AIR QUALITY IMPACT ASSESSMENT RESIDENTIAL DEVELOPMENT AT 58 TAYLORS ROAD, BLACK HILL, NSW

Perception Planning Pty Ltd

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Air Quality Impact Assessment Residential Development at 58 Taylors Road, Black Hill, NSW

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Perception Planning Pty Ltd. The report presents an assessment of the potential air quality impacts associated with the operation of the Black Hill Quarry on the proposed residential development at 58 Taylors Road, Black Hill New South Wales (NSW) (hereafter referred to as the Project).

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

To assess the potential air quality impacts, this report comprises:

- A background to the Project and description of the proposed site;
- A review of the existing meteorological and air quality environment surrounding the site;
- A description of the dispersion modelling approach and emission estimation used to assess potential air quality impacts; and,
- Presentation of the predicted results and discussion of the potential air quality impacts.

2 PROJECT BACKGROUND

2.1 Project setting

The Project site is located approximately 7 kilometres (km) southwest of Beresfield. The area surrounding the site is predominately comprised of rural properties with scattered residential dwellings. The Black Hill Quarry is located approximately 280 meters (m) to the southwest of the Project.

Figure 2-1 presents the location of the Project with reference to the Black Hill Quarry assessed in this study. A receptor has been positioned at the likely location of the proposed dwelling for the Project and is assessed as a discrete receptor.

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project. There is a ridge to the southern end of the Project boundary aligned east-west. The topography in the wider area is undulating to the southwest and flattens to the east towards the coast.

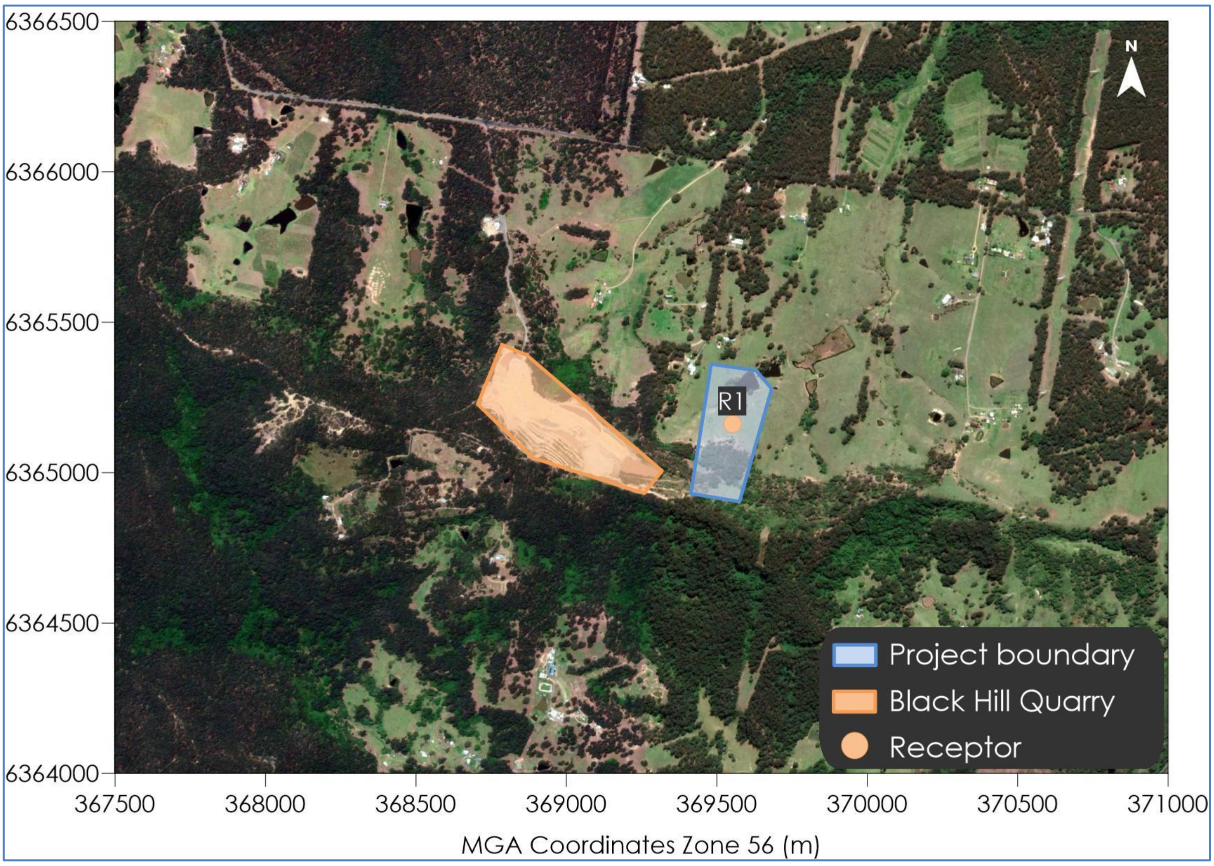

Figure 2-1: Project setting

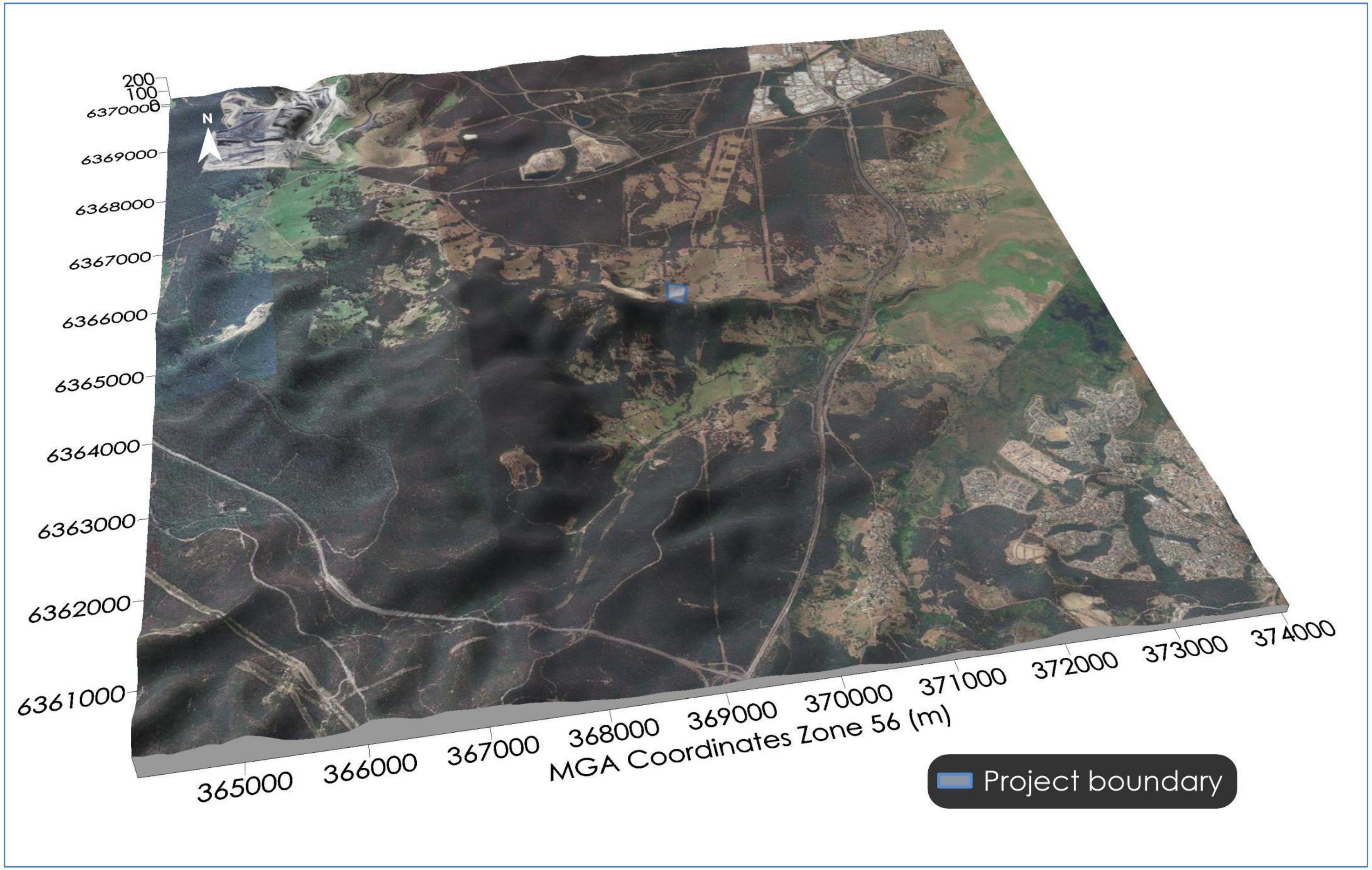

Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Project description

The site is undeveloped with neighbouring residential dwellings to the north. The site is mostly cleared of vegetation apart from dense bushland west and south of the site.

Figure 2-3 provides an indicative site layout of the Project.

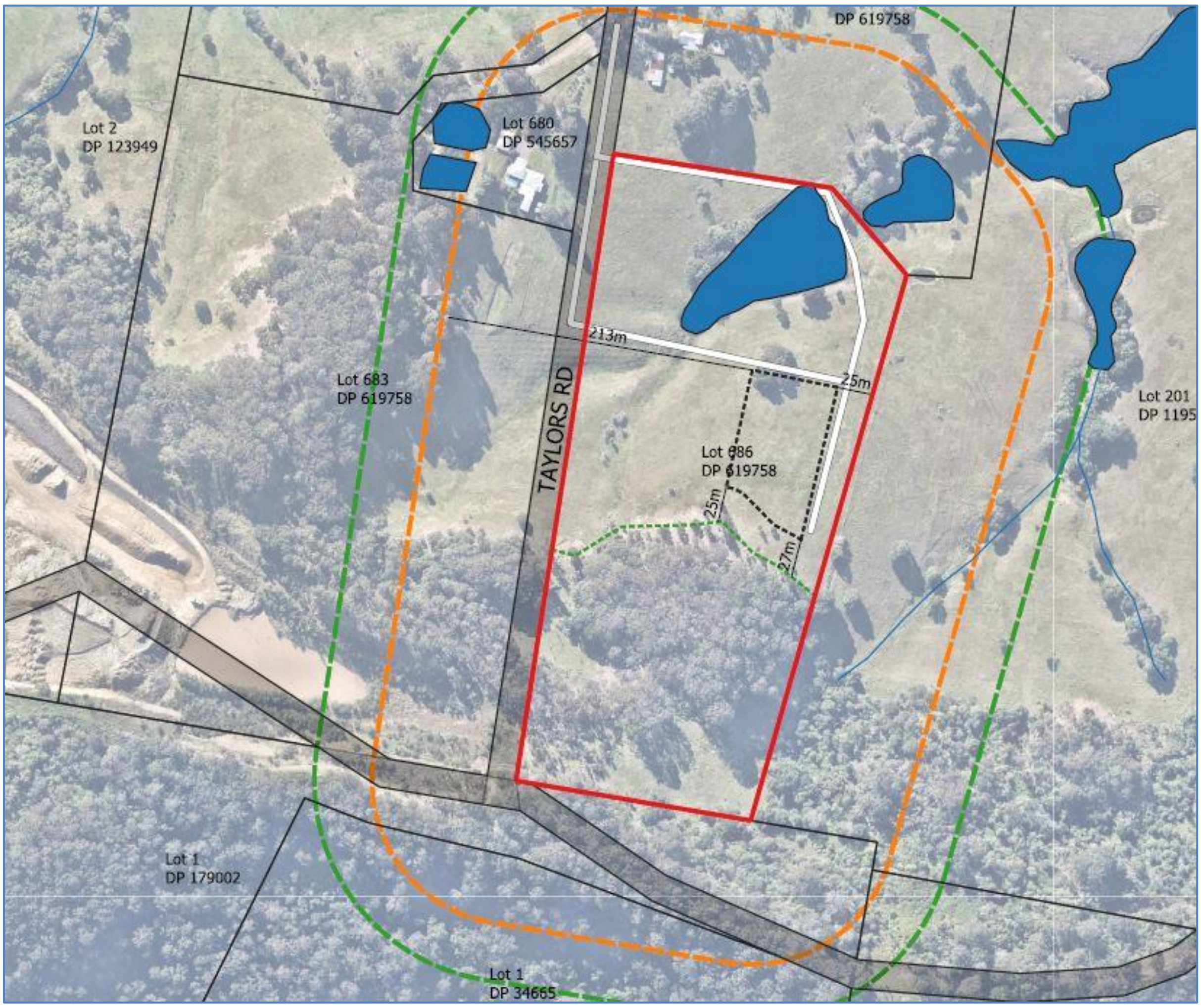

Figure 2-3: Site layout for the Project

The Project is seeking to develop a residential dwelling at 58 Taylors Road, adjacent to the Black Hill Quarry.

The Black Hill Quarry primarily extracts gravel, clay shale and sandstone resources using standard free dig techniques and crushing and screening processes. All product material is transported from the site via road registered trucks. The main air pollutants due to operations from the Black Hill Quarry include dust emissions from the material handling and wind erosion from exposed areas and stockpiles. The on-site and off-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust, however these emissions are generally considered to be too low to generate any significant off-site pollutant concentrations and have not been assessed further in this study. This assessment aims to investigate the potential for dust impacts on the Project area.

3 AIR QUALITY CRITERIA

3.1 Particulate matter

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

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

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

3.2 NSW EPA impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

The air quality goals for total impact relate to the total pollutant burden in the air and not just the contribution from the Black Hill Quarry. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

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

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/m³
PM_{10}	Annual	Total	25 µg/m³
	24 hour	Total	50 µg/m³
$PM_{2.5}$	Annual	Total	8µg/m³
	24 hour	Total	25 µg/m³
Deposited dust	Annual	Incremental	2 g/m²/month
		Total	4 g/m²/month

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

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3.3 Crystalline silica

Silica occurs in nature in a crystalline or amorphous form and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis (**NIOSH, 1974**).

Various jurisdictions have developed criteria for acceptable levels of exposure to crystalline silica. These include the Victorian criterion adopted from Californian reference exposure level values, and occupational standards. **Table 3-2** presents the Victorian impact assessment criteria (**VIC EPA, 2007**) which are the most stringent available standards for respirable crystalline silica, and which are applied to the Black Hill Quarry.

Table 3-2: Air Quality Criterion for Respirable Silica

Pollutant	Averaging period	Criterion (µg/m³)	Organisation
Respirable crystalline silica (as $PM_{2.5}$)	Annual	3	VIC EPA

Source: **VIC EPA (2007)**

4 EXISTING ENVIRONMENT

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

4.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) weather station at Newcastle University (Site No. 061390) were analysed to characterise the local climate in the proximity of the Project. The Newcastle University weather station is located approximately 11.3km southeast of the Project.

Table 4-1 and **Figure 4-1** present a summary of data from the Newcastle University weather station collected over a 11 to 22 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 29.4 degrees Celsius (ºC) and July is the coldest month with a mean minimum temperature of 7.4ºC.

Rainfall decreases during the cooler months, with an annual average rainfall of 1,130.4 millimetres (mm) over 92.5 days. The data indicate that February is the wettest month with an average rainfall of 135.5mm over 9.2 days and August is the driest month with an average rainfall of 57.1mm over 6.1 days.

Relative humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am relative humidity ranges from 62% in October to 79% in June. Mean 3pm relative humidity levels range from 48% in August and September to 62% in February.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the cooler months. Mean 9am wind speeds range from 4.5 kilometres per hour (km/h) in April to 8.5km/h in August. Mean 3pm wind speeds range from 7.7km/h in May to 17.2km/h in December.

Table 4-1: Monthly climate statistics summary – Newcastle University

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (ºC)	29.4	28.4	26.9	24.3	21.2	18.3	18.1	19.7	22.8	24.9	26.2	28.1	24.0
Mean min. temp. (ºC)	19.5	19.4	17.5	13.9	10.4	8.8	7.4	7.9	10.7	13.4	15.9	17.9	13.6
Rainfall													
Rainfall (mm)	81.2	135.5	125.2	118.1	87.5	131.9	64.1	57.1	66.2	68.2	102.3	71.6	1130.4
No. of rain days (≥1mm)	7.4	9.2	9.0	8.2	7.7	9.3	7.1	6.1	6.0	6.5	8.7	7.3	92.5
9am conditions													
Mean temp. (ºC)	23.3	22.6	20.7	18.5	14.8	12.3	11.3	13.0	16.9	19.3	20.2	22.3	17.9
Mean R.H. (%)	72.0	78.0	78.0	77.0	78.0	79.0	77.0	69.0	64.0	62.0	71.0	70.0	73.0
Mean W.S. (km/h)	6.0	5.5	6.0	4.5	5.2	6.5	5.8	8.5	7.7	7.4	6.7	5.5	6.3
3pm conditions													
Mean temp. (ºC)	27.3	26.5	25.0	22.1	19.5	17.0	16.6	18.2	21.1	22.7	23.7	26.0	22.1
Mean R.H. (%)	57.0	62.0	60.0	61.0	59.0	60.0	54.0	48.0	48.0	50.0	58.0	58.0	56.0
Mean W.S. (km/h)	16.2	14.6	12.4	9.2	7.7	9.1	10.0	13.2	14.8	15.2	15.6	17.2	12.9

Source: **Bureau of Meteorology, 2021 (July 2021)**

R.H. – Relative Humidity, W.S. – wind speed

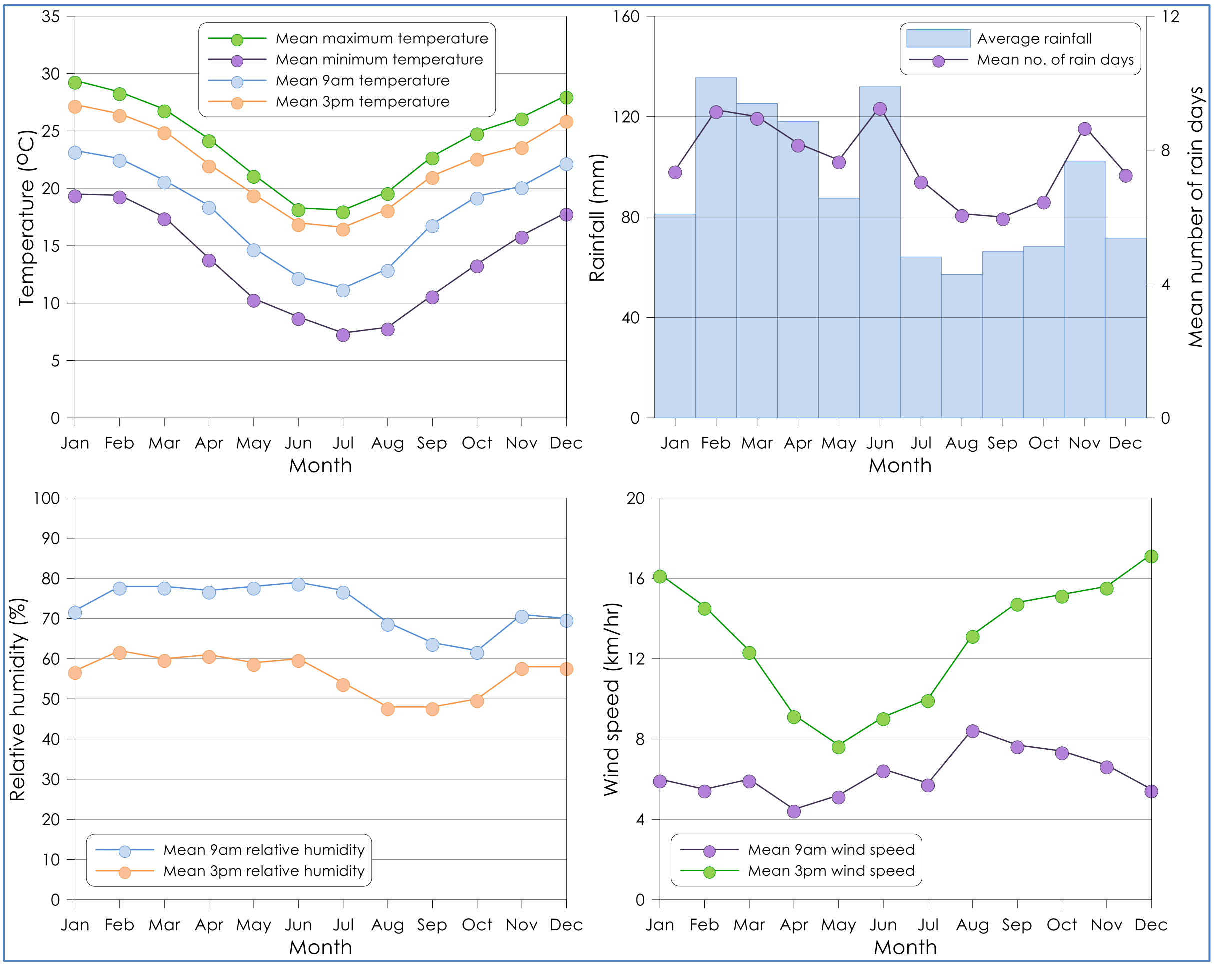

Figure 4-1: Monthly climate statistics summary – Newcastle University

4.2 Local meteorological conditions

Annual and seasonal windroses for the Cessnock Airport AWS (Site No. 061260) during the 2020 calendar period are presented in **Figure 4-2**. The Cessnock Airport AWS is located approximately 25.7km northwest of the Project.

The 2020 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of long-term data trends in meteorological data recorded and appropriate monitoring data for the area as outlined in **Appendix A**.

On an annual basis, winds predominantly occur from the northwest and north-northwest, and from the southwest to south with varied winds from other directions. In summer, winds occur predominantly from the southeast quadrant. In autumn, winds follow a similar pattern to the annual distribution with winds from the northwest to north-northwest most prevalent. During winter, winds primarily occur from the northwest and north-northwest. Spring is generally evenly distributed with winds predominately from the northwest quadrant, southwest quadrant and east-southeast.

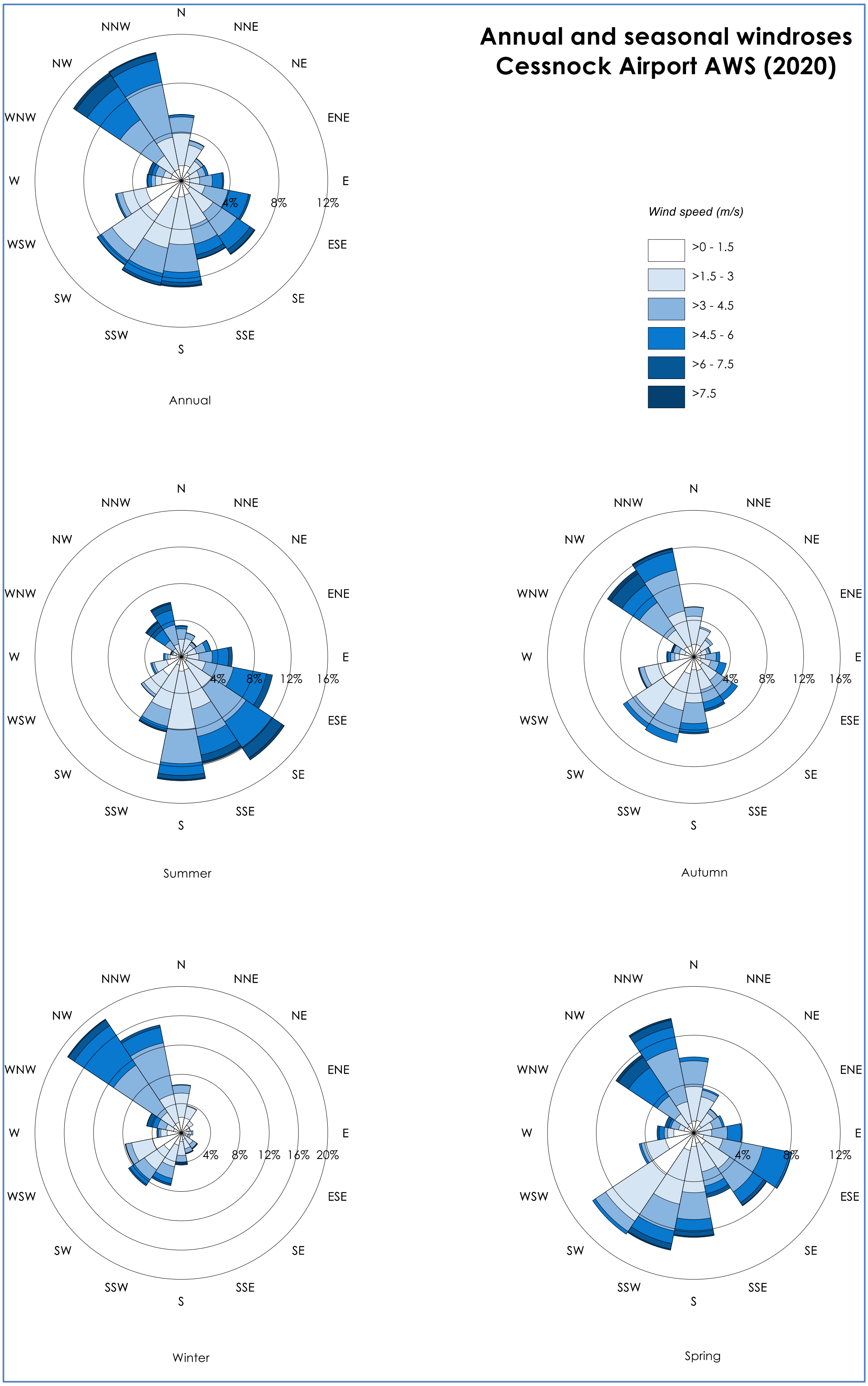

Figure 4-2 : Annual and seasonal windroses – Cessnock Airport AWS (2020)

4.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the Project would include emissions from active extraction operations and anthropogenic activities such as various motor vehicle exhaust and domestic wood heaters.

Ambient air quality monitoring data from the Project site are not available. Therefore, the available data from the nearest air quality monitors operated by the New South Wales (NSW) Department of Planning, Industry and Environment (DPIE) at Beresfield and Wallsend were used to quantify the background levels for the Project site.

4.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data from 2015 to 2020 for the Beresfield and Wallsend monitoring stations are presented in **Table 4-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-3.**

A review of **Table 4-2** indicates that the annual average PM_{10} concentrations for the monitoring stations were below the relevant criterion of 25µg/m³ for all years with the exception of Beresfield in 2019.

The maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m³ during 2015, 2018, 2019 and 2020 at the Beresfield site, and during all years of the review period at the Wallsend monitor, except in 2017.

Anomalously high PM_{10} concentrations were recorded in November 2018 at the monitors and have been attributed to state-wide dust storm events originating from western New South Wales and the Mallee region of Victoria (**NSW DPIE 2020a**). The high PM_{10} concentration recorded in November and December 2019 and January 2020 is attributed to wildfires and the drought period (**NSW DPIE 2019 & NSW DPIE 2020b**).

Table 4-2: Summary of PM_{10} levels from monitoring stations (µg/m³)

Year	Beresfield	Wallsend	Criterion
	Annual average		
2015	18.8	16.7	**25**
2016	19.1	16.6	**25**
2017	19.6	17.4	**25**
2018	21.6	19.4	**25**
2019	**25.9**	22.8	**25**
2020	18.5	17.7	**25**
Year	**Maximum 24-hour average**		**Criterion**
2015	**64.9**	**77.5**	**50**
2016	48.0	**65.5**	**50**
2017	49.4	47.9	**50**
2018	**149.1**	**136.5**	**50**
2019	**136.7**	**127.9**	**50**
2020	**77.7**	**77.9**	**50**

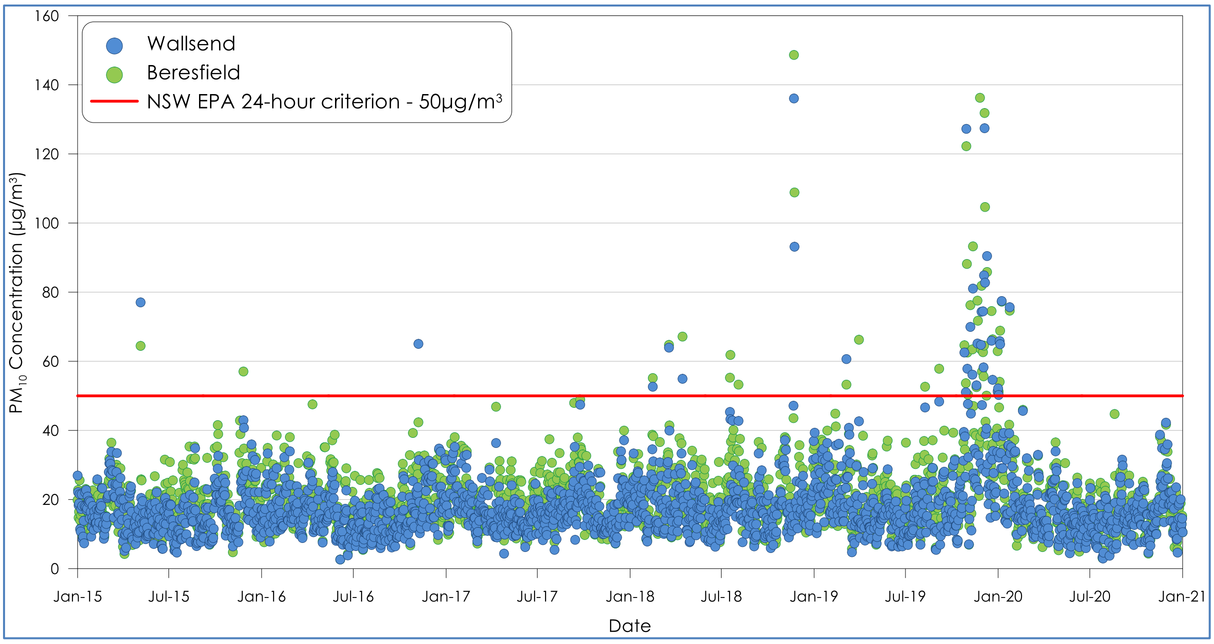

Figure 4-3: 24-hour average PM_{10} concentrations

4.3.2 $PM_{2.5}$ monitoring

A summary of the available $PM_{2.5}$ monitoring data from 2015 to 2020 for the Beresfield and Wallsend monitoring stations are presented in **Table 4-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-4**.

Table 4-3 indicates that the annual average $PM_{2.5}$ concentrations for the monitoring station were below the annual average criterion of 8µg/m³ for all years except for 2018 and 2019 at Beresfield and 2019 at Wallsend.

The maximum 24-hour average $PM_{2.5}$ concentrations were found to exceed the relevant criterion of 25µg/m³ during 2015, 2016, 2019 and 2020 at the Beresfield site, and during 2016, 2019 and 2020 at the Wallsend monitor. Similar to the PM_{10} monitoring data, the mass bushfires affecting NSW in 2019 and 2020 are seen in the $PM_{2.5}$ monitoring data.

Table 4-3: Summary of $PM_{2.5}$ levels from monitoring stations (µg/m³)

Year	Beresfield	Wallsend	Criterion
	Annual average		
2015	7.3	7.3	**8**
2016	7.4	8.0	**8**
2017	7.6	7.3	**8**
2018	**8.7**	7.5	**8**
2019	**12.1**	**10.4**	**8**
2020	7.7	7.3	**8**
Year	**Maximum 24-hour average**		**Criterion**
2015	**25.9**	24.0	**25**
2016	**27.9**	**50.7**	**25**
2017	18.7	20.4	**25**
2018	24.9	20.2	**25**
2019	**100.5**	**108.3**	**25**
2020	**49.7**	**56.8**	**25**

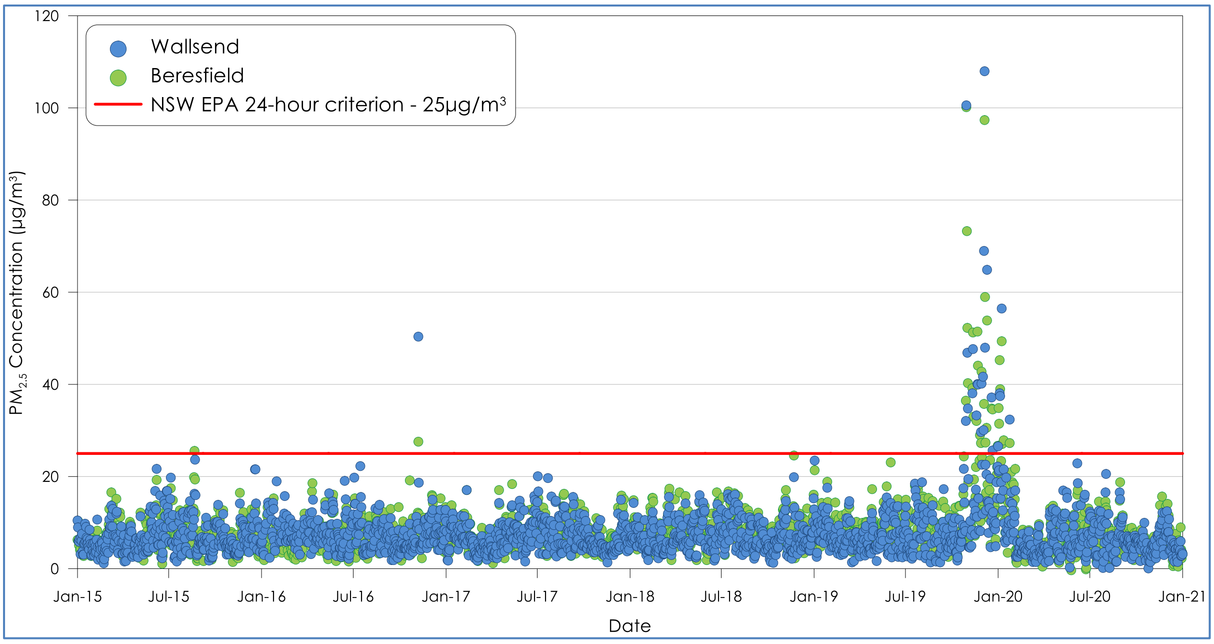

Figure 4-4: 24-hour average $PM_{2.5}$ concentrations

4.3.3 Estimated background levels

As outlined above, there are no readily available site-specific monitoring data, and therefore the background air quality levels from the closest DPIE monitor at Beresfield for the 2020 calendar year were used to represent the background levels for the Project.

It is to be noted that the Beresfield monitor is located in a more urban setting and would generally experience higher particulate levels due to anthropogenic sources. This would present a conservative estimate of background levels for the Project site used to assess the cumulative impacts.

In the absence of available data, estimates of the annual average background TSP and deposited dust concentrations can be determined from a relationship between PM_{10}, TSP and deposited dust concentrations and the measured PM_{10} levels. This relationship assumes that an annual average PM_{10} concentration of 25µg/m^3 corresponds to a TSP concentration of 90µg/m^3 and a dust deposition value of 4g/m^2/month. This assumption is based on the NSW EPA air quality impact criteria.

Applying this relationship with the measured annual average PM_{10} concentration of 18.5µg/m^3 indicates an approximate annual average TSP concentration and deposition value of 66.6µg/m^3 and 3.0g/m^2/month, respectively.

The background air quality levels applied in this assessment are summarised in **Table 4-4**.

Table 4-4: Summary of background levels

Pollutant	Background level	Units
Annual average TSP	66.6	µg/m^3
24-hour average PM_{10}	Daily varying	-
Annual average PM_{10}	18.5	µg/m^3
24-hour average $PM_{2.5}$	Daily varying	-
Annual average $PM_{2.5}$	7.7	µg/m^3
Annual average deposited dust	3.0	g/m^2/month

5 DISPERSION MODELLING APPROACH

5.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach applied for the assessment. The CALPUFF is an advanced air dispersion model which can deal with the effects of complex local terrain on the dispersion meteorology over the modelling domain in a three-dimensional, hourly varying time step.

The model was setup in general accord with the methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC**, **2011**).

5.2 Modelling methodology

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

5.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a three dimensional upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 32deg 51min south and 151deg 36min east. The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

The CALMET domain was run on a domain of 10 x 10km with a 0.1km grid resolution. The available meteorological data for January 2020 to December 2020 from three surrounding meteorological monitoring sites including Cessnock Airport AWS, Wallsend and Beresfield were included in the simulation.

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

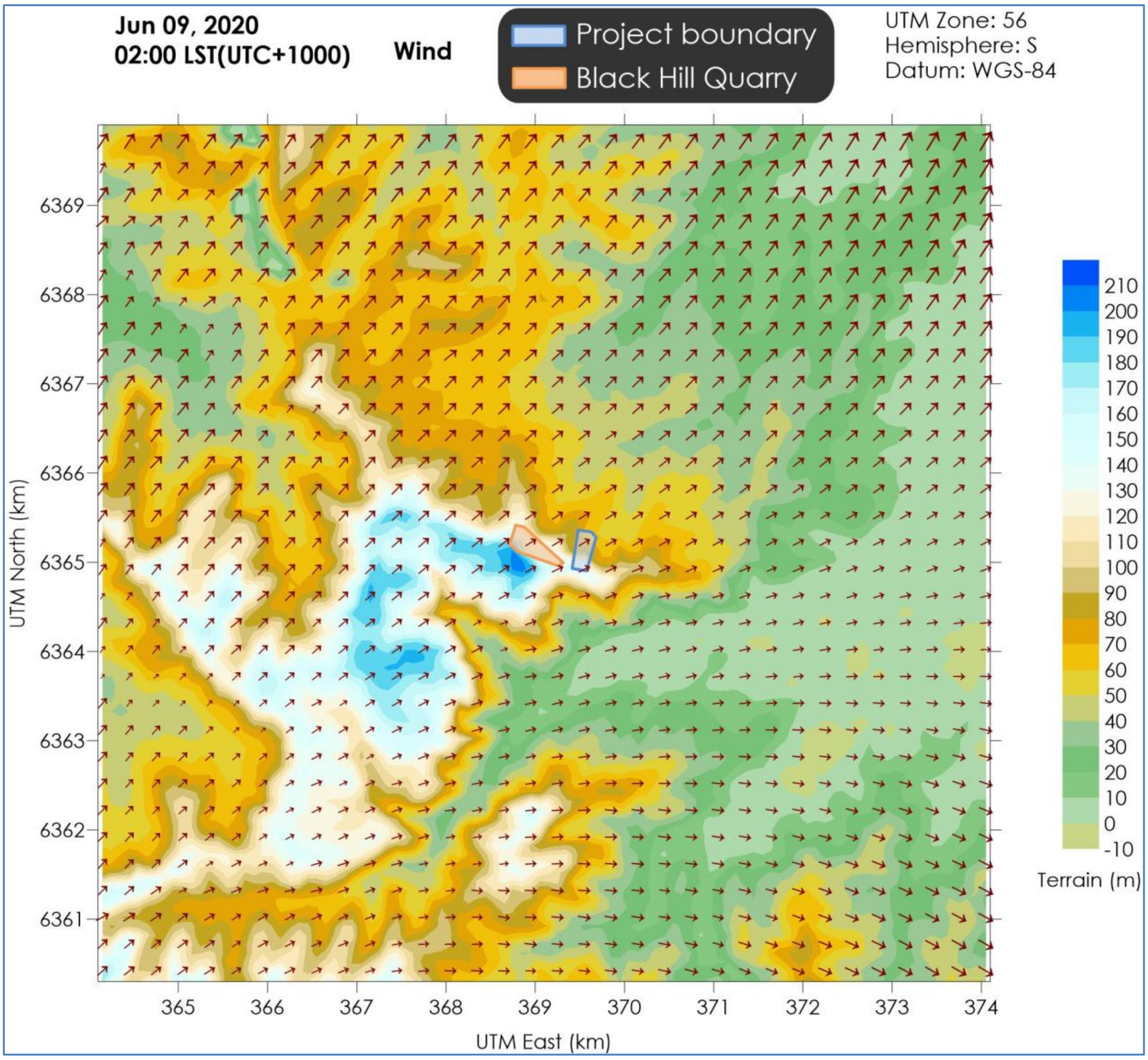

Figure 5-1: Representative 1-hour average snapshot of wind field for the Project

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

Figure 5-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. **Figure 5-3** includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

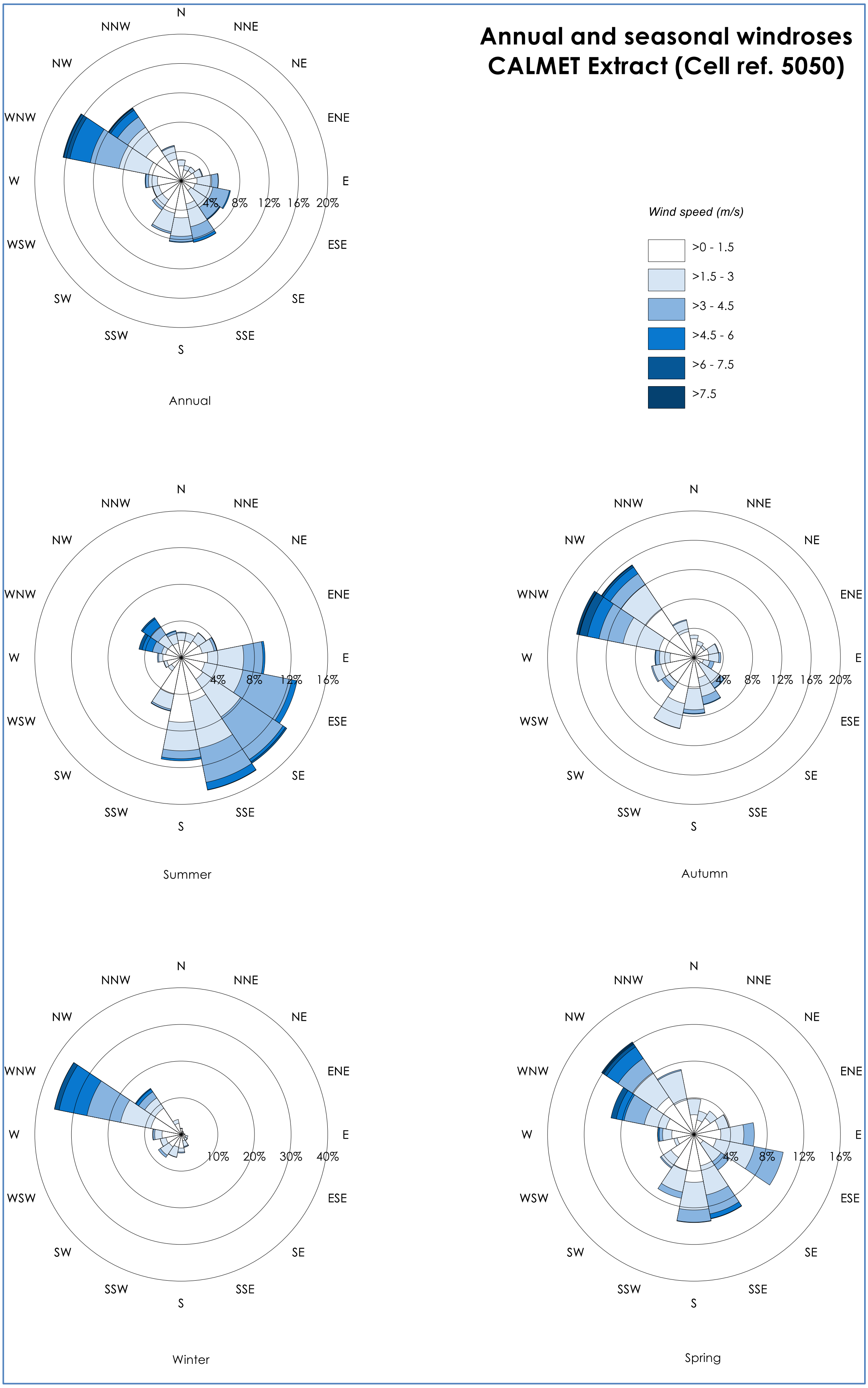

Figure 5-2: Annual and seasonal windroses from CALMET (Cell ref 5050)

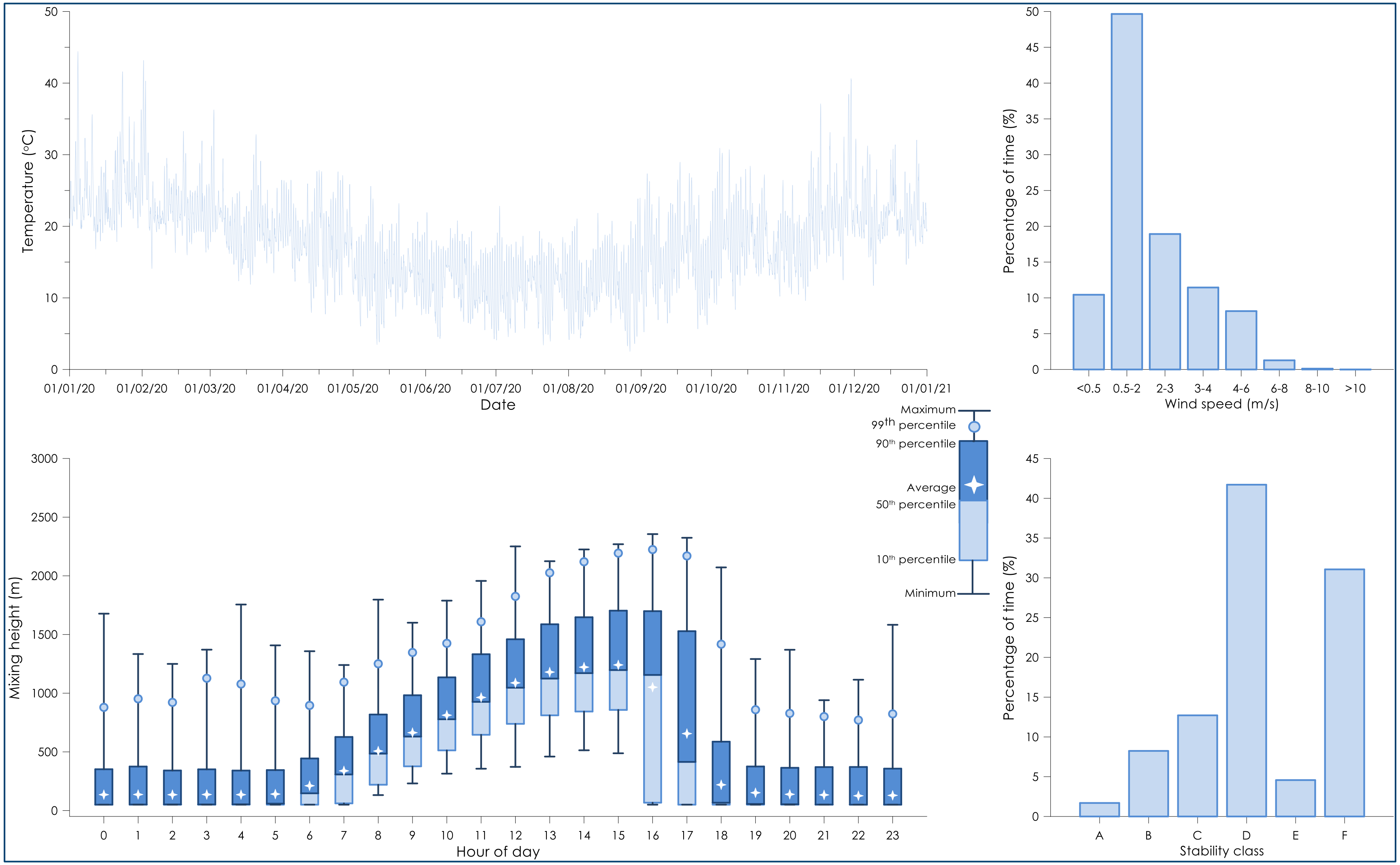

Figure 5-3: Meteorological analysis of CALMET (Cell Ref 5050)

5.3 Dispersion modelling

Dust emissions from each operational activity of the Black Hill Quarry were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

5.4 Emission estimation

The significant dust generating activities associated with operation of the Black Hill Quarry are identified as the removal of topsoil, loading/unloading of material, vehicles travelling on-site and off-site, crushing and screening processes, and windblown dust from exposed areas and stockpiles. The on-site and off-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

Dust emission estimates for the assessed scenario have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emissions sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation. A summary of the estimated dust emissions for the assessed scenario is presented in **Table 5-1**. Detailed calculations of the dust emission estimates are provided in **Appendix B**.

A worst-case scenario has been assessed for the operation of the Black Hill Quarry. For this scenario, the maximum daily truck movements of 55 loads per day with 31 tonne payload (approx. 1,705 tonnes per day [tpd]) occurring every day of the modelling period (i.e. 365 days). This equates to a maximum annual production rate of 622,325tpa and is applied in the emission estimates to calculate an annual dust emission for the Black Hill Quarry. It is noted that this scenario does not reflect the typical daily activities of the Black Hill Quarry as it overestimates the annual allowable tonnage of approximately 500,000tpa, however for the purposes of this assessment a reasonable worst-case scenario for the maximum daily (24-hour average) impacts has been presented.

Table 5-1: Summary of estimated dust emissions for the Black Hill Quarry (kg/year)

Activity	TSP Emissions	PM_{10} emissions	$PM_{2.5}$ emissions
Black Hill Quarry operations	66,283	19,328	5,596

6 DISPERSION MODELLING RESULTS

This section presents the predicted air quality levels which may arise from air emissions generated by the Black Hill Quarry on the Project site.

6.1 Dust concentrations

The dispersion model predictions presented in this section include those for the operation of the Black Hill Quarry in isolation (incremental impact) and the operation of the Black Hill Quarry with consideration of other sources (total cumulative impact). The results show the predicted:

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

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations which were modelled at each point within the modelling domain for the worst day (i.e., a 24-hour period) during the one year long modelling period.

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

Table 6-1 presents the predicted incremental and cumulative particulate dispersion modelling results at the assessed receptor location.

The cumulative (total) impact is defined as the modelling impact associated with the operation of the Black Hill Quarry combined with the estimated ambient background levels presented in **Section 4.3.3**.

The predicted incremental results show that minimal incremental effects would arise at the residential receptor location due to the Black Hill Quarry operations and the predicted cumulative results are also predicted to experience levels below the relevant criteria for each of the assessed dust metrics.

Table 6-1: Dust dispersion modelling results for residential receptor

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD* (g/m²/mth)
	Incremental						Cumulative			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R1	1.5	0.2	4.6	0.5	1.5	0.1	7.9	19.0	68.1	3.1

*Deposited dust

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

The results for incremental 24-hour average $PM_{2.5}$ and PM_{10} concentrations indicate there are no predicted exceedances of the relevant criteria at the Project site for the assessed scenario.

When assessing the total (cumulative) 24-hour average impacts based on model predictions an assessment of cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in accordance with Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA**, **2017**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts. In simple terms, the contemporaneous assessment involves matching one year of ambient air quality monitoring data with meteorological data representing the same period.

Ambient (background) concentration data corresponding with the year of modelling (2020) from the NSW DPIE monitoring site at Beresfield have been applied in this case to represent the prevailing background levels in the vicinity of the Project.

Table 6-2 provides a summary of the findings from the contemporaneous assessment at the proposed residential receptor (R1) for both $PM_{2.5}$ and PM_{10}. Detailed tables of the contemporaneous assessment results are provided in **Appendix D**.

The results indicate that the Black Hill Quarry would not increase the number of days above the 24-hour average criterion at the proposed residential receptor for $PM_{2.5}$ and PM_{10}.

Table 6-2: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion

Receptor ID	$PM_{2.5}$	PM_{10}
R1	0	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for the operation of the Black Hill Quarry on the proposed residential receptor (R1) is presented in **Figure 6-1** and **Figure 6-2** respectively.

The orange bars in the figures represent the predicted contribution from the Black Hill Quarry and the blue bars represent the applied existing background levels. It is clear from the figures that the Black Hill Quarry would have at worst, a small influence at the Project site and in most cases would be difficult to discern beyond the existing background level. In addition, there are no instances shown on **Figure 6-1** and **Figure 6-2** and where the incremental contribution of the Black Hill Quarry causes a cumulative exceedance.

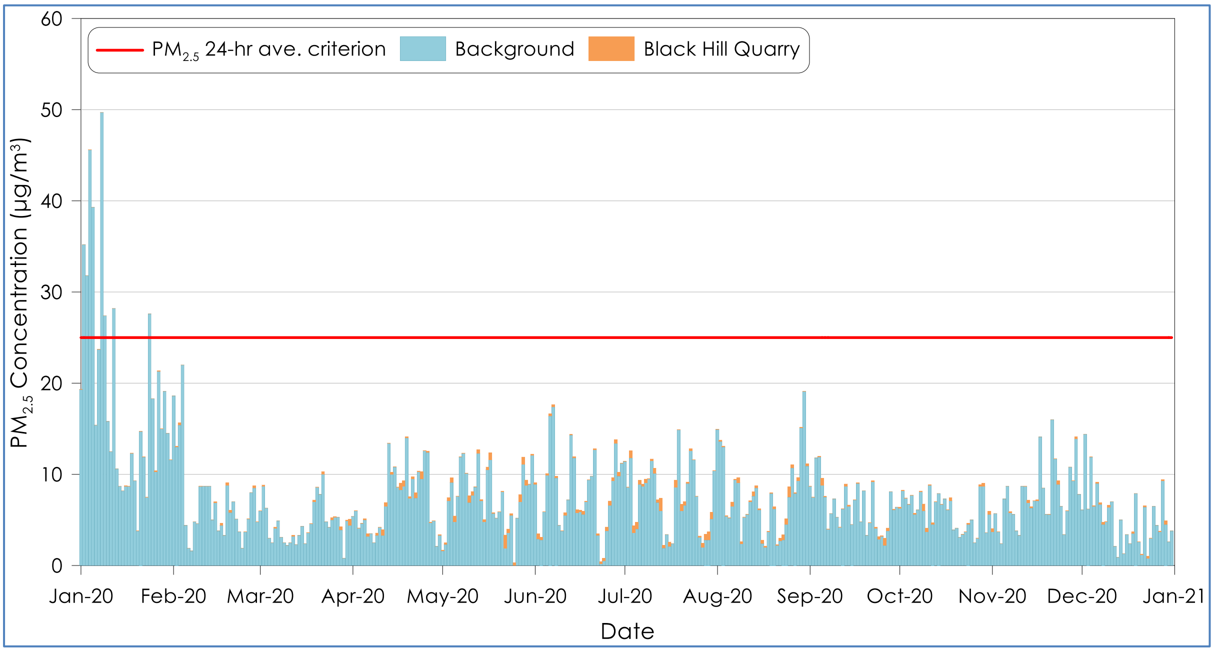

Figure 6-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for R1

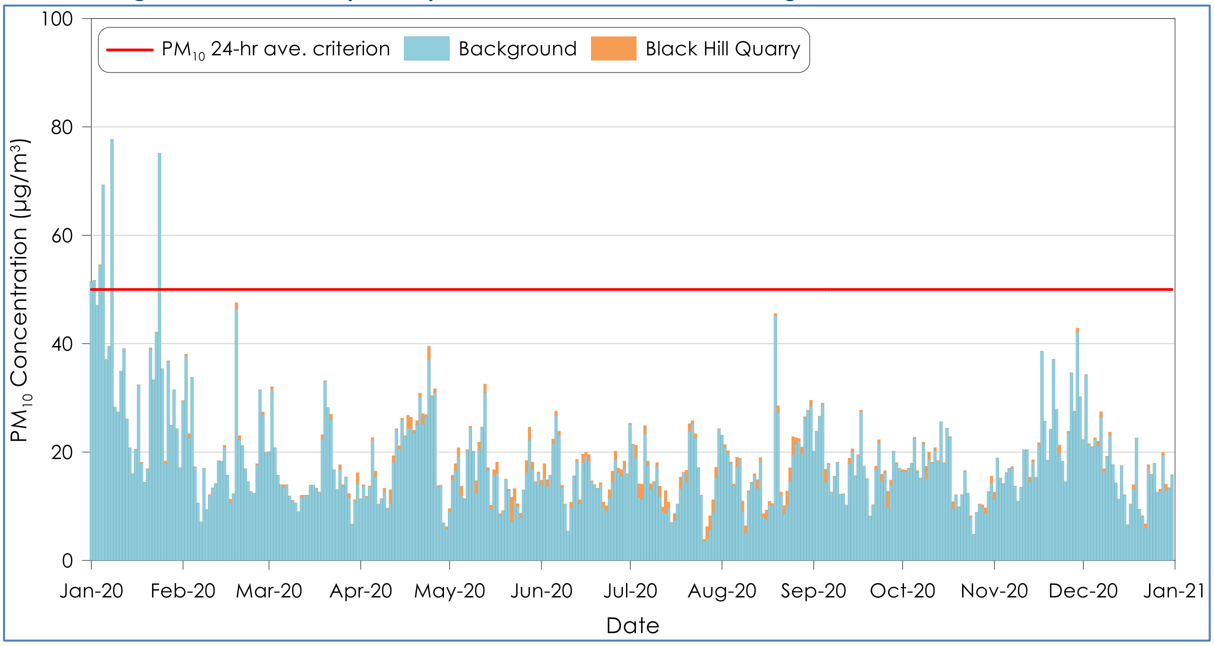

Figure 6-2: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R1

6.3 Respirable crystalline silica

The assessment results show that the proposed residential receptor (R1) has a total maximum predicted incremental annual average $PM_{2.5}$ concentration level of approximately 0.2µg/m^3. This level is due to the total dust from the site, and only a small portion of this dust would contain silica.

As the total level is well below the applicable VIC EPA criteria of 3µg/m^3 for respirable crystalline silica, the actual level from the Black Hill Quarry would be well below the criteria and thus, would not result in an unacceptable level of respirable crystalline silica in the ambient air at the Project site.

7 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the operation of the Black Hill Quarry to the proposed development of a residential dwelling at 58 Taylors Road, Black hill NSW.

Air dispersion modelling was used to predict the potential for off-site dust impacts in the surrounding area due to the operation of the Black Hill Quarry. The estimated emissions of dust applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that all the assessed air pollutants generated by the Black Hill Quarry would comply with the applicable assessment criteria at the proposed residential receptor and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area.

Nevertheless, the Black Hill Quarry would continue to apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

Overall, the assessment demonstrates that even using conservative assumptions, the Black Hill Quarry can operate without causing any significant air quality impact at the proposed residential receptor.

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Appendix A
Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest six contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Cessnock Airport AWS, is presented in **Table A-1**.

The standard deviation of the latest six years of meteorological data spanning 2015 to 2020 was analysed against the available measured wind speed, temperature and relative humidity. The analysis indicates that 2016 dataset is closest to the mean for wind speed and 2020 is closest to the long-term average for temperature and relative humidity. On the basis of a score weighting analysis, 2020 was found to be most representative.

Table A-1: Statistical analysis results for Cessnock Airport AWS

Year	Wind speed	Temperature	Relative humidity
2015	0.3	0.8	3.4
2016	0.3	1.0	4.4
2017	0.3	1.1	5.0
2018	0.3	1.0	5.3
2019	0.3	1.3	6.3
2020	0.4	0.6	3.0

Figure A-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2020 year compared with the mean of the 2015 to 2020 data set. The 2020 year data appear to be well aligned with the mean data.

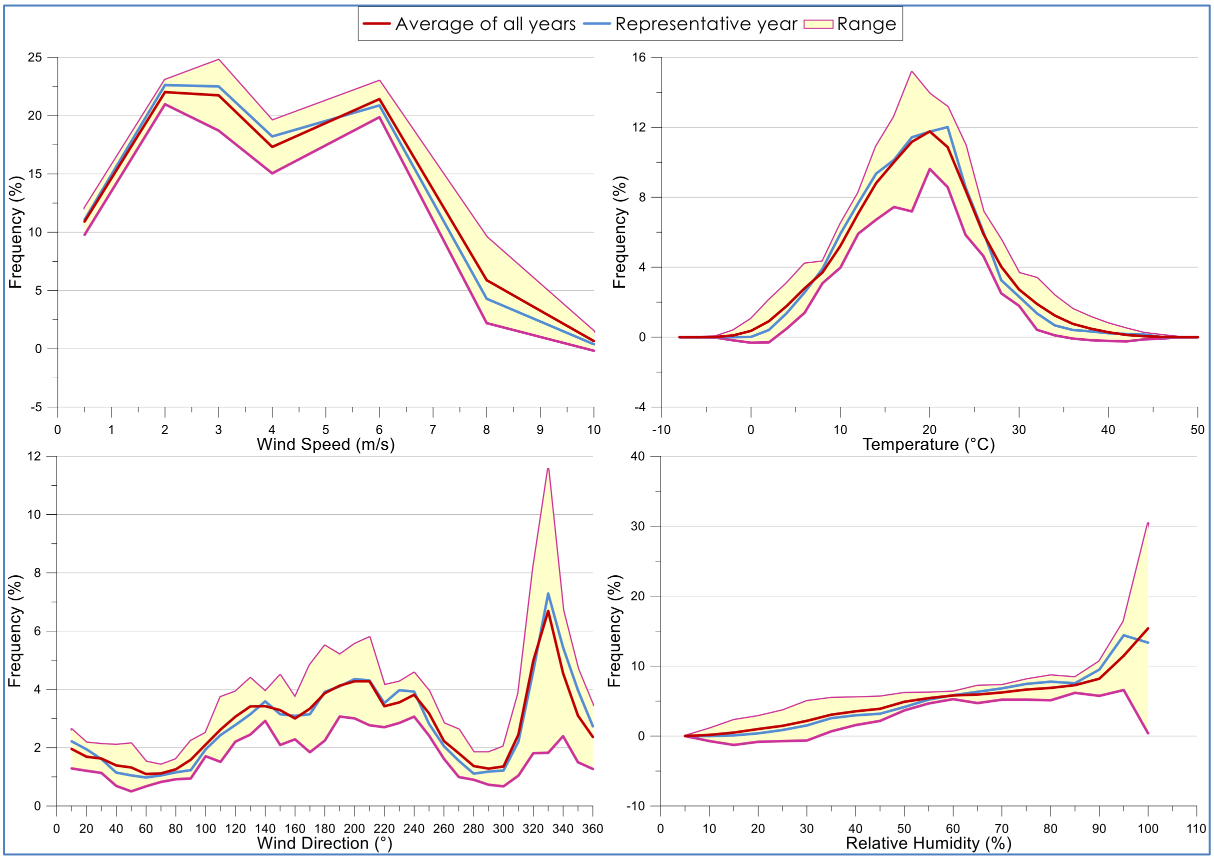

Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Emission Calculations

Emission Calculation

The dust emissions from the Black Hill Quarry have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations and utilising suitable emission and load factors that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: Best Practise Measures for Reducing Non-Road Diesel Exhaust Emissions, Final Report" (**NSW EPA, 2015**).

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

Control factors include the following:

- Hauling on unpaved surfaces – 75% control for watering of trafficked areas;
- Wind erosion from exposed areas – 50% control for watering of exposed areas.

Table B-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Loading / emplacing material	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M^{1.4}}{2}\right) kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M^{1.4}}{2}\right) kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M^{1.4}}{2}\right) kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$
Tertiary crushing (controlled)	0.0027	0.0012	0.0002
Screening (uncontrolled)	$EF = 0.0011\ kg/tonne$	$EF = 0.00037\ kg/tonne$	$EF = 0.000025\ kg/tonne$
Wind erosion on exposed areas, stockpiles	$EF = 850\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

A = horizontal area (m^2) with blasting depth ≤ 21m, EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), s.L. = silt loading (g/m^2), W = average weight of vehicle (tonne), VKT = vehicle kilometres travelled (km).

Table B-2: Dust Emissions Inventory

Activity	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var 1	Units	Var 2	Units	Var 3 - TSP	Var 3 - PM10	Var 3 - PM25	Units	Var 4	Units	Var 5	Units	Var 6	Units
Dozer ripping material	41,771	10,094	4,386	2,496	hr/yr	16.7353	4.0442	1.7572	kg/h	10	S.C. %	2	M.C. %										
Excavator loading extracted material to stockpile	689	326	49	622,325	t/yr	0.00111	0.00052	0.00008	kg/t	0.93	ave ws (ws/2.2)^1.3 (m/s)	2	M.C %										
FEL loading extracted material to haul truck	689	326	49	622,325	t/yr	0.00111	0.00052	0.00008	kg/t	0.93	ave ws (ws/2.2)^1.3 (m/s)	2	M.C %										
Hauling extracted material to processing area (unpaved)	6,721	1,911	191	622,325	t/yr	0.043	0.012	0.001	kg/t	31	t/load	0.4	km/return	3.2	0.9	0.09	kg/VKT	8.3	S.C %	31	ave weight (t)	75	C %
Unloading extracted material at processing area	689	326	49	622,325	t/yr	0.00111	0.00052	0.00008	kg/t	0.93	ave ws (ws/2.2)^1.3 (m/s)	2	M.C %										
FEL loading extracted material to crusher	689	326	49	622,325	t/yr	0.00111	0.00052	0.00008	kg/t	0.93	ave ws (ws/2.2)^1.3 (m/s)	2	M.C %										
Crushing (controlled)	373	168	31	622,325	t/yr	0.0006	0.0003	0.00005	kg/t														
Screening (uncontrolled)	7,779	2,676	181	622,325	t/yr	0.0125	0.0043	0.0003	kg/t														
FEL loading processed material to stockpile	689	326	49	622,325	t/yr	0.00111	0.00052	0.00008	kg/t	0.93	ave ws (ws/2.2)^1.3 (m/s)	2	M.C %										
FEL loading processed material to dispatch truck	689	326	49	622,325	t/yr	0.00111	0.00052	0.00008	kg/t	0.93	ave ws (ws/2.2)^1.3 (m/s)	2	M.C %										
Hauling processed material offsite (unpaved)	1,495	425	43	622,325	t/yr	0.010	0.003	0.000	kg/t	31	t/load	0.1	km/return	3.2	0.9	0.09	kg/VKT	8.3	S.C %	31	ave weight (t)	75	C %
WE - whole site	3,825	1,913	287	9.0	ha	850	425	64	kg/ha/year													50	C %
Exhaust emissions	187	187	181																				
Total TSP emissions (kg/yr.)	**66,283**	**19,328**	**5,596**																				

Appendix C

Isopleth Diagrams

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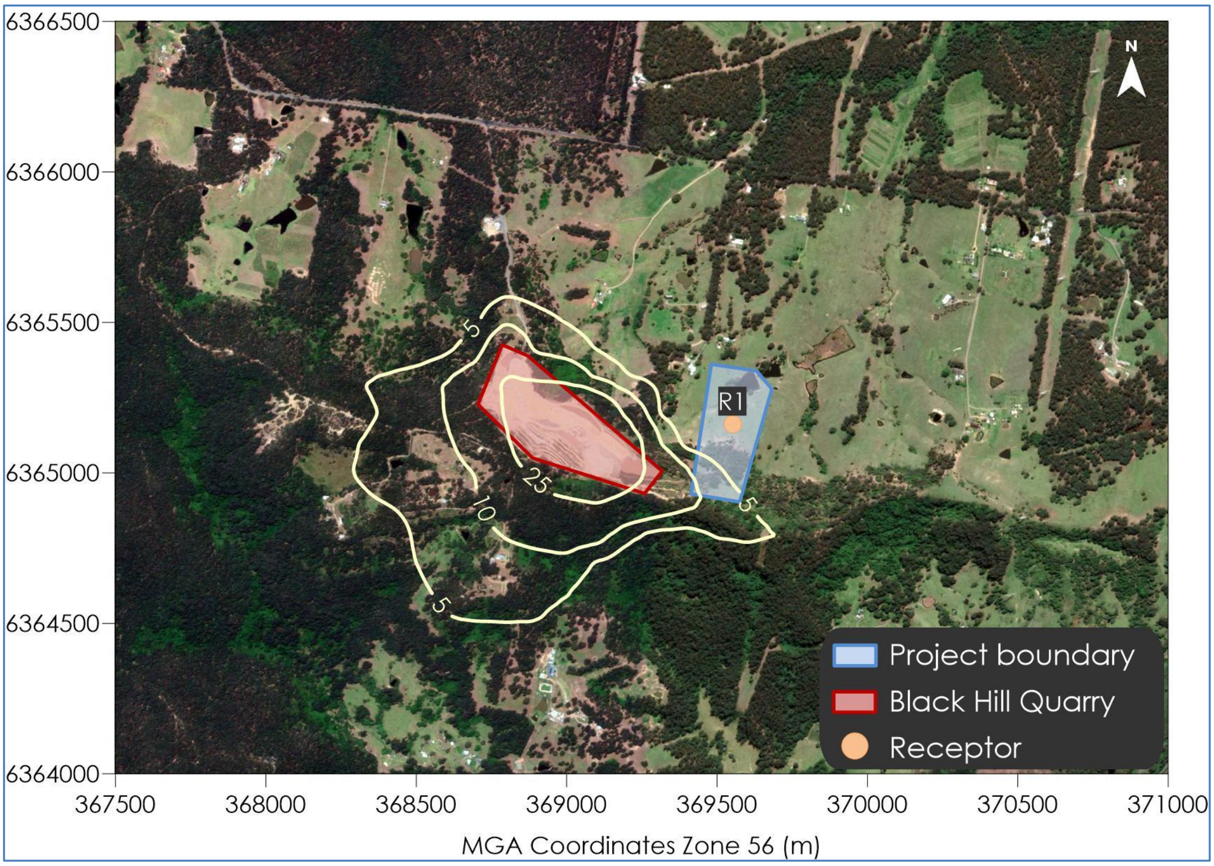

Figure C-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

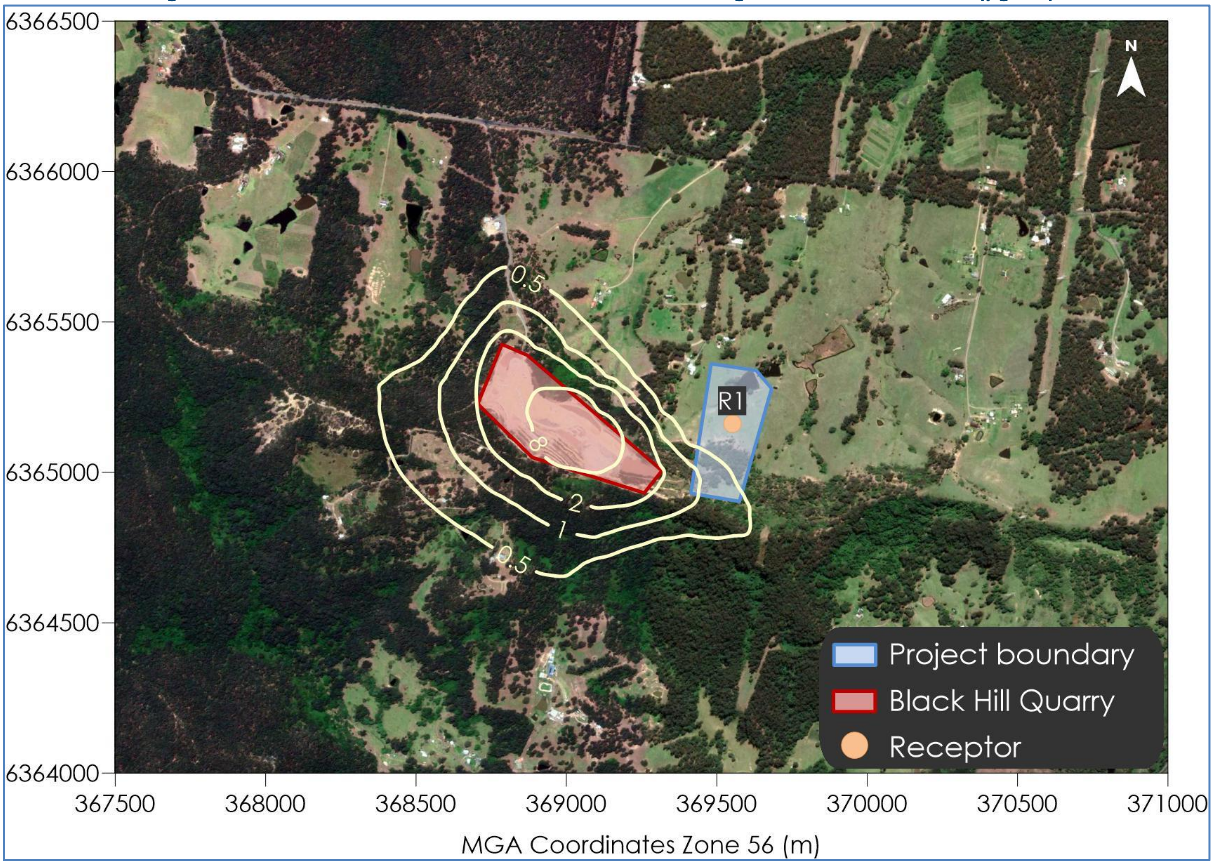

Figure C-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

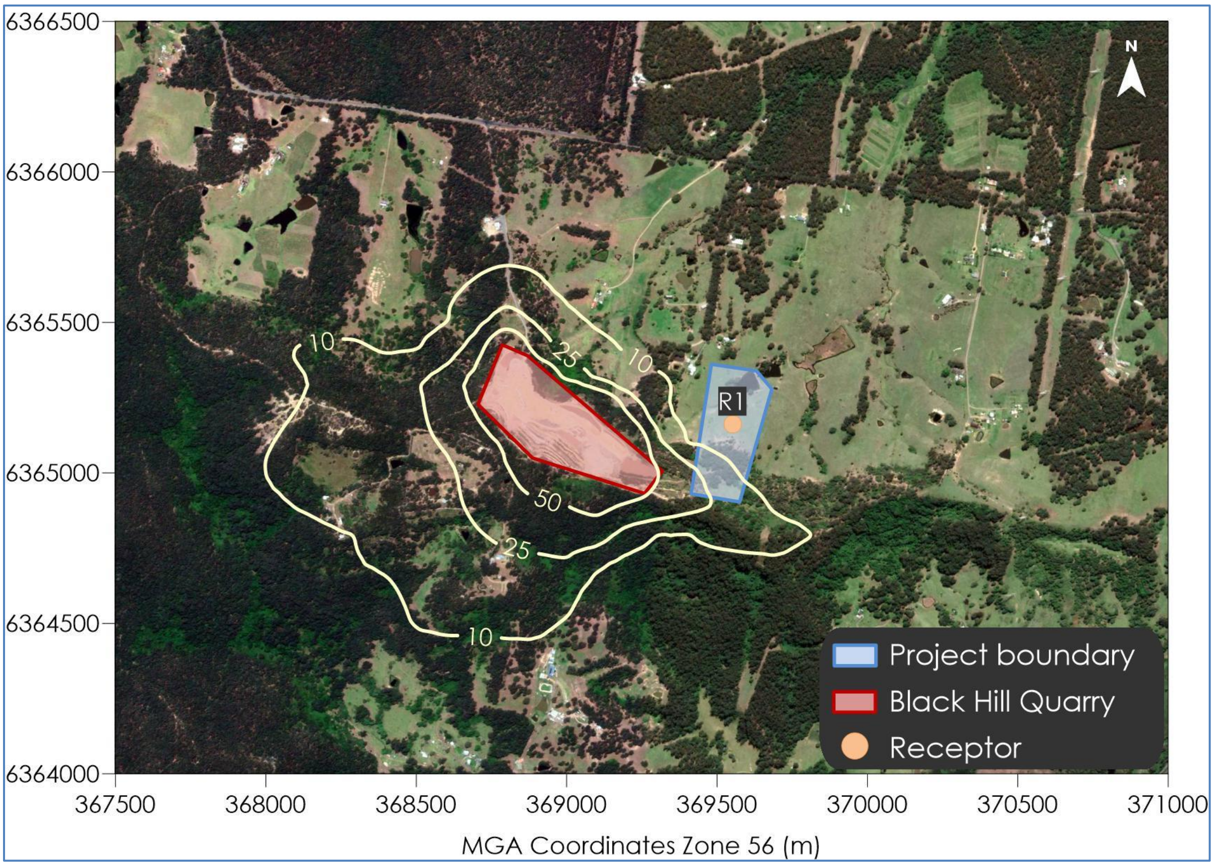

Figure C-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

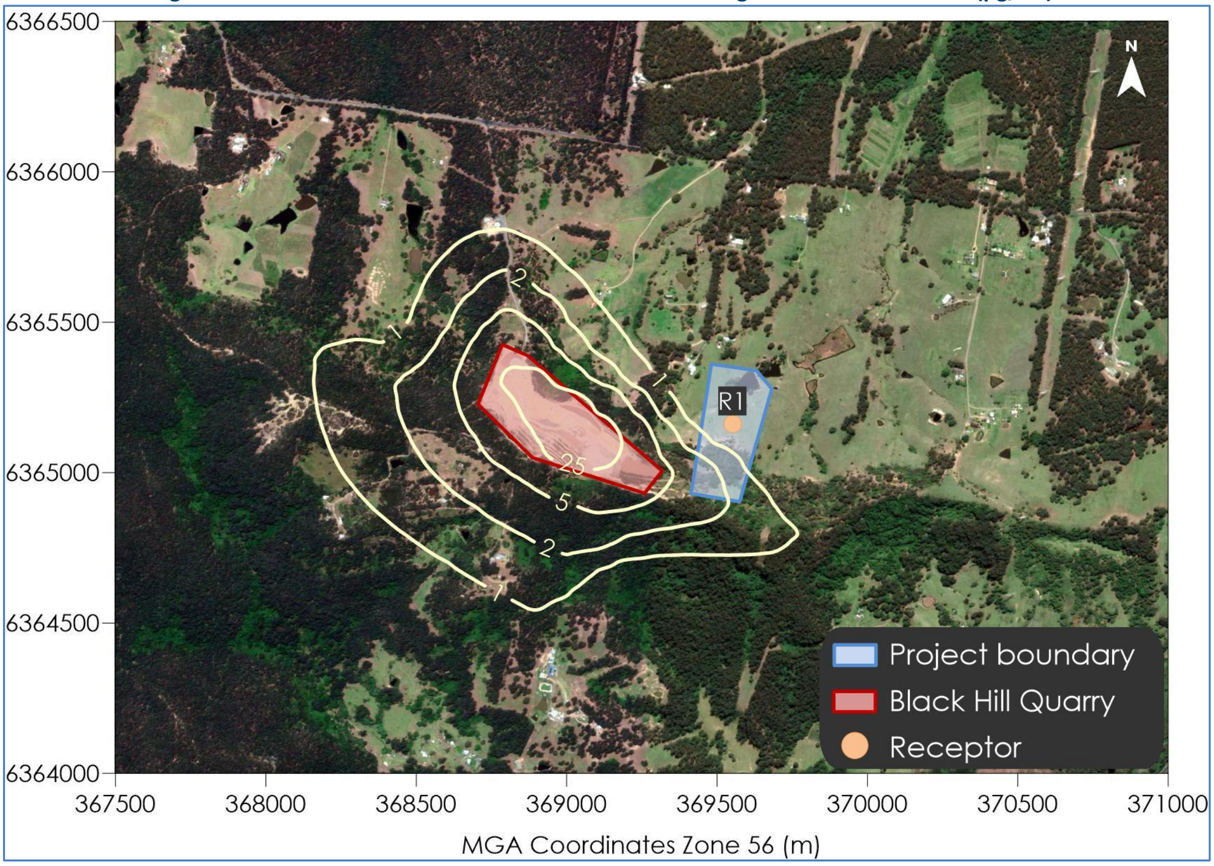

Figure C-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

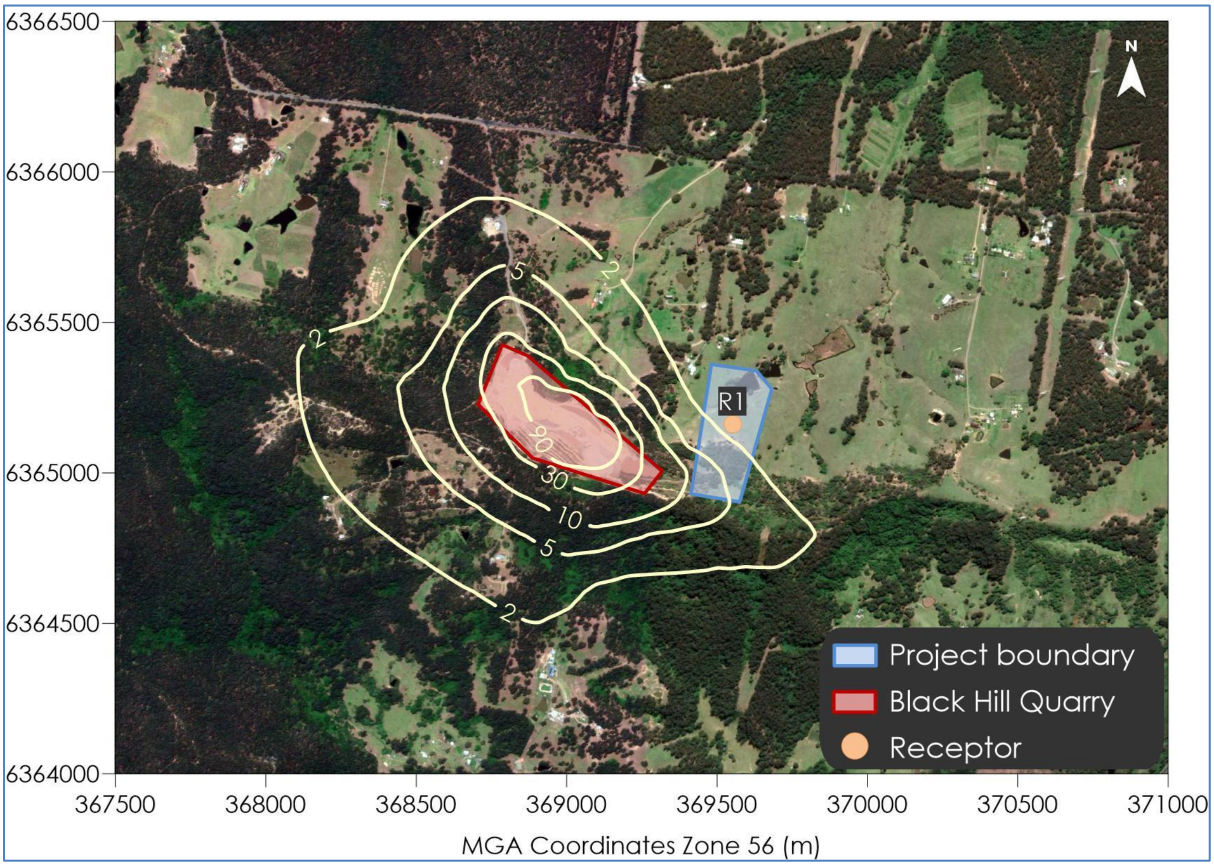

Figure C-5: Predicted incremental annual average TSP concentrations (µg/m³)

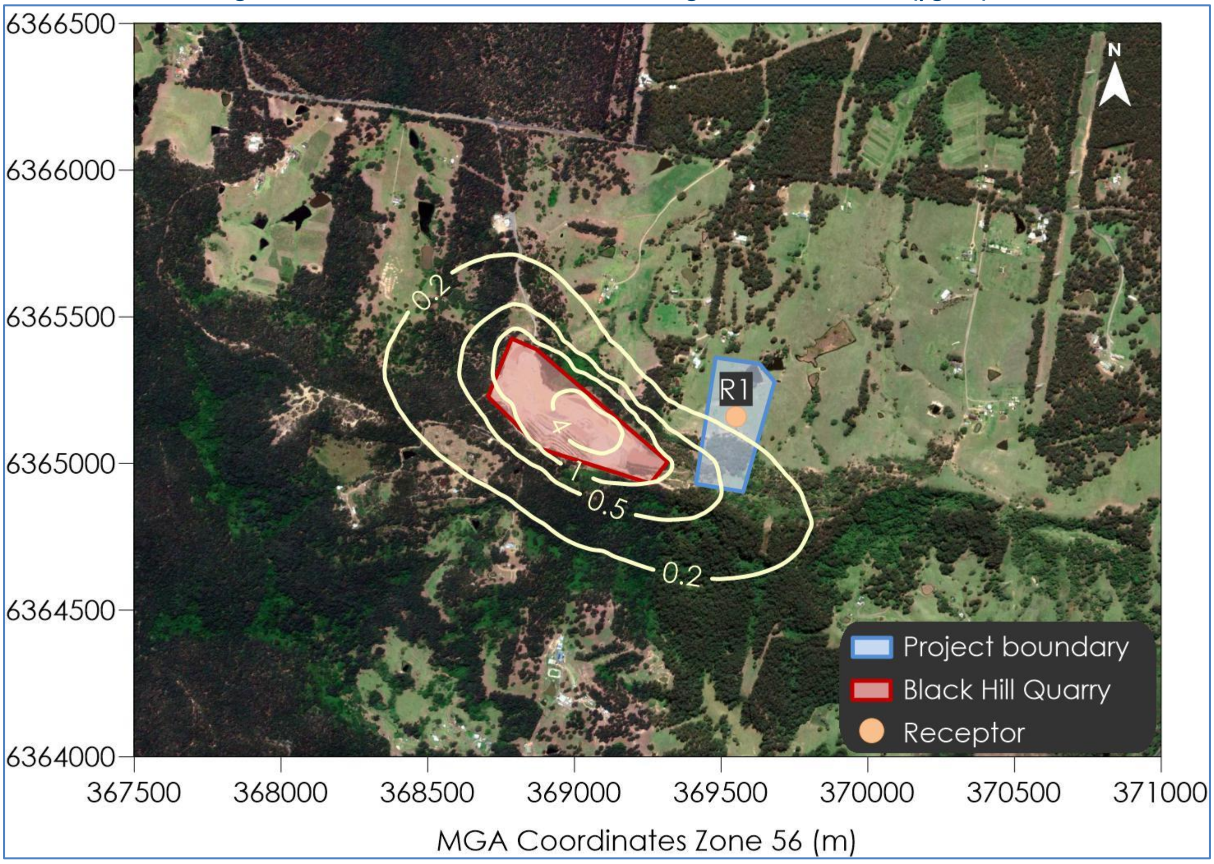

Figure C-6: Predicted incremental annual average dust deposition levels (g/m²/month)

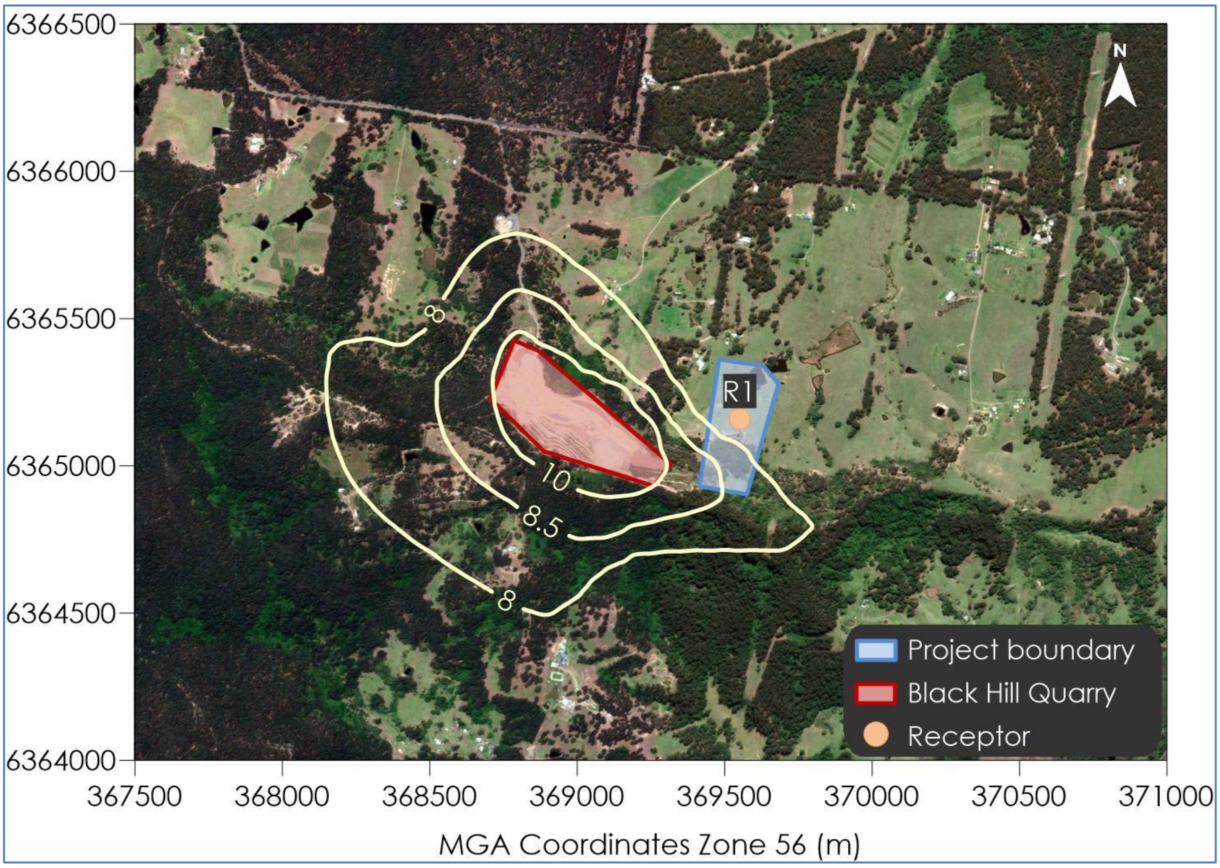

Figure C-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

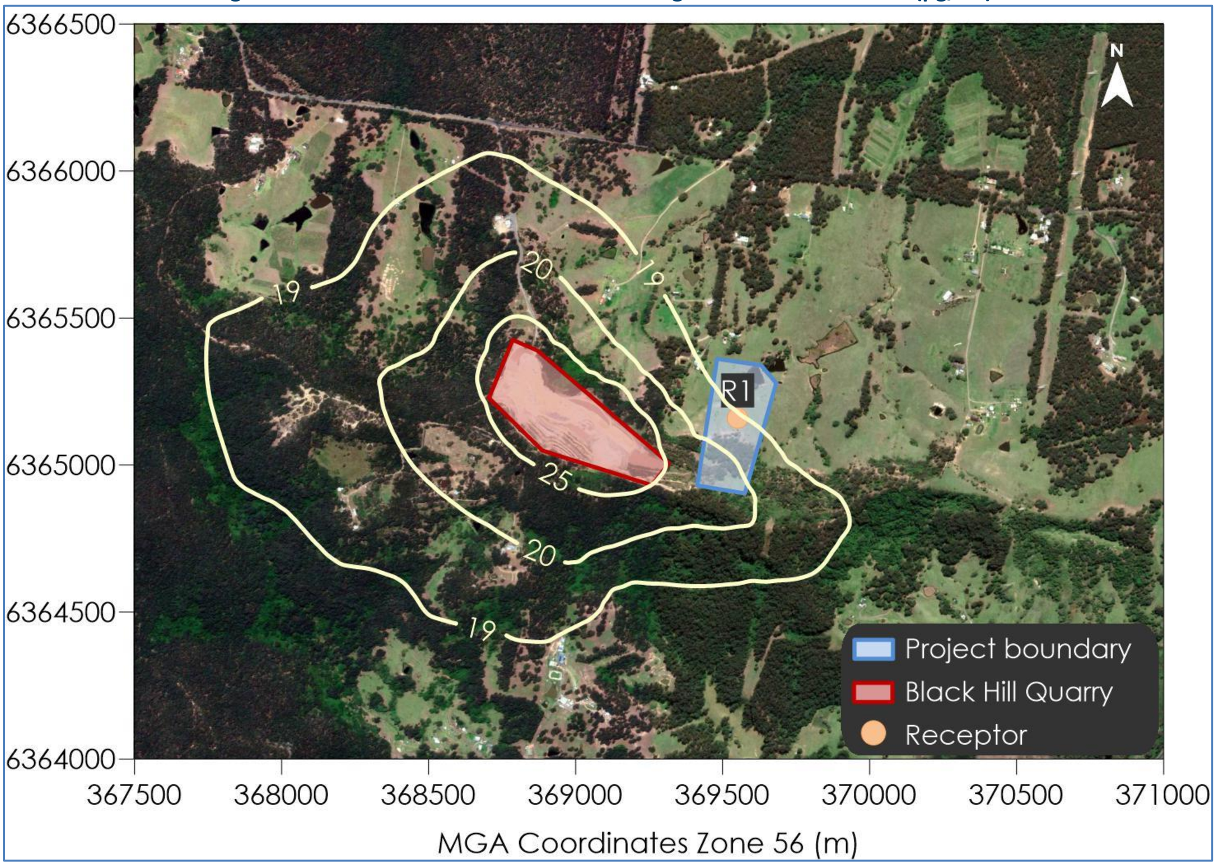

Figure C-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

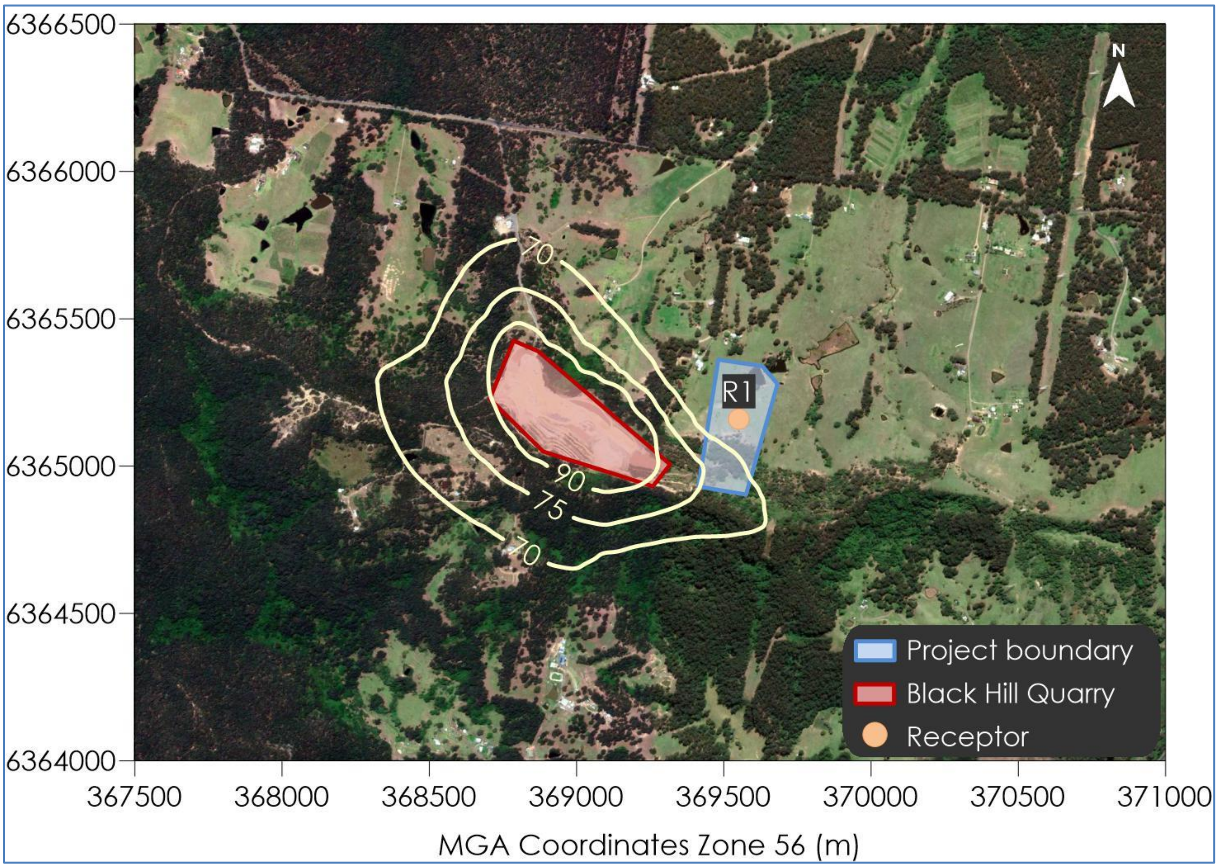

Figure C-9: Predicted cumulative annual average TSP concentrations (µg/m³)

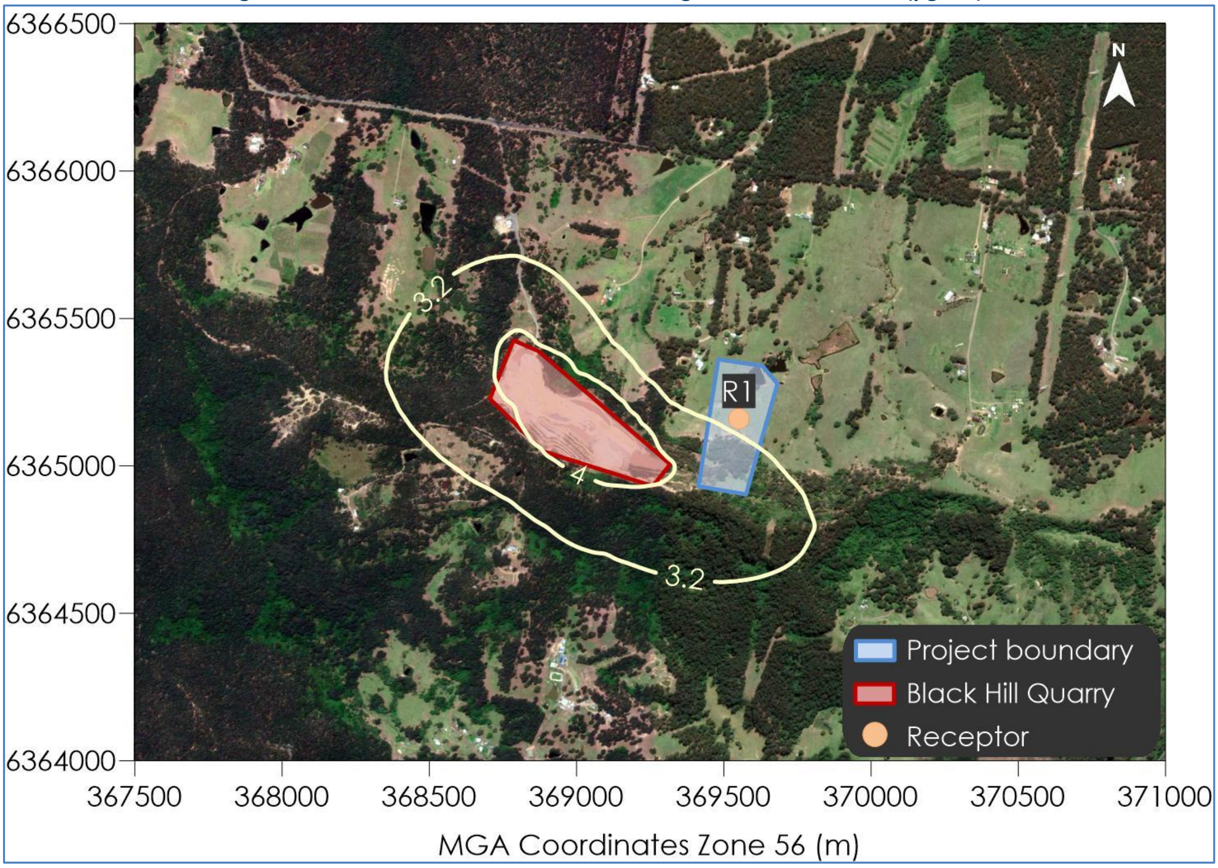

Figure C-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

Appendix D

Further detail regarding 24-hour PM_{10} analysis

Further detail regarding 24-hour average PM_{10} analysis

The analysis below provides a cumulative 24-hour PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 46 to 47 of the Approved Methods.

The background level is the ambient level at Beresfield monitoring station for PM_{10} and $PM_{2.5}$.

The predicted increment is the predicted level to occur at the receptor (R1) due to the Black Hill Quarry.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Table D-1 and **Table D-2** assesses the proposed residential receptor R1 and shows the predicted maximum cumulative levels at the receptor. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the Black Hill Quarry.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

The orange shading represents days where the measured background level is already over the criteria.

Any value above the PM_{10} criterion of 50µg/m^3 or above the $PM_{2.5}$ criterion of 25µg/m^3 is in **bold red.**

Table D-1: Cumulative 24-hour average PM_{10} concentration ($\mu g/m^3$) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
8/01/2020	**77.7**	0.0	**77.7**				
24/01/2020	**75.1**	0.0	**75.1**				
5/01/2020	**69.3**	0.0	**69.3**				
4/01/2020	**54.5**	0.1	**54.6**				
2/01/2020	**51.7**	0.0	**51.7**				
1/01/2020	**51.4**	0.0	**51.4**				
3/01/2020	47.1	0.0	47.1	22/05/2020	7.1	4.6	11.7
19/02/2020	46.4	1.1	47.5	13/07/2020	8.7	4.2	12.9
19/08/2020	45.2	0.3	45.5	25/08/2020	19.5	3.3	22.8
23/01/2020	42.1	0.0	42.1	26/09/2020	9.8	3.0	12.8
29/11/2020	42.1	0.8	42.9	5/07/2020	11.3	2.8	14.1
7/01/2020	39.5	0.1	39.6	2/06/2020	15.2	2.7	17.9
12/01/2020	39.1	0.0	39.1	23/08/2020	10.2	2.7	12.9
21/01/2020	39.1	0.1	39.2	24/04/2020	37	2.6	39.6
17/11/2020	38.6	0.0	38.6	28/07/2020	5.7	2.6	8.3
2/02/2020	37.7	0.4	38.1	4/07/2020	11.7	2.5	14.2
6/01/2020	37.1	0.0	37.1	5/09/2020	14.4	2.5	16.9
21/11/2020	37.1	0.0	37.1	24/08/2020	14.7	2.4	17.1
24/04/2020	37	2.6	39.6	3/07/2020	18.9	2.4	21.3

Table D-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
8/01/2020	**49.7**	0.0	**49.7**				
4/01/2020	**45.6**	0.0	**45.6**				
5/01/2020	**39.3**	0.0	**39.3**				
2/01/2020	**35.2**	0.0	**35.2**				
3/01/2020	**31.8**	0.0	**31.8**				
12/01/2020	**28.2**	0.0	**28.2**				
24/01/2020	**27.6**	0.0	**27.6**				
9/01/2020	**27.4**	0.0	**27.4**				
7/01/2020	23.7	0.0	23.7	22/05/2020	1.9	1.5	3.4
4/02/2020	22	0.0	22.0	13/07/2020	6	1.4	7.4
27/01/2020	21.3	0.1	21.4	25/08/2020	7.5	1.1	8.6
1/01/2020	19.3	0.0	19.3	29/07/2020	2.8	0.9	3.7
29/01/2020	19.1	0.0	19.1	24/04/2020	9.5	0.8	10.3
30/08/2020	19.1	0.0	19.1	3/07/2020	11.8	0.8	12.6
1/02/2020	18.6	0.0	18.6	28/05/2020	11.1	0.8	11.9
25/01/2020	18.3	0.0	18.3	27/05/2020	7	0.8	7.8
7/06/2020	17.4	0.3	17.7	26/09/2020	2.2	0.8	3.0
6/06/2020	16.4	0.3	16.7	5/09/2020	8.8	0.8	9.6
21/11/2020	16	0.0	16.0	18/07/2020	8.6	0.8	9.4