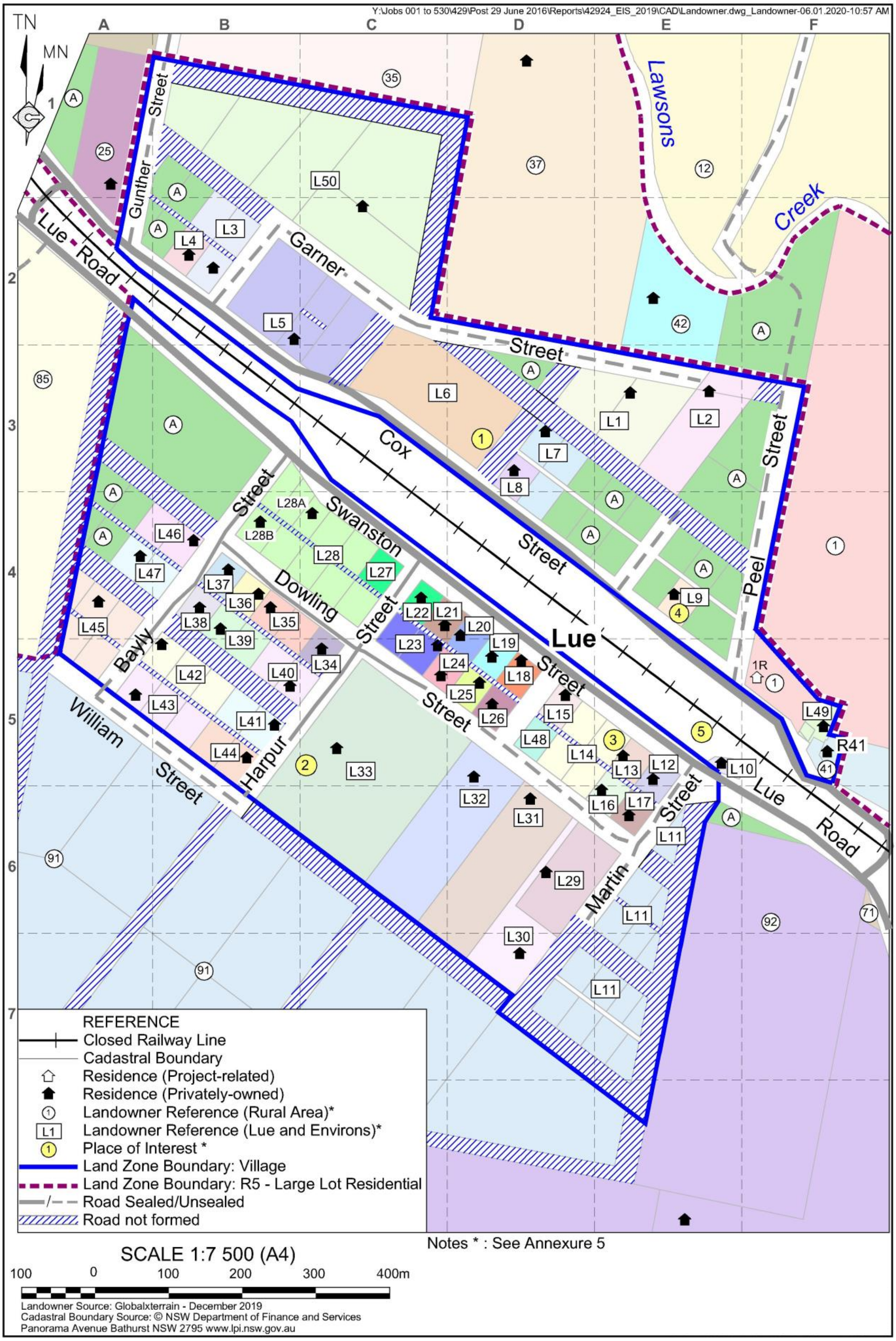


Figure A1-5 Land Ownership (Lue)

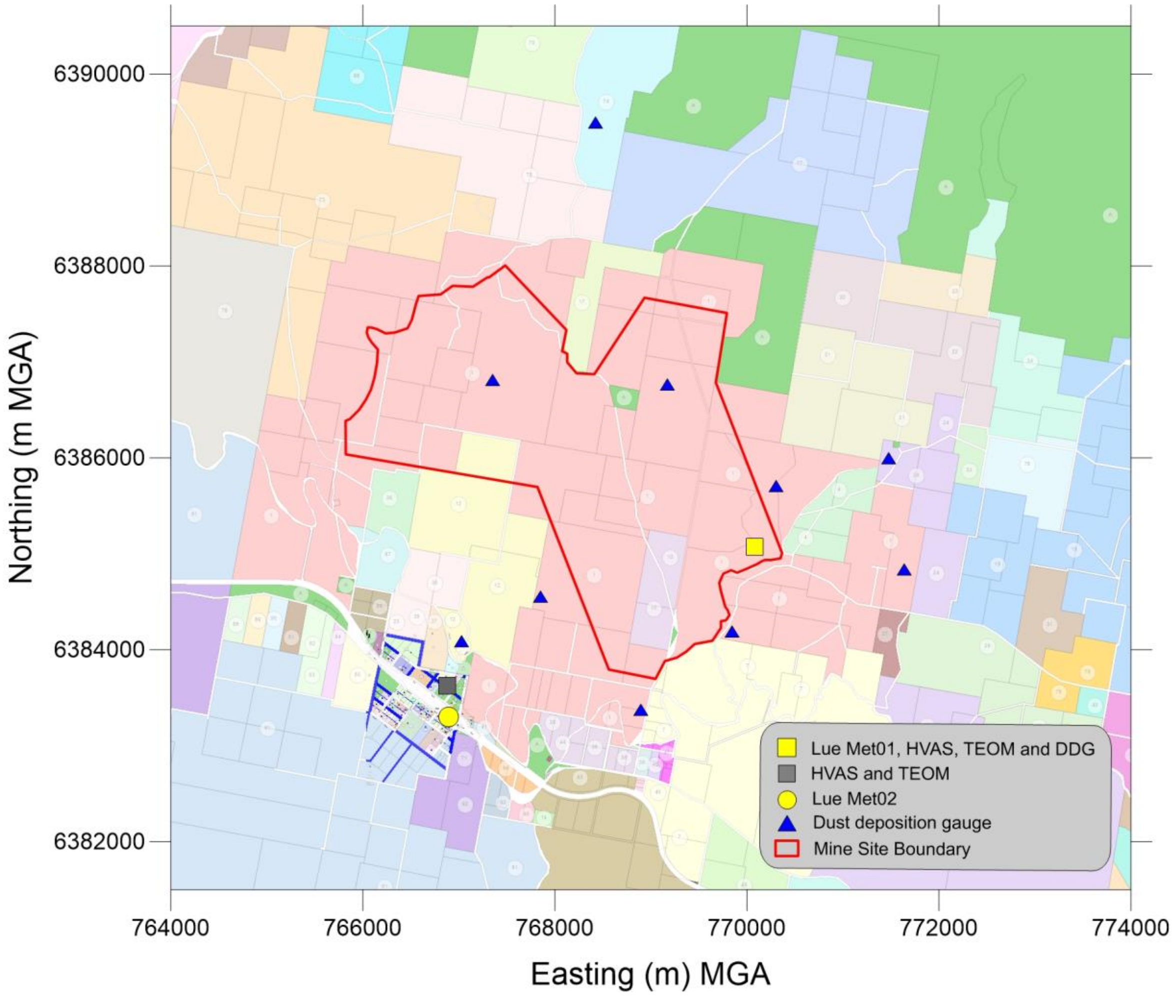


Schedule of Land Ownership – Lue Surrounds (3 December 2019)

Ref[1]	Owner	Ref[1]	Owner
A	Crown Land	50	ACN 059 643 533 Pty Limited
1	Bowdens Silver Pty Limited[2]	51	J.W. & J.M. Kerr
3	Monival Pastoral Company Pty Limited	52	A.J. & A. Hood
4	G.V. Robinson	53	C.M. Wood
6	N.G. & J. Patterson	54	Mudgee Local Aboriginal Land Council
7	Lochiely Pty. Limited	55	D.A. & S.M. Nelson
8	Sam Lynch Electrical Pty Limited	56	J.M. & S.G. Ward
9	A.M. & E.R. Backhouse	57	Havilah South Pty Limited
10[5]	B. Winter	58	A.M Curro
12	J.C. Lydiard	59	S.J. Inglis
13	J.M. O'Neill	60	R.J. & D.M. Barnes
14	A.E. Erskine	61	J.R. & A.M. McNiven
15	P.J.S. & J.A. Bentivoglio	62	N.D. White
16	L.A. & G.P.J. Van Oosterum	63	T.W. & D.L. Kavanagh
17	C.A. Dryden	64	S.L. & S.K. Drent
18	M.J. Brown	65	C.B. & S.L. Cunningham
19	R.G & G.R Mills	66	R.I. Smith & D. De Groot
20	W.A. Brown	67	D.W. & S.A. Chandler
21	K.R. & J. Hornery	68	I.C. & H.A. Hinton
22	M. F. Boller	69	A. & V. Muller
23	D.J.C. Nevell	70	Tugulawa Homestead Pty Ltd
24	G.R. Price	71	State Rail
25[3]	A.A. Skinner	72	P.R. Orr
26	T.J. Stanford	73	WJ Murdoch & Co Pty Limited
27	M.C. & L.R. Friend	74	M.N. & E. Brown
28	Attunga 2850 Pty Ltd	75	P.F. Van Oosterum
29	S.G. & K.D. Price	76	Merryvale Farm Pty Limited
30	R.J. Bleach & L. Smink	77	J. Walker
31	P.J. Carkagis	78	S.J. Price
33	D.S. Anderson & C.L. Downie	79	Stanford (Botobolar) Pty Limited
34	F.F. Beckingham	80	B.R. & D. Clear
35[4]	M.R. Clydesdale	81	L.J. Jones
36	L.M. Patsky	82[3]	D.G. & R.M. Short
37[3]	L.A. Coombe	83[3]	K.R. Rumney
38	T.F. McDonald	84[3]	P. Francis & N.J. Krull
39	C. Gordon & L. Tubnor	85[3]	S.L. & K.A. Turner
40	M. Mitchell	86[3]	A.J. Eno
41	Lue Hospitality Pty Ltd	87[4]	P.B.C. & M.M. Cameron
42	R.A. Bray	88[3]	A. & C.M Jameson
43	S. Burnett	89[3]	G. Andrew & S.J Paterson
44	L.J. & E.R. Statham	90[3]	D.R. Stearman
45	T.D.P. & S.E. Combes	91	Lue Station Pty Ltd
46	T.A & A.O Brown	92	T.D. Combes
47	G.T. Walsh	93	R.E. & C.A. Hawkins
48	ACN 059 643 533 Pty Limited	94	D.M. & C.L. Knott
49	R. C. Scifleet	95	L.D. Adams & D.L. Grisedale

Notes:
1. Some reference numbers have been removed as some properties have been acquired by Bowdens Silver Pty Ltd or existing landowners in the Lue District since the reference numbers were first assigned.
2. Or under purchase option.
3. This property is located in the R1Q Large Lot Residential Zone (LEP 2012) surrounding Lue.
4. This property is partly located in the R1Q Large Lot Residential Zone (LEP 2012) surrounding Lue.
5. Bowdens Silver Pty Ltd has an agreement with this landowner to undertake the Project on their property.

Figure A1-6 Air Quality Monitoring Network



Annexure 2

Wind Roses

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Figure A2-1 Interannual wind roses – Lue Met01 – 2013 to 2017

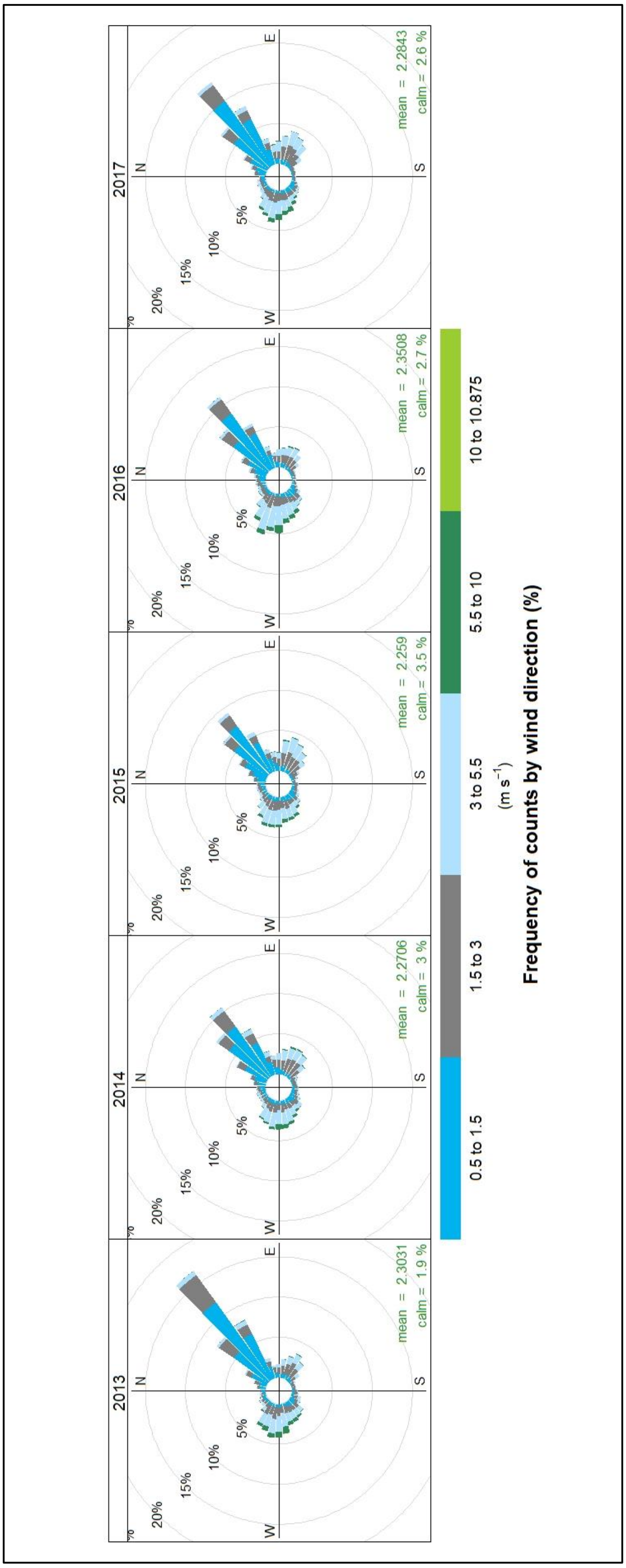


Figure A2-2 Interannual wind roses – Lue Met02 – 2013 to 2017

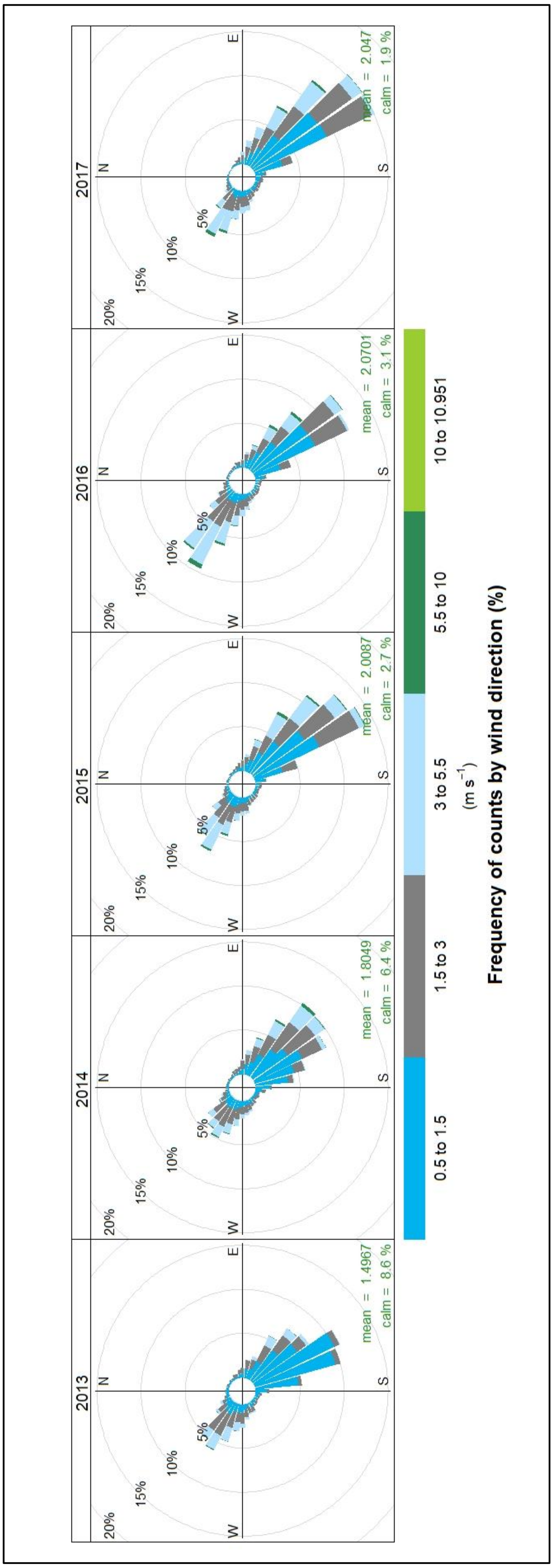


Figure A2-3 Seasonal Wind Roses – Lue Met01 2017

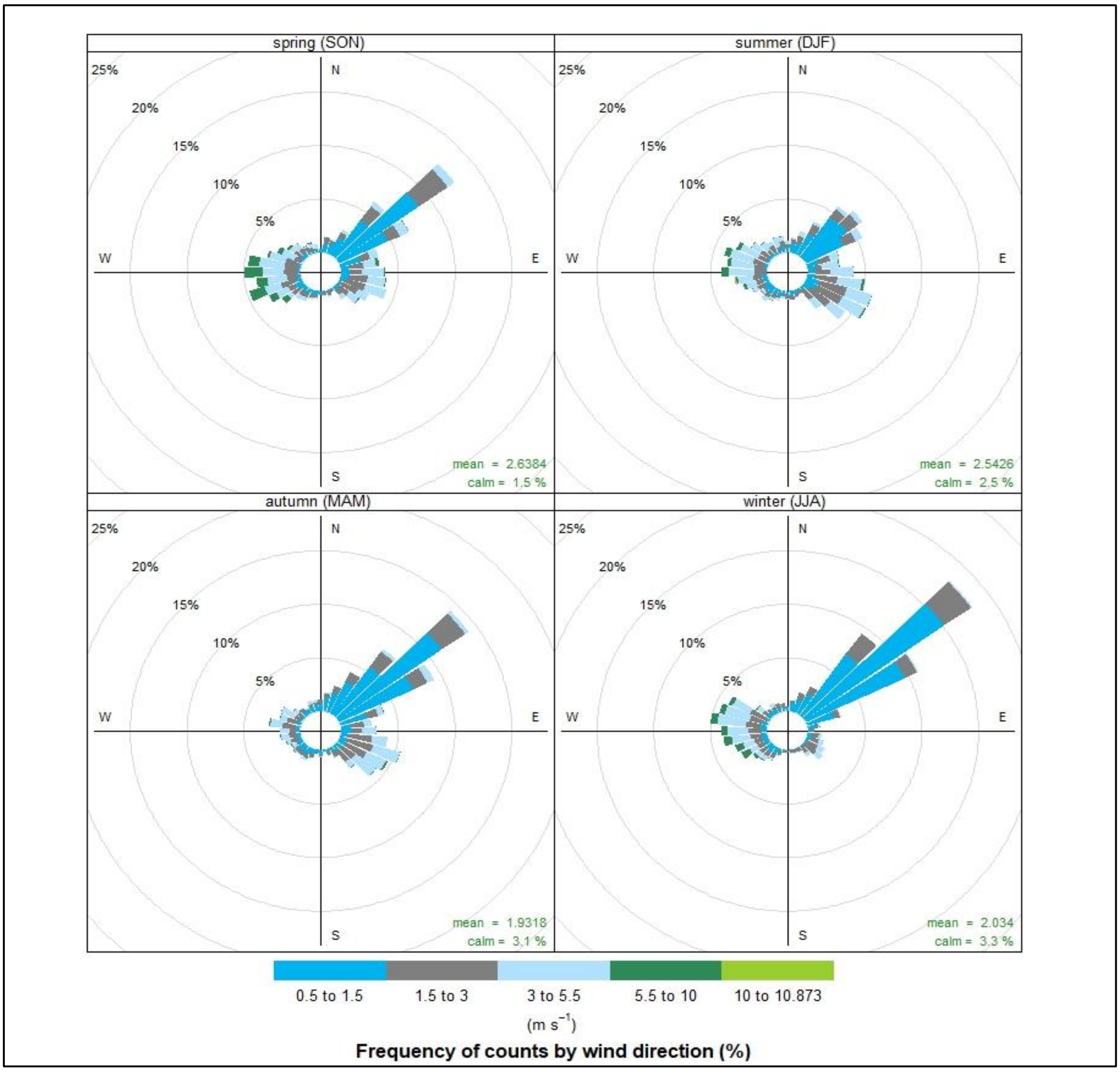


Figure A2-4 Seasonal Wind Roses – Lue Met02 2017

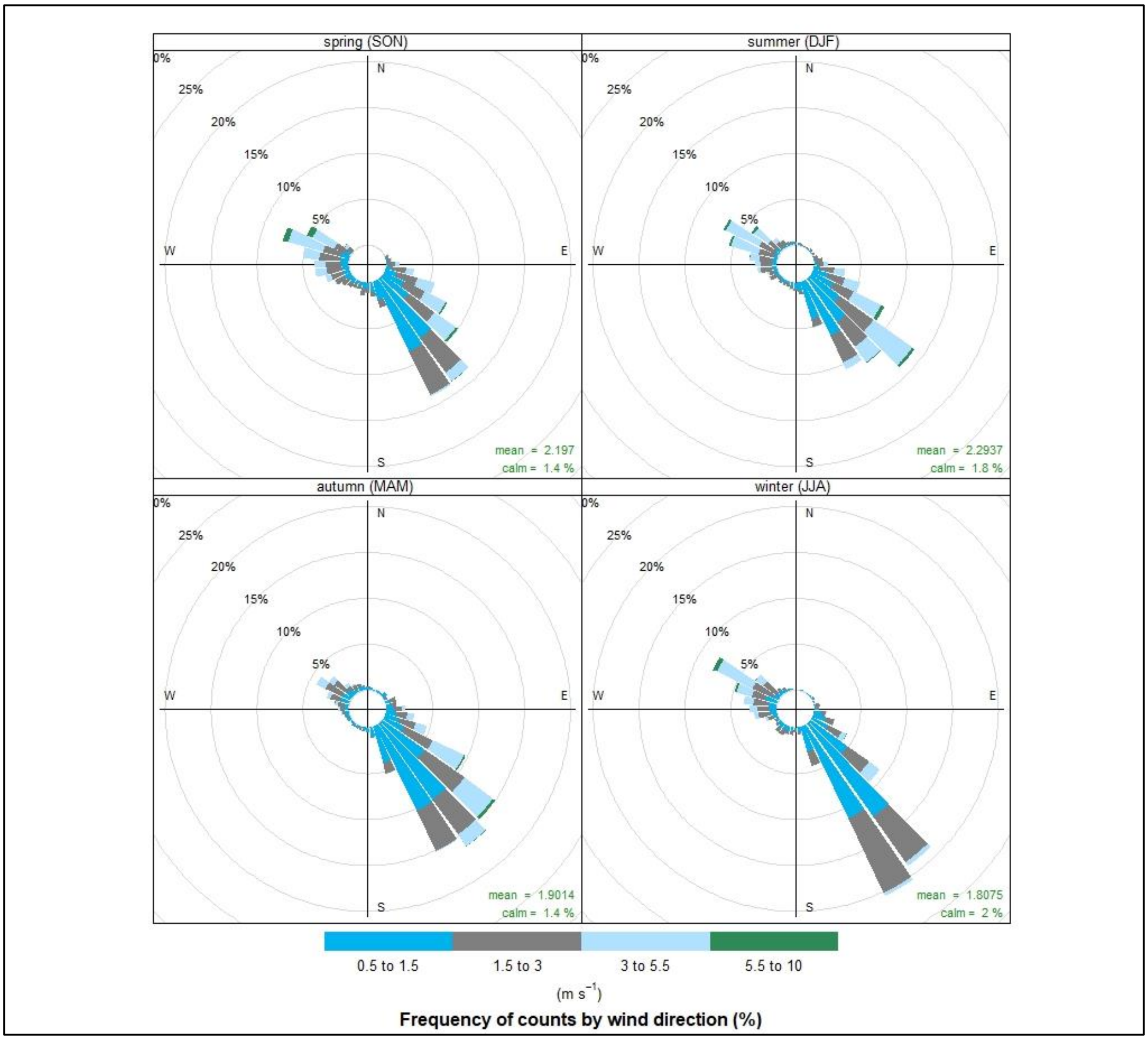


Figure A2-5 Diurnal Wind Roses – Lue Met01 2017

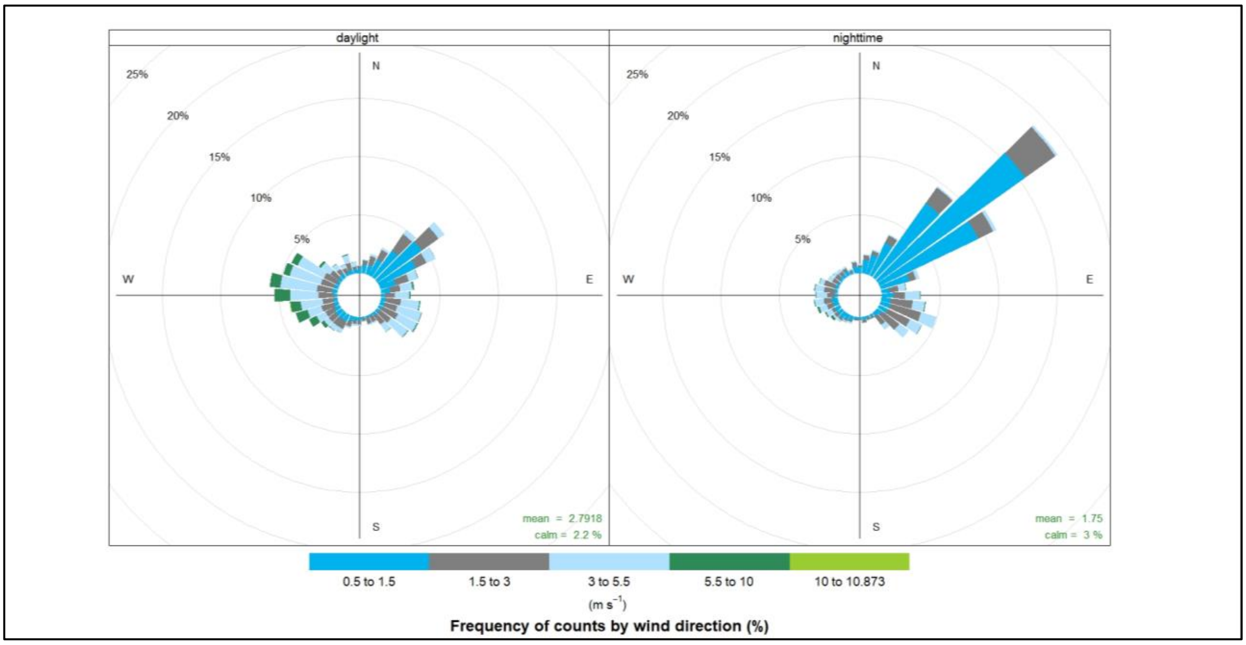
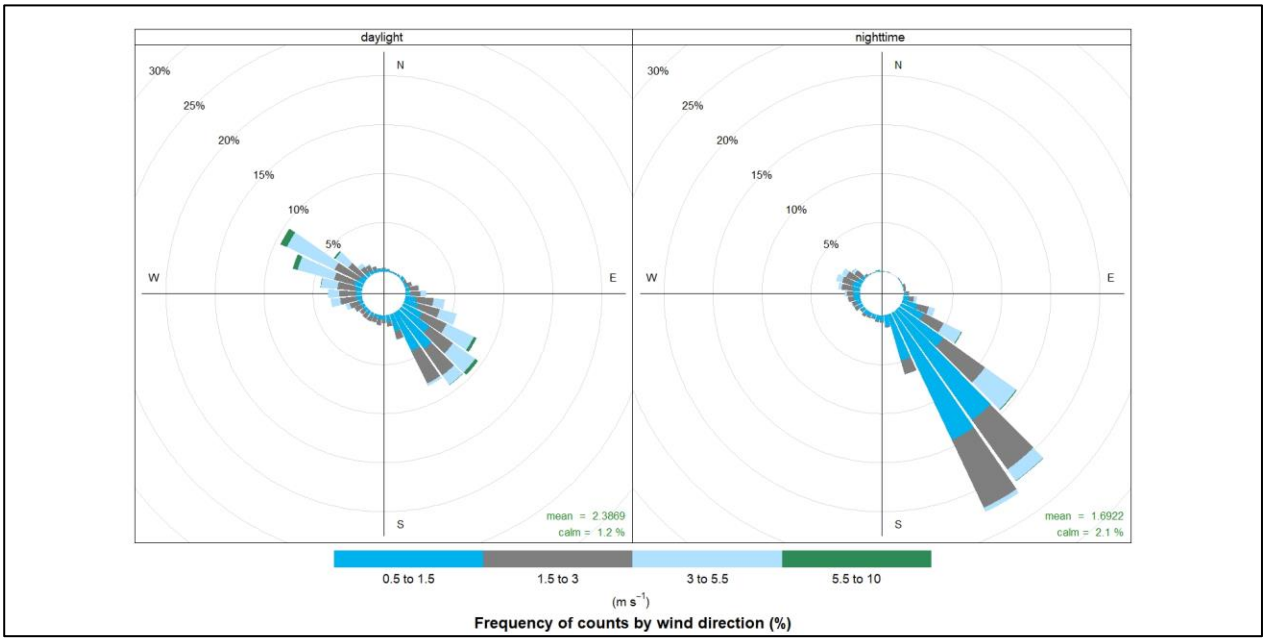


Figure A2-6 Diurnal Wind Roses – Lue Met02 2017



Annexure 3

Model Settings

(Total No. of pages including blank pages = 8)

Model Settings and Set Up

Table A3-1
TAPM settings

Parameter	Setting
Model Version	TAPM v.4.0.5
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 0.3 km)
Number of grid points	25 x 25
Vertical grids / vertical extent	30 / 8000m (~400mb)
Centre of analysis	Lat -32.64167, long 149.875 Easting 769700, Northing 6384790
Year of analysis	2017
Terrain and land use	Default TAPM values based on land-use and soils data sets from Geoscience Australia and the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC)
Assimilation sites	Onsite data (Lue Met01, Lue Met02), Mudgee Airport BoM, Nullo Mountain BoM, Merriwa BoM, Bathurst Airport BoM

Table A3-2
CALMET settings

Parameter	Setting
Grid domain	90 km x 100 km
Grid resolution	1 km
Number of grid points	120 x 120
Reference grid coordinate	739, 6335
Vertical grids / vertical extent	10 cell heights / 4 000m
Upper air meteorology	Prognostic 3D.dat extracted from TAPM at 3km grid
Surface observations	Onsite data (Lue Met01, Lue Met02), Mudgee Airport BoM, Nullo Mountain BoM

Table A3-3
CALMET model options

Flag	Description	Recommended setting	Value used
NOOBS	Meteorological data options	0,1,2	1 - combination of surface and prognostic data
ICLOUD	Cloud Data Options – Gridded Cloud Fields	4	4 -Gridded cloud cover from Prognostic relative humidity at all levels (MM5toGrads algorithm)
IEXTRP	Extrapolate surface wind observations to upper layers	-4	-4 - similarity theory used
IFRADJ	Compute Froude number adjustment effects	1	1 - applied
IKINE	Compute kinematic effects	0	0 - not computed
BIAS (NZ)	Relative weight given to vertically extrapolated surface observations vs. upper air data	NZ * 0	NZ * 0 - layers in lower levels of model will have stronger weighting towards surface, higher levels will have stronger weighting to upper air data
TERRAD	Radius of influence of terrain	No default (typically 5-15km)	5 km
RMAX1 and RMAX2	Maximum radius of influence over land for observations in layer 1 and aloft	No Default	5km, 5km
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind fields are weighted equally	No Default	R1 & R2- 2 km

Table A3-4
CALPUFF model options

Flag	Description	Value used	Description
MCHEM	Chemical Transformation	0	Not modelled
MDRY	Dry Deposition	1	Yes
MWET	Wet Deposition	0	Not modelled
MTRANS	Transitional plume rise allowed?	1	Yes
MTIP	Stack tip downwash?	1	Yes
MRISE	Method to compute plume rise	1	Briggs plume rise
MSHEAR	Vertical wind Shear	0	Vertical wind shear not modelled
MPARTL	Partial plume penetration of elevated inversion?	1	Yes
MSPLIT	Puff Splitting	0	No puff splitting
MSLUG	Near field modelled as slugs	0	Not used
M DISP	Dispersion Coefficients	2	Based on micrometeorology
MPDF	Probability density function used for dispersion under convective conditions	1	Yes
MROUGH	PG sigma y,z adjusted for z	0	No
MCTADJ	Terrain adjustment method	3	Partial Plume Adjustment
MBDW	Method for building downwash	N/A	ISC Method

Modelled Source Locations

Activities (hauling, dozers, excavators, wind erosion, etc.) are represented by a series of volume sources located according to the mine plan for each scenario. The mobile equipment types and locations for the modelled scenarios are shown on **Figures A3.1** to **A3.4**. These figures provided the basis for the spatial allocation of volume sources for dispersion modelling across the active areas for each scenario. A full equipment list with typical models/types is presented within the Noise and Vibration Assessment (SLR, 2020).

For modelling volume sources, estimates of horizontal spread (initial sigma y [σy]) and vertical spread (initial sigma z [σz]) need to be assigned. For sources other than hauling, values of sigma y depend on the size of the area covered by the source, assigned to provide coverage across the entire area. A value of 2m is assigned for sigma z. For hauling, sigma y is assigned based on source separation (divided by 4.3) and sigma z based on recommendations made in the US EPA Haul Road Workgroup.

Figure A3-1 Modelled source locations – Scenario 1

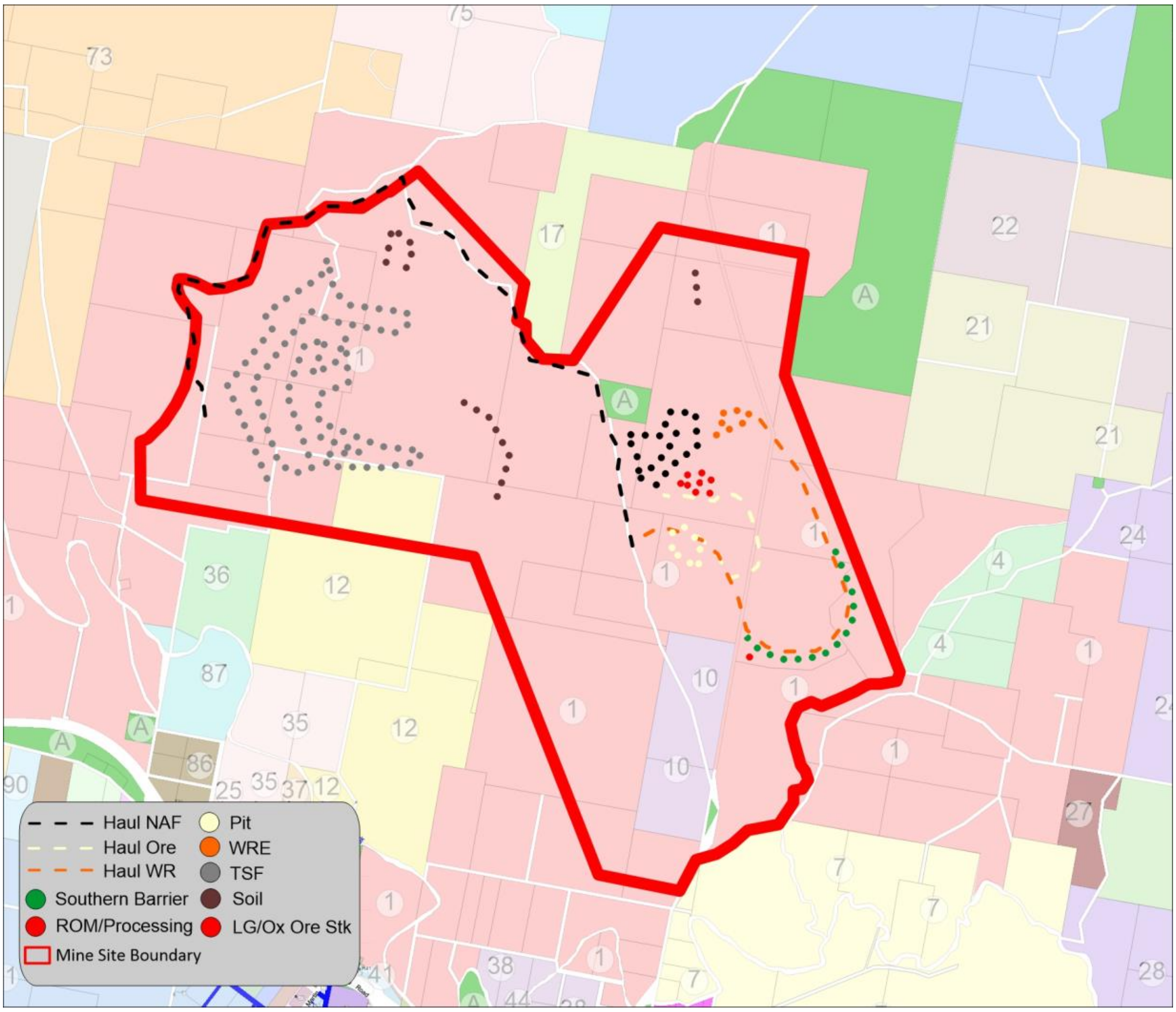


Figure A3-2 Modelled source locations – Scenario 2

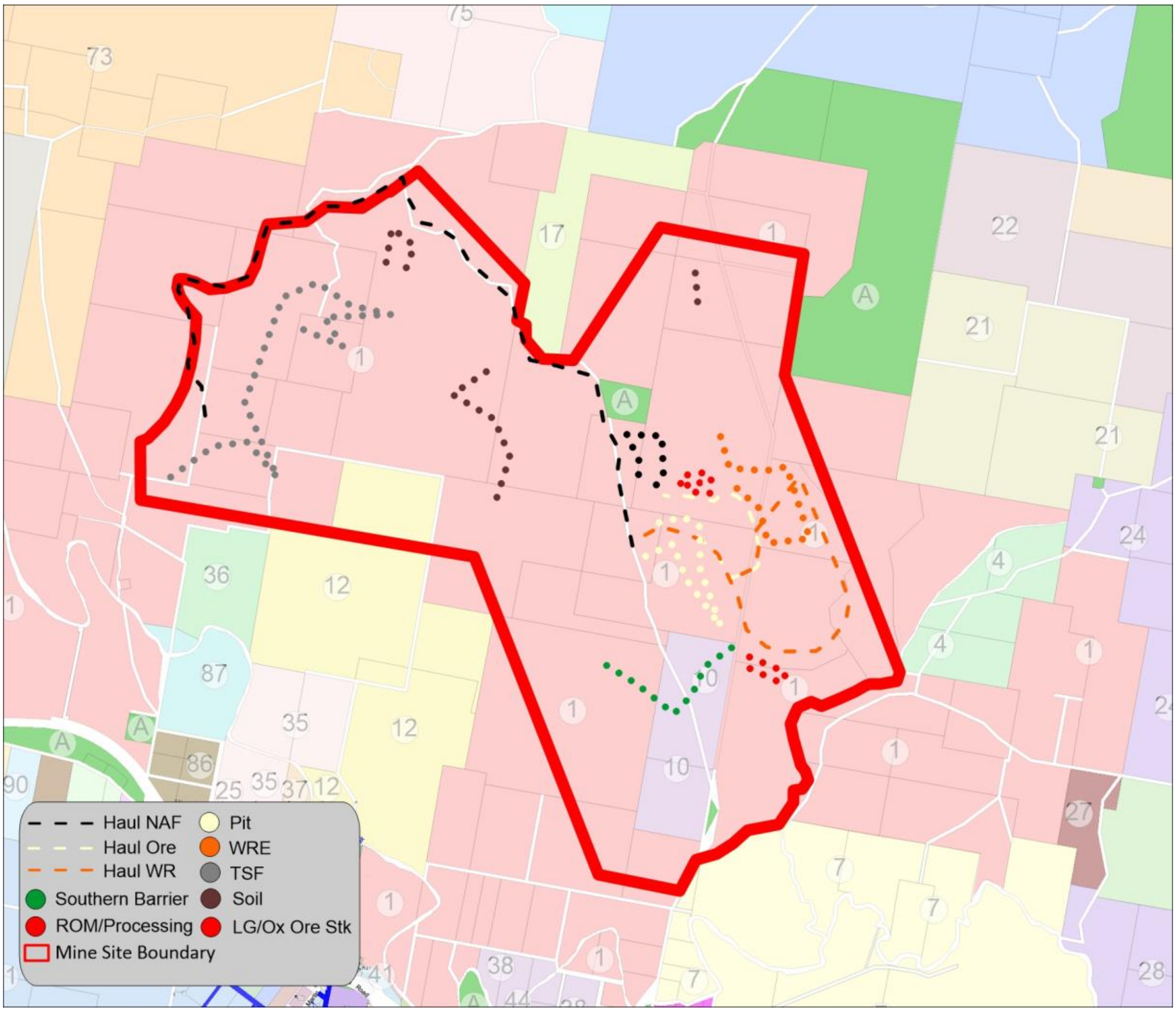


Figure A3-3 Modelled source locations – Scenario 3

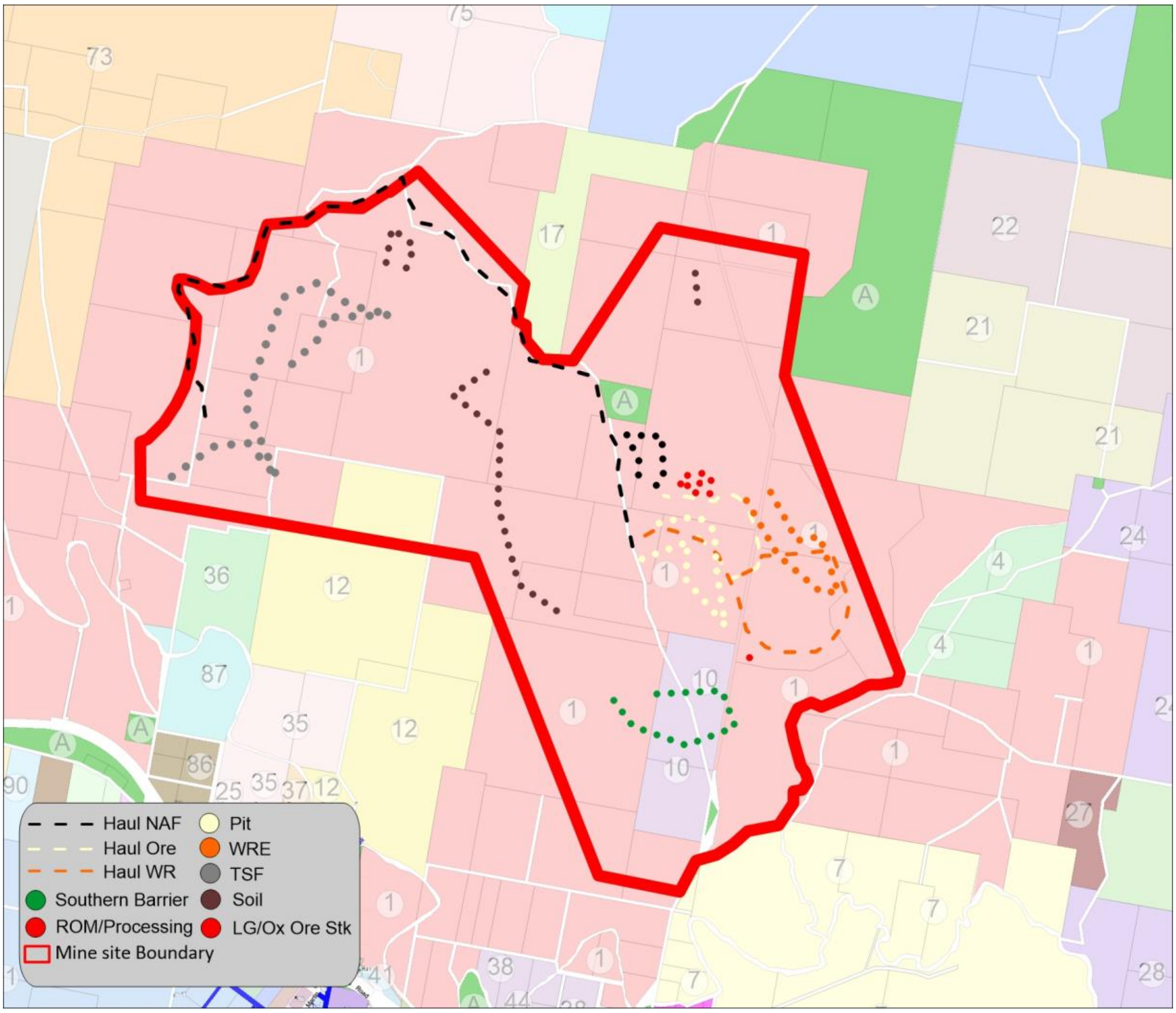
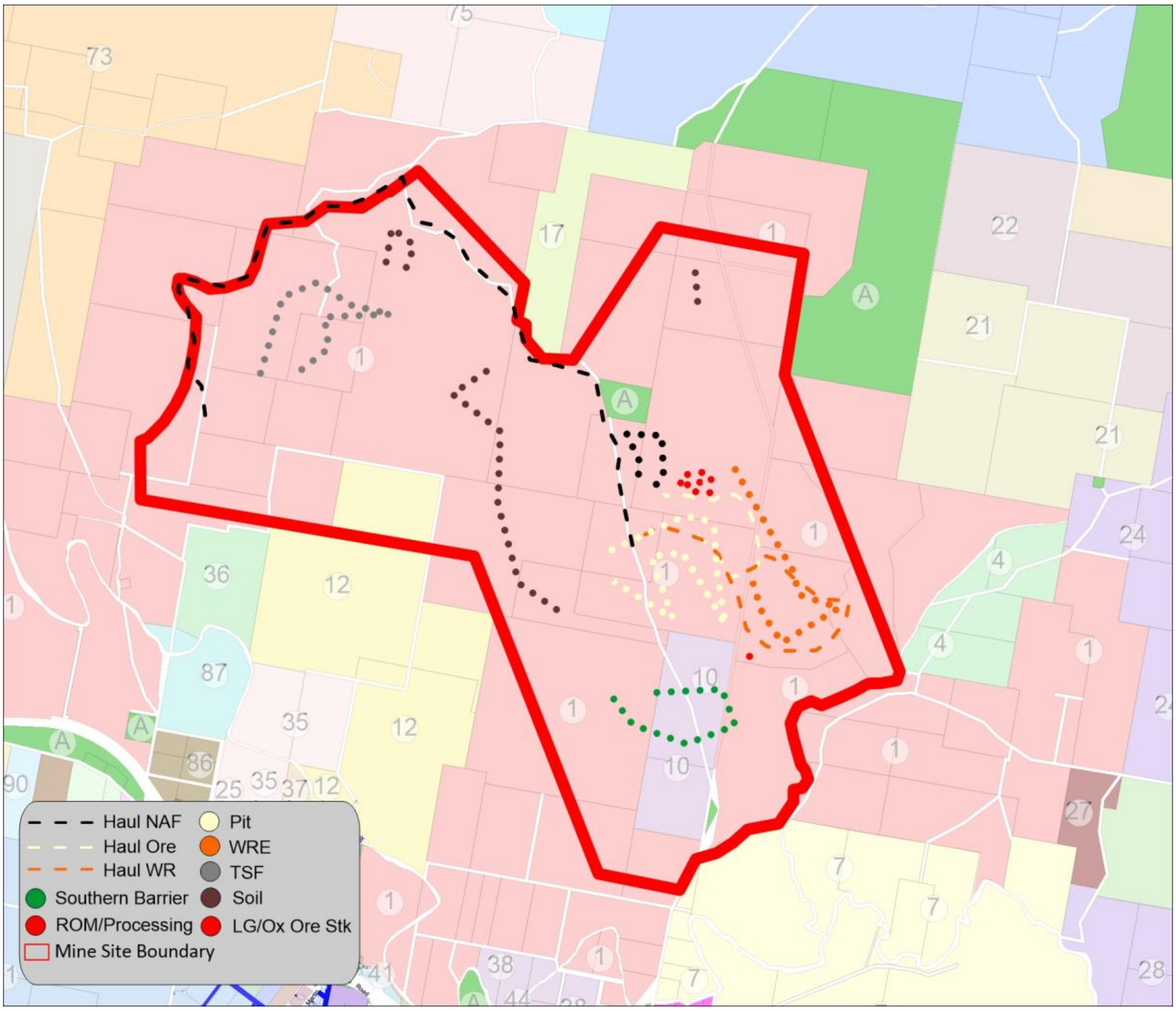


Figure A3-4 Modelled source locations – Scenario 4



Annexure 4

Emission Inventory Development

(Total No. of pages including blank pages = 8)

Overview

Dust emissions were estimated using US EPA AP-42 emission factors and predictive equations taken from the following chapters:

- Chapter 11.9 Western Surface Coal Mining.
- Chapter 13.2.2 Unpaved Roads.
- Chapter 13.2.4 Aggregate Handling and Storage Piles.
- Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing.
- Chapter 13.2.5 Industrial Wind Erosion.

The material properties listed in **Table A4-1** are used as input to the various emission factor equations listed in **Table A4-2** to derive uncontrolled emission factors for each source. Emissions were quantified for each particle size fraction, with the TSP size fraction also used to predict dust deposition rates. Fine particles (PM_{10} and $PM_{2.5}$) were estimated using the fraction-specific equations or ratios for the different particle size fractions available within the literature (shown in **Table A4-2**).

Table A4-1
Material Properties

Properties	Value	Source of information
Silt content of unpaved roads	4%	Average of all measurements for controlled hauls roads on coal mines, measured as part of ACARP project C22027 (Roddis et al., 2015).
Silt content of soil, waste rock and ore	10%	Value typically adopted for mining projects in NSW and selected as the more conservative (higher) value than measurements as part of ACARP project C22027 (~4% average).
Moisture content of soil, waste rock and ore	4%	Lower range of measurements on overburden and topsoil taken as part of ACARP project C22027 (ranged from 4% to 7%).

Table A4-2
Equations and Emission Factors

Inventory activity	Units	TSP emission factor/equation	PM_{10} emission factor/equation	$PM_{2.5}$ emission factor/equation	EF source
Material handling (loading trucks, unloading trucks, rehandle, conveyor transfer	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP42 13.2.4
Dozers	kg/hr	$2.6 \times \frac{s^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{s^{1.5}}{M^{1.4}}$	0.105 x TSP	AP42 11.9
Wind erosion from exposed ground	kg/ha/yr	0.85×1000	0.5 * TSP	0.075 * TSP	AP42 11.9 & 13.2.5
Wind erosion and maintenance of stockpiles and ROM pads	kg/ha/hr	1.8 * u	0.5 * TSP	0.075 * TSP	AP42 11.9 & 13.2.5
Hauling on unsealed roads (including diesel exhaust)	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP42 13.2.2
Grading roads	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	AP42 11.9
Crushing	kg/t	0.0027	0.0012	0.00022	AP42 11.19.2
Screening	kg/t	0.0125	0.0043	0.000025	AP42 11.19.2
Soil stripping	kg/t	0.029	TSP x 0.5	TSP x 0.105	AP42 11.9

Best Management Practice (BMP) Determination

In June 2011, the NSW EPA published the best practice document 'NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining' (Katestone, 2011). Following on from the Benchmarking Study, the EPA developed a series of PRPs for coal mines, - referred to as the "Dust Stop" PRPs and issued guidelines for Best Management Practice (BMP) determinations for operating coal mines. Each operating coal mine in NSW had to identify the top four mining activities that contribute to the emissions of TSP, PM_{10} and $PM_{2.5}$. For each of the top four activities, a BMP determination was required, taking into account the practicability of implementation, costs, regulatory requirements, environmental impacts, safety implications and compatibility with operations.

Whilst the Project is a metalliferous mine many of the study outcomes equally apply. An overview of the BMP determination for the Project and the emission reductions applied, is presented in **Table A4-3**. Control measures are applied to the most significant emissions sources for the Project, consistent with best practice emissions controls (Katestone, 2011). Other control measures, while not explicitly applied as a reduction factor, are accounted for in the emission inventory on the basis of the mine plan, including the following.

- Site-wide vehicle speed limits;
- Progressive rehabilitation of disturbed areas;
- Avoiding disturbance, or temporary rehabilitation of long-term soil stockpiles and waste rock emplacements; and
- Proactive, reactive or corrective measures where watering is not sufficient (for example, as determined through monitoring and/or visual inspection), certain activities may be ceased or relocated to more sheltered areas.

Table A4-3
Best Management Practice Determination

Activity	BMP	Applied?	Control %	Comment
Hauling	Speed reduction	Yes	N/A	Speed restrictions would apply, however, controls are not applied in the emission inventory.
	Surface improvements	No	N/A	Haul roads would be actively maintained and watered, however, specific surface improvements outlined in Katestone (2011) are not proposed for the Project.
	Surface treatments	Yes	90%	80% control is assumed for watering and / or additional surface treatments planned. Australian Coal Association Research Program (ACARP) project C20023 (Cox & Laing, 2014) demonstrated that watering alone can achieve 85% to 95% control efficiency for unsealed roads.
	Use of larger trucks	Yes	N/A	Use of 90t trucks for ore and waste hauling (assists to reduce wheel-generated emissions).
	Conveyors	No	N/A	Use of conveyors from the open cut to the processing area is not practical or possible.
Wind erosion on exposed areas	Minimise pre-strip	Yes	N/A	Incorporated into mine planning, however, controls are not applied in the emission inventory.
	Surface stabilisation	Yes	95% - 99%	Controls are applied in the emissions inventory for rehabilitation areas and soil stockpiles. Controls are based on Katestone (2011) and measurement taken as part of ACARP project C22027 (Roddis et al., 2015).
	Wind speed reduction	Yes	N/A	Achieved through emplacement within the footprint of the open cut void where possible and vegetative cover for rehabilitation areas.
Material handling	Avoidance	Yes	N/A	Limited backfilling for satellite pits would avoid waste rock handling
	Minimising drop heights	Yes	30%	Would apply for the Project and implemented through driver training.
	Water application	No	N/A	Water application across the large areas of waste rock emplacement is not proposed for the Project.
	Modify activities in windy conditions	Yes	N/A	Would apply for the Project and implemented through the Air Quality Management Plan and proactive strategy, however controls are not applied in the emission inventory.
	Minimise dozer travel movements	Yes	N/A	Operational efficiency implemented through mine planning and operator training.
	Keep dozer travel routes moist	No	N/A	Not proposed for the Project.

Table A4-3 (Cont'd)
BMP Determination

Activity	BMP	Applied?	Control %	Comment
Ore handling	Avoidance	Yes	N/A	Achieved through bypassing the ROM pad where possible and direct placement into ROM feed bin.
	Minimising drop heights	Yes	30%	Would apply for the Project and implemented through driver training.
	Enclosure of dump hopper	Yes	70%	Enclosure on 3 sides.
	Water application	No	N/A	Not proposed for the Project.
	Enclosure of dump hopper with dust extraction	No	N/A	Not proposed for the Project.
Crushing	Water sprays	Yes	50%	Water spray on crusher
Screening	Water sprays	Yes	50%	Carry over high moisture content
Stockpiles	Water sprays	No	N/A	Not proposed for the Project.
Drilling	Wet suppression	Yes	70%	Water sprays.

Hourly Varying Emissions

Emission sources can be categorised as wind-insensitive sources (where the emission rate is independent of the wind speed), wind-sensitive sources (where there is a relationship between the emission rate and wind speed) and wind erosion sources (where the emission is dependent on the wind speed).

Hourly emissions files for modelling are developed from the annual emissions as follows:

- The annual emissions for wind-insensitive sources are evenly apportioned for each hour of the year (no adjustment applied).
- Hourly varying emissions for wind erosion sources are derived using Equation 1, adjusted according to the cube of the hourly average wind speed and normalised so that the total emission over all hours in the year adds up to the estimated annual total emission.
- The emissions for wind-sensitive sources are converted to hourly emissions in a similar manner, however the wind speed adjustment is made based on Equation 2.

Equation 1 (Skidmore, 1998)

$$E_i = E_{annual} \times \frac{U_i^3}{\sum_{i=1}^{N} U_i^3}$$

Equation 2 (US EPA, 1987)

$$E_i = E_{annual} \times \frac{\left(\frac{U_i}{2.2}\right)^{1.3}}{\sum_{i=1}^{N} \left(\frac{U}{2.2}\right)^{1.3}}$$

Where: $E_i = emissions\ for\ hour\ i$

$E_{annual} = annual\ emissions$

$U_i = wind\ speed\ for\ each\ hour\ i$

$N = number\ of\ hours\ of\ wind\ speed$

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Annexure 5

Modelling Results for Project-Related Residences

(Total No. of pages including blank pages = 4)

Table A5-1
Predicted annual average PM_{10} concentration (µg/m³)

ID	Project-only				Cumulative			
	SE&CS	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
R1A	13.7	9.3	9.7	14.3	26.6	22.2	22.6	27.2
R1B	3.2	2.7	3.2	4.2	16.1	15.6	16.1	17.1
R1K	0.7	0.5	0.4	0.3	13.6	13.4	13.3	13.2
R1M	1.2	0.9	0.6	0.6	14.1	13.8	13.5	13.5
R1N	1.4	1.1	0.8	0.7	14.3	14.0	13.7	13.6
R1L	1.5	1.0	0.6	0.6	14.4	13.9	13.5	13.5
R1G	2.4	2.4	2.6	2.1	15.3	15.3	15.5	15.0
R1J	1.4	1.3	1.2	1.2	14.3	14.2	14.1	14.1
R1H	1.1	1.1	1.1	1.0	14.0	14.0	14.0	13.9
R1I	0.7	0.7	0.7	0.6	13.6	13.6	13.6	13.5
R1R	3.8	4.1	4.3	3.1	17.4	17.7	17.9	16.7
R1Q	1.3	1.2	1.4	1.7	14.9	14.8	15.1	15.3

Table A5-2
Predicted 24-hour Average PM_{10} Concentration (µg/m³)

ID	Project-only				Cumulative			
	SE&CS	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
R1A	32.6	23.2	44.2	47.3	57.6	59.1	55.8	60.9
R1B	13.1	12.9	13.3	15.9	46.9	47.3	48.1	49.8
R1K	12.1	10.0	10.7	7.8	43.7	43.7	43.7	43.7
R1M	4.1	2.8	2.4	2.3	46.2	44.5	44.1	43.9
R1N	7.0	4.1	3.5	3.1	44.8	44.6	44.4	44.4
R1L	5.1	3.0	2.5	2.2	47.9	45.1	44.1	44.0
R1G	26.8	27.6	27.6	29.3	46.7	46.2	46.6	45.8
R1J	9.4	8.9	8.7	9.6	48.2	49.3	48.8	49.9
R1H	12.5	11.7	10.6	10.0	46.4	47.0	46.6	45.0
R1I	7.9	7.1	6.5	6.3	44.8	44.9	44.8	44.2
R1R	27.4	32.9	**59.9**	42.8	48.7	**50.2**	**65.6**	48.6
R1Q	10.8	9.5	12.9	14.4	49.6	49.2	**53.6**	**53.8**

Table A5-3
Predicted Annual Average $PM_{2.5}$ Concentration (µg/m³)

ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
R1A	4.2	2.1	2.5	4.2	8.1	6.0	6.4	**8.1**
R1B	1.0	0.8	1.2	1.6	4.9	4.7	5.1	5.5
R1K	0.2	0.1	0.1	0.1	4.1	4.0	4.0	4.0
R1M	0.3	0.3	0.2	0.2	4.2	4.2	4.1	4.1
R1N	0.4	0.3	0.3	0.3	4.3	4.2	4.2	4.2
R1L	0.4	0.3	0.2	0.2	4.3	4.2	4.1	4.1
R1G	0.7	0.6	0.7	0.6	4.6	4.5	4.6	4.5
R1J	0.4	0.4	0.4	0.4	4.3	4.3	4.3	4.3
R1H	0.3	0.3	0.3	0.3	4.2	4.2	4.2	4.2
R1I	0.2	0.2	0.2	0.2	4.1	4.1	4.1	4.1
R1R	0.9	1.0	1.0	0.7	4.8	4.9	4.9	4.6
R1Q	0.3	0.3	0.3	0.4	4.3	4.2	4.3	4.3

Table A5-4
Predicted 24-hour Average $PM_{2.5}$ Concentration (µg/m³)

ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
R1A	10.6	5.5	8.3	9.8	22.5	17.5	17.6	20.2
R1B	3.8	3.6	4.8	6.2	16.2	15.7	16.0	16.3
R1K	3.1	2.2	1.9	1.4	15.5	15.4	15.4	15.4
R1M	1.2	0.8	0.7	0.8	15.7	15.8	15.8	15.8
R1N	2.0	1.2	1.0	1.1	15.7	15.8	15.8	15.9
R1L	1.4	0.9	0.7	0.7	15.8	15.9	15.8	15.9
R1G	6.9	7.1	8.2	6.9	15.4	15.4	15.4	15.4
R1J	2.7	2.7	2.9	3.5	15.4	15.4	15.4	15.4
R1H	3.8	3.3	3.1	3.2	15.4	15.4	15.4	15.4
R1I	2.5	2.1	2.0	2.1	15.4	15.4	15.4	15.4
R1R	6.1	6.5	10.9	8.0	15.5	15.4	15.4	15.4
R1Q	2.8	2.4	2.8	3.3	15.4	15.4	15.4	15.4

Table A5-5
Predicted Annual Average TSP Concentration (µg/m³)

ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
R1A	40.2	24.7	25.4	39.3	70.9	55.4	56.1	70.0
R1B	6.6	5.8	6.7	8.5	37.3	36.5	37.4	39.2
R1K	1.4	0.9	0.6	0.5	32.1	31.6	31.3	31.2
R1M	2.7	1.8	1.2	1.0	33.4	32.5	31.9	31.7
R1N	3.1	2.2	1.5	1.3	33.8	32.9	32.2	32.0
R1L	3.6	2.2	1.3	1.0	34.3	32.9	32.0	31.7
R1G	5.9	5.4	5.7	4.5	36.6	36.1	36.4	35.2
R1J	2.8	2.9	2.6	2.6	33.5	33.6	33.3	33.3
R1H	2.4	2.6	2.3	2.1	33.1	33.3	33.0	32.8
R1I	1.5	1.5	1.3	1.2	32.2	32.2	32.0	31.9
R1R	9.6	10.3	10.4	7.3	40.6	41.3	41.4	38.3
R1Q	2.7	2.8	3.4	4.0	33.7	33.8	34.4	35.0

Table A5-6
Predicted Annual Average Dust Deposition (g/m^2/month)

ID	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
R1A	1.01	0.83	0.94	3.11	2.0	1.8	1.9	4.1
R1B	0.14	0.12	0.13	0.09	1.1	1.1	1.1	1.1
R1K	0.08	0.05	0.04	0.16	1.1	1.0	1.0	1.2
R1M	0.09	0.06	0.04	0.03	1.1	1.1	1.0	1.0
R1N	0.07	0.05	0.03	0.03	1.1	1.1	1.0	1.0
R1L	0.13	0.07	0.04	0.03	1.1	1.1	1.0	1.0
R1G	0.29	0.29	0.33	0.13	1.3	1.3	1.3	1.1
R1J	0.07	0.08	0.07	0.04	1.1	1.1	1.1	1.0
R1H	0.08	0.09	0.08	0.07	1.1	1.1	1.1	1.1
R1I	0.05	0.06	0.05	0.04	1.1	1.1	1.1	1.0
R1R	0.63	0.84	0.87	0.49	1.6	1.8	1.9	1.5
R1Q	0.08	0.09	0.10	0.12	1.1	1.1	1.1	1.1

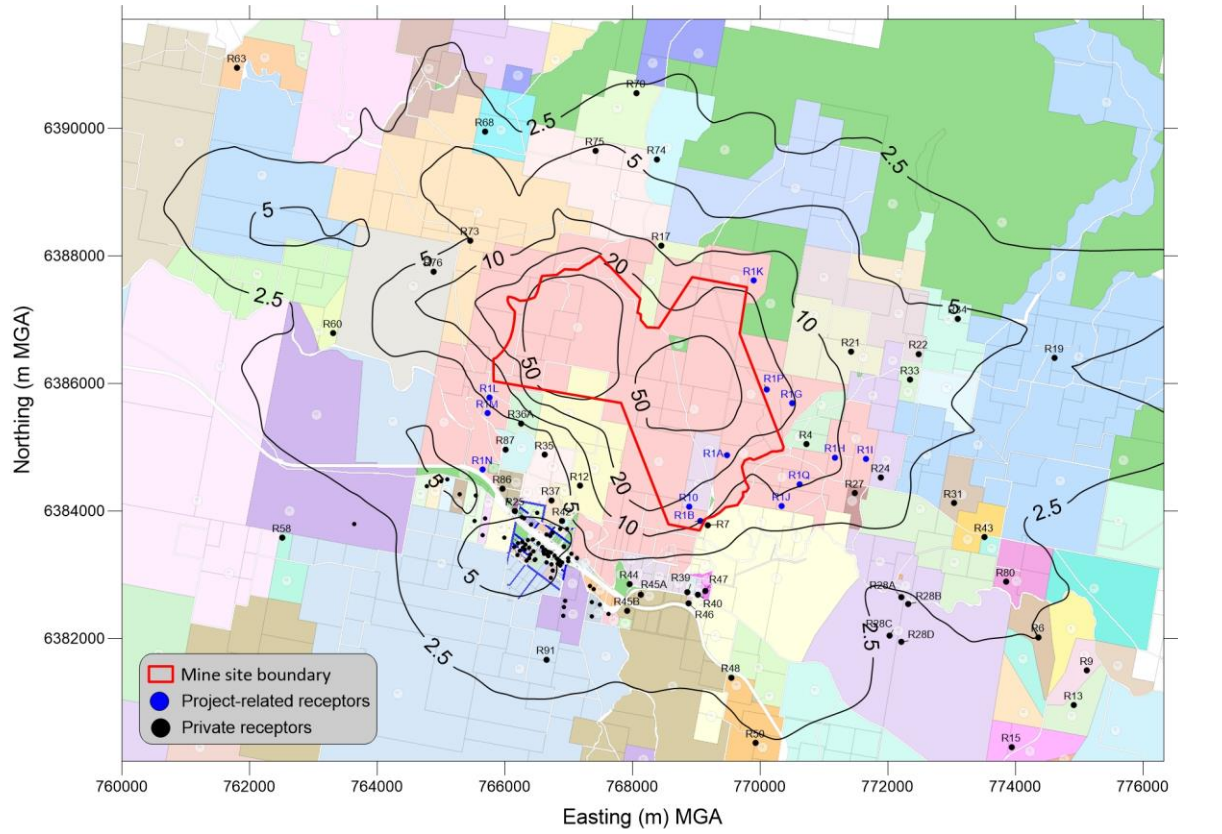
Note: Existing Project-related residences R1C, R1D, R1E, R1F will be removed as a result of Project activities. Therefore, results have not be presented for these residences.

Annexure 6

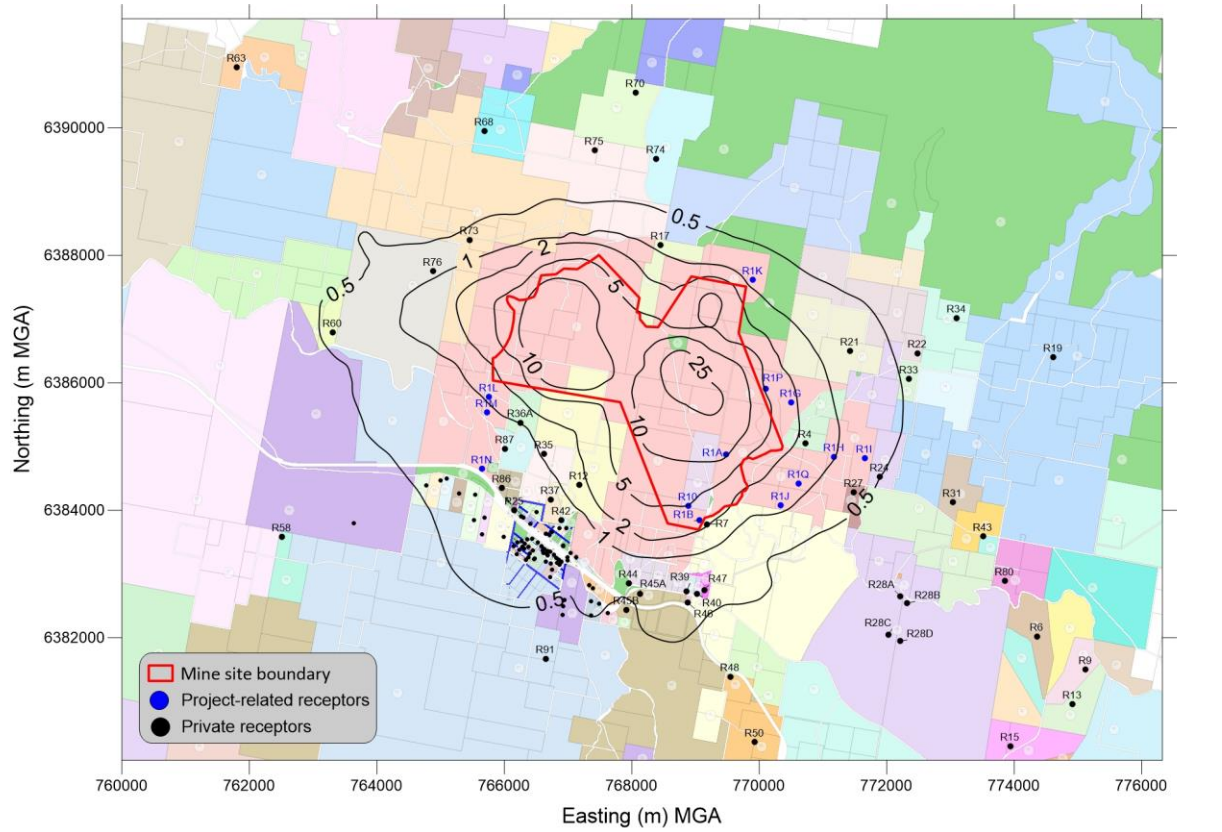
Contour Plots

(Total No. of pages including blank pages = 14)

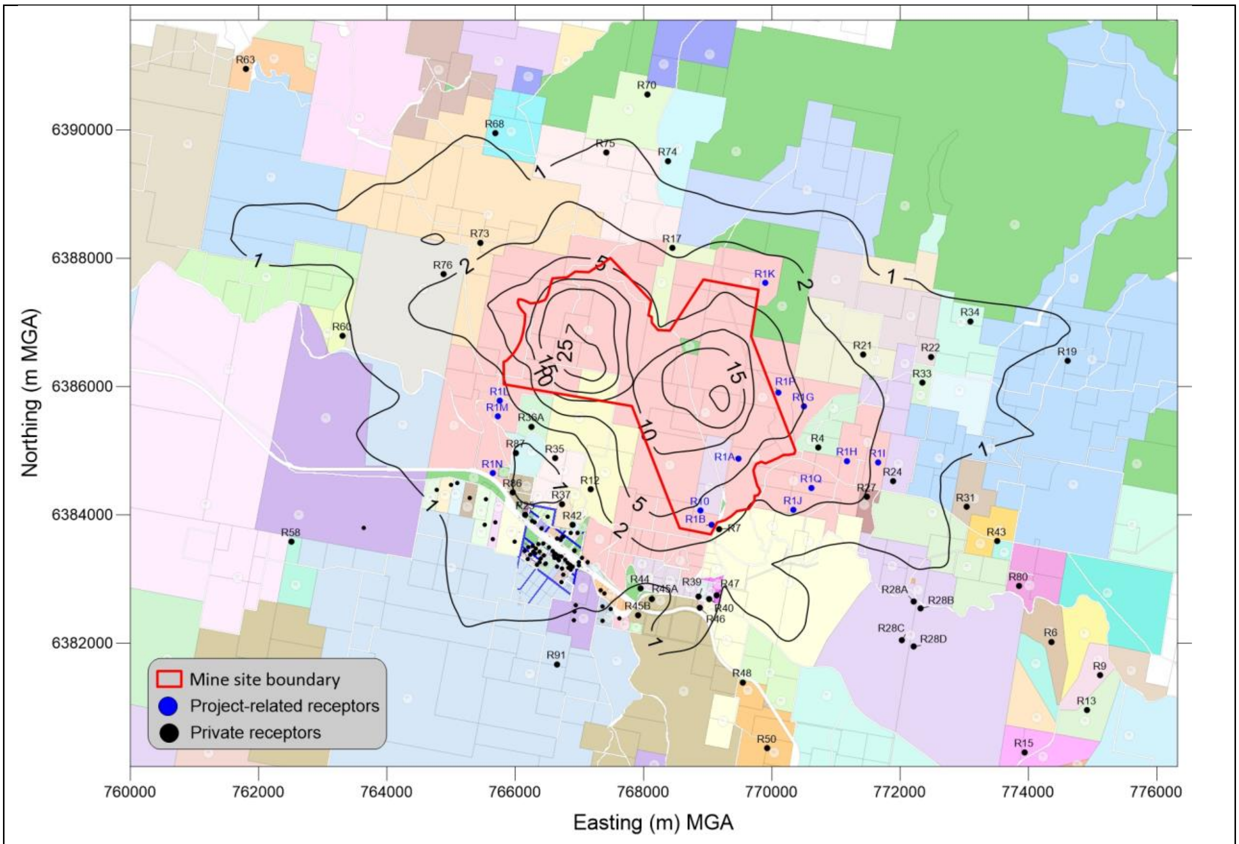
Figure A6-1: Contour plots for Scenario 1 (SE&CS)



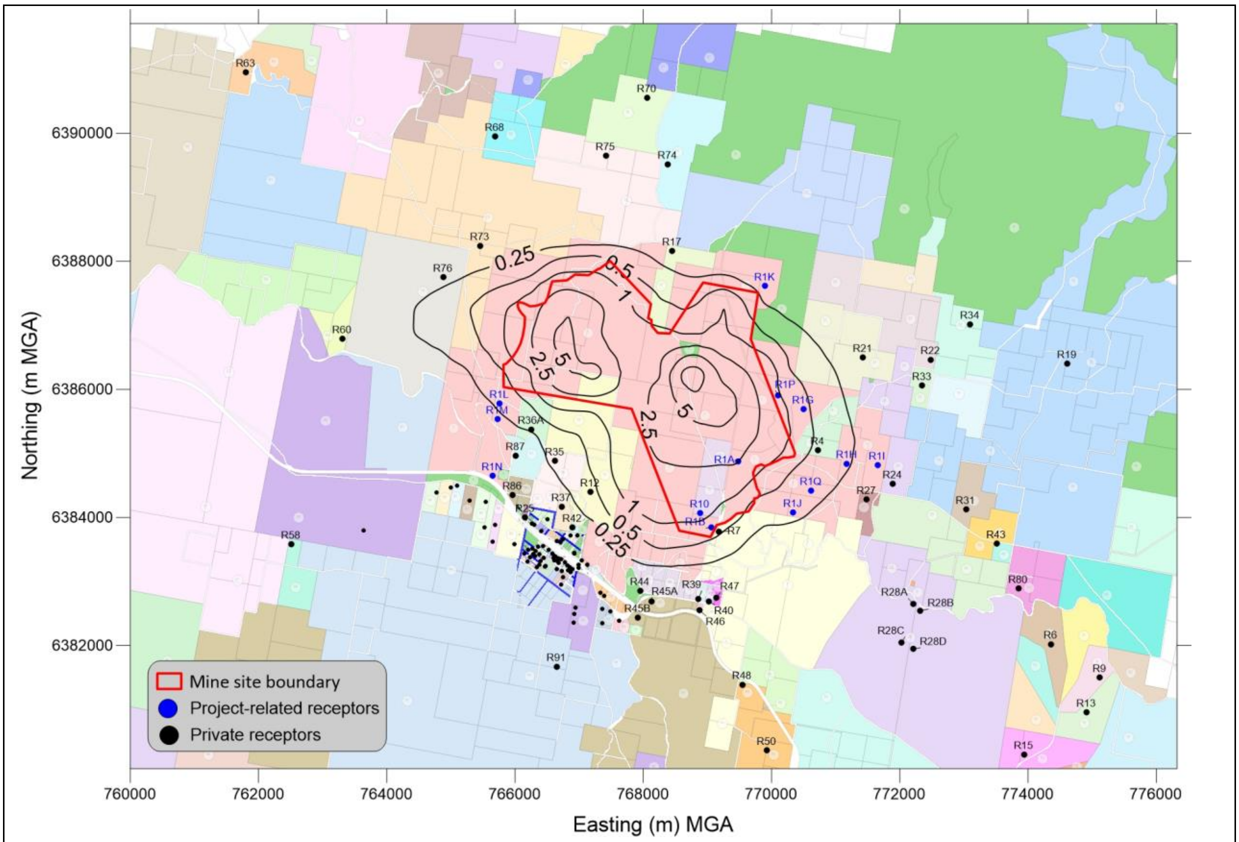
Project-only 24-hour PM_{10} concentration (µg/m³)



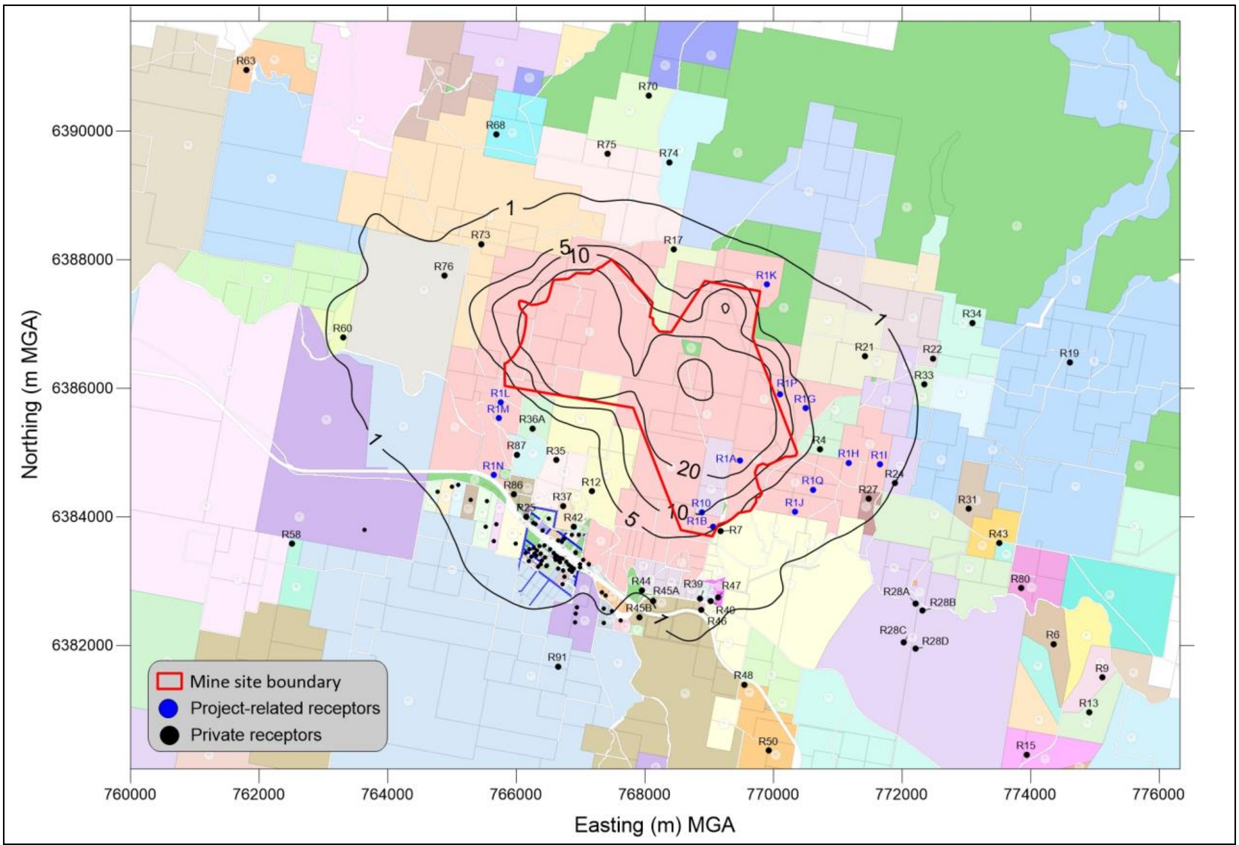
Project-only annual average PM_{10} concentration (µg/m³)



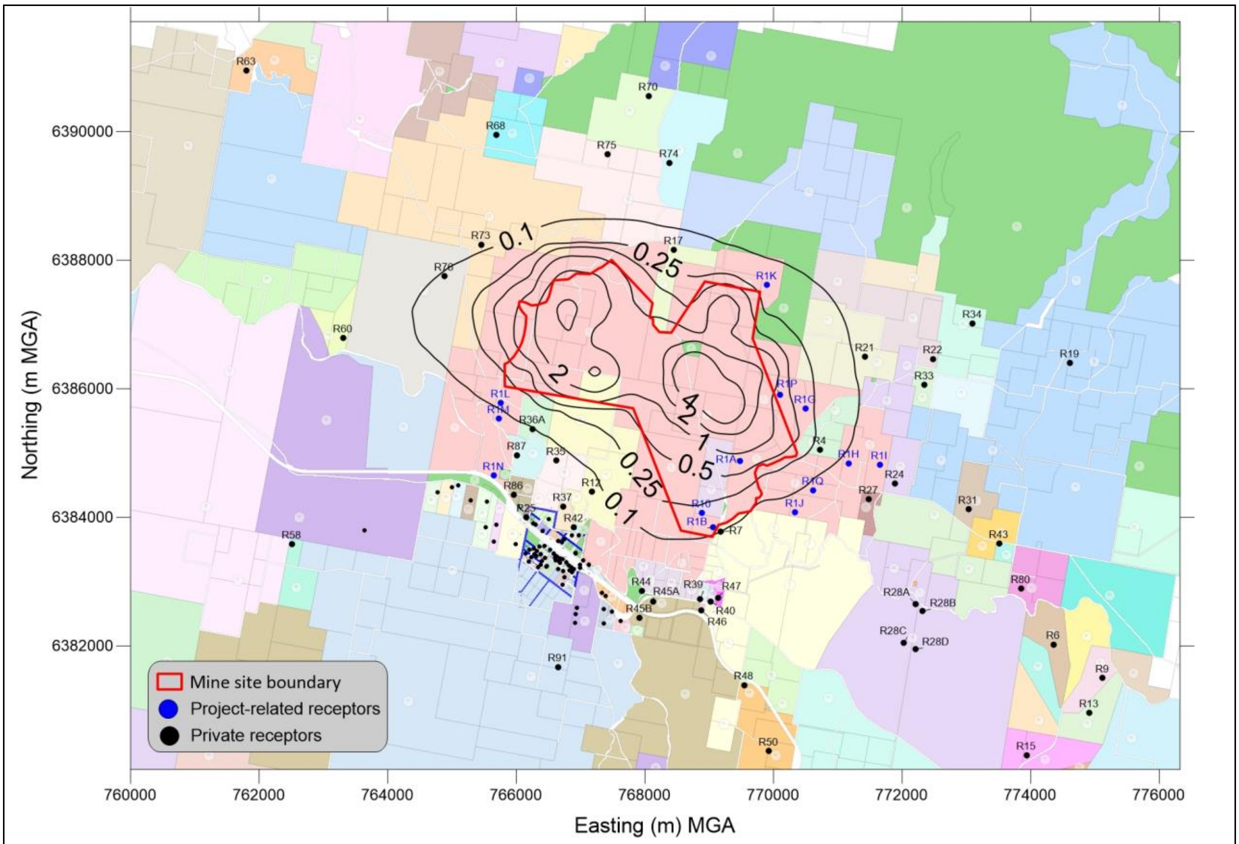
Project-only 24-hour PM$_{2.5}$ concentration (µg/m³)



Project-only annual average PM$_{2.5}$ concentration (µg/m³)

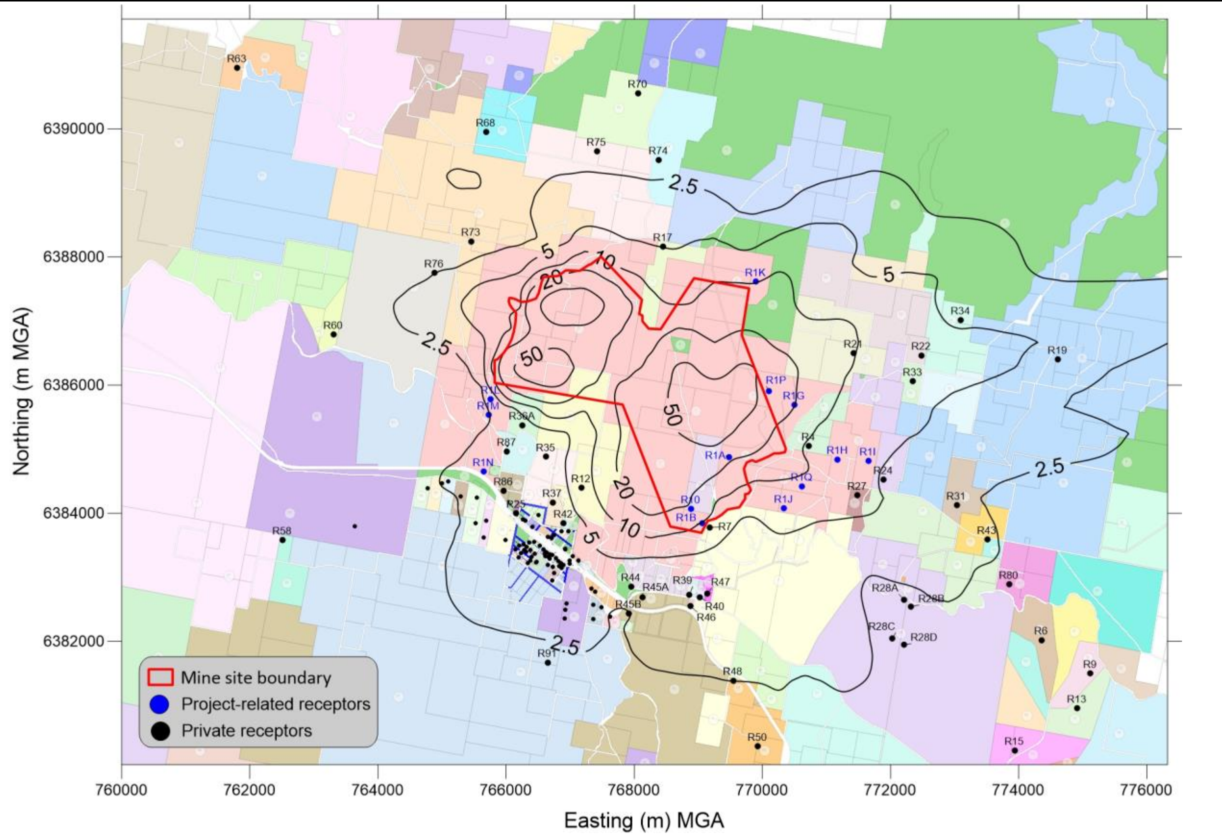


Project-only annual average TSP concentration (µg/m³)

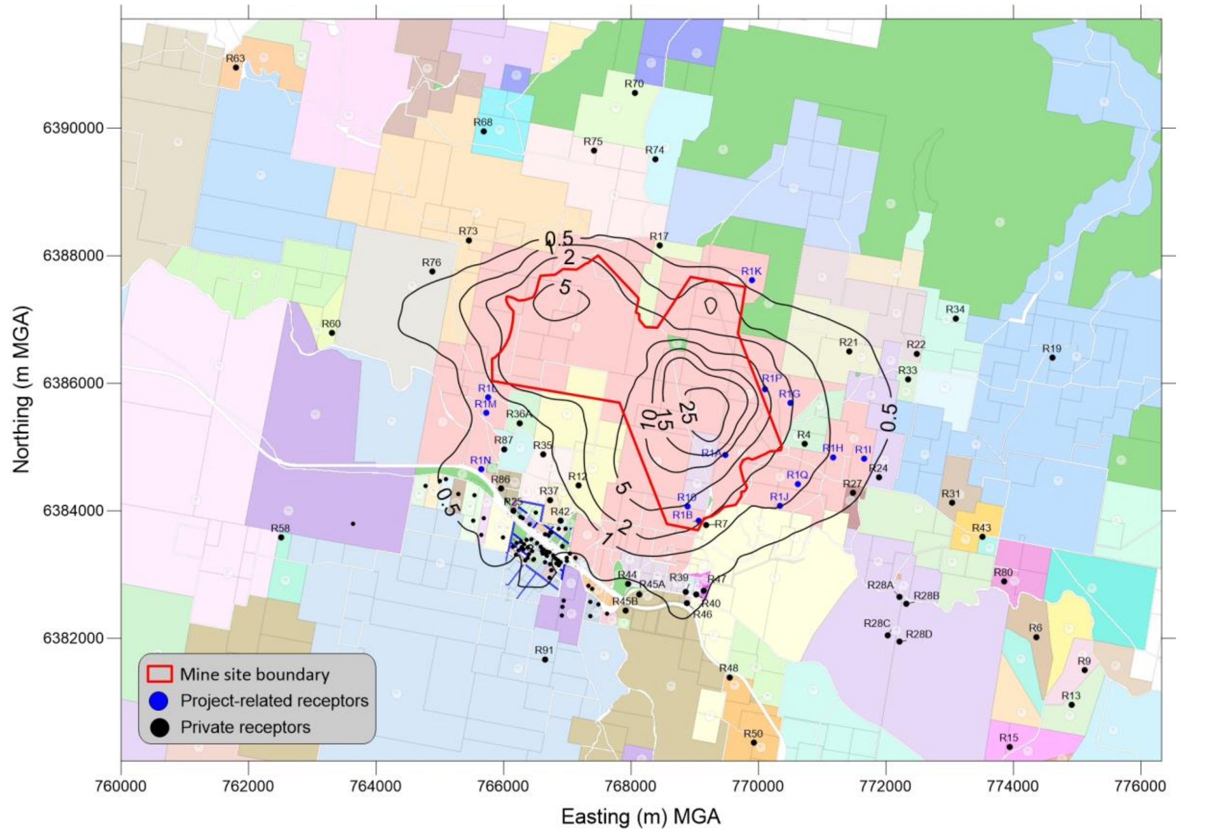


Project-only dust deposition (g/m²/month)

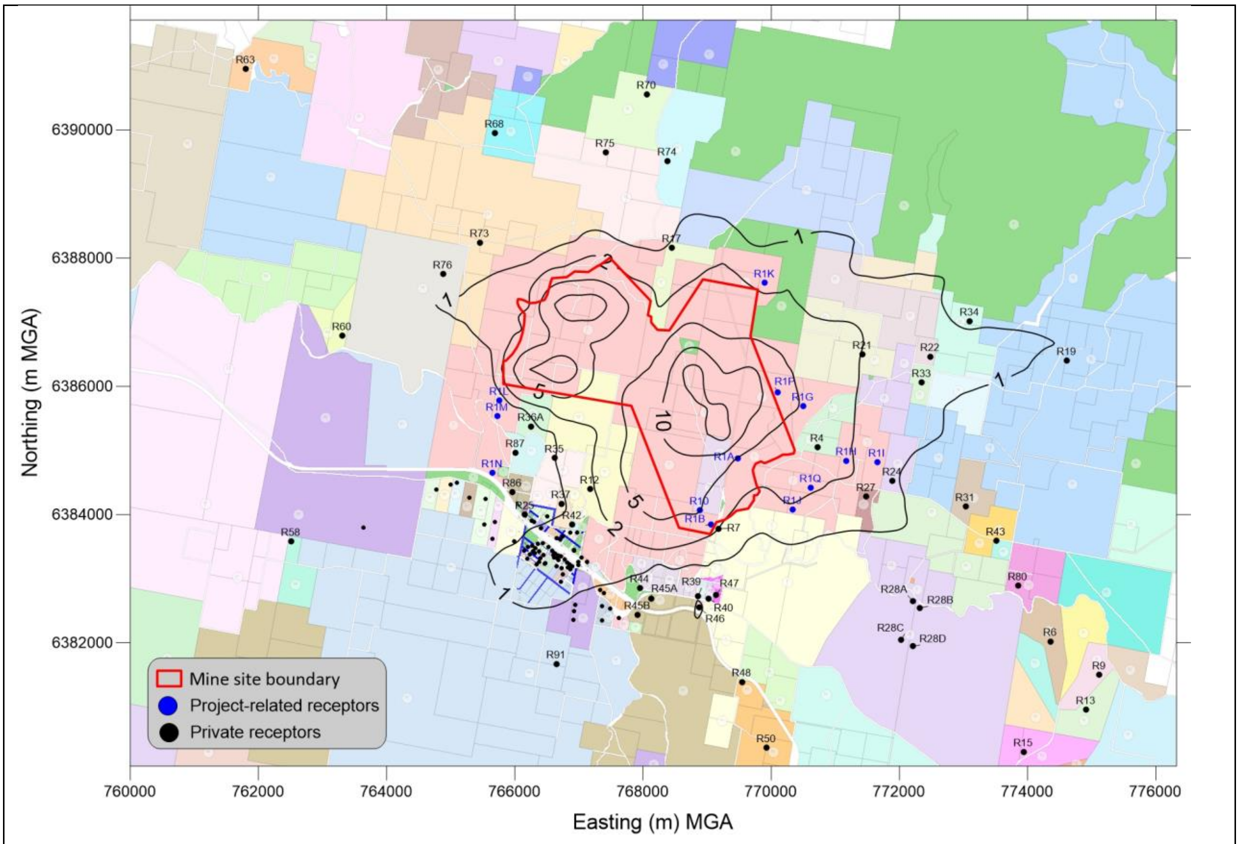
Figure A6-2: Contour plots for Scenario 2 (Year 4)



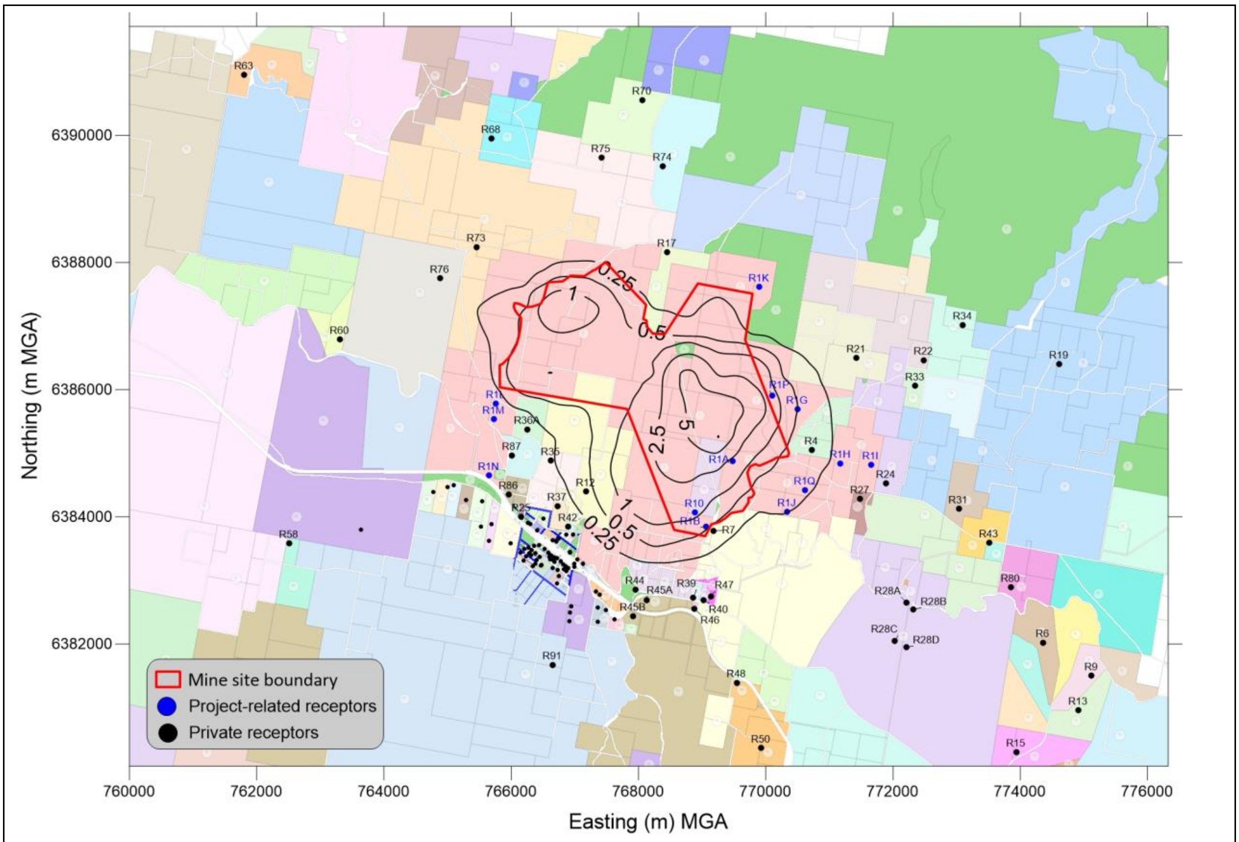
Project-only 24-hour PM_{10} concentration (µg/m³)



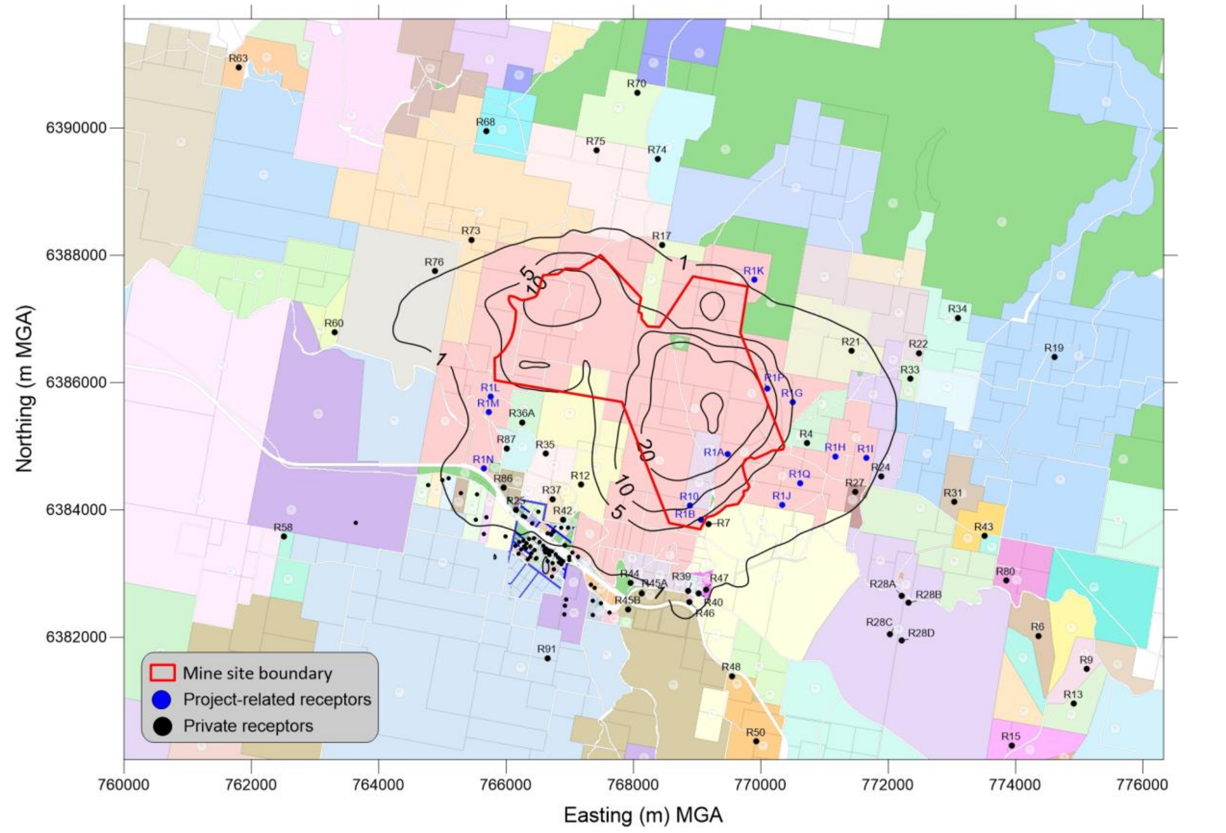
Project-only annual average PM_{10} concentration (µg/m³)



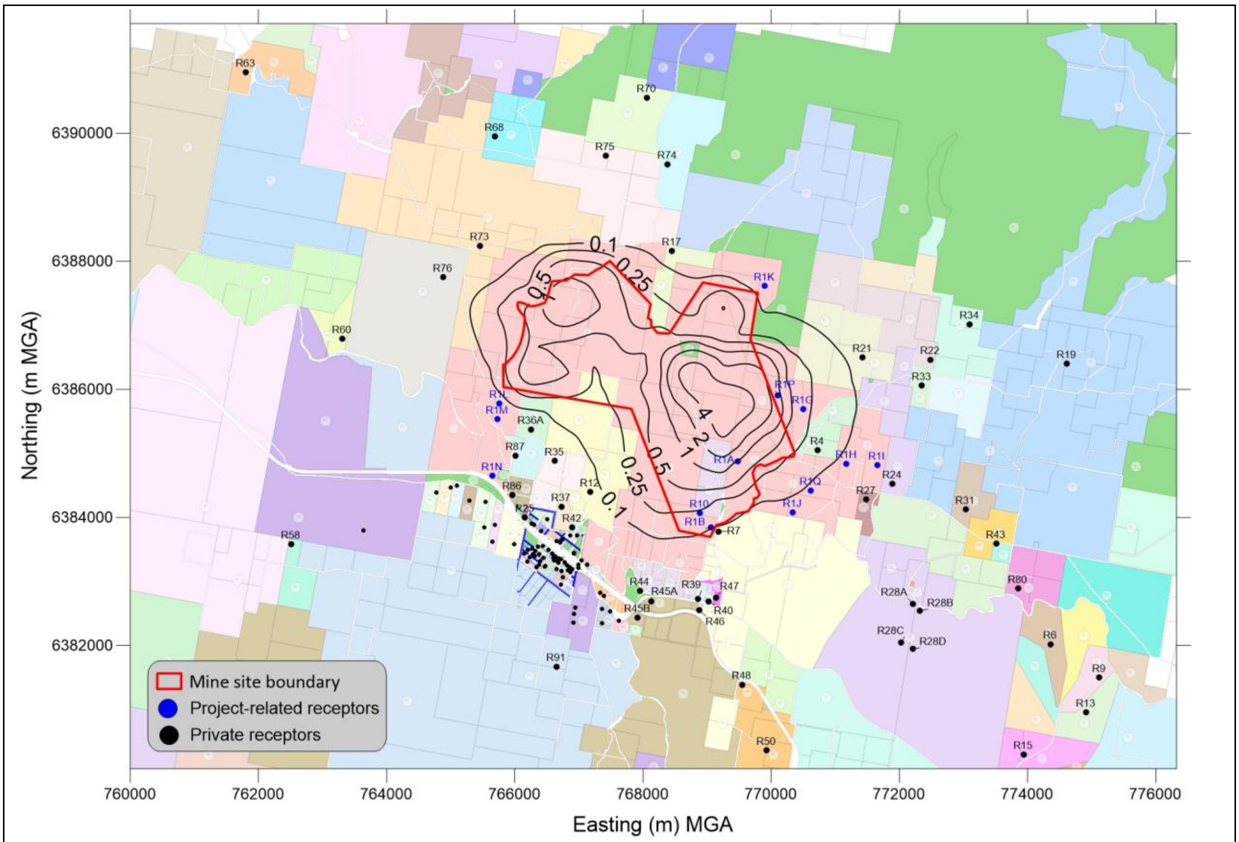
Project-only 24-hour $PM_{2.5}$ concentration (µg/m³)



Project-only annual average $PM_{2.5}$ concentration (µg/m³)

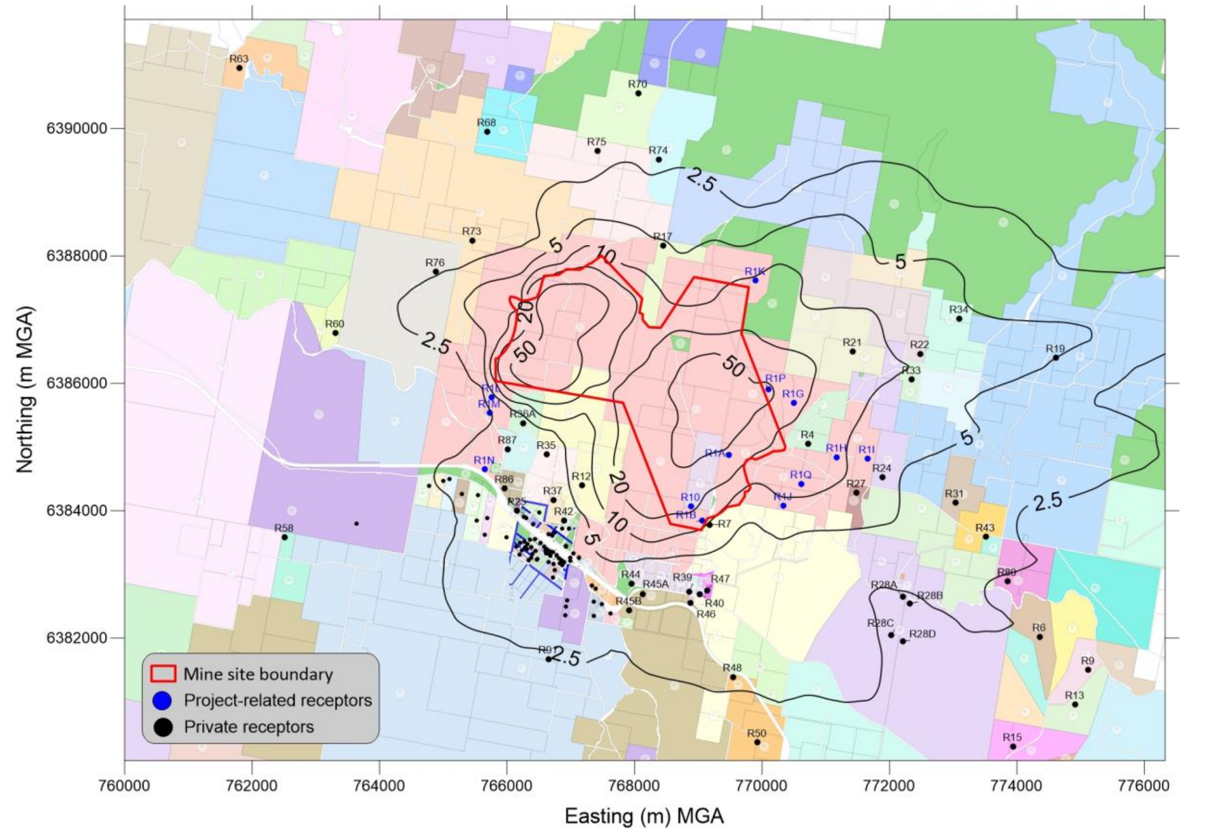


Project-only annual average TSP concentration (µg/m³)

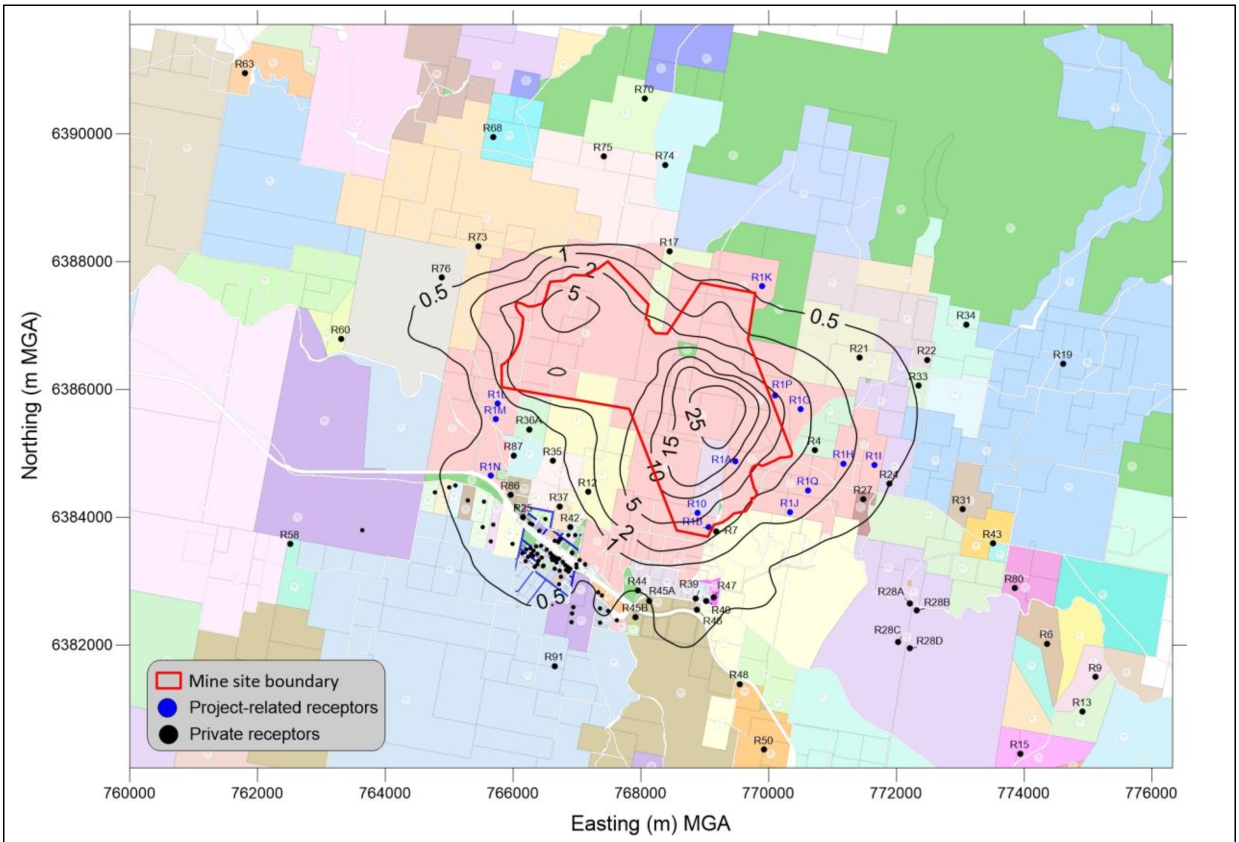


Project-only dust deposition (g/m²/month)

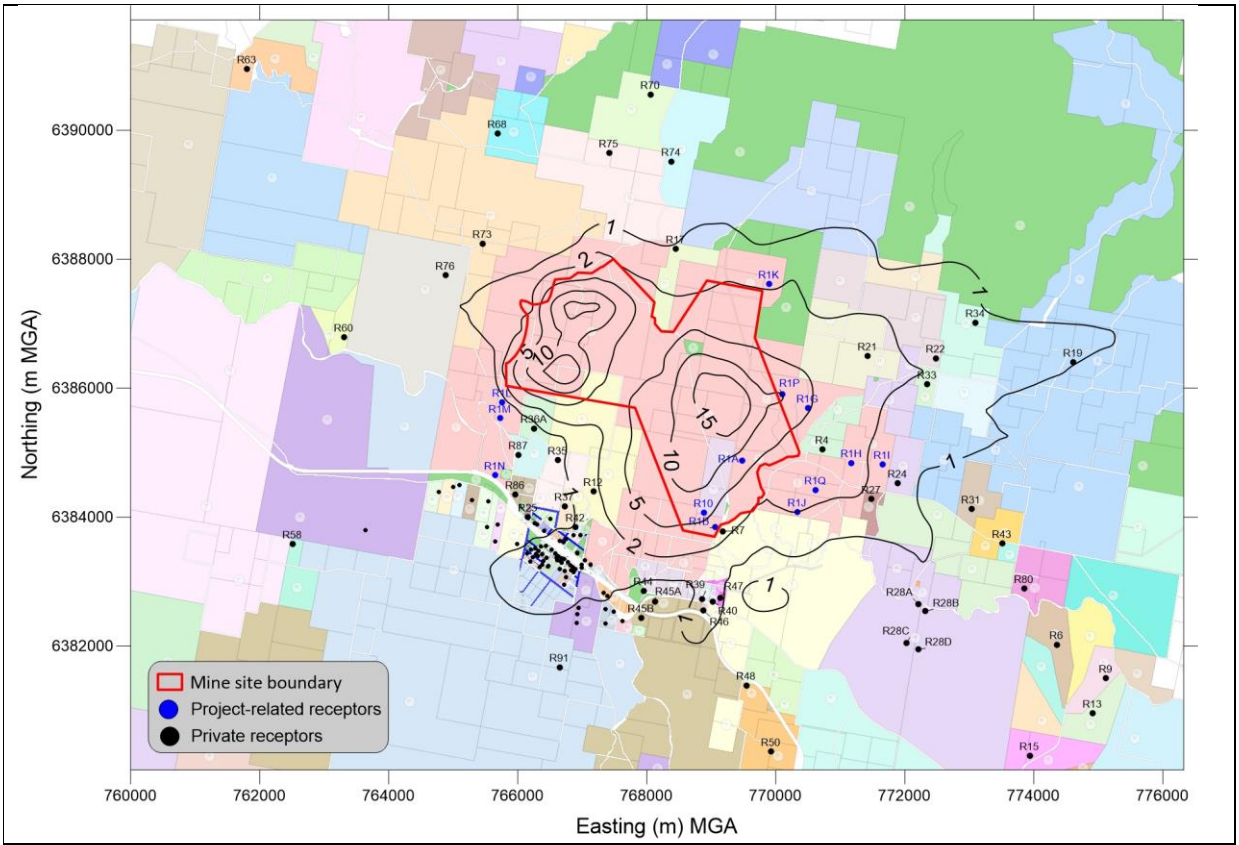
Figure A6-3: Contour plots for Scenario 3 (Year 8)



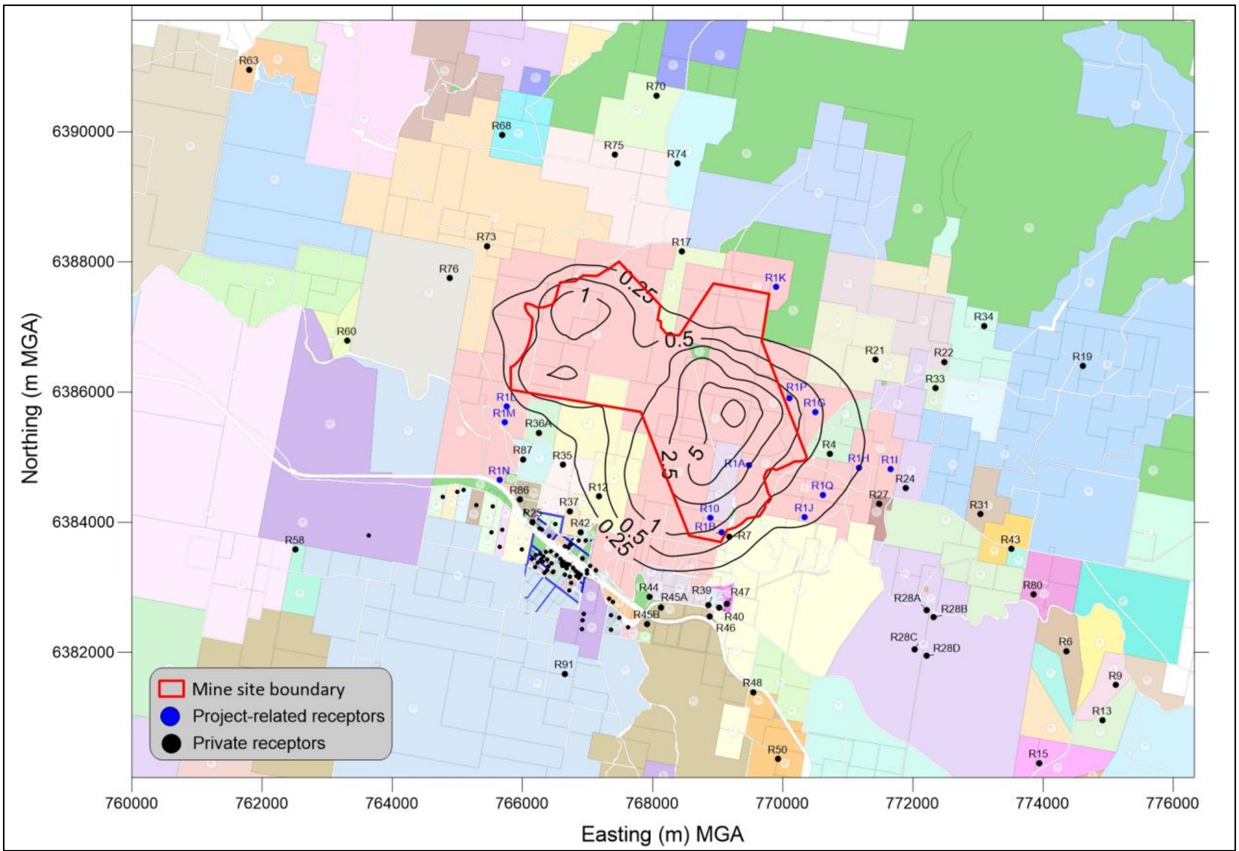
Project-only 24-hour PM_{10} concentration (µg/m³)



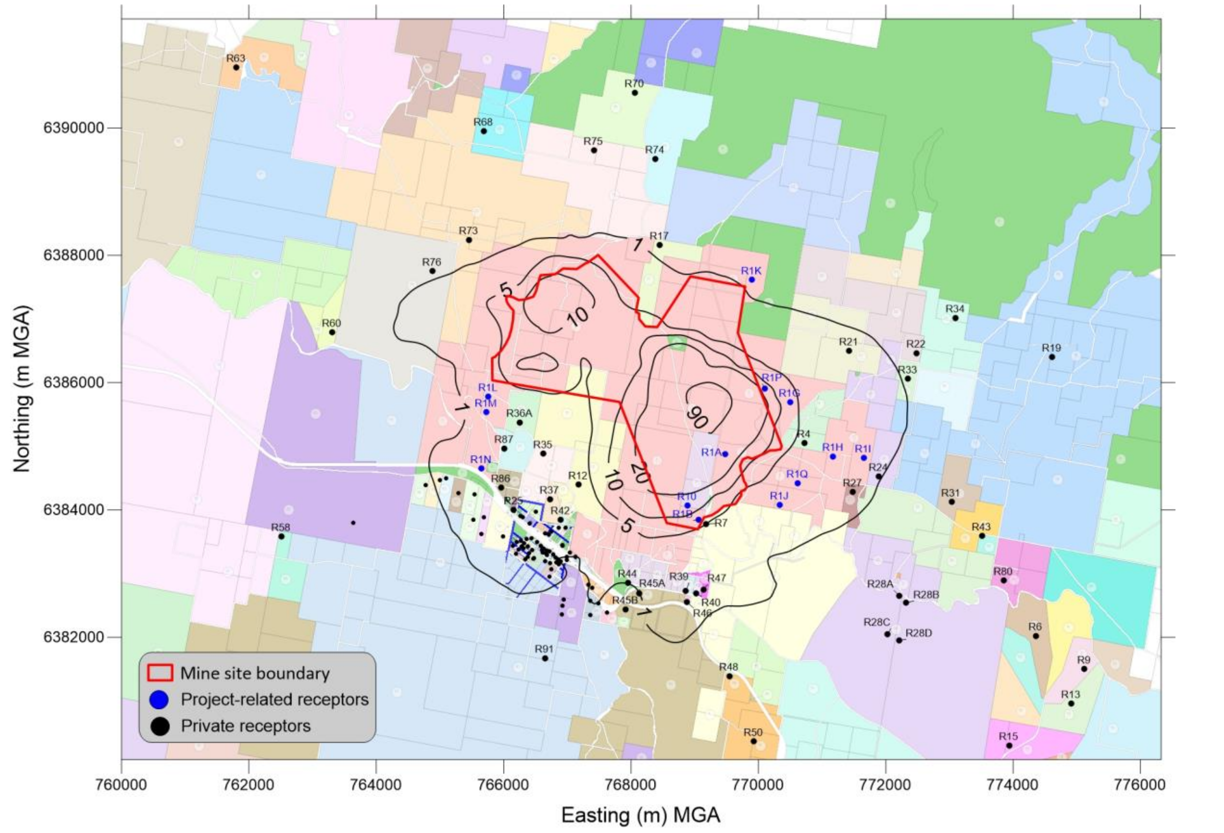
Project-only annual average PM_{10} concentration (µg/m³)



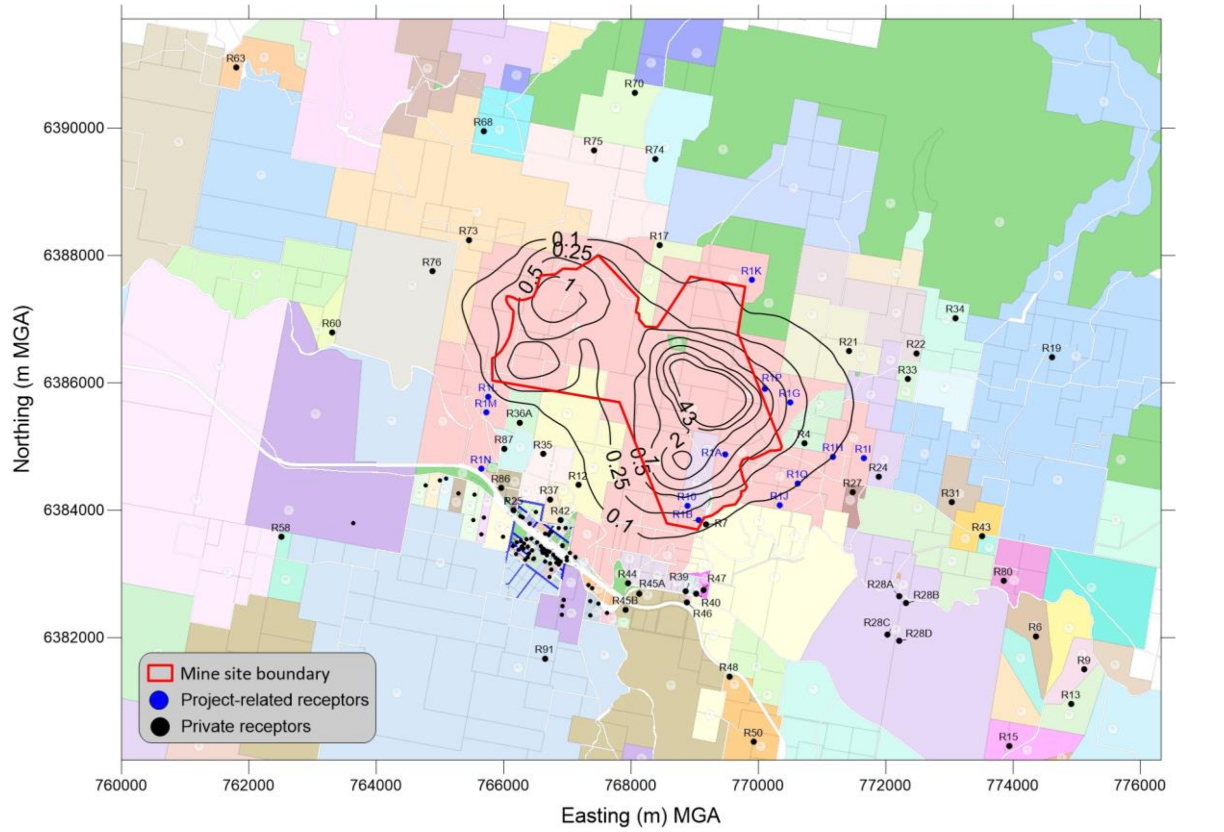
Project-only 24-hour $PM_{2.5}$ concentration (µg/m³)



Project-only annual average $PM_{2.5}$ concentration (µg/m³)

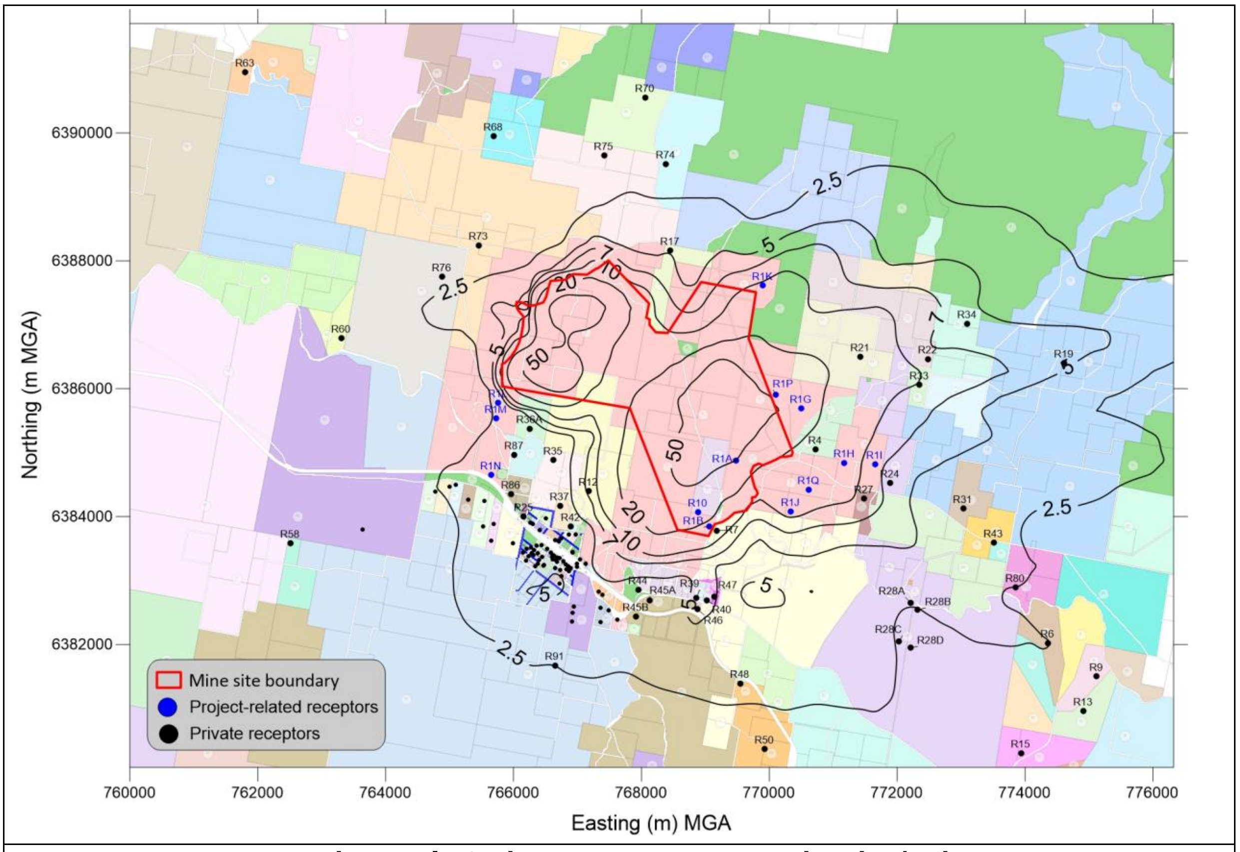


Project-only annual average TSP concentration (µg/m³)

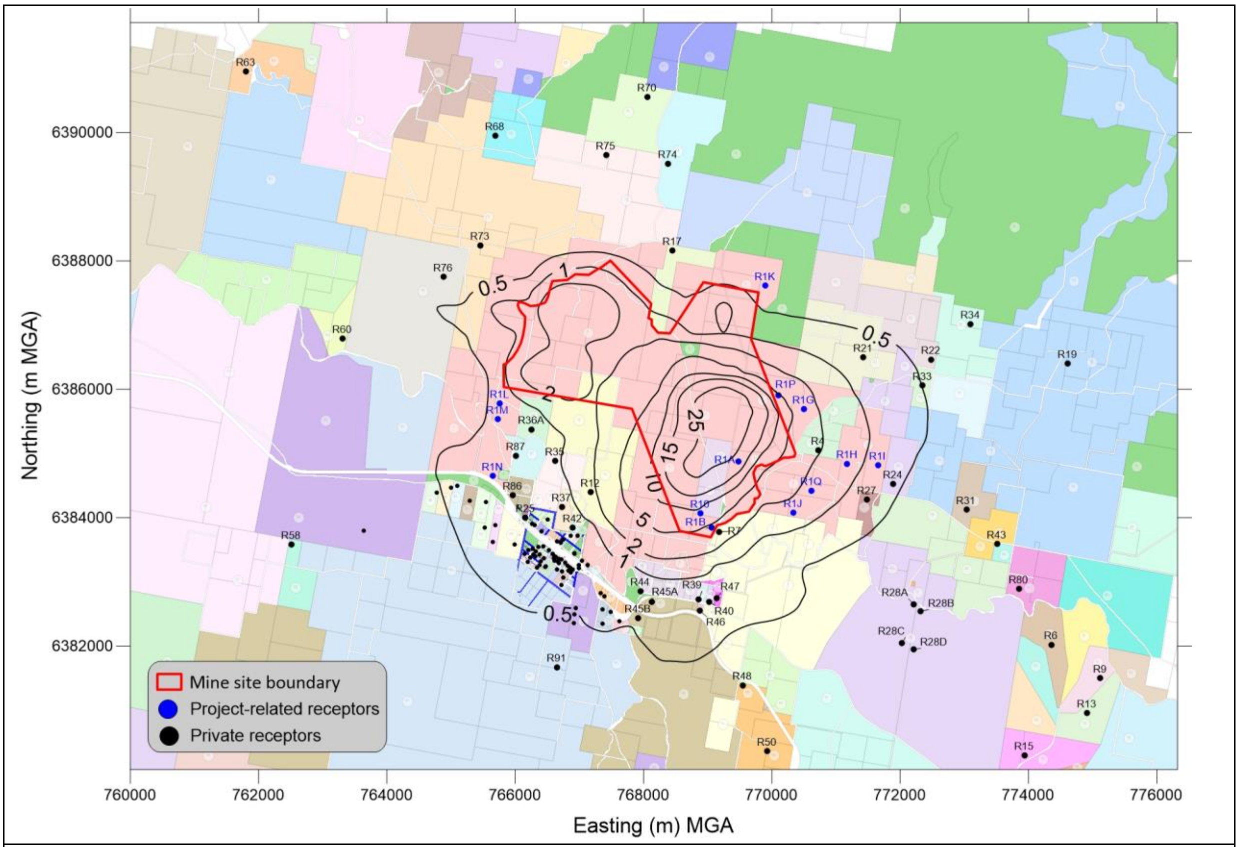


Project-only dust deposition (g/m²/month)

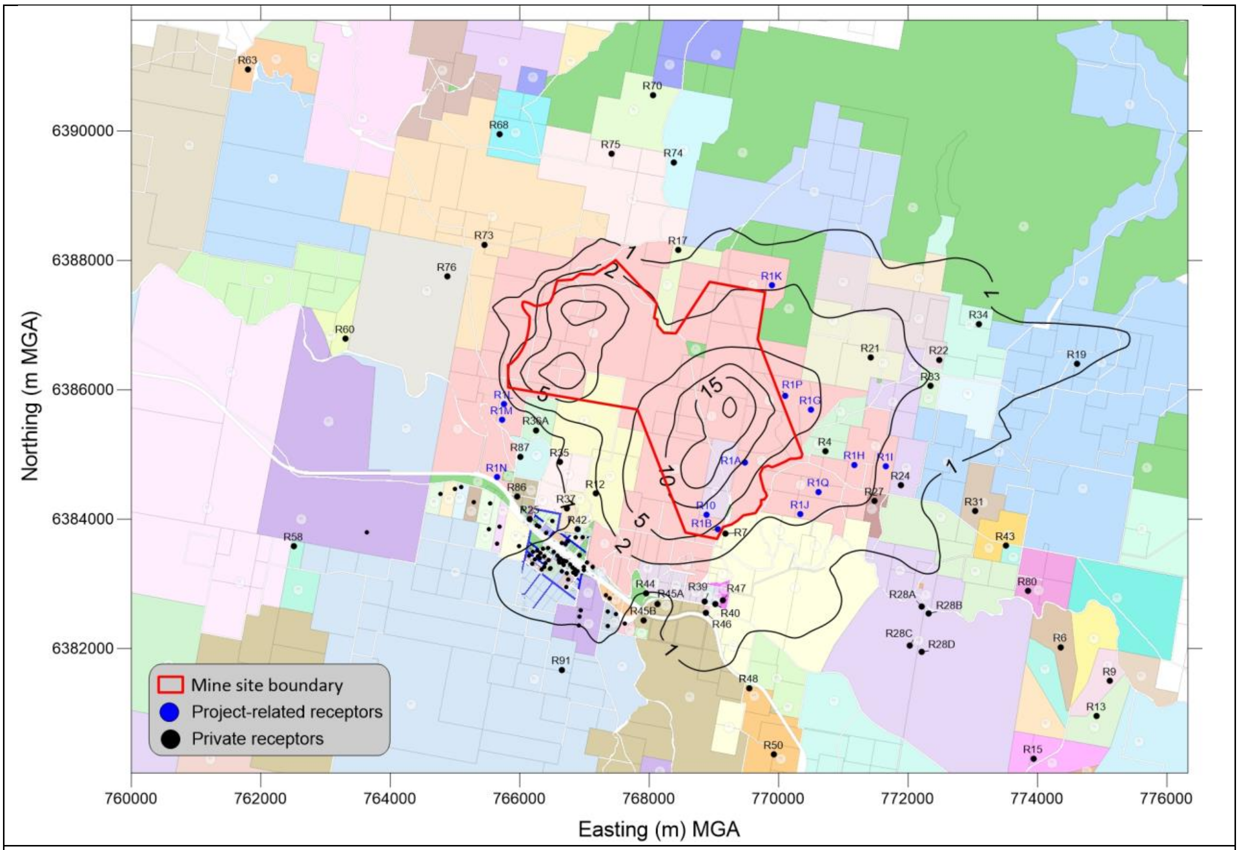
Figure A6-4: Contour plots for Scenario 4 (Year 9)



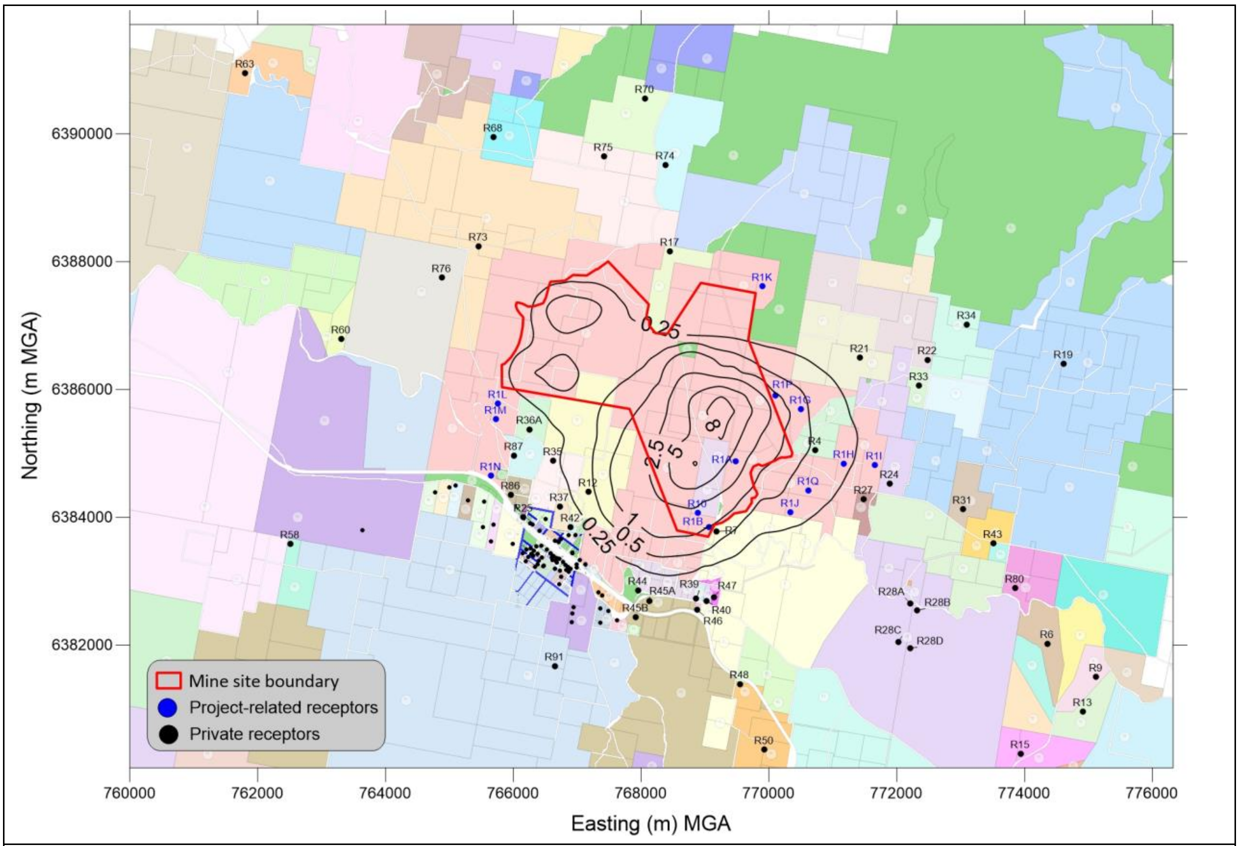
Project-only 24-hour PM_{10} concentration (µg/m³)



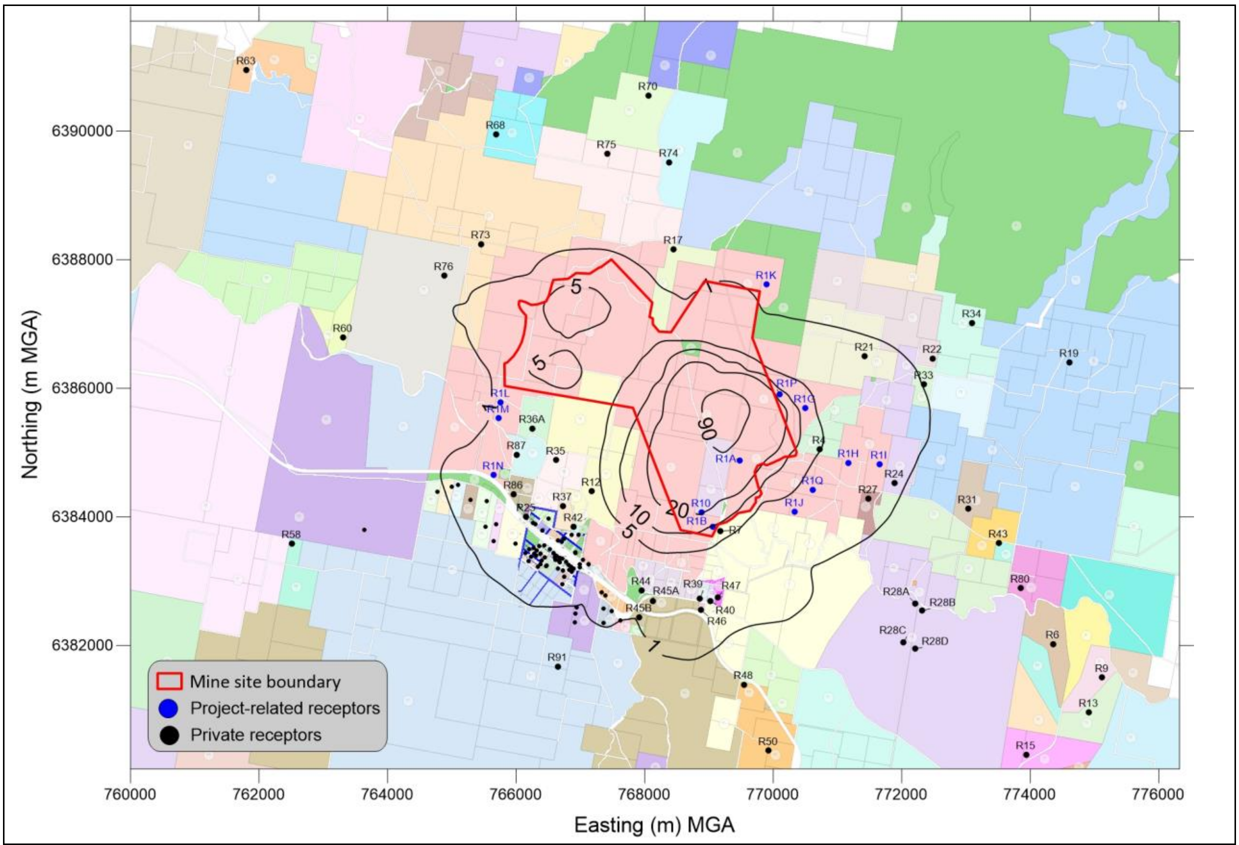
Project-only annual average PM_{10} concentration (µg/m³)



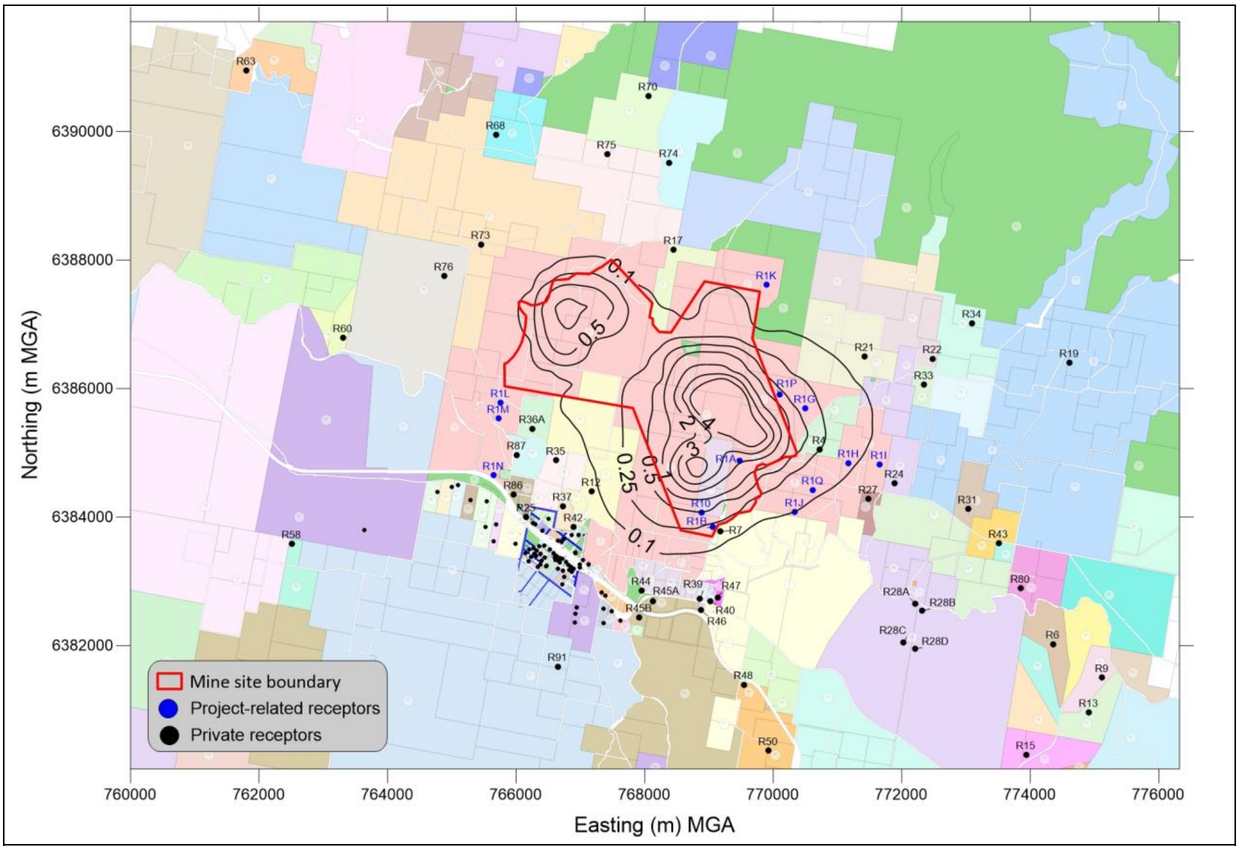
Project-only 24-hour $PM_{2.5}$ concentration (µg/m³)



Project-only annual average $PM_{2.5}$ concentration (µg/m³)



Project-only annual average TSP concentration (µg/m³)



Project-only dust deposition (g/m^2/month)

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Annexure 7

Peer Review
Prepared by Jane Barnett
(ERM Australia Pty Ltd)

(Total No. of pages including blank pages = 10)

9 December 2019

Peer Review of Air Quality Assessment for Bowdens Silver Project, prepared by Ramboll Australia Pty Ltd, dated November 2019

Introduction

I am an air quality Partner at ERM with 25 years' experience in air quality assessment, dispersion modelling, emissions estimation and meteorology. I have extensive experience in the assessment of mines and other extractive industries and it is in this context that I have carried out my review of the air quality assessment for the Bowdens Silver Project (the Project). A copy of my CV is presented in **Appendix A**. The assessment was completed by Ramboll Australia Pty Ltd (Ramboll) and initially submitted in August 2019 for peer review (Ramboll, 2019). I can confirm that I am independent of the assessment process and have not been involved in and dispersion modelling, data analysis or reporting, apart from in a review capacity.

The purpose of this review is to ensure that all of the assessment information has been incorporated, the methodology is sound and the Secretary's Environmental Assessment Requirements (SEARs) have been adequately addressed. Specifically, this includes discussion of:

- The project SEARs
- Air quality impact assessment criteria selected
- Assumed background levels for the Project
- Meteorological data and methodology, including the selection of representative year
- Appropriateness of the determination of sensitive receptors
- Emission estimation calculations
- Modelling results and conclusions
- Greenhouse gas assessment

Project Summary

Bowdens Silver Pty Ltd (the Applicant) is seeking approval to develop and operate an open cut mine and associated infrastructure located approximately 2 km to 3 km northeast of Lue. The Project will recover mineralised rock (ore) containing silver and small percentages of zinc and lead to depths of at least 180 m.

The Project comprises of a main open pit and two satellite open pits, processing plant and associated infrastructure, waste emplacement areas, stockpiles and tailings storage areas. The

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maximum rates of extraction (combining both ore and waste rock) is proposed to be 6 Mtpa, in the first five years of operation.

Peer Review Process

Ramboll was commissioned by R.W. Corkery & Co. Pty. Limited (RWC) on behalf of the Applicant to conduct an air quality and greenhouse gas assessment (AQA) to identify potential impacts of the Project and to recommend appropriate emission mitigation measures. The assessment was to be completed in two stages. Stage 1 (review of the constraints analysis) was undertaken in July 2018 and is described in the following section.

The data analysis presented in the Stage 1 report formed the basis of the detailed air quality impact assessment prepared to support the Environmental Impact Statement (EIS) for the Project (Stage 2). The Stage 2 component is the main subject of this review.

Stage 1: Constraints analysis

In July 2018 I conducted a review of the constraints analysis carried out by Ramboll. This review focussed on the background data analysis, proposed methodology and selection of appropriate air quality assessment criteria.

The report outlining the analysis of constraints was sufficient and appropriate, noting that the ownership and occupancy status of the nearest residences will determine which properties are included as assessment locations in the final study. In addition, the report notes that levels of engineering and operational dust controls applied to emission sources will dictate the extent of impacts from the Project. This is correct and all practical and feasible mitigation measures were included in the modelling study.

The report also noted that the CALPUFF model will used for the assessment. Due to the nature of the surrounding terrain this is entirely appropriate. The constraints analysis has shown that the local topography is likely to influence terrain so this three-dimensional model is the most suitable.

Stage 2: Air Quality Impact Assessment

This review was conducted in two additional stages. The dust emissions inventories developed by Ramboll were reviewed in February 2019, prior to being used in the dispersion modelling. There were very minor issues confirmed with Ramboll and these were addressed prior to modelling. Once modelling was completed and the assessment completed, the second and final stage of the review considered the report as a whole, covering each issue on its merits as discussed in the following sections.

Secretary's Environmental Assessment Requirements (SEARs)

The Project SEARs are listed in the report in Section 1.2 / Table 1.2, along with the reference to the section(s) in the report where they are addressed. These requirements are relatively broad but are addressed adequately in the report. More detailed requirements from other agencies are also listed in the report and addressed adequately therein.

Air quality impact assessment criteria

The impact assessment criteria specified in the AQA are those set by the NSW EPA as part of their Approved Methods for Modelling (EPA, 2016). Relevant criteria have been selected for the likely pollutants and have been applied appropriately.

Existing environment and background values

The characterisation of the existing environment was thorough. Particulate matter was analysed using the existing monitoring network. The network consisted of both real-time and static monitoring devices as well as dust deposition gauges. Data from other OEH sites were also analysed. The year 2017 was chosen as the year of primary focus for both meteorology and existing dust levels in the vicinity of the Project. The rationale for this was that 2017 was the most complete period of continuous monitoring. A comparison of 2017 with the previous four years was undertaken and 2017 determined to be a representative year.

Background particulate matter levels were determined from the available monitoring data and used in the assessment of cumulative impacts. Single values for annual average TSP, PM_{10}, $PM_{2.5}$ and dust deposition were used to represent background values. Daily-varying values were used for the 24-hour average cumulative assessment. These approaches are appropriate. Metals analysis was also undertaken for dust deposition, TSP and, for a short period, PM_{10} and $PM_{2.5}$ samples. Recorded lead values were appropriately considered negligible, being <0.2% of the impact assessment criteria.

Five years of meteorological data were analysed from 2013 to 2017. The year 2017 was determined to be representative for wind speed, wind direction, temperature and rainfall.

Emissions estimation

The emission factors used for this assessment have been drawn largely from the US EPA AP42 (US EPA, 1985 and updates) and also the Emission Estimation Technique Manual for Mining (NPI, 2012). These factors have been used in an appropriate manner and the total values calculated for the Project appear reasonable. Emission inventories and calculation spreadsheets were also reviewed and all issues rectified prior to modelling.

Emissions of PM_{10} and $PM_{2.5}$ have also been considered from diesel exhaust from mining equipment. Assumptions concerning these contributions are appropriate and acceptable. Assumptions concerning emissions of metals, respirable crystalline silica and hydrogen cyanide are also considered appropriate.

Meteorological and dispersion modelling

The CALMET/CALPUFF modelling suite is the most appropriate model for this assessment.

Meteorology for 2017 was determined to be representative of the area around the Mine Site and is suitable for use in the assessment. Meteorological model settings were summarised and are confirmed as appropriate for the chosen model.

Predictions were made across the modelling domain using the CALPUFF dispersion model. Results were presented as contour plots and also specific values for discrete sensitive receptors.

Assessment results

In terms of predicted air quality impacts, the main conclusions are summarised as follows:

- There are no privately-owned residences predicted to experience an exceedance of the annual average PM_{10} assessment criterion of 25 µg/m³, or where the cumulative maximum 24-hour average PM_{10} increment is above 50 µg/m³.
- There are no private residences predicted to experience an exceedance of the annual average $PM_{2.5}$ assessment criterion of 8 µg/m³, or where the cumulative maximum 24-hour average $PM_{2.5}$ concentration is above the 25 µg/m³ criterion.
- The TSP and dust deposition predictions are well below their respective criteria at all private residences.
- There are no predicted exceedances of the criteria for metals, respirable crystalline silica or hydrogen cyanide.

Greenhouse gas assessment

The GHG emission factors have been used appropriately to calculate scope 1, 2 and 3 emissions due to the Project.

Review conclusions

It is my professional opinion that the air quality and greenhouse gas assessment carried out by Ramboll is consistent with the necessary requirements for a Project of this nature. The methodology is sound and includes an acceptable level of conservatism. The assessment conclusions are consistent with what would be expected for a Project such as this.

Yours sincerely

Jane Barnett
Partner, Sydney

Appendix A – Peer Reviewer Credentials

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Jane Barnett

Partner – Air Quality

Jane has over 20 years' experience in air quality consulting, both in the assessment phase and also monitoring and management. She plays a key role in the NSW Air Quality team leading projects from start to finish as well as training and mentoring younger staff. She currently leads a group of approximately 15 air quality and acoustics consultants to deliver projects throughout NSW and Australia.

Jane has significant experience in the preparation of emissions inventories and dispersion modelling for air quality impact assessment. She has been extensively involved in the provision of advice on dust abatement measures for coal mines in the Hunter Valley, the Gunnedah Basin and the Western Coalfields of NSW.

Jane has led various air quality and/or odour assessment projects for industrial activities, waste management, transport and infrastructure, extractive industry, greenhouse gas assessments, air quality monitoring, air quality management plans, research and technical peer review.

Jane is also involved in the delivery of the air quality assessment for some of the largest infrastructure projects in NSW in recent years, in particular, road tunnels. These projects include the WestConnex, Western Harbour Tunnel Beaches Link and F6 Extension Projects.

Experience: 24 years' experience in air quality consulting and project management.

Email: jane.barnett@erm.com

Education

- Bachelor of Technology (Atmospheric Science) (Hons), Macquarie University, NSW, Australia.

Professional Affiliations and Registrations

- NSW Committee Member for the Clean Air Society of Australia New Zealand (CASANZ),
- CASANZ Certified Air Quality Professional (CAQP)

Languages

- English, native speaker

Fields of Competence

- Dispersion modelling (AERMOD, CALMET, CALPUFF, CALINE, GRAL)
- Air quality impact assessment
- Odour assessment
- Technical peer review
- Road transport assessment
- Meteorology
- Emissions estimation

Key Industry Sectors

- Mining
- Transport and infrastructure
- Government
- Waste management and recycling

The business of sustainability

ERM

Key Projects

Roads and Maritime Services: Sydney Gateway Road Project – Air Quality Consulting and Monitoring Services.
Project director, dispersion modelling, analysis and reporting for the Air Quality Technical Report for the proposed Sydney Gateway Road Project EIS, 2018 – current.

Roads and Maritime Services: Western Harbour Tunnel and Beaches Link – Air Quality Consulting and Monitoring Services.
Project director, dispersion modelling, analysis and reporting for the Air Quality Technical Reports for the proposed Western Harbour Tunnel and Beaches Link EISs, 2016 – current.

Roads and Maritime Services: F6 Extension Stage 1 – Air Quality Consulting and Monitoring Services.
Project director, dispersion modelling, analysis and reporting for the Air Quality Technical Report for the proposed F6 Extension Stage 1 EIS, 2018 – 2019.

Sydney Motorway Corporation: Westconnex – Air Quality Consulting and Monitoring Services.
Project management, dispersion modelling, analysis and reporting for the M4 East, New M5 and M4-M5 Link EISs, 2013 – 2019.

Roads and Maritime Services: Assessments for various highway upgrades.
Emissions estimation, meteorological data analysis, dispersion modelling and reporting for numerous road upgrades including the M2 and M7 (Western Sydney Orbital), Eastern Distributor, Cross City Tunnel, Lane Cove Tunnel, Princes Highway (Gerringong to Bomaderry), Foxground to Berry Bypass, Albion Park Rail Bypass, Orange Northern Distributor, North Kiama, Alstonville and Coopernook bypasses, Epping Road widening and Liverpool to Parramatta Bus Transitway.

United Wambo Open Cut Coal Mine Project
Technical peer review of the air quality impact assessment prior to delivery of the EIS to DPE & EPA.

Mount Owen Continued Operations Project
Emissions estimation, meteorological modelling, iterative dispersion modelling, determination of practical mitigation measures, liaison with government departments, reporting and provision of advice for the air quality impact assessment. This project also involved providing detailed technical advice to the Planning and Assessment Commission (PAC) to enable it to make an informed decision on the project.

Cowal Gold Mine Modification 13 and 14
Emissions estimation, meteorological modelling, iterative dispersion modelling, determination of practical mitigation measures and reporting for the air quality impact assessment.

Cadia East Open Pit and Underground Mines
Emissions estimation, meteorological modelling, iterative dispersion modelling, determination of practical mitigation measures, greenhouse gas assessment and reporting for the air quality impact assessment.

WIM150 Mineral Sands Project
Emissions estimation, meteorological modelling, iterative dispersion modelling, determination of practical mitigation measures, greenhouse gas assessment and reporting for the air quality impact assessment.

Gunlake Marulan Quarry
Air quality assessment for the extension of operations at the Marulan site, including meteorological analysis, dispersion modelling, assessment of potential impacts at sensitive receptors and recommendations for additional mitigation and management measures.

Grants Road Sand Quarry
Modelling assessment and advice on various components for this project over many years. This involved providing an AQIA included estimating emissions and dispersion modelling, preparation of an Air Quality Management Plan and advice for dust and meteorological monitoring locations. ERM also compiles these data for the quarry's Annual Review as part of their ongoing compliance.

Lynwood Quarry
Air quality assessment for the proposed operations, including meteorological analysis, dispersion modelling, assessment of potential impacts at sensitive receptors and recommendations for additional mitigation and management measures.

Port Waratah Coal Services and Kooragang Coal Terminal
Emissions estimation and dispersion modelling to assess the expansion of an additional ship loader.

Water Recycling Facilities & Sewage Treatment Facilities: Odour assessment.
Emissions estimation, meteorological data analysis, dispersion modelling and reporting for numerous facilities including: Pitt Town, Huntlee, Box Hill, Bellbird, Shepherds Bay, St. Marys, Murwillumbah, Rouse Hill, Port Macquarie, Forster, Pacific Palms, Moree, Taree and South West Rocks

Spring Farm Advanced Resource Recovery Treatment Facility: Odour measurement and modelling services.
Assessment of the proposed modification of the Spring Farm ARRT to receive and process liquid waste using existing infrastructure for disposal to sewer.

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