AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT

Bloomfield Colliery Continuation Project

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1 INTRODUCTION

Todoroski Air Sciences has assessed the potential for air quality impacts associated with the proposed modifications to the Bloomfield Colliery as part of the Continuation Project (hereafter referred to as the Modification).

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* (Approved Methods) (**NSW EPA, 2022**).

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

- a background to the Modification and description of the site and operations;
- 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;
- presentation of the predicted results and discussion of the potential air quality impacts and associated mitigation and management measures; and
- an assessment of the potential additional greenhouse gas emissions associated with the Modification.

1.1 Overview of Bloomfield Colliery Operations

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

Bloomfield Colliery operates per its current Project Approval (07_0087) which permits extraction of up to 1.3 million tonnes (Mt) of run-of-mine (ROM) coal per year. Mining operations under the existing approval may take place until 31 December 2030.

ROM coal is transported via an internal road to the Bloomfield Coal Handling and Preparation Plant (CHPP) for processing and dispatch via rail. The Bloomfield CHPP is also approved to receive coal from other mining operations, including the Abel Underground Mine and the now completed Tasman Underground Mine and Donaldson Open Cut Coal Mine. The Abel Underground Mine is located southeast of the site and is currently in care and maintenance.

1.2 Modification description

The Modification seeks to continue mining operations towards the north of the existing approved project area into two additional areas known as:

- the Creek cut area; and,
- the Workshop area.

Existing mining methods would continue to be employed with production levels reduced below the currently approved 1.3 million tonnes per annum (Mtpa) of ROM coal to 0.9Mtpa and would extend the life of the site until 31 December 2035.

In order to maintain use of the CHPP, train load out, rail loop and water management structures which are covered under the Abel Project Approval (PA 05_0136), these facilities will be included in the Modification so that these facilities may continue to be used and aligned with the proposed duration of mining activities.

Figure 1-1 presents an overview of the proposed Modification area which consists of:

- the current approved mining area under PA 07_0087;
- the CHPP, train load out, rail loop and water management structures areas; and,
- the Creek Cut area and Workshop area.

The Modification would also allow for the rehabilitation of the proposed areas of disturbance in addition to current rehabilitation commitments at the site under the relevant regulatory requirements and planning considerations.

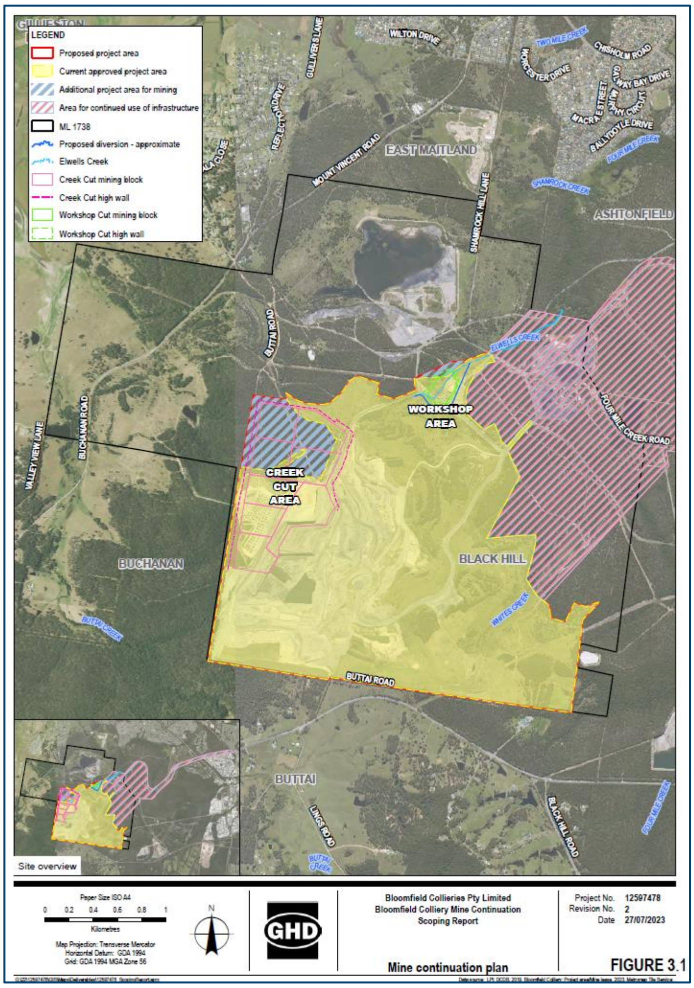

Figure 1-1: Modification layout

2 LOCAL SETTING

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

The general area surrounding the Bloomfield Colliery is comprised of other coal mining operations, agricultural activities and woodland. Suburban residential areas are located in relatively close proximity to the north of the site. Dense bushland surrounds the Bloomfield Colliery, which would have a positive effect in limiting the transport of dust off-site.

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

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

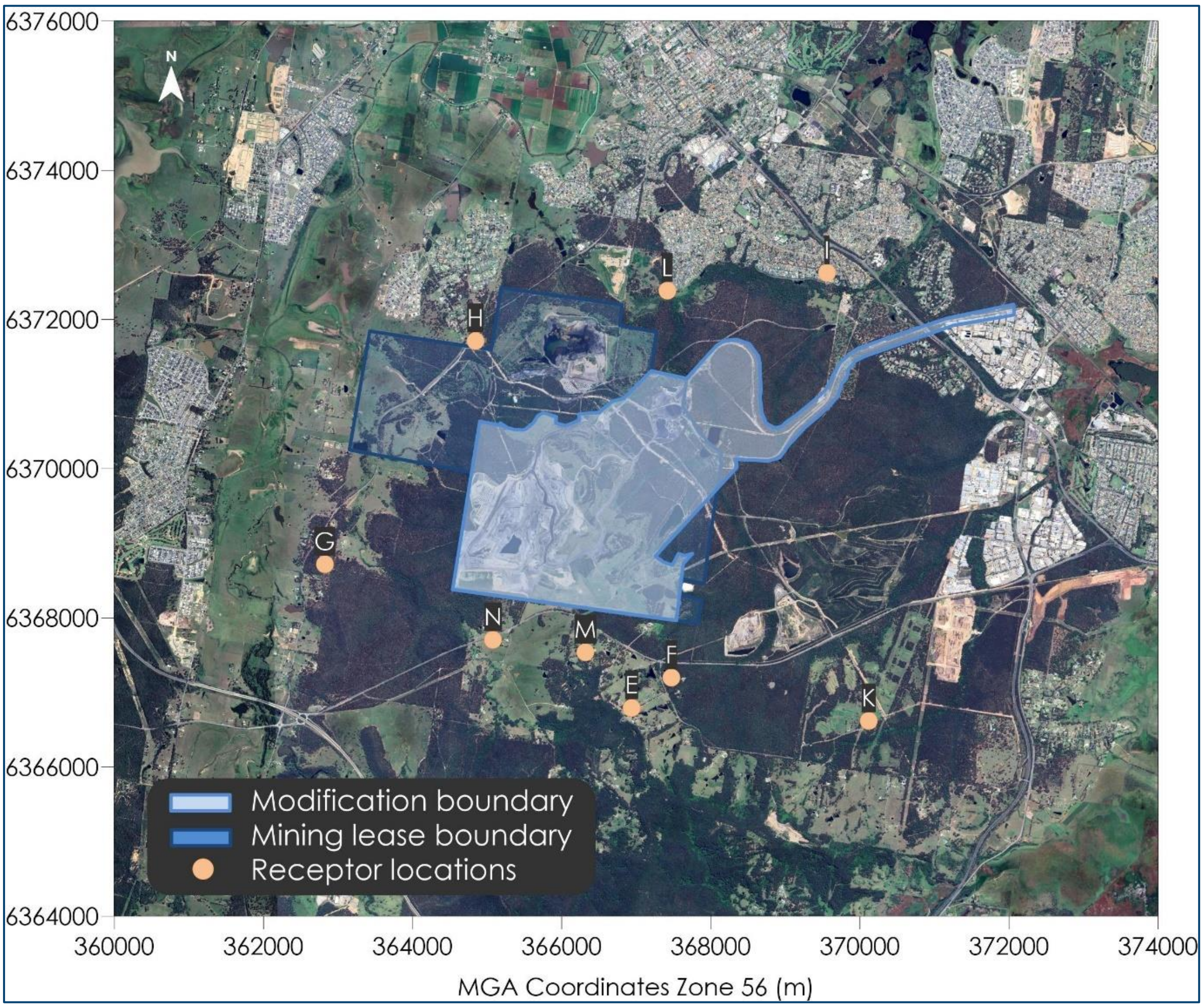

Figure 2-1: Local setting

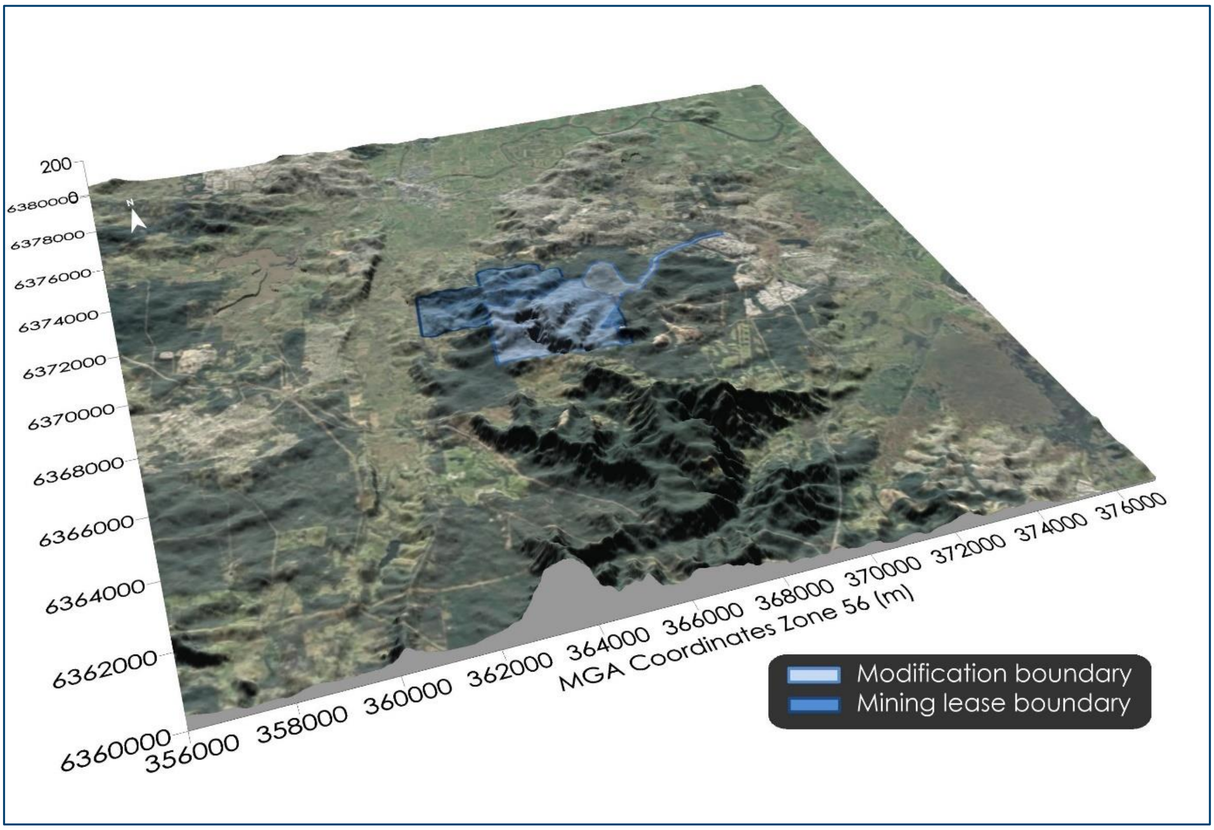

Figure 2-2: Topography surrounding the Modification

3 AIR QUALITY CRITERIA

Air quality goals are set to protect the general health and amenity of the community. The sections below identify the potential air emissions generated by the Modification and the applicable air quality goal.

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 amenity.

3.2 Project Approval limits

A summary of the applicable air quality criteria for Bloomfield Colliery as outlined in PA 07_0087 is presented in **Table 3-1**.

Bloomfield Colliery must ensure that all dust emissions generated by the project do not cause additional exceedances of the criteria in **Table 3-1** at any residence on privately-owned land, or on more than 25 per cent (%) of any privately-owned land.

Table 3-1: Summary of applicable air quality criteria (PA 07_0087)

Pollutant	Averaging period	Criterion
TSP matter	Annual	[a,c] 90 µg/m³
Particulate matter ≤10µm (PM_{10})	Annual	[a,c] 25 µg/m³
	24-hour	[b] 50 µg/m³
Particulate matter ≤2.5µm ($PM_{2.5}$)	Annual	[a,c] 8 µg/m³
	24-hour	[b] 25 µg/m³
[d] Deposited dust	Annual	[b] 2 g/m²/month
		[a] 4 g/m²/month

µg/m³ = micrograms per cubic metre, µm = micrometres and g/m²/month = grams per square metre per month.

Notes:

a. *Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources);*
b. *Incremental impact (i.e. incremental increase in concentrations due to the project on its own);*
c. *Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary.*
d. *Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method; and*

3.3 NSW EPA impact assessment criteria

Table 3-2 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, 2022**).

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

Table 3-2: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total at sensitive receptors	90 $\mu g/m^3$
PM_{10}	Annual	Total at sensitive receptors	25 $\mu g/m^3$
	24-hour	Total at sensitive receptors	50 $\mu g/m^3$
$PM_{2.5}$	Annual	Total at sensitive receptors	8 $\mu g/m^3$
	24-hour	Total at sensitive receptors	25 $\mu g/m^3$
Deposited dust#	Annual	Incremental at sensitive receptors	2 g/m^2/month
		Total at sensitive receptors	4 g/m^2/month

Source: **NSW EPA, 2022**

dust is assessed as insoluble solids as defined by AS 3580.10.1-1991 (AM-19)

3.4 NSW Voluntary Land Acquisition and Mitigation Policy

Part of the NSW *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments* (VLAMP) (**NSW Government, 2018**) describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter (dust) impacts from state significant mining, petroleum and extractive industry developments.

From the VLAMP, voluntary mitigation rights (such as air conditioning) may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-3** at any residence on privately owned land or workplace on privately owned land. [1]

Table 3-3: VLAMP Particulate matter mitigation criteria

<table>
<tr><th>Pollutant</th><th>Averaging period</th><th colspan="2">Mitigation criterion</th><th>Impact type</th></tr>
<tr><td>$PM_{2.5}$</td><td>Annual</td><td colspan="2">8 $\mu g/m^3$*</td><td>Human health</td></tr>
<tr><td>$PM_{2.5}$</td><td>24 hour</td><td colspan="2">25 $\mu g/m^3$**</td><td>Human health</td></tr>
<tr><td>PM_{10}</td><td>Annual</td><td colspan="2">25 $\mu g/m^3$*</td><td>Human health</td></tr>
<tr><td>PM_{10}</td><td>24 hour</td><td colspan="2">50 $\mu g/m^3$**</td><td>Human health</td></tr>
<tr><td>TSP</td><td>Annual</td><td colspan="2">90 $\mu g/m^3$*</td><td>Amenity</td></tr>
<tr><td>Deposited dust</td><td>Annual</td><td>2 g/m^2/month**</td><td>4 g/m^2/month*</td><td>Amenity</td></tr>
</table>

Source: **NSW Government (2018)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

Voluntary acquisition rights may apply as per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-4** at any residence on privately owned land, workplace on privately-owned land where the consequences of those exceedances in the opinion of the consent authority are unreasonably deleterious to worker health or the carrying out of business at that workplace (including consideration of the relevant factors identified on this subject in

[1] Where the consequences of those exceedances in the opinion of the consent authority are unreasonably deleterious to worker health or the carrying out of business at that workplace, including consideration of the relevant factors identified on this subject in the VLAMP.

the VLAMP), or on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 3-4: VLAMP Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	25 µg/m³*		Human health
PM_{10}	24-hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: **NSW Government (2018)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

The particulate matter levels for comparison with the criteria in **Table 3-3** and **Table 3-4** must be calculated in accordance with the Approved Methods.

The key difference between the criteria in **Table 3-3** and **Table 3-4** lies in the allowable exceedances of the criteria over the development's lifespan for short-term (i.e. 24 hour) impacts of $PM_{2.5}$ and PM_{10}. The acquisition criteria permit up to five exceedances of the criteria, while the mitigation criteria allow for zero exceedances. Essentially, the VLAMP criteria grant mitigation rights to properties affected by dust and, in cases of systemic impacts, also provide acquisition rights.

4 EXISTING ENVIRONMENT

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

4.1 Local climate

Long term climatic data collected at the Bureau of Meteorology (BoM) weather station at Newcastle Nobbys Signal Station Automatic Weather Station (AWS) were analysed to characterise the local climate in the proximity of the Modification. The Newcastle Nobbys Signal Station AWS is located approximately 24km west of the Bloomfield Colliery.

Table 4-1 and **Figure 4-1** show climatic parameters which have been collected from the Newcastle Nobbys Signal Station AWS over a 52-to-159-year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 25.6 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 8.5°C.

Rainfall peaks during the first half of the year and declines during the second half. The data show March is the wettest month with an average rainfall of 119.7 millimetres (mm) over 9.2 days and November is the driest month with an average rainfall of 71.3mm over 7.8 days.

Relative humidity levels exhibit variability over the day. Mean 9am relative humidity levels range from 68 per cent in October to 80 per cent in February. Mean 3pm relative humidity levels vary from 56 per cent in August to 74 per cent in February.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. The mean 9am wind speeds range from 20.8 kilometres per hour (km/h) in February and March to 26.4km/h in June. The mean 3pm wind speeds vary from 26.1km/h in May to 35.3km/h in November.

Table 4-1: Monthly climate statistics summary – Newcastle Nobbys Signal Station AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	25.6	25.4	24.7	22.8	20.1	17.5	16.8	18.1	20.3	22.2	23.5	24.9	21.8
Mean min. temp. (°C)	19.3	19.4	18.3	15.4	12.0	9.8	8.5	9.3	11.5	14.1	16.2	18.1	14.3
Rainfall													
Rainfall (mm)	88.1	106.7	119.7	115.6	114.5	117.8	92.9	72.0	71.7	73.2	71.3	79.1	1118.6
No. of rain days (≥1mm)	8.0	8.2	9.2	9.2	8.9	9.1	8.1	7.3	7.2	7.8	7.8	7.5	98.3
9am conditions													
Mean temp. (°C)	21.9	21.9	20.9	18.1	14.6	12.1	10.9	12.2	15.1	17.9	19.5	21.1	17.2
Mean R.H. (%)	77	80	79	78	79	79	77	72	69	68	72	74	75
Mean W.S. (km/h)	20.9	20.8	20.8	21.5	23.6	26.4	26.3	25.8	25.1	23.7	23.2	21.7	23.3
3pm conditions													
Mean temp. (°C)	23.3	23.5	22.9	21.3	18.8	16.5	15.9	16.9	18.5	19.8	21.0	22.4	20.1
Mean R.H. (%)	72	74	72	66	64	63	59	56	59	64	68	71	66
Mean W.S. (km/h)	33.2	32.6	30.6	28.0	26.1	28.2	28.9	30.5	33.9	34.4	35.3	35.2	31.4

Source: **Bureau of Meteorology (2024)**

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

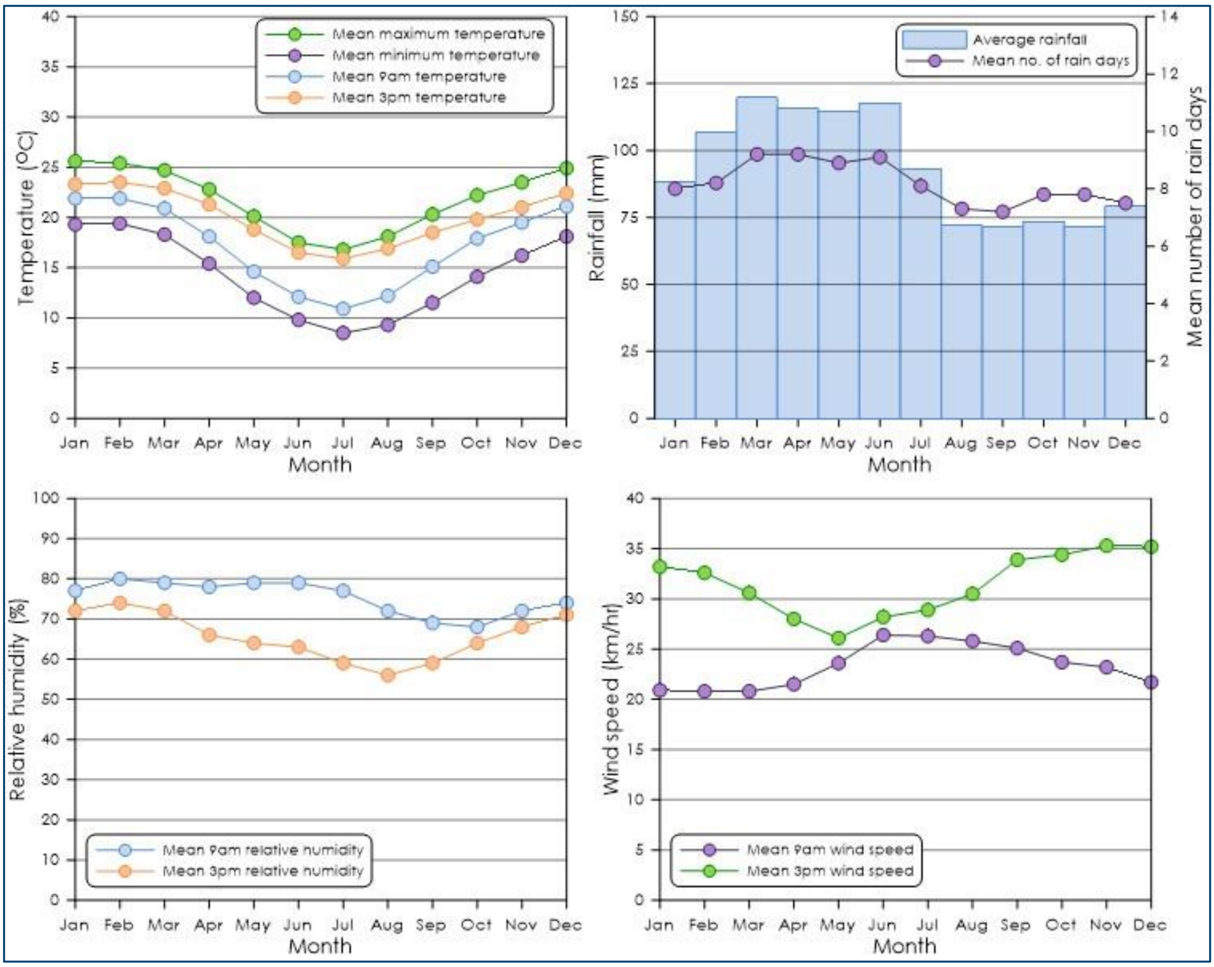

Figure 4-1: Monthly climate statistics summary – Nobbys Signal Station AWS

4.2 Local meteorological conditions

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

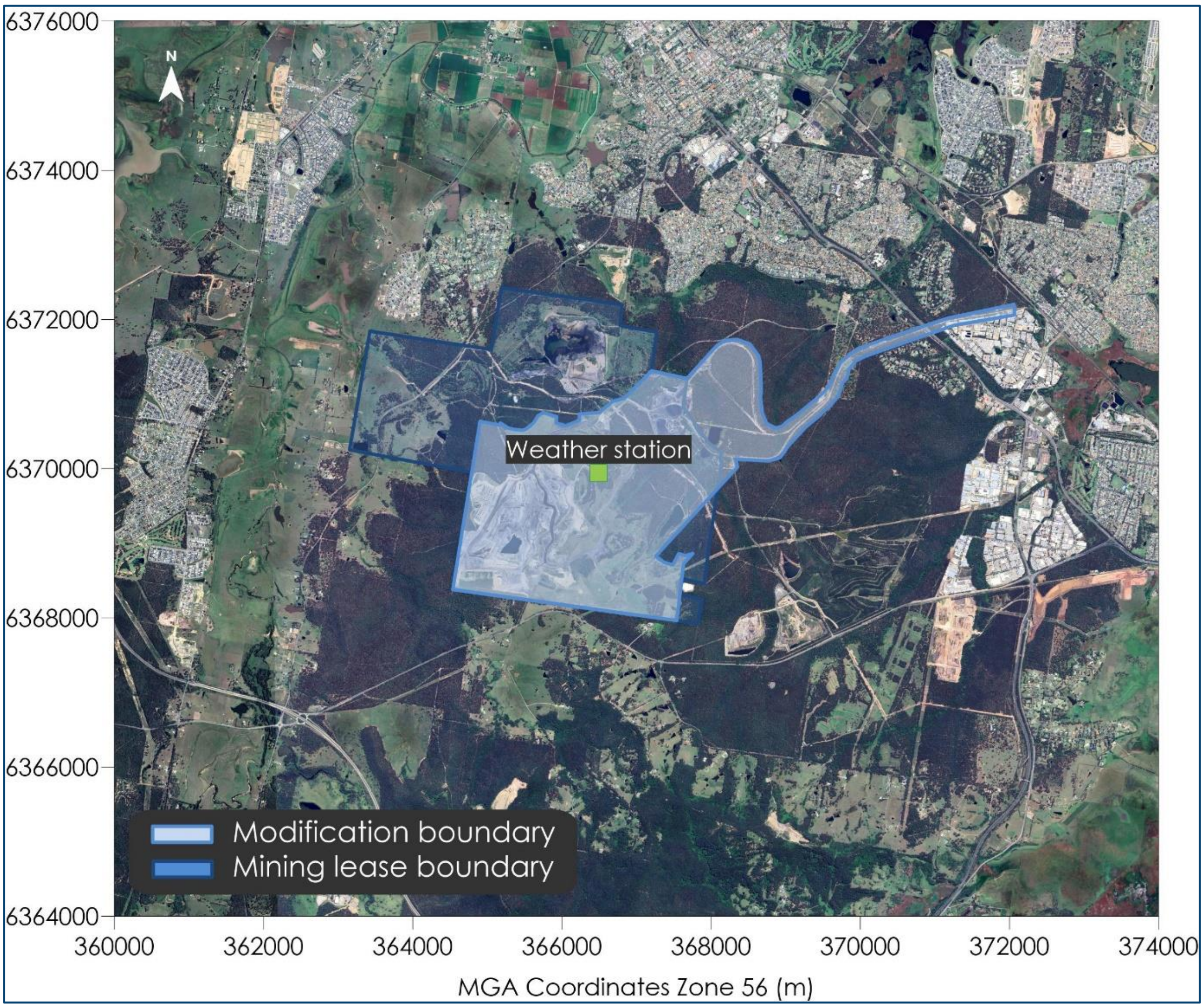

Figure 4-2: Bloomfield Colliery weather station location

Annual and seasonal windroses prepared from the available data collected for the 2022 calendar period for the station are presented in **Figure 4-3**.

The 2022 calendar period corresponds to the period of meteorological modelling based on an analysis of data trends in meteorological data and appropriate monitoring data recorded for the area as outlined in **Appendix A**.

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

In summer the winds predominately occur from the south-southeast and are typically light. The autumn wind distribution shows dominance of light winds from the south followed by relatively stronger winds from the northwest. During winter, relatively stronger winds from the northwest are most frequent. The spring windrose typically shares a similar wind distribution pattern to the annual distribution with winds from the northwest most frequent.

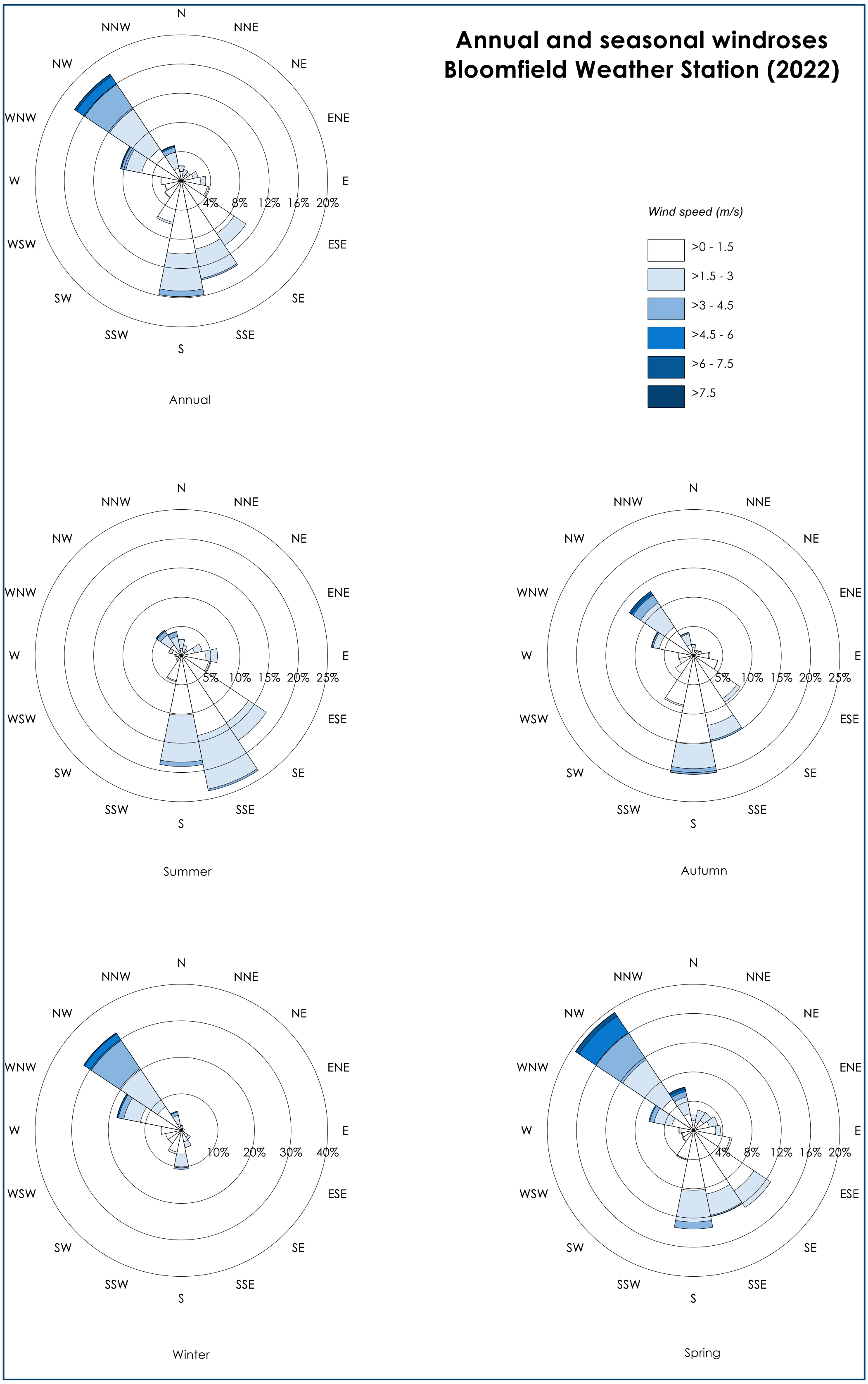

Figure 4-3: Annual and seasonal windroses for the Bloomfield Colliery weather station (2022)

4.3 Local air quality monitoring

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

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

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

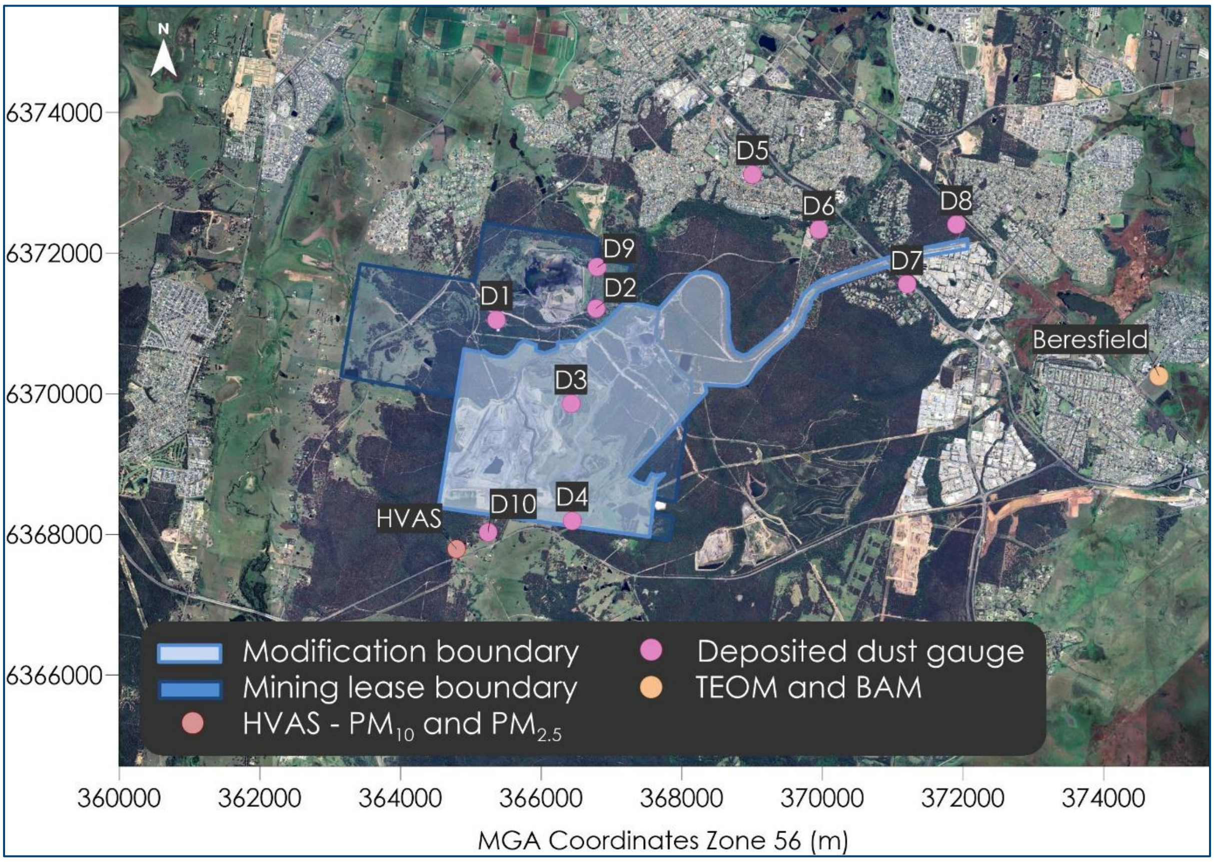

Figure 4-4: Monitoring locations

4.3.1 PM_{10} monitoring

A summary of the available ambient PM_{10} monitoring data from the Bloomfield Colliery HVAS and NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) Beresfield TEOM monitoring station is presented in **Table 4-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-5**. These data include levels measured during all extraordinary event days. Extraordinary event days are characterised as those days influenced by exceptional events such as bushfires, dust storms and hazard reduction burns.

The monitoring data in **Table 4-2** include all emission sources in the general vicinity and indicate that the annual average PM_{10} concentrations for the monitoring stations were generally below the relevant criterion of 25µg/m^3 for the period reviewed with the exception of 2019 at the Beresfield monitor.

The maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m^3 on occasion, occurring in 2018 at Beresfield, at both locations in 2019 and 2020, and at the Bloomfield monitor in 2023.

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

Year	Bloomfield	Beresfield	Criterion
	Annual average		
2018	19.0	21.6	**25**
2019	24.7	**25.9**	**25**
2020	16.9	18.5	**25**
2021	11.1	15.9	**25**
2022	9.5	14.3	**25**
2023	16.2	17.8	**25**
Year	**Maximum 24-hour average**		**Criterion**
2018	42.0	**149.1**	**50**
2019	**119.0**	**136.7**	**50**
2020	**62.0**	**77.7**	**50**
2021	37.0	36.3	**50**
2022	22.7	26.2	**50**
2023	**51.5**	41.0	**50**

The maximum 24-hour average PM_{10} concentrations (see **Figure 4-5**) recorded at the Bloomfield and Beresfield monitors generally follow a similar trend with a significant increase in the frequency of exceedances of the 24-hour average PM_{10} criterion in the 2019/ 2020 summer, predominately due to smoke associated with the widespread bushfires occurring at this time.

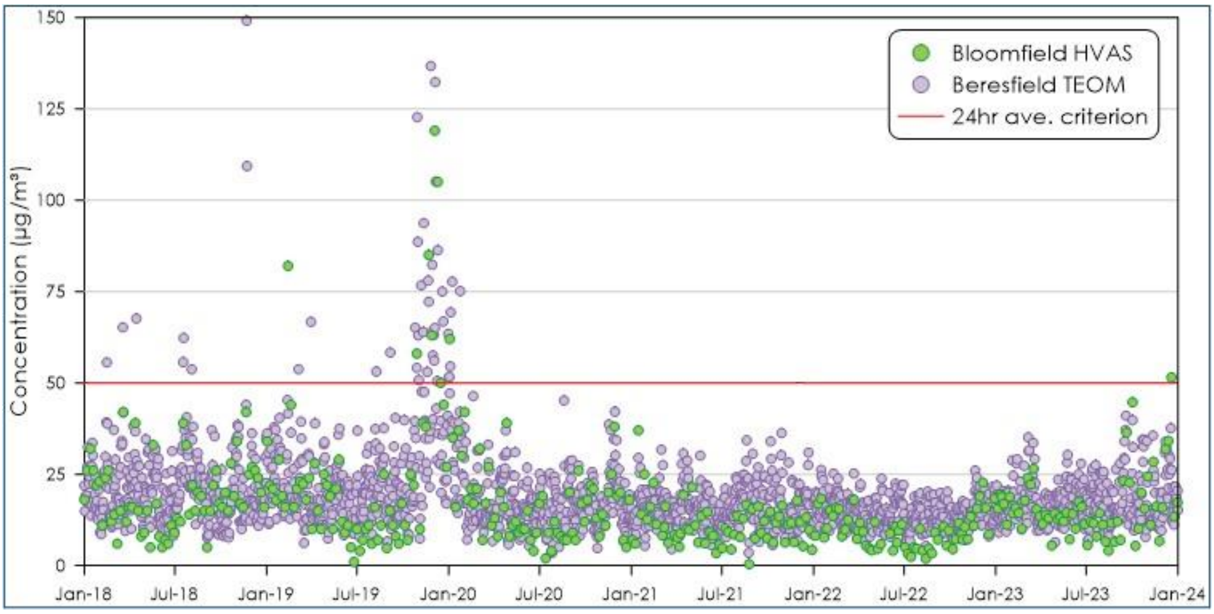

Figure 4-5: 24-hour average PM_{10} concentrations

4.3.2 TSP monitoring

The TSP data is inferred from the PM_{10} HVAS measurements. A summary of the available TSP data is shown in **Table 4-3**. 24-hour average TSP concentrations are presented in **Figure 4-6**. These data include levels measured during all extraordinary event days. Extraordinary event days are characterised as those days influenced by exceptional events such as bushfires, dust storms and hazard reduction burns.

The data presented in **Table 4-3** indicate that the annual average TSP concentrations for the monitoring station are generally less than half the criterion of 90µg/m³. **Figure 4-6** shows that the recorded 24-hour average TSP concentrations follow a similar trend to the PM_{10} HVAS monitoring data as expected.

Table 4-3: Summary of annul average TSP levels (µg/m³)

Year	Annual average	Criterion
2018	40.1	**90**
2019	54.4	**90**
2020	37.1	**90**
2021	24.5	**90**
2022	21.0	**90**
2023	35.5	**90**

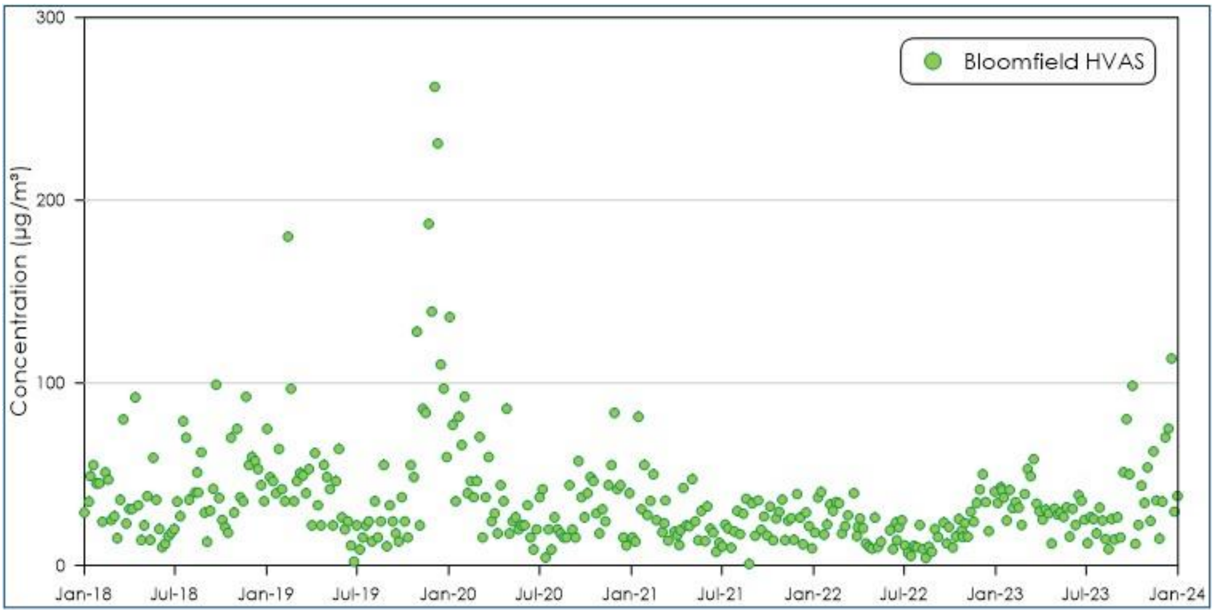

Figure 4-6: 24-hour average TSP concentrations

4.3.3 $PM_{2.5}$ monitoring

A summary of the available $PM_{2.5}$ data for the Bloomfield Colliery HVAS and Beresfield monitoring station is presented in **Table 4-4** and **Figure 4-7**. This data includes levels measured during all extraordinary event days. Extraordinary event days are characterised as those days influenced by exceptional events such as bushfires, dust storms and hazard reduction burns.

Table 4-4 indicates that the annual average $PM_{2.5}$ concentration was above the relevant criterion of 8µg/m^3 in 2018 at Beresfield, for both monitors in 2019 and at the Bloomfield monitor in 2020. For all other periods the annual average $PM_{2.5}$ concentrations were below the relevant criterion.

On occasion, the 24-hour average $PM_{2.5}$ levels were also found to be above the relevant criterion of 25µg/m^3 during the review period (see **Figure 4-7**). Similar to the PM_{10} levels in 2019/2020, there were several days where the region was impacted by smoke from bushfires resulting in a noticeable increase in the frequency of exceedances of the 24-hour average $PM_{2.5}$ criterion.

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

Year	Bloomfield	Beresfield	Criterion
	Annual average		
2018	-	**8.7**	**8**
2019	**14.1**	**12.1**	**8**
2020	**8.5**	7.7	**8**
2021	4.4	5.9	**8**
2022	3.0	5.0	**8**
2023	5.1	6.7	**8**
Year	**Maximum 24-hour average**		**Criterion**
2018	24.0	24.9	**25**
2019	**99.0**	**100.5**	**25**
2020	**39.0**	**49.7**	**25**
2021	16.0	18.9	**25**
2022	9.6	12.3	**25**
2023	19.6	16.6	**25**

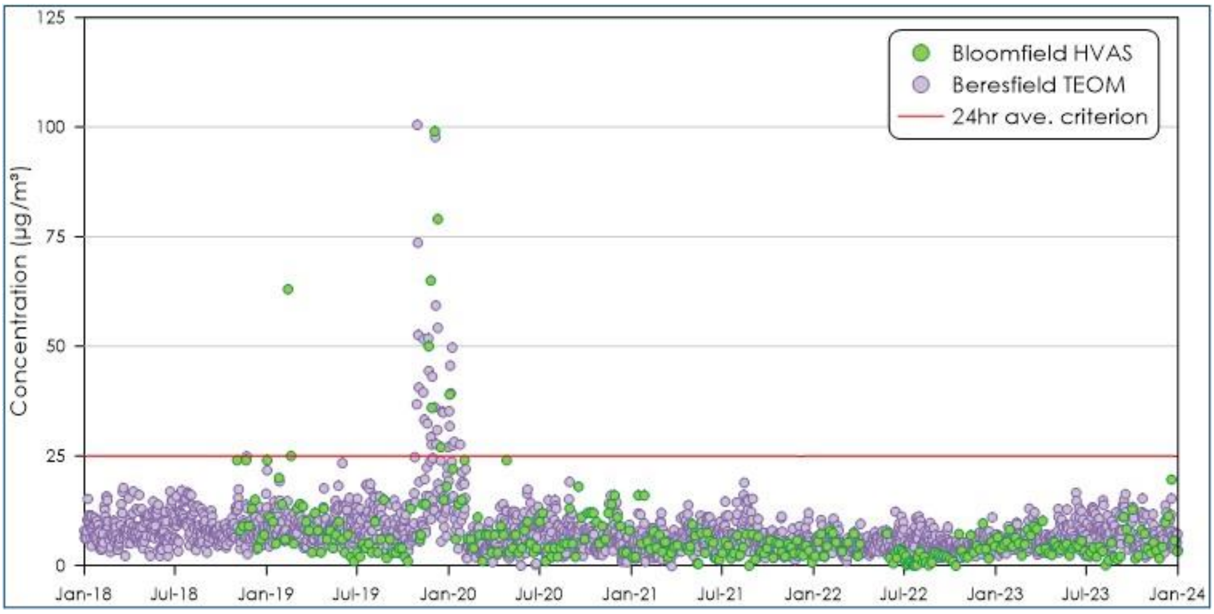

Figure 4-7: 24-hour average $PM_{2.5}$ concentrations

4.3.4 Dust deposition monitoring

Table 4-5 summarises the annual average deposition levels at each gauge during 2018 to 2023.

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

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

Table 4-5: Annual average dust deposition (g/m²/month)

Year	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Criterion
2018	0.9	1.2	1.0	1.3	1.7	1.6	1.5	1.3	0.9	1.6	**4**
2019	1.4	1.4	1.8	1.7	1.4	2.0	2.3	1.8	1.4	1.6	**4**
2020	1.1	1.2	1.1	1.8	1.9	1.5	1.9	1.4	1.2	1.6	**4**
2021	0.6	0.6	1.0	1.0	1.1	1.4	0.8	0.8	0.7	1.9	**4**
2022-2023*	0.6	0.6	1.2	0.7	0.8	1.0	0.9	0.8	0.8	0.6	**4**

*January 2022 to March 2023

5 DISPERSION MODELLING APPROACH

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

Modelling was undertaken using a combination of the CALPUFF Modelling System and the Weather Research and Forecasting model (WRF). 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. WRF is a prognostic air model used to simulate meteorological data for input into CALMET.

The model was set up in general accordance with the NSW EPA's *Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation**, **2011**).

5.1 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from WRF with surface observations.

The WRF 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 WRF modelling used is latitude -33.81 and longitude 155.56. The simulation involved an outer grid with 15km grid spacing, and two nested grids with 3km and 1km grid spacing.

The CALMET initial domain was run on a 10 x 10km with a 0.1km grid resolution for the 2022 modelled year. The available meteorological data for January 2022 to December 2022 from five surrounding meteorological monitoring sites were included in the simulation. The 2022 calendar year was selected as the period for modelling the Modification based on an analysis of five consecutive years as outlined in **Appendix B**. **Table 5-1** outlines the parameters used from each station.

Table 5-1: Surface observation stations used in modelling

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

WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity, SLP = station level pressure
- = data not measured

The seven critical parameters used in the CALMET modelling are presented in **Table 5-2**.

Table 5-2: Seven critical parameters used in CALMET

Parameter	Value
TERRAD	10
IEXTRP	-4
BIAS (NZ)	-1, -0.5, -0.25, 0, 0, 0, 0, 0
R1 and R2	3, 3
RMAX1 and RMAX2	15, 15

5.2 Meteorological modelling evaluation

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extract data. **Figure 5-1** presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period (i.e. illustrative). The wind fields follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

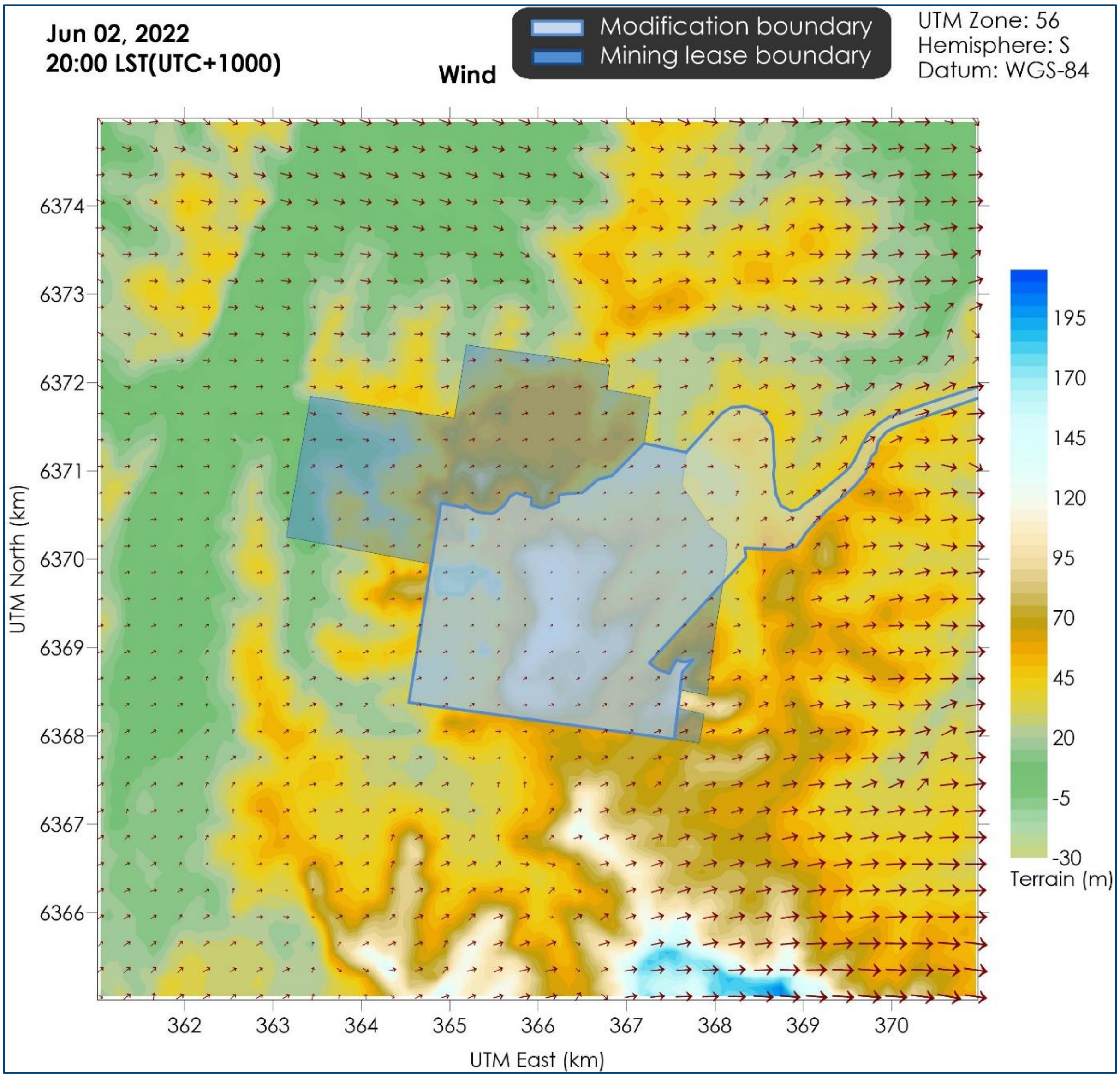

Figure 5-1: Representative 1-hour snapshot of wind field for the Modification

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 for the modelled year and shows sensible trends considered to be representative of the area.

In conclusion, the CALMET generated meteorological data are considered suitable for use in the air dispersion modelling for the Modification.

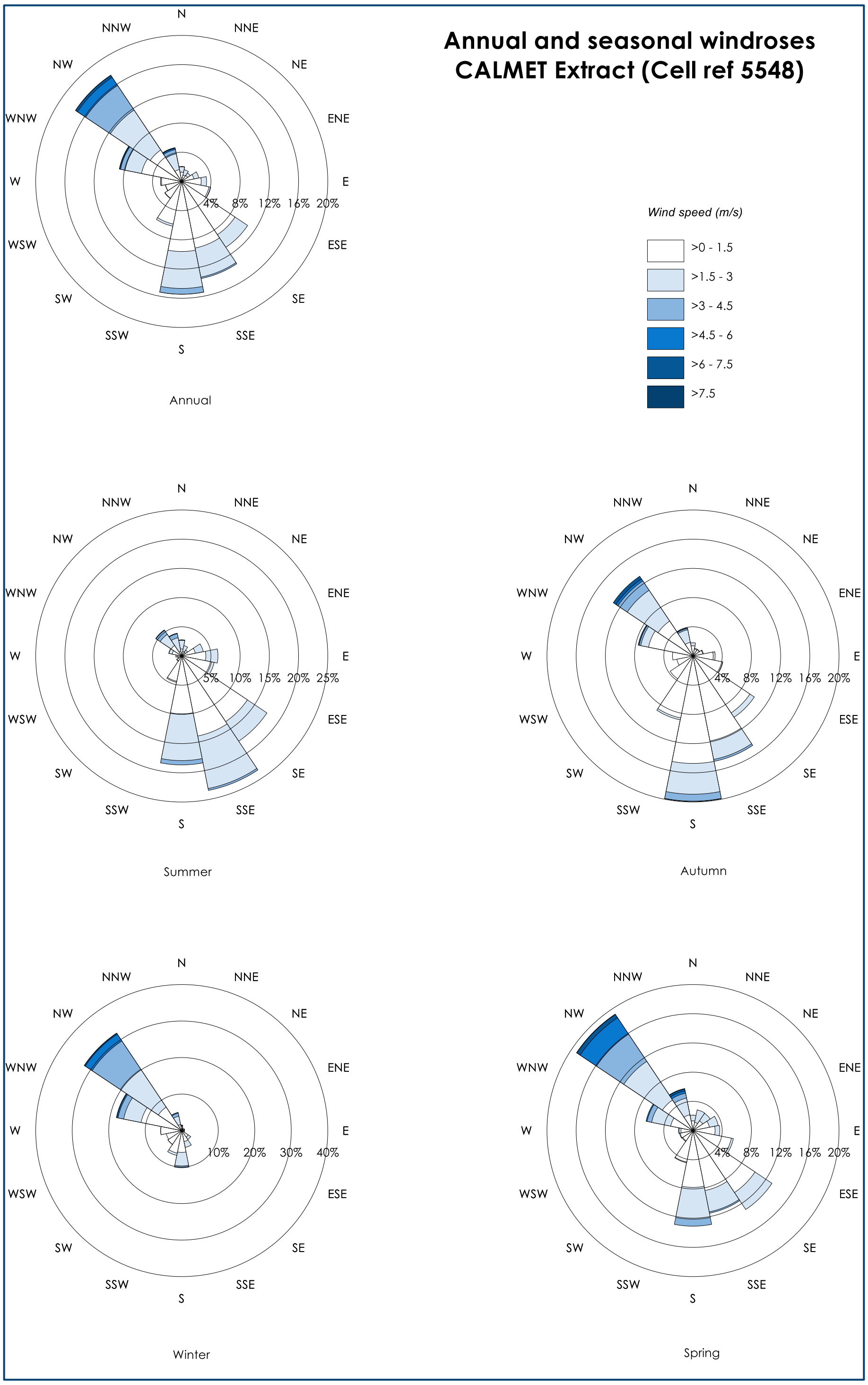

Figure 5-2: Annual and seasonal windroses from CALMET

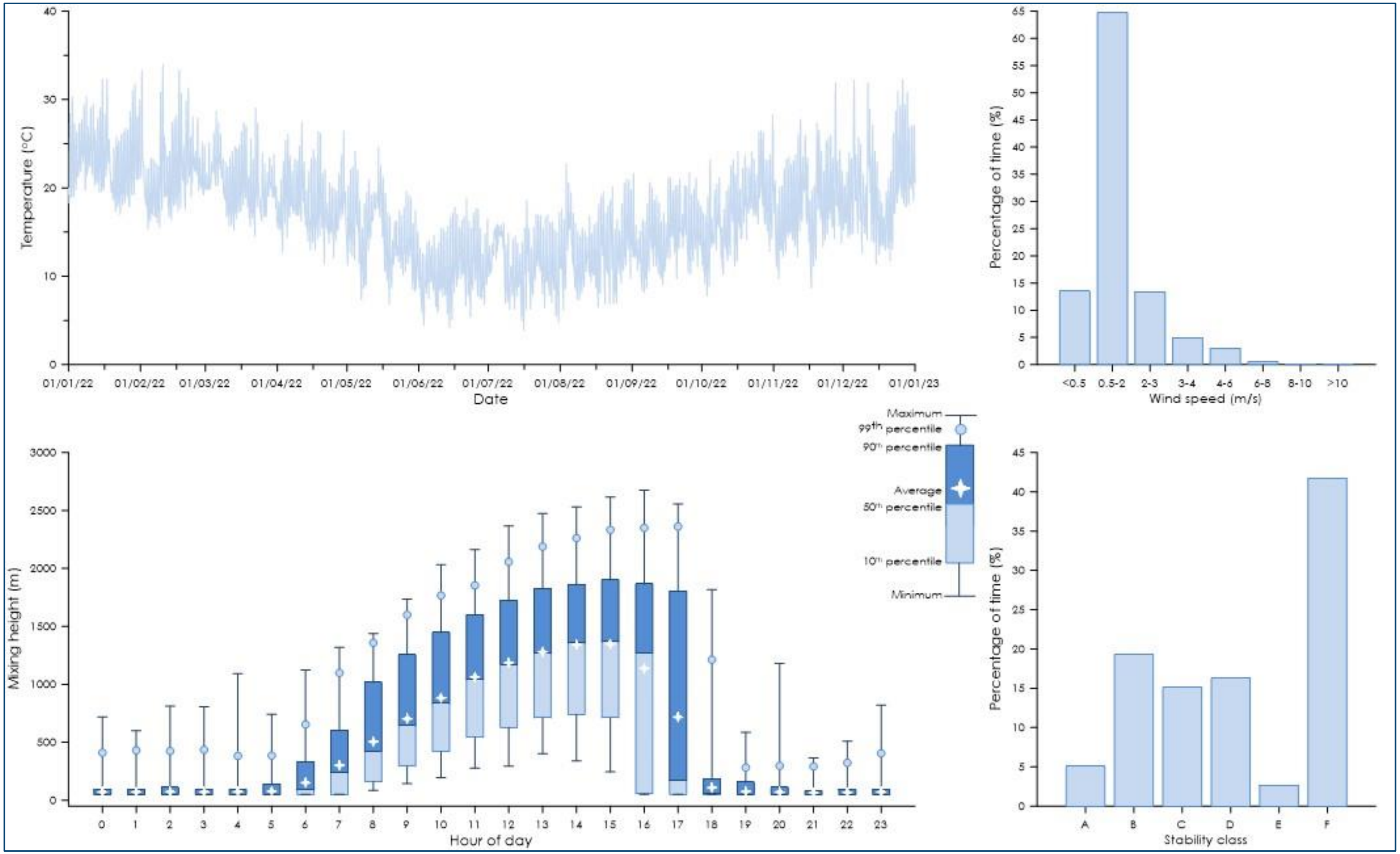

Figure 5-3: Meteorological analysis of CALMET

5.3 Dispersion modelling

CALPUFF modelling is based on the distribution of dust particles for each particle size category derived from the applied emission factor equations.

Emissions from each of the mining activity were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file.

Meteorological conditions associated with dust generation (such as wind speed) and levels of dust-generating activity were considered in calculating the hourly varying emission rate for each source. It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in removing dust emissions from the atmosphere has not been considered in this assessment.

5.4 Modelling scenario

The assessment considers a single scenario to represent the Modification. The modelled activities were chosen to represent potential worst-case dust impacts (i.e. highest dust generating activities and locations) in regard to the quantity of material extracted and handled in each period, the location of the activity and the potential to generate dust at the receptor locations.

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

For the purpose of a representative worst-case scenario, the peak overburden handling rate (17.2Mtpa – occurring during Year 2027) and peak ROM extraction rate (0.9Mtpa – occurring during Year 2028) in the proposed mining schedule has been applied to the mine plan for Year 2032. The Year 2032 scenario nominally represents mining in the additional areas to the north and has potential to cause impact for the residential receptors to the north of the site.

Indicative locations for the Modification activities are presented in **Figure 5-4**.

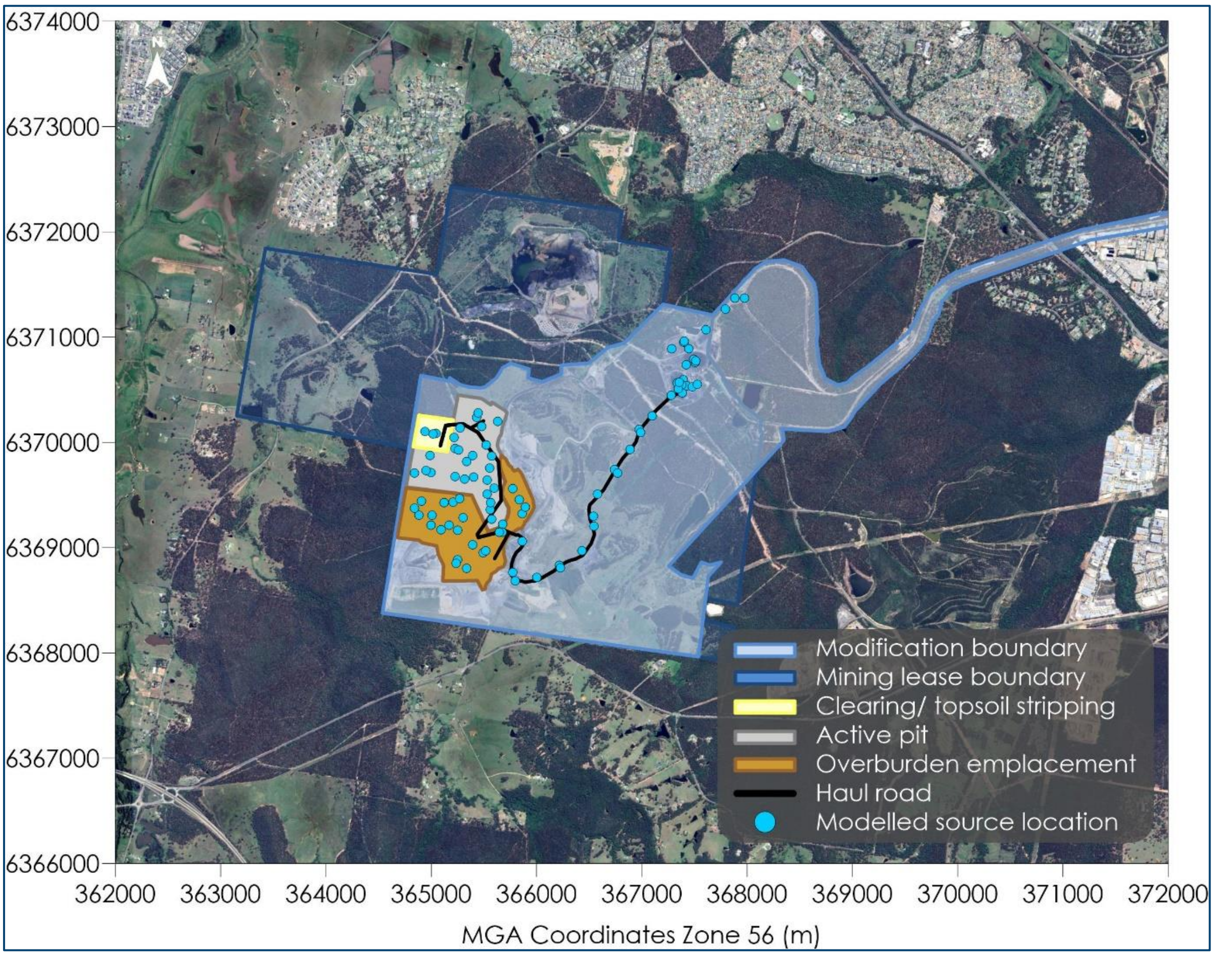

Figure 5-4: Indicative source locations for the modelling scenario (Year 2032).

5.4.1 Emission estimation

For the modelling scenario, emissions have been estimated by analysing the dust generating activities and utilising suitable emission factors.

The emission factors were sourced from both locally developed and United States Environmental Protection Agency developed documentation as approved by the NSW EPA. A summary of the TSP, PM_{10} and $PM_{2.5}$ emissions from all significant activities for the Modification are presented in **Table 5-3**. Full emission inventories and associated calculations are presented in **Appendix C**.

The estimated emissions are commensurate with utilising reasonable best practice dust mitigation applied where feasible. Further details on the dust control measures applied for the Modification are outlined in **Section 5.5**.

Table 5-3: Summary of estimated dust emissions for modelling the Modification (kg per year)

Activity	TSP emission	PM_{10} emission	PM_{25} emission
TS - Excavator loading topsoil	33	16	2
TS - Hauling topsoil to rehab area	313	70	9
TS - Emplacing topsoil at rehab area	33	16	2
TS - Rehandle topsoil at rehab area	3	2	0
OB - Drilling	6,744	3,507	202
OB - Blasting	27,870	14,492	836
OB - Excavator loading OB to haul truck	12,615	5,966	903

Activity	TSP emission	PM_{10} emission	PM_{25} emission
OB - Hauling to dump	191,869	41,966	4,341
OB - Emplacing at dump	12,615	5,966	903
OB - Rehandle OB	1,261	597	90
OB - Dozers on OB in pit	19,632	4,744	2,061
OB - Dozers on OB working on dump + rehab	43,876	10,603	4,607
CL - Dozers ripping/pushing/clean-up	267	27	6
CL - Loading ROM coal to haul truck	3,706	533	70
CL - Hauling ROM to ROM Pad	22,813	5,485	1,117
CHPP - Unloading ROM to ROM Pad	3,706	533	70
CHPP - Loading ROM to hopper	1,112	160	21
CHPP - Rehandle ROM at hopper	741	107	14
CHPP - Plant feed conveyor	14	7	1
CHPP - Crushing	518	233	43
CHPP - Screening	1,295	518	30
CHPP - No. 2 Conveying to CHPP	8	4	1
CHPP - Transfer	981	464	70
CHPP - Conveying to Product stockpile	17	8	1
CHPP - Unloading to Product stockpile	84	40	6
CHPP - Conveying to train load out	33	16	2
CHPP - Transfer	25	12	2
CHPP - Loading coal to train	84	40	6
CHPP - Dozers on Product stockpiles	1,926	252	42
OB - Loading Reject to haul truck	27	13	2
OB - Hauling Reject to dump	4,652	1,070	169
OB - Emplacing Reject at dump	27	13	2
WE - Overburden emplacement areas	65,208	32,604	4,891
WE - Open pit	62,103	31,051	4,658
WE - ROM stockpiles	29	15	2
WE - Product stockpiles	232	116	17
OB - Grading roads	14,771	5,161	458
Locomotive idling	515	515	499
Diesel emissions	2,614	2,614	2,536
Total TSP emissions (kg/yr.)	**504,370**	**169,553**	**28,697**

5.5 Dust mitigation and management

A range of air quality mitigation measures are applied at Bloomfield Colliery to achieve a standard of mine operation consistent with current best practice for the control of dust emissions from coal mines in NSW. The measures applied to the Project reflect those outlined in the NSW EPA document, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, prepared by Katestone Environmental (**Katestone, 2011**), and also imposed on mines in the current NSW EPA Pollution Reduction Programs (PRP's) that relate to haul road emissions, and dust mitigation in response to adverse weather conditions.

Where applicable these controls have been applied in the dust emission estimates as shown in **Appendix B**. A summary of key dust controls applied to current operations at the Project are shown in **Table 5-4**.

Table 5-4: Summary of best practice dust mitigation measures

Activity	Dust mitigation measure
Drilling	Dust suppression system
	Prevent disturbance of drill cuttings.
	Application of water on dusty areas prior to drilling.

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

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

5.6 Accounting for background air quality levels

To account for the contribution from other non-mining sources of particulate matter in the wider area an allowances have been added to the modelling predictions to fully address the total potential cumulative impact.

The total predicted effects from the Project (including any existing effects) were added with the measured background levels (which also include any existing effects from the Bloomfield Colliery). This approach is conservative, (would lead to overestimation of impacts) as the existing colliery emissions are double counted in this assessment.

Ambient air quality monitoring data collected from the Bloomfield air quality monitoring network during 2022 have been applied to represent the prevailing background dust levels.

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

Table 5-5: Estimated background levels from other non-modelled dust sources

Dust metric	Averaging period	Unit	Estimated background
TSP	Annual	µg/m³	21.0
PM_{10}	Annual	µg/m³	9.5
$PM_{2.5}$	Annual	µg/m³	3.0
Dust deposition	Annual	g/m²/month	1.2

6 DISPERSION MODELLING RESULTS

The dispersion modelling predictions for the assessed scenario are presented in this section. The results presented include those for the operation in isolation (incremental impacts) and the operation with other sources and background levels (total (cumulative) impact).

Each of the receptors of relevance to this study as shown in **Figure 2-1**, and detailed in **Appendix A**, were assessed individually as discrete receptors.

Table 6-1 presents the predicted dispersion modelling results at each of the assessed receptor locations for the scenario. The results in **Table 6-1** indicate that no exceedances of the relevant criteria are predicted to arise for the assessed dust metrics. Associated isopleth diagrams of the dispersion modelling predictions are presented in **Appendix D**.

Table 6-1: Dispersion modelling results for receptor locations

Receptor ID	$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	DD ($g/m^2/mth$)
	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
E	2.6	0.2	14.9	0.9	1.6	<0.1	3.2	10.4	22.6	1.2
F	4.1	0.4	24.8	2.1	3.8	0.1	3.4	11.6	24.8	1.3
G	2.0	0.2	10.0	1.0	1.9	<0.1	3.2	10.5	22.9	1.2
H	6.2	0.8	33.1	4.4	7.9	0.1	3.8	13.9	28.9	1.3
I	0.6	0.1	2.8	0.3	0.4	<0.1	3.1	9.8	21.4	1.2
K	2.3	0.2	14.3	0.9	1.6	0.1	3.2	10.4	22.6	1.3
L	1.6	0.2	9.4	0.9	1.5	<0.1	3.2	10.4	22.5	1.2
M	5.0	0.4	27.2	2.2	4.1	0.1	3.4	11.7	25.1	1.3
N	3.5	0.2	18.0	0.9	1.8	<0.1	3.2	10.4	22.8	1.2

* Note that cumulative 24-hour average criteria also apply.

6.1 Assessment of 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 receptors location.

It is important to note that when assessing impacts per the maximum 24-hour average $PM_{2.5}$ and PM_{10} criteria, the predictions show the highest predicted 24-hour average concentrations modelled at each point within the modelling domain for the worst day (a 24-hour period).

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 (**NSW EPA**, **2022**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts. In simple terms, the Level 2 assessment involves matching one year of ambient air quality monitoring data with meteorological data representing the same period.

The analysis has focused on two selected receptor locations (i.e. Receptor H and M) which represents the closest and most likely impacted receptor location surrounding the Modification.

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

As the existing mine was operational during 2022, it would have contributed to the measured levels of dust in the area on some occasions and the approach is conservative, (would lead to overestimation of impacts) as the existing colliery emissions are double counted in this assessment.

Table 6-2 and **Table 6-3** show the predicted maximum cumulative 24-hour average $PM_{2.5}$ and PM_{10} levels at Receptor H. **Table 6-2** and **Table 6-3** show the predicted maximum cumulative 24-hour average $PM_{2.5}$ and PM_{10} levels at Receptor M.

The left half of the tables examines the cumulative impact during the periods of highest background levels and the right half of the tables examines the cumulative impact during the periods of highest contribution from the Modification.

Table 6-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor H

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
14/06/2022	12.3	0.0	12.3	14/03/2022	4	6.2	10.2
26/06/2022	11.2	0.0	11.2	23/07/2022	0.1	6.0	6.1
31/07/2022	11.2	0.0	11.2	1/10/2022	1.5	5.7	7.2
25/12/2022	11	1.1	12.1	18/01/2022	9.2	5.5	14.7
25/07/2022	10.8	0.4	11.2	4/01/2022	2.2	5.3	7.5
10/02/2022	10.7	0.1	10.8	22/01/2022	2.1	4.6	6.7
30/07/2022	10.5	0.0	10.5	9/05/2022	6.5	4.5	11.0
3/08/2022	10.2	0.0	10.2	13/04/2022	3.1	4.5	7.6
23/08/2022	9.7	0.0	9.7	6/02/2022	5.1	4.4	9.5
22/06/2022	9.6	0.1	9.7	6/03/2022	4	4.3	8.3

Table 6-3: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor H

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
21/11/2022	26	0.0	26.0	23/07/2022	13.1	33.1	46.2
10/02/2022	25.2	0.2	25.4	1/10/2022	15.5	32.0	47.5
17/01/2022	24.5	18.4	42.9	14/03/2022	12.6	31.3	43.9
19/02/2022	23.8	2.7	26.5	18/01/2022	19.4	29.4	48.8
17/05/2022	23.8	0.1	23.9	4/01/2022	8.2	28.8	37.0
20/01/2022	23.4	4.1	27.5	9/05/2022	15.9	26.3	42.2
6/12/2022	22.7	9.4	32.1	6/02/2022	18.2	25.2	43.4
23/11/2022	22.5	5.5	28.0	19/01/2022	15.3	24.8	40.1
14/06/2022	22.4	0.2	22.6	6/03/2022	11.8	24.7	36.5
5/04/2022	22.3	5.4	27.7	22/01/2022	7.7	24.4	32.1

Table 6-4: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor M

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
14/06/2022	12.3	2.7	15.0	1/08/2022	7.7	5.0	12.7
26/06/2022	11.2	1.1	12.3	22/08/2022	8.8	4.9	13.7
31/07/2022	11.2	1.1	12.3	31/10/2022	2	4.3	6.3
25/12/2022	11	0.0	11.0	23/08/2022	9.7	3.7	13.4
25/07/2022	10.8	2.6	13.4	20/04/2022	3.6	3.4	7.0
10/02/2022	10.7	0.1	10.8	17/07/2022	6.1	3.4	9.5
30/07/2022	10.5	0.2	10.7	16/09/2022	5.2	3.1	8.3
3/08/2022	10.2	1.6	11.8	30/08/2022	8.6	2.8	11.4
23/08/2022	9.7	3.7	13.4	14/06/2022	12.3	2.7	15.0
22/06/2022	9.6	0.3	9.9	15/08/2022	3.7	2.6	6.3

Table 6-5: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor M

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
21/11/2022	26	1.2	27.2	22/08/2022	18.8	27.2	46.0
10/02/2022	25.2	0.5	25.7	1/08/2022	14.9	25.9	40.8
17/01/2022	24.5	0.2	24.7	31/10/2022	10.6	25.3	35.9
19/02/2022	23.8	0.0	23.8	20/04/2022	11.5	20.6	32.1
17/05/2022	23.8	11.8	35.6	17/07/2022	12	20.4	32.4
20/01/2022	23.4	0.0	23.4	23/08/2022	19.2	18.6	37.8
6/12/2022	22.7	0.0	22.7	16/09/2022	9.5	17.4	26.9
23/11/2022	22.5	9.1	31.6	5/06/2022	8.9	15.8	24.7
14/06/2022	22.4	15.5	37.9	14/06/2022	22.4	15.5	37.9
5/04/2022	22.3	0.2	22.5	15/08/2022	9	15.1	24.1

The results in **Table 6-2** to **Table 6-5** indicate no additional days of exceedance of the cumulative 24-hour average $PM_{2.5}$ and PM_{10} criteria would arise for the Modification.

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for Receptor H and M are presented in **Figure 6-1**. The orange bars in the figures show the predicted additional levels due to the Modification above background levels (i.e. the orange sections of the bars indicate the amount of dust due to the Modification). The blue bars show the existing background levels. The top of the orange bar indicates the predicted future cumulative level associated with the Modification and background combined.

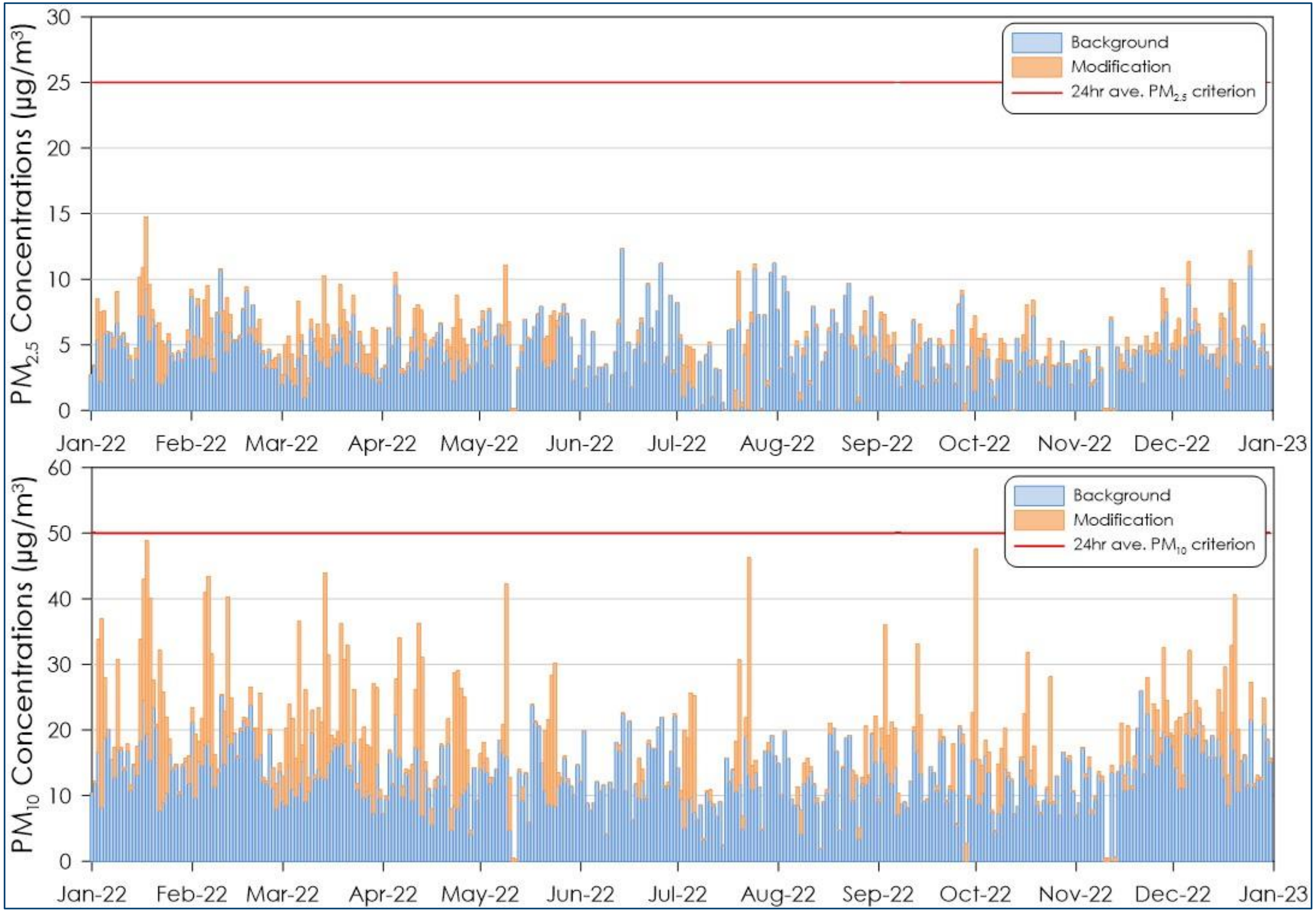

Figure 6-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for Receptor H

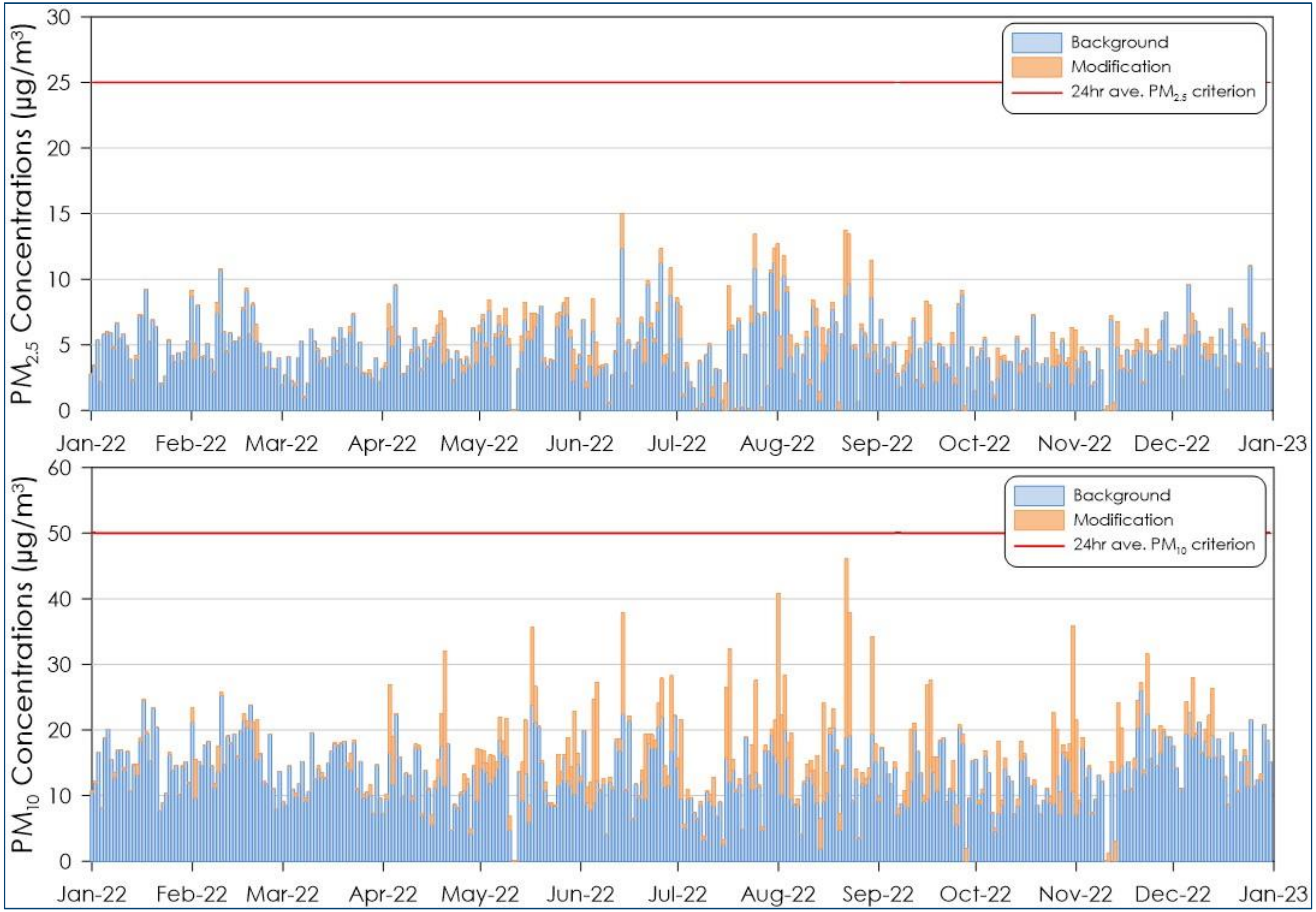

Figure 6-2: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for Receptor M

6.2 Assessment of impacts per VLAMP criteria

6.2.1 Summary of modelling predictions

The results in **Table 6-1** indicate the highest maximum predicted level at the assessed privately-owned receptors would be below the applicable VLAMP mitigation and acquisition criteria outlined in **Table 3-3** and **Table 3-4** respectively.

6.2.2 Dust impacts on privately-owned land

As required by the VLAMP, the potential impacts due to the Modification, extending over more than 25% of any privately-owned land, have been evaluated using the predicted pollutant dispersion contours.

The maximum 24-hour average PM_{10} level ($50 \mu g/m^3$) were found to have the greatest extent of any of the other dust metrics relevant to the application of acquisition upon request rights on vacant land in accordance with the VLAMP. **Figure 6-3** presents the extent of the maximum 24-hour average PM_{10} level due to the Modification.

The isopleth in **Figure 6-3**, indicates that the predicted maximum 24-hour average PM_{10} level would not extend over more than 25% of any privately-owned land parcels as a result of the Modification, and as such the Modification would not exceed this criterion.

It is noted that there is a privately-owned land parcel within the Modification boundary (Lot 30 DP 1113350). Despite lacking a building permit, it is not predicted to be impacted on more than 25% of the land parcel.

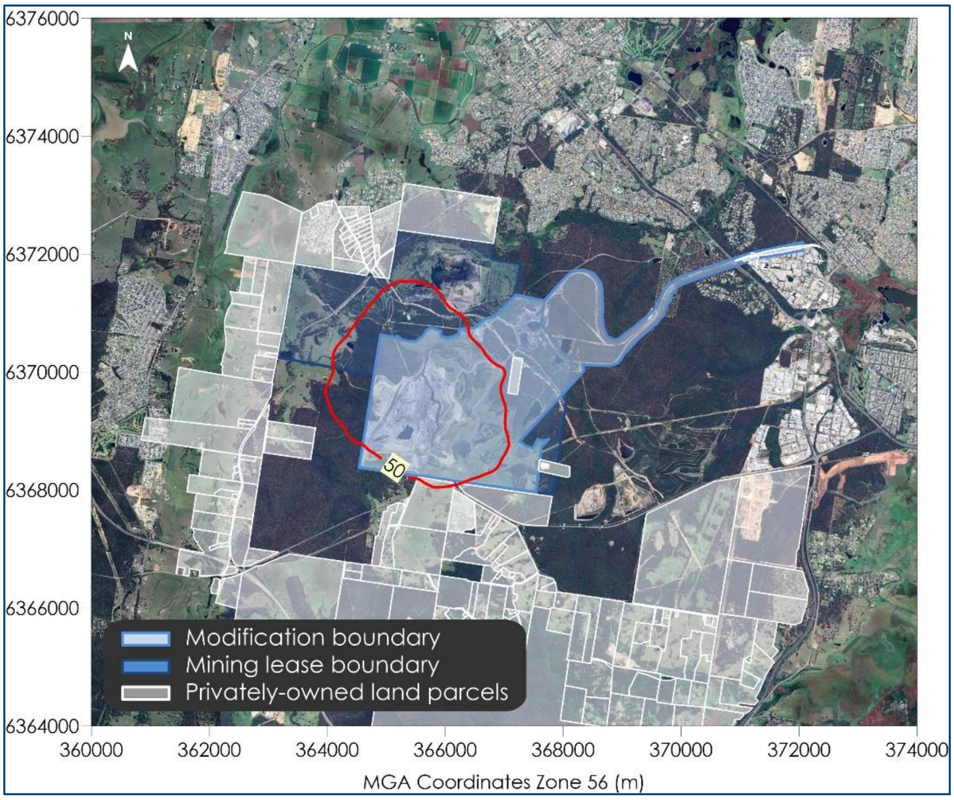

Figure 6-3: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Modification ($\mu g/m^3$)

7 ASSESSMENT OF GREENHOUSE GAS EMISSIONS

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

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

> "...*produced from sources within the boundary of an organisation and as a result of that organisation's activities*" (**DCCEEW, 2023a**).

Scope 2 emissions are produced by the burning of fossil fuels to generate electricity and defined as:

> "...*indirect emissions which occur as a result of activities that generate electricity, heating, cooling or stream that is consumed by an organisation but which is generated outside that organisation's boundaries*" (**DCCEEW, 2023a**).

Scope 3 emissions are other indirect emissions which:

> "...*occur outside of the boundary of an organisation as a result of actions by the organisation*" (**DCCEEW, 2023a**).

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

Scope 3 emissions can be a significant component of the total emissions inventory; however, these emissions are often not directly controlled by the operation. These emissions are understood to be considered in the Scope 1 emissions from other various organisations related to the Bloomfield Colliery. Other Scope 3 emissions also arise from a number of other sources indirectly associated with the operation of the Bloomfield Colliery such as emissions generated by employees travelling to and from the site. These relatively minor individual contributions are difficult to accurately quantify due to the diversity and nature of the sources and have not been considered further in this assessment.

7.1 Emission sources

Scope 1 and 2 GHG emission sources identified from the Bloomfield Colliery are the on-site combustion of diesel fuel, gasoline, petroleum-based oils and greases, sulphur hexafluoride (SF_6) gases from gas insulated switchgear and circuit breaker, emissions associated with land clearing, fugitive emissions from the exposed coal seams, and on-site consumption of electricity. Scope 3 emissions have been identified as resulting from the purchase of consumables for use on-site and the transport of and final use of the product coal.

Estimated quantities of materials and variables used to calculate the potential GHG emissions associated with Scope 1, 2 and 3 emissions for the Bloomfield Colliery, both with and without the Modification, have been described for the operational and decommissioning phases. Per the requirements of the *Interim climate change assessment requirements for large emitters* (**NSW EPA, 2024**), calculations are prepared for a "modified-business" scenario (i.e. the Modification), a "business-as-usual" scenario and a "modification only" scenario.

These estimates are based on a conservative upper limit of the assumed maximum production throughout the remaining life of the Bloomfield Colliery and would provide a reasonable worst-case approximation of the potential GHG emissions for the purpose of this assessment.

7.1.1 Modified-business scenario

Table 7-1 summarises the quantities of materials estimated for the operational phase under the modified-business scenario.

Table 7-1: Summary of quantities of materials estimated for the operational phase of the modified-business scenario

Period	Product coal (Mt)	Diesel (ML)	Diesel - Transport (ML)	Gasoline – Transport (ML)	Grease (ML)	Oil (ML)	SF6 (kt)	Land clearing (ha)	Electricity (GWh)
FY2025	0.4	5.8	1.0E-01	3.8E-02	3.0E-02	4.7E-02	0.3	-	6.9
FY2026	0.4	8.2	1.4E-01	5.4E-02	4.2E-02	6.7E-02	0.3	3.9	6.4
FY2027	0.5	7.7	1.4E-01	5.1E-02	4.0E-02	6.3E-02	0.3	0.7	9.0
FY2028	0.5	5.8	1.0E-01	3.8E-02	3.0E-02	4.7E-02	0.3	-	7.7
FY2029	0.5	7.1	1.2E-01	4.7E-02	3.7E-02	5.8E-02	0.3	28.1	7.8
FY2030	0.6	5.8	1.0E-01	3.9E-02	3.0E-02	4.7E-02	0.3	-	8.8
FY2031	0.3	7.3	1.3E-01	4.8E-02	3.7E-02	5.9E-02	0.3	2.5	4.0
FY2032	0.3	7.8	1.4E-01	5.2E-02	4.0E-02	6.4E-02	0.3	10.4	6.0
FY2033	0.5	6.5	1.1E-01	4.3E-02	3.3E-02	5.2E-02	0.3	9.1	6.9
FY2034	0.5	4.6	8.0E-02	3.0E-02	2.3E-02	3.7E-02	0.3	3.4	6.7
FY2035	0.1	1.3	2.2E-02	8.5E-03	6.6E-03	1.0E-02	0.3	-	1.9

Note: Mt = million tonnes, ML = megalitres, kL = kilolitres, t = tonne, ha = hectares, kt = kilotonnes and GWh = gigawatt hour

The decommissioning phase involves bulk earthworks to prepare the site for closure and is projected to occur over a four-year period. **Table 7-2** summarises the quantities of materials estimated for the decommissioning phase. Values are assumed to be 10% of the maximum required annual quantity for the operational phase of the modified-business scenario.

Table 7-2: Summary of quantities of materials estimated for the decommissioning phase of the modified-business scenario

Period	Diesel (ML)	Diesel - Transport (ML)	Gasoline – Transport (ML)	Grease (ML)	Oil (ML)
FY2036	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03
FY2037	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03
FY2038	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03
FY2039	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03

7.1.2 Business-as-usual scenario

Estimates for a business-as-usual scenario based on the current approved operations under PA 07_0087 have been calculated. Emission sources identified for the modified-business scenario are the same for the business-as-usual scenario and have been described for the operational and decommissioning phases in **Table 7-3** and **Table 7-4**, respectively. The quantities of materials estimated for the decommissioning phase are assumed to be the same as the modified-business scenario.

Table 7-3: Summary of quantities of materials estimated for the operational phase of the business-as-usual scenario

Period	Product coal (Mt)	Diesel (ML)	Diesel - Transport (ML)	Gasoline – Transport (ML)	Grease (ML)	Oil (ML)	SF6 (kt)	Land clearing (ha)	Electricity (GWh)
FY2025	0.4	5.8	1.0E-01	3.8E-02	3.0E-02	4.7E-02	0.3	-	6.9
FY2026	0.3	1.9	3.3E-02	1.2E-02	9.6E-03	1.5E-02	0.3	-	3.4

Table 7-4: Summary of quantities of materials estimated for the decommissioning phase of the business-as-usual scenario

Period	Diesel (ML)	Diesel - Transport (ML)	Gasoline – Transport (ML)	Grease (ML)	Oil (ML)
FY2027	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03
FY2028	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03
FY2029	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03
FY2030	0.8	1.4E-02	5.4E-03	4.2E-03	6.7E-03

7.1.3 Modification only scenario

The Modification only scenario is the difference between the modified-business and the business-as-usual scenario presented in **Sections 7.1.1** and **7.1.2**, respectively.

7.1.4 Scope 3 sources

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

Product coal is transported to the Port of Newcastle by rail and then transferred to coal loaders before being shipped to its final destination. The approximate rail distance is taken to be 50km (return distance). The approximate shipping distance of 13,000km (return distance) is based predominately on destinations in the Asian market.

The emissions generated from the end use of coal produced by the Modification have been assumed to be used in power generation and would be equivalent to those generated in NSW. The type of thermal coal consumed is classified as bituminous.

7.2 Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the Modification, emission factors were obtained from:

- the NGA Factors (**DEECCW, 2023a**);
- emission factors for Scope 3 transport based on factors presented in the *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*; and,
- emission factors for land clearing (**TAGHGG, 2013**).

The emission factors used in this assessment are summarised in **Table 7-5**.

Table 7-5: Summary of emission factors

Type	Energy content factor (GJ/kL)	Emission factor			Units	Scope
		CO_2	CH_4	N_2O		
Diesel	38.6	69.9	0.1	0.1	kg CO_2-e/GJ	1
		17.3	-	-		3
Diesel - Transport	38.6	69.9	0.1	0.4	kg CO_2-e/GJ	1
		17.3	-	-		3
Gasoline - Transport	34.2	67.4	0.6	1.6	kg CO_2-e/GJ	1
		17.2	-	-		3
Petroleum based greases	38.8	3.5	-	-	kg CO_2-e/GJ	1
		18	-	-		3
Petroleum based oils	38.8	13.9	-	-	kg CO_2-e/GJ	1
		18	-	-		3
Land clearing – woodland/forest	-	521	-	-	t CO_2-e/ha	1
Rail transport	-	16.3	-	-	t CO_2-e/Mt-km	3
Ship transport	-	5.39	-	-	t CO_2-e/Mt-km	3
Thermal coal*	27.0	90	0.04	0.2	kg CO_2-e/GJ	3

*Assumes type of coal is bituminous coal

Note: GJ = gigajoule, GJ/kL = gigajoule per kilolitre, kg CO_2-e = kilograms of carbon dioxide equivalent, t CO_2-e = tonnes of carbon dioxide equivalent, t = tonnes, Mt-km = million tonne-kilometres, CO_2 = Carbon Dioxide, CH_4 = Methane and N_2O = Nitrous Oxide

Site specific fugitive emissions factors determined using Method 2 of the *National Greenhouse and Energy Reporting Act 2007* (NGER Act) have been used to estimate fugitive emissions over the life of the Modification under both the Modified and base case scenarios. The emission factors vary with depth and location across the activity mining area. The estimated fugitive emissions have been provided for the assessment and presented in the following section.

Leakage rate of SF6 is approximately 0.045% with a global warming potential of 23,500 as based on current NGERs reports for the Bloomfield Colliery.

Emission factors for electricity usage were obtained from *Australia's emissions projections 2023* (**DCCEEW, 2023b**). These emission factors are based on projections for the decarbonising of the NSW electricity grid overtime. The Scope 2 and 3 emissions factors for electricity usage are presented in **Table 7-6**. From 2031 to 2035, the projections assume no Scope 3 emissions related to electricity production. This suggests that methods associated with fuel extraction, production and transport generate negligible emissions aligning with Australia's net zero target.

Table 7-6: Summary of emission factors for electricity usage (t of CO_2-e per MWh)

Period	Scope 2	Scope 2 and 3	Scope 3 *
2023	0.68	0.73	0.05
2024	0.59	0.63	0.04
2025	0.52	0.56	0.04
2026	0.39	0.42	0.03
2027	0.29	0.32	0.03
2028	0.28	0.3	0.02
2029	0.27	0.3	0.03
2030	0.19	0.2	0.01
2031	0.11	0.11	0
2032	0.06	0.06	0
2033	0.02	0.02	0
2034	0.03	0.03	0
2035	0.03	0.03	0

Source: **DCCEEW (2023b)**

* Calculated by subtracting the Scope 2 column from the Scope 2 and 3 column.

Note: The emission factors for electricity usage are based off calendar years but have been used to calculate emissions from electricity usage on a financial year basis.

7.3 Summary of greenhouse gas emissions

Table 7-7 and **Table 7-8** summarises the estimated annual CO_2-e emissions for the life of the modified-business and the business-as-usual scenarios, respectively. The estimated annual CO_2-e emissions for the modification only scenario is the difference between the modified-business and the business-as-usual scenarios and summarised in **Table 7-9**.

The estimated annual CO_2-e emissions for the life of the modified-business and the business-as-usual scenarios are also presented graphically in **Figure 7-1** and **Figure 7-2**. These figures illustrate that the majority of emissions generated by Bloomfield Colliery under either scenario would be from diesel fuel consumption and (to a lesser extent) fugitive emissions.

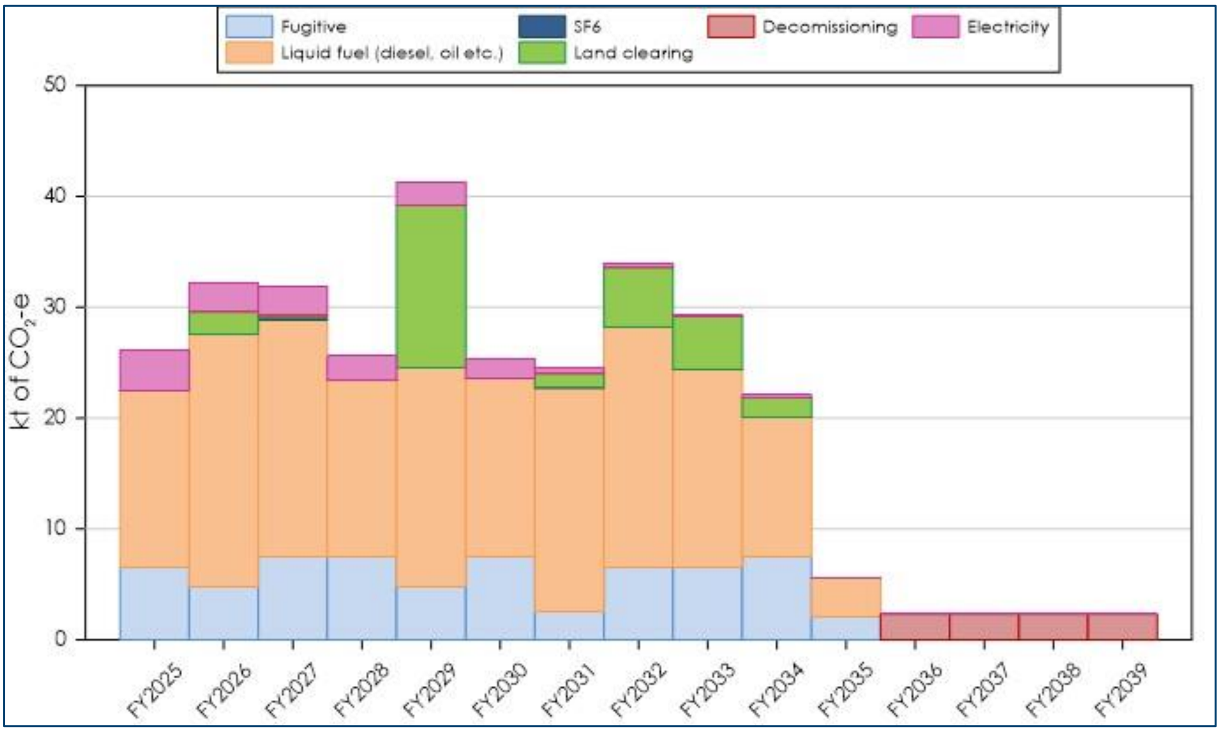

Figure 7-1: Summary of CO_2-e emissions for the modified-business scenario

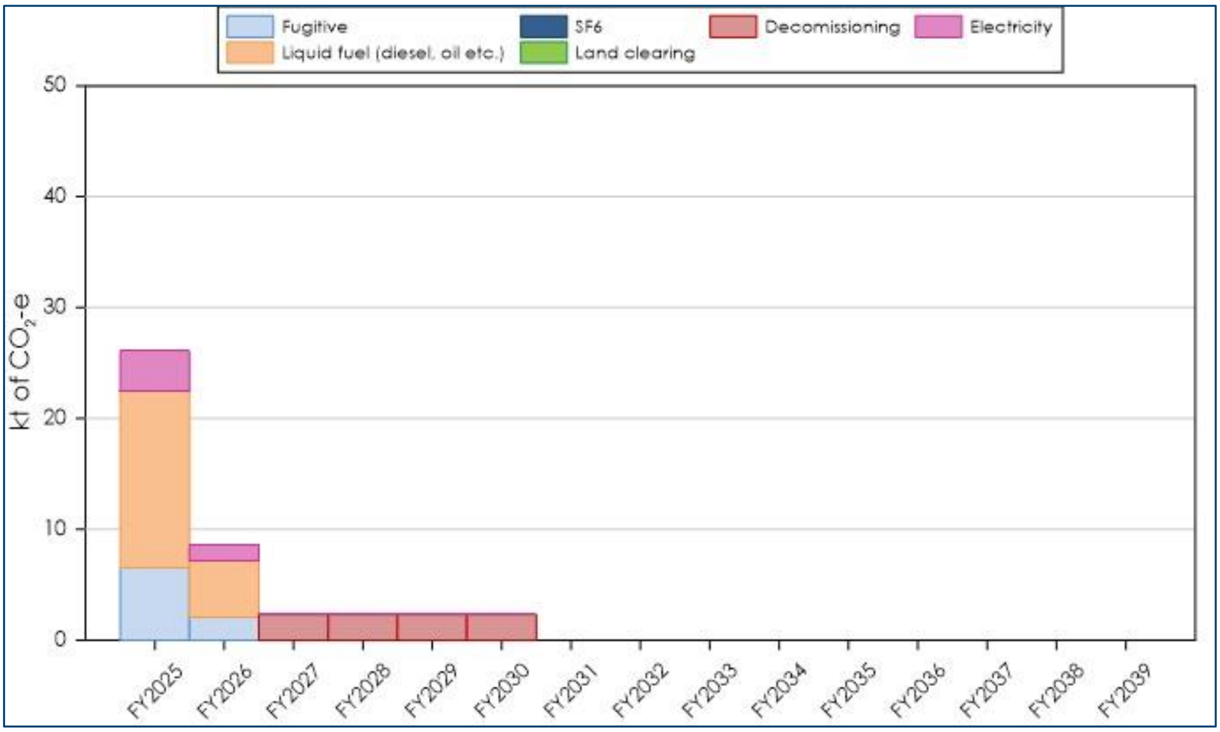

Figure 7-2: Summary of CO_2-e emissions for the business-as-usual scenario

Table 7-7: Summary of CO_2-e emissions for the modified-business scenario (kt CO_2-e)

Period	Scope 1									Scope 2	Scope 3			
	Fugitive	Diesel	Gasoline	Diesel - Transport	Oil	Grease	Explosives	Land clearing	Decom.	Electricity	Consumables	Rail	Ship	Final Use
FY2025	6.5	15.6	0.3	9.1E-02	4.0E-03	2.5E-02	3.0E-03	-	-	3.6	4.3	0.3	28	975
FY2026	4.8	22.2	0.4	1.3E-01	5.7E-03	3.6E-02	3.0E-03	2.0	-	2.5	5.9	0.3	29	997
FY2027	7.4	21.0	0.4	1.2E-01	5.4E-03	3.4E-02	3.0E-03	0.3	-	2.6	5.6	0.4	38	1,332
FY2028	7.4	15.6	0.3	9.1E-02	4.0E-03	2.5E-02	3.0E-03	-	-	2.2	4.1	0.4	35	1,210
FY2029	4.8	19.3	0.3	1.1E-01	5.0E-03	3.1E-02	3.0E-03	14.6	-	2.1	5.2	0.4	33	1,159
FY2030	7.4	15.8	0.3	9.2E-02	4.1E-03	2.6E-02	3.0E-03	-	-	1.7	4.1	0.5	41	1,416
FY2031	2.5	19.7	0.3	1.1E-01	5.1E-03	3.2E-02	3.0E-03	1.3	-	0.4	5.0	0.2	18	609
FY2032	6.5	21.2	0.4	1.2E-01	5.4E-03	3.4E-02	3.0E-03	5.4	-	0.4	5.4	0.3	24	850
FY2033	6.5	17.5	0.3	1.0E-01	4.5E-03	2.8E-02	3.0E-03	4.7	-	0.1	4.5	0.4	33	1,133
FY2034	7.4	12.4	0.2	7.2E-02	3.2E-03	2.0E-02	3.0E-03	1.8	-	0.2	3.2	0.4	33	1,135
FY2035	2.0	3.5	0.1	2.0E-02	8.9E-04	5.6E-03	3.0E-03	-	-	0.1	0.9	0.1	10	333
FY2036	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2037	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2038	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2039	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-

Note: Decom. = decommissioning

Table 7-8: Summary of CO_2-e emissions for the business-as-usual scenario (kt CO_2-e)

Period	Scope 1									Scope 2	Scope 3			
	Fugitive	Diesel	Gasoline	Diesel - Transport	Oil	Grease	Explosives	Land clearing	Decom.	Electricity	Consumables	Rail	Ship	Final Use
FY2025	6.5	15.6	0.3	9.1E-02	4.0E-03	2.5E-02	3.0E-03	-	-	3.6	4.3	0.3	28.1	975.4
FY2026	2.0	5.1	0.1	3.0E-02	1.3E-03	8.2E-03	3.0E-03	-	-	1.3	1.4	0.2	18.5	643.2
FY2027	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2028	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2029	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2030	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-

Note: Decom. = decommissioning

Table 7-9: Summary of CO_2-e emissions for the modification only scenario (kt CO_2-e)

Period	Scope 1									Scope 2	Scope 3			
	Fugitive	Diesel	Gasoline	Diesel - Transport	Oil	Grease	Explosives	Land clearing	Decom.	Electricity	Consumables	Rail	Ship	Final Use
FY2025	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FY2026	2.8	17.1	0.3	1.0E-01	4.4E-03	2.8E-02	0.0E+00	2.0	-	1.2	4.5	0.1	10.2	353.3
FY2027	7.4	21.0	0.4	1.2E-01	5.4E-03	3.4E-02	3.0E-03	0.3	-2.3	2.6	5.1	0.4	38.3	1,332.4
FY2028	7.4	15.6	0.3	9.1E-02	4.0E-03	2.5E-02	3.0E-03	-	-2.3	2.2	3.6	0.4	34.8	1,209.5
FY2029	4.8	19.3	0.3	1.1E-01	5.0E-03	3.1E-02	3.0E-03	14.6	-2.3	2.1	4.6	0.4	33.3	1,159.2
FY2030	7.4	15.8	0.3	9.2E-02	4.1E-03	2.6E-02	3.0E-03	-	-2.3	1.7	3.6	0.5	40.7	1,415.7
FY2031	2.5	19.7	0.3	1.1E-01	5.1E-03	3.2E-02	3.0E-03	1.3	-	0.4	5.0	0.2	17.5	609.3
FY2032	6.5	21.2	0.4	1.2E-01	5.4E-03	3.4E-02	3.0E-03	5.4	-	0.4	5.4	0.3	24.5	850.5
FY2033	6.5	17.5	0.3	1.0E-01	4.5E-03	2.8E-02	3.0E-03	4.7	-	0.1	4.5	0.4	32.6	1,133.4
FY2034	7.4	12.4	0.2	7.2E-02	3.2E-03	2.0E-02	3.0E-03	1.8	-	0.2	3.2	0.4	32.6	1,135.1
FY2035	2.0	3.5	0.1	2.0E-02	8.9E-04	5.6E-03	3.0E-03	-	-	0.1	0.9	0.1	9.6	333.0
FY2036	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2037	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2038	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-
FY2039	-	-	-	-	-	-	-	-	2.3	-	0.6	-	-	-

Note: Decom. = decommissioning

Table 7-10 and **Table 7-11** present a summary of the estimated CO_2-e emissions per tonne of ROM coal for the modified-business scenario and the business-as-usual scenario, respectively. These estimates exclude the contribution from the decommissioning phase.

The results indicate that on average over the 11-year window, the modified-business scenario would generate approximately 0.042 t CO_2-e/ t ROM for Scope 1 and 0.002 t CO_2-e/ t ROM for Scope 2. The business-as-usual scenario would generate approximately 0.029 t CO_2-e/ t ROM for Scope 1 and 0.005 t CO_2-e/ t ROM for Scope 2 over a two-year period. For the modification only scenario, the estimated average CO_2-e emissions per unit of production are calculated as 0.039 t CO_2-e/ t ROM for Scope 1 and 0.002 t CO_2-e/ t ROM for Scope 2 for an 11-year period.

The increase in estimated Scope 1 emissions per tonne of ROM coal factor for the modified-business scenario compared to the business-as-usual scenario is due to the increase in fugitive emissions and liquid fuels consumed in the later years of mining. Conversely the estimated Scope 2 emissions per tonne of ROM coal factor for the modified-business scenario reduces compared to the business-as-usual scenario with the progressive decarbonisation of the NSW electricity grid.

Table 7-10: Summary of CO_2-e emissions per unit of production for the modified-business scenario (excluding decommissioning phase)

Per unit of production	ROM coal (t)	Scope 1 (t CO_2-e)	Scope 2 (t CO_2-e)	Scope 1 (t CO_2-e/ t ROM)	Scope 2 (t CO_2-e/ t ROM)
FY2025	647,400	22,504	3,579	0.035	0.0055
FY2026	600,404	29,637	2,489	0.049	0.0041
FY2027	850,714	29,263	2,623	0.034	0.0031
FY2028	724,247	23,427	2,156	0.032	0.0030
FY2029	734,104	39,223	2,107	0.053	0.0029
FY2030	828,382	23,624	1,673	0.029	0.0020
FY2031	376,170	24,028	440	0.064	0.0012
FY2032	564,090	33,616	360	0.060	0.0006
FY2033	648,593	29,167	138	0.045	0.0002
FY2034	634,673	21,872	202	0.034	0.0003
FY2035	180,798	5,571	58	0.031	0.0003
Average				**0.042**	**0.002**

Table 7-11: Summary of CO_2-e emissions per unit of production for the business-as-usual scenario (excluding decommissioning phase)

Per unit of production	ROM coal (t)	Scope 1 (t CO_2-e)	Scope 2 (t CO_2-e)	Scope 1 (t CO_2-e/ t ROM)	Scope 2 (t CO_2-e/ t ROM)
FY2025	647,400	22,504	3,579	0.035	0.0055
FY2026	316,778	7,223	1,313	0.023	0.0041
Average				**0.029**	**0.005**

7.4 Comparison with base case scenario

The Modification seeks an extension of mining operations to 31 December 2035 and a reduction to the approved ROM coal extraction rate from 1.3 Mtpa to 0.9 Mtpa. In comparison to the business-as-usual scenario, there is an increase in GHG emissions as expected. **Figure 7-1** and **Figure 7-2** show the estimated annual emissions for the modified-business scenario and the business-as-usual scenario over time.

The change in emissions is quantified as the modification only scenario (i.e. the difference between the modified-business scenario and the business-as-usual scenario). **Table 7-12** summarises the emissions associated with the modified-business scenario, business-as-usual scenario and the modification only scenario based on Scopes 1, 2 and 3.

Table 7-12: Summary of CO_2-e emissions per scope for all scenarios (Mt CO_2-e)

Period	Scenario	Scope 1	Scope 2	Scope 3
Average Annual*	Modified-business	0.024	0.0016	0.98
	Business-as-usual	0.007	0.0012	0.37
	Modification only	0.017	0.0004	0.62
Total	Modified-business	0.31	0.02	12.78
	Business-as-usual	0.06	0.01	2.93
	Modification only	0.25	0.011	9.85

*Excludes decommissioning phase

7.5 Contribution of greenhouse gas emissions

The estimated annual GHG emissions for Australia up to September 2023 was 459.7 million tonnes of carbon dioxide equivalent (Mt CO_2-e) (**DCCEEW, 2024a**). In comparison, the estimated annual average GHG emission for the modification only scenario is 0.017 Mt CO_2-e (Scope 1 and 2) and the modified-business scenario is 0.026 Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of GHG emissions from the modification only scenario in comparison to the Australian GHG emissions for the 2023 period is estimated to be approximately 0.004% and for the modified-business scenario is approximately 0.006%.

At a state level, the estimated GHG emissions for NSW in the 2022 period were 111.0 Mt CO_2-e (**DCCEEW, 2024b**). The annual contribution of GHG emissions from the modification only scenario (Scopes 1 and 2) in comparison to the NSW GHG emissions for the 2022 period is estimated to be approximately 0.015%. The annual contribution of GHG emissions for the modified-business scenario is approximately 0.023% of the NSW GHG emissions for the 2022 period.

The Scope 3 emissions include the use of coal by other parties. It is reasonable to expect that there may be future policy changes in the countries which receive Australian coal due to the Paris agreement or other influencing factors. As such, it is also reasonable to expect that the Bloomfield Colliery would monitor such changes and adjust accordingly to any new policy, guidelines, carbon pricing, coal demand and trade contracts.

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

7.6 Comparison with projected future GHG emissions for NSW

The projected future GHG emissions for NSW to 2050 can be obtained from the Net Zero Emissions Dashboard (**NSW Government, 2024**). Projections are provided for three scenarios: Business as Usual (BAU), as originally designed, and as currently tracking. The BAU scenario factors in historical state policies but excludes the impact of actions outlined in the Net Zero Plan and other current government policies and programs. The 'as originally designed' scenario adjusts the emissions trajectory based on the designed abatement and timelines in the existing NSW and Commonwealth policies and programs.

The ‘as currently tracking’ scenario further adjusts the ‘as originally designed’ scenario to reflect increased uncertainties in the expected emissions reductions under certain programs and policies.

Figure 7-3 presents a comparison of the annual Scope 1 emissions for the modified-business scenario with the projected future GHG emissions for NSW to 2050.

In comparison to the projected future GHG emissions for NSW, the Scope 1 emissions associated with the modified-business scenario would comprise approximately 0.005% in FY2036-38 (during decommissioning) to 0.049% in FY2034 of the NSW emissions per the Program/policy abatement as originally designed.

Figure 7-4 and **Figure 7-5** present comparisons of the annual fugitive emissions and stationary emissions for the modified-business scenario with the projected future GHG emissions for NSW to 2050.

The fugitive emissions associated with the modified-business scenario would comprise approximately 0.02% in FY2031 to 0.10% in FY2034 of the NSW emissions per the Program/policy abatement as originally designed. For Stationary Energy Emissions, the modified-business scenario would comprise approximately 0.03% in FY2036-38 (during decommissioning) to 0.22% in FY2030 of the NSW emissions per the Program/policy abatement as originally designed.

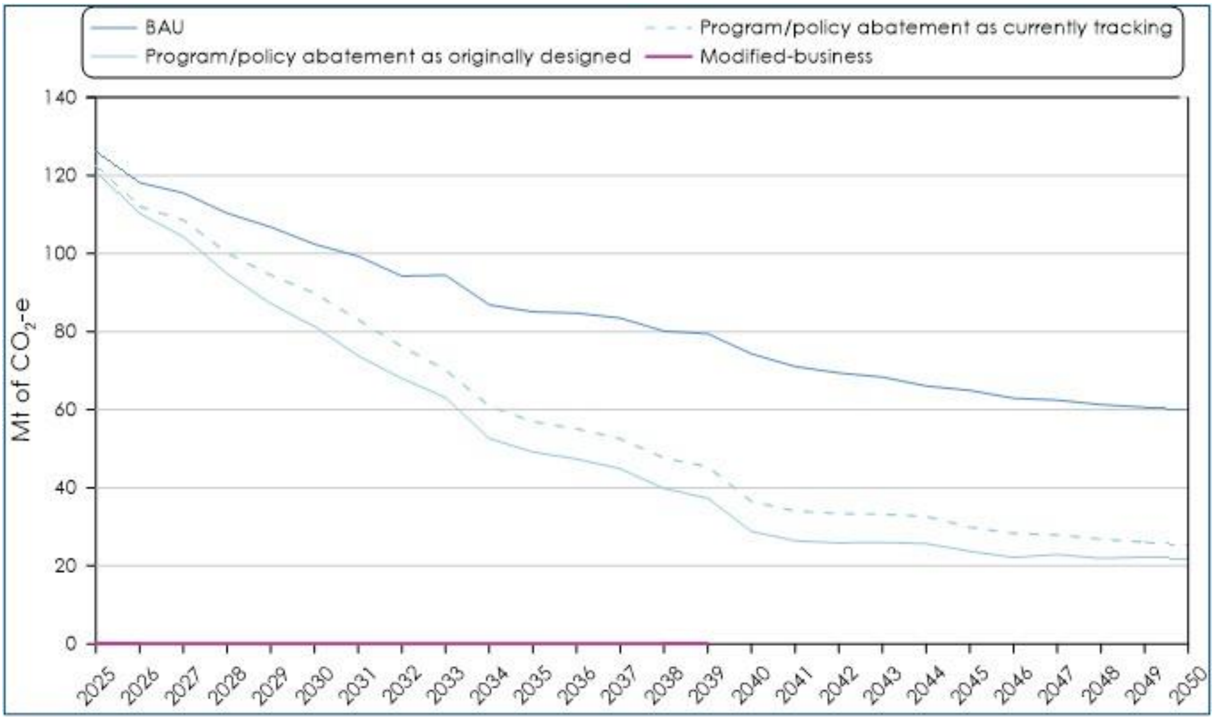

Figure 7-3: Comparison of Scope 1 emissions for the modified-business scenario with projected future GHG emissions for NSW

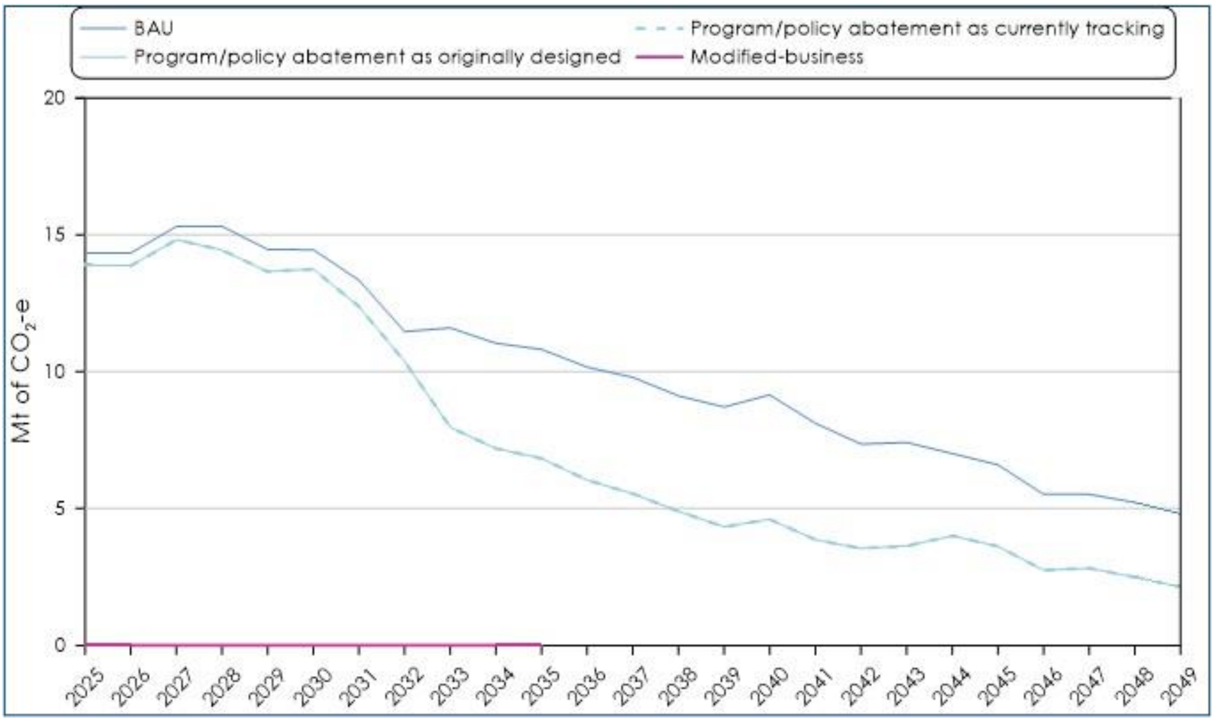

Figure 7-4: Comparison of Fugitive emissions for the modified-business scenario with projected future GHG emissions for NSW

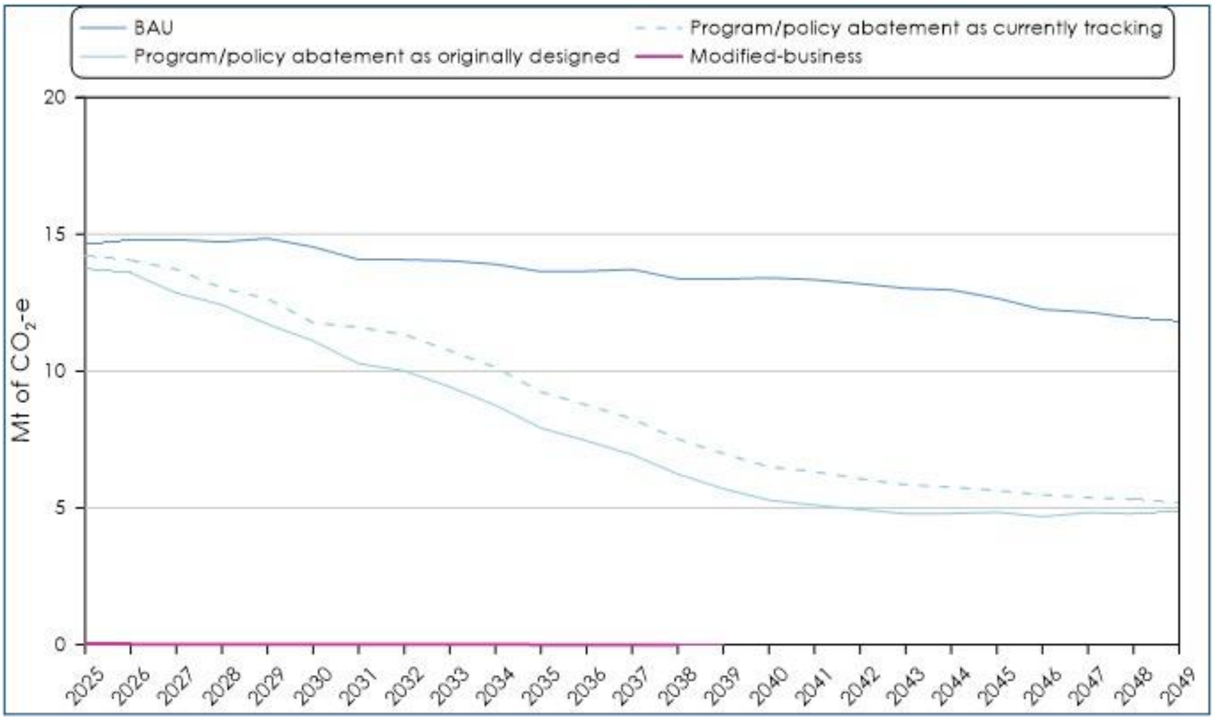

Figure 7-5: Comparison of Stationary Energy emissions for the modified-business scenario with projected future GHG emissions for NSW

7.7 Greenhouse gas abatement measures

Bloomfield Colliery have considered a range of best-practice greenhouse gas abatement measures to apply to the Modification which include:

- Bloomfield will service and maintain all machinery, as far as reasonably practical, in accordance with original equipment manufacturer recommendations for maintenance.
- Bloomfield will target equipment maintenance to ensure, as far as reasonably practical, equipment remains fit for purpose over its whole life cycle.
- Bloomfield will undertake appropriate mine planning to minimise fuel usage by mobile plant and equipment.
- Bloomfield will modify operations, where reasonable and feasible, to minimise greenhouse gas emissions.
- Bloomfield will undertake periodic reviews of technologies and abatement measures to reduce GHG emissions from the Project, including whether these measures are reasonable and feasible to implement at Bloomfield. These reviews will be undertaken every 5 years and will include consideration of alternative fuels including biodiesel.
- The current Air Quality Monitoring Program will be updated to include greenhouse gas considerations for investigating and implementing all reasonable and feasible abatement measures to minimise GHG emissions.
- Bloomfield will continue to monitor, report and audit greenhouse gas emissions in accordance with the requirements of the Clean Energy Regulator, (NGERS), including requirements of the safeguard mechanism.

8 SUMMARY AND CONCLUSIONS

This study has examined the air quality impacts that may arise from the Modification at Bloomfield Colliery. The Modification incorporates the continuation of mining operations towards the north with a reduced ROM extraction rate of 0.9Mtpa. This assessment presents a potential worst-case scenario incorporating all these activities occurring at the same time to investigate the potential air quality impacts in the surrounding environment.

The air dispersion modelling methodology uses local weather and dust monitoring data, incorporates conservative emission estimation and existing background air quality levels.

The results indicate that the Modification would be below the relevant criterion for the assessed dust metrics with the application of best practice mitigation measures.

As the Modification seeks an extension of the permitted mining operations to 2035 there is a corresponding increase in GHG emissions generated relative the business-as-usual scenario.

The estimated annual average GHG emission for the modification only scenario is 0.017 Mt CO_2-e (Scope 1 and 2), which is calculated to be approximately 0.004% of the Australian GHG emissions for the period to September 2023 and approximately 0.015% of the NSW GHG emissions for the 2022 period.

In comparison to the projected future GHG emissions for NSW, the Scope 1 emissions associated with the modified-business scenario would comprise approximately 0.005% to 0.049% of the NSW emissions per the Program/policy abatement as originally designed. The fugitive emissions for the modified-business scenario are projected to range from 0.02% to 0.10% and for Stationary Energy emissions it will account for between 0.03% and 0.22% of the projected future GHG emissions for NSW per the Program/policy abatement as originally designed.

Bloomfield Colliery will apply a range of best-practice greenhouse gas abatement measures to minimise the generation of greenhouse gas during the life of the Modification.

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Appendix A
Sensitive Receptor Locations

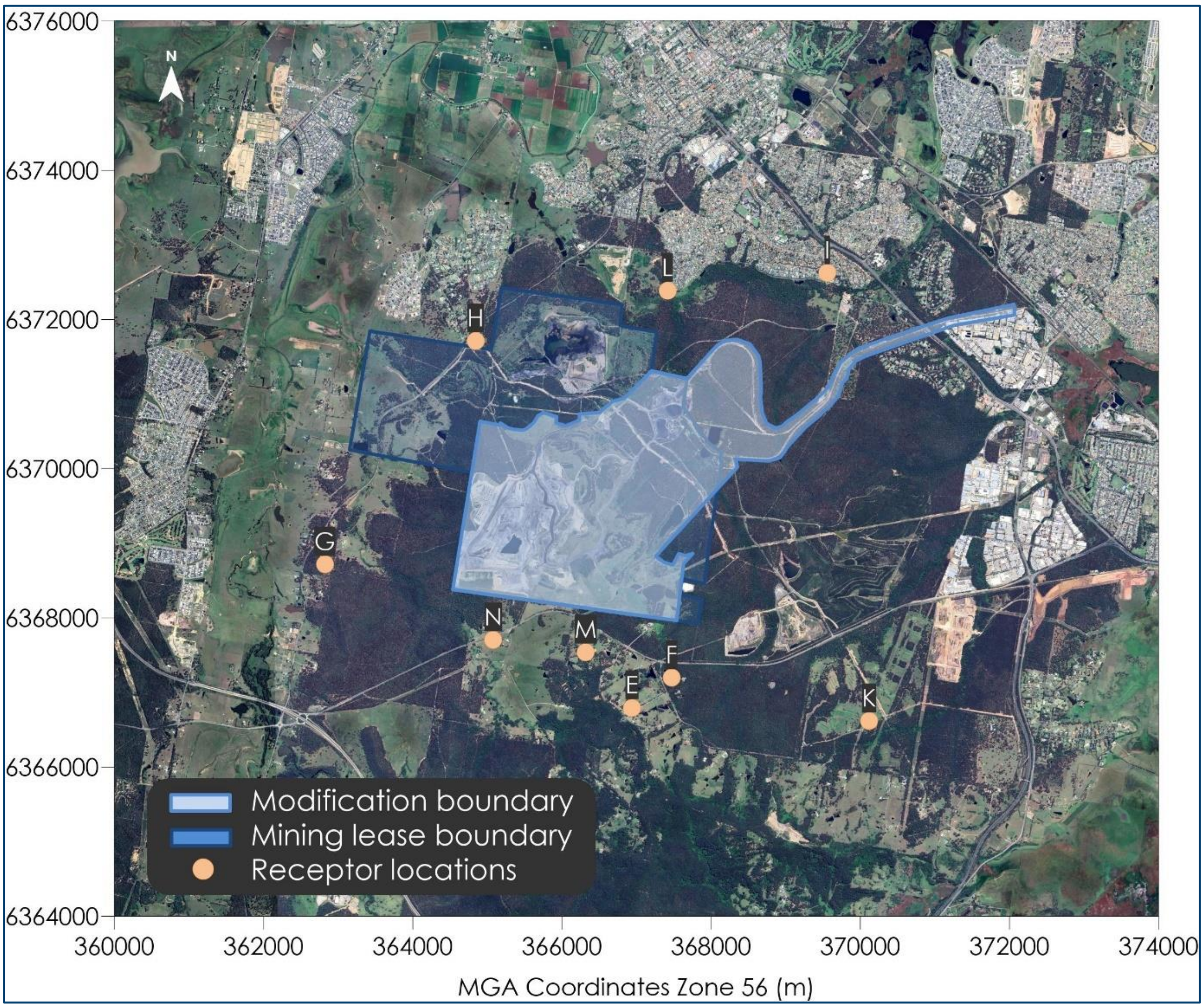

Figure A-1: Location of receptors assessed in this study

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

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

Appendix B

Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of five contiguous years of meteorological data from the Newcastle Nobbys Signal Station AWS is presented in **Table B-1**.

The standard deviation of the five years of meteorological data spanning 2018 to 2022 was analysed against the measured wind speed, temperature and relative humidity. The analysis indicates that the 2018 and 2022 datasets are closest to the mean for wind speed, the 2021 and 2022 datasets for temperature and the 2020 dataset is closest for relative humidity.

A score weighting analysis was performed to consider the deviation from the average for each of the meteorological data with an equal score value for the different parameters applied. On the basis of the score weighting analysis, 2022 was found to be most representative.

Table B-1: Statistical analysis results for Newcastle Nobbys Signal Station AWS

Year	Wind speed	Temperature	Relative humidity	Score
2018	1.1	0.7	4.0	5.8
2019	1.3	0.9	3.4	5.6
2020	1.3	0.6	2.8	4.7
2021	1.2	0.4	3.5	5.1
2022	1.1	0.4	3.2	4.7

Figure B-1 shows the frequency distributions for wind speed, temperature, wind direction and relative humidity. The graphs indicate that the 2022 period trends are close the mean values for each of the meteorological parameters assessed.

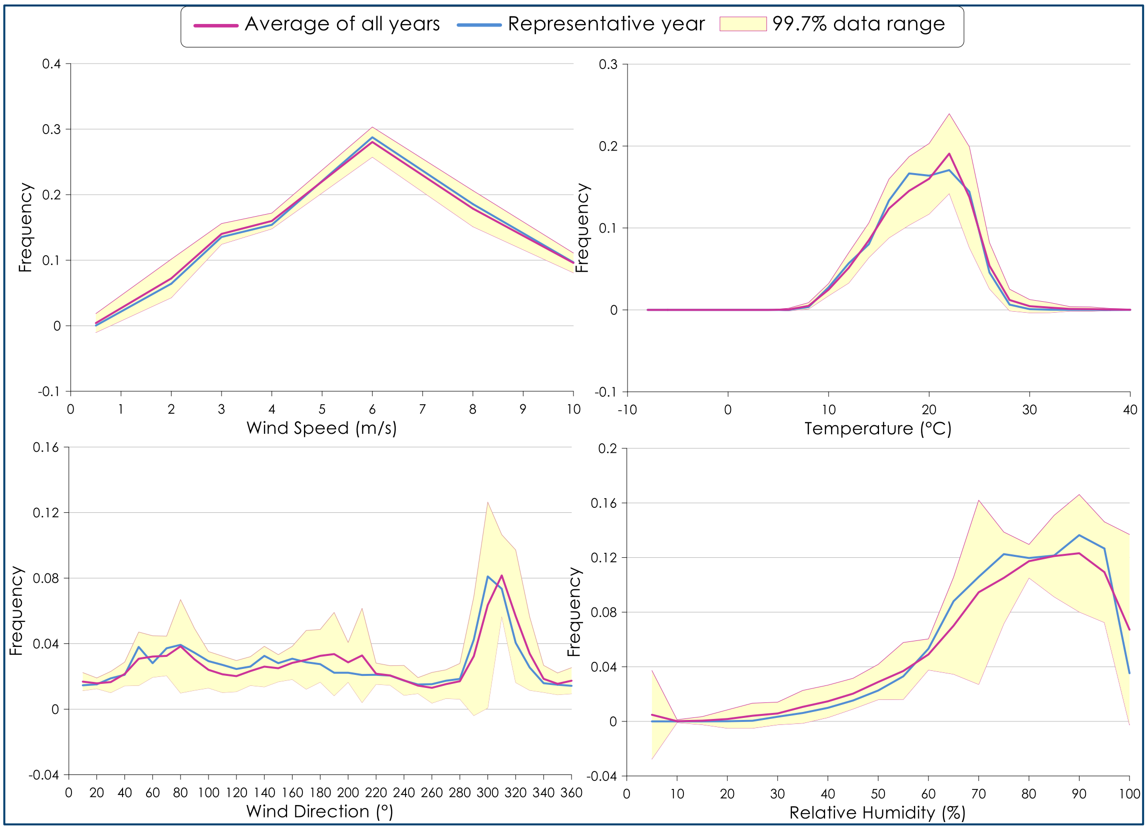

Figure B-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix C

Emission Calculations

<u>Emission Calculation</u>

The mining schedule and mine plan designs provided by the Proponent have been combined with emissions factor equations that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions, and composition of the material being handled.

Emission factors and associated controls have been sourced from the US EPA AP42 Emission Factors (**US EPA, 1985 and Updates**), the National Pollutant Inventory document *Emission Estimation Technique Manual for Mining, Version 3.1* (**NPI, 2012**) and the NSW EPA document, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, prepared by Katestone Environmental (**Katestone Environmental, 2011**).

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

Control factors include the following:

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

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

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

Table C-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Drilling (overburden)	$EF = 0.59\ kg/hole$	$0.52 \times TSP$	$0.03 \times TSP$
Blasting (overburden)	$EF = 0.00022 \times A^{1.5}\ kg/blast$	$0.52 \times TSP$	$0.03 \times TSP$
Loading / emplacing overburden & loading product coal to stockpile & conveyor transfer	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$
Dozers on overburden	$EF = 2.6 \times \frac{s^{1.2}}{M^{1.3}}\ kg/hour$	$EF = 0.45 \times \frac{s^{1.5}}{M^{1.4}} \times 0.75\ kg/hour$	$EF = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \times 0.105\ kg/hour$
Dozers on coal	$EF = 35.6 \times \frac{s^{1.2}}{M^{1.4}}\ kg/hour$	$EF = 8.44 \times \frac{s^{1.5}}{M^{1.4}} \times 0.75\ kg/hour$	$EF = 35.6 \times \frac{s^{1.2}}{M^{1.4}} \times 0.022\ kg/hour$
Loading / emplacing coal	$EF = \frac{\left(0.58 \times \left(\frac{S}{2}\right)^{1.2} \times \left(\frac{U}{2}\right)^{1.3}\right)}{M^{1.2}}\ kg/tonne$	$EF = \frac{\left(0.596 \times \left(\frac{S}{2}\right)^{0.9} \times \left(\frac{U}{2}\right)^{1.3}\right)}{M^{1.2}} \times 0.75\ kg/tonne$	$EF = TSP \times 0.019\ kg/tonne$
Wind erosion on exposed areas & conveyors	$EF = 850\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$
Wind erosion on stockpiles	$EF = 1.9 \times \left(\frac{s}{1.5}\right) \times 365 \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right) kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$
Crushing	$EF = 0.0006\ kg/tonne$	$EF = 0.00027\ kg/tonne$	$EF = 0.00005\ kg/tonne$
Screening	$EF = 0.0011\ kg/tonne$	$EF = 0.00037\ kg/tonne$	$EF = 0.000025\ kg/tonne$
Grading roads	$EF = 0.0034 \times sp^{2.5}\ kg/VKT$	$EF = 0.0056 \times sp^{2.0} \times 0.6\ kg/VKT$	$EF = 0.0034 \times sp^{2.5} \times 0.031\ kg/VKT$

EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), W = average weight of vehicle (tonne), VKT = vehicle kilometres travelled (km), S = mean vehicle speed (kph).

Table C-2: Dust Emissions Inventory

Activity	TSP emission	PM10 emission	PM25 emission	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 1	Units	Var. 2	Units	Var. 3 - TSP	PM10	PM25	Units	Var. 4	Units	Var. 5	Units	Var. 6	Units
TS - Excavator loading topsoil	33	16	2	44,823	t/yr.	0.00075	0.00035	0.00005	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	2	M.C. %										
TS - Hauling topsoil to rehab area	313	70	9	44,823	t/yr.	0.046	0.010	0.001	kg/t	195	t/load	2.8	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	S.C. %	249	Ave weigh	85	% C.
TS - Emplacing topsoil at rehab are	33	16	2	44,823	t/yr.	0.00075	0.00035	0.00005	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	2	M.C. %										
TS - Rehandle topsoil at rehab are	3	2	0	4,482	t/yr.	0.00075	0.00035	0.00005	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	2	M.C. %										
OB - Drilling	6,744	3,507	202	38,099	holes/y	0.59	0.31	0.02	kg/hole													70	% C.
OB - Blasting	27,870	14,492	836	96	blasts/y	289	150.4	8.7	kg/blast	12,000	Area of blast m²												
OB - Excavator loading OB to haul	12,615	5,966	903	17,211,870	t/yr.	0.00075	0.00035	0.00005	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	2	M.C. %										
OB - Hauling to dump	191,869	41,966	4,341	17,211,870	t/yr.	0.050	0.011	0.001	kg/t	195	t/load	4.5	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	S.C. %	249	Ave weigh	85	% C.
OB - Emplacing at dump	12,615	5,966	903	17,211,870	t/yr.	0.00075	0.00035	0.00005	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	2	M.C. %										
OB - Rehandle OB	1,261	597	90	1,721,187	t/yr.	0.00075	0.00035	0.00005	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	2	M.C. %										
OB - Dozers on OB in pit	19,632	4,744	2,061	1,173	hr/yr.	16.7	4.0	1.8	kg/h	10	S.C. %	2	M.C. %										
OB - Dozers on OB working on dur	43,876	10,603	4,607	2,622	hr/yr.	16.7	4.0	1.8	kg/h	10	S.C. %	2	M.C. %										
CL - Dozers ripping/pushing/clean-	267	27	6	321	hr/yr.	0.8	0.1	0.0	kg/h	0.25	S.C. %	5	M.C. %										
CL - Loading ROM coal to haul truc	3,706	533	70	863,530	t/yr.	0.004	0.001	0.0001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	5	M.C. %					0.25	S.C. %				
CL - Hauling ROM to ROM Pad	22,813	5,485	1,117	863,530	t/yr.	0.167	0.036	0.004	kg/t	195	t/load	10.4	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	S.C. %	249	Ave weigh	85	% C.
CHPP - Unloading ROM to ROM Pad	3,706	533	70	863,530	t/yr.	0.004	0.001	0.0001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	5	M.C. %					0.25	S.C. %				
CHPP - Loading ROM to hopper	1,112	160	21	863,530	t/yr.	0.004	0.001	0.0001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	5	M.C. %					0.25	S.C. %			70	% C.
CHPP - Rehandle ROM at hopper	741	107	14	172,706	t/yr.	0.004	0.001	0.0001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	5	M.C. %					0.25	S.C. %				
CHPP - Plant feed conveyor	14	7	1	0.054	ha	850	425	64	kg/ha/yr.													70	% C.
CHPP - Crushing	518	233	43	863,530	t/yr.	0.0006	0.00027	0.00005	kg/t														
CHPP - Screening	1,295	518	30	863,530	t/yr.	0.0015	0.0006	0.000035	kg/t														
CHPP - No. 2 Conveying to CHPP	8	4	1	0.031	ha	850	425	64	kg/ha/yr.													70	% C.
CHPP - Transfer	981	464	70	863,530	t/yr.	0.00376	0.00178	0.00027	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	0.631	M.C. %									70	% C.
CHPP - Conveying to Product stocl	17	8	1	0.067	ha	850	425	64	kg/ha/yr.													70	% C.
CHPP - Unloading to Product stock	84	40	6	699,459	t/yr.	0.00012	0.00006	0.00001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	7.3	M.C. %										
CHPP - Conveying to train load ou	33	16	2	0.128	ha	850	425	64	kg/ha/yr.													70	% C.
CHPP - Transfer	25	12	2	699,459	t/yr.	0.00012	0.00006	0.00001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	7.3	M.C. %									70	% C.
CHPP - Loading coal to train	84	40	6	699,459	t/yr.	0.00012	0.00006	0.00001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	7	M.C. %										
CHPP - Dozers on Product stockpil	1,926	252	42	1,100	hr/yr.	1.8	0.2	0.0	kg/h	0.7	S.C. %	7	M.C. %										
OB - Loading Reject to haul truck	27	13	2	259,059	t/yr.	0.00011	0.00005	0.00001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	8	M.C. %										
OB - Hauling Reject to dump	4,652	1,070	169	259,059	t/yr.	0.158	0.035	0.003	kg/t	195	t/load	7.1	km/return trip	3.2	0.7	0.1	kg/VKT	2.2	S.C. %	249	Ave weigh	85	% C.
OB - Emplacing Reject at dump	27	13	2	259,059	t/yr.	0.00011	0.00005	0.00001	kg/t	0.619	Ave. $(WS/2.2)^{1.3}$ m/s	8	M.C. %										
WE - Overburden emplacement ar	65,208	32,604	4,891	76.7	ha	850	425	64	kg/ha/yr.														
WE - Open pit	62,103	31,051	4,658	73.1	ha	850	425	64	kg/ha/yr.														
WE - ROM stockpiles	29	15	2	6.1	ha	8	4	1	kg/ha/yr.	0.25	S.C. %	73	No. of rain days (>0.25mm)					1	% of time wind speed >5.4m/			50	% C.
WE - Product stockpiles	232	116	17	17.3	ha	21	11	2	kg/ha/yr.	0.70	S.C. %	73	No. of rain days (>0.25mm)					1	% of time wind speed >5.4m/			50	% C.
OB - Grading roads	14,771	5,161	458	24,000	km	0.62	0.22	0.02	kg/VKT	8	speed of graders in km/h												
Locomotive idling	515	515	499																				
Diesel emissions	2,614	2,614	2,536																				
Total emissions (kg/yr.)	**504,370**	**169,553**	**28,697**																				

Table C-3: Emissions inventory – Diesel emissions

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

Appendix D

Isopleth Diagrams

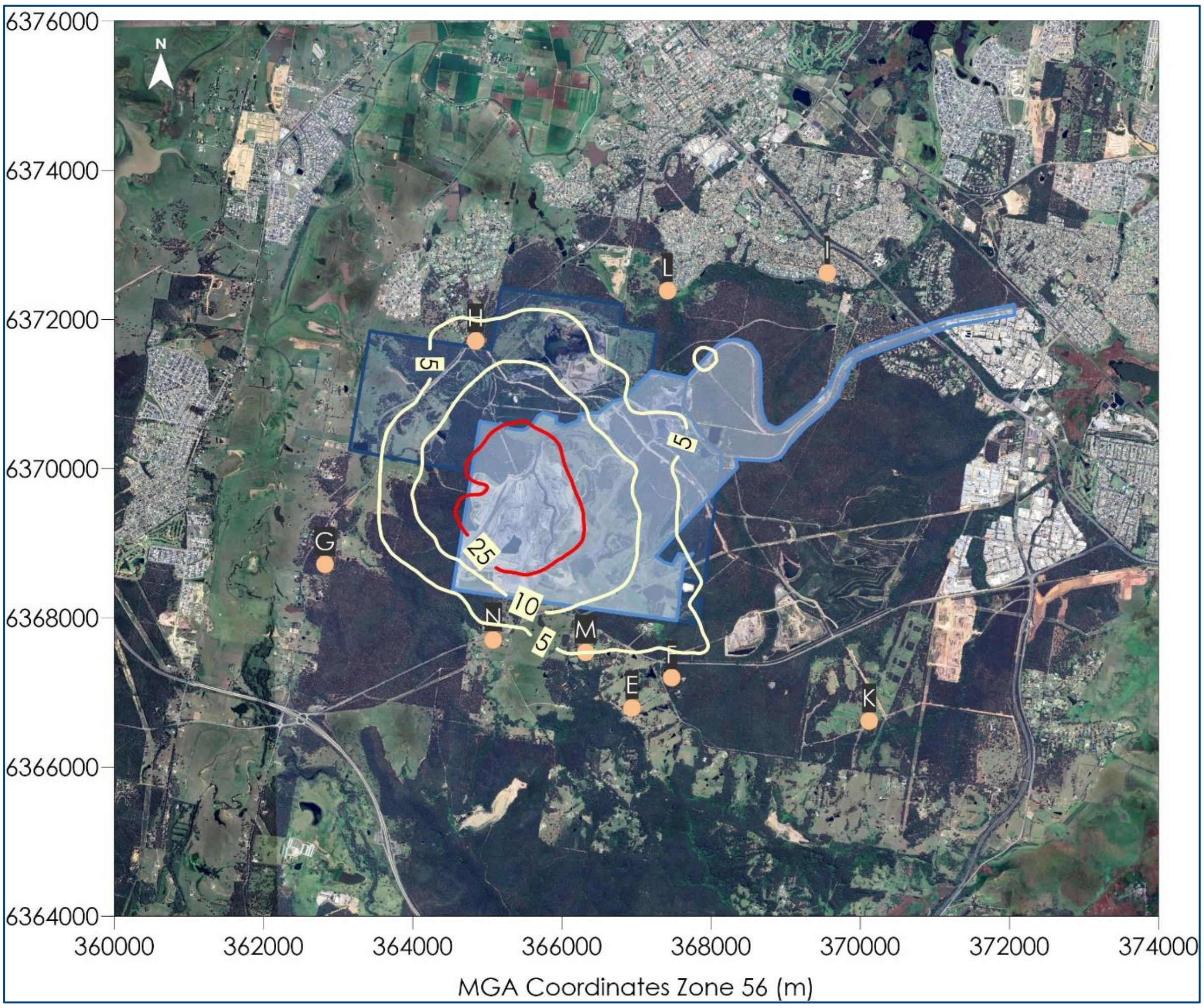

Figure D-1: Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Modifcation (µg/m³)

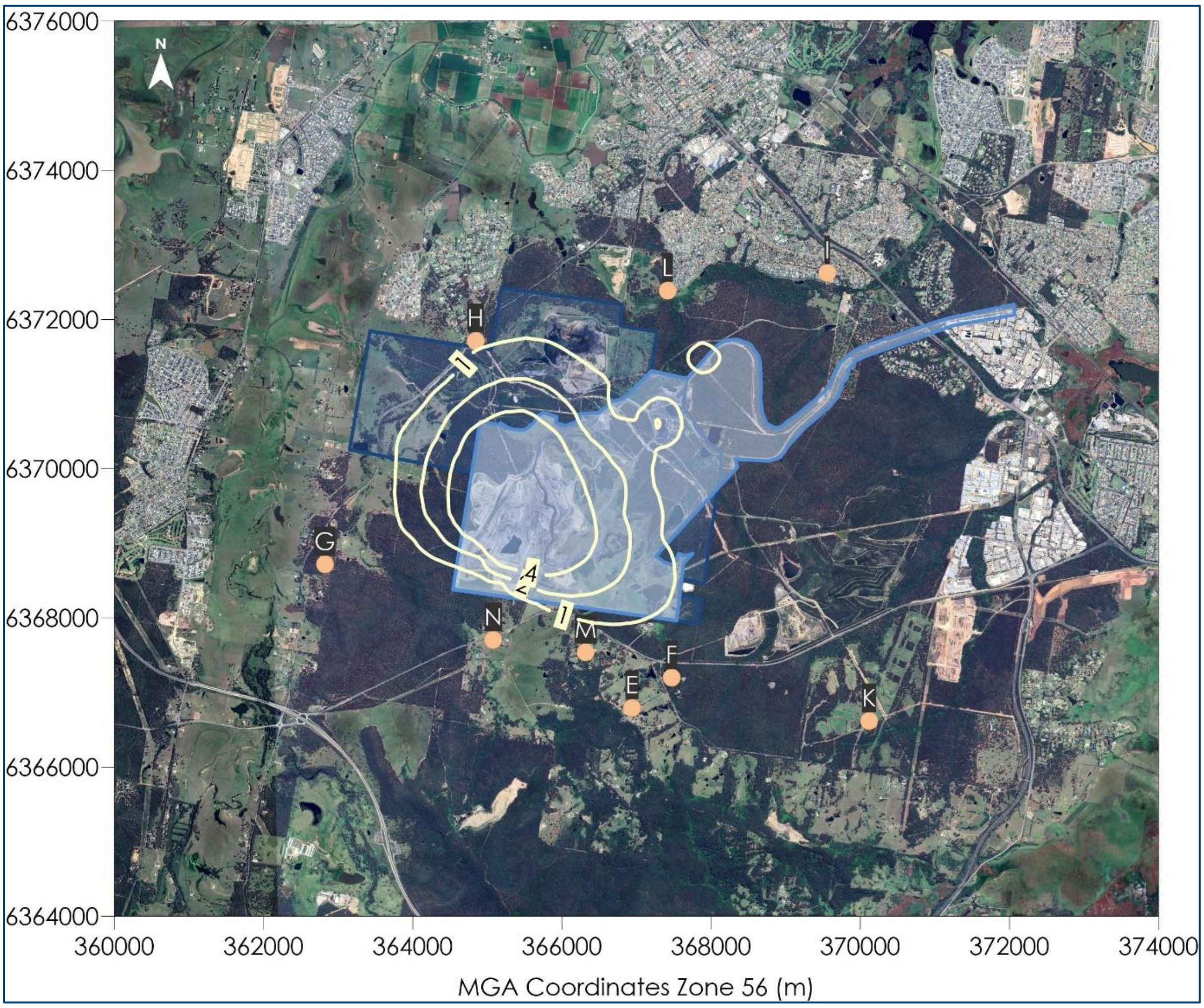

Figure D-2: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Modification (µg/m³)

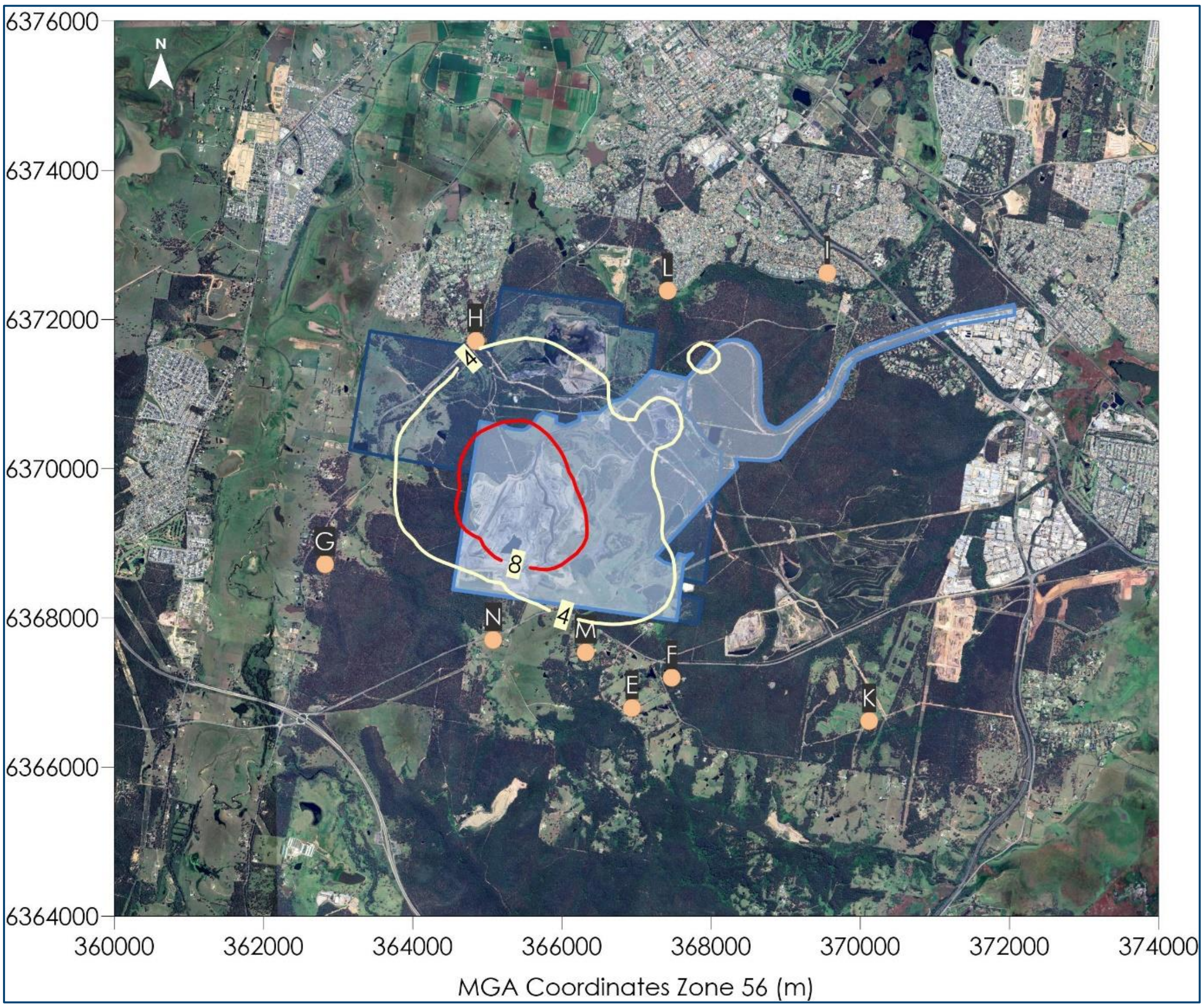

Figure D-3: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Modification and other sources (µg/m³)

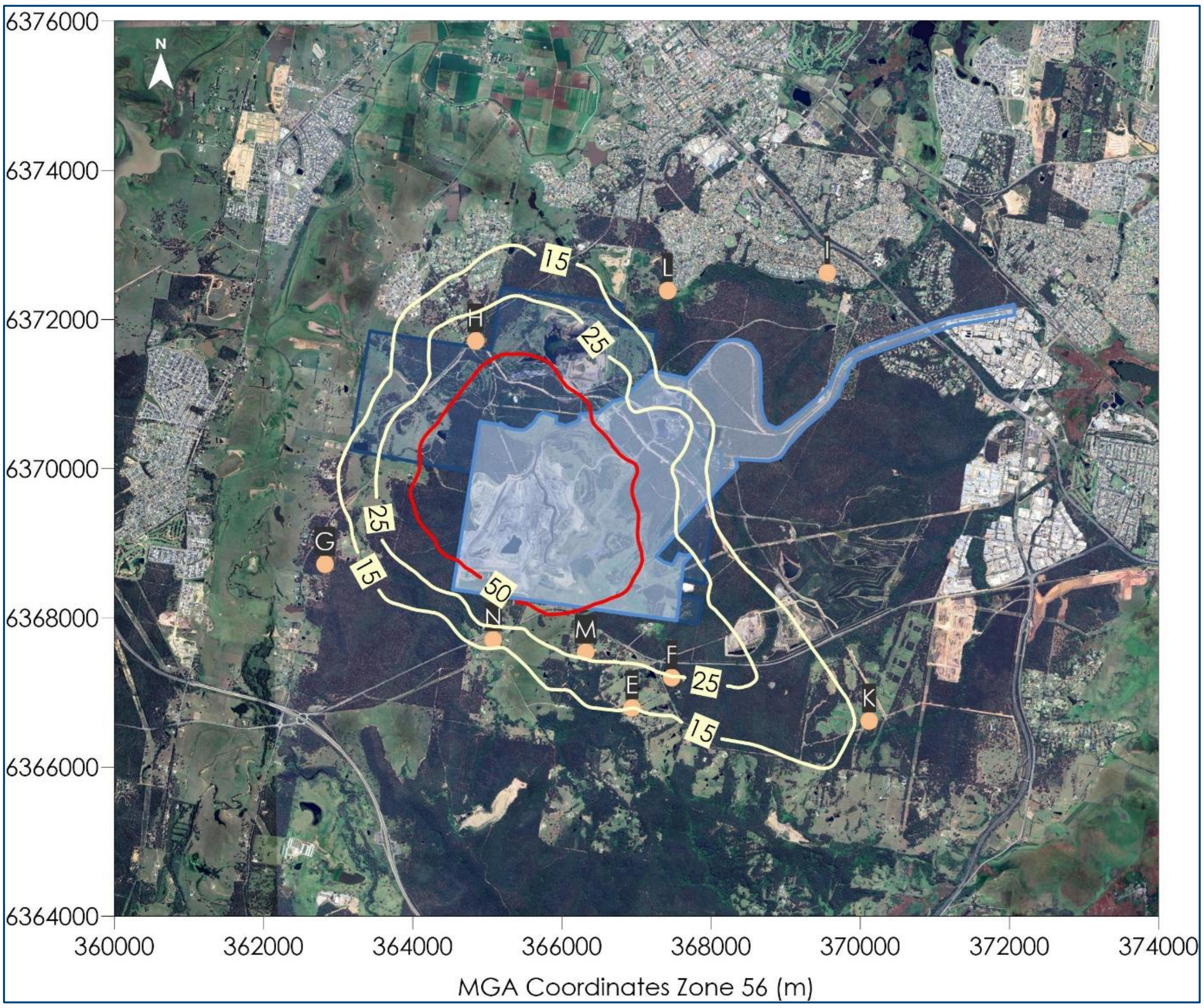

Figure D-4: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Modifcation (µg/m³)

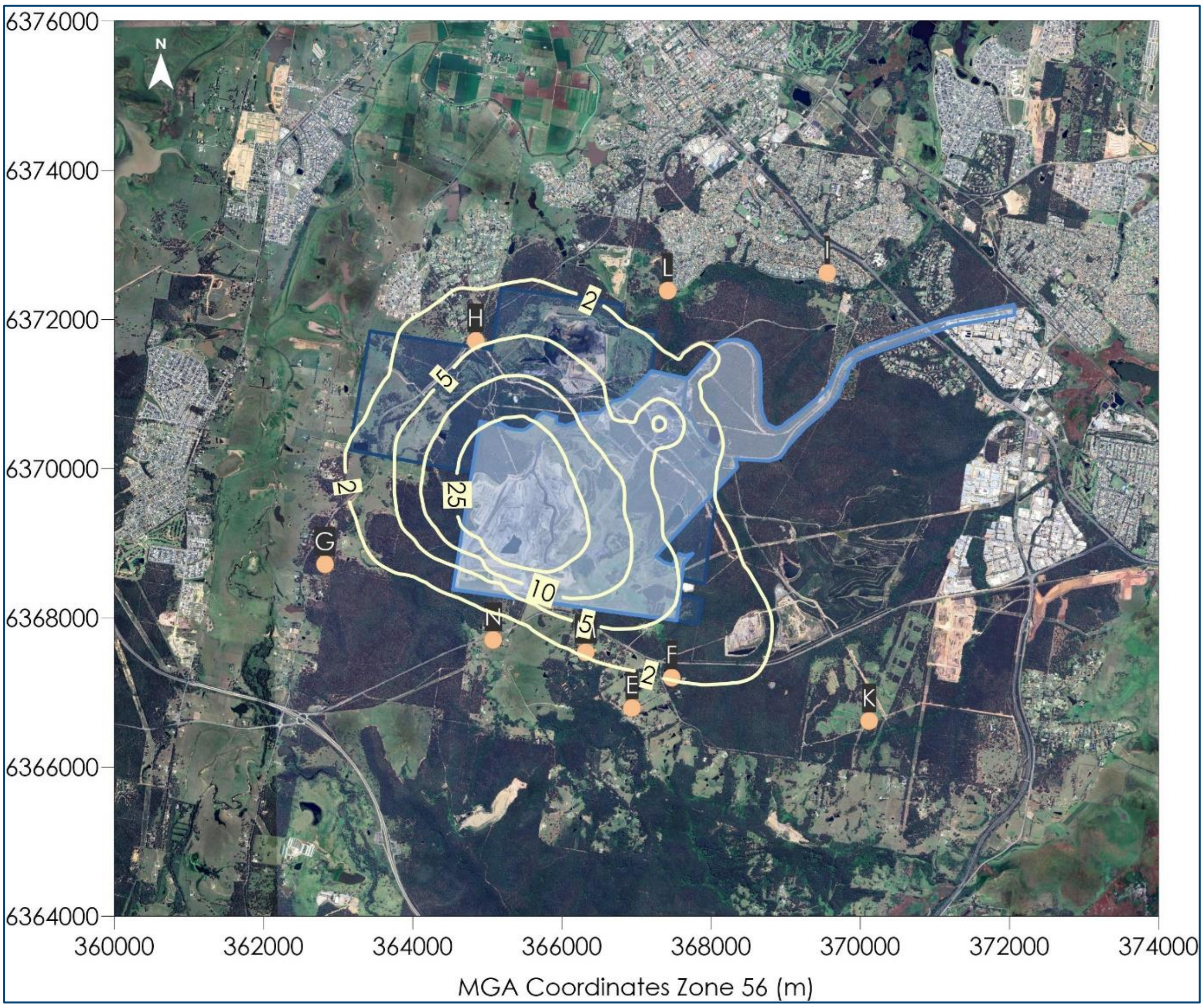

Figure D-5: Predicted annual average PM_{10} concentrations due to emissions from the Modification ($\mu g/m^3$)

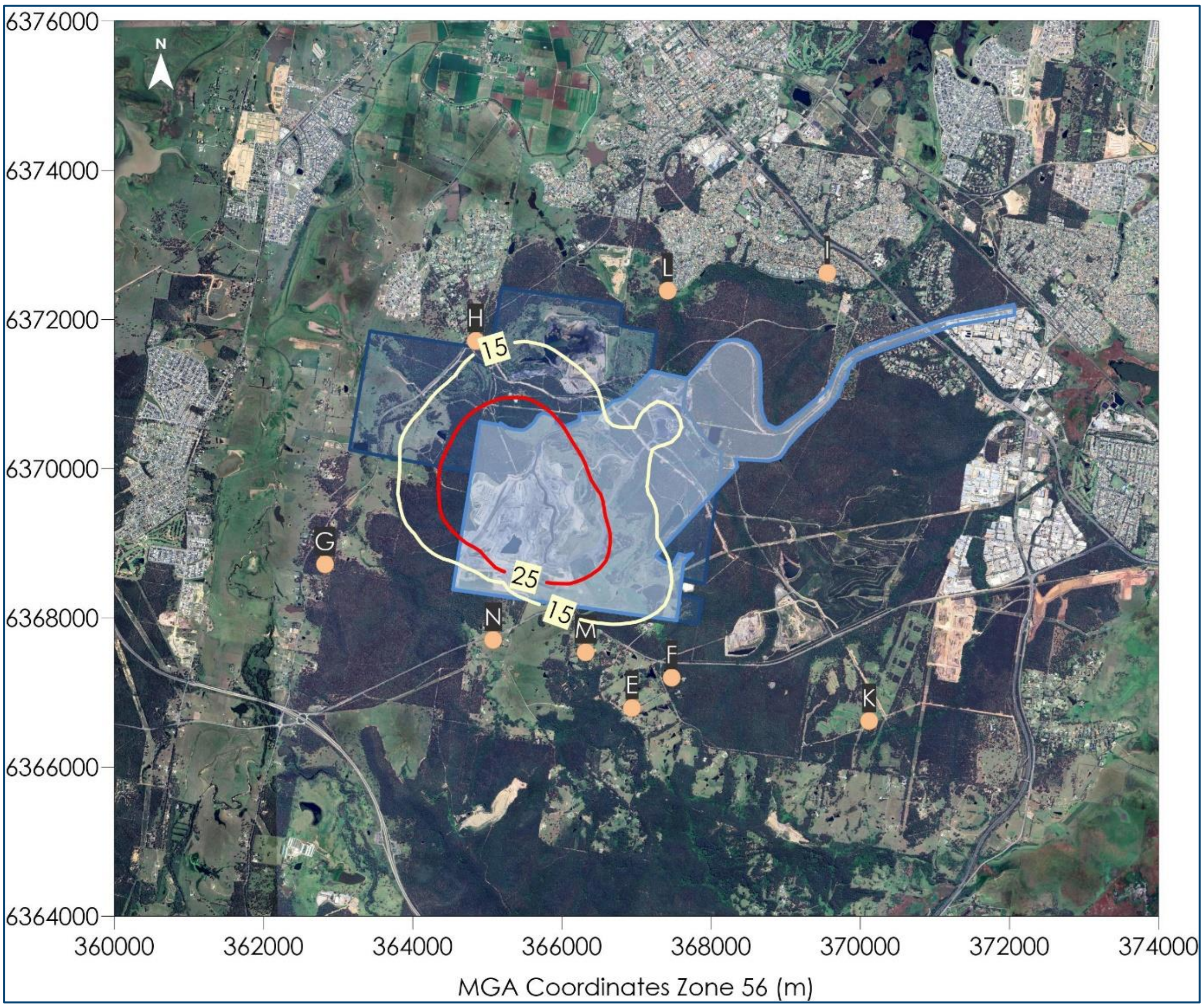

Figure D-6: Predicted annual average PM_{10} concentrations due to emissions from the Modification and other sources ($\mu g/m^3$)

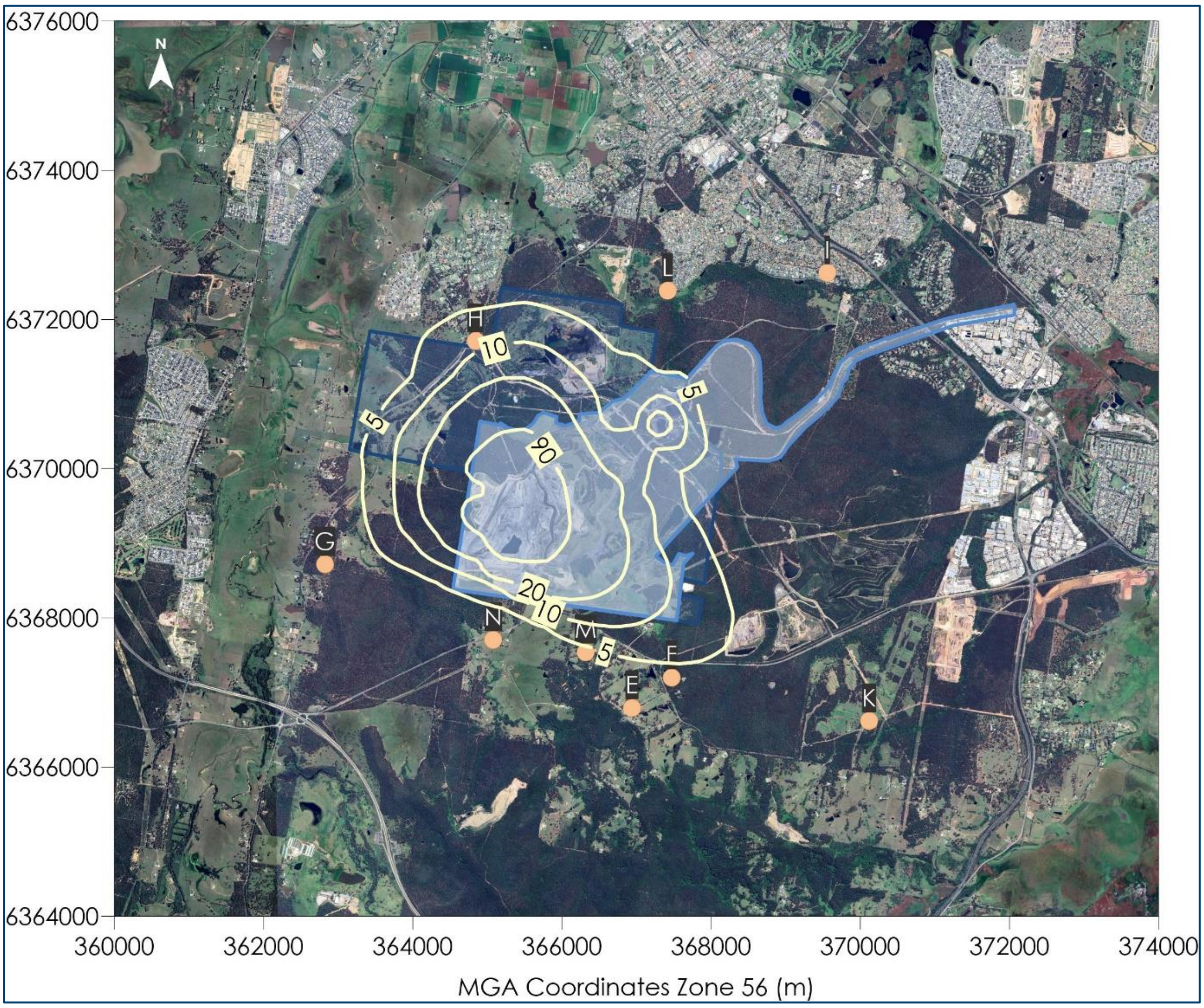

Figure D-7: Predicted annual average TSP concentrations due to emissions from the Modification (µg/m³)

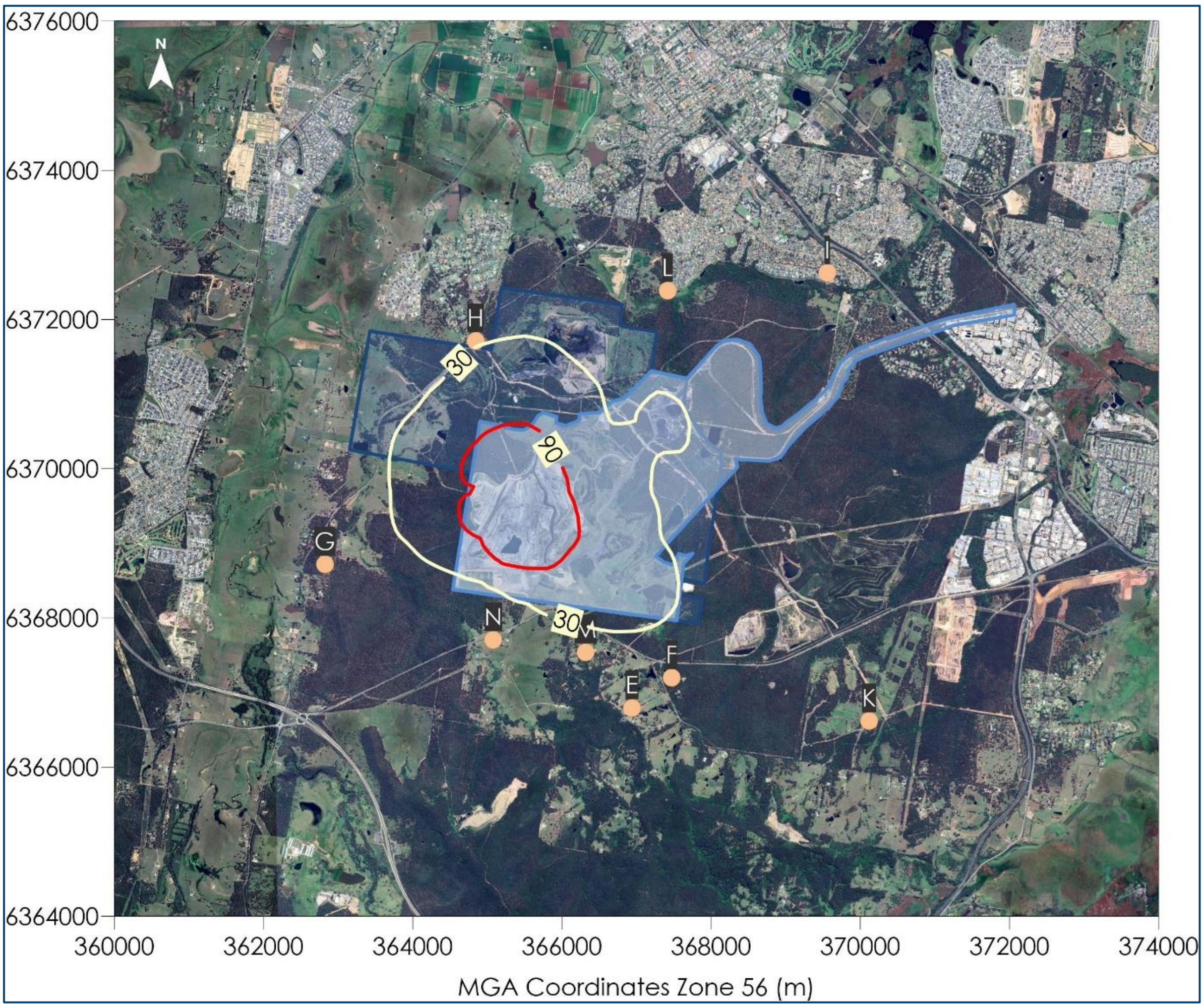

Figure D-8: Predicted annual average TSP concentrations due to emissions from the Modification and other sources (µg/m³)

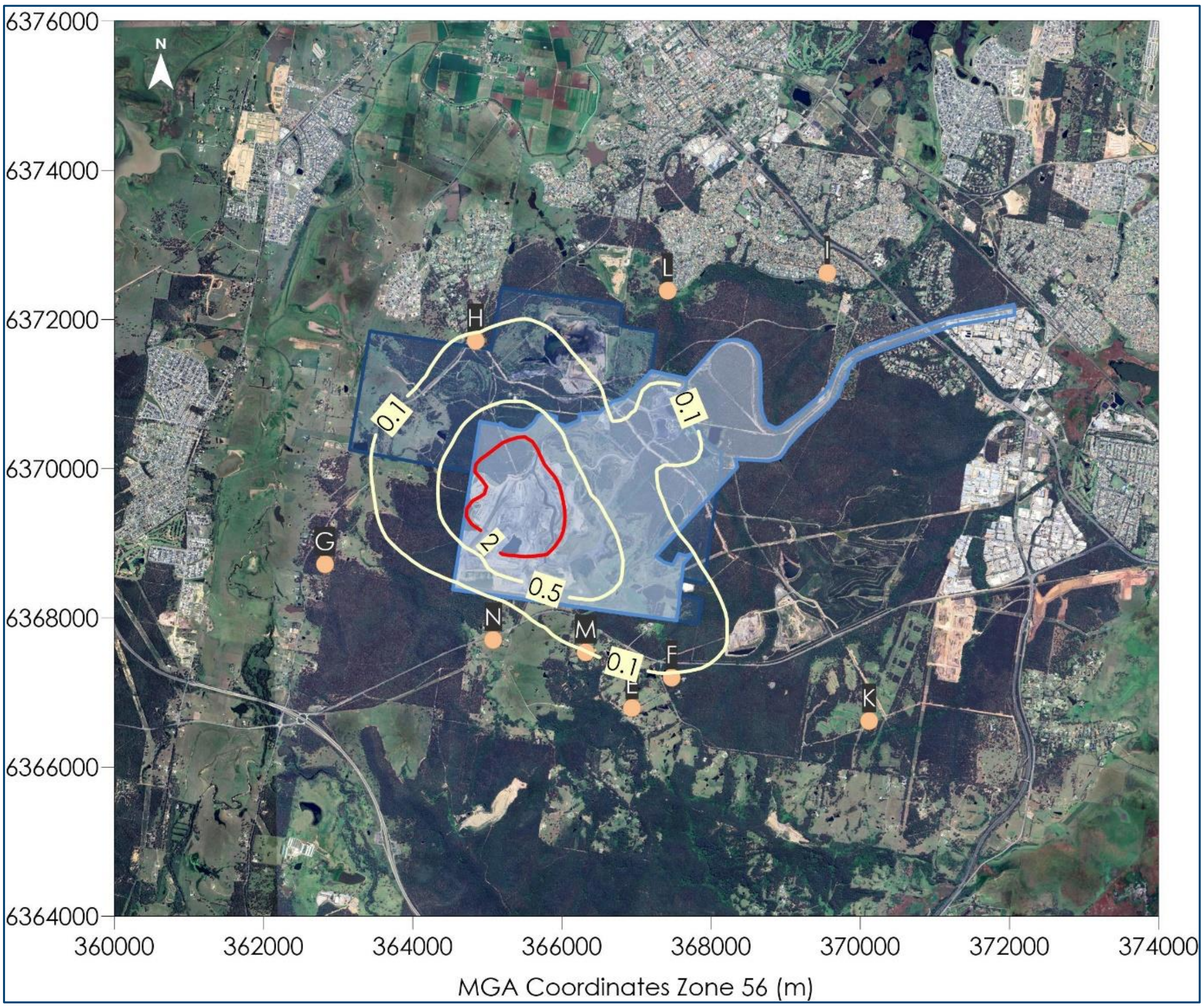

Figure D-9: Predicted annual average dust deposition levels due to emissions from the Modification (g/m²/month)

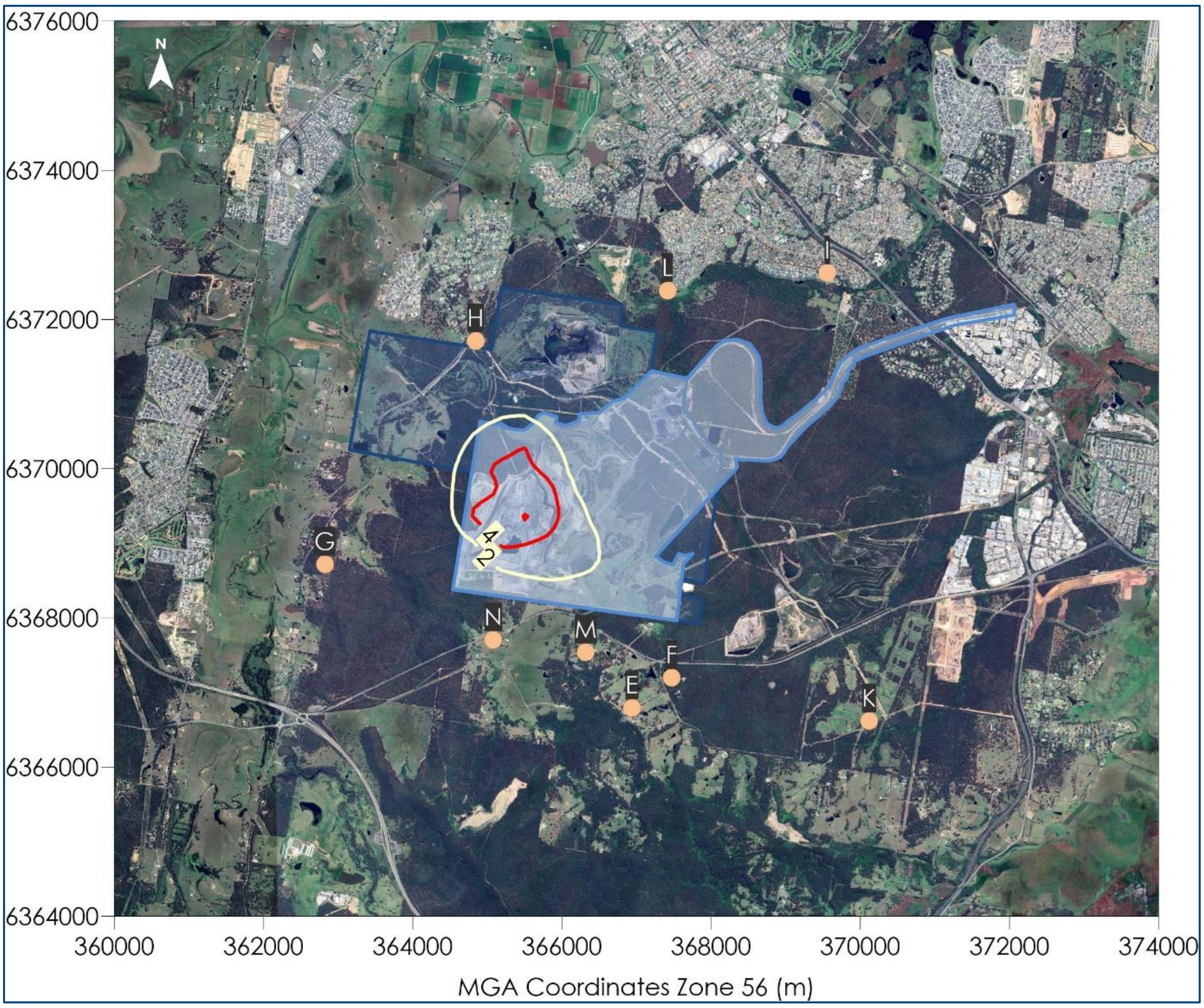

Figure D-10: Predicted annual average dust deposition levels concentrations due to emissions from the Modification and other sources (g/m²/month)