Air Quality Monitoring and Environmental Performance – 2022

Metropolitan Coal

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1 INTRODUCTION

In accordance with Metropolitan Coal's Project Approval 08_0149, the Metropolitan Coal 2022 Annual Review is required to be submitted by 31 March 2023. Zephyr Environmental (Zephyr) has prepared an Air Quality Monitoring and Environmental Performance Assessment Report in support of this Annual Review.

Monitoring parameters include deposited dust and PM_{10} monitoring results, as well as meteorological monitoring from 1 January to 31 December 2022.

2 MONITORING NETWORK

The Metropolitan Coal air quality monitoring network is shown in Figure 2-1. It consists of ten dust deposition gauges, a High Volume Air Sampler (HVAS) measuring PM_{10}, a Tapered Element Oscillating Microbalance (TEOM) also measuring PM_{10}, and an automatic weather station (AWS) measuring a number of meteorological parameters. The deposition gauges are static, measuring a single value each month. Similarly, the HVAS measures a single 24-hour average PM_{10} concentration every six days while the TEOM records continuously at 10-minute intervals to enable a 24-hour average to be calculated every day of the year. The HVAS, TEOM and AWS are all co-located.

Monthly dust deposition rates are measured at the ten dust deposition gauges (DG1 to DG10) consistent with EPL 767 and the Metropolitan Coal Air Quality and Greenhouse Gas Management Plan. Their locations are shown in Figure 2-1 and also described in Table 2-1.

Table 2-1: Dust deposition gauges

Site ID	Address / Location
DG1	136 The Crescent - EPA ID-1
DG2	28 Old Station Road - EPA ID-2
DG3	Mine Entrance - EPA ID-3
DG4	Helensburgh Golf Course - EPA ID-4
DG5	83 Parkes Street - EPA ID-5
DG6	59 Parkes Street -EPA ID-11
DG7	32 Old Station Road - EPA ID-12
DG8	88 Parkes Street - EPA ID-13
DG9	Helensburgh Public School - EPA ID-14
DG10	Helensburgh Private School - EPA ID-15

DG4 is a control dust gauge located at the Helensburgh Golf Course some 2 kilometres (km) from the mine's Surface Facilities Area and is not included in the assessment of the dust deposition performance indicator.

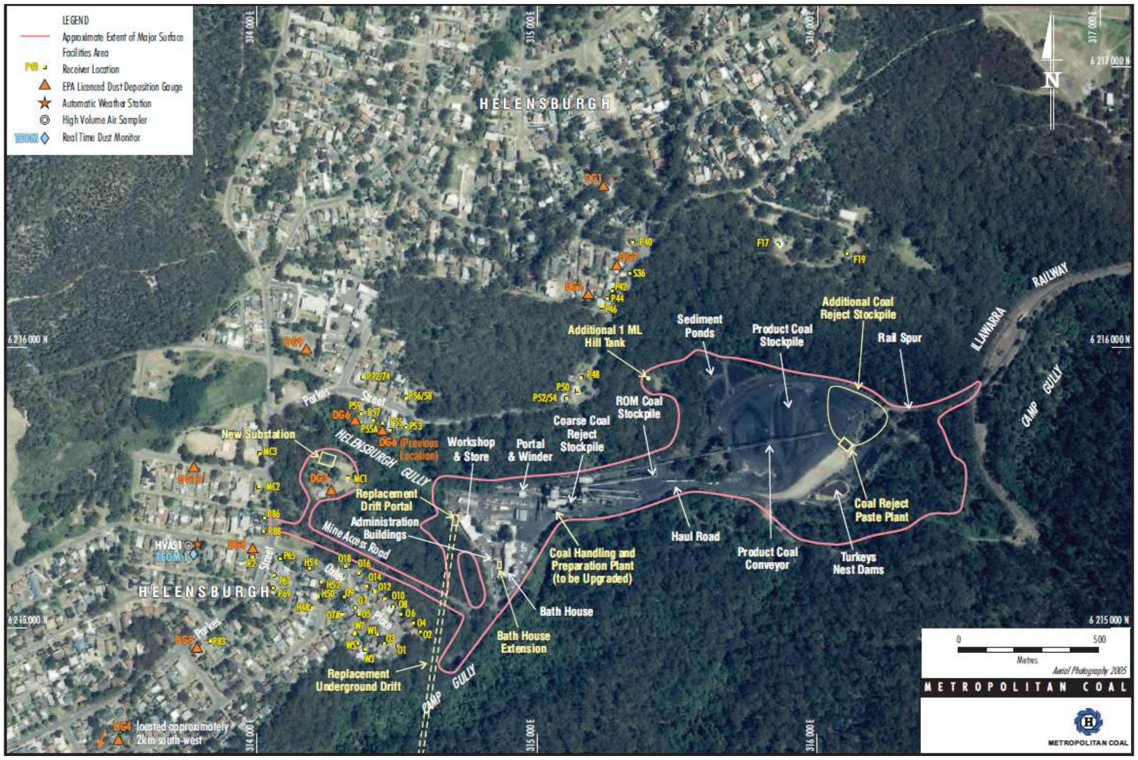

Figure 2-1: Metropolitan Coal's air quality and meteorological monitoring network

3 AIR QUALITY CRITERIA AND PERFORMANCE INDICATORS

There are both impact assessment criteria and air quality performance indicators relevant to the Metropolitan Coal operations. These have been developed in consideration of the predicted impacts of the Project, which were included in the Metropolitan Coal Project Environmental Assessment (Helensburgh Coal Pty Ltd, 2008). Both sets of criteria are described in the following sections.

3.1 Impact assessment criteria

The Project Approval requires Metropolitan Coal to ensure that dust generated by the Project does not cause additional exceedances of the air quality impact assessment criteria listed in Tables 5, 6 and 7 of Condition 11, Schedule 4 at any residence on privately-owned land, or on more than 25% of any privately-owned land. These criteria are summarised in Table 3-1 and Table 3-2 below.

Table 3-1: Long-term and short-term impact assessment criteria for particulate matter

Pollutant	Averaging period	Criterion
Total suspended particulate (TSP)	Annual	90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	30 µg/m^3
	24-hour	50 µg/m^3

Table 3-2: Long-term impact assessment criteria for deposited dust

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

Deposited dust is 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, or its latest version.

3.2 Air quality performance indicators

In accordance with the Air Quality and Greenhouse Gas Management Plan, Metropolitan Coal is also required to assess the Project against the air quality performance indicators shown in Table 3-3.

Table 3-3: Air quality performance indicators

Pollutant	Averaging period	Monitoring Point	Performance indicator [1, 2]
PM_{10}	24-hour	High Volume Air Sampler (HVAS)	37.5 µg/m^3
	Annual		25 µg/m^3
	10-minute	Tapered Element Oscillating Microbalance (TEOM)	[3] 150 µg/m^3
	24-hour		[3] 37.5 µg/m^3
Deposited dust	Annual	Metropolitan Coal Dust Gauges excluding DG4	3 g/m^2/month

[1] Total measured level excluding extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities
[2] Background PM_{10} concentrations due to all other sources plus incremental increases in PM_{10} concentrations due to the mine alone
[3] Indicative performance criteria only – to be reviewed and updated with ongoing monitoring results

3.3 Other conditions

3.3.1 Greenhouse gas

In addition the air quality conditions above, Condition 10, Schedule 4 of the Project Approval requires that Metropolitan Coal implement all reasonable and feasible measures to minimise

a) energy use on site; and

b) the scope 1, 2 and 3 greenhouse gas emissions produced on site,

to the satisfaction of the Director-General (now secretary) of the Department of Planning and Environment (DPE). This is discussed further in Section 7.2.

3.3.2 Odour

Condition 9, Schedule 4 also requires that Metropolitan Coal does not cause or permit the emission of offensive odour from the site, as defined under Section 129 of the *Protection of the Environment Operations Act* (POEO Act). There are not considered to be any odorous emissions from the site, nor have there been any complaints regarding odour, so this is not discussed further in this report.

4 METEOROLOGICAL MONITORING

The site's AWS measures a number of parameters in real time, reporting 10-minute averages which have been used to calculate the 1-hour averages presented in this analysis. The measured meteorological parameters are listed in Table 4-1.

Table 4-1: Meteorological parameters measured at the AWS

Parameter	Unit	Frequency	Height above ground
Wind speed	m/s	Continuous 10-minute average	10m
Wind direction	Degrees		10m
Sigma theta	Degrees		10m
Temperature	ºC		2m and 10m
Relative humidity	%		2m
Solar radiation	W/m^2		2m
Rainfall	mm	Continuous 10-minute total	Ground level

Figure 4-1 presents an annual summary of a number of these parameters, indicating the typical seasonal variations expected at the site. The total annual rainfall was recorded as 3,050 mm, with 43% of that falling in March (707 mm) and July (601 mm). Over 70% of the rainfall for the year fell in just the four months of February, March, April and July. There were also significant falls in January, May, September and October, with 2022 being one of the wettest years on record.

The maximum temperature measured at 2 m over a 1-hour period was 33.9ºC on 1st February, with the lowest minimum of 2.1ºC recorded on 16th July. The variations in average daily temperature are shown in Figure 4-2.

Figure 4-3 shows a similar plot for variations in daily average humidity. Relative humidity is generally higher in the cooler months, but there are also a number of days in March and November which are high during heavy rainfall.

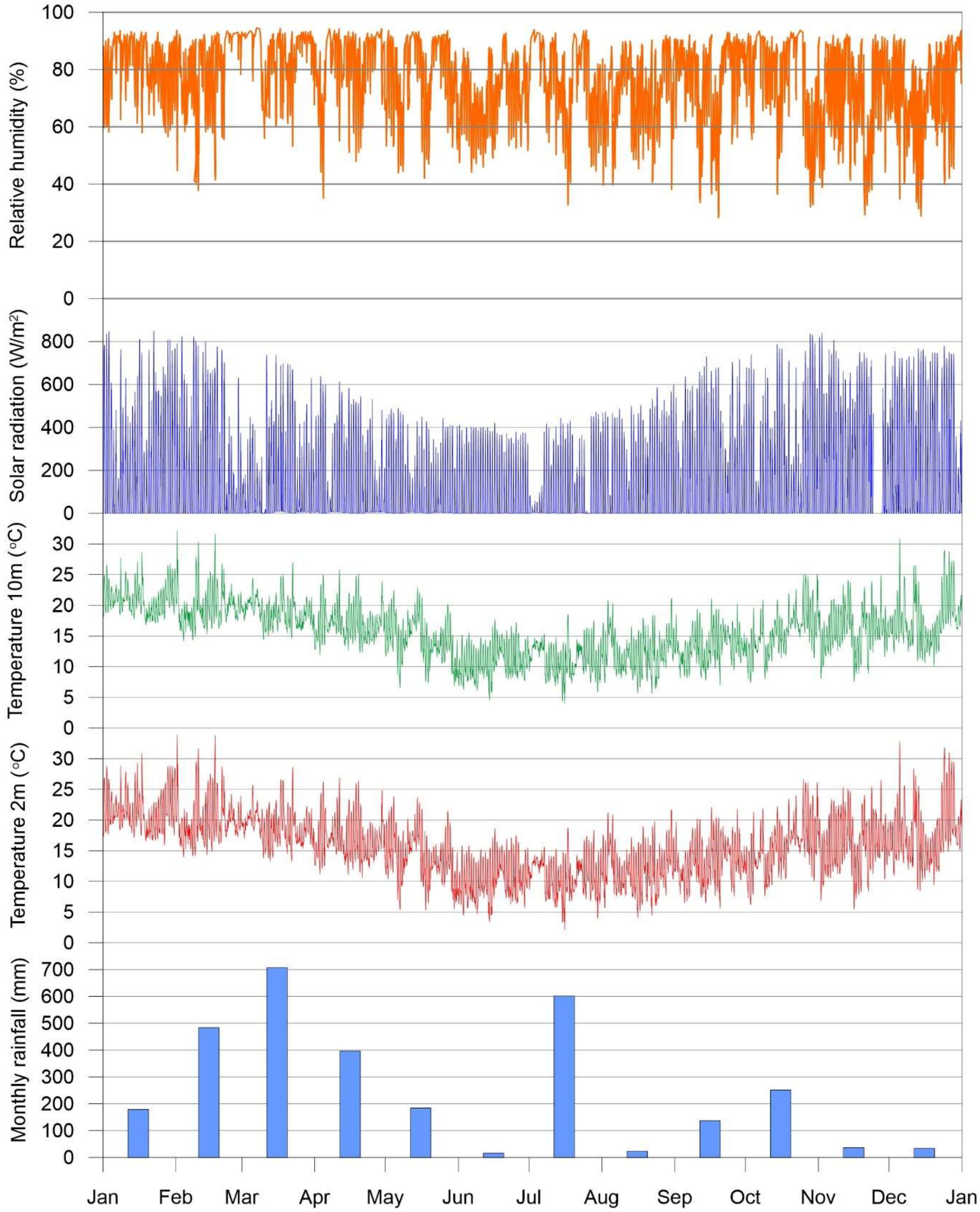

Figure 4-1: Annual summary of meteorological parameters for 2022

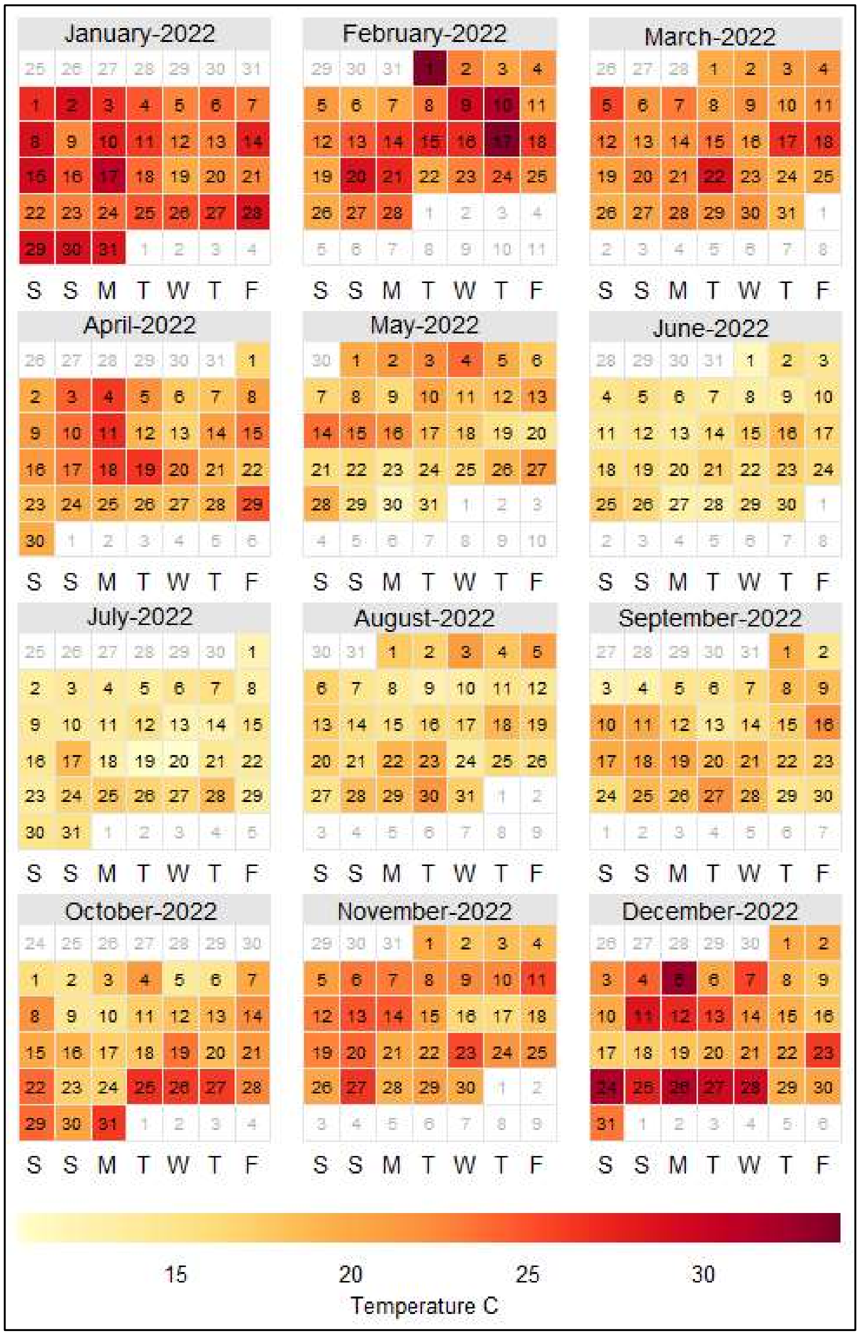

Figure 4-2: Variation in average daily temperature at 2 m for 2022

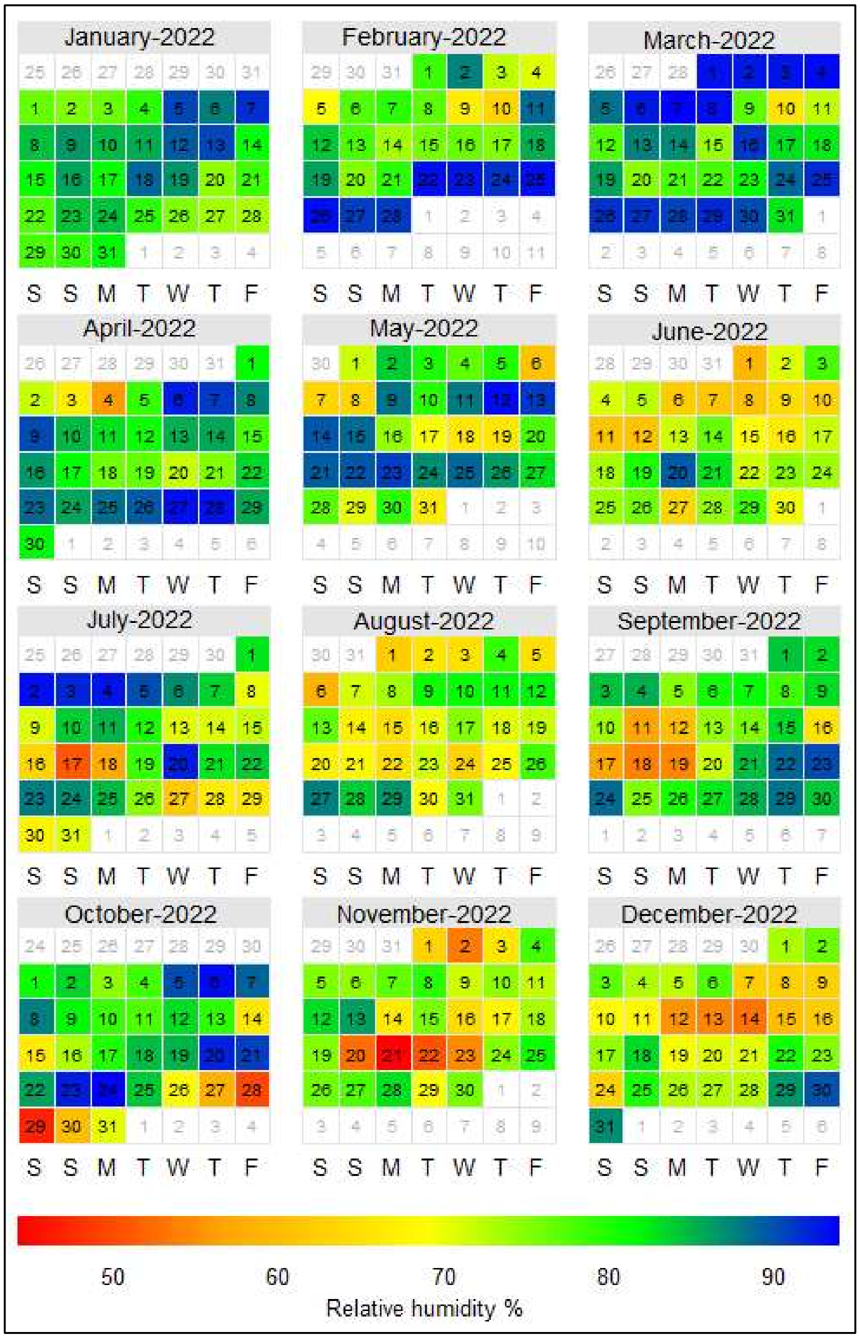

Figure 4-3: Variation in average daily humidity for 2022

Regarding wind speed and direction, Figure 4-4 and Figure 4-5 present the annual and seasonal variation in 1-hour wind speeds for the year, respectively. Figure 4-6 shows the monthly variation.

On an annual basis, winds are predominantly from the west, northwest and southeast. Southeasterlies dominate in summer while the westerlies and north westerlies dominate in winter. Average wind speeds are low at 1.3 m/s on an annual basis, slightly higher in spring and summer and slightly lower in autumn and winter.

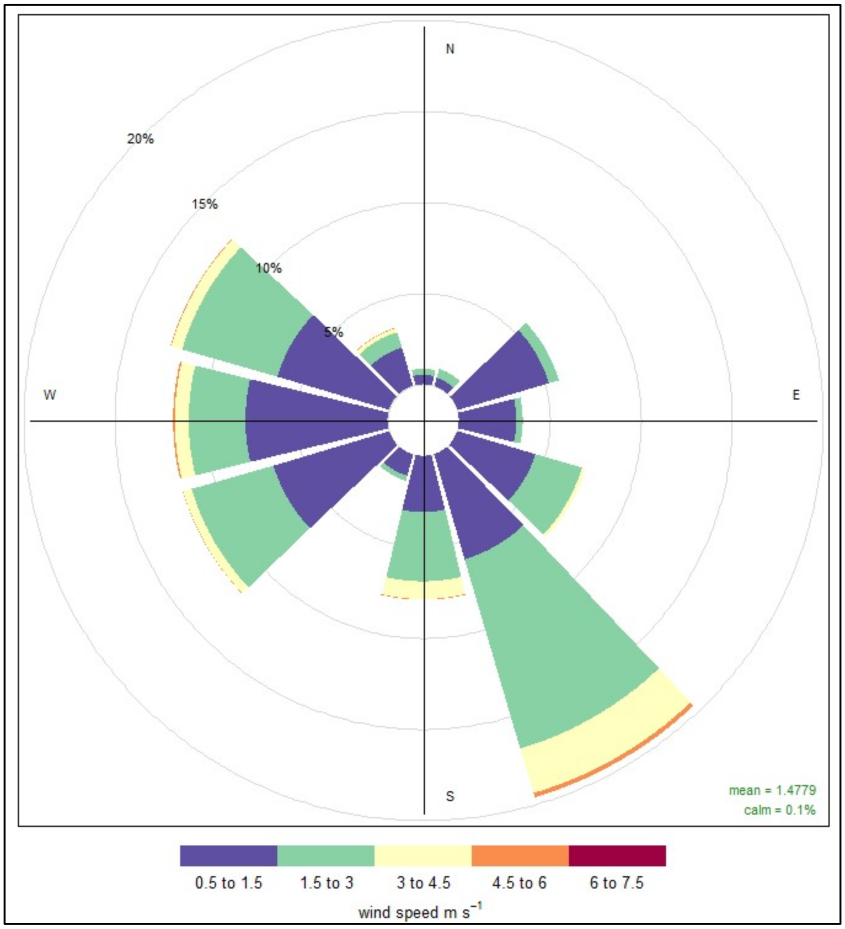

Figure 4-4: Annual windrose for Metropolitan Coal 2022

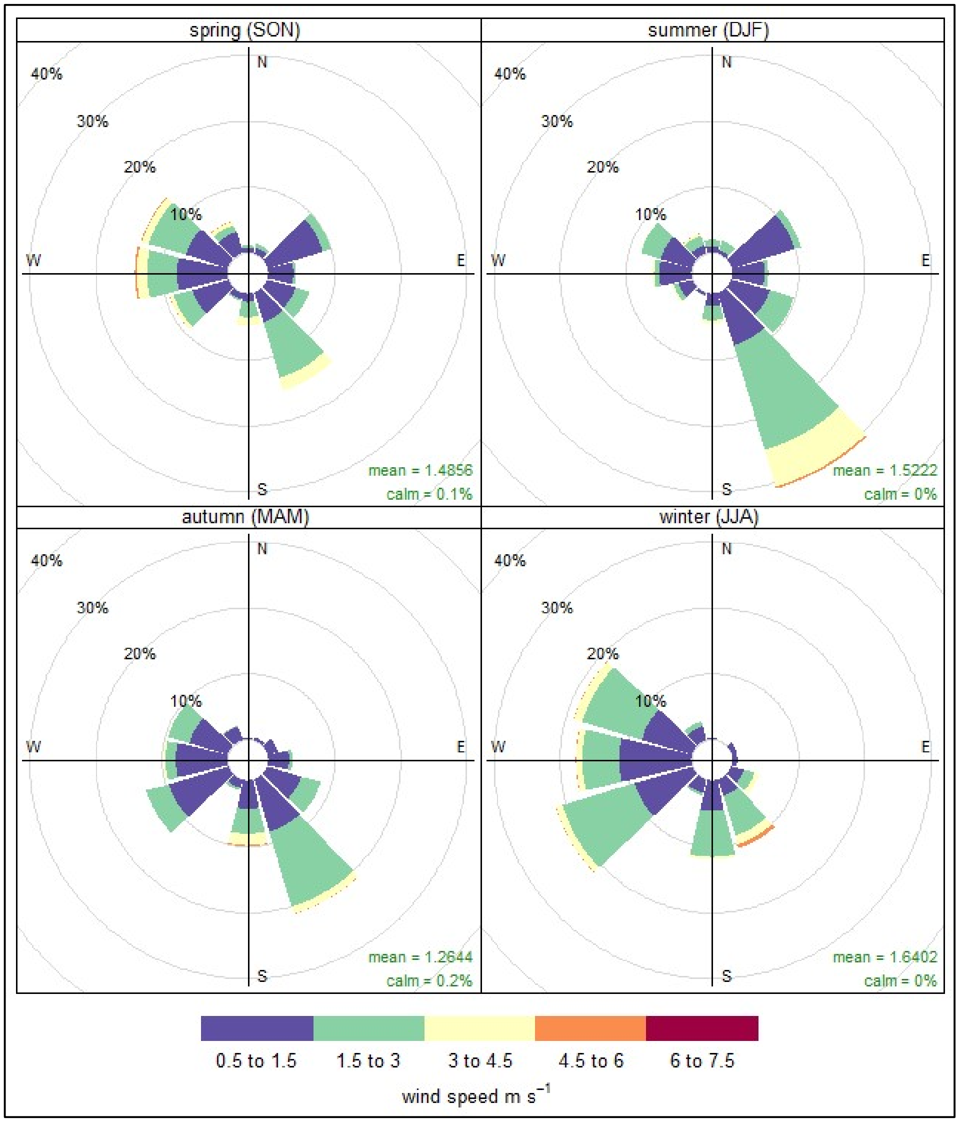

Figure 4-5: Seasonal windroses for Metropolitan Coal 2022

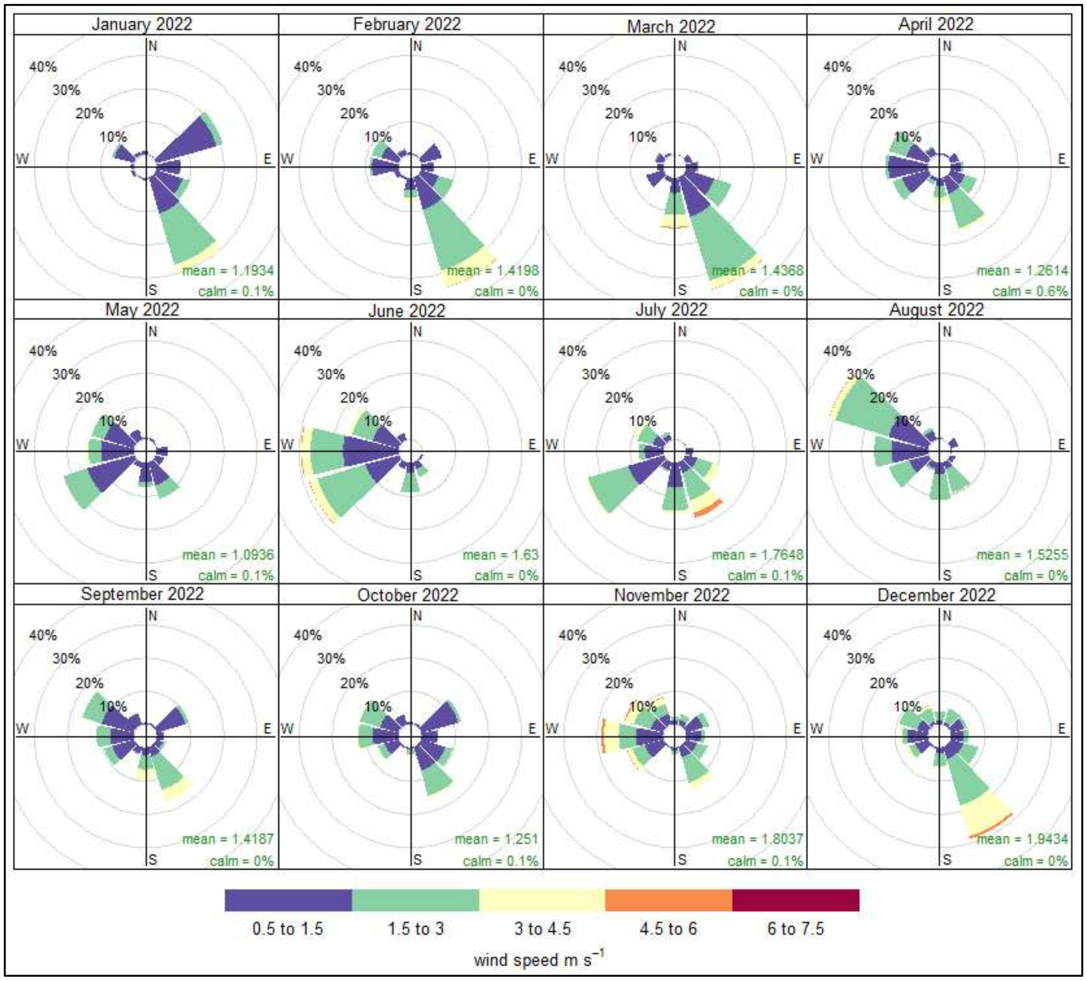

Figure 4-6: Monthly windroses for Metropolitan Coal 2022

Atmospheric stability refers to the degree of turbulence or mixing that occurs within the atmosphere and is a controlling factor in the rate of atmospheric dispersion of dust from mining operations. Highly stable conditions lead to poor dispersion while unstable conditions enable more effective dispersion of pollutants.

Atmospheric stability has been calculated using the meteorological data collected, and Figure 4-7 presents the diurnal variation in atmospheric stability at Metropolitan Coal AWS. The profile shows that atmospheric instability increases during the daylight hours as the sun-generated convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for effective atmospheric dispersion of emissions would be greatest during daytime hours and lowest during evening through to early morning hours.

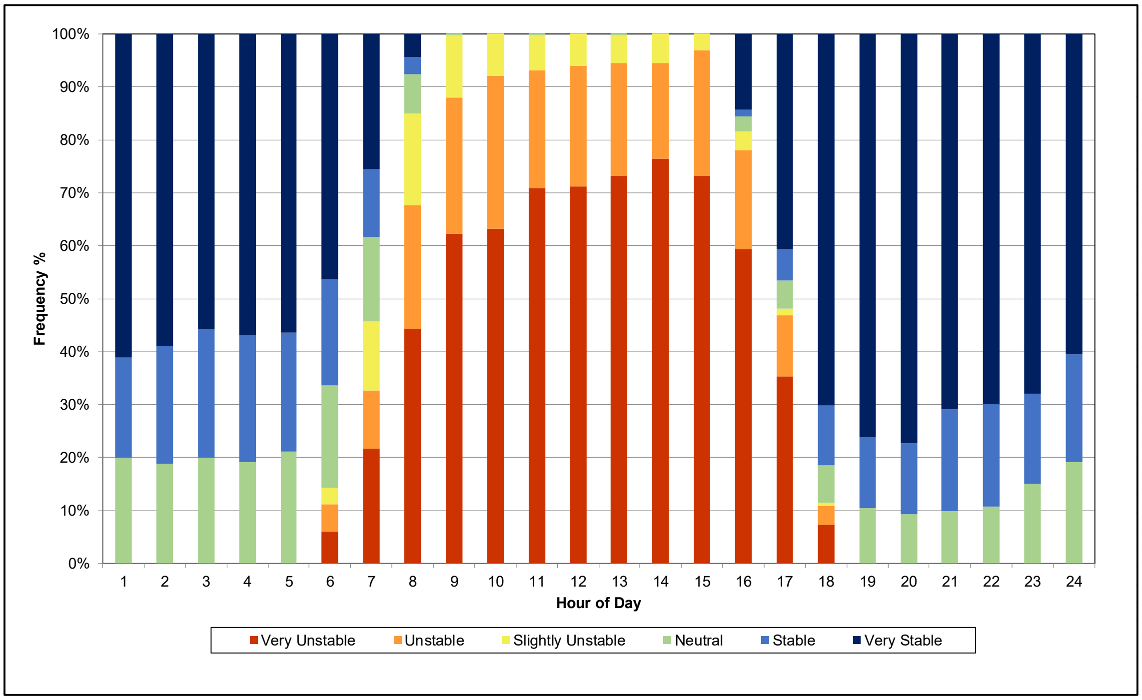

Figure 4-7: Diurnal variation in stability for Metropolitan Coal 2022

5 AIR QUALITY MONITORING

5.1 Particulate matter

5.1.1 High Volume Air Sampler (HVAS)

A HVAS is a static sampler that takes a single composite sample over a 24-hour period using a gravimetric method. The exposed filter paper can then be analysed for the particulate size fraction determined by the sample inlet used; in this case PM_{10}.

Samples from January to December were taken every six days. Figure 5-1 shows each individual PM_{10} measurement over the year, a total of 61 days were sampled (100% capture rate). The highest concentration was 23 µg/m^3 on 2 August, well below both the impact assessment criterion and performance indicator.

The annual average PM_{10} concentration measured by the HVAS was 8.4 µg/m^3. This is lower than the previous two years of 12.8 µg/m^3 (2021) and 14.1 µg/m^3 (2020).

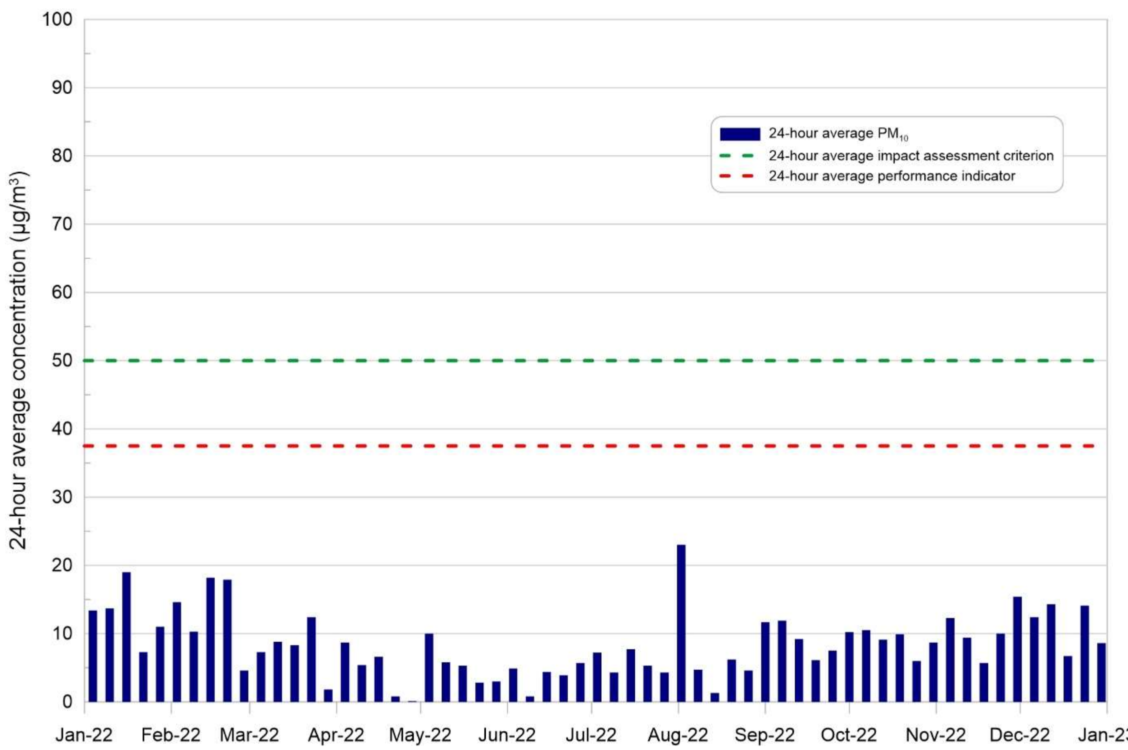

Figure 5-1: PM_{10} measurements from the HVAS – 2022

5.1.2 Tapered Element Oscillating Microbalance (TEOM)

The TEOM, which has been co-located with the HVAS, measures PM_{10} continuously. Measurements are made every 10-minutes and these values can be averaged into 1-hour and 24-hour concentrations. Figure 5-2 presents the available 24-hour average data, a total of 364 out of a possible 365 measurements. The highest concentration was 26 µg/m³, measured on 6 January.

The annual average was 11.1 µg/m³, slightly higher than that measured by the HVAS and lower than the previous two years of 12.8 µg/m³ (2021) and 15.3 µg/m³ (2020).

Figure 5-3 presents the available 10-minute average PM_{10} data, with a capture rate of 98.8%. The highest 10-minute average concentration was 61.8 µg/m³, measured on 13 June, well below the performance indicator of 150 µg/m³.

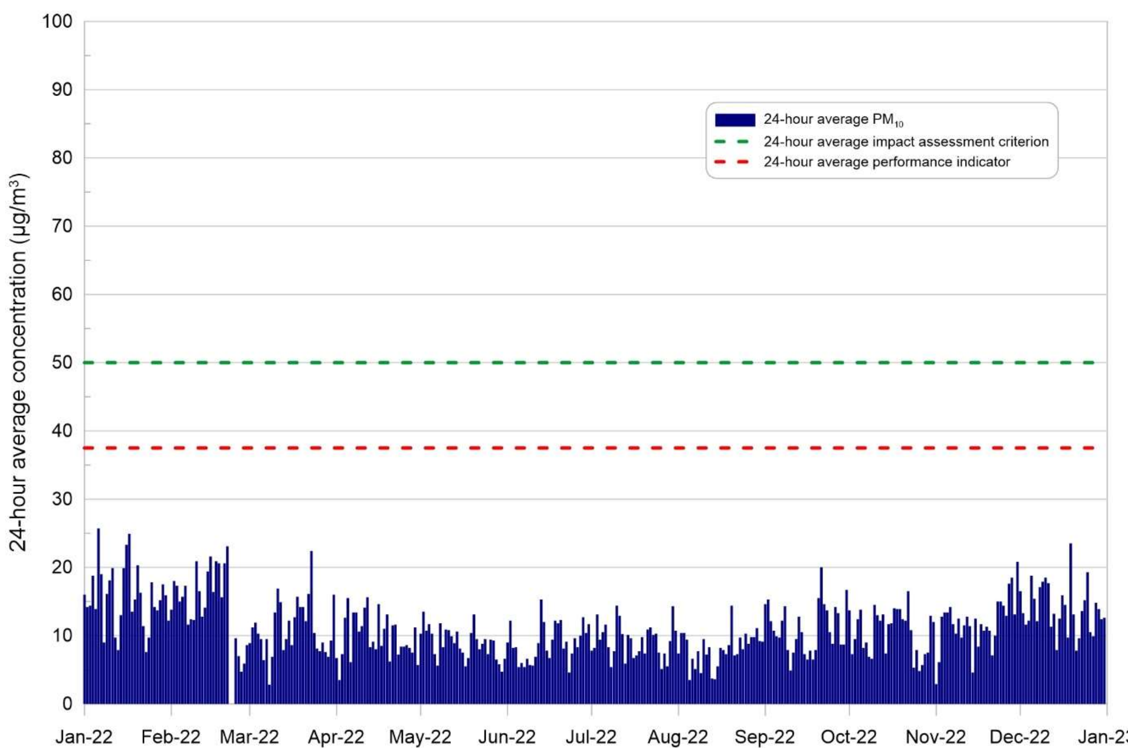

Figure 5-2: 24-hour average PM_{10} concentrations measured by the TEOM – 2022

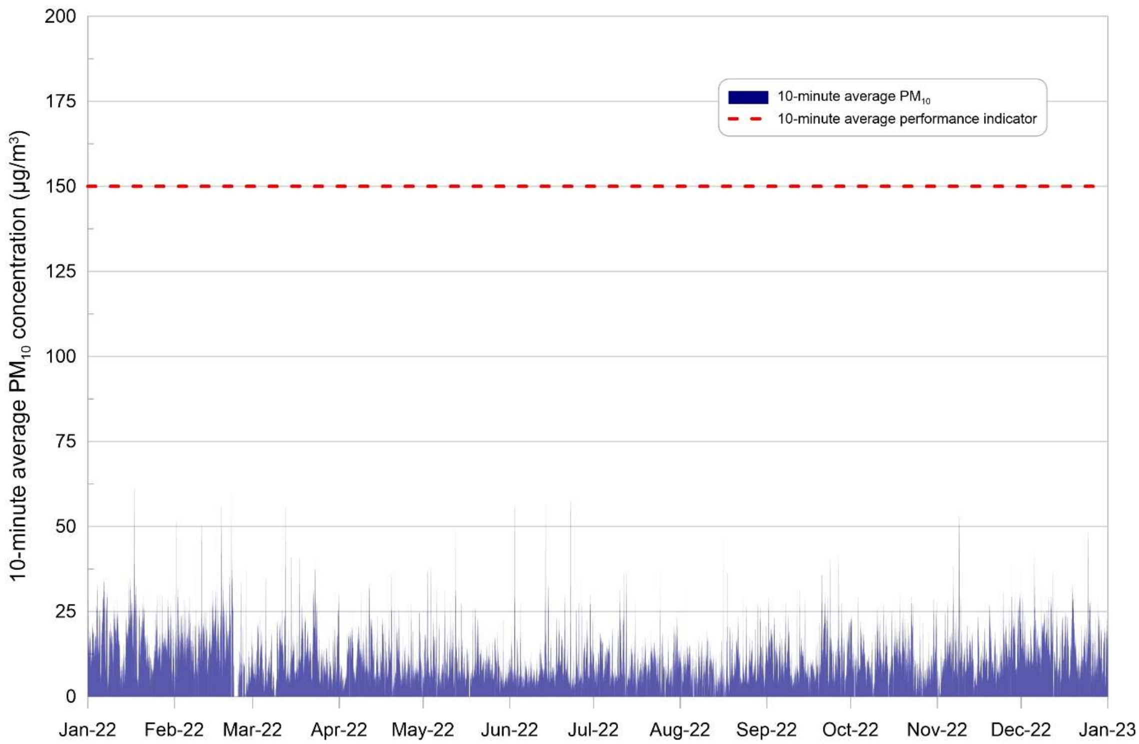

Figure 5-3: 10-minute average PM_{10} concentrations measured by the TEOM – 2022

5.1.3 Long term PM_{10} analysis

Figure 5-4 presents the 24-hour HVAS data for the last ten years, from January 2012 to December 2022. The data show 12 exceedances of the performance indicator over that time and six exceedances of the assessment criterion. These were almost exclusively due to regional events such as prescribed burns or bushfires. The data does not show any trend, either increasing or decreasing over the 11-year period.

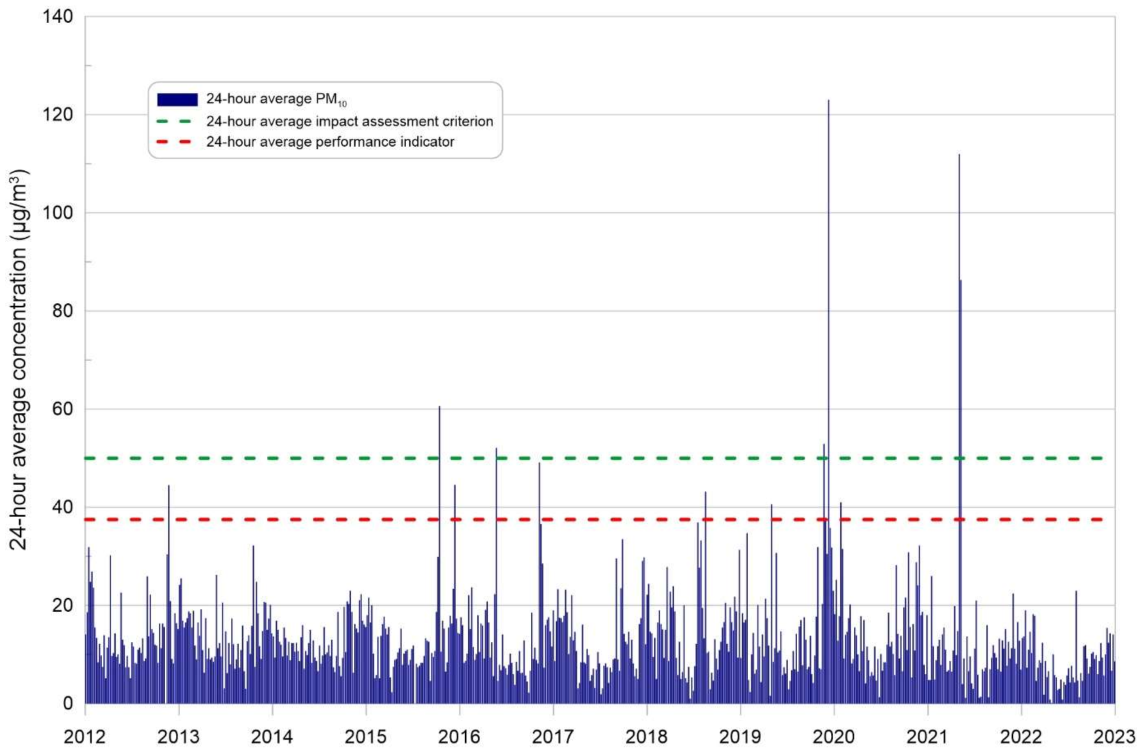

Figure 5-4: 24-hour average PM_{10} concentrations – 2012 to 2022

Figure 5-5 shows the historical annual average PM_{10} measurements from 2007 to 2022. The annual average PM_{10} concentrations for 2022 are not only below the assessment criterion and performance indicator, but also below the long-term average for the site of 14 µg/m³. This figure indicates that the concentrations are influenced by external factors such as drought, with high annual averages in years following significant drought (2009 and 2019), and much lower concentrations in wetter years.

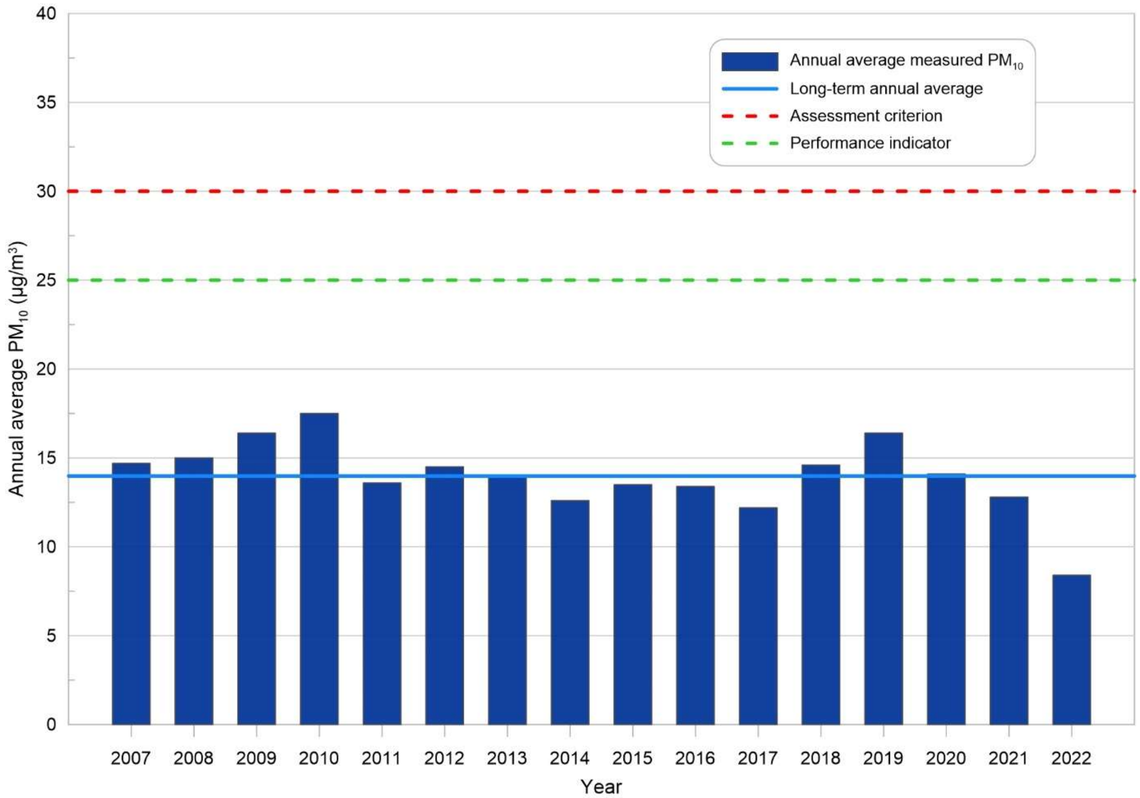

Figure 5-5: Annual average PM_{10} concentrations – 2007 to 2022

5.2 Dust Deposition Gauges (DGs)

As noted in Section 2, there are ten DGs placed at various locations surrounding the Metropolitan Coal site. Samples are collected on a monthly basis (approximately 30 days) and then analysed in a laboratory. For the purposes of this report, the relevant indicator is total insoluble solids, and these results are summarised in Table 5-1.

There was a data capture rate of 100% with 12 samples collected across all ten sites. All gauges recorded annual averages less than the assessment criterion of 4 g/m^2/month and performance indicator of 3 g/m^2/month.

The highest monthly result was 6.7 g/m^2/month, recorded in April at DG9. DG9 also recorded one of the highest annual averages at 1.2 g/m^2/month, also recorded at DG1. Only four of the 120 samples (3%) were greater than 2 g/m^2/month.

This information is also presented in graphical form in Figure 5-6 for monthly results, and in Figure 5-7 for annual averages.

Table 5-1: Monthly and annual average dust deposition rates (insoluble solids) for 2022

Month	DG1	DG2	DG3	DG4^	DG5	DG6	DG7	DG8	DG9	DG10
January	1.6	0.8	0.9	0.5	0.4	0.5	0.8	0.5	0.5	0.5
February	1.5	1	1.1	0.9	0.7	0.8	1.2	0.9	0.1	0.4
March	1.3	0.1	0.3	0.1	0.1	0.7	1.3	0.2	0.5	2
April	1.3	0.5	0.5	0.3	0.2	0.4	0.4	0.7	6.7	0.4
May	1.1	0.2	0.3	0.3	0.2	0.2	0.3	0.8	1.3	0.8
June	0.5	0.2	0.3	0.3	0.3	0.4	0.5	0.3	0.4	0.4
July	0.6	0.5	0.6	0.5	0.2	0.3	0.5	0.4	0.5	0.6
August	1.1	0.3	0.5	0.5	0.1	0.2	0.3	0.5	0.4	0.6
September	0.9	0.5	0.2	0.4	0.2	0.5	0.7	0.6	0.5	0.4
October	1.3	0.2	0.5	0.2	0.1	0.2	0.6	0.9	2	3.9
November	2	0.4	0.7	0.5	0.4	0.6	0.4	0.3	0.8	0.4
December	0.6	2.3	1.2	1	0.6	1.8	2.2	0.9	1	0.7
Average	**1.2**	**0.6**	**0.6**	**0.5**	**0.3**	**0.6**	**0.8**	**0.6**	**1.2**	**0.9**

^ DG4 is a control dust gauge that is located at the Helensburgh Golf Course some 2 km from the Major Surface facilities Area and is not included in the assessment of environmental performance in Section 6.

Historical data are also presented in Figure 5-8, showing the annual average deposition rates for each DG since 2011. While there are occasional elevated values at some DGs in some years, there is no apparent trend, either increasing or decreasing, across the 12 year period. However, it is noted that the annual average deposition rates at DG1 are regularly higher than at other gauges.

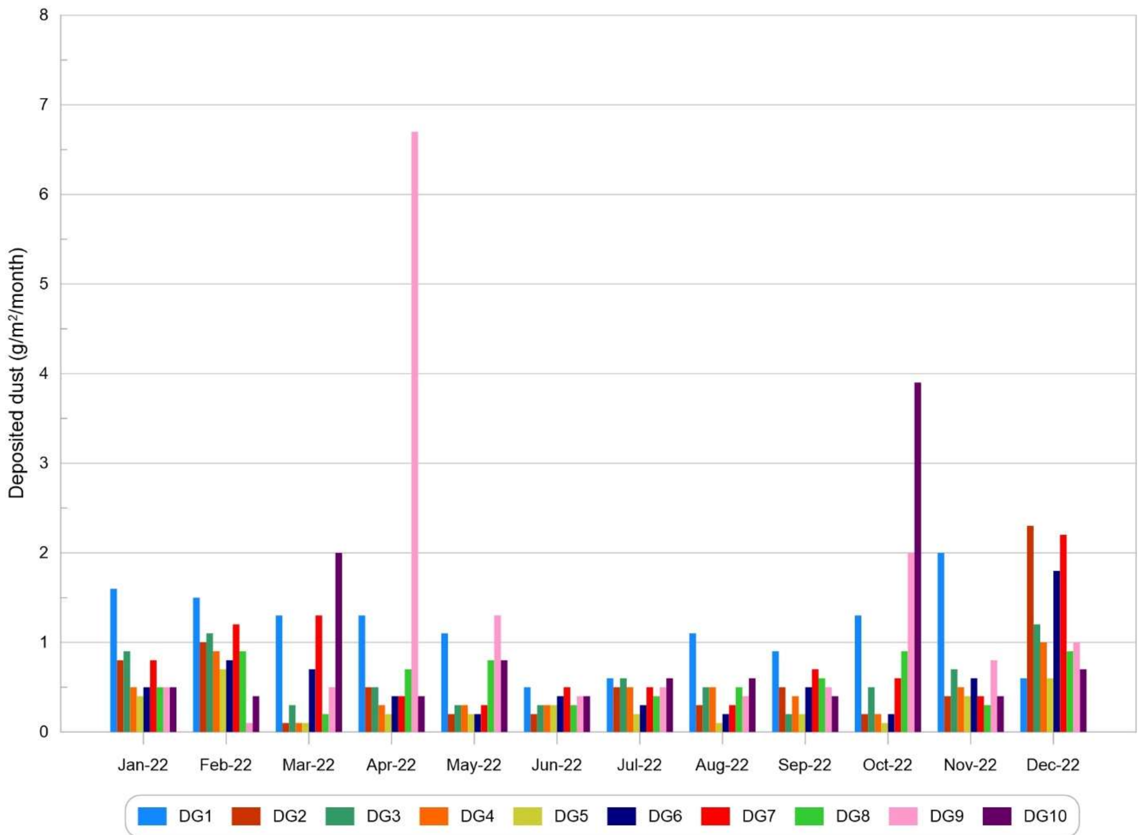

Figure 5-6: Monthly dust deposition rates measured at all dust gauges during 2022

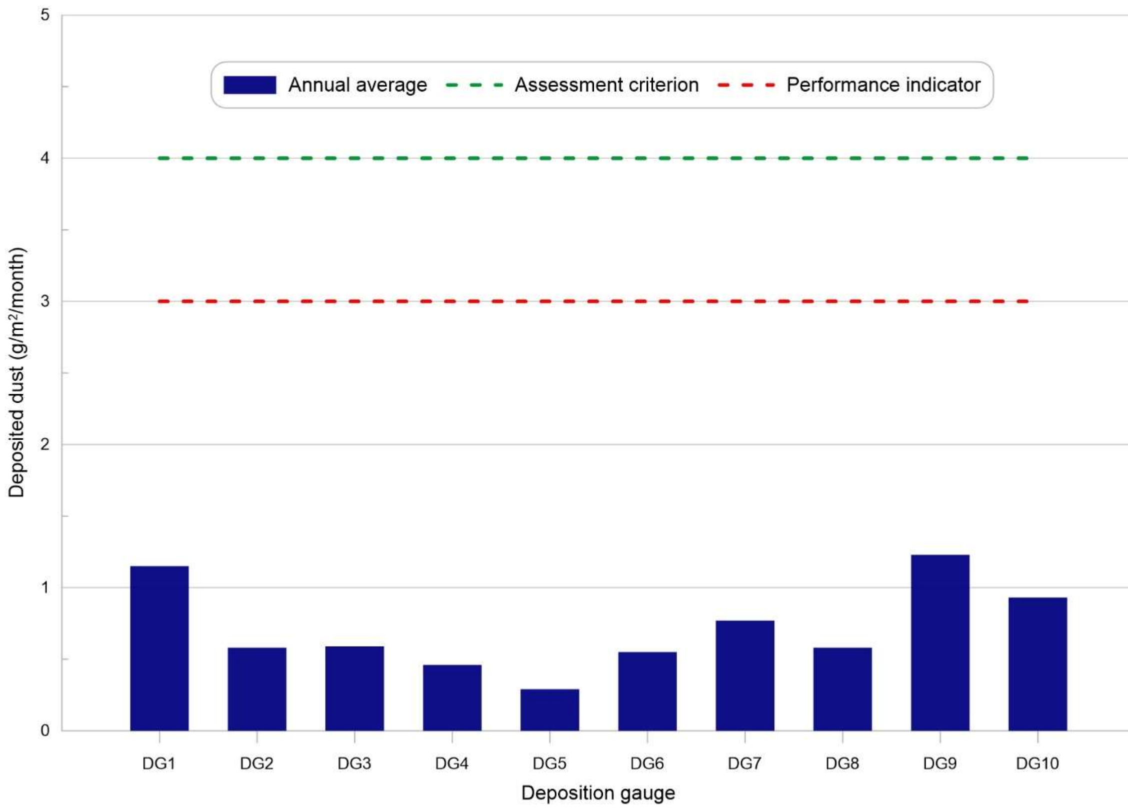

Figure 5-7: Annual average dust deposition rates for all dust gauges in 2022

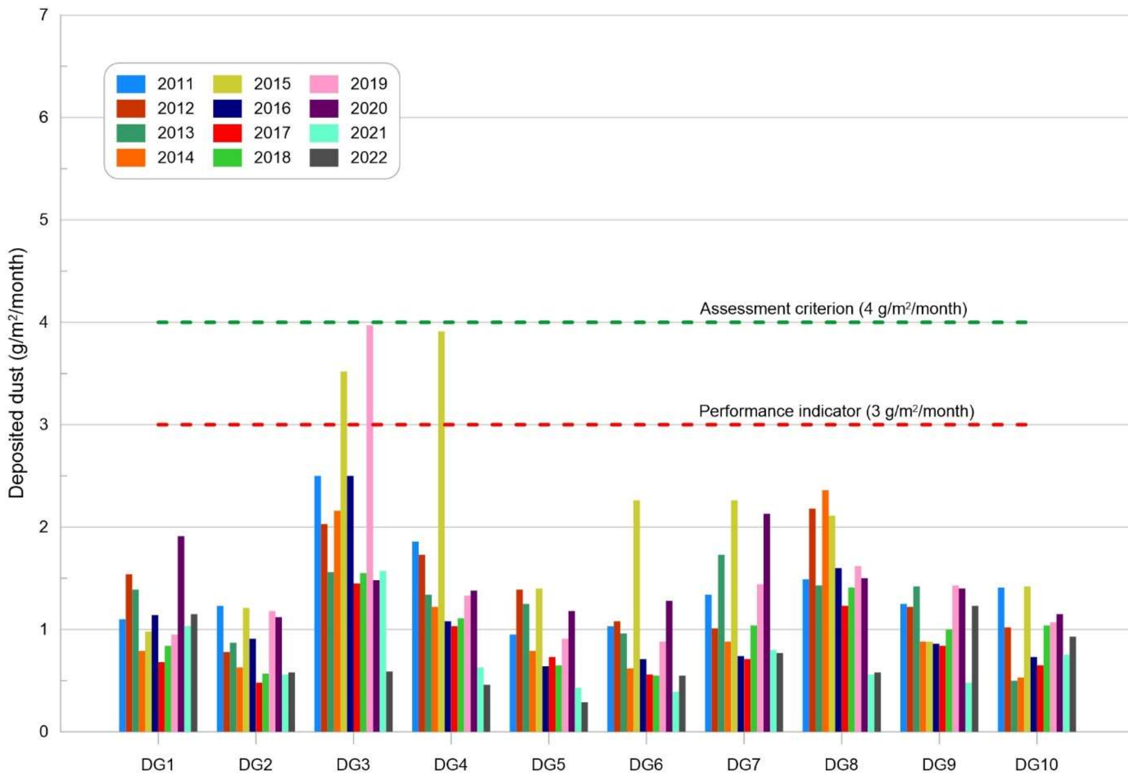

Figure 5-8: Annual average dust deposition rates for all dust gauges from 2011 to 2022

6 ASSESSMENT AGAINST CRITERIA AND PERFORMANCE INDICATORS

6.1 Impact assessment criteria

6.1.1 Particulate matter

Section 5.1 presents the results for both the HVAS and TEOM PM_{10} monitoring. Figure 5-1 no exceedances of the 24-hour average 50 µg/m^3 impact assessment criterion measured at the HVAS, nor at the TEOM, as shown in Figure 5-2.

The highest 24-hour average PM_{10} concentration at the HVAS was 23 µg/m^3 on 2 August 2022. The highest 24-hour average PM_{10} concentration at the TEOM was 26 µg/m^3, measured on 6 January 2022.

The annual averages measured at the HVAS and TEOM, were 8.4 µg/m^3 and 11.5 µg/m^3, respectively, both well below the assessment criterion of 30 µg/m^3. These low values were not unexpected given the significant amount of rainfall experienced throughout the year.

6.1.2 Total suspended particulates

Total suspended particulates (TSP) are not measured directly at the HVAS. Consistent with previous reviews, annual average TSP has been estimated from the PM_{10} measurements by applying a conservative assumption that 40-50% of the TSP is comprised of PM_{10}. This relationship applies across the majority of air sheds and has been validated through data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (NSW Minerals Council, 2000).

Based on the annual average PM_{10} concentrations recorded by the HVAS, the annual average TSP is anticipated to be less than 16.8 µg/m^3, (8.4 µg/m^3 x 2); significantly below the TSP air quality impact assessment criterion of 90 µg/m^3.

6.1.3 Dust deposition

As shown in Section 5.2, the annual average dust deposition rate at all dust gauges remained below the assessment criterion of 4 g/m^2/month. Compliance was achieved with the long-term impact assessment criterion for dust deposition during the reporting period.

6.2 Air quality performance indicators

6.2.1 Particulate matter

Section 5.1 presents the results for both the HVAS and TEOM PM_{10} monitoring. Figure 5-1 shows no 24-hour average concentrations above the 37.5 µg/m^3 performance indicator measured at the HVAS. Similarly, Figure 5-2 shows no exceedances at the TEOM.

Concentrations of 10-minute average PM_{10} measured by the TEOM are presented in Figure 5-3. As detailed in Section 5.1.2, there were no occasions where these 10-minute averages were above the performance indicator of 150 µg/m^3.

The annual averages measured were also well below the performance indicator of 25 µg/m^3, for both the HVAS and TEOM.

6.2.2 Dust deposition

As shown in Section 5.2, the annual average dust deposition rate at all dust gauges remained below the performance indicator of 3 g/m^2/month. Compliance was achieved with the long-term performance indicator for dust deposition during the reporting period.

6.3 Summary

Table 6-1 presents a summary of the assessment against impact assessment criteria and air quality performance indicators.

Table 6-1: Summary of assessment of environmental performance

Monitoring aspect	Impact assessment criteria or performance indicator	Condition met?	Comment
Air Quality Impact Assessment Criteria [1] (Project Approval Condition 11, Schedule 4)	24-hour average PM_{10} (50 µg/m^3)	Yes	No exceedances of the 24-hour average PM_{10} impact assessment criterion of 50 µg/m^3 were observed using either the TEOM or HVAS instruments.
	Annual average PM_{10} (30 µg/m^3)	Yes	An annual average PM_{10} concentration of 8.4 µg/m^3 was recorded by the HVAS monitoring instrument.
	Annual average TSP (90 µg/m^3)	Yes	Based on the annual average PM_{10} concentrations recorded by the HVAS monitoring instrument, the annual average TSP is anticipated to be less than 16.8 µg/m^3, (8.4 µg/m^3 x 2); significantly below the TSP air quality impact assessment criterion of 90 µg/m^3.
	Annual average deposited dust (4 g/m^2/month)	Yes	The annual average dust deposition rates for each of the sites indicate that compliance with the deposited dust performance indicator was achieved at every one of the dust gauges during the reporting period.
Air Quality Performance Indicator [2, 3]	TEOM 10-minute average PM_{10} (150 µg/m^3)	Yes	The maximum 10-minute average PM_{10} concentration recorded by the TEOM was 61.8 µg/m^3 on 13 June 2022, well below the performance indicator of 150 µg/m^3.
	TEOM 24-hour average PM_{10} (37.5 µg/m^3)	Yes	There were no exceedances of the 24-hour average performance indicator concentration.
	HVAS 24-hour average PM_{10} (37.5 µg/m^3)	Yes	There were no exceedances of the 24-hour average performance indicator concentration.
	Annual average PM_{10} (25 µg/m^3)	Yes	An annual average PM_{10} concentration of 8.4 µg/m^3 was recorded by the HVAS monitoring instrument.
	Annual average deposited dust (3 g/m^2/month) [4]	Yes	The annual average dust deposition rates for each of the sites indicate that compliance with the deposited dust performance indicator was achieved at every one of the dust gauges during the reporting period.

[1] PM_{10} air quality impact assessment criteria to be determined using HVAS data
[2] Total measured excluding extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities
[3] Background PM_{10} concentrations due to all other sources plus the incremental increase in PM_{10} concentrations due to the mine alone
[4] Dust deposition performance indicator to be assessed using DG1 to DG10 excluding DG4, which is a control dust

7 MANAGEMENT AND MITIGATION MEASURES

7.1 Air quality

A number of measures have been implemented to manage and mitigate air quality impacts at Metropolitan Coal, including:

- enclosed conveyor systems;
- the operation of automated water sprays on stockpile areas based on meteorological forecasts;
- the implementation of the recommendations of the Metropolitan Colliery Site Specific Particulate Matter Control Best Practice Assessment, including the installation of dust control sprays on the run of mine (ROM) stockpile;
- watering of haulage roads and stockpile areas with a water truck when required;
- sealed car parks and yard areas;
- planting of native plants on exposed areas to stabilise soils; and
- deployment of a real-time portable dust monitoring system to supplement the data acquired by the static air quality monitoring network.

Metropolitan Coal has also implemented the following measures to minimise dust emissions associated with off-site coal and coal reject haulage:

- offsite rail transport of Coal Wash Reject, minimising trucking;
- rail profiler to evenly spread coal in train wagons to minimise turbulence and dust generation during travel
- a project implemented to maximise coal yield thereby reducing reject trucking;
- automatic covers fitted to coal reject haulage trucks;
- all haulage vehicles are required to pass through a truck wash before leaving the site; and
- the mine entrance road is washed on an as-needed basis;

7.2 Energy and greenhouse gas

In addition to the air quality measures discussed above, Condition 10, Schedule 4 of the Project Approval requires that Metropolitan Coal implement all reasonable and feasible measures to minimise

a) energy use on site; and

b) the scope 1, 2 and 3 greenhouse gas emissions produced on site,

to the satisfaction of the Director-General (now secretary) of the Department of Planning and Environment (DPE).

Scope 1 and Scope 2 greenhouse gas emissions are emissions due to the operation of the Project and consumption of electricity on-site. Scope 3 greenhouse gas emissions are emissions that will result from the off-site transport and combustion of the coal produced by the Project, plus emissions associated with the production of diesel that is used on-site.

Table 7-1 outlines the key greenhouse gas emission sources and the respective scope of emissions.

Table 7-1: Summary of Project CO_2-e emission sources

Project component	Direct emissions (Scope 1)	Indirect emissions (Scope 2)	Indirect emissions (Scope 3)
Consumption of diesel fuel to power on-site equipment	Emissions from the combustion of diesel during operations	N/A	Emissions attributable to the extraction of diesel fuel
Electricity consumption	N/A	Emissions resulting from generation of the electricity consumed during operations	Emissions attributable to the extraction of fuel used in electricity generators
Coal extraction (gas flaring and ventilation)	Emissions resulting from venting or burning methane and venting carbon dioxide (CO_2)	N/A	N/A
Transporting product and reject coal by truck	N/A	N/A	Emissions from the combustion of diesel from third-party truck operators
Transporting product coal by train	N/A	N/A	Emissions from the combustion of diesel from third-party train operators
Steelmaking	N/A	N/A	Emissions generated from off-site coke usage for steel and iron production