Vulcan South AEMP

Prepared for:

METServe Pty Ltd

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Final

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Glossary

Term	Definition
µg/m^3	micrograms per cubic metre
µm	microns
°	degrees
°C	degrees Celsius
km	kilometres
m	metres
mg/m^2/day	milligrams per square metre per day
m/s	metres per second
Mtpa	Million tonnes per annum
UTM	Universal Transverse Mercator
Nomenclature	**Definition**
DDEP	dust deposition
PM_{10}	particulate matter with a diameter less than 10 micrometres
Abbreviation	**Definition**
AEMP	Air Emissions Management Plan
Air EPP	Environmental Protection (Air) Policy 2019
Air NEPM	National Environmental Protection (Ambient Air Quality) Measure
AS/NZS	Australian and New Zealand Standards
BAM	Beta Attenuation Monitor
BoM	Bureau of Meteorology
CHPP	Coal handling and processing plant
DETSI	Department of Environment, Tourism, Science and Innovation
EA	Environmental Authority
EHP	Department of Environment and Heritage Protection (Qld)
EP Act	*Environmental Protection Act 1994*
FY	Financial year
GDA	Geocentric Datum of Australia
MGA	Map Grid of Australia
ML	Mining Lease
NPI	National Pollutant Inventory
NSW	New South Wales
PRC	Peer Review Committee
QLD	Queensland
ROM	Run-of-mine
SSE	Site Senior Executive
TARP	Trigger Action Response Plan
TEOM	Tapered Element Oscillating Microbalance
TLO	Train load-out area
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VSAQA	Vulcan South Air Quality Assessment
VSP	Vulcan South Project

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Mining and Energy Technical Services Pty Ltd (METServe) on behalf of Vitrinite Pty Ltd (Vitrinite) to develop an Air Emissions Management Plan (AEMP) for the Vulcan South Project (VSP). The VSP is an open cut coal mine located approximately 45 km south of Moranbah and 20 km north of Dysart in Queensland's Bowen Basin. The VSP is situated within mining lease ML700060 immediately south and west of several established mining operations including BMA's Peak Downs and Saraji mines.

The VSP will operate for 9 years and will extract approximately 13.5 million tonnes (Mt) of Run of Mine (ROM) hard coking coal at a rate of up to 1.95 million tonnes per annum (Mtpa). Truck and shovel mining methods will be employed to develop three open cut pits. The site will include development of a mine infrastructure area and a modular coal handling and preparation plant (CHPP), rail loop and train load-out facility (TLO). The CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product for permanent storage within active waste rock dumps. Waste rock material will be dumped in previously excavated active pit areas for progressive rehabilitation.

The VSP was recently granted Environmental Authority (EA) Permit: P-EA-100265081. The EA requires that VSP establish an AEMP as developed by an appropriately qualified person for all stages of the authorised activity and that the AEMP be submitted to the Department of Environment, Tourism, Science and Innovation (DETSI) before commencement of operations.

This report addresses the requirements of the EA to develop an AEMP for the VSP. The details and outcomes of this AEMP report can be incorporated into Vitrinite's emissions management documentation suitable for submission to DETSI.

1.1 Scope of the AEMP

The key objectives of the AEMP, as discussed in this report, are as follows:

- provide a single document detailing all the components necessary for implementing an AEMP which can be referred to and revised as necessary
- detail the legislative requirements and Australian Standards which the AEMP must address and according to which the meteorological and air quality monitoring network must operate (Section 2)
- describe the regional context for the VSP within which the AEMP must operate, including identification of sensitive receptors to be protected by the AEMP, existing monitoring stations, and an analysis of existing air quality and meteorology (Section 3). This information will help to inform the foundational basis for establishing suitable monitoring to support an effective AEMP via a robust Trigger Action Response Plan (TARP).
- detail routine dust management practices to be implemented at the VSP site and additional options for dust and particulate mitigation (Section 3.3). These mitigation options will inform actions which can be implemented within the TARP in response to triggers.
- describe the monitoring plan to be established to support the AEMP and TARP (Section 5). Monitoring requirements, equipment types, monitoring locations, target pollutants, and data management and forecasting are discussed.
- provide details on TARP trigger levels and responses including complaints handling and record keeping (Section 6)
- detail a suitable dust-risk and forecasting system to assist with the continuous improvement and continued relevance of the AEMP and TARP while providing additional benefits through data collation, TARP

implementation, annual and triennial reviews and report writing, and data provision and presentation to relevant parties (Section 7)

- provide guidance for review and revision of the AEMP and its components, primarily the monitoring network and TARP (Section 8)
- list personnel and training requirements for those responsible for implementing the monitoring network and AEMP and TARP (Section 9).

To develop an effective AEMP for the VSP it is critical to understand the operations which will occur at the mine that contribute to emissions of dust and particulates and how these can be managed. It is also important to understand the regional context within which the VSP operates, particularly regarding other emissions sources and the locations of sensitive receptors to be protected by the AEMP. The most critical practical components of the AEMP are the monitoring network and TARP, with the siting of the monitoring equipment and the design of the TARP being largely dependent on the above matters.

Emissions associated with coal mining operations are typically assessed in terms of particulate matter with an aerodynamic diameter of 10 microns (µm) or less (PM_{10}), and dust deposition. Dust and particulates in elevated concentrations have the potential to cause adverse impacts on the amenity and health of people living in the vicinity of mining operations. Each pollutant poses different risks such that:

- Particulates (PM_{10}) which are inhalable pose health risks especially for vulnerable populations including elderly people, children or those with pre-existing respiratory conditions
- Deposited dust is primarily a concern for nuisance and amenity, soiling houses, vehicles and clothing, however, it can cause greater issues depending on the chemicals/elements which are bound to the dust and when the dust enters sources of drinking water or soils edible crops.

To characterise the risk of impacts at sensitive receptors from these pollutants arising from the VSP, this report has analysed existing dust and particulate monitoring data and meteorological monitoring data available in the local region. Katestone previously conducted an air quality assessment of the VSP that incorporated dispersion modelling (*Vulcan South Air Quality Assessment*, September 2022) (VSAQA), and the outcomes of this assessment have been utilised to inform aspects of this AEMP, including consideration of the risk of impacts, monitoring locations and dust mitigation strategies.

1.2 Vulcan South Project

Nearby MLs and the maximum extent of VSP mining operations are presented in Figure 1. It is important to consider the nearby sources when siting the monitors utilised in the AEMP and TARP; monitoring locations should ideally enable the differentiation of dust and particulates contributed by the VSP from those contributed by other nearby mines and background sources. The monitoring locations will also need to appropriately account for the gradual progression of mining operations within the Mine ML.

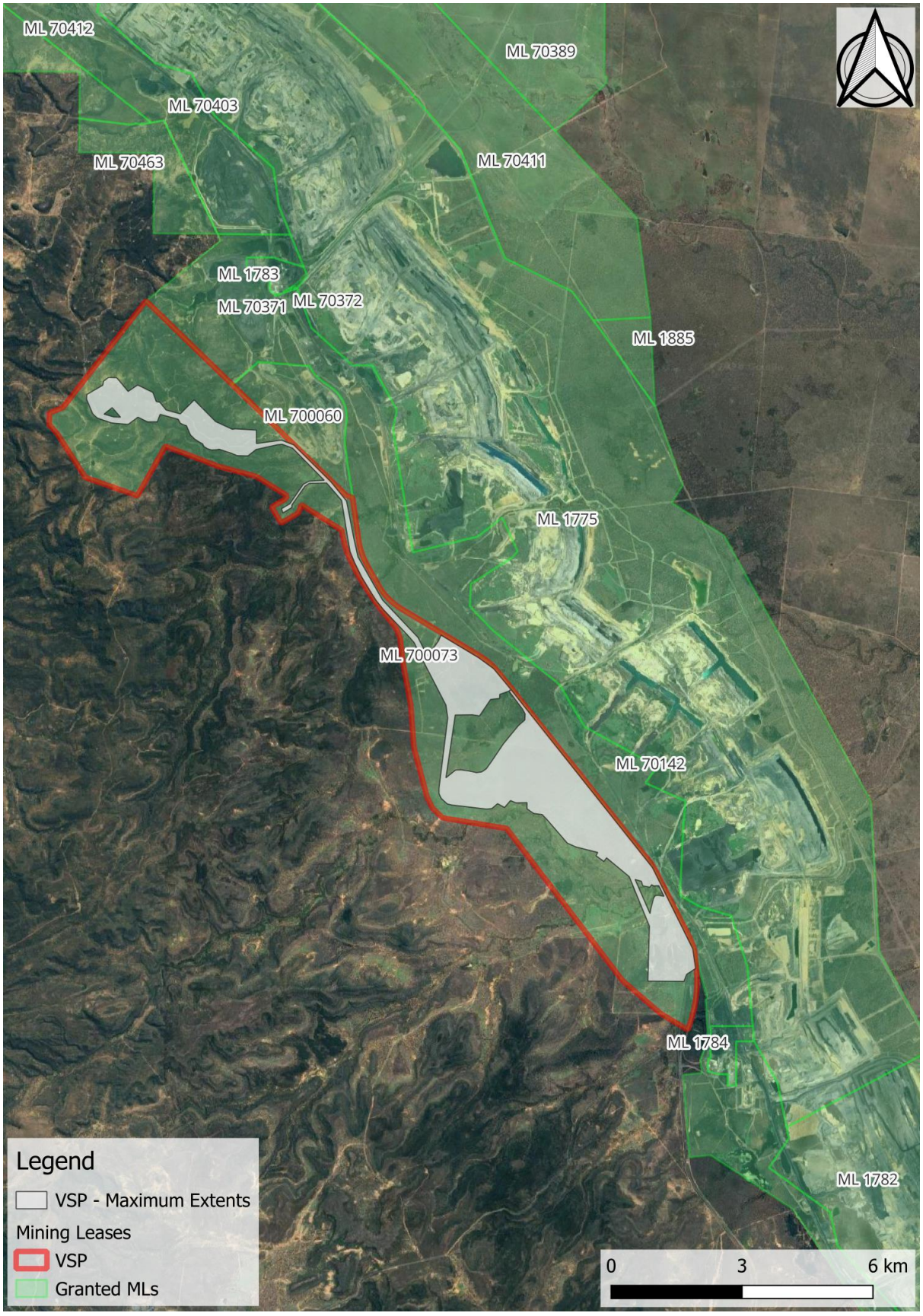

Figure 1 **VSP maximum mining extents and local mine leases**

Key dust-generating activities associated with the VSP will include:

- topsoil stripping;
- drilling and blasting;
- extraction and haulage of overburden and ROM coal;
- wind erosion of stockpiles, exposed and rehabilitated areas;
- material handling at CHPP and rail load out;
- dozers on stockpiles;
- other material handling (such as transfers to and from stockpiles, etc.); and
- road grading.

Figure 2 shows the layout of the operational areas where the above key dust-generating activities will occur. Mining will move from the north to the south, with previously mined areas being progressively rehabilitated. These mining activities will be the primary targets for mitigation strategies employed by the TARP and will be the main sources of emissions to capture using the monitoring network.

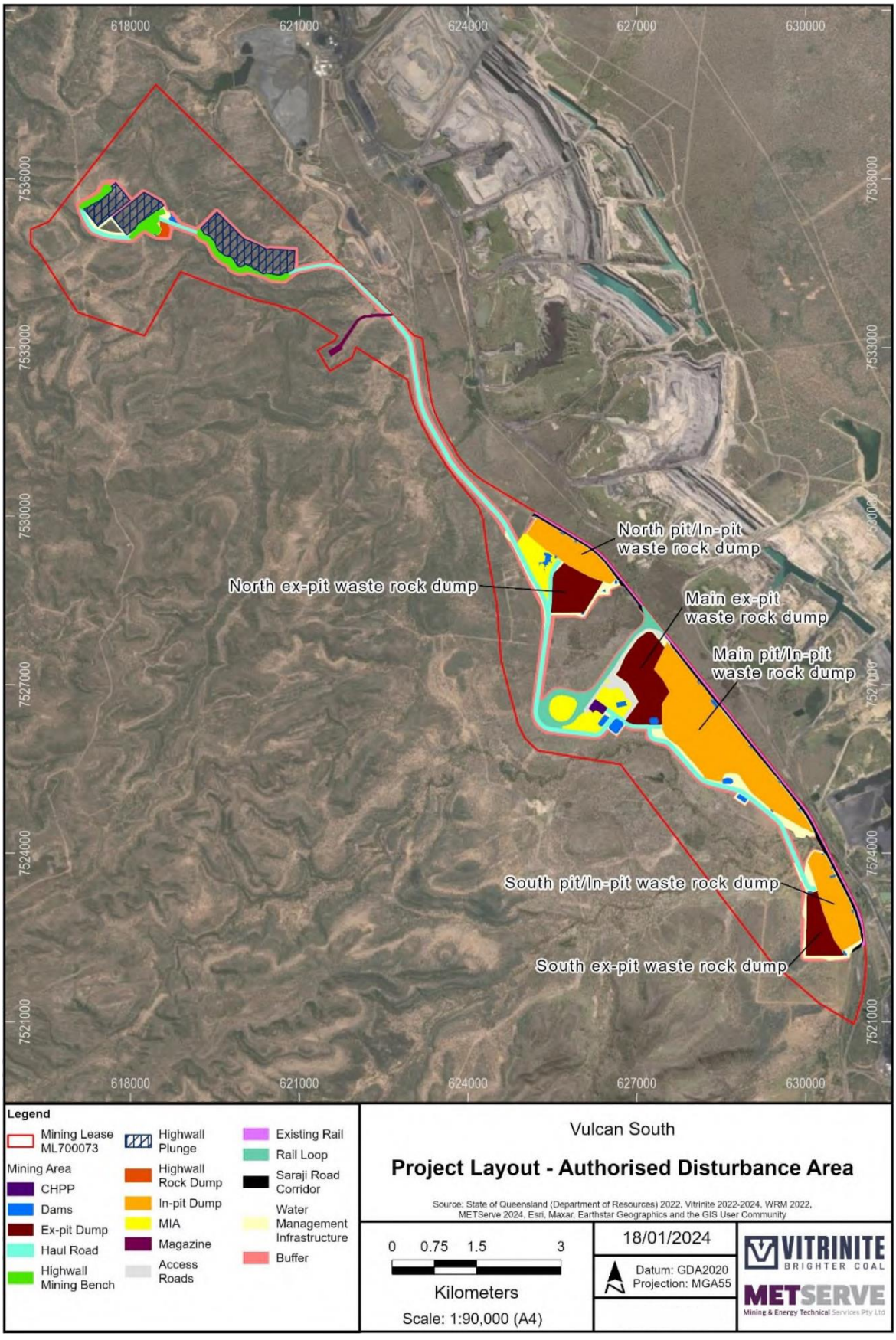

Figure 2 **VSP operational areas**

2. LEGISLATION

This section details the relevant legislative requirements and guidelines and procedures which the AEMP must consider. Air quality objectives are also presented; one of the AEMP's key purposes is ensuring that mine-related emissions do not result in exceedances of these objectives at any sensitive receptors.

2.1 National Environmental Protection Measure

The *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) details the obligations for state and territory governments to conduct ambient air quality monitoring and sets air quality standards for a number of air pollutants. The latest variation of the Air NEPM was issued in 2021. The Air NEPM includes air quality standards for PM_{10} that are relevant to the VSP as detailed later in Table 2 (see Section 2.4).

The Air NEPM also includes technical papers developed by the Peer Review Committee that detail how to collect, handle and analyse air quality monitoring data. Relevant technical papers include:

- National Environment Protection (Ambient Air Quality) Measure Technical Paper No.5. Data Collection and Handling, Peer Review Committee (PRC, 2001)
- National Environment Protection (Ambient Air Quality) Measure Technical Paper No.6. Meteorological Measurements, Peer Review Committee (PRC, 2001)
- National Environment Protection (Ambient Air Quality) Measure. Technical Paper No.8. Annual Reports, PRC 2002 Peer Review Committee (PRC, 2002).

Relevant data collection and handling practices from these papers are included in Section 5.3 of this AEMP report.

2.2 Environmental Protection Act

The Environmental Protection Act 1994 (EP Act) provides for the management of the air environment in Queensland. The EP Act gives DETSI the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity.

The *Environmental Protection (Air) Policy 2009* (Air EPP) was made under the EP Act and gazetted in 1997; the Air EPP was revised and reissued in 2019. The objective of the Air EPP is to identify the environmental values of the air environment to be enhanced or protected and to achieve the objective of the EP Act, that is, ecologically sustainable development.

The environmental values to be enhanced or protected under the Air EPP are the qualities of the environment that are conducive to:

- protecting health and biodiversity of ecosystems
- human health and wellbeing
- protecting the aesthetics of the environment, including the appearance of building structures and other property
- protecting agricultural use of the environment.

The administering authority must consider the requirements of the Air EPP when it decides an application for an environmental authority (EA), amendment of a licence or approval of a draft environmental management plan. Schedule 1 of the Air EPP specifies air quality indicators and objectives for specific air pollutants.

2.3 Environmental Authority

The VSP is subject to EA P-EA-100265081. Schedule B of the EA details conditions relating to air quality, including the establishment of an AEMP. Schedule B conditions largely relate to EA Table B1, depicted here in Table 1. Pertinent conditions of Schedule B relating to the AEMP are reproduced below:

B4 Air quality monitoring exceedance

If air quality monitoring indicates an exceedance of any relevant limit in Table B1 – Ambient air quality limits, dust abatement measures must be immediately implemented in accordance with the Air Emissions Management Plan required under condition B8, to minimise any adverse impacts to the sensitive place and to limit further exceedances.

NOTE: Exceedances due to events that cannot be managed by the environmental authority holder, such as bushfires, fuel reduction burning for fire management purposes or dust storms, would not be considered to be in breach of condition B4 if the environmental authority holder can demonstrate that the exceedance was caused by such events.

B5 The environmental authority holder must determine if an exceedance recorded under condition B4 is a result of the authorised activities being undertaken.

B6 A report must be provided to the administering authority within ten (10) business days of an exceedance in the air quality limits of Table B1 – Ambient air quality limits that is a result of authorised activities being undertaken as determined under condition B5. The report must detail:

- *a) the air quality data at the sensitive place;*
- *b) a description of meteorological conditions recorded in accordance with Table B1 – Ambient air quality limits occurring at the time;*
- *c) the air quality data upwind of the authorised activities (if known);*
- *d) measures taken to reduce dust generated by the authorised activities including those undertaken under condition B4; and*
- *e) the contribution of the authorised activities to the PM10 concentration and dust deposition at the sensitive place.*

B7 The air quality monitoring required by condition B2 remains effective and targeted through the life of the project with the monitoring locations reviewed annually. The annual review should consider:

- *a) the frequency and cause of any exceedances of air quality limits measured by the air quality monitoring program conducted under this environmental authority over at least the preceding two (2) years;*
- *b) dust complaints;*
- *c) future progression of the mining activity;*
- *d) locations of sensitive and commercial places relative to the mining activity; and*
- *e) mining activity types.*

B8 Air Emissions Management Plan

An Air Emissions Management Plan must be developed by an appropriately qualified person and implemented for all stages of the authorised activity and submitted to the administering authority on, or before the commencement of authorised activities.

B9 The Air Emissions Management Plan required by condition B8 must incorporate a program for continuous improvement for the management of dust and particulate matter resulting from the authorised activities with respect to, but not limited to:

a) the collection of air quality and meteorological data at locations and using the monitoring methods described in Table B1 – Ambient air quality limits; and

b) a system to identify adverse meteorological conditions likely to produce elevated levels of dust deposition, PM10 at a sensitive place due to the authorised activities; and

c) a dust and particulate matter control strategy which:

i. activates a timely implementation of management control action;

ii. acts in response to the system required by condition B9(b);

iii. acts in response to any air quality monitoring that indicates a potential for an exceedance of the air quality limits of Table B1 – Ambient air quality limits.

B10 The Air Emissions Management Plan required by condition B8 must be reviewed every three (3) years by an appropriately qualified person and any recommendations incorporated into the Air Emissions Management Plan.

Table 1 P-EA-100265081 Table B1 - Ambient air quality limits

Monitoring locations	Air Quality Determination/ Indicator	Air quality limit	Averaging period	Frequency	Monitoring Method
All sensitive places within 6km of mine site*	Particulate matter less than 10µm in aerodynamic diameter (PM_{10})	50µg/m^3	24 hour	Continuous	AS3580.9.8 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} continuous direct mass method using tapered element oscillating microbalance analyser.
All sensitive places within 6km of mine site*	Dust deposition	120 mg/m^2/ day	Monthly	Monthly	AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter — Deposited matter – Gravimetric method.
Weather Station	Meteorological data (including but not limited to wind speed and direction, relative humidity, temperature, precipitation and rainfall intensity, solar radiation)	N/A	Continuous (minimum 1-hour average)	Continuous	1. Monitoring by automatic meteorological station(s) 2. Australian Standard AS/NZS 3580.14 Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications; or 3. an alternative method approved by the administering authority.

2.4 Air quality objectives

The air quality objectives relevant to this AEMP are detailed in Table 2, having been derived from the Air NEPM, Air EPP and EA. The Air EPP does not specify an objective for dust deposition, however, the VSP EA does. The objective given in the EA is included in Table 2 and is a typical value for managing amenity impacts from deposited dust.

Table 2 Ambient air quality objectives

Pollutant	Averaging Period	Objective	Reference
PM_{10}	24-hour average	50 ug/m^3	Air NEPM/Air EPP 2019/ P-EA-100265081
	Annual average	25 ug/m^3	Air NEPM/Air EPP 2019
Dust deposition	Monthly	120 mg/m^2/day	P-EA-100265081

2.5 Australian Standards for air quality monitoring

Ambient air quality monitoring stations should be sited and operated in accordance with all relevant Australian Standards. By adopting the relevant Australian Standards this will ensure that the data collected is of the highest integrity. The relevant standards are described in Appendix A, which includes standards outlined in the EA conditions and suitable alternative monitoring methods.

A weather station should be sited so the variables measured are representative of the dominant wind flows at the subject site and the surrounding region. Local scale obstructions can cause variations in meteorological parameters that mean that the data are not representative and must, therefore, be avoided. Meteorological monitoring stations should be sited in accordance with AS/NZS 3580.14, as described in Appendix A.

3. EXISTING ENVIRONMENT

This section describes the existing environment surrounding the VSP as relevant to the AEMP.

Sensitive receptors are identified in Section 3.1, which are the locations to be protected from dust and particulate impacts by the AEMP and TARP.

Meteorological data analysis assists with identifying expected dispersion patterns of dust and particulates from the mine and, subsequently, with determining the suitability of monitoring site locations for effective use under the TARP. Meteorological data analysis is presented in Section 3.2.

Analysis of the existing air quality monitoring data, identification of other existing local dust emissions sources and consideration of historic assessment work that identifies the likely impacts of the VSP's operations is provided in Section 3.3.

3.1 Sensitive receptors

Table 3 and Figure 3 describe the location of one nearby sensitive receptor relevant to the AEMP and TARP. This receptor is the only one within the 6 km designation contained in P-EA-100265081 Table B1 (Table 1).

When considering sensitive receptors and locations to install monitoring equipment the following should be considered:

- The sensitivity of a particular receptor to dust and particulate impacts with respect to location relative to mining, extent of occupation (e.g. a few hours per day or all year round), sensitivity of the inhabitants, and ability for the receptor to mitigate impacts. In this case, the sensitive receptor is a permanent dwelling near to mining with minimal opportunities to mitigate impacts.
- the distribution of wind directions to determine how often a receptor is downwind from the mining operation
- what other sources are present and likely to contribute to measured levels of dust and particulates
- whether the monitoring can satisfy all conditions of the EA.

The AEMP will need to ensure that impacts resulting from operations at the VSP do not result in exceedances at the O'Sullivan Residence. Monitoring will need to be conducted at the residence or a suitably representative location near to the residence.

For the consideration of VSP's contribution to concentrations at the O'Sullivan Residence, it should be noted that the O'Sullivan Residence will potentially be downwind of some part of the VSP mining operation when the wind is from between 321-24°.

Table 3 Sensitive receptor

Name	Type	X-coordinate (UTM m, GDA2020, z55)	Y-coordinate (UTM m, GDA2020, z55)
O'Sullivan Residence	Residential (permanent residence)	629,574	7,519,127

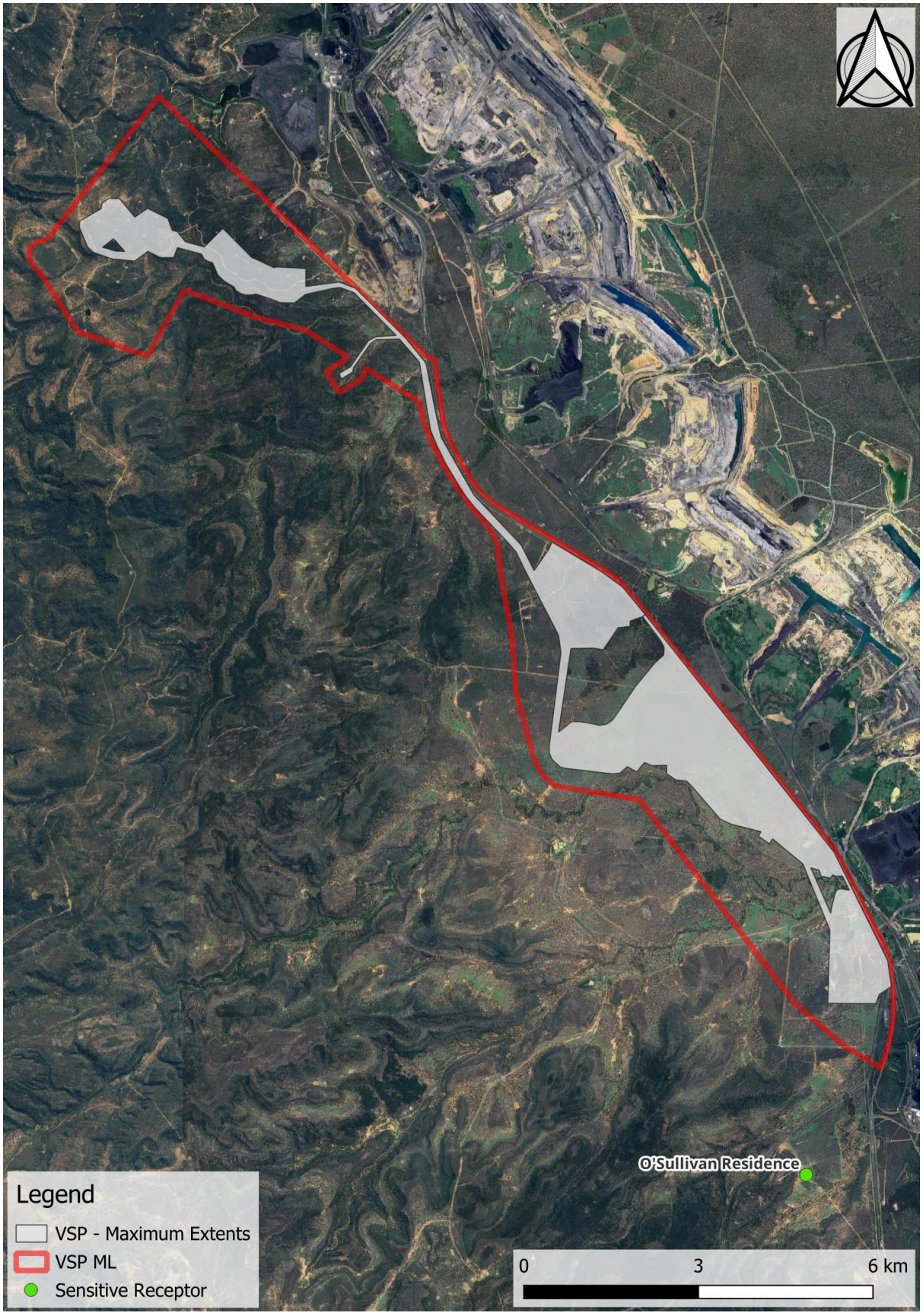

Figure 3 Sensitive receptor

3.2 Meteorology

3.2.1 Analysis of meteorological data

Analysis of meteorological data has considered three sources of data:

- Purchased data from the Bureau of Meteorology (BoM) automatic weather station at the Moranbah airport, approximately 24 km north from the northern edge of the VSP ML, covering the period 1 January 2019 – 14 August 2024
- Publicly available meteorological monitoring data from the DETSI monitoring stations in Moranbah East and Moranbah West, approximately 30 km north from the northern edge of the VSP ML, covering the period 1 January 2019 – 31 December 2023 and 27 June 2020 – 31 December 2023, respectively. Note that published data for 2024 at these sites is not yet available in a validated format.
- Meteorological monitoring data provided by METServe for the existing meteorological monitoring station located at the Vitrinite Vulcan Project mine site, approximately 10 km north of the VSP rail-loop for the period 1 January 2023 to 7 November 2024.

The monitoring data is summarised in Table 4 and annual wind roses for each monitor are depicted in Figure 4. The monitoring data show the following:

- All monitoring sites shows a majority of winds from the southeast through to northeast
- Wind speeds differ between the sites, likely indicative of differences in terrain and surrounding landuse.
- Monitoring data for the Vulcan Project mine site does not appear to be reliable, with wind speeds averaging approximately 0.1 m/s. This is likely attributable to the monitor being approximately 3 m above ground and near to buildings and trees. This current monitoring setup would not achieve the requirements of the AEMP and will, therefore, need to be replaced with a station that accords with AS/NZS 3580.14, as described in Appendix A.
- Based on the wind roses in Figure 4, the O'Sullivan Residence will rarely be downwind of VSP mining operations. Winds from the north-northwest to north-northeast, those that would place the residence downwind of mining operations, are very infrequent.
- Wind direction should inform TARP triggers, with alerts only generated when the O'Sullivan Residence is downwind of VSP mining operations and monitoring suggests that VSP mining operations are contributing significantly to measured concentrations near to the O'Sullivan Residence.

Table 4 Summary of 1-hour averaged regional meteorological data

Parameter	Monitoring Site	Year					
		2019	2020	2021	2022	2023	2024
Average Temperature (°C)	BoM Moranbah	22.9	23.1	22.8	22.3	22.7	21.8
	DETSI Moranbah East	23.3	23.8	23.6	23.2	23.3	-
	DETSI Moranbah West	-	21.6	24.1	22.0	22.6	-
	Vulcan	-	-	-	-	22.0	15.2
Average Wind Speed (m/s)	BoM Moranbah	4.2	4.0	3.9	3.8	3.8	4.0
	DETSI Moranbah East	2.0	2.0	1.9	1.8	1.7	-
	DETSI Moranbah West	-	2.5	2.4	2.0	2.1	-

Parameter	Monitoring Site	Year					
		2019	2020	2021	2022	2023	2024
	Vulcan	-	-	-	-	0.1	0.1
Wind Speed Data Capture (%)	BoM Moranbah	99.9%	100.0%	100.0%	99.2%	99.4%	99.9%
	DETSI Moranbah East	100.0%	99.9%	99.9%	99.9%	99.9%	-
	DETSI Moranbah West	-	51.2%	41.7%	58.5%	87.7%	-
	Vulcan	-	-	-	-	92.6%	100.0%
Wind Direction Data Capture (%)	BoM Moranbah	99.9%	100.0%	100.0%	99.2%	99.4%	99.9%
	DETSI Moranbah East	99.9%	99.8%	99.8%	99.7%	99.9%	-
	DETSI Moranbah West	-	51.2%	41.6%	58.3%	87.7%	-
	Vulcan	-	-	-	-	92.6%	100.0%

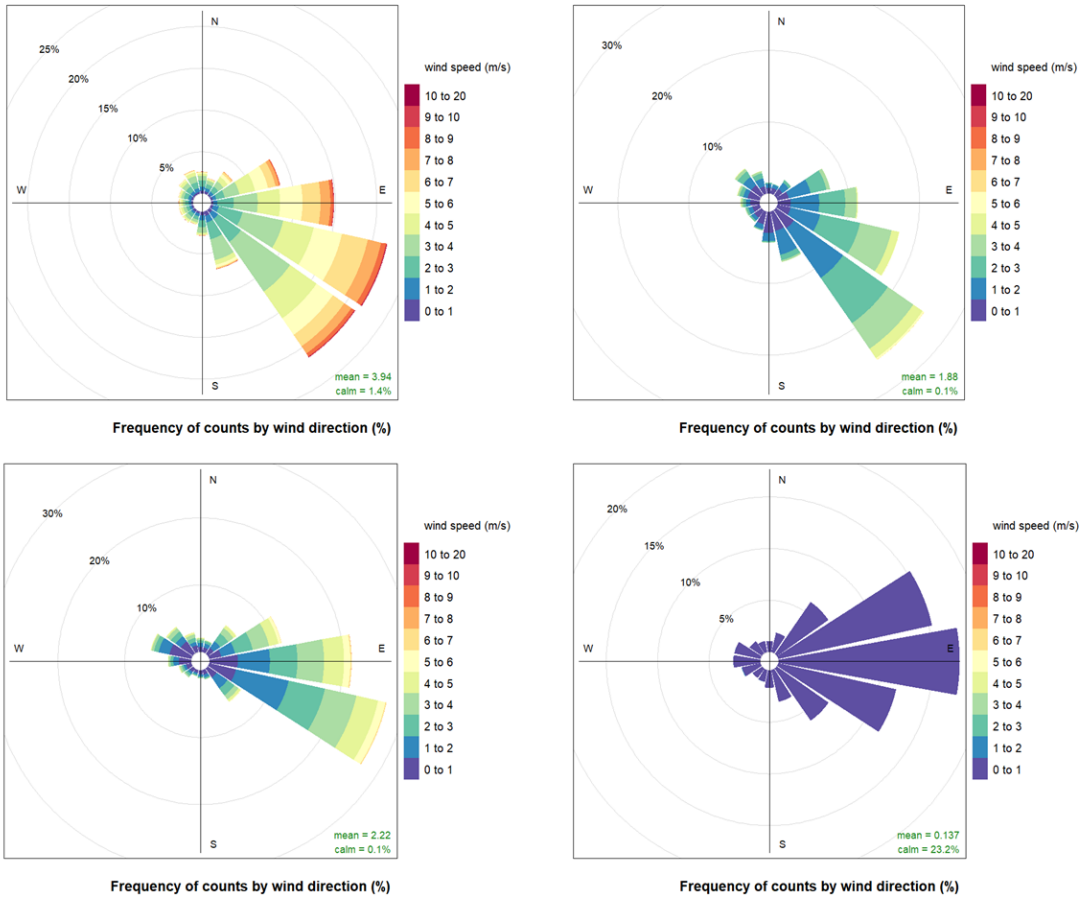

Figure 4 **Annual distribution of winds at the BoM Moranbah Airport (upper-left), DETSI Moranbah East (upper-right), DETSI Moranbah West (lower-left), and Vulcan Coal Mine (lower-right) monitoring stations**

3.3 Air quality

3.3.1 Existing local dust emission sources

Industries near the VSP producing significant emissions of PM_{10} have been identified through a review of the National Pollutant Inventory (NPI) database (NPI 2018/19 - NPI 2022/23) and are detailed in Table 5. Reported emissions for the region are exclusively attributable to coal mining. The nearest operations are the Peak Downs (ML 1775), Vulcan (ML 700060), and Saraji (ML 1784) coal mines which immediately abut the VSP mining lease to the east and north, as depicted in Figure 1.

Emissions from these nearby mines are expected to continue during the operation of the VSP. Given the proximity and locations of these nearby mines relative to the VSP and O'Sullivan Residence, an important consideration for the monitoring network will be the ability to differentiate between contributions to particulate concentrations from the VSP and other nearby mining operations.

Table 5 Summary of facilities within 25 km of the Mine area which reported dust emissions to NPI (FY18/19 to FY22/23)

Facility Name	Main Activities	PM_{10} (t/yr)				
		2019	2020	2021	2022	2023
Lake Vermont	Open cut coal mining	8,074	9,921	20,356	10,561	9,020
Saraji Mine	Coal Mining	6,961	8,218	8,547	7,364	7,373
Peak Downs Mine	Coal Mining	13,426	14,599	15,242	12,250	11,807
South Walker Creek Mine Operations	Coal Mining	2,941	3,458	3,634	5,397	5,603
Vulcan Coal Mine	Coal Mining	-	-	-	167	1,060

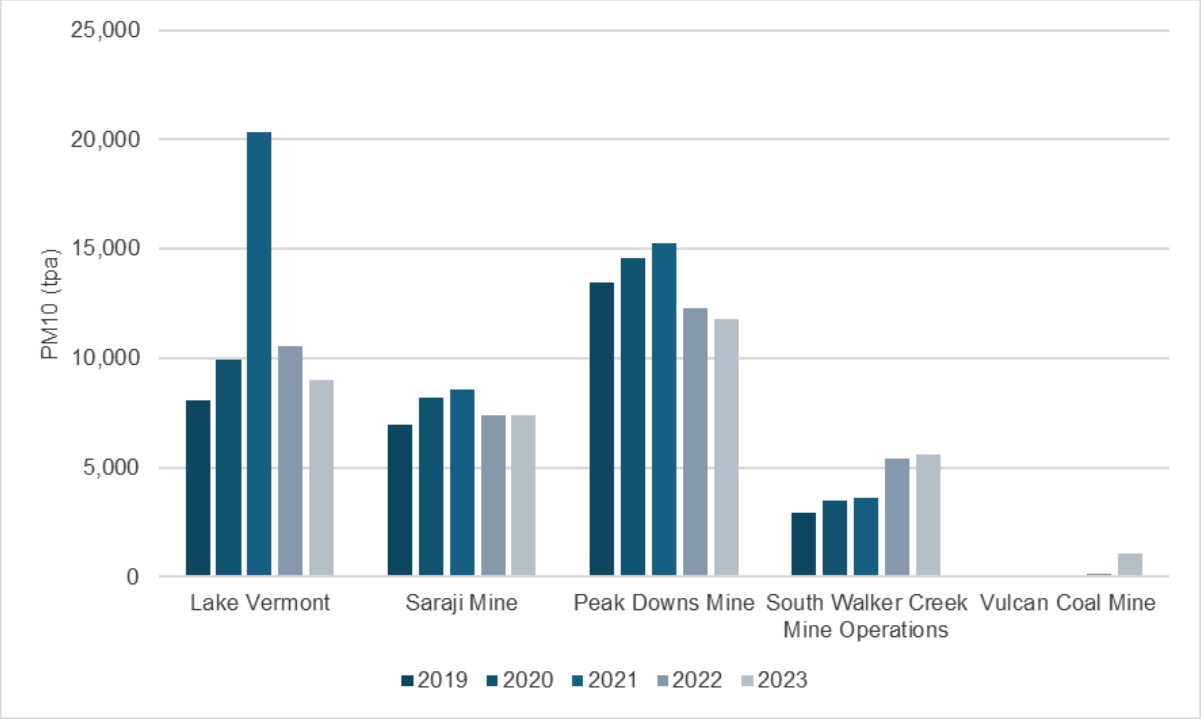

Figure 5 PM_{10} (tpa) for operations nearest the VSP as reported to the NPI (FY18/19 to FY22/23)

3.3.2 Analysis of regional dust monitoring data

Vitrinite does not currently conduct air quality monitoring in the area surrounding the VSP. Therefore, to characterise the existing air quality, a review of nearby PM_{10} monitoring data collected at the two DETSI monitoring stations at Moranbah East and Moranbah West, has been conducted. Data from these sites will give a broad representation of likely air quality conditions in the region, including the influence of nearby coal mining, but cannot be expected to directly reflect conditions at the O'Sullivan Residence, given the distance between these locations and their settings relative to nearby coal mining dust sources.

Summary statistics for 24-hour average PM_{10} concentrations are provided in Table 6. Figure 6 and Figure 7 present time-series of 24-hour average PM_{10} concentrations recorded at the DETSI Moranbah East and Moranbah West monitoring sites, respectively. The data indicate that:

- Annual average PM_{10} is at most 126% (31.5 µg/m^3) of the relevant air quality criterion (25 µg/m^3)
- 24-hour average PM_{10} has historically exceeded the relevant air quality criterion (50 µg/m^3) a number of times, with 2023 showing six exceedances at the Moranbah East monitor and ten at the Moranbah West monitor
- This indicates that the ambient background air quality within the region is degraded and exceedances of the relevant air quality criteria may occur independent of operations at the VSP.

Monthly air quality bulletins published by DETSI were reviewed for possible explanations of the monitored exceedances at Moranbah. The bulletins indicated that exceedances were widely attributable to strong winds causing erosion of dry surfaces, mining operations, bushfires, and vehicles movements on unsealed roads.

For the purposes of the AEMP, the existing regional air quality supports the need for the VSP to be able to differentiate its contributions to dust and particulate emissions from those of other regional sources. This will help to explain potential exceedances at the O'Sullivan Residence, whether attributable to the VSP or other sources. It will also help VSP operators to focus their mitigation efforts on emissions from the mine and avoid unnecessary additional mitigation efforts being implemented due to external regional sources.

Table 6 Summary statistics for 24-hour average PM_{10} as measured at the DETSI Moranbah East and West monitoring sites

Year	Monitor	Maximum PM_{10} (µg/m^3)	70th Percentile PM_{10} (µg/m^3)	Annual Average PM_{10} (µg/m^3)	Data Capture (days with data)	Days above 50 µg/m^3
2019	Moranbah East	217.8	35.5	28.7	93.9%	32
2020		89.8	23.4	22.6	100.1%	5
2021		49.7	23.4	21.1	99.8%	0
2022		43.5	22.1	26.9	97.7%	0
2023		96.2	26.9	0.0	99.9%	6
2020	Moranbah West	93.6	32.9	31.5	51.2%	4
2021		72.0	27.7	21.1	97.7%	6
2022		50.7	24.9	20.5	100.0%	2
2023		121.1	30.8	19.0	88.9%	10

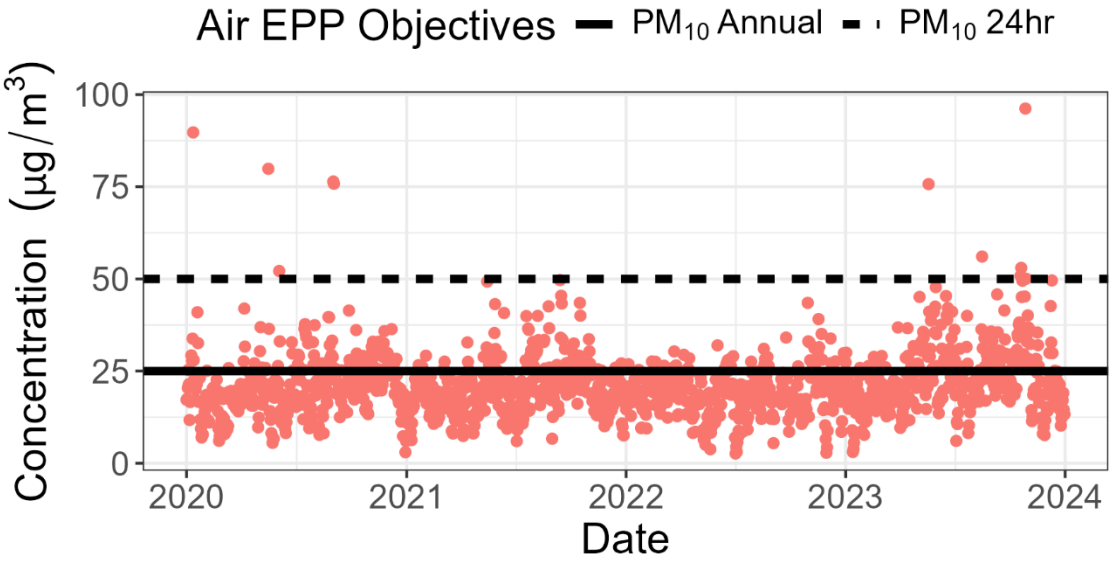

Figure 6 **Time series of daily PM_{10} concentrations at DETSI Moranbah East monitoring site**

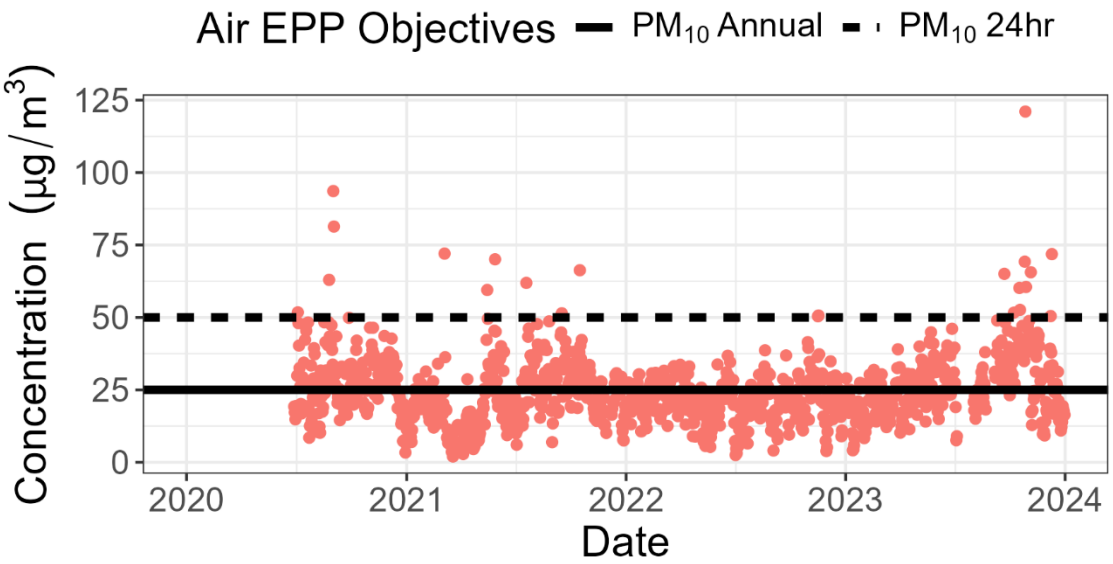

Figure 7 **Time series of daily PM_{10} concentrations at the DETSI Moranbah West monitoring site**

3.3.3 Potential air quality impacts due to the Mine based on historic work

Katestone assessed the VSP project in September 2022 in the VSAQA report. The report utilised dispersion modelling and predicted that some exceedances of the 24-hour average PM_{10} Air EPP objective could occur due to operations at the VSP when considered cumulatively with an ambient background.

Ambient background was found to be the most significant contributor to total concentrations, constituting 32-68% of the cumulative ground-level concentrations of 24-hour average PM_{10}. Besides ambient background, pit operations were the primary contributors to predicted ground-level PM_{10}. These active areas were those nearest to the O'Sullivan residence, which may explain their greater contributions in conjunction with a more north-south wind pattern as predicted by the meteorological model. Activities occurring within these pit areas included pre-stripping waste material with excavators, excavating overburden, and excavating ROM.

To avoid the predicted exceedances, it was recommended that additional dust mitigation measures be implemented. These involved ceasing certain operations during evening hours (7 pm – 6 am) which coincide with stable nighttime conditions which typically result in poorly mixed and dispersed air which can lead to higher concentrations of pollutants. The implementation of an effective monitoring network and TARP will enable clear identification of those times when operational activities may need to be reduced or stopped altogether.

All dispersion modelling results for the VSP indicated compliance with criteria for dust deposition at all sensitive receptors under all assessed scenarios in isolation and inclusive of ambient background contributions.

Predictions from VSAQA alongside a review of other regional emissions sources reporting to the NPI, the analysis of existing air quality and regional meteorology around Moranbah, and the EA requirement to determine if an exceedance recorded under condition B4 is a result of the VSP, all support the need to monitor both upwind and downwind of the VSP, so that the contribution of the VSP to measured concentrations downwind of the mine can be estimated.

4. DUST MANAGEMENT

4.1 Routine dust management

As part of the VSAQA conducted by Katestone for the VSP, routine dust mitigation measures and proactive mitigation measures were identified. Routine dust mitigation measures should be implemented at all times. Proactive mitigation measures can be applied pre-emptively to avoid dust impacts during high risk periods, as discussed in Section 4.2.

Table 7 presents the routine mitigation measures which were adopted during the VS AQA.

Table 7 Routine emissions control measures and reduction efficiencies

Activity	Control Measure	Control Efficiency	Control Reference
ROM coal haulage	Watering and/or chemical suppressants on haul roads	85%	Katestone 2011, *NSW Coal Mining Benchmarking Study*
Overburden haulage	Watering and/or chemical suppressants on haul roads	85%	
Vegetation established but not self-sustaining	Expected ground cover	40%	NPI Emissions Estimation Technique Manual for Mining 2012, Table 4, v3.1

4.2 Additional dust management

Proactive mitigation measures were found to be necessary for compliance at the O'Sullivan Residence sensitive receptor as part of VSAQA. These measures primarily involved temporarily ceasing certain operations near to the sensitive receptor (including pit operations and overburden dumping) particularly at night when pollutant dispersion and dilution is reduced. Some additional mitigation strategies which are recommended for adoption within the TARP and for ongoing development of the AEMP, which may prevent the need to cease mining operations, include:

- enclosing or installing wind barriers for various aspects of the CHPP
- review of clearing and rehabilitation processes, to minimise the areas of land exposed to wind erosion
- use of water in the active pit to keep material damp or minimise emissions from extraction and handling, where practicable and safe
- adjusting site activities based on real-time PM_{10} monitoring results or planning site activities with consideration of forecast weather conditions and the potential risk of dust impacts at sensitive receptor locations
- reducing the intensity of targeted operations near to the sensitive receptor in response to monitoring and TARP triggers.

Dust management practices will be enhanced as part of the AEMP and TARP through the availability of real-time monitoring for PM_{10} and meteorological data. The integration of this data into a proactive dust management system will allow for the planning and management of operations in order to pre-emptively reduce the risk of dust emissions adversely impacting the O'Sullivan Residence.

The dust management system will need to include means for dust and meteorological forecasting to identify adverse conditions which are conducive to the transport of dust and particulates towards sensitive receptors. This will allow proactive mitigation to be applied in a timely manner and ensure the efficient use of available dust management equipment.

The following tools will constitute the proactive dust management system:

- Dust monitoring as part of the AEMP (Section 5)
- Trigger Action Response Plan (TARP) (Section 6)
- Dust and meteorology forecasting (Section 7).

5. MONITORING PLAN

5.1 Monitoring for the AEMP and TARP

Design of the VSP monitoring network to be implemented for dust deposition, PM_{10} and meteorology within the context of the requirements of EA conditions and other legislative requirements has been informed by the preceding sections on existing meteorology, air quality, and sensitive receptors.

Fundamentally, the key function of the monitoring network is to identify in real-time occasions when VSP mining is causing increased concentrations of PM_{10} at monitoring sites representative of sensitive receptors. Timely identification of these occasions then enables the implementation of appropriate dust mitigation measures with the final aim of ensuring the VSP is not responsible for causing any exceedances of relevant air quality criteria at a sensitive receptor. Critically important is the ability to distinguish between contributions of dust from the VSP and other regional sources.

Key capacities for the monitoring network will be:

- the compliance of dust deposition monitoring with AS/NZS 3580.10.1:2016
- the compliance of PM_{10} monitoring with AS 3580.9.8:2022 or AS 3580.9.11:2022
- the compliance of air quality monitoring sites with the siting requirements of AS/NZS 3580.1.1:2016
- the compliance of meteorological monitoring with AS/NZS 3580.14:2014
- to demonstrate (through monitoring) compliance with the dust deposition limit of 120 mg/m^2/day averaged over one month, and the PM_{10} objective of 50 $\mu g/m^3$ over a 24-hour averaging period at sensitive receptors
- to determine if a monitored exceedance is a result of the VSP
- the ability to incorporate the monitoring data, especially real-time PM_{10} and meteorological data, into a dust management and forecasting system which allows for proactive mitigation
- the effective incorporation of monitoring data into a TARP with appropriate triggers and responses
- the ability to provide monitoring data results to the administering authority when requested in response to any complaints of environmental nuisance or impact at any sensitive receptor or commercial place
- the ability to store, present, and analyse data for the purposes of annual/triennial reviews and optimisation of the AEMP.

Considering the distribution of winds at the VSP region (Section 3.2) and existing emission sources (Section 3.3.1), the following overarching points are made for monitoring under the AEMP:

a) Real-time monitoring of PM_{10} should aim to establish VSP contributions to concentrations at or near to the O'Sullivan Residence sensitive receptor.

b) Monitoring for dust deposition should be conducted near the O'Sullivan Residence sensitive receptor.

c) To assist with distinguishing the contribution of the VSP site from those arising due to operations at other nearby mining operations or regional events, an additional real-time PM_{10} monitoring site should be installed to the north of the VSP. Real-time monitoring north of the VSP will enable mine contributions to be calculated at the O'Sullivan Residence as the difference between the upwind PM_{10} concentration and downwind PM_{10} concentration. The O'Sullivan Residence will be downwind of the VSP during times when winds are blowing from the north between 326° - 35°. This will in turn enable TARP triggers to focus on those occasion when the VSP contribution is high, rather than all occasions when concentrations are high (which would include regional dust episodes and periods of high concentrations as a result of emissions from other mines).

Discussion of the monitoring locations, equipment and data objectives for the AEMP network is provided in the following sections.

5.2 Monitoring equipment

There are a wide range of monitors available that can measure dust/particulate concentrations in the ambient air (as summarised in Appendix B). The decision as to which monitors to use must take into consideration:

- compliance with the Australian Standards
- compliance with EA conditions
- compliance with Government regulations/conditions
- robustness of the equipment including power requirements
- reliability of the measurements
- the frequency of maintenance or sample collection required
- security of the site and availability of power supply.

5.2.1 Dust deposition

Dust deposition rate is the mass of particulate matter that collects on an area over a one-month period and is used as a metric of the potential for particulate matter to affect amenity. Dust deposition gauges are a method for measuring the dust deposition rate.

Dust deposition is required to be measured in accordance with the AS/NZS 3580.10.1:2016 – Methods for sampling and analysis of ambient air, Method 10.1 – Determination of particulate matter – Deposited matter – Gravimetric method. Dust deposition rate samples can be analysed for the following:

- deposited matter – the particles which are collected in the dust gauge and which pass through a 1 mm mesh sieve which complies with AS 1152-1993
- total solids – the mass of the particulate matter deposited in the gauge
- soluble matter – the mass of the soluble portion of the deposited matter
- insoluble matter – the mass of the insoluble portion of the deposited matter
- combustible matter – the mass of the portion of the insoluble matter lost during combustion
- ash – the mass of that portion of the insoluble matter remaining after combustion.

The insoluble solids portion of the sample is the component that is assessed against the dust deposition limit of 120 mg/m²/day. The insoluble solids portion can be further analysed for combustible matter and ash. Combustible matter is an indicator of organic materials such as grass seeds, pollen, coal and other plant matter. Ash is the material that remains after the insoluble solids sample is combusted and generally includes crustal matter such as dirt and sand.

Dust emissions from VSP activities such as vehicle movements on haul roads, wind erosion of exposed ground, and handling of overburden are likely to contain a greater proportion of materials that will be present in the ash component of the dust deposition sample. Existing sources of similar materials in the region surrounding the VSP are likely to include agriculture, vehicle activity on unsealed roads and wind-blown dust of exposed soil, as well as extensive regional mining. Investigation of the combustible component of collected dust samples will assist in identifying the amount of coal dust present.

5.2.2 PM_{10}

Although the EA conditions require that real-time PM_{10} monitoring be conducted using TEOMs, beta attenuation monitors (BAMs) are recommended as a suitable alternative for installation as part of the VSP AEMP monitoring network. These monitors are recommended as they have the following features:

- US EPA and Australian Standards compliant monitors for PM_{10}
- They are continuous real-time monitors which do not require regular attendance for sample collection. Continuous data collection allows for 1-hour averaging periods and is useful in source identification alongside meteorological monitoring data.

Advantages of BAMs compared to other compliance monitors such as TEOMs (and high/low volume samplers) as listed in Appendix B, are their ability to be powered via solar or mains, their lower capital cost and maintenance demands (compared to TEOMs), and their collection of short averaging period (1-hour) data (as compared to high/low volume samplers). However, both TEOMs and BAMs are suitable monitors for the intended purpose and which is used should be at Vitrinite's discretion.

High and low volume samplers (HVS/LVS) are not recommended as these both require regular (daily to weekly) attendance to collect sample filters which then require careful packing and transport to a laboratory for analysis. Their sampling periods (minimum 24-hours) are also not suitable for use within a TARP which requires real-time monitoring data to feed into triggers and actions.

Other monitors such as the T-640X and the Dust Master Pro use a light scattering principle to measure dust concentrations. The T-640x has accreditation with the United States Environmental Protection Agency (USEPA) but does not have compliance with Australian Standards without calibration with a collocated standard monitor. The Dust Master Pro does conform with AS3580.9.9:2017 for monitoring PM_{10}, but only when undertaking gravimetric sampling that requires manual filter changes and does not provide real-time data. Neither are recommended for this AEMP.

The final configuration of the AEMP monitoring network is presented in Section 5.3

5.2.3 Meteorological monitoring

The meteorological monitoring station must be installed in compliance with the Australian Standards detailed in Appendix A2 and achieve the minimum equipment accuracy requirements detailed in Table A2.

A weather station should be sited so the variables measured are representative of the dominant wind flows at the subject site and the surrounding region. Appropriate siting should avoid local scale obstructions which can cause variations in meteorological parameters that might mean the data are not representative, as appears to be the case for the current meteorological monitor at the Vulcan Mine site.

5.3 Monitoring locations

Ambient air quality monitoring stations should be sited and operated in accordance with the relevant Australian Standards and methods outlined in the EA conditions. By adopting the relevant Australian Standards this will ensure that the data collected is of the highest integrity. The relevant standards are further discussed in Appendix A.

In addition to the requirements of the Australian Standards, Katestone recommends the following be considered in the selection of suitable sites for monitoring. Monitoring should seek sites:

- that are secure and have a low potential for vandalism/theft
- that have adequate and reliable access for installation and regular maintenance

- that are not prone to natural disasters e.g. flooding
- that have adequate and reliable access to power, if required
- that have adequate and reliable communication services e.g. phone, ADSL lines, radio or wireless data transfer within line-of-sight requirements
- where access times are aligned with the intended data capture rates e.g. if data capture rates are stipulated as 90%, access outside of normal working hours may be required to remedy equipment failures or perform unscheduled maintenance activities
- where personnel will be able to perform their activities in a safe environment and workplace in accordance with relevant regulatory requirements.

The VSP monitoring network will need to be continually representative of VSP mining operations as the mine evolves. With reference to Figure 2, VSP will gradually progress from north to south, commencing operations at the highwall plunges and northern pit, followed by the main central pit, and lastly the southern pit. Upwind monitoring sites along the northeastern boundary of the MLA will need to capture this progression of the mine. As such the VSP monitoring network will consist of two stages – Stage 1 Northern Works and Stage 2 Main and Southern Works.

The layout of the monitoring network for each stage is presented in Figure 8. For each stage the meteorological station and O'Sullivan Residence PM_{10} monitoring sites will remain constant, while the MLA northeastern edge PM_{10} monitoring sites are periodically adjusted as mining progresses south to best capture upwind air quality during each stage of mining.

Stage 1 Northern Works: The MLA northeastern edge PM_{10} monitoring site will need to be situated to the north of the northern pit to ensure dust contributions from off-site operations upwind of the VSP North pit under northerly winds are captured. Under VSP operations in the North pit and the highwall mining areas to its northwest, the O'Sullivan Residence will be downwind of these operations under winds between 321-344°. The recommended monitoring location will not be downwind of any part of these VSP operations under these wind angles, but will be downwind of off-site mining operations, thus it represents an appropriate upwind monitoring location during the Northern Works. This stage will comprise two PM_{10} monitoring sites (Northern site and O'Sullivan Residence site) and one meteorological station.

Stage 2 Main and Southern Works: During the Stage 2 Main and Southern Works, the O'Sullivan Residence will be downwind of VSP operations under winds between 326-24° The Stage 1 MLA northern edge PM_{10} monitor will be relocated to Stage 2 - S1, as depicted in Figure 8, to better represent conditions upwind of the Main pit. An additional upwind monitoring site is necessary to capture contributions from sources upwind of VSP across a wider angle of wind directions that reflects the wider range of wind directions under which the O'Sullivan Residence will be downwind of VSP operations. An additional PM_{10} monitor will be installed at Stage 2 – S2 to be upwind of South pit operations under winds from the north to north-northeast. This stage will comprise three PM_{10} monitoring sites (O'Sullivan Residence site, South pit upwind site, and Main pit upwind site) and one meteorological station.

Figure 9 presents the terrain surrounding the VSP, with terrain data derived from Geoscience Australia's SRTM-derived 1 Second Digital Elevation Model Version 1.0. The terrain to the southwest is elevated and undulating, with deep valleys cutting into the escarpment generally in a southwest-northeast direction. The terrain to the northeast of the VSP, however, is largely flat. The focus of the monitoring network is upon identifying potential dust impacts at the O'Sullivan Residence, which is south of the mining operations. Therefore, it is important that winds from the north are accurately represented. The predominantly flat terrain to the northeast of the site would be expected to have relatively little influence on the broader synoptic flow of winds that will pass over the site in the direction of the O'Sullivan Residence. It is, therefore, recommended that the meteorological monitoring site is located at the northeastern extent of the southern half of the VSP mining lease to take the best possible advantage of the broad area of relatively flat terrain upwind of this location under winds from the north.

Meteorological and PM_{10} monitoring sites for the VSP monitoring network presented in Figure 8 are indicative sites. It is acknowledged that exact locations are subject to a range of feasibility considerations including, but not limited to, final infrastructure and mining layouts, land accessibility, and suitability of the land considering the above dot points. Table 8 summarises the monitoring to be conducted at each site. Vitrinite should seek to establish a monitoring station in the direction of, and as close as possible to, the O'Sullivan Residence

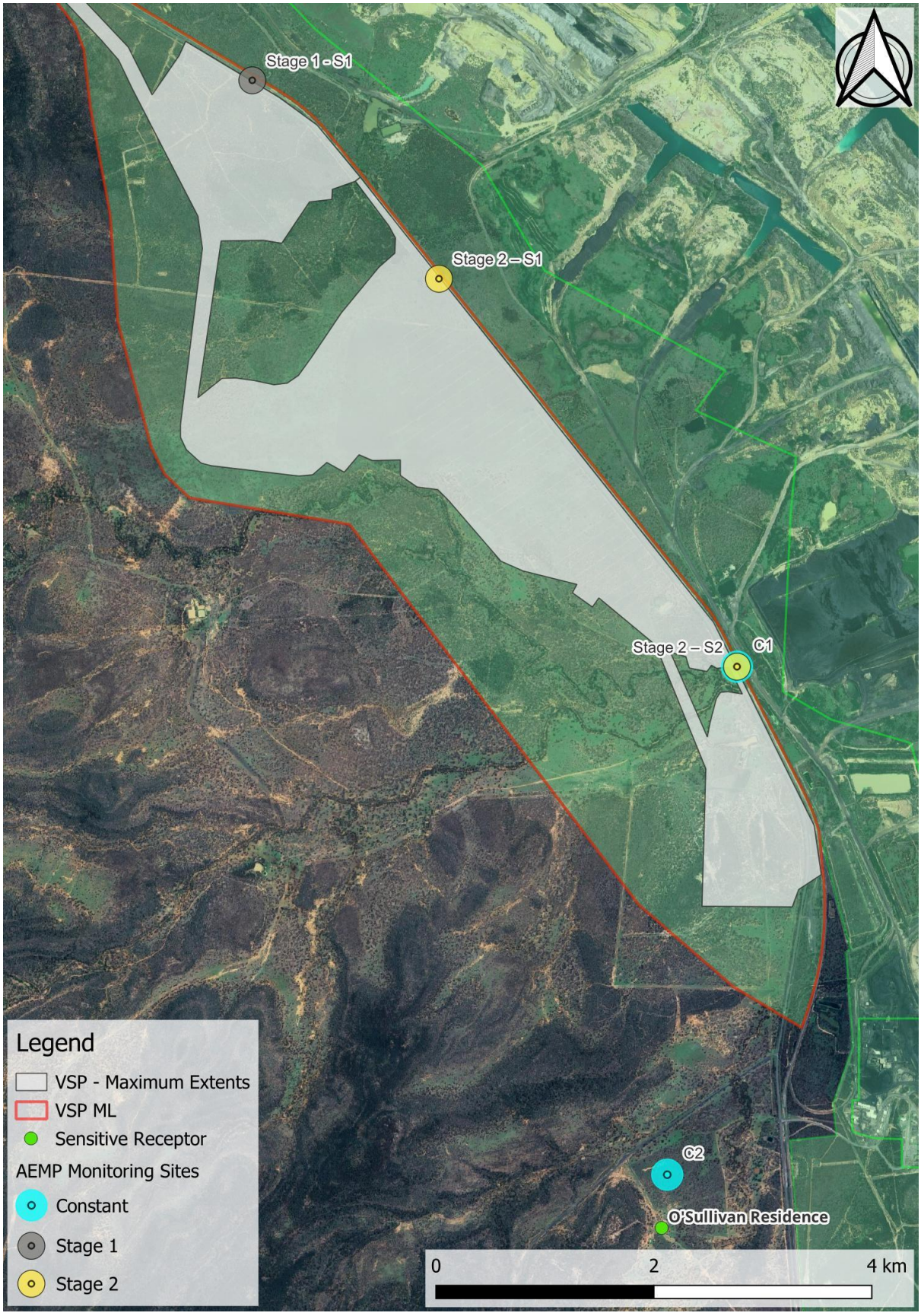

Figure 8 **Indicative VSP AEMP monitoring sites**

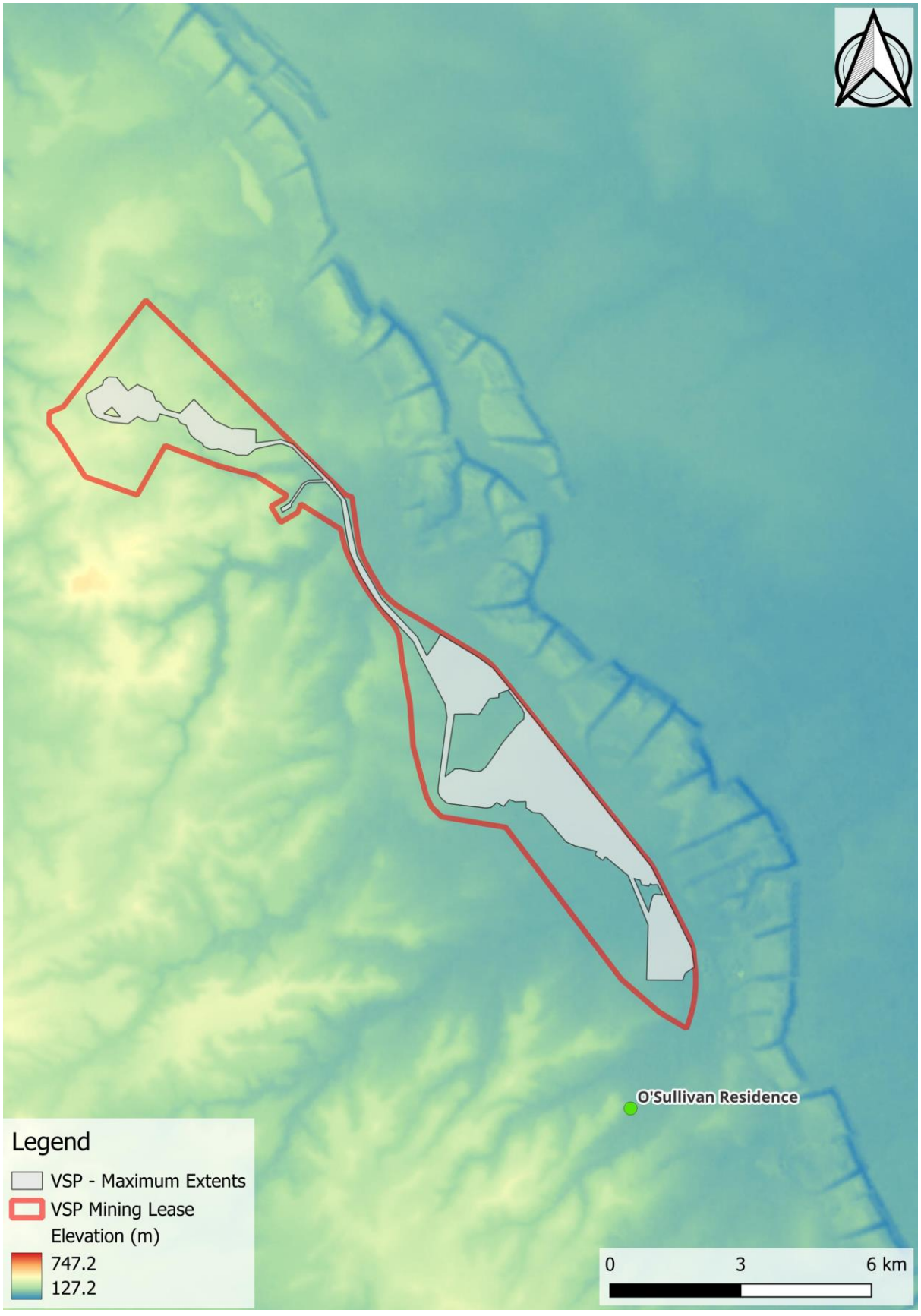

Figure 9 Terrain surrounding the VSP

Table 8 VSP AEMP monitoring network

Approximate Location (GDA 2020, MGA Zone 55)				Equipment type	Parameters to be monitored
#	Name	X(m)	Y(m)		
Stage 1 – Northern Works					
Stage 1 - S1	Northern site	625,816	7,529,652	BAM or TEOM	PM_{10}
				Dust Gauge	Dust deposition (DDEP)
Stage 2 – Main and Southern Works					
Stage 2 – S1	Main site	627,530	7,527,833	BAM or TEOM	PM_{10}
				Dust Gauge	Dust deposition (DDEP)
Stage 2 – S2	Southern site	630,265	7,524,275	BAM or TEOM	PM_{10}
				Dust Gauge	Dust deposition (DDEP)
Constant sites – all works					
C1	Met Site	630,265	7,524,275	Meteorological Station	Wind (speed & direction), temperature, relative humidity, precipitation and rainfall intensity, solar radiation
C2	O'Sullivan Residence	629,625	7,519,614	BAM or TEOM	PM_{10}
				Dust Gauge	Dust deposition (DDEP)

5.4 Monitoring data objectives

5.4.1 Minimum data capture rates

Under the NEPM PRC Technical Paper No.5. (PRC, 2001), to calculate a valid average the following is required:

- 75% valid data
- 75% of each season, for an annual average.

The document states:

For representative monitoring data and for credible compliance assessment it is desirable to have data capture rates higher than 95%. 75% data availability is specified as an absolute minimum requirement for data completeness.

The following benchmarks should be used to determine acceptable data capture:

- 95% data availability
- 90% valid data.

Where data availability refers to monitoring data being collected by the instrument and stored. Valid data may be less than the available data as some data points may be removed during the validation process.

5.4.2 Equipment maintenance

Maintenance of monitoring instruments is essential to ensure good operation and compliance with Australian Standards, with each type of monitor requiring a different set of maintenance procedures. Maintenance will be conducted in accordance with relevant Australian Standards and manufacturer recommendations and documentation. Dust deposition monitors do not generally require routine maintenance and Vitrinite staff should be able to undertake monthly changeovers. Maintenance of automatic particulate monitors should be performed at the appropriate intervals by a third-party specialist provider. Full calibration of the real-time monitoring stations should be performed annually by a third-party specialist provider.

Routine maintenance of automatic particulate monitors should involve as a minimum, check on:

- flow meter;
- sampling inlet heads and flow lines;
- logging equipment;
- rectifying of any identified issues including part replacement; and
- filters (replaced where required).

Occasionally, elements of the monitoring system may fail to operate due to damage, breakdown, power failure or other unforeseen situations. To minimise the amount of time the equipment is offline, Vitrinite will follow a troubleshooting procedure that is expected to include the following steps:

- equipment faults or alarms or states are identified by the dashboard operator or site environmental staff;
- remote access diagnostics are performed to determine the level of fault;
- site staff check power supply to monitoring equipment and restart if necessary;
- If the fault cannot be rectified by site staff or via remote access, then a technician will be called to the site within 24 hours of notification to rectify the problem, pending personnel availability; and
- In the unlikely event that a major fault in the equipment is identified, Vitrinite will install a temporary monitoring station while the instrument is sent away for repair.

The troubleshooting procedure will be further defined once the third-party vendors are engaged and the equipment is fully operational.

5.4.3 Reporting requirements

Routine monitoring summaries should be generated and reviewed periodically to allow Vitrinite to confirm that data is being collected as expected and that the data is valid and within acceptable bounds of data capture. This will allow early intervention should problems be identified. Routine reporting must be performed monthly and include the following elements:

- summary of the PM_{10}, dust deposition and meteorological data
- data capture rates for all parameters
- any observational comments on events (e.g. fires, dust storms, construction works) that might have contributed to dust and particulates near the monitors
- records of any instrument maintenance performed.

Annual monitoring analysis reports must also be generated in accordance with the EA conditions. The reports should include the following elements:

- summary of the PM_{10} and dust deposition and meteorological data in time series form
- data capture rates for all parameters
- analysis of data to validate data and identify outliers, extreme events etc
- performance against the EA limit conditions
- quantitative description of air quality in the region, including:
    - seasonal and diurnal trends in the data
    - dependence of concentrations on meteorological conditions such as wind speed and wind direction
- review of the monitoring data alongside TARP triggers and actions to ensure monitoring data and the TARP are working as expected
- recommendations for improvements to TARP triggers and monitoring practices
- review of the monitoring sites to ensure they are appropriately located with respect to future progression of mining and wind directions.

6. TRIGGER ACTION RESPONSE PLAN

6.1 TARP overview

A TARP integrates real-time air quality and meteorological monitoring data with site operations and a proactive dust risk management and forecasting system which identifies, investigates, and mitigates dust and particulate emissions. The trigger levels are defined such that proactive responses can be implemented to mitigate the risks of potential exceedances of the relevant air quality objectives at sensitive receptors. Coupling forecasting with air quality and meteorological monitoring enables the prediction of impending adverse conditions so that mitigating actions can be taken further in advance to avoid impacts before they happen.

The following are key components of a TARP:

- **Trigger**: A trigger is defined by one or more conditions and an associated trigger level. When the conditions of a trigger are met, an alert is issued. This may be a trigger for ambient dust and particulate measurements or meteorological conditions or forecasting.
- **Alert**: An alert occurs as a result of the conditions of a trigger being met. Each alert requires one or more responses
- **Response**: A response is a set of defined dust management actions that may be implemented as a result of an alert being issued
- **Action**: An action is a specific activity that is conducted as part of a response.

The VSP TARP includes a range of thresholds that will trigger alerts requiring increasing levels of responses and actions.

The following sections detail TARP trigger levels to be based on real-time PM_{10} monitoring and wind direction data. Proposed actions and requirements for record keeping and complaints handling are also discussed. The TARP triggers and actions should be reviewed and refined as part of the EA requirement to review the AEMP and monitoring network annually.

6.2 Triggers

6.2.1 Air quality

The TARP has been designed to provide as much warning as possible for VSP staff to allow proactive management of fugitive dust. The following levels of triggers/responses have been defined:

1. Normal condition – green – (No Action)
2. Low trigger – yellow - (Watch and wait). This is an early warning level to increase awareness of potential dust issues before they arise.
3. Medium trigger – orange - (Investigate). A medium trigger indicates that there may be a potential dust issue and specific investigation and action is warranted.
4. High trigger – red - (Escalate). A high trigger indicates that dust concentrations are outside of the normal range and that an action is warranted to reduce emissions from the VSP.

A trigger, particularly a low or medium trigger, does not indicate the presence of an explicit dust impact but indicates conditions which may precede an impact if no actions were taken.

In order to focus upon the specific contribution of the VSP to measured concentrations, an algorithm should be used to automatically calculate the mine contribution in each hour of the day. When a monitor is downwind of part

of the VSP operations, the measured concentration at the upwind monitors should be subtracted from that at the downwind monitor, with the calculated value representing an estimate of the mine contribution. If the calculated value is negative, it should be set to zero, indicating no mine contribution. If a monitor is not downwind of the VSP then the mine contribution should be set to zero.

Trigger values for 24-hour rolling average concentrations of PM_{10} have been set at the 25th, 50th, and 75th percentile values of the 24-hour PM_{10} Air EPP air quality objective of 50 µg/m^3 as shown in Table 9. They focus on total concentrations, but a trigger level above Normal is only achieved if the calculated mine contribution to total concentrations is greater than 12.5 µg/m^3, which sets an expectation that mine generated emissions should not exceed 25% of any air quality target values. These trigger values should be compared against after each hour of new data is logged, using a rolling 24-hour average.

Trigger values for 1-hour average concentrations of PM_{10} are presented in Table 9 and focus on occasions when the mine contribution to concentrations exceed 50 µg/m^3 within a given hour, as an indication of potentially significant mine contributions. Such events also indicate significant emissions from the VSP, which require additional controls. For the purposes of record keeping and future reviews of the AEMP, it is important that both total concentrations and mine contributions are recorded.

The trigger levels should be assessed for continued effectiveness during each annual review of the AEMP and revised if it is determined that triggers are not:

- coinciding with complaints received from the O'Sullivan Residence
- consistently coinciding with elevated concentrations
- resulting in avoidance of exceedances.

Table 9 Trigger values for rolling 24-hour average ambient concentrations of PM_{10}

Trigger Level	Rolling 24-hour average concentration of PM_{10} (µg/m^3)	VSP contribution (µg/m^3)
Normal	≤12.5	N/A
Low	>12.5 – 25	>12.5
Medium	>25 – 37.5	>12.5
High	>37.5	>12.5
EA Concentration Limit for 24-hour PM_{10}	50	-

Table 10 Trigger values for 1-hour average VSP contribution to concentrations of PM_{10}

Trigger Level	1-hour average VSP contributed concentration of PM_{10} (µg/m^3)
Normal (no trigger)	<50
Low	50 – 74.9
Medium	75 – 99.9
High	≥100

6.2.2 Meteorology

The EA conditions require *"A system to identify adverse meteorological conditions likely to produce elevated levels of dust deposition, PM_{10} at a sensitive place due to the authorised activities; and a dust and particulate matter control strategy which activates a timely implementation of management control action…"*. Therefore, triggers and actions are also recommended based on forecast meteorological conditions. A 7-day forecast should be provided and the actions required will depend upon the immediacy of the forecast risk, based on the following categories:

1. Advice: General advice of emerging risks in the next 4-7 days

2. Watch and Act: Impending risks in the next 2-3 days, watch and plan for action if necessary
3. take immediate action: Immediate action is required today to reduce the risk today or tomorrow.

Initial trigger values are suggested in Table 11. The effectiveness of these triggers will need to be reviewed at the first annual review of the AEMP. Dust lift-off index is a dimensionless index that increases with wind speed and low soil moisture and is a more sensitive parameter than just wind speed alone.

Table 11 Trigger values for meteorological forecast variables

Level	Trigger
Normal	Forecast predicting low dust lift-off index and low winds (<5.4 m/s as 3-hourly average) in the direction of downwind receptors
Low	Forecast of moderate dust lift-off index with wind direction that places sensitive receptors downwind of the VSP; or Forecast of moderate winds (>5.4 m/s as a 3-hourly average) in the direction of downwind receptors
Medium	Forecast of high dust lift-off index with wind direction that places sensitive receptors downwind of the VSP; or Forecast of strong winds (>9.7 m/s as a 3-hourly average) in the direction of downwind receptors
High	Forecast of extreme dust lift-off index with wind direction that places sensitive receptors downwind of the VSP; or Forecast of very strong winds (>13.9 m/s as a 3-hourly average) in the direction of downwind receptors

6.3 Actions

Dust management actions and responses that will be triggered by the PM_{10} trigger level alerts and dust risk forecast alerts are presented in Table 12 and Table 13, respectively.

Table 12 Actions and responses for ambient monitoring data triggers

Trigger Level	Action required	Responsibility
Normal	• Ensure all routine dust management practices are being employed as defined in Section 4.1 of this AEMP. If not, implement routine practices.	Environmental Advisor; Operational staff and contractors
Low	• Ensure all routine dust management practices are being employed as defined in Section 4.1 of this AEMP. If not, implement routine practices. • Alert relevant operators that dust levels are elevated therefore heightened awareness of sources of dust may be required. • Review staff personal PM monitors (if applicable) to identify possible locations and activities of elevated dust generation. • Record any visible sources of dust from the VSP or other regional events for the purposes of analysing and discussing potential exceedances (photography, time, date, location). • If significant sources of dust are identified, apply additional controls or reduce activity rate to reduce dust emissions	Environmental Superintendent; Environmental Advisor; Operational staff and contractors
Medium	As for low, in addition: • Visual observations to be made to check if there are any significant visible dust emissions from specific mining operations. • Apply targeted mitigation particularly to haul roads and activities where dust emissions are visible. Increase watering from routine management levels.	Environmental Superintendent; Environmental Advisor; Operational staff and contractors

	• Relocate mining activities and material handling to a part of the mine that is further from the affected monitor or reduce intensity of the operations.	
High	As for medium, in addition: • Significantly reduce activities within pit and/or overburden dump in the direction of winds coinciding with the trigger • Focus control application to haul roads in the direction of winds coinciding with the trigger. • Progressively cease dust generating activities if monitored levels do not reduce in response to the above actions (i.e. if trigger level does not reduce to medium or below). • If total rolling 24-hour average concentration exceeds 50 µg/m^3 and mine contribution is greater than 12.5 µg/m^3, consider ceasing all dust-generating activities to prevent an EA limit exceedance with a significant VSP contribution.	Safety, Health and Environment Manager; Environmental Superintendent

Table 13 Actions and responses for forecast meteorological triggers

Immediacy	Trigger Level	Action required	Responsibility
Advice (risk 4-7 days ahead)	Low or Moderate	• No action required.	Environmental Superintendent; Environmental Advisor
	High	• Communicate forecast with relevant work groups to raise awareness.	
Watch and Act (risk 2-3 days ahead)	Low	• No action required.	Environmental Superintendent; Environmental Advisor
	Moderate or High	• Communicate forecast with relevant work groups to raise awareness. • Assess potential for shifting dust-generating operations to more favourable conditions. • Make necessary preparations, such as ensuring sufficient water will be available and that sufficient water trucks and drivers will be available. • Consider pre-emptive watering of stockpiles and haul roads or application of alternative dust suppressant (e.g. polymers). • Prepare water sprays for high dust-generating activities such as material handling.	
Take immediate action (risk today or tomorrow)	Low	• Alert shift employees that dust potential is elevated. Advise risk level and times of concern. • Increase application of water to stockpiles, haul roads and materials before handling. • Visual observations of site every 2 hours, including major stockpiles, waste dumps, haul roads and material handling areas, looking for visible dust emissions. • Application of additional dust abatement as necessary where visible emissions observed.	Safety, Health and Environment Manager; Environmental Superintendent; Environmental Advisor; Operational staff and contractors
	Moderate or High	• Alert shift employees that dust potential is elevated. Advise risk level and times of concern. • Where possible, shift dust-generating operations to times with more favourable conditions. • Pre-emptive watering of materials before handling. • Continuous application of water to stockpiles and haul roads at maximum rate practicable.	

		• Visual observations of site every hour, including major stockpiles, waste dumps, haul roads and material handling areas, looking for visible dust emissions. • Application of additional dust abatement as necessary where significant visible emissions observed. • If necessary to prevent significant visible dust emissions, reduce activity rate or cease activities.	

6.4 Complaints handling

The VSP will need to operate a complaint handling procedure. Community complaints that relate to air quality impacts should be logged and responded to in an appropriate and timely manner by an Environmental Advisor or Environmental Superintendent according to the requirements of the EA.

Records should be standardised to include:

- time of complaint
- type of complainant (e.g. nearby resident)
- location of complaint
- details and reasons for complaint
- dust levels and meteorological conditions at the time
- TARP trigger level and actions at the time of complaint
- investigation steps undertaken
- any actions that were taken
- conclusions formed.

Actions taken by site environmental staff in relation to community complaints will include reviewing all available data at the time of the complaint including:

- actual dust and meteorological data
- mine operations including location and intensity

Additional follow up actions may include:

- an inspection of the complainant's residence
- sampling at the complainant's residence
- investigation and documentation of any other potential dust generating sources in the vicinity of the complainant's residence.

7. ENVIRONMENTAL DUST RISK MANAGEMENT

The AEMP must incorporate a program of continuous improvement for the management of dust and particulate matter emissions resulting from mining activities. This can be achieved through the development of a proactive dust-risk forecasting system and a digitised TARP. This is an integrated system that automatically collates real-time PM_{10} monitoring data and meteorological monitoring data and effectively communicates alerts to responsible mine staff as part of the TARP. The system allows for logging of actions and responses taken to address TARP triggers. It will also have capacity to store TARP responses and the collected monitoring data to facilitate the information's use in report generation and analysis. Finally, the system should be able to generate forecasts of adverse conditions which may lead to high dust risk.

The proactive environmental risk management and forecasting system is capable of satisfying the requirements of EA condition B9. Additionally, the EA includes various conditions for the maintaining and provision of monitoring data. Condition A20, Table A2 of the EA indicates that all monitoring results must be retained for 9 years and be provided to the administering authority upon request and in the format requested. In the event of an exceedance of the EA air quality limits at a sensitive place as a result of the authorised activities at the VSP, a report must be provided to the administering authority within ten business days and must include air quality data from the sensitive place, meteorological conditions, and information regarding the actions taken to reduce the impact (EA Condition B6).

If Vitrinite currently uses a system capable of the above, then this should be utilised and integrated as part of the AEMP monitoring network and TARP. If no existing system is in place then Katestone can provide this through our subsidiary company Weather Intelligence subject to further consultation with Vitrinite.

8. REVIEW AND REVISION

Regular review and revision of this AEMP will ensure the plan remains applicable and adaptive to the specific conditions experienced at the site and surrounding areas. This process is detailed in the following sections.

8.1 Continuous Improvement

Continuous improvement of this AEMP will be achieved through the ongoing evaluation of dust management performance against environmental policies, objectives and targets.

Continuous improvement will be delivered through periodic review of the AEMP as required under the EA, which will:

- review air quality monitoring data against relevant air quality criteria
- identify areas for improvement of dust management and performance
- determine the cause/s of any non-conformances
- develop and implement a plan of action to address any non-conformances
- document any changes in procedures resulting from process improvement
- amend the TARP and AEMP as necessary.

8.2 Revision

As part of the annual review of the AEMP, amendments should be made where appropriate to ensure that the plan is continuously effective in achieving its purpose and objectives for existing mining and future mining at the VSP, and suitably accounts for any changes to nearby sensitive receptors. The review should consider:

- frequency and cause of any exceedances of air quality objectives
- dust complaints
- frequency of TARP trigger level exceedances and their effectiveness in ensuring appropriate action
- future progression of Mine activities
- locations of sensitive receptors
- mining activity intensity
- additional mitigation options.

9. PERSONNEL

9.1 Responsibilities

The relevant staff members responsible for the AEMP and TARP are detailed in Table 14. Industry standard position names have been utilised to be reviewed and updated to Vitrinite equivalents as necessary.

Table 14 Responsibilities of Mine staff members

Position	Responsibilities
Site Senior Executive (SSE)	• Review and approve the AEMP and TARP • Decision making on ceasing operations if excessive dust is identified that cannot be controlled by other means (e.g. watering)
Safety, Health and Environment Manager	• Overseeing and supporting the implementation of the AEMP. • Decision making on limiting operations if excessive dust is identified that cannot be controlled by other means (e.g. watering) • Coordinating with the Environmental Superintendent and Environmental Advisor and other relevant staff to appropriately organise and maintain records relating to the AEMP. • Assisting the Environmental Superintendent with reporting requirements relating to the EA, AEMP, and other environmental related documents and procedures.
Environmental Superintendent	• Ensuring complaints are handled in the appropriate manner. • Training staff in the use of the AEMP and TARP. • Daily checking of the proactive management system to plan operations. • Reviewing and elevating decision making on limiting or ceasing operations if excessive dust is identified that cannot be controlled by watering. • Regular inspections of the site and dust generating activities. • Ensuring all complaints are recorded and investigated, and that corrective action is taken. • Prepare annual review reports.
Environmental Advisor	• Maintaining air quality monitoring equipment and ensuring their operation in accordance with Australian Standards. • Organising maintenance or sampling of the monitoring equipment as needed and reviewing collected data from the monitors to identify any abnormalities. • Coordinate between operational staff and the Environmental Superintendent • Assist the Environmental Superintendent with training on the AEMP and TARP, action of TARP triggers, and all reporting relating to the AEMP • Assist the Environmental Superintendent with responding to complaints.
Permanent site staff	• Undertake staff training as run by the Environmental Superintendent or Environmental Advisor. • Conduct visual monitoring of dust and report as required. • Report elevations in personal particulate monitoring measurements (if relevant). • Notifying the Environmental Superintendent or Environmental Advisor if excessive dust is identified. • Assist with the enacting of mitigation strategies in response to TARP triggers.
Contractors	• Undertake site induction. • Adhering to site speed limits and designated haul road routes. • Notify Environmental Superintendent or Environmental Advisor if excessive dust is identified and report on the condition of the site haul roads.

9.2 Training

All employees with responsibilities under this AEMP shall be trained in its contents and use. Training will occur when new employees start work and refresher training will be undertaken at intervals no longer than 3-yearly.

Regular meetings will also be held with all employees to reinforce dust management awareness and the procedures and work practices to minimise dust generation. Contractors working on site will undergo site induction and training that will refer to this AEMP and the dust control measures and practices contained within.

10. REFERENCES

Australian Government 2012, *National Pollutant Inventory Emission Estimation Technique Manuel for Mining*, Department of Climate Change, Energy, the Environment and Water, v.3.1

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APPENDIX A MONITORING STANDARDS

A1 Air quality

A1.1 Monitoring standards

Australian Standards that are relevant to the siting and method of conducting particulate matter and dust monitoring are specified in Table A1.

Table A1 Australian Standards relevant to ambient air quality and meteorological monitoring

Feature	Australian Standard
Siting	*AS/NZS 3580.1.1:2016* - Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment
Dust deposition rate	*AS/NZS 3580.10.1:2016* - Methods for sampling and analysis of ambient air, Method 10.1 - Determination of particulate matter - Deposited matter - Gravimetric method
PM_{10}	*AS/NZS 3580.9.8:2022* - Methods for sampling and analysis of ambient air, Method 9.8 - Determination of suspended particulate matter – PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser; OR AS/*NZS 3580.9.11:2022* - Methods for sampling and analysis of ambient air, Method 9.11: Determination of suspended particulate matter - PM_{10} beta attenuation monitors

A1.2 Siting

A key element of any ambient air quality monitoring program is the correct siting of equipment. The Australian Standard for the siting of air quality monitoring equipment (*AS/NZS 3580.1.1 2016*) includes the following site considerations:

- A sampling unit should be situated so that it can yield data which is representative of the location and the target source
- Avoid sites that have restricted airflows in the vicinity of the sampling inlet, such as sites adjacent to buildings, walls, trees. As a general rule, a sampling inlet should be located away from any nearby structure to the extent that the sampling inlet has a minimum clear sky angle of 120° (see Figure A1).
- Avoid sites that are adjacent to objects that may alter pollutant concentrations by absorption or adsorption
- Avoid sites where chemical interference with the measured pollutant may occur
- Avoid sites where physical interference may produce atypical results
- Ground level sampling sites (sample inlet less than 5 metres above ground level) are generally preferable in sparsely built up areas
- Local activities around a sampling site may change its suitability as a site, either temporarily or permanently.

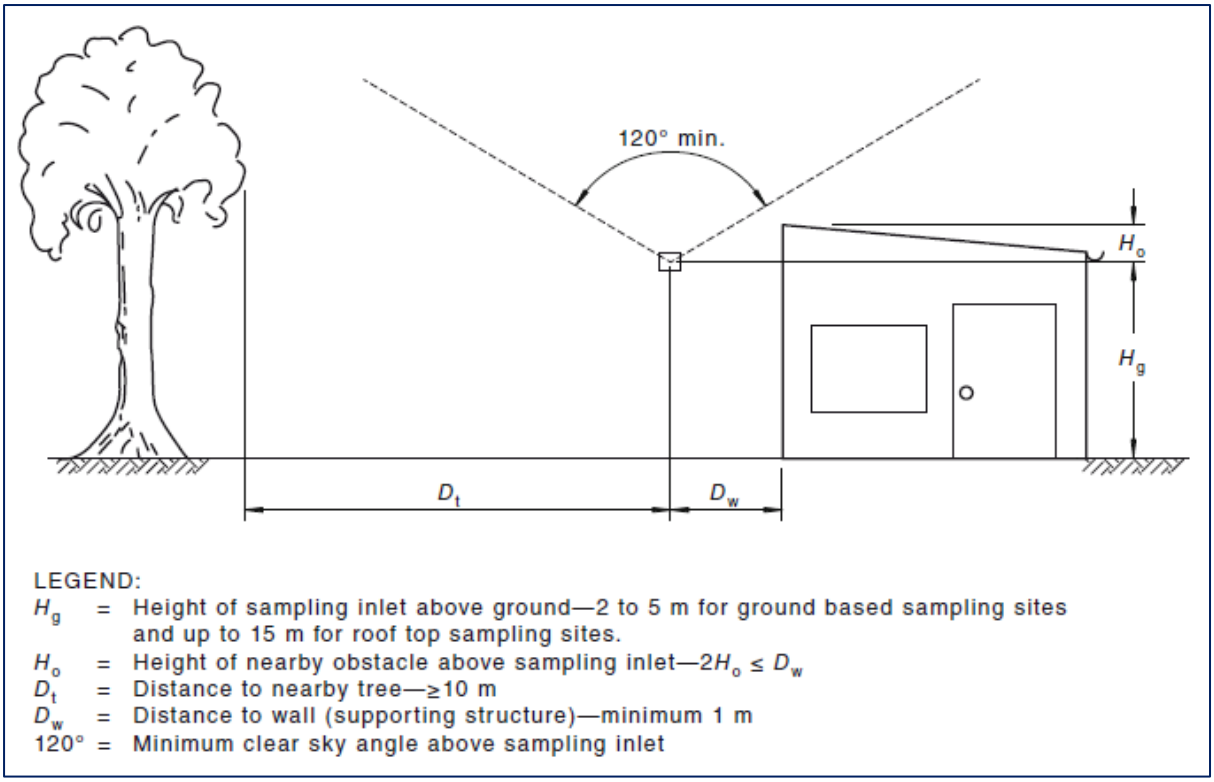

Figure A1 ***AS/NZS 3580.1.1:2016*** **Generalised ground level sampling site requirements**

A2 Meteorology

The siting requirements from the Australian Standard *AS/NZS 3580.14:2014* for wind speed, wind direction, temperature and relative humidity are summarised below.

Wind speed and wind direction:

- anemometer should be at a height of 10 m
- located in a "flat open area substantially free of obstructions, where the anemometer is distance from any obstruction by at least 10 times the height of the obstruction" – see Figure A2.

Temperature and relative humidity:

- mounted over a plot of open level ground at least 9 metres in diameter free of obstructions, and freely exposed to sunshine and wind
- to be clear of obstructions, this means a distance of at least four times the obstruction height
- located at least 30 m from large, paved areas and not close to hollows or ridges or other changes in terrain
- area should ideally be unwatered short grass, or natural earth (not concrete)
- should not be located close to artificial or natural sources of moisture
- measurements at 2 m or higher above ground.

The station should not be:

- in a gully or other depression
- on a geological formation such as a rock outcrop

- on or near steep slopes, cliffs, or ridges
- on a veranda or under an awning.

If there is a solar panel, this should face north.

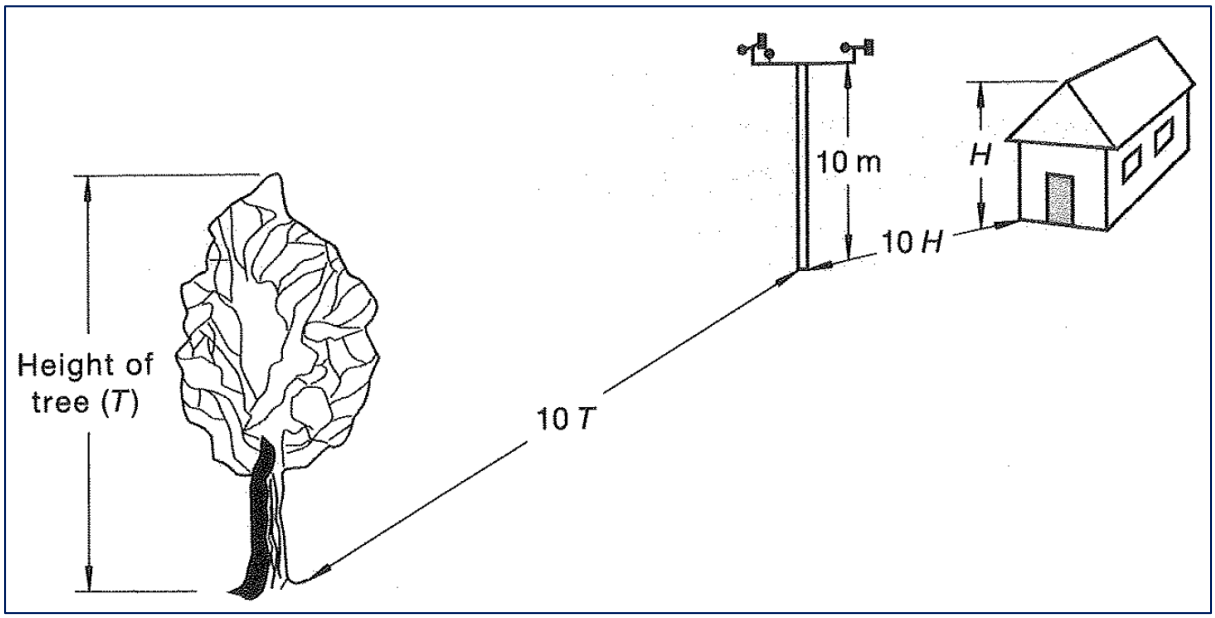

Figure A2 Example of siting wind instruments

The Australian Standard *AS/NZS 3580.14:2014* also provides a minimum requirement for weather monitoring equipment accuracy. Table A2 details the relevant accuracy requirements for sensors likely to be used.

Table A2 Minimum requirement for weather monitoring equipment accuracy (*AS/NZS 3580.14:2014*)

Sensor	Minimum requirements
Wind speed	±2 m/s or 1%
Wind direction	±3° and 1° resolution
Relative humidity	±2% (10-90% RH), ±4% (90-100% RH)
Air temperature	±0.3°C

APPENDIX B DUST MONITORING EQUIPMENT OPTIONS

Table B1 Summary of dust monitoring equipment options

Monitor Name	BAM	TEOM	High Volume Sampler	Low Volume Sampler	T-640x	Dust Master Pro	Dust gauge	Dust profiler
Technique employed	beta attenuation (BAM)	microbalance	manual gravimetric	manual gravimetric	light scatter	light scatter and manual gravimetric	manual gravimetric	Light scatter
Pollutants measured	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	deposited dust	PM_{10}
Type of measurement	continuous	continuous	sample based	sample based	continuous	continuous & sample based	sample based	particle counter that converts to mass fraction via proprietary algorithm
Minimum valid averaging period	1 hr	10 min	24 hr	24 hr	1 min	10 min	N/A	1 min
Compliant with Australian Standards?	yes (PM_{10})	yes (PM_{10})	yes (PM_{10})	yes (PM_{10})	unknown	yes	yes	no
Applicable Australian Standard	AS 3580.9.11:2022 (PM_{10})	AS 3580.9.8:2022 (PM_{10})	AS3580.9.6:2015 (PM_{10})	AS 3580.9.9:2017 (PM_{10})	unknown	AS 3580.9.9:2017 (PM_{10}) – manual gravimetric sampling only	AS/NZS 3580.10.1:2016 (dust deposition)	-

Monitor Name	BAM	TEOM	High Volume Sampler	Low Volume Sampler	T-640x	Dust Master Pro	Dust gauge	Dust profiler
Equivalence with USEPA Reference Methods?	yes (PM_{10})	yes (PM_{10})	yes (PM_{10})	no	US EPA approved	unknown	unknown	no
EHP Model Mining Conditions?	no but has been accepted by EHP as alternative	no but has been accepted by EHP as alternative	yes	yes	no	yes (if gravimetric sampling used)	yes	no
Power requirement	mains or solar	mains only	mains only	mains, battery, solar	mains	mains, battery, solar	none	mains
System footprint	a/c or solar powered enclosure	a/c enclosure, concrete slab required	self-contained	self-contained	concrete slab required	tripod	tripod	tripod
Remote Communications	yes	yes	possible but not required	possible but not required	yes	yes	no	yes
Positive aspects of monitor	Highly reliable. USEPA approved for PM_{10} (coarse). RTPM option allows for 1 min data	good data resolution	Simple design & reliable. Low cost compliance sampler for PM_{10}	Simple design & reliable. Low cost compliance sampler for PM_{10}	good data resolution	good data resolution, highly transportable	low cost, highly transportable	provides indication of trends
Negative aspects of monitor	relative high cost	relative high cost & higher maintenance than BAM	24 hour average only, labour intensive	24 hour average only, labour intensive, low flow rate	higher installation cost due to concrete slab	continuous readings are not AS compliant	requires monthly change of dust bottles	not Australian standard, measures counts rather than mass, low flow rate