Mt Shamrock Quarry Proposed Extension: Air Quality Impact Assessment

Prepared for:

Umwelt (Australia) Pty Ltd

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Final

Prepared by:

Katestone Environmental Pty Ltd
ABN 92 097 270 276
Level 4, 154 Melbourne Street, South Brisbane
Queensland, 4101, Australia

www.katestone.global
admin@katestone.com.au
Ph +61 7 3369 3699

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Prepared by:	Sarah Richardson, Padraig McDowell and Jemima Goodhew
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Term	Definition
µg/m^3	micrograms per cubic metre
µm	microns
°	degrees
g/s	grams per second
g/kg	grams per kilogram
g/tonne	grams per tonne
g/VKT	grams per vehicle kilometre travelled
km	kilometres
m	metres
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
Nomenclature	**Definition**
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
TSP	total suspended particulates
Abbreviation	**Definition**
AHD	Australian Height Datum
ABS	Australian Bureau of Statistics
Air NEPM	National Environmental Protection (Ambient Air Quality) Measure
AWS	automatic weather station
BoM	Bureau of Meteorology
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
EF	Emission factor
EMP	Environment Management Plan
EP Act 2017	Environment Protection Act 2017
EPA	Environment Protection Authority
EPR	Environment Protection Regulations 2021
ERC	Environmental Review Committee
ERS	Environment Reference Standard
DEECA	Department of Energy, Environment and Climate Action
NPI	National Pollutant Inventory
TAPM	The Air Pollution Model
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
WA	Works Authority

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by Umwelt (Australia) Pty Ltd on behalf of Holcim (Australia) Pty Ltd (Holcim) to prepare an Air Quality Impact Assessment of the Mt Shamrock Quarry proposed Extension. An air quality impact assessment is required to support a Work Plan Variation and Planning Permit Application (PPA) to permit extraction within the proposed Extension Area at the existing basalt Quarry at Mt Shamrock Road, Pakenham Victoria (the Quarry).

The Quarry has approval to carry out quarrying (extractive industry) by Planning Permit T050156 (Permit) issued by the Cardinia Shire Council under the Planning and Environment Act 1987 (P&E Act) and Work Authority (WA) 174 issued under the Mineral Resources (Sustainable Development) Act 1990 MR(SD) Act. Annual compliance reporting for the Quarry demonstrates that air quality monitoring data is in compliance with the limits specified in the Quarry Environment Management Plan (EMP) and Environment Protection Authority (EPA) Licence.

Holcim has identified older basalt resources at a location in the northeast corner of the Quarry boundary within the existing WA 174 boundary but outside the current extraction limit approved under WA 174 (the proposed Extension area). Holcim is seeking to extend the Quarry to the northeast (proposed Extension) to secure an estimated seven to nine million tonnes (Mt) of fresh basalt which is currently located beneath 30 m of overburden and weathered rock against the old quarry faces and unmined resource.

Key aspects of the proposal are as follows:

- Extraction will progress towards the Quarry extension area in the northeast, outside the current extraction limit approved under WA 174, but remaining within the existing WA 174 boundary.
- The location of the processing plant will not change.
- The location of all access roads will not change.
- The current annual extraction and processing rate of up to approximately 1.2 million tonnes will be retained.
- Extraction, processing, and sale operation hours that are in accordance with the current Planning Permit will be retained.
- The Quarry will continue to operate in accordance with all requirements of the Environment Management Plan (EMP) for the site.

The air quality impact assessment has been caried out with regard to the following relevant legislation and policy:

- *Environment Protection Act* 2017 and the General Environmental Duty (GED).
- *Environment Protection Regulations 2021.*
- *Environment Reference Standards* and Guide to the Environment Reference Standard, Publication 1992, June 2021.
- Guideline for assessing and minimising air pollution in Victoria 2022, Publication 1961, February 2022.
- Guidance notes for using the regulatory air model AERMOD in Victoria, Publication 1551, October 2013.
- Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD), Publication 1550, October 2013.
- *National Environment Protection (Ambient Air Quality) Measure 2021* (Air NEPM).
- The Mt Shamrock Quarry Environmental Management Plan.

- Preparation of Work Plans and Work Plan Variations: Guideline for Extractive Industry Projects (State Government Victoria, 2020).

A level 2 quantitative dispersion modelling assessment has been carried out using the TAPM meteorological model, the AERMET meteorological pre-processor, and the US EPA regulatory air dispersion model AERMOD. In accordance with EPA Victoria guidance, the assessment has used five years of modelled meteorological data. Incremental and cumulative dust (PM_{10}, $PM_{2.5}$ and dust deposition rates) for Quarry operations and for the proposed Extension have been assessed at sensitive receptor locations and benchmarked against the relevant air pollution assessment criteria.

A Level 2 assessment was deemed appropriate to determine the level of risk to air quality and a more detailed Level 3 assessment is not required. Quarry operations are typical routine operations, with known risks that can be identified with standard methodology, and control measures that are known to be effective. Potential impacts to air quality from the Quarry are limited to dust and amenity impacts, with no activities at the site that will result in emissions of pollutants requiring a more detailed assessment (bioaerosols, air toxics, etc.). As a basalt quarry, there will be no respirable crystalline silica emitted from the site. Risks to air quality have been adequately assessed using the Level 2 quantitative dispersion modelling assessment along with long-term monitoring of ambient PM_{10} and dust deposition near the site.

The findings of the assessment show:

- Analysis of ambient monitoring data (PM_{10} and dust deposition) from 2020 to 2023 inclusive, collected by Holcim demonstrates that the Quarry operations are in compliance with the limits specified in the Quarry EMP, with exceedances of the relevant criteria attributed to regional events and activities external to the Quarry.
- In comparison, the proposed Extension is estimated to result in:
    - A negligible change in stockpile and exposed area wind erosion emissions.
    - A negligible change in emissions from the removal, extraction and transfer of topsoil, overburden, and Basalt, including drilling and blasting.
    - A negligible change in emissions from processing including crushing, screening, and stockpiling of basalt.
    - An approximate increase in the total rate of TSP, PM_{10} and $PM_{2.5}$ emissions of 8%, 5%, and 4%, respectively, with the increase attributed primarily to the greater travel distance for the haul of basalt from the active pit area to the processing plant.
- Model results showed that, for both the Quarry and for the proposed Extension, incremental dust concentrations **comply** with the relevant 24-hour average and annual average PM_{10} air quality criteria of 50 µg/m³ and 20 µg/m³, respectively, and **comply** with the relevant 24-hour average and annual average $PM_{2.5}$ air quality criteria of 25 µg/m³ and 8 µg/m³, respectively, at all sensitive receptors.
- The predicted maximum incremental dust concentrations at the location of the receptors to the northeast and east (nearest to the proposed Extension Area) increase slightly due to the proposed Extension; however, remain below the relevant air quality criteria.
- Model results showed that, at receptor zone E just beyond the southern site boundary, dust nuisance impacts due to the Quarry are slightly higher than the monthly dust deposition rate threshold of 2 g/m²/month over a one-year period for the 2019, 2022, and 2023 model years. However, historical dust deposition monitoring demonstrates that the monthly ash content of the samples at this location (A6) are consistently below the required monitoring threshold of 4 g/m²/month.

Overall, the results of the cumulative assessment of the Quarry (i.e. including ambient background) show that on occasions exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criteria may occur; however, exceedances

are generally the result of elevated background concentrations and regional events rather than being attributed to operations at the Quarry. The dispersion model has also been configured with conservative assumptions and, therefore, the assessment is likely to overpredict potential impacts of the proposed Extension. Key assumptions increasing the conservative nature of the assessment include:

- Assessment based on the upper limit of 1.2 Mtpa (range is closer to 0.85 to 1.2 Mtpa).
- No additional control applied for the wet suppression system that is regularly used throughout the site including exposed areas that are subject to wind erosion.
- Cumulative impacts assessed using ambient background concentrations from EPA Traralgon monitoring station (where Holcim Data was unavailable including PM_{10} for 2019, and $PM_{2.5}$ for all model years) that has been demonstrated as likely to over-estimate existing levels at the site.

The proposed Extension is not expected to result in a significant increase in dust emissions or nuisance impacts at sensitive receptor locations. The haul distance between the active pit area and the processing plant will increase slightly; however, the associated increase in vehicle induced dust emissions is not anticipated to be significant. Potential impacts from the proposed Extension will be managed using the continuation of the operation and management measures that are already in place under the Quarry EMP.

The continued operation of the dust deposition and ambient PM_{10} monitoring at the Holcim sites in accordance with the EMP is a critical component of ensuring existing operations and the proposed Extension do not result in adverse air quality impacts and dust nuisance at sensitive receptors in proximity of the Quarry. In accordance with current procedures, all exceedances of the relevant PM_{10} criteria and dust deposition threshold need to be investigated and responded to in a timely manner. Additional management measures and dust controls may need to be employed in situations where dust monitoring shows potential exceedances of the relevant air quality criteria or dust deposition threshold.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Umwelt (Australia) Pty Ltd on behalf of Holcim (Australia) Pty Ltd (Holcim) to prepare an Air Quality Impact Assessment of the proposed Mt Shamrock Quarry Extension.

Holcim operates the Mt Shamrock basalt Quarry (the Quarry) at Mt Shamrock Road, Pakenham Victoria under an existing Work Plan and Works Authority (WA) No.174. Holcim is proposing an extension of the active pit to an area in the northeast of the site to secure an estimated seven to nine million tonnes (Mt) of fresh basalt (the proposed Extension).

This air quality impact assessment has been prepared to support a Work Plan Variation and Planning Permit Application (PPA) to permit extraction within the proposed Extension area to the northeast of the Quarry extraction limit approved under the WA 174. The assessment has been prepared in accordance with all relevant regulatory guidance and legislation.

2. THE PROJECT DESCRIPTION

2.1 Operations

Holcim operates the Mt Shamrock Quarry (the Quarry), located at 95 Mount Shamrock Road, Pakenham Victoria 3810. The Quarry is located within the Cardinia Shire Council local government area (LGA) 65 km southeast of Melbourne. The nearest urban centres are Pakenham approximately 5 km south of the Quarry and Beaconsfield Upper approximately 5 km northwest (Figure 1).

The Quarry is approved to carry out quarrying (extractive industry) by Planning Permit T050156 (Permit) issued by the Cardinia Shire Council under the Planning and Environment Act 1987 (P&E Act) and WA 174 issued under the Mineral Resources (Sustainable Development) Act 1990 MR(SD) Act.

The Mt Shamrock, Pakenham Quarry has been in operation since 1974 and since that time has supplied between 0.85 and 1.2 million tonnes per annum (Mtpa) of quarry products into the local and regional markets. The Quarry has a reputation for supply of consistently high-grade products that have been used in major Federal, State, Local Government, and private sector infrastructure projects. Major regional projects supplied include Pakenham Bypass (2005-2007), Cardinia Road overpass, High-Capacity Metro Trains depot - Nar Nar Goon, several Level crossing removals, Eastlink resheet, Monash Freeway widening and Upper Yarra Reservoir (2020/2021).

The Quarry has operated in a relatively unobtrusive manner due to natural shielding of the site provided by the topography and by responsible development and management of the operations. In recent times the Quarry has been extracting and selling up to approximately 1.2 Mtpa.

The current process of extracting and processing of basalt reserves at the Quarry generally occurs in the following manner:

- Soil and overburden are removed, transported to the edge of the pit and used as part of the progressive rehabilitation works.
- Conventional drilling and blasting techniques are used to fragment the rock for transportation to the processing plant. A tracked hydraulic percussion drill rig is used to drill blast holes, which is then loaded with bulk explosives and initiated by non-electric detonation. Secondary breaking is carried out by an excavator mounted hydraulic rock breaker.
- The blasted rock is loaded into dump trucks and hauled to the crushing plant for processing into a range of aggregate sizes and various graded products.
- Products are either stockpiled on site by dump truck or blending plant, or directly loaded into road trucks for sale. A front end loader loads the stockpiled material into road trucks for sale.

The current Planning Permit allows the following operating hours:

- Production and sales between the hours of 7:00am to 6:00pm Mondays to Fridays and 7:00am to 12:00pm Saturdays.
- Blasting is confined to between the hours of 11:00am to 12 noon and 2:00pm to 3:00pm Mondays to Fridays and takes place on average once a week. There will be no blasting on public holidays, or at any other time unless authorised by the Responsible Authority and Department of Energy, Environment and Climate Action (DEECA).

Works outside of these hours is only for essential maintenance unless authorised by the Responsible Authority and DEECA. A site manager is present at all times during normal operating hours.

The Quarry is accessed from the end of Mt Shamrock Road, at a point about 1.3km north of the intersection with Pakenham Road. Main internal routes are properly formed, drained, and are regularly graded. All roads are watered to control dust. Traffic movement around the site is controlled by a Traffic Management Plan and appropriate signage. Car parking is available for visitors and employees next to the main office and amenities. All quarry trucks leaving the site are required to tarp their loads to prevent the emission of dust and spillage of product.

Holcim has identified older basalt resources at a location in the northeast corner of the site within the WA174 boundary but outside of the current extraction limit (the proposed Extension Area) (Figure 2). Holcim is seeking to extend the Quarry to the northeast (proposed Extension) to secure an estimated seven to nine million tonnes (Mt) of fresh basalt which is currently located beneath 30 m of overburden and weathered rock against the old quarry faces and unmined resource.

Key aspects of the proposal are as follows:

- The location of the processing plant and all access roads will not change.
- The current annual extraction and processing rate of up to approximately 1.2 million tonnes will be retained.
- Extraction, processing, and sale operation hours that are in accordance with the current Planning Permit will be retained.
- The Quarry will continue to operate in accordance with all requirements of the Environment Management Plan (EMP) for the site.

The proposed Extension is located within the Quarry site and is approximately 11 hectares in size. The Quarry currently occupies a total area of approximately 122 ha, including a 14.39 ha area at the south-east of the Quarry for management of surface water. This area includes a water storage area known as Donazzan's Dam. The Extension Area is located within the Green Wedge Zone (GWZ) and affected by the Environmental Significance Overlay – Schedule 1 (Northern Hills) (ESO1) under the Cardinia Planning Scheme.

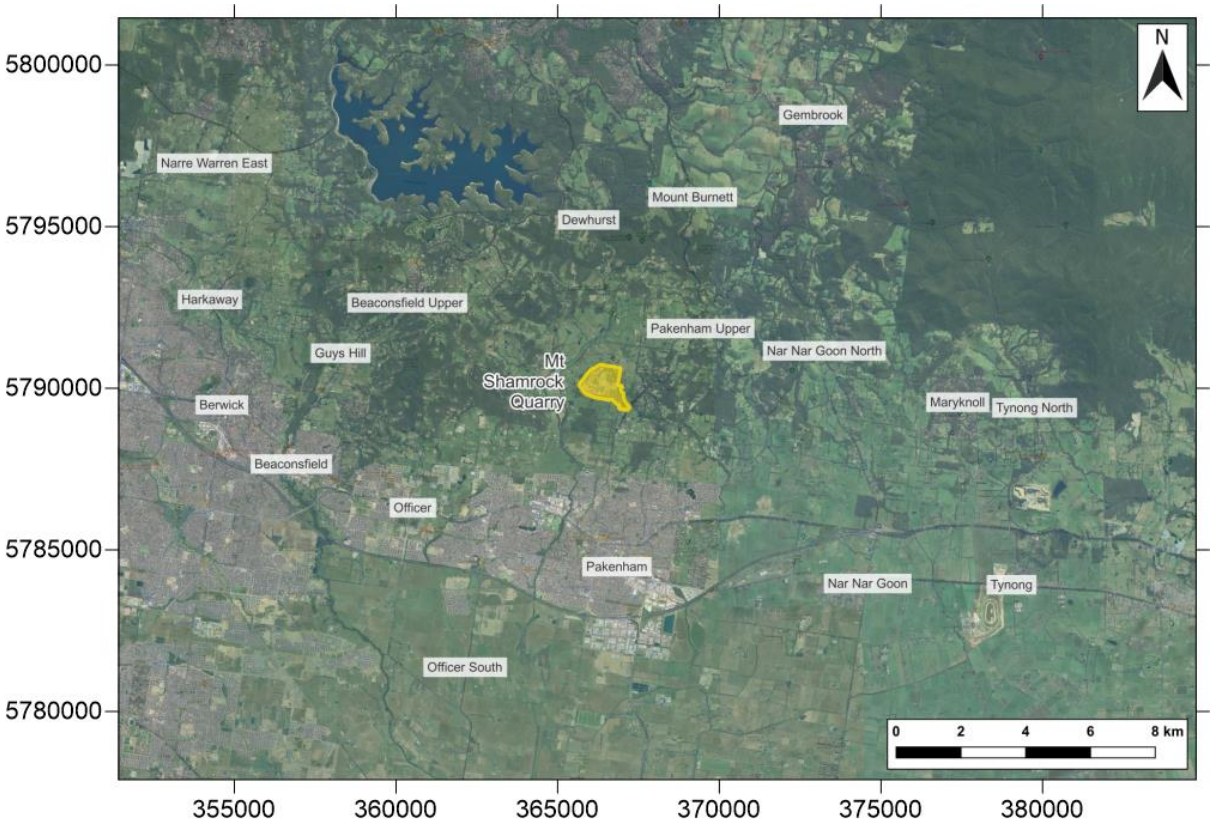

Figure 1 **Location of Mt Shamrock basalt Quarry at Pakenham, Victoria**

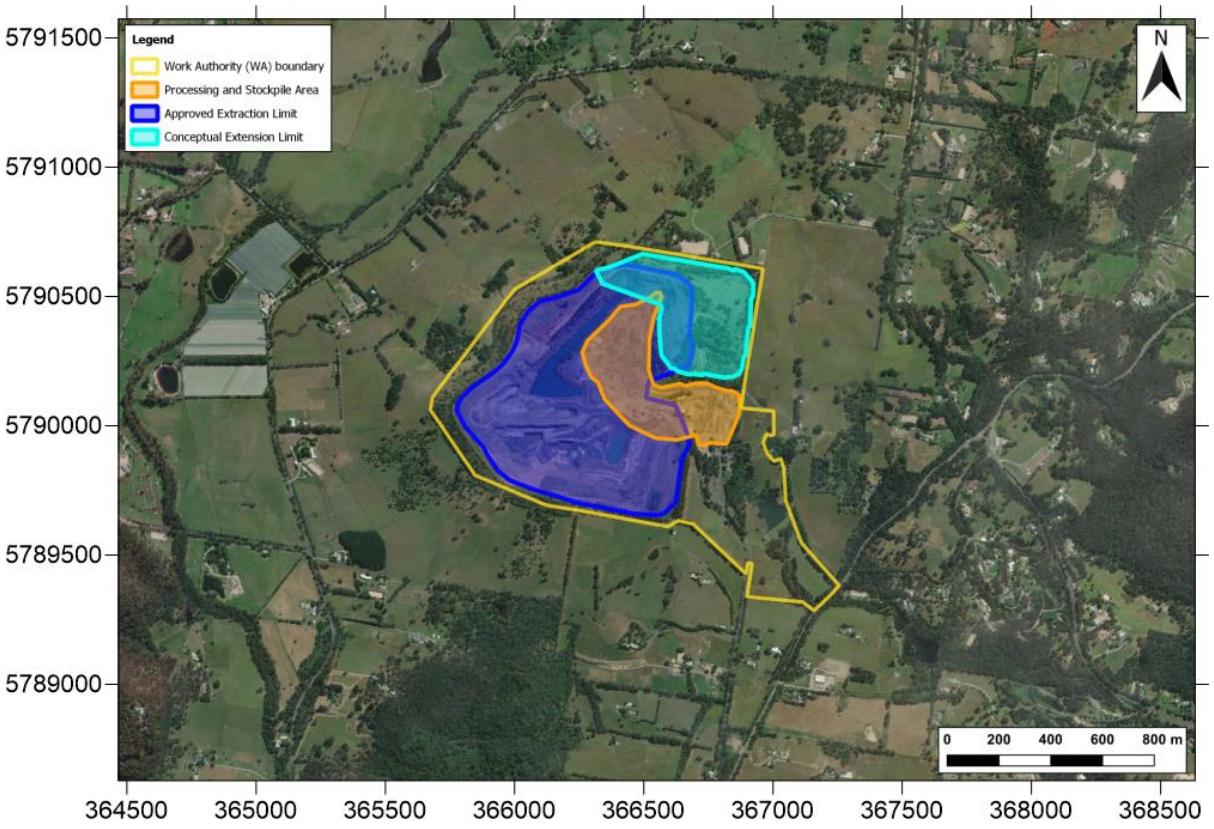

Figure 2 **Current extraction limit and proposed Extension limit**

2.2 Environmental Management Plan

The Mt Shamrock Quarry is currently operated in accordance with the requirements of the Environment Management Plan (EMP) for the site (Holcim, 2021). The EMP forms an integral part of the Holcim overarching Safety Health and Environment Management system (SHE) Standards and aims to provide the Quarry with guidance on operational, environmental, cultural, rehabilitation and monitoring management for the life of the Quarry.

The EMP details methods of operation and management measures that are required to manage potential environmental impacts, and protective and mitigating measures to be implemented to manage the sites significant environmental hazards. Holcim is required to prevent dust emissions from the Quarry operation from causing nuisance at residences or sensitive sites within the surrounding area and to ensure that dust levels do not adversely impact on the health and amenity of persons in the surrounding area.

In accordance with the EMP, the following levels are to be achieved at any residence or other sensitive site:

- PM_{10} no greater than 64 µg/m³ (1-hour average reactive monitoring threshold to ensure compliance with 24-hour average criteria of 50 µg/m³).
- Dust deposition no greater than 4 g/m²/month (no more than 2 g/m²/month greater than background).
- No (0) justified complaints from sensitive receptors.

The dust deposition criteria of 4 g/m²/month (or no more than 2 g/m²/month greater than background) is typically assessed over an annual average period (NSW EPA, 2017). The monthly trigger is used to monitor potential dust nuisance impacts in a timely manner to identify when further investigation and a review of operational controls and management practices is required.

In addition to the implementation of dust mitigation measures across the site, the EMP details the following monitoring requirements for the Quarry:

- Monthly monitoring of dust deposition and analysis and reporting of dust samples for compliance undertaken by an experienced entity independent of the operator.
- Continuous monitoring of wind speed and wind direction at the site.
- Continuous 1-hour average PM_{10} monitoring, with the data provided to the Quarry Manager for purposes of reactive monitoring to enable reactive management of dust emissions.
- Visual monitoring of dust emissions and potential dust generating activities and areas during quarrying activities.
- Monitoring of community complaints during works to assess the operations against objectives and targets.
- Review of all data by an external consultant and, in the event of any exceedances, notification of the site and Quarry manager.

3. REGULATORY FRAMEWORK FOR AIR QUALITY

3.1 Overview

Victoria revised its environmental legislation from 1 July 2021 commencing with the new Environment Protection Act 2017 (EP Act 2017). Accordingly, this assessment has been prepared with consideration to the following supporting legislation, policy, and guidance:

- Preparation of Work Plans and Work Plan Variations: Guideline for Extractive Industry Projects, December 2020.
- General Environmental Duty (GED) of the *Environment Protection Act* 2017.
- *Environment Protection Regulations 2021.*
- *Environment Reference Standard* and Guide to the Environment Reference Standard, Publication 1992, June 2021.
- Guideline for assessing and minimising air pollution in Victoria 2022, Publication 1961, February 2022.
- EPA Victoria's Guidelines for Input Meteorological data for AERMOD, Publication 1550, October 2013.
- EPA Victoria's Guidance Notes for Using AERMOD, Publication 1551, October 2013.
- National Environment Protection (Ambient Air Quality) Measure 2021 (Air NEPM).
- The Mt Shamrock Quarry Environmental Management Plan (EMP).

3.2 *Preparation of Work Plans and Work Plan Variations Guideline*

The process for approval requires an assessment of a Work Plan Variation and Planning Permit Application by the Earth Resources Regulator (ERR) and the Department of Transport and Planning. The Work Plan Variation for the proposed extension to the Quarry is required in accordance with the *Preparation of Work Plans and Work Plan Variations: Guideline for Extractive Industry Projects* (State Government Victoria, 2020). Statutory endorsement and approval of work plans and work plan variations under the Mineral Resources (Sustainable Development) Act 1990 (MRSDA) are administered by ERR within the DEECA.

The *Preparation of Work Plans and Work Plan Variations Guideline for Extractive Industry Projects* (State Government Victoria, 2020) provides guidance on the preparation of work plans, work plan variations, and work plan administrative updates for extractive industry projects to meet Victorian regulatory requirements. A work plan is a document that needs to:

- *Describe the nature and scale of the proposed extractive industry activities.*
- *Identify and assess all risks the works may pose to the environment, to any member of the public, or to nearby land, property, or infrastructure (known as a 'quarrying hazard').*
- *Identify and assess all risks the rehabilitation works may pose to the environment, to any member of the public or to land, property infrastructure in the vicinity of the rehabilitation activity (known as the 'rehabilitation hazard').*
- *Include a risk management plan that specifies the control measures the work authority holder will use to eliminate or minimise all identified risks and monitoring to demonstrate compliance with performance standards.*
- *Include a community engagement plan.*
- *Include a rehabilitation plan.*

A work plan variation covering the details above is required to seek approval for the proposed change in operations that are not consistent with the existing approved work plan for the site. An air quality assessment is required to identify and assess all risks the proposed Extension may pose to the air environment, to any member of the public, or to nearby land, property, or infrastructure. The identified risks must then be eliminated or minimised as far as reasonably practicable using risk control measures. The residual risks following implementation of control measures need to then be assessed and the risk management plan updated accordingly.

An assessment of risks (risk management plan) for the proposed Extension prepared in accordance with the requirements of the *Preparation of Work Plans and Work Plan Variations Guideline for Extractive Industry Projects* (State Government Victoria, 2020) is provided in Appendix E.

3.3 *Environment Protection Act 2017*

The EP Act provides the EPA powers and tools to prevent and minimise the risks of harm to human health and the environment from pollution and waste. It does not provide criteria to be used in an air quality assessment. Such criteria are contained in the *Guideline for assessing and minimising air pollution in Victoria* (EPA Victoria, 2022) (Publication 1961). The EP Act makes it a criminal offence to unlawfully pollute the air environment. The cornerstone of the EP Act is the general environmental duty (GED). This requires anyone engaging in any activity that may cause harm to human health and the environment from pollution or waste to eliminate such risks, or if it is not reasonably practical to do so, to reduce those risks as far as reasonably practicable. Furthermore, the person or company undertaking activities with risks to cause harm must implement and maintain systems for identification, assessment, and control of risks of harm and to aid evaluation of their controls.

These measures assist to inform the state of knowledge, where the state of knowledge is defined as the body of accepted knowledge that is:

- known about the harm or risks of harm to human health and the environment; and
- the controls for elimination or reducing those risks.

The state of knowledge changes over time. This is because ways of working develop, and new hazards and risks emerge.

3.4 *Environment Protection Regulations 2021*

The *Environment Protection Regulations 2021* support the EP Act by providing clarity and further detail for duty holders on how to fulfil their obligations. They aim to further the purpose of, and give effect to, the EP Act.

Chapter 5 Part 5.2 – Air provides some details on obligations for reporting emissions to air to the National Pollutant Inventory (NPI).

Schedule 1 details activity categories that require development and/or operational licences under the EP Act. The Mt Shamrock Quarry is classified as prescribed activity type C01 (extractive industry and mining) defined as extractive industry and mining but excluding any of the following (a) eductor dredging, (b) activities discharging or depositing mining or extractive industry wastes solely to land, and that are in accordance with the Mineral Resources (Sustainable Development) Act 1990, and (c) activities that involve discharges or emissions solely to the atmosphere in accordance with the Mineral Resources (Sustainable Development) Act 1990. The proposed Extension of the quarry will, therefore, be subject to a development and operating licence to be issued by the EPA Victoria.

3.5 Environment Reference Standard

The Environment Reference Standard (ERS) replaced the previous *State Environment Protection Policy (Air Quality Management)* (SEPP AQM) on 1 July 2021. The ERS covers common air pollutants in Victoria providing reference standards for ambient air, not compliance standards, primarily for the use of decision-makers when presiding over decisions. Decision makers can include EPA officers, officers from other government authorities and departments, environmental auditors, and representatives from local government and planning authorities.

Objectives for common air pollutants are generally adopted from the Air NEPM. The ERS is also used to inform management practices to ensure that the GED requirements are met, and for implementation in specific conditions or criteria in industry licensing. The ERS objectives for key criteria pollutants of concern from the quarry, including PM_{10} (particulate matter with a diameter less than 10 microns) and $PM_{2.5}$ (particulate matter with a diameter less than 2.5 microns) are reproduced in Table 1 below.

Table 1 ERS indicators and objectives

Column 1 Indicators	Column 2 Objectives	Column 3 Averaging Periods
Particles as PM_{10} (maximum concentration)	50 µg/m^3	24-hours
	20 µg/m^3	Annual
Particles as $PM_{2.5}$ (maximum concentration)	25 µg/m^3	24-hours
	8 µg/m^3	Annual
Visibility reducing particles (minimum visual distance)	20 km	1-hour
Table note: (1) Converted from ppm to µg/m^3 at 0^{o}C		

3.6 Guideline for assessing and minimising air pollution in Victoria

Publication 1961 (EPA Victoria, 2022) is part of Victoria's new environmental laws and relates to the EP Act. Publication 1961 "provides a framework to assess and control risks associated with air pollution. It is a technical guideline for air pollution practitioners and specialists with a role managing pollution discharges to air." The objectives of Publication 1961 include:

- A clear framework for air pollution assessment and management that protects the environmental values of air (as defined in the ERS) to ensure risks of harm to human health and the environment are minimised so far as reasonably practicable.
- Guidance on methods for assessing risk of harm from air pollution to human health and the environment. This includes a broad risk-based assessment framework, site-specific risk assessment methods, and risk-based air pollution assessment criteria (APAC).
- A conceptual framework for identifying and selecting risk management techniques and technologies to ensure that risks are minimised so far as reasonably practicable.
- Clarity on EPA's expectations for the minimum reporting standards related to the assessment and management of air pollution in Victoria.

Publication 1961 defines three levels of assessment in order of increasing complexity. The details associated with each level of assessment are presented below.

- Level 1 assessments – screening level assessments that are qualitative or semiquantitative in nature. They are used to quickly describe risks from activities that either have:
    - Intrinsically low risks, or
    - Risks that are so common and well understood can be effectively controlled without the need for extensive assessment work.
- Level 2 assessments – the most common type of risk assessment for industry. They usually involve the use of dispersion modelling or monitoring. Predicted or measured pollutant concentrations can be benchmarked against a set of pre-defined APAC to understand the resulting risks.
- Level 3 assessments – detailed risk assessments only used in exceptional circumstances when a simple comparison of a pollutant's concentration to an APAC cannot adequately describe the risk.

This report will constitute a Level 2 assessment. Justification for the use of a Level 2 assessment, rather than a more detailed Level 3 assessment, is provided in Section 9.

APAC for the assessment and management of air emissions are detailed in the guidance document and supersede those in the older SEPP AQM.

APAC are risk-based concentrations that aid in identifying the likelihood of an activity posing an unacceptable risk to humans or the environment. Exceedance of these criteria indicate a need for further risk management controls and investigation into causes for the exceedance. There are two broad categories of APAC, namely: health-based that are concerned with protection of public health; and environmental APAC that aim to protect ecosystems and agricultural land uses.

For modelling assessments, the EPA recommends the following for applying APAC to predicted concentrations:

- Concentrations are reported for:
    - The most impacted location at or beyond the boundary of the site.
    - Any sensitive land uses that have been specifically identified.
- Results are presented as:
    - The incremental ground-level concentration at the location due to the emissions from the subject site. When elevated receptors are present, concentrations need to also be provided for the relevant elevations.
    - Background concentrations of the pollutant.
    - Total concentrations (cumulative – background plus incremental).
- The percentiles of the data are reported as follows:
    - The 99.9th percentile for averaging times of an hour or less.
    - The 100th percentile (maximum) for all averaging times greater than an hour.
- APAC with averaging times less than 24 hours apply at any location at or beyond the boundary of the facility. APAC with averaging times of 24 hours or greater apply at discrete sensitive locations.

Relevant health-based for the quarry are provided in Table 2. There are no environmental APAC relevant to the Project.

Table 2 Health-based APAC

Pollutant	Pollutant Type	Cumulative/Incremental[1]	Averaging time	APAC (µg/m^3)	Basis
PM_{10}	Criteria pollutant	Cumulative	24-hour	50	ERS
			Annual	20	
$PM_{2.5}$	Criteria pollutant	Cumulative	24-hour	25	ERS
			Annual	8	

Table Notes:

[1] Cumulative APAC apply to total concentration (cumulative including background) and incremental APAC apply to the incremental concentration (excluding background)

3.7 National Environmental Protection Measure for Ambient Air Quality

The National Environment Protection Council (NEPC) defines national ambient air quality standards and goals in consultation, and with agreement from all Australian State and territory governments. These were first published in 1998 in the *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) and previously varied in 2015. The Air NEPM contains, amongst other parameters, standards for particulates and combustion products. Compliance with the Air NEPM standards is determined by ambient air quality monitoring undertaken at locations prescribed by the Air NEPM and that are representative of large urban populations. The goal of the Air NEPM is to monitor and improve ambient air quality. Whilst the Air NEPM is relevant to ambient air quality levels rather than the assessment of emissions from individual facilities, a number of Australian States including Victoria have adopted the Air NEPM standards as APAC.

The standards in the Air NEPM are not intended to be applied as environmental standards by regulators without consideration of regulatory impacts in their jurisdictions. The Explanatory Statement clarifies the intent of the Air NEPM as a standard for reporting representative ambient air quality within an airshed, and not as a regulatory standard. The Air NEPM standards for PM_{10} and $PM_{2.5}$ are those adopted in the ERS.

3.8 Amenity and nuisance dust

In accordance with the ERS, Holcim is required to protect the following environmental values of the ambient air environment in relation to amenity and dust nuisance:

- Local amenity and aesthetic enjoyment, described as air quality that supports lifestyle, recreation, and leisure.
- Visibility, described as air quality with low levels of particulate matter and very good visible range.

Amenity and dust nuisance can result from fugitive dust emissions (total suspended particulates (TSP) (suspended particles larger than 10 microns (µm))) and dust deposition, with impacts to amenity and individual's wellbeing resulting from unsightly soiling of surfaces, visible plumes, and reduction in visibility. The Air NEPM, ERS objectives, and APAC focus on PM_{10} and $PM_{2.5}$, with current health research indicating that the smaller size fractions (10 µm or less) have a greater influence on influence on human health.

The likelihood and consequences of nuisance dust impacts from an activity are typically assessed using a nuisance dust risk assessment approach (Publication 1961). Specifically, a nuisance dust risk assessment involves estimating the likelihood and consequence of dust impacts from an activity to inform what reasonably practicable measures or actions would be required to comply with the GED.

An approach to assess risk to amenity and nuisance dust includes the analysis of monitoring data (dust deposition gauges) or the results of dispersion modelling. The measured or predicted rate of dust deposition is typically compared to the following threshold:

- Total rate of dust deposition of 4 g/m^2/month over a twelve-month period.
- Rate of dust deposition due to the facility of no more than 2 g/m^2/month above background over a twelve-month period.

The above threshold typically applies at the boundary of industrial premises and should be used to identify when further investigation and a review of operational controls and management practices is required to prevent and minimise dust nuisance as far as reasonably practicable to meet the GED. The averaging period is set at a monthly average to enable an assessment of nuisance dust in a timely manner to ensure that people's amenity is not adversely impacted. If dust levels exceed the trigger level of 2 g/m^2/month above background, then site management practices should be reviewed and dust management implemented to reduce dust levels to within the guidelines.

4. AIR QUALITY ASSESSMENT METHODOLOGY

The potential impacts associated with the Quarry and the proposed Extension have been assessed using dispersion modelling, which is consistent with a level 2 assessment approach in EPA Victoria's Publication 1961. Details of the assessment method are provided in the following sections.

4.1 Existing environment

The assessment includes an analysis of the following information about the receiving environment, as per the requirements of Publication 1961:

- Local topography and land use
- Population density and vulnerability
- Sensitive receptors
- Meteorology
- Existing sources of emissions and background air pollution.

4.2 Meteorology

Surface and profile meteorological data files suitable for use in AERMOD were generated based on five years of meteorological modelling (2019 to 2023) using the TAPM meteorological model and the AERMET meteorological pre-processor. Available meteorological monitoring data from Holcim's onsite meteorological monitoring station was assimilated into TAPM.

Preparation of data files and modelling procedures were performed in accordance with EPA Victoria's Guidance for Construction of input meteorological data files for the EPA Victoria's regulatory air pollution model (AERMOD) (Publication 1550).

Details of model configuration are provided in Appendix A.

4.3 Emission rates

Emission rates of key criteria pollutants, as TSP, PM_{10}, and $PM_{2.5}$, have been based on published emission factors from the relevant National Pollutant Inventory (NPI) emission estimation technique manuals. Relevant factors from the United States AP-42 air emission factors have been applied where relevant NPI factors are not available.

Emission estimates have used site layout information and key operational data provided by Holcim. Details of any emission control equipment or activities associated with the emission sources have also been considered.

4.4 Dispersion modelling

The dispersion model AERMOD (version 22112) was used to predict ground-level concentrations of key pollutants due to the existing Quarry and due to the proposed Extension. Concentrations were predicted across the model domain and at key sensitive receptors. AERMOD was configured for five years (2019 to 2023) in accordance with EPA Victoria's Guidance Notes for Using AERMOD (Publication 1551).

Details of the model configuration are provided in Appendix A.

4.5 Cumulative impacts

Existing air quality at the site using a summary of the available Holcim and EPA Victoria ambient air quality monitoring is presented in Section 5.5.2. The Holcim monitoring network is designed to monitor the impact of existing operations at the Quarry to ensure operations do not result in nuisance impacts at residences or sensitive sites within the surrounding area and to ensure that dust levels do not adversely impact on individual's health and amenity. The available monitoring data provides an indication of the impact of existing operations at the Quarry on air quality in the area.

Cumulative impacts of criteria pollutants PM_{10} and $PM_{2.5}$ have been assessed in accordance with the requirements of EPA Publication 1961. Specifically, a five-year dataset for the 2019 to 2023 period has been prepared to provide a contemporaneous background alongside the modelled concentration of PM_{10} and $PM_{2.5}$ at each identified sensitive receptor (See Section 5.3, Figure 7).

Where available, the PM_{10} air quality monitoring data from the Holcim monitoring sites (See Section 5.5.2, Figure 11) has been used, substituting data from an upwind monitor (i.e. upwind from the Quarry to represent background levels without contribution from the Quarry) for each hour of the required period through analysis of the onsite Holcim meteorological data. Data from the EPA Victoria Traralgon site has been used for the 2019 period as no Holcim data is available for this period.

The Holcim monitoring network does not include ambient $PM_{2.5}$ monitoring. Consequently, the $PM_{2.5}$ air quality monitoring data from the EPA Victoria Traralgon site (See Section 5.5.2, Figure 12) has been used for the preparation of the contemporaneous background data file. Validated data for Traralgon was not available for the 2023 year. Cumulative $PM_{2.5}$ impacts for the 2023 model year have relied on the use of Traralgon monitoring data for the 2022 year.

Exceedance levels measured by Holcim during January and February 2020 that were the result of large bushfires were retained in the final dataset used in the assessment. In addition, levels at the EPA Traralgon site used in the background file (2019 PM_{10} data, and 2019 to 2023 $PM_{2.5}$ data) are generally higher than those measured at the Holcim monitoring sites and are likely to over-predict cumulative impacts due to the Quarry.

Further details and a visualisation of the background data file are provided in Appendix A3.

4.6 Presentation of results

The results of the dispersion modelling have been prepared in accordance with guidance provided in Publication 1961. Concentrations for 24-hour average periods and monthly deposition rates are presented as the 100th percentile (maximum).

Results of the dispersion modelling have been determined at identified residential receptors that were provided by Holcim. Results provide the maximum contribution at each receptor due to the Quarry and due to the proposed Extension, as well as the maximum combined concentration due to the quarry and the representative ambient background concentration.

Results also present contour plots showing the geographic extent of the maximum concentrations arising from the Quarry and from the proposed Extension.

4.7 Limitations and uncertainty

The study relies on the accuracy of several data sets that feed into the dispersion model, all of which will have uncertainties associated with them. The input data sets include:

- Meteorological monitoring observations from the onsite meteorological monitoring station.
- Air quality monitoring observations from the EPA Victoria and Holcim sites.
- Emissions and operational data provided by Holcim.
- Synoptic and surface information datasets from CSIRO.

It is also important to note that numerical models are based on an approximation of governing equations and will inherently be associated with some degree of uncertainty. The more complex the physical model, the greater the number of physical processes that must be included. There will be physical processes that are not explicitly accounted for in the model and, in general, these approximations tend to lead to an over prediction of air pollutant levels.

The dispersion model has been configured with conservative assumptions and, therefore, the assessment is likely to overpredict potential impacts of the proposed Extension. Key assumptions increasing the conservative nature of the assessment include:

- Assessment based on the upper limit of 1.2 Mtpa (range is closer to 0.85 to 1.2 Mtpa).
- No additional control applied for the wet suppression system that is regularly used throughout the site including exposed areas that are subject to wind erosion.
- Cumulative impacts assessed using ambient background concentrations from EPA Traralgon monitoring station (where Holcim Data was unavailable including PM_{10} for 2019, and $PM_{2.5}$ for all model years) that has been demonstrated as likely to over-estimate existing levels at the site.

5. EXISTING ENVIRONMENT

5.1 Local topography and land-use

The Mt Shamrock Quarry is located approximately 65 km southeast of Melbourne centre and 60 km inland from the Victorian coastline within the Cardinia Shire Council local government area, and 5 km north of Pakenham township (Figure 1).

The topography of the local area is steep to undulating (Figure 3). The Quarry is located on a ridge marking the boundary between the Toomuc Creek and Deep Creek catchments. The Toomuc Valley runs approximately north-south between the Dandenong Ranges and the alluvial plains generally south of the Princes Highway. Terrain within the Quarry site boundary is between 180 and 220 metres AHD (Australian Height Datum).

Much of the local native vegetation in proximity to the Quarry has historically been disturbed, predominantly for agricultural purposes (including widespread clearing). Pockets of vegetation remain, generally along watercourses, roadside reserves, along fence lines and on steeper slopes. Extensive tree planting and landscaping has occurred around the perimeter of the quarry, creating a buffer. The planting has enhanced the visual appearance of the horizon line through the re-establishment of vegetation on the hillside which has been previously cleared.

Land use in the immediate vicinity of the Quarry is predominantly agricultural, grazing, pockets of vegetation, and rural residences lots primarily between 2 and 8 hectares (Figure 4).

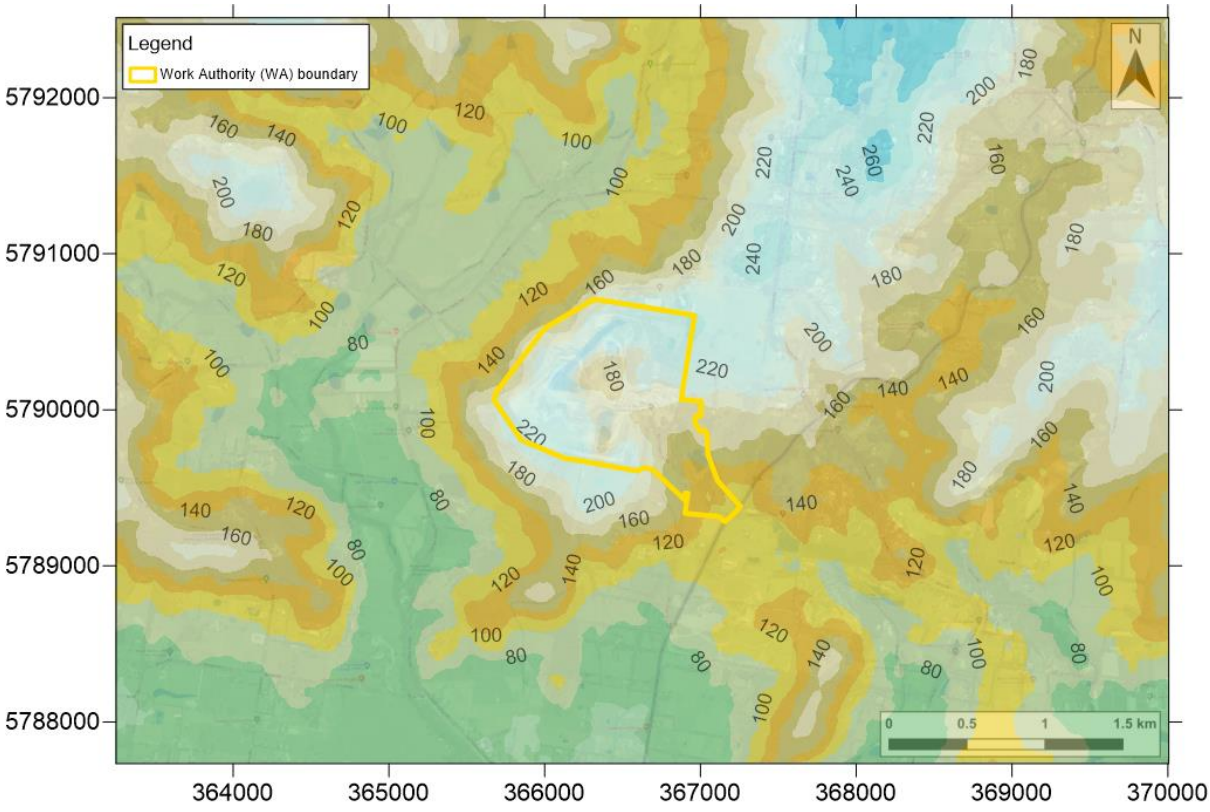

Figure 3 **Topography of the Quarry site**

Figure 4 **Land use of the Quarry site**

5.2 Population density and vulnerability

The Publication 1961 (EPA Victoria, 2022) recommends that all air pollution reports consider the simple indicators of population density and vulnerability of the receiving environment in order to provide context for the risks that are being assessed. These factors are to be considered holistically when evaluating whether the risks of a development are being minimised as far as reasonably practicable.

Population density data for the areas surrounding the Quarry have been derived from the Australian Bureau of Statistics (ABS, 2021) by Mesh Block (MB) and are presented in Figure 5. In 2021 there were 368,286 Mesh Blocks covering the whole of Australia without gaps or overlaps. Most areas surrounding the site include populations between 0 – 200 persons (98%).

There is a single area with greater than 500 located approximately 5 km south of the Quarry (Pakenham town). The areas immediately surrounding the quarry range from 0 to 300 people, in large mesh block areas highlighting the low density of receptors surrounding the quarry.

Figure 6 displays socio-economic indexes for areas (SEIFA) as derived from the ABS (2021). The values represent an index of relative socio-economic disadvantage (IRSD) for the statistical area level 1 (SA1). SA1s have a population of between 200 to 800 people. An IRSD decile of one represents the most disadvantaged population, which is particularly vulnerable to air pollution. The nearest and most disadvantaged area is approximately 2.5 km south of the WA 174 boundary and has been demarcated with an IRSD decile of two. The areas directly surrounding the site range from IRSD decile of 6 to 8, indicating a low disadvantage.

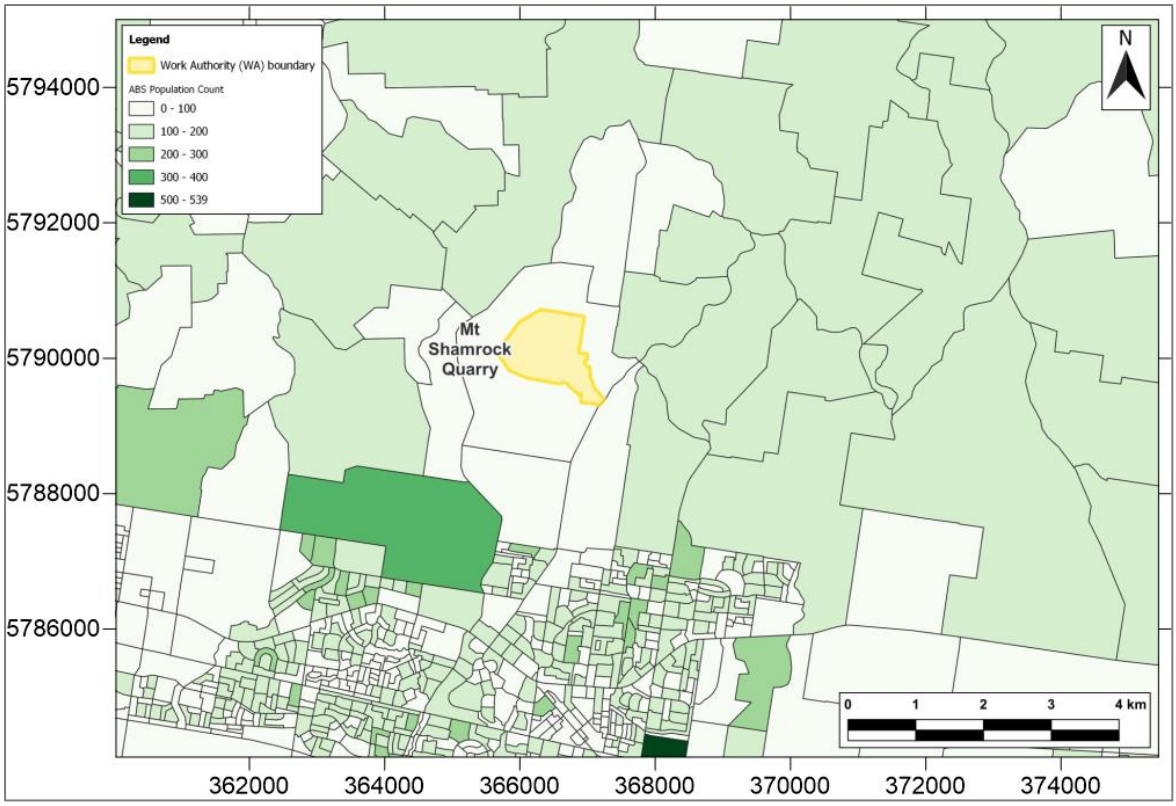

Figure 5 **Mesh Block (MB) Population Densities in the receiving environment (ABS, 2021)**

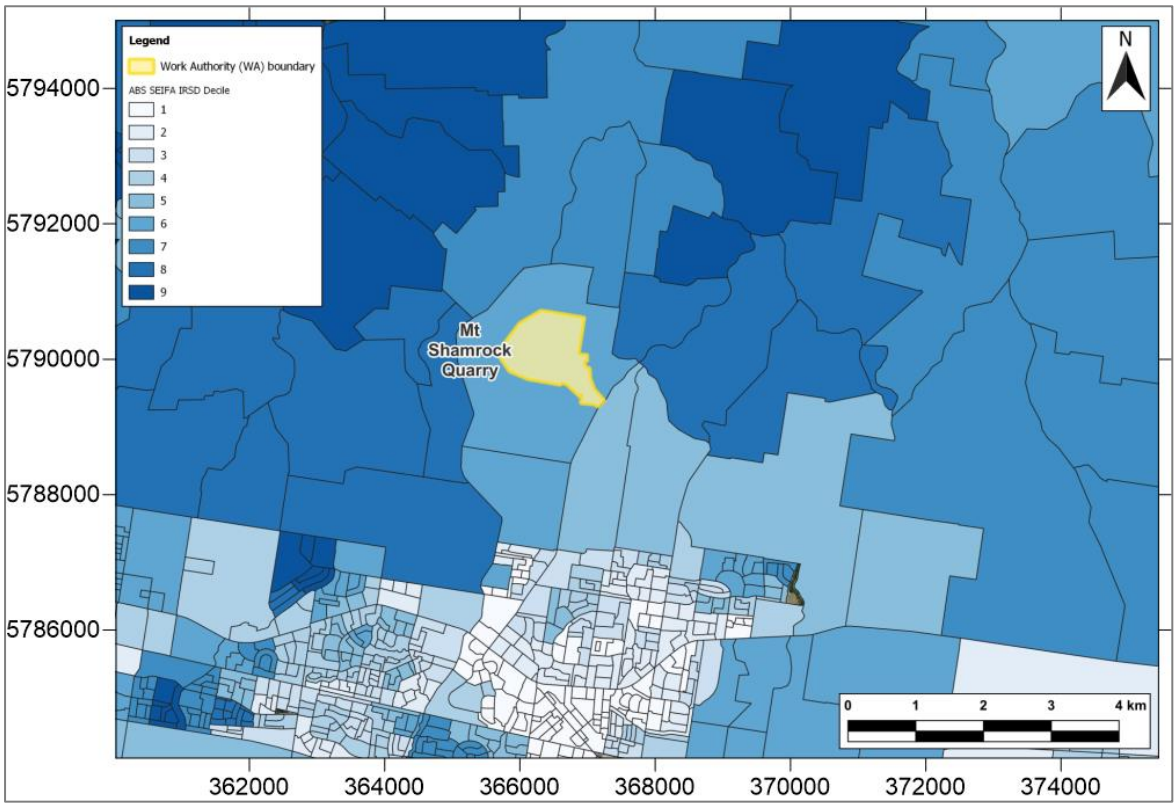

Figure 6 **Population vulnerabilities as represented by IRSD deciles (ABS, 2021)**

5.3 Sensitive receptors

Publication 1961 (EPA Victoria, 2022) recommends consideration of the following factors in identifying and presenting sensitive land uses:

- Discussion and presentation of surrounding land uses including present and future planned uses (Section 5.1).
- Characterise the sensitive land uses using population density and vulnerability data as provided by the ABS (Section 5.2).

Sensitive land uses are defined as any land uses that require a particular focus on protecting the beneficial uses of the air environment relating to human health and wellbeing, local amenity, and aesthetic enjoyment, for example residential premises, childcare centres, pre-schools, primary schools, education centres or informal outdoor recreation sites. Areas of ecological significance should also be identified.

The existing Pony Club located to the immediate north of the WA 174 boundary is owned by Cardinia Shire Council and is currently zoned Public Park and Recreation Zone. This location is not considered to be a sensitive receptor.

For the purposes of assessing impacts at sensitive locations in this report, the 135 discrete sensitive receptors provided by Holcim have been grouped into sensitive zones to be included in the modelling (Figure 7). Gridded receptors (contour maps) across the study area have also been included.

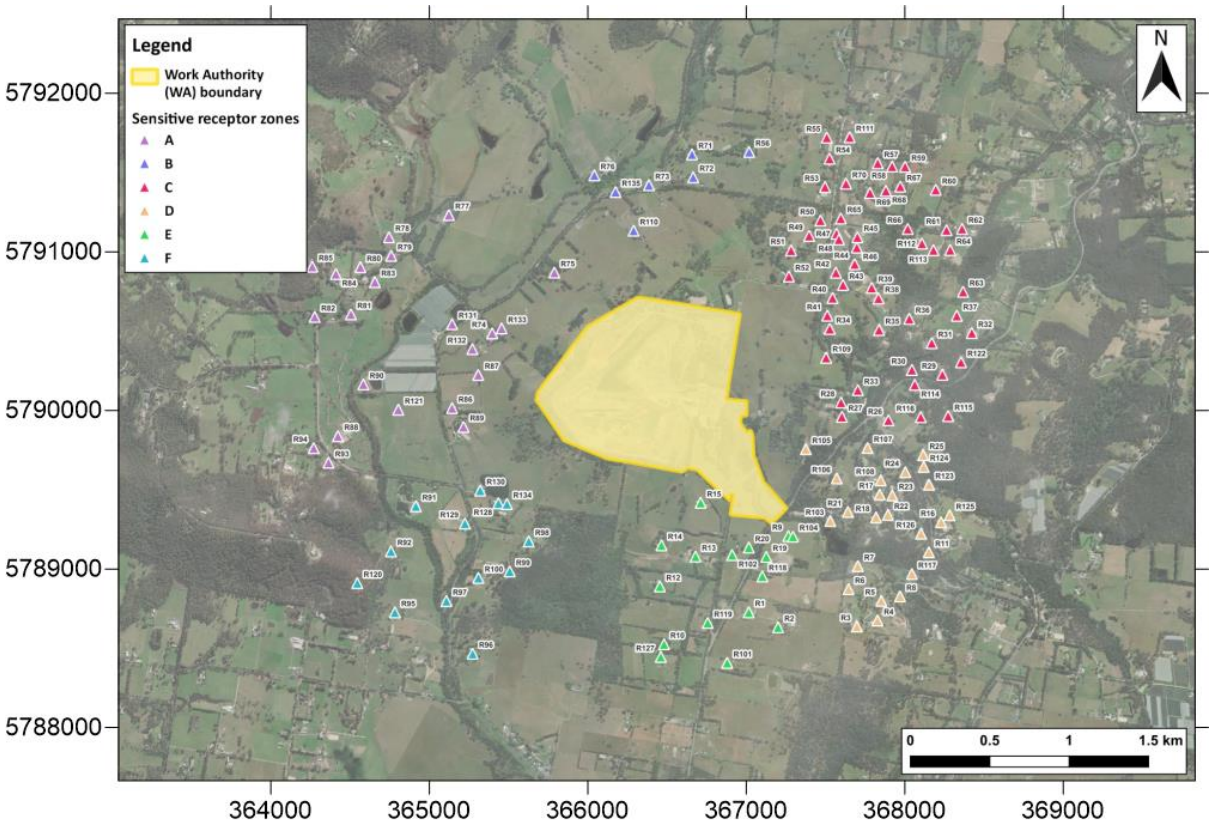

Figure 7 **Sensitive receptors identified in the surrounding environment**

5.4 Meteorology

Local meteorological conditions including wind speed and wind direction play a key role in the generation and dispersion of dust at the Quarry. This section presents a summary of the meteorological conditions with influence upon the project, referring to the monitoring data measured at the onsite monitoring station operated by Holcim (Figure 11). The onsite meteorological data is monitored in accordance with AS2923.

5.4.1 Wind speed and wind direction

Wind speed and wind direction are important meteorological parameters that will influence the dispersion of air pollutants. Figure 8 illustrates the wind speed distribution from the onsite monitoring station. The onsite monitoring station has been operational from 2020 to present, with data up to December 2023 included in the analysis.

The average wind speed over the 4-years is 2.53 m/s. The predominant wind directions at site are from the northwest and southeast, with occasional winds from the northeast quadrant.

Figure 9 illustrates that on average over the four years of data, variations in wind direction are to be expected between seasons. Autumn and winter exhibit dominant north-westerly winds, while in summer the dominant winds are from the southwest. Wind speeds are expected to peak in winter and be at their lowest during summer.

Figure 10 shows the predicted average diurnal variation in wind speed and wind direction. The wind direction is consistent across all hours with speed peaking during midday before dropping into the night. The dominant north-westerly winds are most prevalent in the morning, with the southwesterlies building through the night.

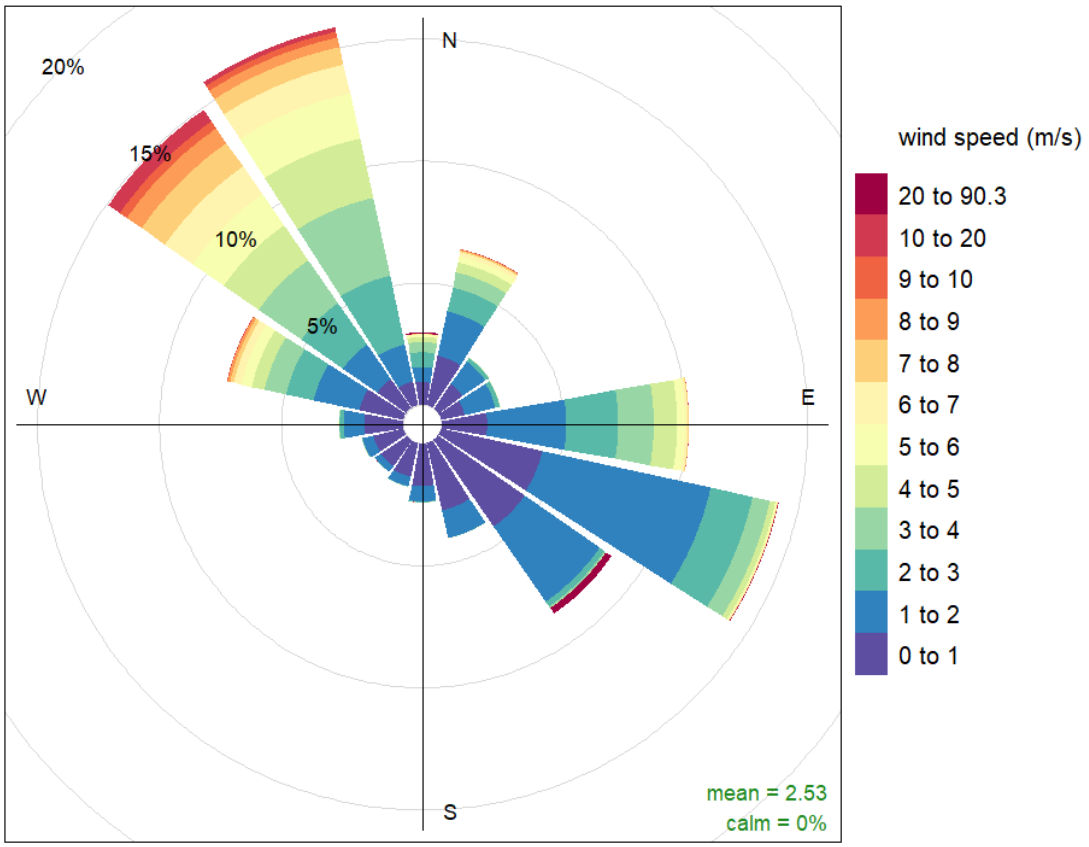

Figure 8 Annual distribution of winds for the onsite meteorological station (2020 – 2023)

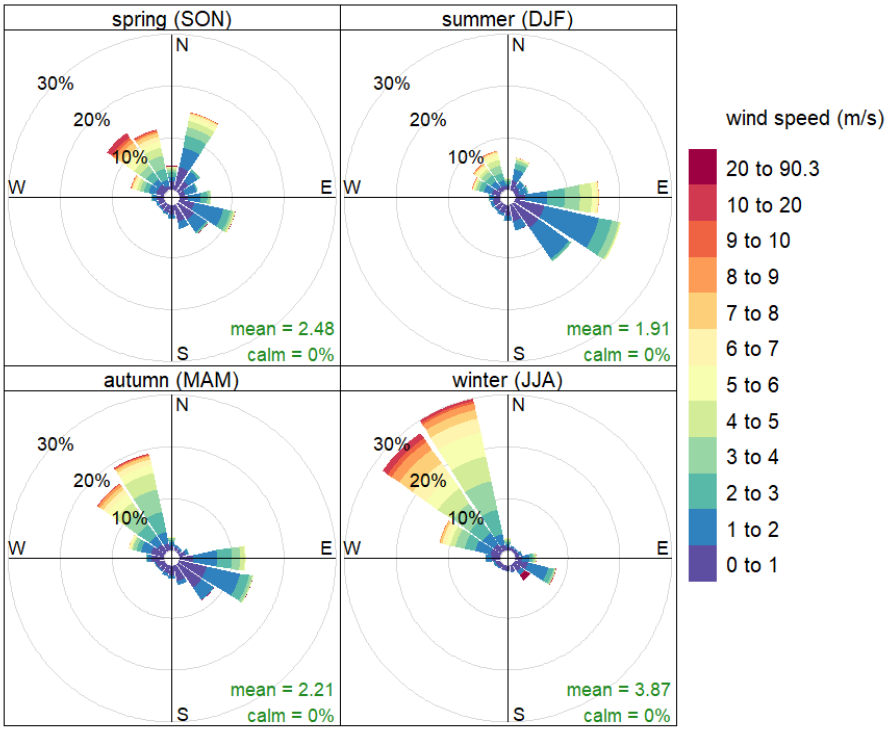

Figure 9 **Seasonal distribution of winds for the onsite meteorological station (2020 – 2023)**

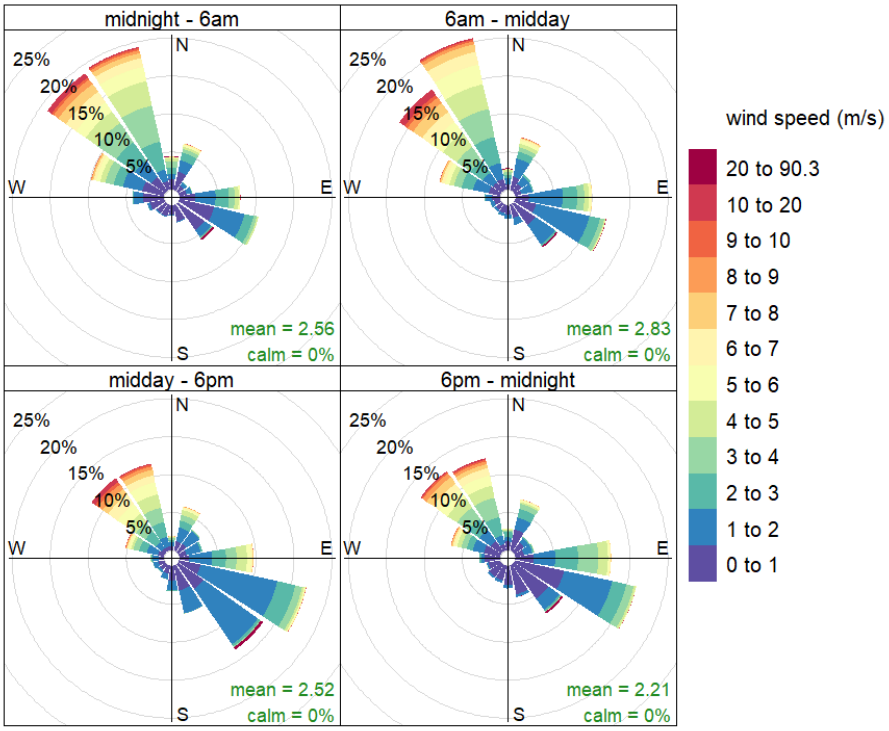

Figure 10 **Diurnal distribution of winds for the onsite meteorological station (2020 – 2023)**

5.5 Existing Air Quality

5.5.1 Existing sources of emissions

The Mt Shamrock Quarry conducts a number of activities that may generate emissions to air, primarily dust (PM_{10} and $PM_{2.5}$). Other existing industrial activities located within 10 km of the WA 174 boundary have been identified through a review of the National Pollutant Inventory (NPI) for the 2022-2023 reporting year. The search identified reported emissions of PM_{10} and $PM_{2.5}$ from three facilities (Table 3). All three facilities were located greater than 5 km from the WA 174 boundary and were responsible for relatively small dust contributions. Cumulative impacts from an existing facility are not expected to influence impact of the Quarry and have not been included in the assessment.

Table 3 Total emissions to air for facilities within 10 km of the Quarry as reported to the NPI for the 2022-2023 reporting year

Facility	Main Activities	Particulate Matter PM_{10}	Particulate Matter $PM_{2.5}$	Distance and direction from WA 174 boundary
G & K O'CONNOR PTY LTD	Meat processing	4,298	363	8.9 km South
Pakenham	Stockfeed manufacturing and distribution	33,223	156	5.4 km South
SOUTH EAST ASPHALT PTY LTD	Asphalt manufacturing	3,454	68	7 km South

5.5.2 Existing air quality monitoring data

The risks to air quality from the proposed Extension need to be considered in the context of the cumulative risks posed by other air pollution sources, including how the background concentrations vary during the year due to seasonal or other temporal trends. Existing air quality relevant to this assessment has been characterised using a review of available sources, including ambient PM_{10} monitoring and dust deposition monitoring data from the sites operated by Holcim near the site as part of the conditions of the EMP. Due to limitations in the dataset, the assessment relies on additional monitoring data from the EPA Victoria operated air quality monitoring site at Traralgon (Figure 12).

As a condition of the Quarry EMP, Holcim currently operate dust monitoring at seven locations in the immediate vicinity of the Quarry (Figure 11). Four of the sites (A1, A3, A4, and A6) provide results of ambient PM_{10} monitoring (15-minute average data) and monthly rates of dust deposition. An additional three sites (A2, A5, and A7) provide results of monthly rates of dust deposition. The site located approximately 1 km east of the southern WA boundary (A7) is operated at a background monitor. Monitoring is conducted in accordance with AS 3580.10.1.2000 and AS 3580.9.11:2022.

The period of ambient PM_{10} data from sites A1, A3, A4, and A6 available for the analysis covers the period January 2020 to December 2023. A period of erroneous 15-minute PM_{10} data at site A6 between 1 April 2020 and 26 June 2020 was removed from the dataset prior to use in the assessment.

A summary of the 24-hour and annual average data from each of the seven Holcim sites are presented in Table 5, with a visualisation of the data over the monitoring period presented in Figure 13. Table 5 also provides a summary of the 24-hour and annual average data from the EPA Victoria monitoring site at Traralgon, with a visualisation of this data over the 2019 to 2022 monitoring period presented in Figure 14.

Key points of interest in relation to the data are as follows:

- The 24-hour average PM_{10} concentrations measured across the Holcim sites in the vicinity of the Quarry are generally below the criteria of 50 µg/m³.
- Occasional exceedances of the criteria do occur.
- Where exceedances do occur, an investigation into the potential cause of exceedance events is carried out by external consultancy Blue Atmosphere as part of the monthly reporting requirements.
- Analysis shows that the exceedance events are attributed to influences external to the Quarry (Table 4).
- On occasion high monitor readings were the result of inconsistent readings due to moisture entering the unit rather than actual dust events.

Where available, the monthly PM_{10} monitoring reports prepared for Holcim were reviewed to identify the potential cause of the exceedance events during the 2020 to 2023 period. A summary of the exceedance events is provided in Table 4.

Table 4 Exceedance events during monitoring period and potential cause where available

Year	Date and site(s)	Description	Attributed to activities at the Quarry
2020	3, 4, 6, 13, 14, 15 January at Site A1 and Site A3. 3, 4, 6, 7, 13, 14 and 15 January, and 7 and 15 February at Site A4. 3, 4, 6, 7, 13, 14, 15 and 16 January, and 7 and 15 February at Site A6.	Regional bushfire event across January and February 2020 resulting in a number of exceedances across the site (Blue Atmosphere, 2020a, 2020b).	No
2020	20 March at all four sites. 25 March at Site A4. 27 March at Site A1 and Site A4.	Environmental audit report confirmed that exceedance event(s) were caused by events external to the Quarry.	No
2020	2 April at Site A4	Modem damaged due to severe electrical storms during April so data not reliable (Blue Atmosphere, 2020c); however, time period of high levels (early hours of the morning) suggests influence external to Quarry (e.g. wood fires).	No
2020	5, 6, 8, 12, 21 and 27 July at Site A4	Reactive sampler damaged at the time due to storms during the month so data not reliable (Blue Atmosphere, 2020c).	No

Year	Date and site(s)	Description	Attributed to activities at the Quarry
2020	1 November at Site A4	Reactive sampler damaged at the time due to storms during July so data not reliable (equipment was removed for repair on 2 November) (Blue Atmosphere, 2020c).	No
2021	10 July at Site A4 and Site A6	Analysis of the data against corresponding wind direction data suggesting that the source of the exceedance was from outside Quarry operations (Blue Atmosphere, 2021a).	No
2022	14 March at Site A4	Analysis of the available data suggesting that the high readings in the monitor were caused by high concentrations of water aerosols in the air entering the unit and affecting readings and not caused by dust from the Quarry (Blue Atmosphere, 2022a).	No
2022	22 and 23 May at Site A4 and Site A6	Analysis of the available data suggesting that the high readings were caused by high concentrations of water in the air entering the unit and affecting readings and not caused by dust from the Quarry (Blue Atmosphere, 2022b).	No
2023	6 April at Site A3	No information provided on potential cause of exceedance as 1-hour concentrations below limit of 64 µg/m³ so not required to be investigated under Quarry EMP) (Blue Atmosphere, 2023	No

Analysis of the EPA Victoria Traralgon data from 2019 to 2022 shows the following:

- The elevated dust concentrations that were observed at the Holcim monitoring sites during the large bushfires in January and February 2020 were also observed at the EPA Traralgon monitoring site during this period.
- Ambient concentrations of PM_{10} and $PM_{2.5}$ at this site experience similar trends, with exceedance events of $PM_{2.5}$ corresponding with PM_{10} exceedance events.
- Annual average criteria for PM_{10} of 20 µg/m³ was not exceeded during the 2019 to 2022 period.

- Annual average criteria for $PM_{2.5}$ of 8 µg/m³ was exceeded during the 2019 and 2020 calendar years; however, the exceedance during both 2019 and 2020 have been attributed to major bushfire events (EPA Victoria, 2020, 2021).
- Ambient PM_{10} levels at the EPA Traralgon site are higher than those measured at the Holcim A4 and A6 sites, and significantly higher than those measured at the Holcim A1 and A3 sites (Table 5). Therefore, where the EPA Traralgon data has been used in the cumulative assessment due to the unavailability of Holcim Data (PM_{10} for 2019, and $PM_{2.5}$ for all model years), predicted impacts at sensitive receptors will be highly conservative and an over-estimate.

A summary of the monthly dust deposition data from each site for the period January 2021 to December 2023 is provided in Table 6, and as a visualisation of the data in Figure 15 for total insoluble solids, and in Figure 16 for ash content.

Historically, the total insoluble solids content (g/m²/month) of the samples were compared to the threshold value of 4 g/m²/month; however, it was determined that the bottles were heavily influenced by activities other than the Quarry including slashing, bird droppings, animal hair and other farming activities. This was especially the case during summer periods. As a result, the high total insoluble solids in the samples each month were not correlating with the reactive PM_{10} monitor. Consequently, it was accepted at the Quarry Environmental Review Committee (ERC) meeting that compliance of the Quarry with environmental conditions would be determined using an assessment of the total ash content of the sample against the 4 g/m²/month threshold, rather than the total insoluble solids. The ash content better represents the actual level of mineral dust and therefore the contribution of the Quarry, removing all inorganic matter and external contaminants. The annual average monthly ash content of the samples across the seven sites for the 2021, 2022 and 2023 years ranged between 0.5 and 1.2 g/m²/month (Table 6).

As illustrated in Figure 16, the monthly ash content is below the 4 g/m²/month threshold with the exception of site A7 during September 2021. Observations at this time determined that the high level was the result of extensive truck and earth moving machinery activity near the dust deposition gauge during the month (Blue Atmosphere, 2021b).

Overall, the air quality in the study area is expected to be good. However, as the monitoring data shows, exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criteria may occur. The exceedances of PM_{10} and $PM_{2.5}$ criteria at the Holcim sites and at the EPA Victoria Traralgon site have been reported to be a result of windblown dust, bushfires, hazard reduction burns and urban sources such as domestic wood heating (EPA Victoria, 2020, 2021, 2022).

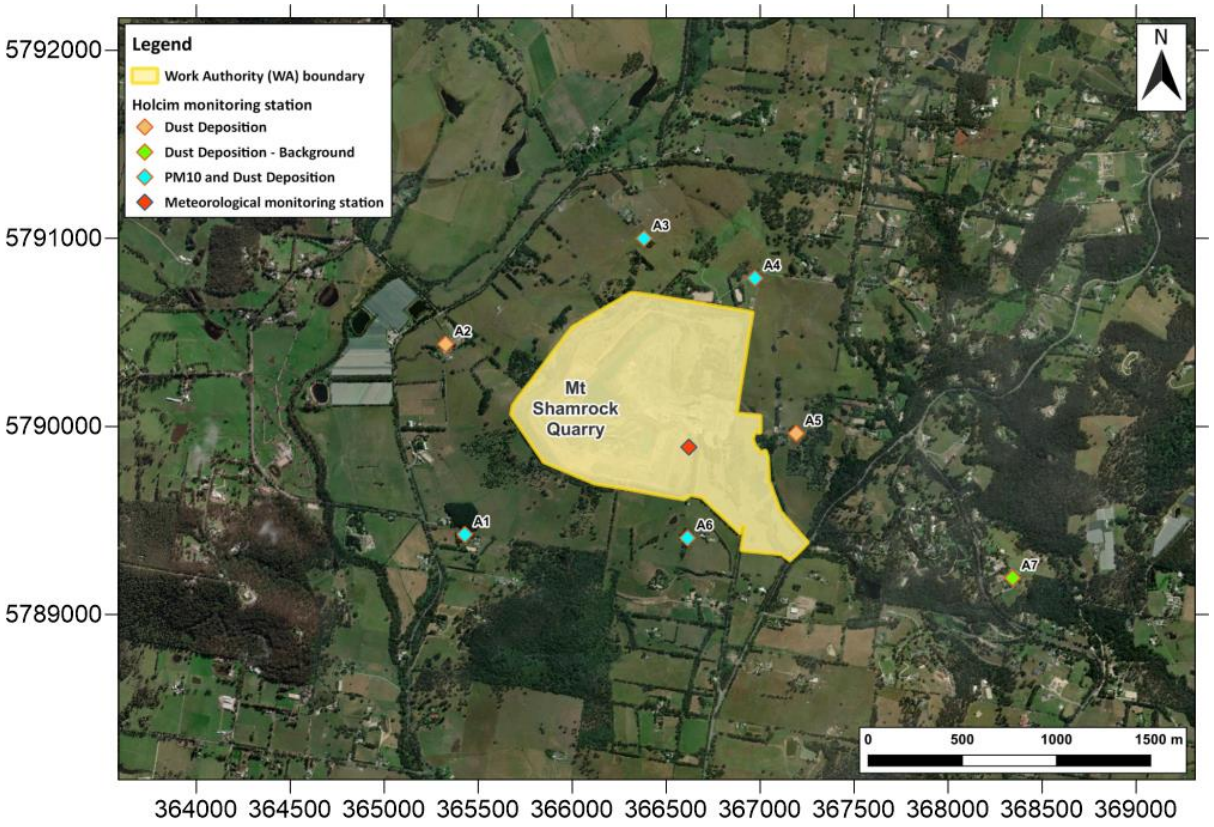

Figure 11 **Location of dust deposition and PM_{10} monitoring sites operated by Holcim in proximity of the Quarry**

Figure 12 **Location of the Traralgon monitoring station in relation to the Quarry**

Table 5 Summary of monitoring from Holcim monitoring stations (PM_{10}) and from EPA Victoria Traralgon monitoring site (PM_{10} and $PM_{2.5}$)

Parameter	Year	PM_{10}					$PM_{2.5}$
		Holcim				EPA Victoria	EPA Victoria
		A1	A3	A4	A6	Traralgon [1]	Traralgon [1]
Annual average (µg/m³)	2019	-	-	-	-	17.6	8.9
	2020	6.4	8.4	18.6	24.3	20.9	9.0
	2021	6.1	4.3	4.3	11.6	16.6	7.2
	2022	4.7	4.2	6.8	9.3	14.7	6.8
	2023	5.5	4.4	3.9	5.8	-	-
Maximum 24-hour average (µg/m³)	2019	-	-	-	-	80.0	37.4
	2020	267.9 [2]	278.8 [2]	283.7 [2]	431.2 [2]	236.3 [2]	236.0 [2]
	2021	28.0	26.0	56.5	78.9	43.4	31.8
	2022	32.1	39.9	72.3	68.0	33.7	20.2
	2023	45.7	50.8	28.3	48.8	-	-
75th percentile 24-hour average (µg/m³)	2019	-	-	-	-	22.7	10.6
	2020	4.3	6.6	14.7	14.0	22.7	9.9
	2021	11.0	5.5	7.2	15.2	19.3	8.5
	2022	6.4	5.5	10.6	11.2	17.1	8.3
	2023	7.3	5.4	4.0	8.2	-	-
Exceedance of 24-hour average criteria	2019	-	-	-	-	5	8
	2020	8	7	20	11	9	5
	2021	0	0	1	1	0	2
	2022	0	0	3	2	0	0

Parameter	Year	PM_{10}					$PM_{2.5}$
		Holcim				EPA Victoria	EPA Victoria
		A1	A3	A4	A6	Traralgon [(1)]	Traralgon [(1)]
	2023	0	1	0	0	-	-

Table Notes:

[(1)] EPA Victoria Traralgon data summary for 2019, 2020, 2021 calendar years sourced from published annual Air NEPM compliance reports prepared by EPA Victoria. Data for 2022 sourced from downloaded data files (exceptional events removed as per publication 1961 guidance). Validated data for 2023 calendar year not available at time of reporting.

[(2)] Elevated concentrations due to regional bush fire event during January and February 2020.

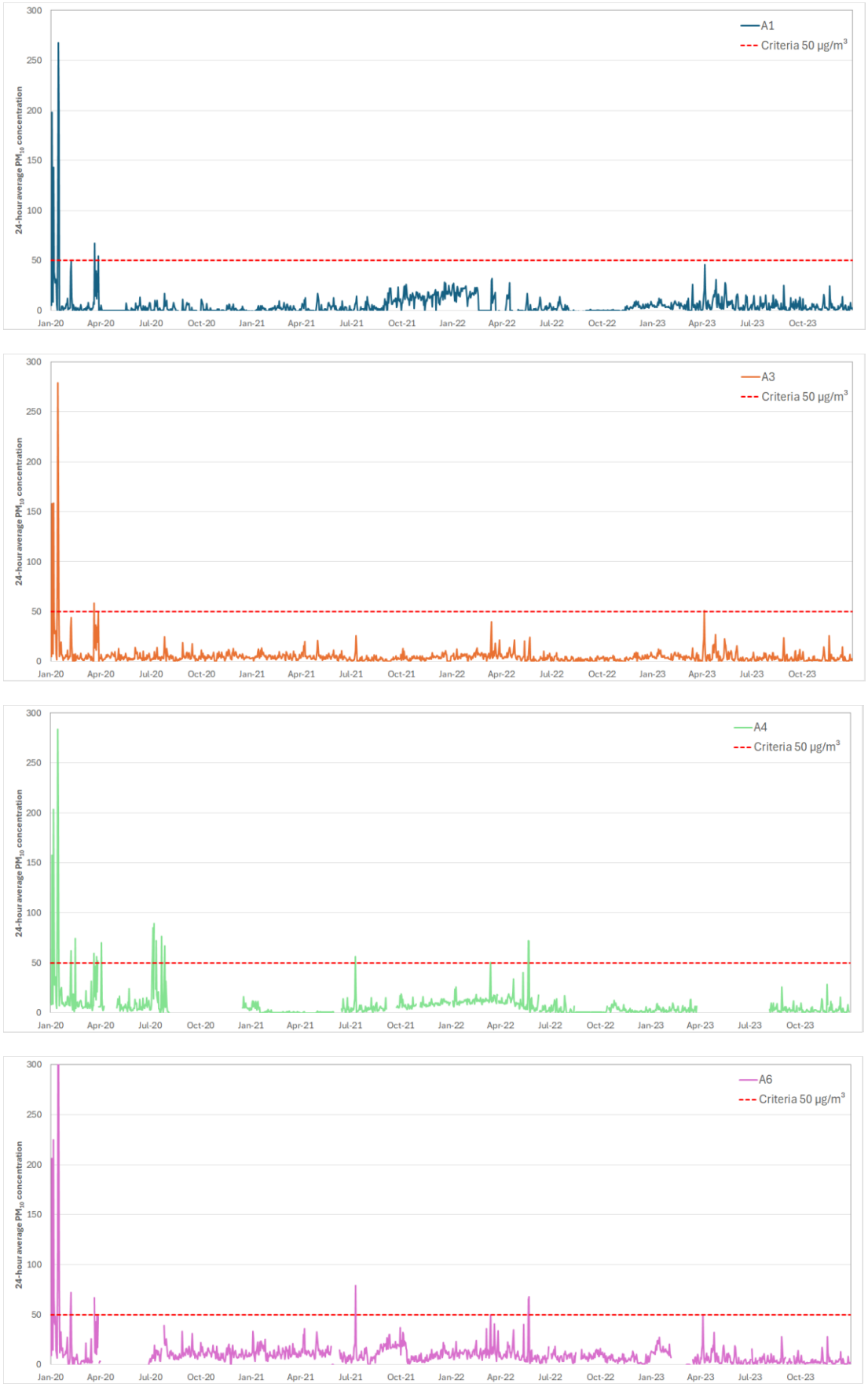

Figure 13 Summary of ambient 24-hour average PM_{10} concentrations at Holcim monitoring sites

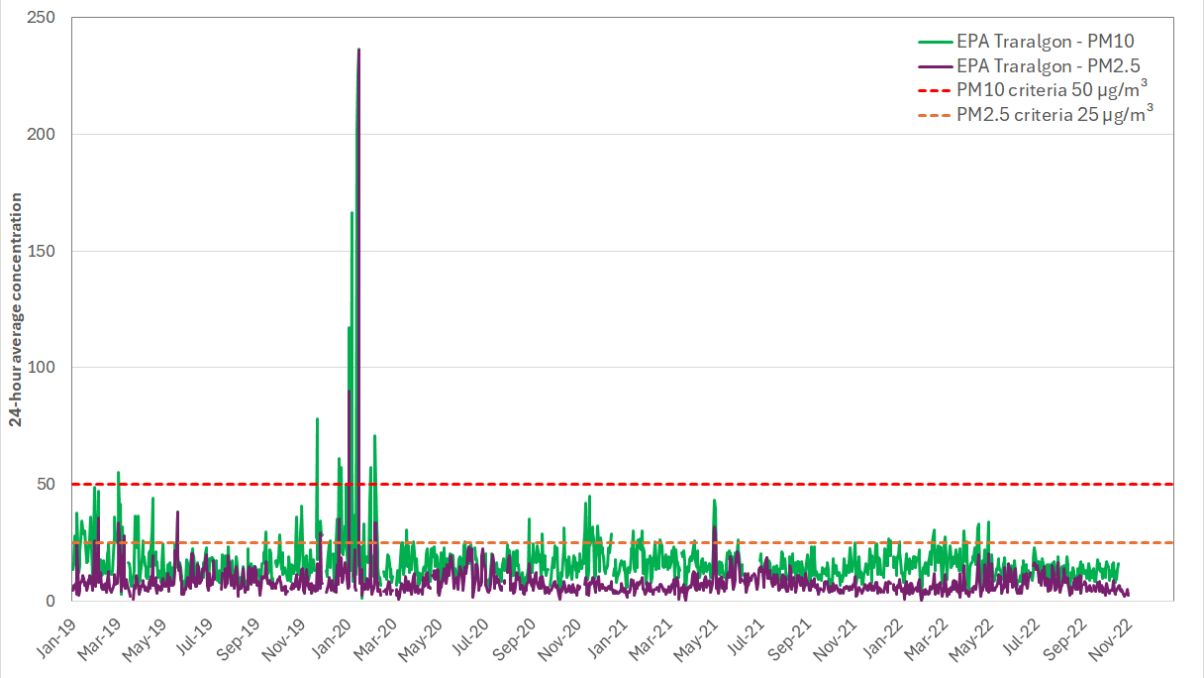

Figure 14 **Summary of ambient 24-hour average PM_{10} and $PM_{2.5}$ concentrations at EPA Victoria monitoring site at Traralgon (2019 to 2022, note different time-period covered compared to Holcim data)**

Table 6 Summary of data from Holcim dust deposition monitoring sites January 2021 to December 2023 (monthly ash content g/m²/month)

Year	Value	Monthly ash content (g/m²/month)						
		A1	A2	A3	A4	A5	A6	A7
2021	Maximum [1]	1.3	1.3	0.7	2.4	2.0	1.3	**5.0** [4]
	Minimum [2]	0.4	0.1	0.3	0.3	0.6	0.2	0.1
	Average [3]	0.7	0.7	0.5	0.8	1.1	0.8	0.9
2022	Maximum [1]	1.0	1.5	1.4	1.4	1.3	1.9	0.9
	Minimum [2]	0.4	0.1	0.2	0.4	0.3	0.2	0.2
	Average [3]	0.7	0.8	0.7	0.9	0.7	0.7	0.5
2023	Maximum [1]	1.2	1.0	1.5	1.8	2.6	1.8	1.2
	Minimum [2]	0.3	0.2	0.2	0.6	0.3	0.1	0.2
	Average [3]	0.7	0.6	0.6	1.2	1.2	0.8	0.6

Table Notes:

[1] Maximum of twelve monthly dust samples across calendar year

[2] Minimum of twelve monthly dust samples across calendar year

[3] Average of twelve monthly dust samples across calendar year

[4] Level exceeds 4 g/m²/month threshold and attributed to extensive truck and earth moving machinery activity near dust deposition gauge during the month (Blue Atmosphere, 2021b).

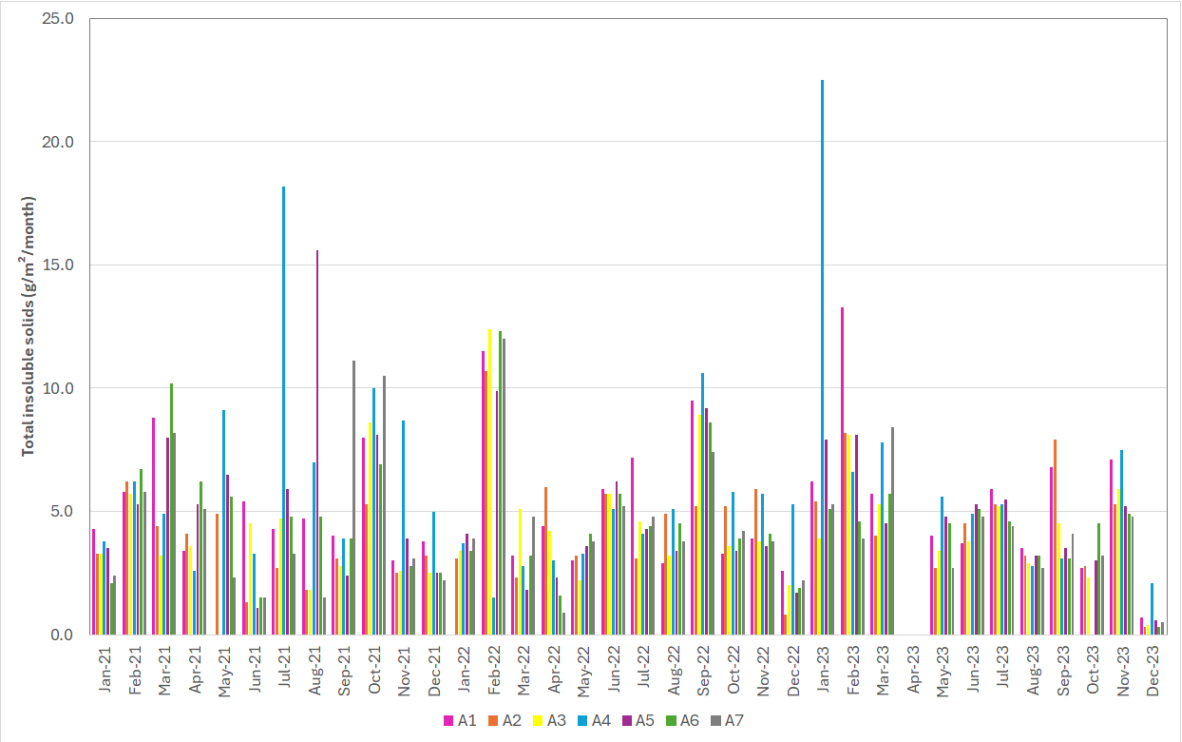

Figure 15 **Monthly total insoluble solids at Holcim dust deposition monitoring sites January 2021 to December 2023 (note: threshold of 4 g/m²/month relates to ash content, not total insoluble solids presented in this figure)**

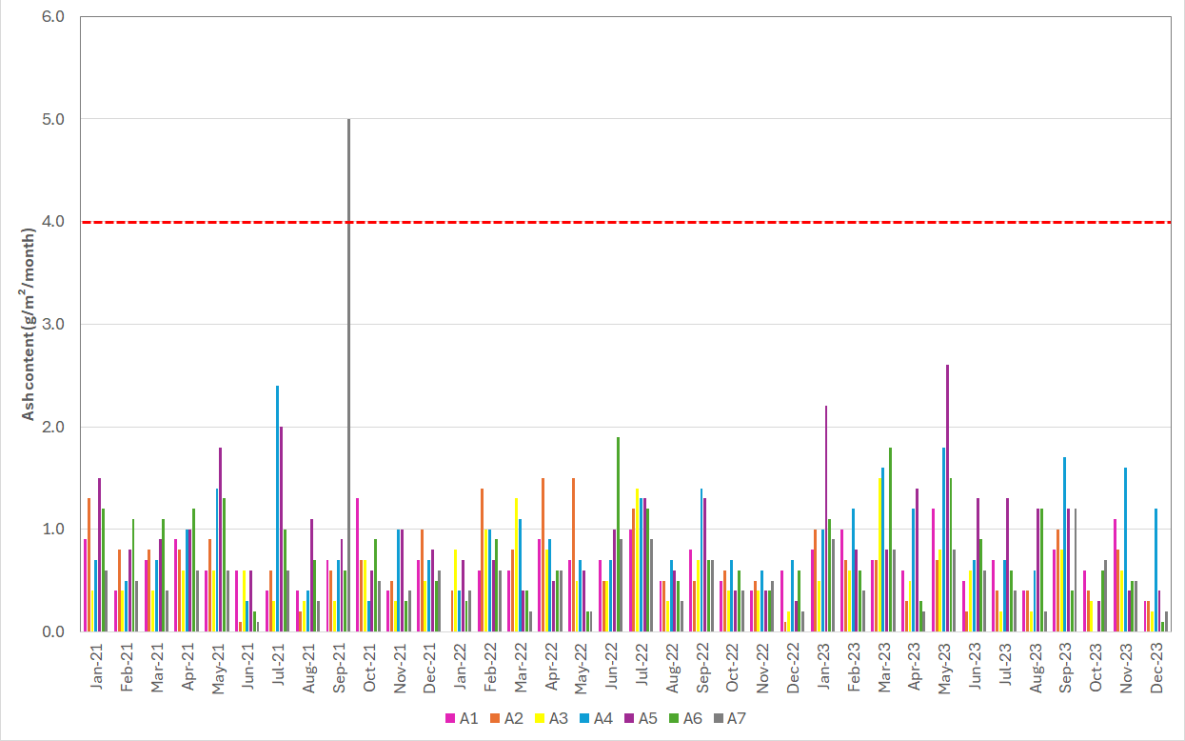

Figure 16 **Monthly ash content at Holcim dust deposition monitoring sites January 2021 to December 2023 (threshold of 4 g/m²/month total, or 2 g/m²/month above background)**

6. EMISSIONS TO THE ATMOSPHERE

The emissions inventory has been developed for the Quarry and for the proposed Extension and is summarised in Table 7. The layout of the site and location of emission sources are shown in Figure 17 and Figure 18.

Operational data used in the emissions inventory, such as extraction and processing rates and activity location, were based on information provided by Holcim. Other factors that determine dust emissions are the characteristics of the material (moisture, silt content, etc.) as well as the mitigation measures that are employed across the site (Table 8). These key factors have been accounted for in estimating the dust emissions from the Quarry and proposed Extension.

Activity data as well as further details of the methodology and emission factors used for estimating dust emissions from the Quarry and the proposed Extension are provided in Appendix B and Appendix C.

In comparison to the Quarry, the proposed Extension is estimated to result in:

- A negligible change in stockpile and exposed area wind erosion emissions.
- A negligible change in emissions from the removal, extraction and transfer of topsoil, overburden, and Basalt, including drilling and blasting.
- A negligible change in emissions from processing including crushing, screening, and stockpiling of basalt.
- An approximate increase in the total rate of TSP, PM_{10} and $PM_{2.5}$ emissions of 8%, 5%, and 4%, respectively, with the increase attributed primarily to the greater travel distance for the haul of basalt from the active pit area to the processing plant.

Table 7 Emission rates of dust from the Quarry and for the proposed Extension

Activity	Quarry			Proposed Extension			Percentage increase due to proposed Extension s		
	Emission rate (g/s)			Emission rate (g/s)					
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Removal, extraction and transfer of topsoil, overburden, and Basalt, including drilling and blasting	1.41	0.59	0.06	1.41	0.59	0.06	0%	0%	0%
Processing including crushing, screening, and stockpiling of basalt	0.65	0.29	0.05	0.65	0.29	0.05	0%	0%	0%
Haul of topsoil, overburden, basalt, and product	4.59	1.04	0.15	5.41	1.24	0.17	18%	20%	13%
Wind erosion of stockpiles and exposed areas	3.00	1.50	0.22	2.96	1.48	0.22	-1%	-1%	-1%
Total	**9.65**	**3.42**	**0.49**	**10.44**	**3.60**	**0.51**	**8%**	**5%**	**4%**

Table 8 Assumed dust control measures in place at the Quarry and for the proposed Extension

Controls	Unit	Quarry	Proposed Extension	Notes
Haul roads	%	75	75	Level 2 watering (>2 litres/m²/hr)
Site entrance sealed road	%	0	0	No control
Topsoil/overburden removal	%	0	0	No control
Basalt extraction	%	50	50	Wet suppression
Conveyors	%	0	0	Transfers enclosed and water sprays
Material handling (drop to stockpiles, etc.)	%	63	63	Drop heights minimised and wet suppression
Crushing, screening, and transfers between	%	50	50	Water sprays, wet suppression and dust collectors
Drilling	%	70	70	Dust extraction system
Blasting	%	0	0	No control
Rehabilitation of previous pit	%	30	30	Primary rehabilitation
Established rehabilitation of areas prior to active pit	%	90	90	Established vegetation
Exposed area wind erosion	%	0	0	Wet suppression where possible
Stockpile wind erosion	%	50	50	Wet suppression
Crushed material stockpiles	%	63	63	Wet suppression and inherent moisture

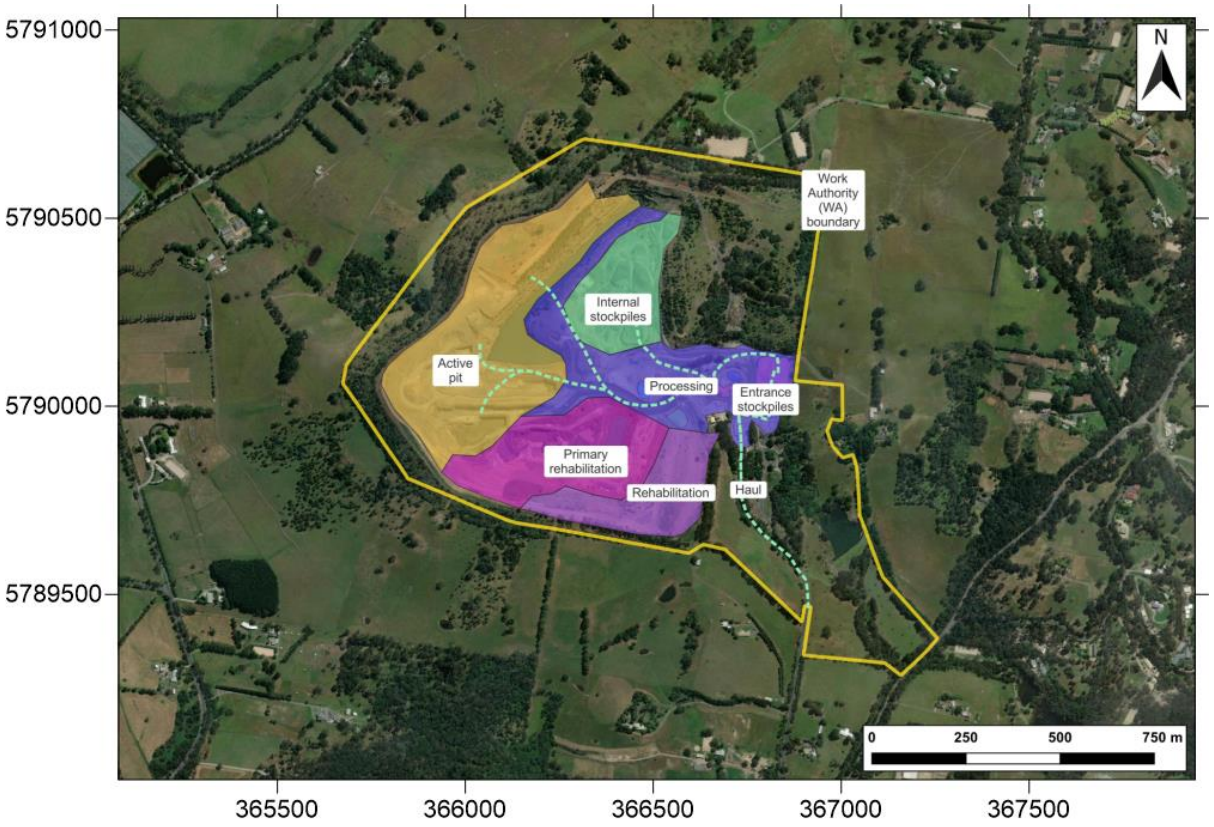

Figure 17 **Site layout and emission sources for the Quarry**

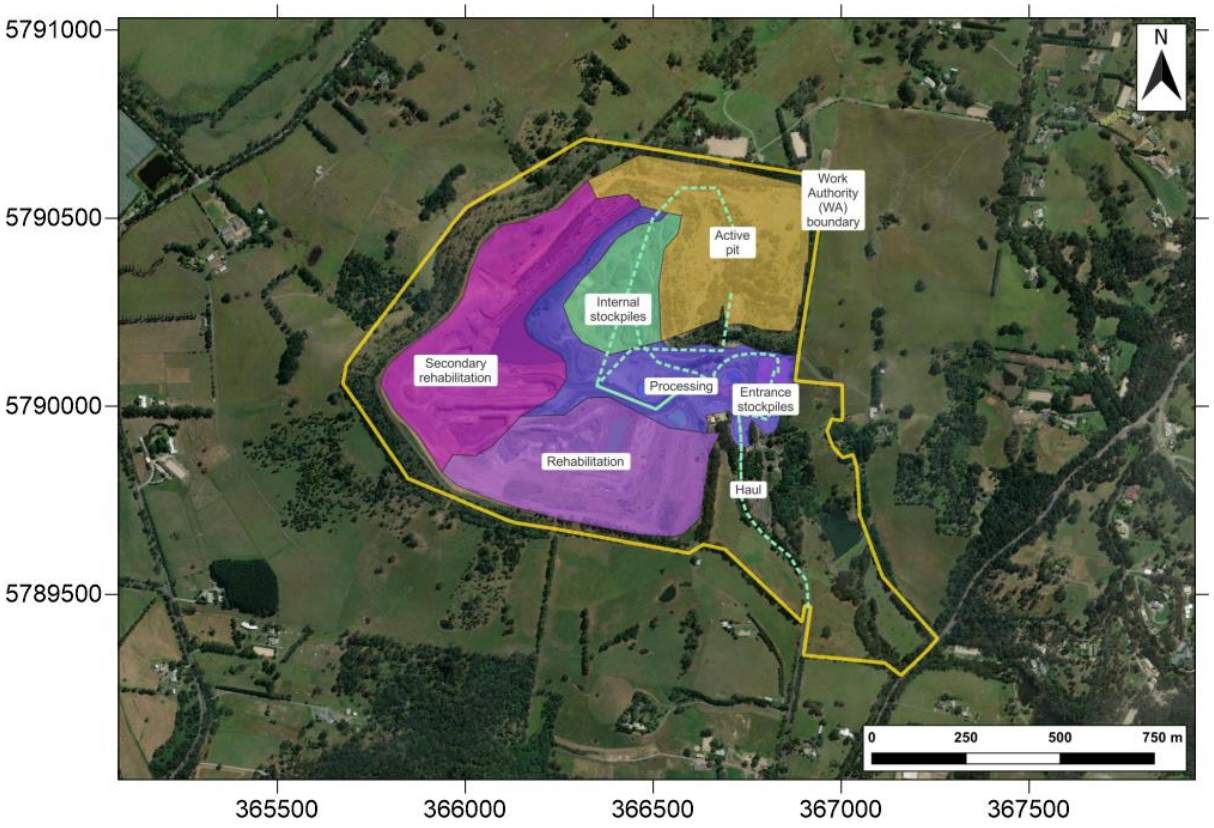

Figure 18 **Site layout and emission sources for the proposed Extension**

7. RESULTS

7.1 Overview

This section presents the results of the dispersion modelling for the assessment of dust emissions associated with the existing Quarry and for the proposed Extension. Regarding the cumulative assessment, the following exceedance events exist in the background dataset that is used for the contemporaneous assessment of PM_{10} from the Quarry and for the proposed Extension (see discussion in Appendix A3):

- 3, 4 and 6 January, 13, 14 and 15 February, and 20 March 2020.
- 6 April 2023.

The background dataset that is used for the contemporaneous assessment of $PM_{2.5}$ from Quarry operations also exceeds the annual average $PM_{2.5}$ criteria of 8.0 µg/m³ during the 2019 and 2020 model years.

As discussed in Section 5.5.2, ambient PM_{10} levels at the EPA Traralgon site are higher than those measured at the Holcim A4 and A6 sites, and significantly higher than those measured at the Holcim A1 and A3 sites (Table 5), meaning that where the EPA Traralgon data has been used in the cumulative assessment due to the unavailability of Holcim Data (PM_{10} for 2019, and $PM_{2.5}$ for all model years), predicted impacts at sensitive receptors will be highly conservative and an over-estimate.

Model results have been assessed to determine the potential for the proposed Extension to result in additional exceedance events.

The results of the dispersion modelling for the six receptor zones (Figure 7) are presented in the summary tables of this section as follows:

- Results for the Quarry in isolation (Table 9), with background (Table 10), and number of exceedances (Table 11).
- Results for proposed Extension in isolation (Table 12), with background (Table 13), and number of exceedances (Table 14).

A summary of the results of dispersion modelling at each of the 135 receptors identified by Holcim is provided in Appendix D.

Contour plots of the predicted incremental ground-level concentration of PM_{10}, $PM_{2.5}$ and monthly dust deposition rates for the relevant averaging periods, for the Quarry and for the proposed Extension are presented in Plate 1 to Plate 5. Contours present the highest concentration or deposition rate to occur at each location across the five-year model period and are provided side-by-side for the Quarry and the proposed Extension to show changes in impacts to air quality.

7.2 The Quarry

The assessment of the Quarry and the available data identified the following:

- Available ambient PM_{10} and dust deposition monitoring conducted by Holcim demonstrated that the Quarry is in compliance with the limits specified in the Quarry EMP, with exceedances of the relevant criteria attributed to regional events and activities external to the Quarry.
- Ambient PM_{10} levels measured at Holcim site A6 south of the site boundary and nearest to activities at the Quarry are generally comparable to levels experienced at the EPA Victoria site at Traralgon, while levels measured at the remaining Holcim sites (A1, A3, and A4) are generally lower than those experienced at Traralgon (5.5.2).

- Modelling results show that incremental maximum dust concentrations due to the Quarry:
    - **Comply** with the relevant 24-hour average PM_{10} air quality criteria of 50 µg/m³ and annual average criteria of 20 µg/m³ at all sensitive receptors.
    - **Comply** with the relevant 24-hour average $PM_{2.5}$ air quality criteria of 25 µg/m³ and annual average criteria of 8 µg/m³ at all sensitive receptors.
    - Are slightly higher than the monthly dust deposition rate threshold of 2 g/m²/month (above background, or 4 g/m²/month total) over a one-year period for 2019, 2022, and 2023 at receptor zone E just beyond the southern site boundary; however, dust deposition monitoring (Table 6) demonstrates that the monthly ash content of the samples at this location (A6) are consistently below the required monitoring threshold of 4 g/m²/month (total). Predicted monthly dust deposition rates at receptor R15 to the south of the site boundary are generally higher than the monthly average ash content at the Holcim A6 monitor at the same location, as shown in Figure 19, demonstrating that the model predicted rates of dust deposition are an over-prediction of impacts from the Quarry.
- Modelling results for the Quarry with the inclusion of contemporaneous background data show:
    - Predicted ambient concentrations of PM_{10} at receptor 110 to the north of the site boundary with the inclusion of ambient background correlate with the monitoring data at this location (A3), demonstrating reasonable validity of the model predictions (Figure 20).
    - Predicted concentrations **comply** with the relevant 24-hour average $PM_{2.5}$ air quality criteria of 25 µg/m³ at all sensitive receptors.
    - In addition to the exceedances in the background dataset (Section 7.1), the contribution of the Quarry results in:
        - One exceedance of the annual average PM_{10} air quality criteria of 20 µg/m³ at receptor zone E (south of the site boundary) during model year 2019: however, the background on this occasion was elevated at 17.6 µg/m³ (EPA Traralgon data) and analysis of the data suggests that the data from the EPA site is likely to over-estimate background concentrations at receptors beyond the WA 174 boundary.
        - No additional exceedances of the annual average $PM_{2.5}$ air quality criteria of 8 µg/m³
        - One exceedance of the 24-hour average PM_{10} air quality criteria of 50 µg/m³ at receptor zone E (south of site boundary) during model year 2019; however, the background on this occasion was elevated at 44.2 µg/m³ (EPA Traralgon data) and analysis of the data suggests that data from the EPA site is likely to over-estimate background concentrations at receptors beyond the WA 174 boundary.
        - One additional exceedance of the 24-hour average PM_{10} air quality criteria of 50 µg/m³ at receptor zone A (west of site boundary) and receptor zone E during model year 2020; however, the background on this occasion was elevated at 48.4 µg/m³ (Holcim data) and the contribution from the Quarry was minimal.

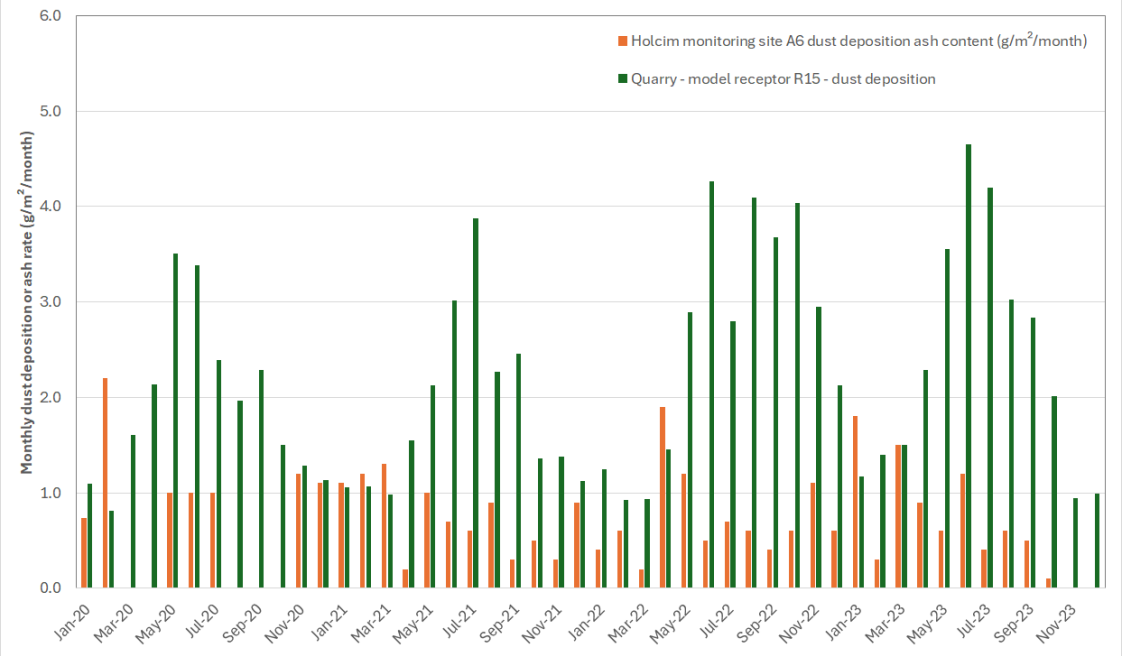

Figure 19 **Predicted rates of monthly average dust deposition at modelled receptor 15 due to the Quarry and Holcim monthly rate of ash deposition (from analysis of dust deposition monitoring) at same (nearby) location (A6)**

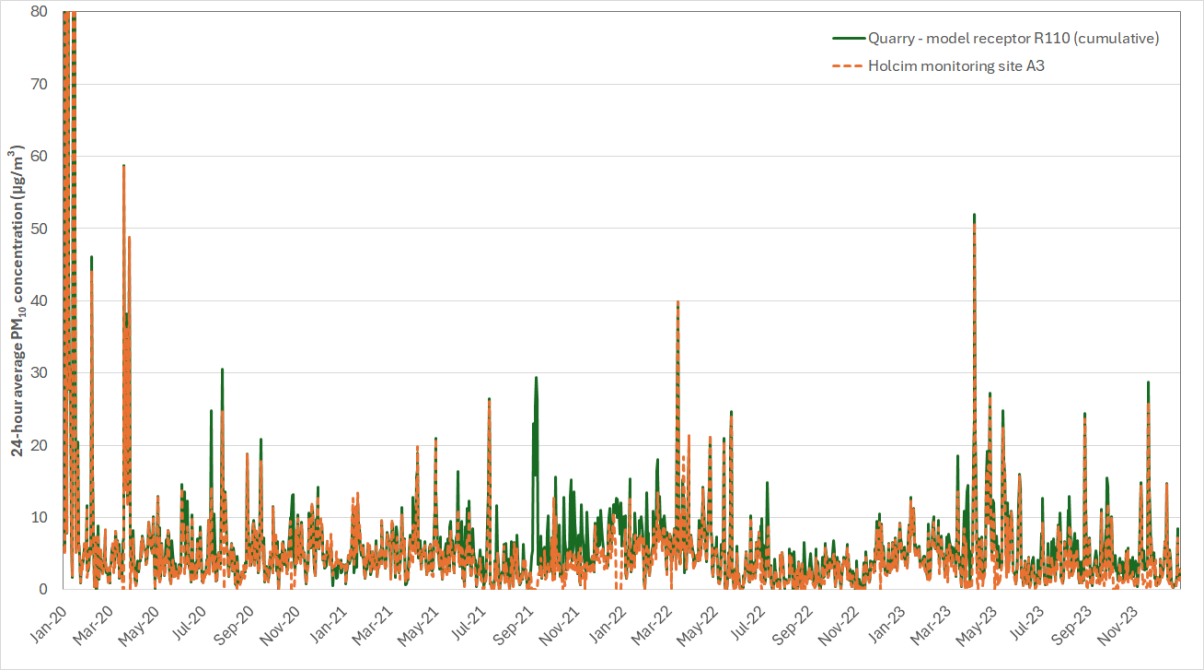

Figure 20 **Predicted cumulative PM_{10} impacts (24-hour average) at modelled receptor 110 due to the Quarry and Holcim PM_{10} monitoring data at same (nearby) location (A3) (Note: concentrations measured during January 2020 higher than shown in graph)**

Table 9 The Quarry – predicted concentrations in isolation

Pollutant	Averaging period	Criteria	Year	Predicted ground-level concentrations (µg/m³)/ deposition rates (g/m²/month)						
				Receptor zone						Maximum at any receptor
				A	B	C	D	E	F	
PM_{10}	24-hour	50 µg/m³	2019	7.4	9.7	17.8	16.2	21.5	5.7	21.5
			2020	17.2	11.4	11.2	21.8	21.3	6.8	21.8
			2021	12.6	9.5	7.5	15.4	18.5	6.8	18.5
			2022	11.7	9.3	9.2	23.9	25.7	10.3	25.7
			2023	17.8	6.4	5.1	6.1	23.4	4.5	23.4
PM_{10}	Annual	20 µg/m³	2019	0.3	0.4	1.0	1.6	3.0	0.2	3.0
			2020	0.9	0.5	0.9	1.9	2.8	0.3	2.8
			2021	1.0	0.7	0.7	1.8	2.9	0.4	2.9
			2022	0.8	0.5	0.6	1.1	3.5	0.5	3.5
			2023	1.5	1.0	0.6	0.9	3.9	0.5	3.9
$PM_{2.5}$	24-hour	25 µg/m³	2019	0.9	1.5	2.6	2.4	3.2	0.7	3.2
			2020	2.2	1.2	1.6	3.2	3.1	0.7	3.2
			2021	1.5	1.0	1.0	2.3	2.7	0.8	2.7
			2022	1.5	1.4	1.4	3.5	3.8	1.3	3.8
			2023	2.7	0.8	0.6	1.2	3.5	0.5	3.5
$PM_{2.5}$	Annual	8 µg/m³	2019	0.04	0.1	0.1	0.3	0.5	0.02	0.5
			2020	0.1	0.1	0.1	0.3	0.4	0.04	0.4
			2021	0.1	0.1	0.1	0.3	0.4	0.1	0.4
			2022	0.1	0.1	0.1	0.2	0.6	0.1	0.6
			2023	0.2	0.1	0.1	0.2	0.6	0.1	0.6
Dust deposition	Annual	2 g/m²/month above background	2019	0.2	0.2	0.7	1.2	2.1	0.1	2.1
			2020	0.5	0.2	0.5	1.2	1.9	0.1	1.9
			2021	0.5	0.3	0.4	1.1	1.9	0.2	1.9

Pollutant	Averaging period	Criteria	Year	Predicted ground-level concentrations (µg/m^3)/ deposition rates (g/m^2/month)						
				Receptor zone						Maximum at any receptor
				A	B	C	D	E	F	
Dust deposition	Annual	2 g/m^2/month above background	2022	0.4	0.2	0.3	0.7	2.6	0.3	2.6
			2023	0.8	0.4	0.3	0.5	2.4	0.2	2.4

Table 10 The Quarry – predicted concentrations with background

Pollutant	Averaging period	Criteria	Year	Predicted ground-level concentrations (µg/m³)/ deposition rates (g/m2/month)						
				Receptor zone						Maximum at any receptor
				A	B	C	D	E	F	
PM_{10}	24-hour	50 µg/m³	2019	48.9	49.7	49.7	49.5	52.2	48.9	52.2
			2020	285.7	285.5	285.5	285.8	286.2	285.5	286.2
			2021	35.6	29.3	29.3	32.2	34.9	29.3	35.6
			2022	41.4	39.9	40.0	40.4	41.2	40.1	41.4
			2023	52.0	52.0	52.2	52.5	55.4	51.9	55.4
PM_{10}	Annual	20 µg/m³	2019	17.9	18.0	18.6	19.2	20.6	17.8	20.6
			2020	9.2	8.7	9.2	10.1	11.1	8.6	11.1
			2021	5.9	5.6	5.6	6.7	7.7	5.3	7.7
			2022	5.2	4.8	5.0	5.5	7.9	4.9	7.9
			2023	6.0	5.5	5.0	5.4	8.4	5.0	8.4
$PM_{2.5}$	24-hour	25 µg/m³	2019	24.2	24.2	24.2	24.1	24.2	24.1	24.2
			2020	23.3	23.3	23.3	23.6	24.9	23.3	24.9
			2021	21.1	21.1	21.1	21.4	22.0	21.1	22.0
			2022	20.2	20.2	20.2	20.5	21.0	20.2	21.0
			2023	20.4	20.3	20.4	20.5	20.8	20.3	20.8
$PM_{2.5}$	Annual	8 µg/m³	2019	8.9	8.9	9.0	9.1	9.3	8.9	9.3
			2020	9.8	9.8	9.8	10.0	10.1	9.8	10.1
			2021	7.4	7.3	7.3	7.5	7.7	7.3	7.7
			2022	6.9	6.8	6.8	6.9	7.3	6.8	7.3
			2023	7.0	6.9	6.8	6.9	7.4	6.8	7.4

Table 11 The Quarry – number of exceedances

Pollutant	Averaging period	Criteria	Source	Year	Number of exceedances of 24-hour average criteria						
					Receptor zone						Highest at any receptor
					A	B	C	D	E	F	
PM_{10}	24-hour	50 µg/m^3	Background only	2019	0	0	0	0	0	0	0
				2020	7	7	7	7	7	7	7
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	1	1	1	1	1	1	1
PM_{10}	24-hour	50 µg/m^3	Quarry only	2019	0	0	0	0	0	0	0
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0
PM_{10}	24-hour	50 µg/m^3	Cumulative	2019	0	0	0	0	1	0	1
				2020	8	7	7	7	8	7	8
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	1	1	1	1	1	1	1
$PM_{2.5}$	24-hour	25 µg/m^3	Background only	2019	0	0	0	0	0	0	0
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0
$PM_{2.5}$	24-hour	25 µg/m^3	Quarry only	2019	0	0	0	0	0	0	0
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0

Pollutant	Averaging period	Criteria	Source	Year	Number of exceedances of 24-hour average criteria						
					Receptor zone						Highest at any receptor
					A	B	C	D	E	F	
$PM_{2.5}$	24-hour	25 µg/m^3	Quarry only	2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0
$PM_{2.5}$	24-hour	25 µg/m^3	Cumulative	2019	0	0	0	0	0	0	0
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0

7.3 Proposed Extension

The assessment of the proposed Extension and the available data identified the following:

- Modelling results show that incremental maximum dust concentrations due to the proposed Extension:
    - **Comply** with the relevant 24-hour average PM_{10} air quality criteria of 50 µg/m³ and annual average criteria of 20 µg/m³ at all sensitive receptors.
    - C**omply** with the relevant 24-hour average $PM_{2.5}$ air quality criteria of 25 µg/m³ and annual average criteria of 8 µg/m³ at all sensitive receptors.
    - In comparison to existing operations, increase slightly in ambient PM_{10} concentrations at the location of the receptor nearest to the pit extension (R52) (Figure 21).
- Modelling results show that rates of dust deposition for the proposed Extension:
    - Are slightly higher than the monthly dust deposition rate threshold of 2 g/m²/month over a one-year period for 2019, 2022, and 2023 at receptor zone E just beyond the southern site boundary, consistent with the modelling results for existing operations. As discussed in Section 7.2, the model predicted rates of dust deposition are an over-prediction of impacts from the Quarry.
    - At the most affected receptor (regarding potential dust nuisance impacts from existing operations (R15)), the proposed Extension is predicted to result in, at most, an increase in the monthly rate of dust deposition of 0.58 g/m²/month (Figure 22).
    - Receptor locations beyond the northeast boundary of the site and closest to the proposed pit Extension Area (zone C), including receptor 52 (Figure 23), are predicted to remain below the monthly dust deposition rate threshold of 2 g/m²/month.
- Regarding cumulative impacts, the proposed Extension is predicted to result in, compared to the Quarry:
    - No additional exceedances of the annual average PM_{10} air quality criteria of 20 µg/m³.
    - No additional exceedances of the annual average $PM_{2.5}$ air quality criteria of 8 µg/m³.
    - No exceedances of the 24-hour average PM_{10} air quality criteria of 50 µg/m³ during the 2021 and 2022 model years, and no additional exceedances during the 2020 and 2023 model years.
    - One additional exceedance of the 24-hour average PM_{10} air quality criteria of 50 µg/m³ at receptor zone B (north of site boundary) and one additional exceedance at receptor zone D (southeast of site boundary) during model year 2019; however, both additional exceedances occurred on days where the background data from the EPA Traralgon site were elevated (> 40 µg/m³) and the contribution from the Quarry was minor. In addition, analysis of the EPA data suggests that the Traralgon site is likely to over-estimate background concentrations at receptors beyond the WA 174 boundary.
    - One additional exceedance of the 24-hour average $PM_{2.5}$ air quality criteria of 25 µg/m³ at receptor zone E during model year 2020; however, the additional exceedance day occurred on a day where the background data from the EPA Traralgon site was elevated (> 22 µg/m³) and the contribution from the Quarry was minor. In addition, analysis of the EPA data suggests that the Traralgon site is likely to over-estimate background concentrations at receptors beyond the WA 174 boundary.

Overall, the assessment shows that, on occasions, exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criteria may occur; however, exceedances are generally the result of elevated background concentrations and regional events rather than being attributed to operations at the Quarry. In addition, while Holcim monitoring shows that maximum rates of dust deposition may exceed the threshold of 4g/m²/month, other sources contribute to rates measured and the contribution from the Quarry (ash content) is generally below the threshold. Comparison of rates of dust deposition predicted by the model at Receptor 15 with corresponding deposition monitoring (ash content) at the same location (Holcim Site A6) confirms that model predictions over-predict actual dust nuisance impacts (Figure 19).

The proposed Extension is not expected to result in a significant increase in dust emissions or nuisance impacts at sensitive receptor locations. The haul distance between the active pit area and the processing plant will increase slightly; however, the associated increase in vehicle induced dust emissions is not anticipated to be significant. Potential impacts from the proposed Extension are expected to be able to be adequately managed using the continuation of the operation and management measures that are already in place under the Quarry EMP. Mitigation measures and management are discussed further in Section 8.

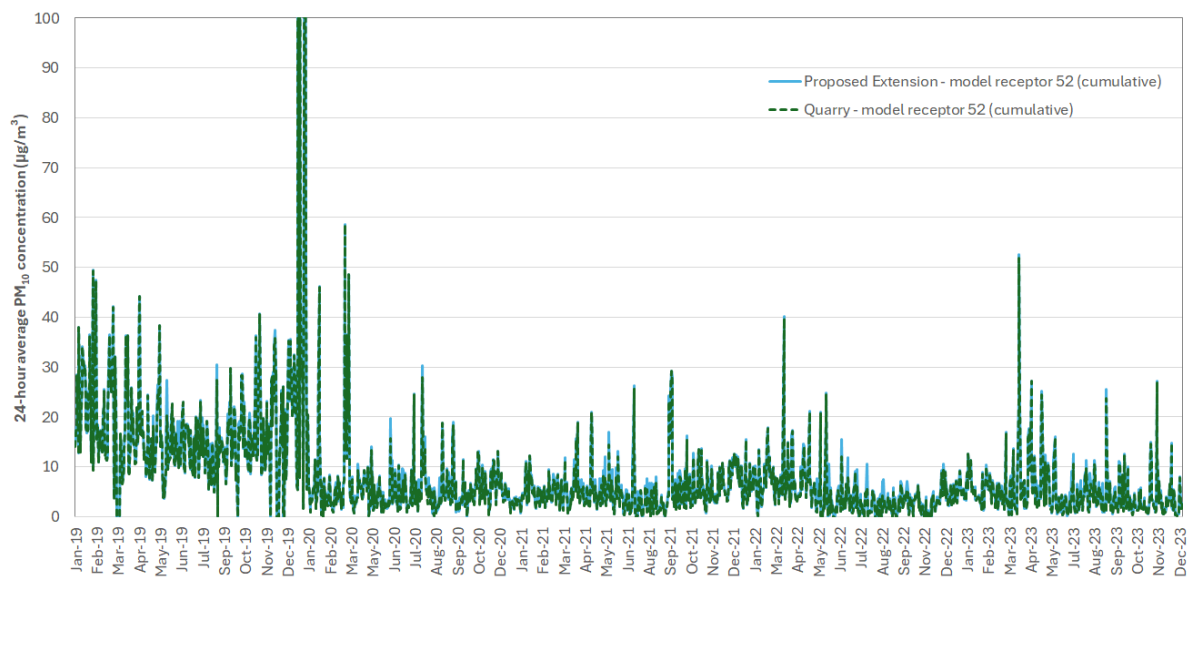

Figure 21 **Predicted cumulative PM_{10} impacts (24-hour average) at modelled receptor 52 due to the Quarry and impacts due to the proposed Extension**

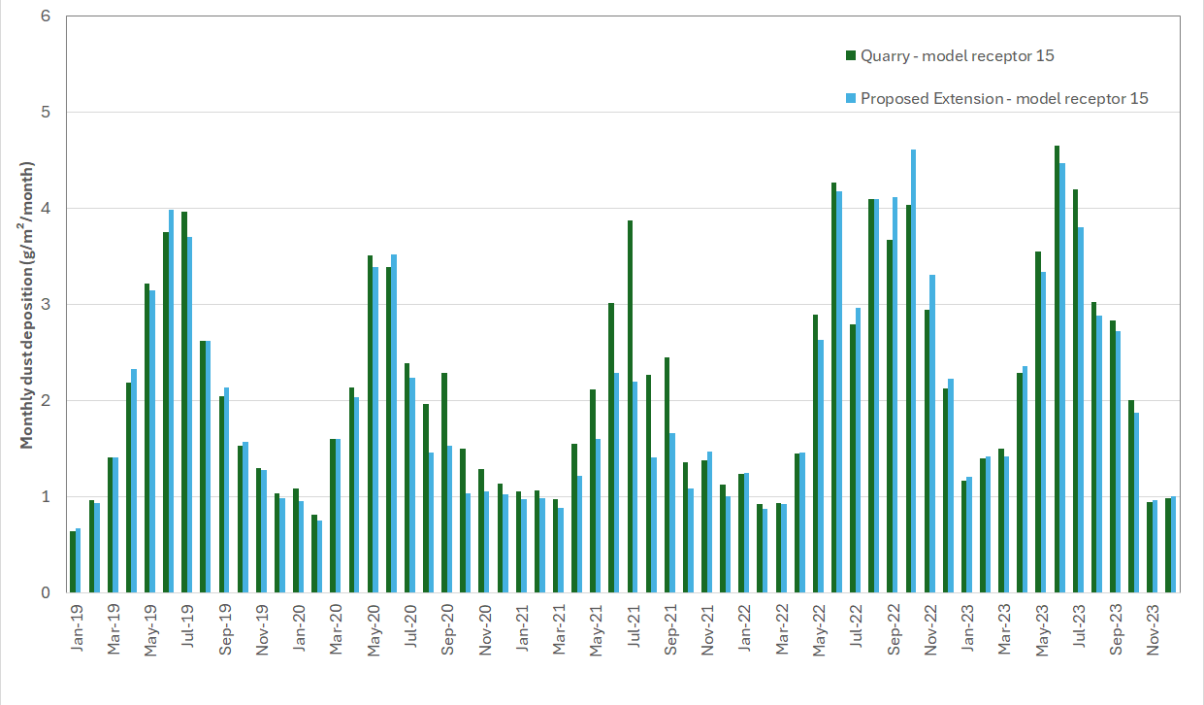

Figure 22 **Predicted monthly rates of dust deposition (g/m²/month) at modelled receptor 15 due to the Quarry and due to the proposed Extension**

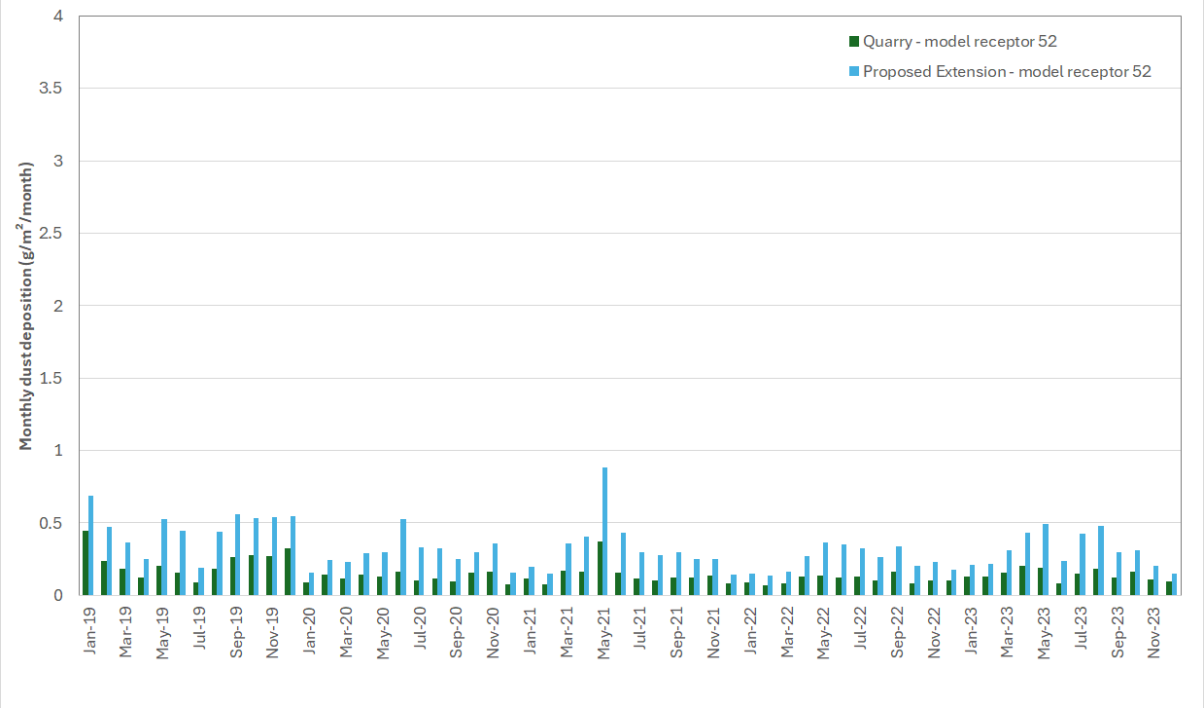

Figure 23 **Predicted monthly rates of dust deposition (g/m²/month) at modelled receptor 52 due to the Quarry and due to the proposed Extension**

Table 12 Proposed Extension – predicted concentrations in isolation

Pollutant	Averaging period	Criteria	Year	Predicted ground-level concentrations (µg/m³)/ deposition rates (g/m²/month)						
				Receptor zone						Maximum at any receptor
				A	B	C	D	E	F	
PM_{10}	24-hour	50 µg/m³	2019	5.8	13.8	17.7	18.1	21.6	4.9	21.6
			2020	14.1	14.5	12.8	22.4	20.8	6.7	22.4
			2021	8.0	14.5	9.4	19.2	16.9	7.0	19.2
			2022	8.8	12.6	11.6	24.9	26.2	9.7	26.2
			2023	17.3	9.9	7.0	8.4	21.6	4.3	21.6
PM_{10}	Annual	20 µg/m³	2019	0.3	0.4	1.2	1.8	3.0	0.1	3.0
			2020	0.9	0.6	1.2	2.2	2.5	0.2	2.5
			2021	1.0	1.0	1.2	2.6	2.7	0.3	2.7
			2022	0.7	0.7	0.8	1.3	3.6	0.4	3.6
			2023	1.3	1.5	0.7	1.3	3.7	0.4	3.7
$PM_{2.5}$	24-hour	25 µg/m³	2019	0.7	1.8	2.6	2.7	3.2	0.7	3.2
			2020	1.8	1.8	1.9	3.3	3.1	0.7	3.3
			2021	1.0	1.8	1.2	2.8	2.5	0.8	2.8
			2022	1.1	1.7	1.7	3.7	3.9	1.3	3.9
			2023	2.6	1.1	0.8	1.4	3.2	0.5	3.2
$PM_{2.5}$	Annual	8 µg/m³	2019	0.03	0.1	0.2	0.3	0.5	0.02	0.5
			2020	0.1	0.1	0.2	0.3	0.4	0.03	0.4
			2021	0.1	0.1	0.2	0.4	0.4	0.05	0.4
			2022	0.1	0.1	0.1	0.2	0.6	0.1	0.6
			2023	0.2	0.2	0.1	0.2	0.6	0.1	0.6
Dust deposition	Annual	2 g/m²/month	2019	0.2	0.2	0.8	1.3	2.1	0.1	2.1
			2020	0.4	0.3	0.7	1.5	1.7	0.1	1.7
			2021	0.5	0.5	0.6	1.5	1.9	0.2	1.9

Pollutant	Averaging period	Criteria	Year	Predicted ground-level concentrations (µg/m^3)/ deposition rates (g/m^2/month)						
				Receptor zone						Maximum at any receptor
				A	B	C	D	E	F	
Dust deposition	Annual	2 g/m^2/month	2022	0.4	0.4	0.4	0.8	2.7	0.2	2.7
			2023	0.8	0.7	0.4	0.7	2.4	0.2	2.4

Table 13 Proposed Extension – predicted concentrations with background

Pollutant	Averaging period	Criteria	Year	Predicted ground-level concentrations (µg/m³)/ deposition rates (g/m2/month)						
				Receptor zone						Maximum at any receptor
				A	B	C	D	E	F	
PM_{10}	24-hour	50 µg/m³	2019	48.9	50.2	49.7	50.2	53.4	48.9	53.4
			2020	285.7	285.6	285.8	285.9	286.2	285.5	286.2
			2021	33.7	29.4	30.0	32.8	34.7	29.3	34.7
			2022	40.7	40.0	40.4	40.7	41.2	40.1	41.2
			2023	52.0	52.2	52.7	52.8	55.7	51.7	55.7
PM_{10}	Annual	20 µg/m³	2019	17.9	18.0	18.8	19.4	20.6	17.7	20.6
			2020	9.1	8.9	9.5	10.5	10.8	8.5	10.8
			2021	5.8	5.9	6.1	7.5	7.5	5.2	7.5
			2022	5.1	5.1	5.2	5.7	8.0	4.7	8.0
			2023	5.8	5.9	5.2	5.8	8.2	4.9	8.2
$PM_{2.5}$	24-hour	25 µg/m³	2019	24.2	24.2	24.2	24.1	24.2	24.1	24.2
			2020	23.3	23.3	23.3	23.7	25.4	23.2	25.4
			2021	21.1	21.1	21.1	21.4	22.0	21.1	22.0
			2022	20.2	20.2	20.2	20.5	21.1	20.2	21.1
			2023	20.3	20.4	20.4	20.6	20.8	20.3	20.8
$PM_{2.5}$	Annual	8 µg/m³	2019	8.9	8.9	9.1	9.2	9.3	8.9	9.3
			2020	9.8	9.8	9.9	10.1	10.1	9.8	10.1
			2021	7.3	7.3	7.4	7.6	7.7	7.3	7.7
			2022	6.8	6.8	6.9	7.0	7.4	6.8	7.4
			2023	6.9	6.9	6.9	7.0	7.3	6.8	7.3

Table 14 Proposed Extension – number of exceedances

Pollutant	Averaging period	Criteria	Source	Year	Number of exceedances of 24-hour average criteria						
					Receptor zone						Highest at any receptor
					A	B	C	D	E	F	
PM_{10}	24-hour	50 µg/m^3	Background only	2019	0	0	0	0	0	0	0
				2020	7	7	7	7	7	7	7
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	1	1	1	1	1	1	1
PM_{10}	24-hour	50 µg/m^3	Extension only	2019	0	0	0	0	0	0	0
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0
PM_{10}	24-hour	50 µg/m^3	Cumulative	2019	0	1	0	1	1	0	1
				2020	8	7	7	7	8	7	8
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	1	1	1	1	1	1	1
$PM_{2.5}$	24-hour	25 µg/m^3	Background only	2019	0	0	0	0	0	0	0
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0
$PM_{2.5}$	24-hour	25 µg/m^3	Extension only	2019	0	0	0	0	0	0	0
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0

Pollutant	Averaging period	Criteria	Source	Year	Number of exceedances of 24-hour average criteria						
					Receptor zone						Highest at any receptor
					A	B	C	D	E	F	
$PM_{2.5}$	24-hour	25 µg/m^3	Extension only	2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0
$PM_{2.5}$	24-hour	25 µg/m^3	Cumulative	2019	0	0	0	0	1	0	1
				2020	0	0	0	0	0	0	0
				2021	0	0	0	0	0	0	0
				2022	0	0	0	0	0	0	0
				2023	0	0	0	0	0	0	0

8. MITIGATION MEASURES AND MANAGEMENT

The results of the assessment in Section 7 show that on occasions exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criteria may occur; however, exceedances are generally the result of elevated background concentrations and regional events rather than being attributed to operations at the Quarry. Regarding the proposed Extension, the increased rate of dust emissions associated with the additional haul distance is not expected to result in a significant increase in dust concentrations or nuisance impacts at sensitive receptor locations. Potential impacts from the proposed Extension are expected to be able to be adequately managed using the continuation of the operation and management measures that are already in place under the Quarry EMP.

The following dust controls measures have been considered in the assessment and should be continued at the site during the proposed Extension:

- Level 2 watering of all internal haul roads (> 2 litres/m²/hour).
- Wet suppression during extraction and removal of basalt.
- Enclosure of transfers at processing plant.
- Minimisation of drop heights and use of wet suppression during material handling.
- Water sprays, wet suppression, and dust collectors during crushing, screening, and transfers between processing.
- Dust extraction used during drilling.
- Staged and timely rehabilitation following exhaustion of resources from pit area.
- Water sprays on all stockpiles.

The continued operation of the dust deposition and ambient PM_{10} monitoring at the Holcim sites in accordance with the EMP is a critical component of ensuring existing operations and the proposed Extension do not result in adverse air quality impacts and dust nuisance at sensitive receptors in proximity of the Quarry. In accordance with current procedures, the monitoring program is to include the following:

- Monthly monitoring of dust deposition and analysis and reporting of dust samples for compliance undertaken by an experienced entity independent of the operator, with results of dust deposition to be no greater than 4 g/m²/month (no more than 2 g/m²/month greater than background).
- Continuous monitoring of wind speed and wind direction at the site.
- Continuous 1-hour average PM_{10} monitoring, with the data provided to the Pit Manager's office for the purposes of reactive monitoring to enable reactive management of dust emissions (PM_{10} no greater than 64 µg/m³ (reactive monitoring 1-hour average)).
- All exceedances of the relevant PM_{10} criteria and dust deposition threshold need to be investigated and responded to in a timely manner.
- Visual monitoring of dust emissions and potential dust generating activities and areas during quarrying activities.
- Monitoring of community complaints during works to assess the operations against objectives and targets and no justified complaints from sensitive receptors.
- Additional management measures and dust controls may need to be employed in situations where dust monitoring shows potential exceedances of the relevant air quality criteria or dust deposition threshold.

9. ASSESSMENT LEVEL

As discussed in Section 3.6, Publication 1961 defines three levels of assessment in order of increasing complexity based on the identified level of risk of an activity. The risk to air quality from the proposed Extension has been assessed using a Level 2 assessment, the most common type of risk assessment.

The Level 2 quantitative dispersion modelling assessment has been prepared to satisfy the standard requirements of EPA Victoria, including those specified in the legislation and policy detailed in Section 3. A Level 2 assessment was deemed to be appropriate to determine the level of risk to air quality, and that a more detailed Level 3 assessment would not be required. This is based on the following aspects of the activity:

- Quarry operations are typical routine operations, with known risks that can be identified with standard methodology, and control measures that are known to be effective.
- Potential impacts to air quality from the Quarry are limited to dust and amenity impacts, with no activities at the site that will result in emissions of pollutants requiring a more detailed assessment (bioaerosols, air toxics, etc.). As a basalt quarry, there will be no respirable crystalline silica emitted from the site.
- The Quarry is an existing operation in a rural area, with the existing risk to air quality at nearest rural residences demonstrated to be low based on the results of long-term monitoring data.
- The proposed Extension will not result in any changes to operation beyond the progression of the pit area towards the Quarry extension area in the northeast.
- The level of risk to air quality at the nearest rural residences, for the Quarry and for the proposed Extension, have been adequately understood using the Level 2 risk assessment and identified as low, confirming that a detailed Level 3 risk assessment is not necessary.
- The results of the Level 2 assessment show that on occasions exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criteria may occur; however, exceedances are generally the result of elevated background concentrations and regional events rather than being attributed to operations at the Quarry.
- The Quarry will continue to operate in accordance with the conditions of the EMP to ensure risks to air quality are monitored and minimised.

10. AIR QUALITY CONCLUSIONS

An air quality impact assessment has been prepared for the proposed Extension to support a Work Plan Variation and Planning Permit Application (PPA) to permit extraction within the proposed Extension Area at the Basalt Quarry at Mt Shamrock Road, Pakenham Victoria (the Quarry). A level 2 quantitative dispersion modelling assessment has been carried out in accordance with the relevant legislation and guidance to determine the potential impacts to air quality on nearby sensitive receptors due to the proposed Extension.

The results of the cumulative assessment of the Quarry (i.e. including ambient background) in Section 7 show that on occasions exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criteria may occur; however, exceedances are the result of elevated background concentrations and regional events rather than being attributed to operations at the Quarry. The proposed Extension is not expected to result in a significant increase in dust emissions or nuisance impacts at sensitive receptor locations. The haul distance between the active pit area and the processing plant will increase slightly; however, the associated increase in vehicle induced dust emissions is not anticipated to be significant.

Potential impacts from the proposed Extension will be managed using the continuation of the operation and management measures that are already in place under the Quarry EMP.

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12. CONTOUR PLATES

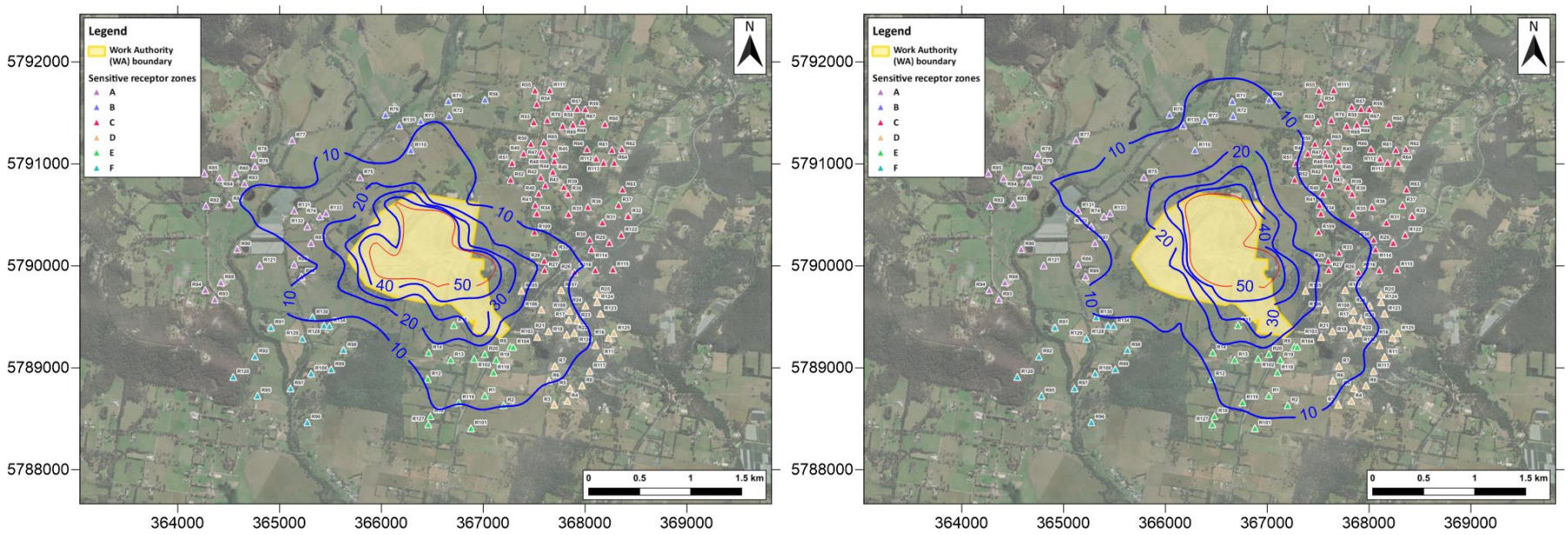

Plate 1 **Predicted maximum incremental 24-hour average ground-level concentrations of PM_{10} due to the Quarry (left) and due to the proposed Extension (right)**

Location:	**Averaging period:**	**Data source:**	**Units:**
Pakenham, Victoria	24-hour	AERMOD	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
Contour plot (highest across 2019-2023)	50 µg/m^3	Sarah Richardson	June 2024

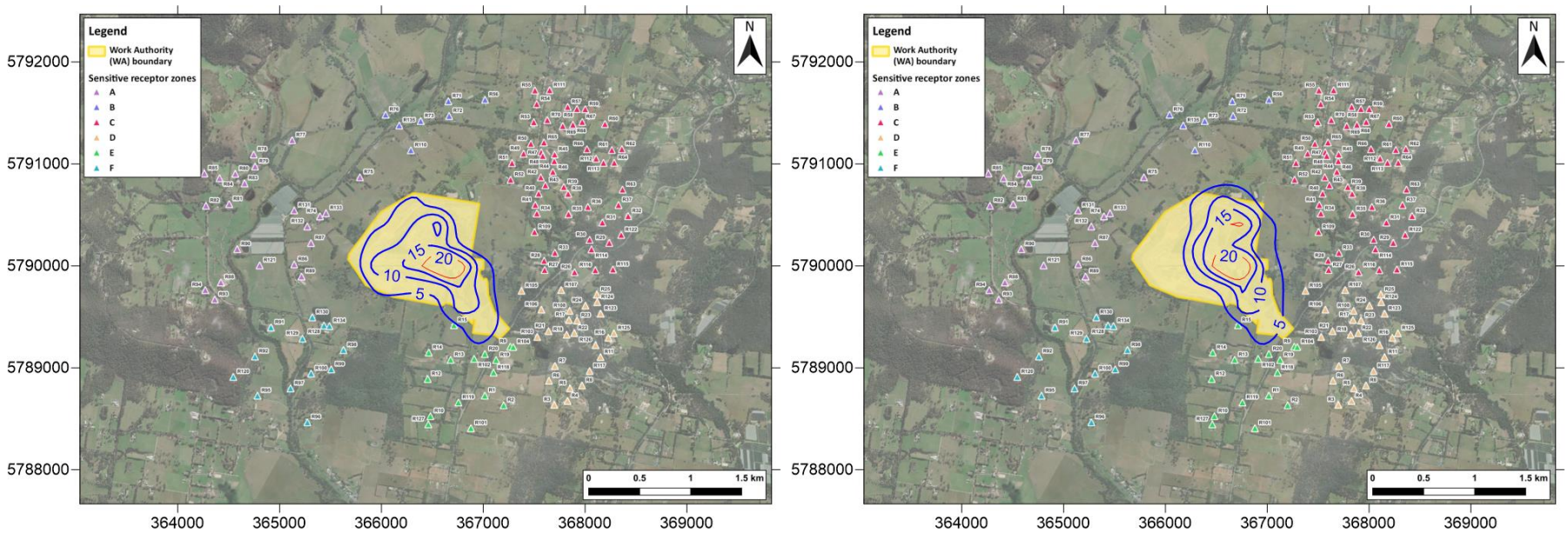

Plate 2 **Predicted incremental annual average ground-level concentrations of PM_{10} due to the Quarry (left) and due to the proposed Extension (right)**

Location:	**Averaging period:**	**Data source:**	**Units:**
Pakenham, Victoria	Annual	AERMOD	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
Contour plot (highest across 2019-2023)	20 µg/m^3	Sarah Richardson	June 2024

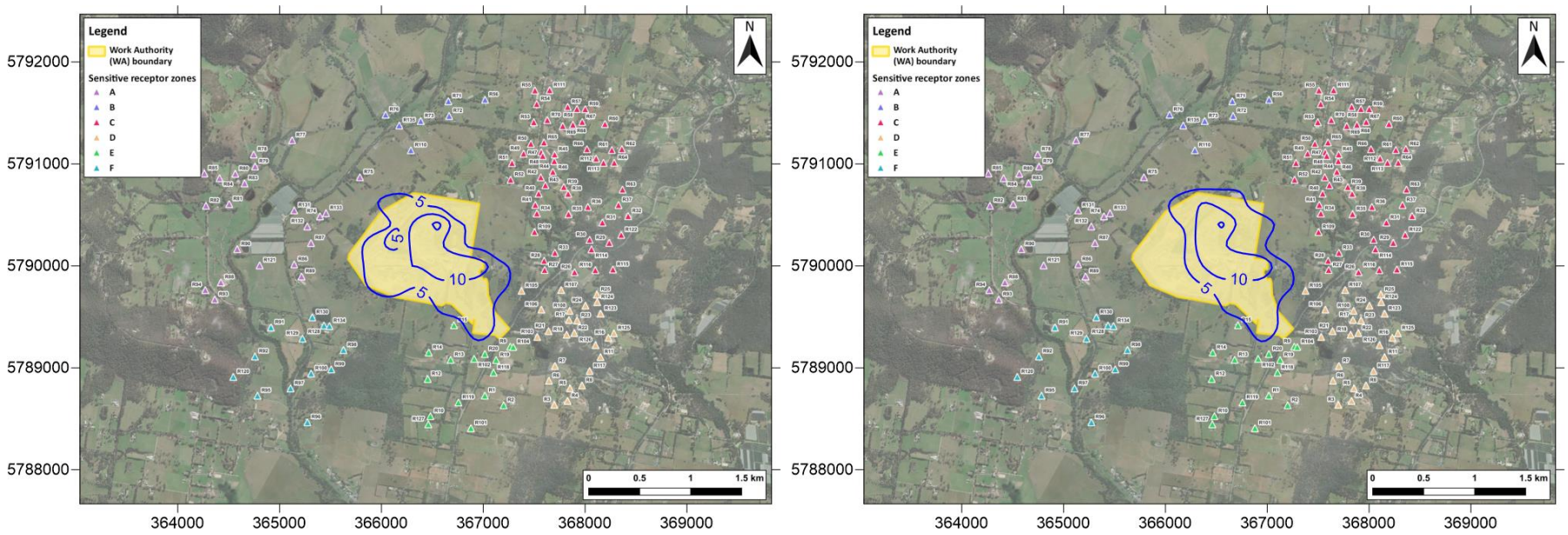

Plate 3 **Predicted maximum incremental 24-hour average ground-level concentrations of $PM_{2.5}$ due to the Quarry (left) and due to the proposed Extension (right)**

Location:	**Averaging period:**	**Data source:**	**Units:**
Pakenham, Victoria	24-hour	AERMOD	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
Contour plot (highest across 2019-2023)	25 µg/m^3	Sarah Richardson	June 2024

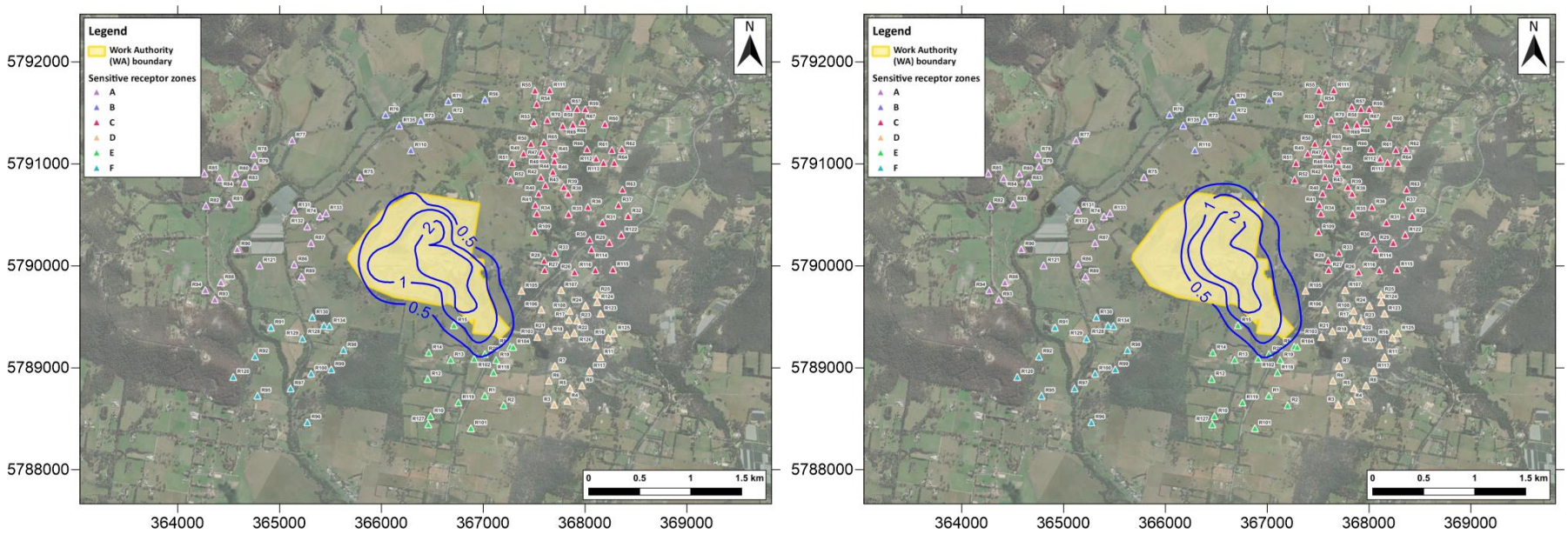

Plate 4 **Predicted incremental annual average ground-level concentrations of $PM_{2.5}$ due to the Quarry (left) and due to the proposed Extension (right)**

Location:	**Averaging period:**	**Data source:**	**Units:**
Pakenham, Victoria	Annual	AERMOD	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
Contour plot (highest across 2019-2023)	8 µg/m^3	Sarah Richardson	June 2024

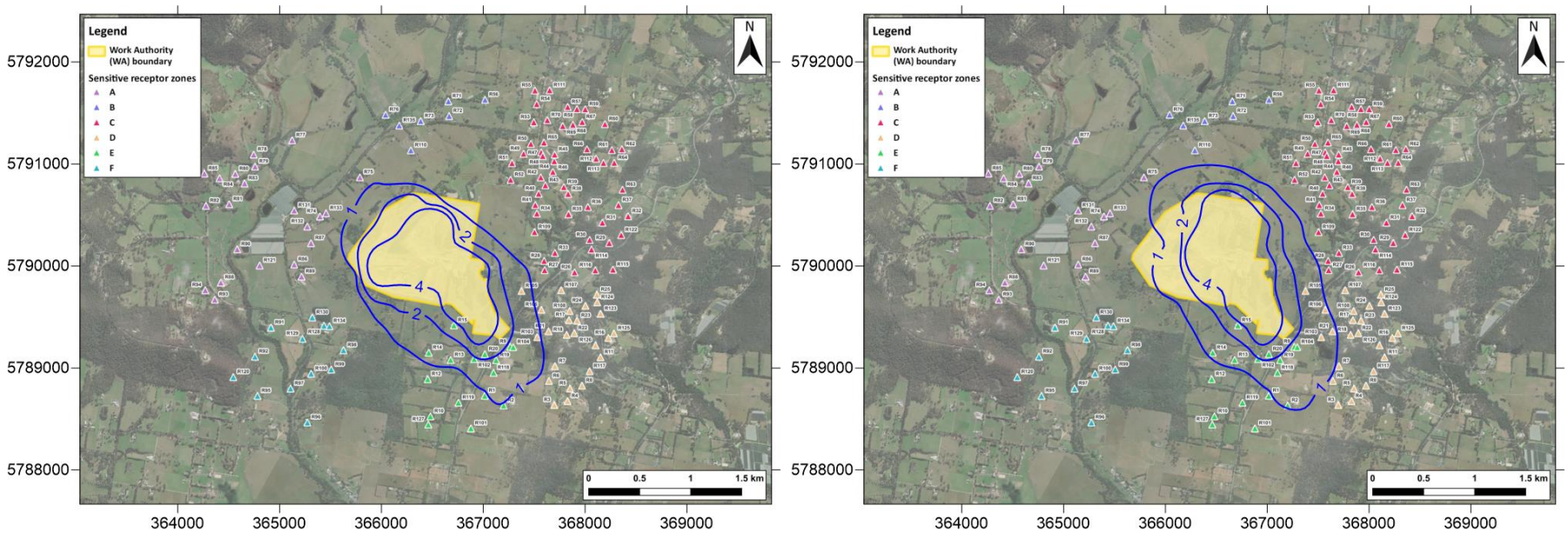

Plate 5 **Predicted annual average incremental monthly dust deposition rate due to the Quarry (left) and due to the proposed Extension (right)**

Location: Pakenham, Victoria	**Period:** Annual average monthly deposition rate	**Data source:** AERMOD	**Units:** g/m²/month
Type: Contour plot (highest across 2019-2023)	**Objective:** 2 g/m²/month	**Prepared by:** Sarah Richardson	**Date:** June 2024

APPENDIX A METEOROLOGICAL AND DISPERSION MODELLING METHODOLOGY

A1 Meteorology

Five years of meteorological data (January 2019 to December 2023) suitable for use in AERMOD were generated using TAPM and the available meteorological monitoring data from the onsite monitoring station operated by Holcim. The meteorological data were generated with reference to the Victoria EPA's *guidance for Construction of input meteorological data files for EPA Victoria's regulatory pollution model (AERMOD)* (publication 1550).

A1.1 TAPM meteorology

TAPM (The Air Pollution Model) was developed by the CSIRO and has been validated by the CSIRO, Katestone and others for many locations in Australia, in south-east Asia and in North America (CSIRO, 2008). Katestone has extensive experience with TAPM for sites throughout Australia and in parts of America, Bangladesh, New Caledonia and Vietnam. The model performs well in simulating regional wind patterns and has proven to be a useful tool for simulating meteorology in locations where monitoring data providing the vertical distribution of meteorological parameters are unavailable.

TAPM is a prognostic meteorological model which predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20 km to 200 km) and at a local scale (down to a few hundred metres). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy, soil type and radiative fluxes.

TAPM requires synoptic meteorological information for the region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data were supplied on a grid resolution of approximately 75km, and at elevations of 100m to 5km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

The five-calendar year period from 2019 to 2023 was selected to coincide with the availability of meteorological monitoring data from the onsite meteorological monitoring station operated by Holcim.

TAPM version 4.0.5 was configured with the following parameters:

- Modelling period from 1 January 2019 to 31 December 2023.
- 41 x 41 grid point domain with nesting resolutions of 30 km, 10 km, 3 km, 1 km and 300 m.
- 25 vertical levels.
- Grid centred on latitude -38° 1.5', longitude 145° 29'.
- Geoscience Australia 9 second DEM terrain data.
- TAPM default land cover data edited to be consistent with aerial imagery.
- Default options selected for advanced meteorological inputs.
- Data assimilation as follows:
    - Data from the onsite meteorological monitoring station (for the available period of 1 January 2020 to 31 December 2023) assimilated over two vertical levels with a radius of influence of 5km and a quality factor of 0.7.

A1.2 Comparison of TAPM output with observational data

TAPM was originally run without data assimilation and the predicted meteorological monitoring data was compared to observational data at the onsite meteorological monitoring station operated by Holcim for the period of available data, as well as at the site of the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) at Ferny Creek.

Comparison of the observational data with the model predictions showed that the model generally performed well at simulating the meteorology across the region; however, the comparison with the on-site data showed that the model was over-predicting the strength and frequency of winds from the direct north, while also significantly under-predicting the frequency of calm winds less than 3 to 4 m/s from the east to southeast direction at the site. This was also apparent at the Ferny Creek site.

The second iteration was run using assimilation of the observational data at the onsite meteorological monitoring station operated by Holcim. The wind roses provided in Figure A 1 demonstrate the improvement in the correlation between the TAPM simulations and the onsite meteorological monitoring data following assimilation of the onsite data.

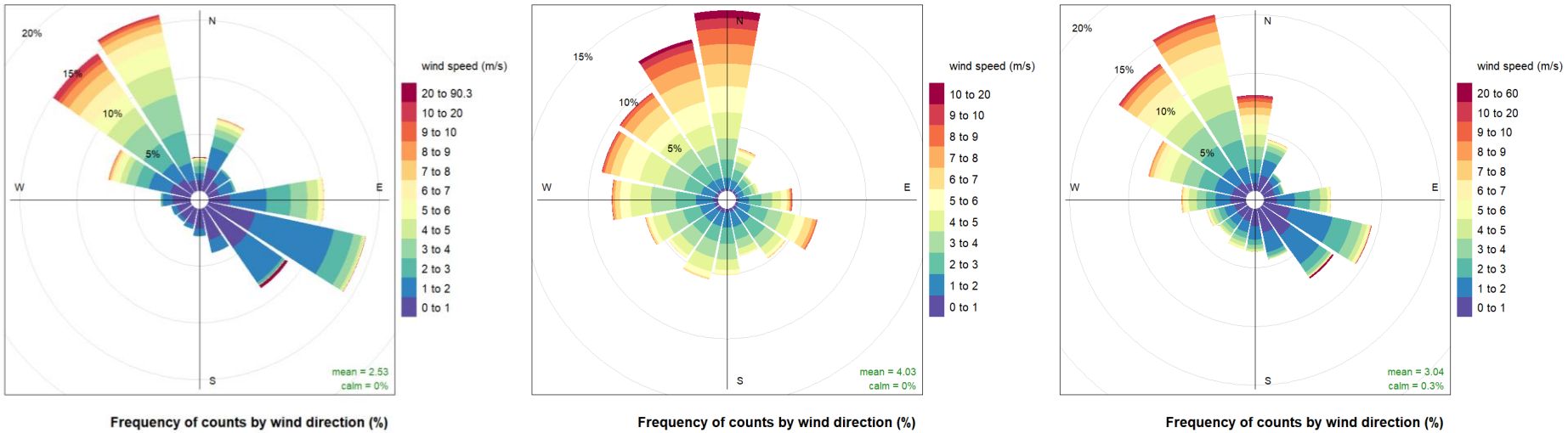

Figure A 1 **Annual wind rose for onsite meteorological monitoring data (left), TAPM predictions at the site without data assimilation (centre), and TAPM predictions at site following assimilation of onsite monitoring data (right)**

A1.3 AERMET meteorological modelling configuration

AERMET is a meteorological data pre-processor for the AERMOD air pollution dispersion model. AERMET processes commercially available or custom on-site met data and creates two files: a surface data file and a profile data file.

The meteorological output data from TAPM was used as input into the AERMET meteorological model to generate the meteorological data file for AERMOD. The data file was generated in accordance with the publication Construction of input meteorological data files for EPA Victoria's regulatory pollution model (AERMOD) (publication 1550) where possible.

According to EPA Victoria and the AERMET/AERMOD user guides, the Albedo and Bowen ratio should be determined from land use within a 10 km by 10 km rectangle centred on the meteorological station, and roughness length (Z0) should be determined based on land cover within a 1.0 km radius from the meteorological station. If the value of Z0 varies significantly by direction, sector dependency should be used with sector width >= 30°. Details of the meteorological station are listed in Table A 1.

Table A 1 Details of onsite meteorological station operated by Holcim

Parameter	Value
Latitude (°)	-38.027656
Longitude (°)	145.479859
Easting (m)	366,582
Northing (m)	5,790,026
UTM zone	55 H
Altitude (m AHD)	174

From the aerial view images, the land use within a 1 km radius of the monitoring station location is a mix of quarry, grassland, mixed forest, and a very small pond. Table A2 presents surface roughness values.

Table A3 presents the albedo and Bowen ratios used in developing the meteorological file based on season. These have been determined based on land cover within the 10 km by 10 km domain with no sector dependency. A weighted geometric mean has been used to determine the Bowen ratio, and a weight arithmetic mean used to determine the albedo, which is then subsequently used to calculate the diurnal variation. From the aerial view images, it is evident that the main land use groups are low density residential, industrial/commercial, mixed forest, grass, and quarry.

Table A2 Seasonal surface roughness (Z_o) for each sector - radius of 1km centred on Project site

Sector	WDIR (°)	Summer	Autumn	Winter	Spring
Sector A	239 – 34	0.235712	0.113464	0.053163	0.18684
Sector B	34 – 82	0.148647	0.034118	0.007831	0.095443
Sector C	82 – 103	0.272487	0.090021	0.026685	0.185850
Sector D	103 – 152	0.245913	0.094844	0.032377	0.174641
Sector E	152 – 192	0.147717	0.029080	0.005629	0.089875
Sector F	192 – 239	0.200721	0.061988	0.018396	0.138397

Table A3 Seasonal Bowen ratio and albedo parameters (for average, not wet or dry)

Parameter	Summer	Autumn	Winter	Spring
Albedo Arithmetic Weighted Average	0.16862	0.16862	0.18346	0.16862
Bowen Ratio Geometric Mean	0.64086	0.98285	0.98285	0.50279

The following TAPM parameters were used as inputs to AERMET as specified by the Victorian EPA:

- 10 m wind speed (WSPD).
- 10 m wind direction (WDIR).
- Screen level temperature (TEMPSCR).
- Screen level relative humidity (RHUM).
- Net Radiation (NETR).
- Daytime mixing height (ZMIX).

A2 Dispersion modelling

AERMOD is a steady-state dispersion model designed for short-range (up to 50 kilometres) dispersion of air pollutant emissions from stationary sources. The AERMOD dispersion model was conjured for the assessment of the Quarry as follows:

- Modelling period from 1 January 2019 to 31 December 2023.
- Model domain of 200 x 200 grid points at 40 m resolution.
- Terrain data included.
- Discrete receptors included.
- PM_{10} and $PM_{2.5}$ modelled as gases (i.e. no deposition/depletion) to predict ground-level concentrations of PM_{10} and $PM_{2.5}$.
- TSP modelled as:
    - Dry deposition and total deposition (both wet and dry).
    - No dry or wet depletion.
    - Specified particle diameter for TSP of 30 µm, PM_{10} of 10 µm, and $PM_{2.5}$ of 2.5 µm.
    - Mass fraction determined from the total emission rates of TSP, PM_{10} and $PM_{2.5}$ in each modelled source type.
    - Particle density 2.2 g/cm³.
- All emission sources modelled as volume sources as per EPA Victoria's guidance notes for fugitive sources.
- Hours of operation between 6 am and 5 pm every day.
- Wind erosion sources modelled as hourly varied based on wind speed for all hours.
- All other options set to default.

Source characteristics used to model operations were based on the following:

- Initial sigma-z values for sources calculated as the release height divided by 2.15.
- Initial sigma-y values for haul sources calculated as the centre-to-centre distance divided by 2.15.
- Initial sigma-y values for volume sources representing other pit activities calculated as the length of the area over which emissions occur divided by 4.3.
- Release height of 4 m for active pt areas, haul roads, and wind erosion sources.
- Release height of 2 m for processing plant sources.

A3 Contemporaneous background

Cumulative impacts of PM_{10} and $PM_{2.5}$ have been assessed in accordance with the requirements of EPA Publication 1961. Specifically, a five-year dataset for the 2019 to 2023 period has been prepared to provide a contemporaneous background alongside the modelled concentration of PM_{10} and $PM_{2.5}$ at each receptor. The dataset has been prepared using the following:

- Available ambient PM_{10} monitoring from Holcim's network of monitors in the vicinity of the Quarry (A1, A3, A4, and A6) (Figure 11).
- Available ambient PM_{10} and $PM_{2.5}$ monitoring from EPA Victoria site at Traralgon (Figure 12).

The background PM_{10} data file has been prepared using an analysis of the corresponding wind direction data from Holcim's onsite meteorological monitor. For each hour of the PM_{10} data file, the wind direction has been used to identify which of Holcim's monitor(s) were upwind of the Quarry, with the corresponding PM_{10} concentration data (i.e. measurements excluding the impact of the Quarry) substituted into the file. As a preference, PM_{10} data from site A3 was substituted in for all hours measuring winds between 240 and 135 degrees while data from A1 was substituted for hours measuring winds between 135 and 240 degrees. Data from site A4 and site A6 were then used to fill in hours with missing PM_{10} data. This provides a dataset that represents background sources at the site excluding the impact from the Quarry so that it is not double counted in the cumulative modelling assessment.

Where corresponding available data was not available from Holcim's monitoring network, including PM_{10} data for the 2019 year, and $PM_{2.5}$ for all years, the dataset was prepared using monitoring data from the EPA Victoria Traralgon site. Validated $PM_{2.5}$ data for Traralgon was not available at the time of reporting. Consequently, cumulative $PM_{2.5}$ impacts for the 2023 model year have relied on the use of Traralgon monitoring data for the 2022 year. As discussed in Section 5.5.2, ambient PM_{10} levels at the EPA Traralgon site are higher than those measured at the Holcim A4 and A6 sites, and significantly higher than those measured at the Holcim A1 and A3 sites (Table 5), meaning that where the EPA Traralgon data has been used in the cumulative assessment due to the unavailability of Holcim Data (PM_{10} for 2019, and $PM_{2.5}$ for all model years), predicted impacts at sensitive receptors will be highly conservative and likely an over-estimate.

Rates of dust deposition from the Quarry were assessed in isolation in accordance with the relevant threshold of 2 g/m²/month.

A visualisation of the final five-year datasets used in the assessment is provided in Figure A 2. As shown, the exceedance levels during January and February 2020 that were the result of the large bushfires were retained in the final dataset used in the assessment, and levels at the EPA Traralgon site (2019 PM_{10} data, and 2019 to 2023 $PM_{2.5}$ data) are higher than those measured at the Holcim sites and are likely to over-predict cumulative impacts due to the Quarry.

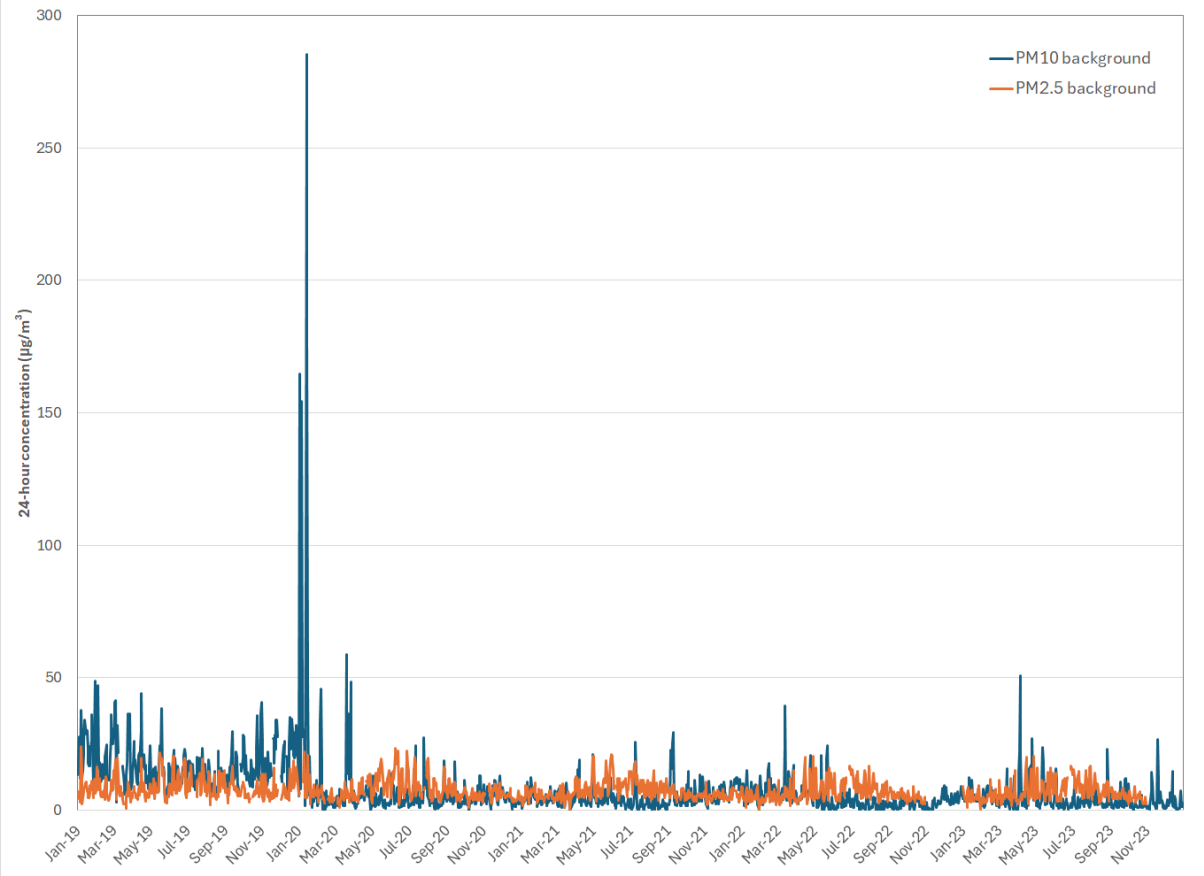

Figure A 2 Five-year PM_{10} and $PM_{2.5}$ contemporaneous background dataset

APPENDIX B ACTIVITY DATA

The activity data that has been utilised to calculate the emissions from the Quarry and for the proposed Extension is presented in Table B 1.

Table B 1 Activity data for the Quarry and for the proposed Extension

Activity	Units	The Quarry	Proposed Extension	Notes
Operational parameters				
Operating hours	hours/ day	11	11	7am to 6pm and half day Saturday, modelled 7am to 6am all days
	days/ week	6	6	Monday to Saturday, modelled 7 days
Topsoil removal	tpa	30,000	30,000	Assumption based on depth of material and area
Overburden removal	Tpa	300,000	300,000	Assumption based on depth of material and area
Basalt extracted, processed, and exported	tpa	1,200,000	1,200,000	Assumed value for extract, process, and export emissions
Proportion stockpiled prior to processing	%	10	10	Supplied
Proportion material – primary crushing	%	100	100	Supplied
Proportion material – secondary crushing	%	88	88	Supplied
Proportion material – tertiary crusher	%	75	75	Supplied
Proportion material – quaternary crusher	%	13	13	Supplied
Proportion material – screening	%	75	75	Supplied
Proportion product material - aggregate	%	60	60	Supplied
Proportion product material – wet mix	%	40	40	Supplied
Proportion of aggregate stockpiled at internal stockpile area	%	40	40	Assumption
Holes drilled per blast	no.	80	80	Supplied
Blast area	m^2	1,200	1,200	Assumption
Blast frequency	no. /day	1	1	Assumption
	no./year	40	40	Supplied

Activity	Units	The Quarry	Proposed Extension	Notes
Processing conveyors				
Total conveyor length (exposed portion)	m	469	469	Supplied
Material characteristics				
Entrance road silt loading	g/m²	8.2	8.2	USEPA AP42 mean value
Internal road silt content	%	4.3	4.3	USEPA AP42 mean value
Topsoil moisture content	%	11.0	11.0	USEPA AP42 mean value
Overburden moisture content	%	7.9	7.9	USEPA AP42 mean value
Basalt moisture content	%	2.7	2.7	Mean reference value
Product moisture content	%	4.5	4.5	Average of aggregate and wet mix
Vehicle details				
Empty weight – internal haul	tonnes	46	46	Supplied
Payload – internal haul	tonnes	55	55	Supplied
Empty weight – product haul	tonnes	16	16	Supplied
Payload – product haul	tonnes	30	30	Supplied
Areas of wind erosion sources				
Raw material stockpile	ha	0.2	0.2	Katestone estimated based on QGIS overlay
Secondary product stockpile	ha	0.1	0.1	
Secondary surge stockpile	ha	0.01	0.01	
Processing wet mix stockpile	ha	0.02	0.02	
Processing aggregate stockpile	ha	0.1	0.1	
Product aggregate stockpile – site entrance	ha	0.8	0.8	
Product aggregate stockpile – internal area	ha	3.0	3.0	
Product wet mix stockpile – site entrance	ha	0.2	0.2	
Primary rehabilitation (previous active pit, 30% control)	ha	10.8	20.7	
Rehabilitation (90% control)	ha	6.5	17.3	
Exposed area within site	ha	8.8	8.8	
Active pit area	ha	20.7	17.6	
Haul distances				
Sealed entrance (one way)	m	356	356	

Activity	Units	The Quarry	Proposed Extension	Notes
Active pit to topsoil/overburden dump area at edge of pit	m	150	150	Katestone estimated based on QGIS overlay
Active pit to processing plant	m	604	70% of material – 990 30% of material - 750	
Processing plant to site entrance aggregate stockpile	m	259	259	
Processing plant to internal aggregate stockpile	m	359	359	
Processing plant to site entrance wet mix stockpile	m	111	111	
Entrance stockpile to sealed road - aggregate	m	387	387	
Entrance stockpile to sealed road – wet mix	m	332	332	
Controls				
Haul roads	%	75	75	Level 2 watering (>2 litres/m²/hr)
Site entrance sealed road	%	0	0	No control
Topsoil/overburden removal	%	0	0	No control
Basalt extraction	%	50	50	Wet suppression
Conveyors	%	0	0	Only transfers are enclosed
Material handling (drop to stockpiles, etc.)	%	63	63	Drop heights minimised and wet suppression
Crushing, screening, and transfers between	%	50	50	Water sprays, wet suppression and dust collectors
Drilling	%	70	70	Dust extraction system
Blasting	%	0	0	No control
Rehabilitation of previous pit	%	30	30	Primary rehabilitation
Established rehabilitation of areas prior to active pit	%	90	90	Established vegetation
Exposed area wind erosion	%	0	0	Assume no control
Stockpile wind erosion	%	50	50	Water added
Crushed material stockpiles	%	63	63	Wet suppression and inherent moisture
Meteorological parameters				
Mean onsite wind speed	m/s	3.04	3.04	TAPM
Number of rainfall days (>0.25mm)	no.	137	137	BoM Dandenong rainfall data
Table Notes:				

Activity	Units	The Quarry	Proposed Extension	Notes
[1] Certain activities operate on a campaign basis (e.g. topsoil or overburden stripping) or are limited to within a short window of time during the day (e.g. drilling and blasting). For emission estimation purposes, activities have been assumed to occur all hours between 7am and 6pm, Monday through to Saturday, with sources modelled seven days/week.				

APPENDIX C METHODOLOGIES FOR CALCULATING EMISSIONS

C1 Material handling

Processing operations at the Quarry involve the transfer of material from one location to another. Emissions are dependent on the amount of material transferred (kg/tonne of material).

Emission rates for material transfers were calculated using the following equation (US EPA, 2006):

$$EF = k \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{2}{M}\right)^{1.4}$$

where:

k: 0.74 for particles less than 30 µm

0.35 for particles less than 10 µm

0.053 for particles less than 2.5 µm

U: Mean wind speed in m/s

M: Material moisture content

C2 Wheel generated dust from unpaved haul roads

Wheel-generated dust from haulage of material around the site along unpaved haul routes was estimated using the emission factor defined in AP42 for haulage of materials through unpaved roads. The emission factor for wheel-generated dust on haul roads is dependent on the size of the truck and the silt content of the road. In equation form, the emission factors (g/VKT) for dust are defined using the following equations:

$$EF_{TSP} = 281.9 \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45}$$

$$EF_{PM10} = 281.9 \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45}$$

$$EF_{PM2.5} = 281.9 \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45}$$

where:

s: Silt content of the road

W: mean vehicle weight in tons

The total emissions are dependent on the total distance travelled by the truck, which is based on truck capacity and the length of the haul road to be travelled.

C3 Wheel generated dust from paved haul roads

Wheel-generated dust from haulage of material on the sealed entrance road was estimated using the emission factor defined in AP42 for haulage of materials through paved roads. The emission factor for wheel-generated dust on paved haul roads is dependent on the size of the truck and the road surface silt loading. In equation form, the emission factors (g/VKT) for dust are defined using the following equations:

$$EF_{TSP} = 3.23 \times (sL)^{0.91} \times (W)^{1.02}$$

$$EF_{PM10} = 0.62 \times (sL)^{0.91} \times (W)^{1.02}$$

$$EF_{PM2.5} = 0.15 \times (sL)^{0.91} \times (W)^{1.02}$$

where:

sL: Road surface silt loading in grams per square metre

W: mean vehicle weight in tons

The total emissions are dependent on the total distance travelled by the truck, which is based on truck capacity and the length of the haul road to be travelled.

C4 Drilling

Dust emitted during drilling at the Quarry was estimated based on the emission factor defined in the NPI. The TSP emission factor is 0.59 kg/hole and the PM_{10} emission factor is 0.31 kg/hole. The ratio of $PM_{2.5}$ to TSP emissions is 3%.

C5 Blasting

The emission rate for blasting has been calculated using the following equations (NPI, 2012):

$$EF_{TSP} = 0.00022 \times A^{1.5}$$

$$EF_{PM10} = 0.000114 \times A^{1.5}$$

where:

EF_{TSP}: TSP blasting emission factor (kg/blast)

EF_{PM10}: PM_{10} blasting emission factor (kg/blast)

A: Area blasted (m^2)

Blasting was assumed to occur during the daylight operating hours and was modelled between 7am and 6pm. Of TSP emissions, 3.0% are estimated to be $PM_{2.5}$. The particulate matter distribution is based on size particle distribution for blasting as defined in the AP42.

C6 Wind erosion of active stockpiles

Emissions of dust from wind erosion of stockpiles are dependent on the surface area of the stockpiles (kg/ha/hr). The emission rate of dust from stockpiles has been calculated using the emission factor for active storage piles from the AP42 Chapter 11.9. In equation form, the emission factor for TSP is defined as:

$$EF_{TSP} = 1.8 \times \mathrm{u}$$

where

u: Wind speed (m/s)

Of TSP emissions, 50% are estimated to be PM_{10} and 7.5% of TSP emissions are estimated to be $PM_{2.5}$. The particulate matter distribution is based on size particle distribution for wind erosion as defined in the AP42 and the NPI.

Emissions of dust from wind erosion of active stockpiles have been modelled as hourly varying, using a threshold wind speed of 5.4 m/s so that emissions occur during hours when the wind speed is greater than the threshold wind speed, and the magnitude of dust emissions is proportional to the square of the wind speed.

C7 Wind erosion of exposed areas

Emissions of dust from wind erosion of exposed areas are dependent on the size of the exposed areas (Mg/ha/yr). The emission rate is based on the equation defined in the AP42 for estimating emissions of wind exposed areas. A rain factor was not applied. The TSP emission factor was estimated using the following equation:

$$EF_{TSP} = 0.85$$

Of TSP emissions, 50% are estimated to be PM_{10} and 7.5% are estimated to be $PM_{2.5}$. The particulate matter distribution is based on the size particle distribution for wind erosion as defined in the AP42 and the NPI.

Emissions of dust from wind erosion of exposed areas have been modelled as hourly varying, using a threshold wind speed of 5.4 m/s so that emissions occur during hours when the wind speed is greater than the threshold wind speed, and the magnitude of dust emissions is proportional to the square of the wind speed.

C8 Crushing

The emission factor for TSP and PM_{10} for crushing of basalt is based on the US EPA AP42 document, chapter 11.19.2 (August 2004).

For primary, secondary, tertiary, and quaternary crushing, TSP and PM_{10} emission factors are estimated to be 0.0027 and 0.0012 kg/tonne of material crushed, respectively. The emission factor for $PM_{2.5}$ has been estimated from the emission factor for TSP, and the ratio of the $PM_{2.5}$ and TSP emission factors for controlled tertiary crushing.

C9 Screening

The emission factor for TSP and PM_{10} due to screening of basalt is based on the US EPA AP42 document, chapter 11.19.2 (August 2004). TSP, PM_{10} and $PM_{2.5}$ emission factors are estimated to be 0.0011, 0.00037, and 0.000025 kg/tonne of material screened, respectively.

C10 Conveyor

Emission rates for the conveyors were calculated using the following equation:

$$EF_{TSP} = 0.031 \times 0.2 \times \frac{aU_{avg}^2 + bU_{avg} + C}{aU_{ref}^2 + bU_{ref} + C}$$

where:

EF_{TSP}	emission factor for TSP (g/m/s)
U_{avg}	average wind speed on site
U_{ref}	reference wind speed
a	constant (0.00006)
b	constant (-0.0002)
c	constant (0.0001)

TSP emissions are based on the speed of prevailing winds, referenced on the study by GHD and Oceanics Australia (GHD-Oceanics, 1975), using a reference emission rate of 0.031 g/s/m at a reference wind velocity of 10 m/s (U_{ref}). A factor of 0.2 is used to account for the difference in particle size distribution between particulate matter sampled in the GHD Oceanics study and the normal TSP size fraction of PM_{30-50}. The remaining ratio of quadratics is a correction for the wind speed based on the work of Witt et al. (1999).

Of TSP emissions, 36.4% are estimated to be PM_{10} and 7% of TSP emissions are estimated to be $PM_{2.5}$. The particulate matter distribution is based on size ratios of dust emitted from transfers.

The emission factor defines emissions of dust based on the length of the conveyor (g/m/s). Total emissions are dependent on conveyor length.

APPENDIX D SENSITIVE RECEPTOR RESULTS

Table D 1 Particulate matter as PM_{10}, $PM_{2.5}$ and dust deposition rate for the Quarry and for the proposed Extension

Receptor	PM_{10}										$PM_{2.5}$										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
1	10.4	1.5	285.5	18.5	7	11.9	1.4	285.5	18.6	7	1.6	0.2	24.1	9.9	0	1.8	0.2	24.1	9.8	0	2.1	0.9	2.0	0.9
2	10.0	1.5	285.4	18.3	7	10.7	1.6	285.4	18.4	7	1.5	0.2	24.1	9.8	0	1.6	0.2	24.1	9.8	0	2.2	1.0	2.4	1.0
3	8.3	1.2	285.5	18.0	7	9.6	1.2	285.4	18.1	7	1.3	0.2	24.1	9.8	0	1.4	0.2	24.1	9.8	0	2.5	0.8	2.5	0.8
4	9.0	1.1	285.5	18.0	7	8.7	1.2	285.5	18.0	7	1.4	0.2	24.1	9.8	0	1.3	0.2	24.1	9.8	0	2.2	0.7	2.4	0.8
5	9.1	1.1	285.5	18.0	7	9.6	1.3	285.5	18.1	7	1.4	0.2	24.1	9.8	0	1.4	0.2	24.1	9.8	0	2.0	0.7	2.4	0.8
6	10.6	1.5	285.5	18.1	7	10.2	1.6	285.5	18.2	7	1.6	0.2	24.1	9.8	0	1.5	0.2	24.1	9.9	0	2.8	0.9	3.0	1.0
7	11.0	1.4	285.6	18.2	7	11.6	1.6	285.6	18.2	7	1.6	0.2	24.1	9.8	0	1.7	0.2	24.1	9.9	0	2.5	0.8	2.9	1.0
8	8.6	0.9	285.6	18.0	7	9.0	1.1	285.5	18.0	7	1.3	0.1	24.1	9.8	0	1.3	0.2	24.1	9.8	0	1.7	0.6	2.1	0.7

Receptor	PM_{10}										$PM_{2.5}$										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
9	14.7	2.7	285.7	18.7	7	16.9	2.7	285.7	18.8	7	2.2	0.4	24.1	10.0	0	2.5	0.4	24.2	10.0	0	5.3	1.9	5.2	1.9
10	8.8	0.8	285.4	18.3	7	8.1	0.7	285.4	18.2	7	1.3	0.1	24.1	9.8	0	1.2	0.1	24.1	9.8	0	1.0	0.5	1.1	0.5
11	9.2	0.6	285.6	18.0	7	8.9	0.8	285.6	18.1	7	1.4	0.1	24.1	9.8	0	1.3	0.1	24.1	9.8	0	0.8	0.4	1.2	0.5
12	11.6	1.1	285.5	18.6	7	10.4	1.0	285.5	18.4	7	1.7	0.2	24.1	9.8	0	1.5	0.2	24.1	9.8	0	1.4	0.8	1.6	0.7
13	14.4	1.8	285.6	19.1	7	14.7	1.6	285.6	19.1	7	2.2	0.3	24.1	9.9	0	2.2	0.3	24.4	9.9	0	2.2	1.2	2.2	1.2
14	16.5	1.7	285.6	19.1	7	14.7	1.5	285.6	18.9	7	2.5	0.3	24.8	9.9	0	2.2	0.2	24.4	9.9	0	2.1	1.2	2.3	1.1
15	25.7	3.9	286.2	20.6	8	26.2	3.7	286.2	20.6	8	3.8	0.6	24.8	10.1	0	3.9	0.6	25.4	10.1	1	4.6	2.6	4.6	2.7
16	8.3	0.6	285.6	18.0	7	9.2	0.7	285.6	18.1	7	1.2	0.1	24.1	9.8	0	1.4	0.1	24.1	9.8	0	0.8	0.4	0.8	0.4
17	12.7	0.9	285.6	18.3	7	13.4	1.1	285.7	18.4	7	1.9	0.1	24.1	9.9	0	2.0	0.2	24.1	9.9	0	1.1	0.6	1.4	0.6
18	12.5	1.0	285.7	18.3	7	12.1	1.3	285.7	18.3	7	1.9	0.1	24.1	9.9	0	1.8	0.2	24.1	9.9	0	1.2	0.6	1.9	0.7
19	14.7	2.6	285.6	18.8	7	16.0	2.9	285.6	18.9	7	2.3	0.4	24.6	10.0	0	2.5	0.5	24.7	10.0	0	4.3	1.9	4.6	2.1
20	15.6	3.1	285.6	19.2	7	17.0	3.2	285.6	19.3	7	2.5	0.5	24.9	10.0	0	2.7	0.6	24.9	10.0	0	5.0	2.3	5.4	2.4

Receptor	PM_{10}										$PM_{2.5}$										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
21	13.6	1.4	285.8	18.5	7	15.1	1.8	285.7	18.6	7	2.0	0.2	24.1	9.9	0	2.2	0.3	24.1	9.9	0	2.0	0.8	2.9	1.1
22	12.3	0.8	285.7	18.2	7	12.3	1.1	285.7	18.3	7	1.8	0.1	24.1	9.8	0	1.8	0.2	24.1	9.9	0	1.1	0.5	1.5	0.6
23	10.9	0.8	285.6	18.2	7	11.9	1.0	285.7	18.3	7	1.6	0.1	24.1	9.8	0	1.8	0.1	24.1	9.8	0	1.0	0.5	1.1	0.6
24	8.8	0.7	285.5	18.2	7	9.5	0.8	285.6	18.3	7	1.3	0.1	24.1	9.8	0	1.4	0.1	24.1	9.8	0	0.9	0.4	1.0	0.5
25	7.6	0.6	285.5	18.1	7	8.0	0.7	285.6	18.2	7	1.1	0.1	24.1	9.8	0	1.2	0.1	24.1	9.8	0	0.8	0.4	0.9	0.4
26	10.8	0.6	285.5	18.2	7	10.3	0.8	285.6	18.3	7	1.6	0.1	24.1	9.8	0	1.5	0.1	24.1	9.8	0	1.0	0.4	1.0	0.5
27	16.6	1.0	285.5	18.6	7	15.7	1.2	285.8	18.8	7	2.4	0.1	24.1	9.8	0	2.3	0.2	24.1	9.9	0	1.5	0.7	1.6	0.8
28	17.8	0.9	285.5	18.6	7	17.7	1.2	285.7	18.8	7	2.6	0.1	24.1	9.8	0	2.6	0.2	24.1	9.9	0	1.4	0.6	1.6	0.8
29	6.8	0.4	285.4	18.0	7	8.0	0.4	285.5	18.1	7	1.0	0.1	24.1	9.8	0	1.2	0.1	24.1	9.8	0	0.5	0.2	0.7	0.3
30	8.2	0.4	285.4	18.0	7	9.4	0.5	285.5	18.2	7	1.1	0.1	24.1	9.8	0	1.4	0.1	24.1	9.8	0	0.6	0.3	0.8	0.4
31	6.1	0.3	285.4	17.9	7	7.3	0.4	285.5	18.0	7	0.8	0.0	24.1	9.8	0	0.9	0.1	24.1	9.8	0	0.4	0.2	0.6	0.3
32	5.1	0.3	285.4	17.9	7	6.3	0.3	285.4	17.9	7	0.6	0.0	24.1	9.8	0	0.7	0.0	24.1	9.8	0	0.3	0.2	0.4	0.2

Receptor	PM10										PM2.5										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
33	13.8	0.7	285.5	18.3	7	14.8	0.9	285.6	18.6	7	2.0	0.1	24.1	9.8	0	2.2	0.1	24.1	9.8	0	1.1	0.5	1.3	0.6
34	8.7	0.5	285.5	18.1	7	10.8	0.9	285.6	18.5	7	1.2	0.1	24.1	9.8	0	1.4	0.1	24.1	9.8	0	0.6	0.3	1.0	0.6
35	6.0	0.4	285.4	18.0	7	8.7	0.6	285.5	18.2	7	0.9	0.1	24.1	9.8	0	1.1	0.1	24.1	9.8	0	0.5	0.2	0.7	0.4
36	5.1	0.3	285.4	17.9	7	8.1	0.4	285.5	18.1	7	0.7	0.0	24.1	9.8	0	0.9	0.1	24.1	9.8	0	0.4	0.2	0.6	0.3
37	4.3	0.3	285.4	17.9	7	6.3	0.3	285.4	17.9	7	0.6	0.0	24.1	9.8	0	0.7	0.0	24.1	9.8	0	0.3	0.2	0.4	0.2
38	6.6	0.3	285.4	17.9	7	7.0	0.4	285.5	18.0	7	0.9	0.0	24.1	9.8	0	0.9	0.1	24.1	9.8	0	0.3	0.2	0.5	0.3
39	5.7	0.3	285.4	17.9	7	6.4	0.4	285.5	18.0	7	0.7	0.0	24.1	9.8	0	0.8	0.1	24.1	9.8	0	0.3	0.2	0.4	0.3
40	5.0	0.4	285.5	18.0	7	8.3	0.6	285.5	18.2	7	0.7	0.0	24.1	9.8	0	1.0	0.1	24.2	9.8	0	0.4	0.2	0.6	0.4
41	6.0	0.4	285.5	18.0	7	10.8	0.8	285.6	18.4	7	0.9	0.1	24.2	9.8	0	1.3	0.1	24.2	9.8	0	0.4	0.3	0.9	0.5
42	3.9	0.3	285.4	17.9	7	7.8	0.5	285.5	18.1	7	0.6	0.0	24.1	9.7	0	0.8	0.1	24.2	9.8	0	0.3	0.2	0.6	0.3
43	4.3	0.3	285.5	17.9	7	7.0	0.5	285.5	18.1	7	0.6	0.0	24.1	9.8	0	0.7	0.1	24.1	9.8	0	0.3	0.2	0.5	0.3
44	3.4	0.2	285.4	17.8	7	6.9	0.4	285.5	18.0	7	0.5	0.0	24.1	9.7	0	0.7	0.0	24.1	9.8	0	0.3	0.1	0.5	0.2

Receptor	PM_{10}										$PM_{2.5}$										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
45	3.3	0.3	285.4	17.8	7	5.8	0.4	285.5	17.9	7	0.5	0.0	24.1	9.7	0	0.7	0.0	24.1	9.8	0	0.3	0.1	0.5	0.2
46	3.4	0.2	285.4	17.8	7	6.3	0.4	285.5	18.0	7	0.5	0.0	24.1	9.7	0	0.6	0.0	24.1	9.8	0	0.3	0.1	0.5	0.2
47	2.7	0.2	285.4	17.8	7	6.4	0.4	285.5	17.9	7	0.4	0.0	24.2	9.7	0	0.7	0.0	24.2	9.7	0	0.3	0.1	0.5	0.2
48	3.1	0.2	285.4	17.8	7	5.9	0.4	285.5	18.0	7	0.4	0.0	24.2	9.7	0	0.7	0.0	24.2	9.7	0	0.3	0.1	0.5	0.2
49	3.0	0.2	285.4	17.8	7	7.1	0.4	285.5	18.0	7	0.4	0.0	24.2	9.7	0	0.8	0.0	24.2	9.8	0	0.3	0.1	0.5	0.2
50	3.0	0.2	285.4	17.8	7	7.3	0.4	285.5	17.9	7	0.4	0.0	24.2	9.7	0	0.8	0.0	24.2	9.7	0	0.3	0.1	0.4	0.2
51	3.3	0.3	285.5	17.9	7	9.7	0.6	285.6	18.1	7	0.5	0.0	24.2	9.7	0	1.0	0.1	24.2	9.8	0	0.4	0.2	0.6	0.3
52	4.9	0.3	285.5	17.9	7	9.7	0.7	285.6	18.3	7	0.7	0.0	24.2	9.7	0	1.1	0.1	24.2	9.8	0	0.4	0.2	0.9	0.5
53	4.6	0.2	285.4	17.8	7	7.3	0.4	285.5	17.9	7	0.5	0.0	24.2	9.7	0	0.8	0.0	24.2	9.7	0	0.2	0.1	0.4	0.2
54	3.4	0.2	285.4	17.8	7	5.1	0.3	285.4	17.8	7	0.4	0.0	24.2	9.7	0	0.6	0.0	24.2	9.7	0	0.2	0.1	0.3	0.1
55	3.0	0.2	285.4	17.8	7	6.1	0.3	285.4	17.8	7	0.4	0.0	24.2	9.7	0	0.7	0.0	24.2	9.7	0	0.2	0.1	0.3	0.1
56	6.3	0.4	285.4	17.9	7	10.5	0.6	285.5	17.9	7	0.9	0.1	24.2	9.7	0	1.3	0.1	24.2	9.8	0	0.4	0.2	0.5	0.3

Receptor	PM10										PM2.5										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
57	3.5	0.2	285.4	17.8	7	5.7	0.3	285.4	17.8	7	0.4	0.0	24.1	9.7	0	0.6	0.0	24.1	9.7	0	0.2	0.1	0.2	0.1
58	2.3	0.1	285.4	17.7	7	4.9	0.2	285.4	17.8	7	0.3	0.0	24.1	9.7	0	0.6	0.0	24.1	9.7	0	0.2	0.1	0.3	0.1
59	1.8	0.1	285.4	17.7	7	4.1	0.2	285.4	17.8	7	0.3	0.0	24.1	9.7	0	0.5	0.0	24.1	9.7	0	0.2	0.1	0.3	0.1
60	2.3	0.2	285.4	17.7	7	3.4	0.2	285.4	17.8	7	0.3	0.0	24.1	9.7	0	0.4	0.0	24.1	9.7	0	0.2	0.1	0.3	0.1
61	4.0	0.2	285.4	17.8	7	5.8	0.3	285.4	17.8	7	0.5	0.0	24.1	9.7	0	0.7	0.0	24.1	9.7	0	0.2	0.1	0.3	0.1
62	3.9	0.2	285.4	17.8	7	5.4	0.3	285.4	17.8	7	0.5	0.0	24.1	9.7	0	0.6	0.0	24.1	9.7	0	0.2	0.1	0.3	0.1
63	3.9	0.3	285.4	17.8	7	5.4	0.3	285.4	17.9	7	0.5	0.0	24.1	9.7	0	0.6	0.0	24.1	9.8	0	0.2	0.1	0.3	0.2
64	4.6	0.2	285.4	17.8	7	5.8	0.3	285.4	17.9	7	0.6	0.0	24.1	9.7	0	0.7	0.0	24.1	9.8	0	0.2	0.1	0.3	0.2
65	3.1	0.2	285.4	17.8	7	7.4	0.4	285.5	17.9	7	0.4	0.0	24.2	9.7	0	0.8	0.0	24.2	9.7	0	0.3	0.1	0.5	0.2
66	3.1	0.2	285.4	17.8	7	5.1	0.3	285.4	17.9	7	0.4	0.0	24.1	9.7	0	0.5	0.0	24.1	9.7	0	0.3	0.1	0.4	0.2
67	1.9	0.2	285.4	17.7	7	4.3	0.2	285.4	17.8	7	0.3	0.0	24.1	9.7	0	0.5	0.0	24.1	9.7	0	0.2	0.1	0.3	0.1
68	2.3	0.2	285.4	17.8	7	5.3	0.3	285.4	17.8	7	0.3	0.0	24.1	9.7	0	0.6	0.0	24.1	9.7	0	0.3	0.1	0.3	0.1

Receptor	PM10										PM2.5										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
69	3.4	0.2	285.4	17.8	7	6.4	0.3	285.4	17.9	7	0.4	0.0	24.1	9.7	0	0.7	0.0	24.1	9.7	0	0.3	0.1	0.4	0.2
70	3.9	0.2	285.4	17.8	7	6.8	0.3	285.4	17.9	7	0.4	0.0	24.2	9.7	0	0.7	0.0	24.2	9.7	0	0.2	0.1	0.3	0.2
71	7.9	0.5	285.4	17.8	7	12.8	0.7	285.5	17.9	7	1.1	0.1	24.2	9.7	0	1.6	0.1	24.2	9.8	0	0.3	0.2	0.4	0.3
72	8.7	0.5	285.4	17.9	7	14.5	0.8	285.5	18.0	7	1.2	0.1	24.2	9.8	0	1.8	0.1	24.2	9.8	0	0.4	0.2	0.5	0.3
73	9.6	0.6	285.4	17.9	7	13.8	0.9	285.5	17.9	7	1.2	0.1	24.2	9.8	0	1.8	0.1	24.2	9.8	0	0.4	0.3	0.7	0.4
74	17.2	1.0	285.7	17.9	7	13.2	0.7	285.7	17.8	7	2.2	0.1	24.1	9.8	0	1.8	0.1	24.1	9.8	0	1.4	0.6	1.1	0.4
75	17.8	1.5	285.6	17.9	7	17.3	1.3	285.7	17.9	7	2.7	0.2	24.2	9.8	0	2.6	0.2	24.2	9.8	0	1.8	0.8	1.9	0.8
76	6.2	0.6	285.4	17.8	7	9.6	0.8	285.5	17.8	7	0.9	0.1	24.1	9.8	0	1.3	0.1	24.2	9.8	0	0.4	0.3	0.6	0.4
77	7.9	0.6	285.4	17.7	7	7.6	0.6	285.5	17.7	7	1.2	0.1	24.1	9.8	0	1.1	0.1	24.1	9.8	0	0.8	0.4	0.8	0.4
78	5.9	0.5	285.4	17.7	7	8.1	0.4	285.5	17.7	7	0.9	0.1	24.1	9.8	0	1.0	0.1	24.1	9.8	0	0.6	0.3	0.6	0.2
79	7.5	0.5	285.5	17.7	7	9.0	0.4	285.5	17.7	7	0.9	0.1	24.1	9.8	0	1.1	0.1	24.1	9.8	0	0.6	0.3	0.6	0.2
80	8.9	0.4	285.5	17.7	7	8.8	0.4	285.5	17.7	7	1.1	0.1	24.1	9.8	0	1.1	0.0	24.1	9.8	0	0.6	0.2	0.6	0.2

Receptor	PM10										PM2.5										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
81	9.3	0.4	285.5	17.7	7	6.8	0.3	285.5	17.7	7	1.3	0.1	24.1	9.8	0	1.0	0.0	24.1	9.8	0	0.6	0.2	0.5	0.2
82	7.6	0.3	285.5	17.7	7	5.6	0.3	285.5	17.7	7	1.1	0.0	24.1	9.8	0	0.9	0.0	24.1	9.8	0	0.5	0.2	0.4	0.2
83	10.0	0.4	285.5	17.7	7	9.1	0.4	285.5	17.7	7	1.3	0.1	24.1	9.8	0	1.2	0.0	24.1	9.8	0	0.7	0.2	0.6	0.2
84	9.2	0.4	285.5	17.7	7	8.2	0.3	285.5	17.7	7	1.2	0.0	24.1	9.8	0	1.1	0.0	24.1	9.8	0	0.6	0.2	0.5	0.2
85	9.1	0.3	285.5	17.7	7	8.2	0.3	285.5	17.7	7	1.2	0.0	24.1	9.8	0	1.1	0.0	24.1	9.8	0	0.6	0.2	0.5	0.2
86	7.1	0.5	285.6	17.7	8	5.7	0.4	285.5	17.7	8	1.0	0.1	24.1	9.8	0	0.7	0.1	24.1	9.8	0	0.6	0.3	0.5	0.2
87	15.4	0.9	285.7	17.8	7	8.6	0.6	285.6	17.8	8	2.1	0.1	24.1	9.8	0	1.4	0.1	24.1	9.8	0	1.1	0.4	0.8	0.3
88	3.7	0.2	285.4	17.7	7	3.5	0.2	285.4	17.7	7	0.4	0.0	24.1	9.7	0	0.4	0.0	24.1	9.7	0	0.3	0.1	0.2	0.1
89	9.7	0.5	285.6	17.8	8	8.2	0.4	285.5	17.7	8	1.0	0.1	24.1	9.8	0	0.9	0.1	24.1	9.8	0	0.6	0.3	0.5	0.2
90	4.3	0.3	285.5	17.7	7	3.2	0.3	285.5	17.7	7	0.6	0.0	24.1	9.8	0	0.5	0.0	24.1	9.7	0	0.4	0.2	0.4	0.2
91	8.7	0.3	285.4	17.7	7	8.1	0.3	285.4	17.7	7	1.1	0.0	24.1	9.7	0	1.0	0.0	24.1	9.7	0	0.3	0.1	0.3	0.1
92	6.0	0.2	285.4	17.7	7	6.1	0.2	285.4	17.7	7	0.8	0.0	24.1	9.7	0	0.8	0.0	24.1	9.7	0	0.2	0.1	0.2	0.1

Receptor	PM_{10}										$PM_{2.5}$										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
93	4.6	0.2	285.4	17.7	7	4.5	0.2	285.4	17.7	7	0.5	0.0	24.1	9.7	0	0.5	0.0	24.1	9.7	0	0.2	0.1	0.2	0.1
94	3.4	0.2	285.4	17.7	7	3.5	0.2	285.4	17.7	7	0.4	0.0	24.1	9.7	0	0.4	0.0	24.1	9.7	0	0.2	0.1	0.2	0.1
95	3.5	0.2	285.4	17.7	7	3.6	0.2	285.4	17.7	7	0.5	0.0	24.1	9.7	0	0.5	0.0	24.1	9.7	0	0.2	0.1	0.2	0.1
96	3.4	0.2	285.4	17.7	7	4.6	0.2	285.4	17.7	7	0.5	0.0	24.1	9.7	0	0.6	0.0	24.1	9.7	0	0.3	0.1	0.3	0.1
97	3.3	0.3	285.4	17.7	7	4.5	0.2	285.4	17.7	7	0.6	0.0	24.1	9.7	0	0.6	0.0	24.1	9.7	0	0.2	0.1	0.2	0.1
98	6.1	0.5	285.5	17.8	7	7.0	0.4	285.5	17.7	7	0.9	0.1	24.1	9.8	0	0.9	0.1	24.1	9.7	0	0.6	0.3	0.4	0.2
99	5.0	0.4	285.4	17.7	7	6.4	0.3	285.4	17.7	7	0.7	0.1	24.1	9.7	0	0.8	0.0	24.1	9.7	0	0.4	0.2	0.3	0.2
100	3.9	0.3	285.4	17.7	7	5.2	0.3	285.4	17.7	7	0.7	0.0	24.1	9.7	0	0.7	0.0	24.1	9.7	0	0.3	0.1	0.3	0.1
101	8.5	0.9	285.4	18.4	7	9.3	0.8	285.4	18.4	7	1.3	0.1	24.1	9.8	0	1.4	0.1	24.1	9.8	0	1.2	0.5	1.2	0.5
102	14.2	2.4	285.6	19.2	7	16.3	2.4	285.6	19.3	7	2.2	0.4	24.1	10.0	0	2.5	0.4	24.5	10.0	0	3.5	1.6	3.5	1.6
103	14.7	1.8	285.8	18.5	7	15.8	2.2	285.7	18.6	7	2.2	0.3	24.1	9.9	0	2.3	0.3	24.1	9.9	0	2.9	1.1	3.7	1.3
104	14.1	2.6	285.7	18.7	7	16.4	2.6	285.7	18.7	7	2.2	0.4	24.1	10.0	0	2.4	0.4	24.1	10.0	0	5.0	1.8	5.0	1.8

Receptor	PM10										PM2.5										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
105	23.9	1.9	285.8	19.2	7	24.9	2.6	285.9	19.4	7	3.5	0.3	24.1	10.0	0	3.7	0.4	24.1	10.1	0	2.1	1.2	3.5	1.5
106	18.6	1.3	285.7	18.7	7	18.7	1.9	285.8	18.8	7	2.8	0.2	24.1	9.9	0	2.8	0.3	24.1	9.9	0	1.6	0.9	2.6	1.1
107	11.5	0.9	285.5	18.4	7	11.7	1.1	285.7	18.5	7	1.7	0.1	24.1	9.9	0	1.7	0.2	24.1	9.9	0	1.2	0.6	1.3	0.7
108	10.8	0.8	285.6	18.3	7	12.3	1.0	285.7	18.4	7	1.6	0.1	24.1	9.8	0	1.8	0.1	24.1	9.9	0	1.1	0.5	1.2	0.6
109	10.7	0.6	285.5	18.3	7	15.5	1.1	285.6	18.7	7	1.6	0.1	24.1	9.8	0	2.2	0.1	24.1	9.8	0	0.8	0.4	1.3	0.7
110	11.4	1.0	285.5	18.0	7	13.4	1.5	285.6	18.0	7	1.5	0.1	24.2	9.8	0	1.8	0.2	24.2	9.8	0	0.6	0.4	1.0	0.7
111	3.0	0.2	285.4	17.7	7	4.2	0.3	285.4	17.8	7	0.3	0.0	24.1	9.7	0	0.5	0.0	24.2	9.7	0	0.2	0.1	0.3	0.1
112	4.4	0.2	285.4	17.8	7	6.3	0.3	285.4	17.9	7	0.5	0.0	24.1	9.7	0	0.7	0.0	24.1	9.7	0	0.3	0.1	0.3	0.2
113	4.8	0.3	285.4	17.8	7	6.3	0.3	285.4	17.9	7	0.6	0.0	24.1	9.7	0	0.7	0.0	24.1	9.8	0	0.2	0.1	0.3	0.2
114	8.5	0.4	285.4	18.0	7	9.5	0.5	285.5	18.2	7	1.3	0.1	24.1	9.8	0	1.4	0.1	24.1	9.8	0	0.7	0.3	0.8	0.4
115	7.7	0.4	285.4	18.0	7	7.6	0.5	285.5	18.1	7	1.1	0.1	24.1	9.8	0	1.1	0.1	24.1	9.8	0	0.6	0.3	0.7	0.3
116	9.1	0.5	285.4	18.1	7	8.9	0.6	285.5	18.2	7	1.3	0.1	24.1	9.8	0	1.3	0.1	24.1	9.8	0	0.8	0.3	0.8	0.4

Receptor	PM10										PM2.5										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
117	8.7	0.8	285.6	18.0	7	9.6	1.0	285.6	18.1	7	1.3	0.1	24.1	9.8	0	1.4	0.2	24.1	9.8	0	1.3	0.5	1.7	0.6
118	13.0	2.2	285.5	18.7	7	14.0	2.4	285.5	18.8	7	2.0	0.4	24.2	9.9	0	2.2	0.4	24.3	9.9	0	3.5	1.5	3.7	1.6
119	10.0	1.1	285.5	18.5	7	10.3	0.9	285.5	18.5	7	1.5	0.2	24.1	9.8	0	1.5	0.1	24.1	9.8	0	1.4	0.6	1.4	0.6
120	5.1	0.2	285.4	17.7	7	5.3	0.2	285.4	17.7	7	0.8	0.0	24.1	9.7	0	0.8	0.0	24.1	9.7	0	0.2	0.1	0.2	0.1
121	5.1	0.3	285.5	17.7	8	4.2	0.3	285.5	17.7	7	0.7	0.0	24.1	9.8	0	0.5	0.0	24.1	9.8	0	0.4	0.2	0.4	0.2
122	6.4	0.3	285.4	17.9	7	6.6	0.4	285.4	18.0	7	0.8	0.0	24.1	9.8	0	1.0	0.1	24.1	9.8	0	0.5	0.2	0.6	0.3
123	7.6	0.6	285.5	18.1	7	8.5	0.7	285.6	18.2	7	1.1	0.1	24.1	9.8	0	1.2	0.1	24.1	9.8	0	0.8	0.4	0.9	0.4
124	8.0	0.6	285.5	18.1	7	8.2	0.7	285.6	18.2	7	1.2	0.1	24.1	9.8	0	1.2	0.1	24.1	9.8	0	0.8	0.4	0.9	0.4
125	7.1	0.5	285.5	18.0	7	8.1	0.6	285.6	18.0	7	1.1	0.1	24.1	9.8	0	1.2	0.1	24.1	9.8	0	0.7	0.3	0.8	0.4
126	9.8	0.6	285.6	18.1	7	9.9	0.8	285.6	18.1	7	1.5	0.1	24.1	9.8	0	1.5	0.1	24.1	9.8	0	0.8	0.4	1.1	0.5
127	8.1	0.7	285.4	18.2	7	7.3	0.6	285.4	18.1	7	1.2	0.1	24.1	9.8	0	1.1	0.1	24.1	9.8	0	0.9	0.5	1.0	0.4
128	9.1	0.5	285.5	17.8	7	9.2	0.4	285.5	17.7	7	1.3	0.1	24.1	9.8	0	1.3	0.1	24.1	9.7	0	0.4	0.2	0.4	0.2

Receptor	PM10										PM2.5										Dust deposition			
	The Quarry					Proposed Extension					The Quarry					Proposed Extension					The Quarry		Proposed Extension	
	Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Cumulative			Isolation		Isolation	
	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest max 24-hour (µg/m³)	Highest annual average (µg/m³)	Highest no. exceedances 24-hr criteria	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)	Highest max monthly (g/m²/month)	Highest annual average max monthly (g/m²/month)
129	7.6	0.4	285.4	17.7	7	7.8	0.3	285.4	17.7	7	1.1	0.0	24.1	9.7	0	1.1	0.0	24.1	9.7	0	0.3	0.2	0.3	0.1
130	10.3	0.5	285.5	17.7	7	9.7	0.4	285.5	17.7	7	1.3	0.1	24.1	9.8	0	1.2	0.0	24.1	9.7	0	0.4	0.2	0.4	0.2
131	14.3	0.7	285.6	17.8	7	10.7	0.5	285.6	17.7	7	1.8	0.1	24.1	9.8	0	1.5	0.1	24.1	9.8	0	1.0	0.4	0.8	0.3
132	17.0	0.9	285.7	17.8	7	10.4	0.6	285.6	17.8	7	2.2	0.1	24.1	9.8	0	1.5	0.1	24.1	9.8	0	1.2	0.4	0.9	0.3
133	16.5	1.2	285.7	17.9	7	14.1	0.8	285.7	17.8	7	2.1	0.1	24.1	9.8	0	1.8	0.1	24.1	9.8	0	1.5	0.7	1.1	0.4
134	8.9	0.5	285.5	17.8	7	9.1	0.4	285.5	17.7	7	1.3	0.1	24.1	9.8	0	1.3	0.1	24.1	9.8	0	0.5	0.2	0.4	0.2
135	8.1	0.7	285.5	17.9	7	10.1	1.0	285.5	17.9	7	1.1	0.1	24.1	9.8	0	1.3	0.1	24.2	9.8	0	0.5	0.3	0.7	0.4

APPENDIX E RISK MANAGEMENT PLAN – AIR QUALITY HAZARDS

Table E 1 Mt Shamrock Quarry proposed Extension Risk Management Plan: Air Quality Hazards for operation phase

Risk event		Sensitive receptors [1]	Inherent risk assessment			Control measures and performance standards [2]	Residual risk assessment			Monitoring and ongoing management	
Aspect	Source	How hazard may harm or damage receptor, and evidence to support assessment [4]	Likelihood	Consequences	Risk rating		Likelihood	Consequences	Risk rating	Aspect to be monitored and managed	Details of monitoring and ongoing management, and details of risk treatment plan [3]
Movement of haul trucks on site	Generation of dust from use of unsealed roads	Lowered air quality due to increased presence of particulate matter [4]	ALMOST CERTAIN	MINOR	HIGH	Ensure vehicle maintenance, optimise scheduling and travel distances, reduce vehicle speed to 40km/hr maximum, during dry conditions use water tanker on internal roads, restrict vehicle movement to watered roads where possible, undertake street sweeping on internal sealed roads, train staff on measures to reduce dust generation.	UNLIKELY	MINOR	LOW	Emissions of dust and particles will comply with the EPA limits at the nearest sensitive receptors	Continuation of ambient PM_{10}, dust deposition and meteorological monitoring program in accordance with EMP
Movement of haul trucks on site	Combustion emissions from vehicles	Lowered air quality due to increased presence of combustion air pollutants [5]	POSSIBLE	MINOR	MEDIUM	Ensure vehicle maintenance, optimise scheduling and travel distances, minimising idling, use biodiesel where practicable.	UNLIKELY	MINOR	LOW	Emissions of combustion pollutants to air will comply with the EPA limits at the nearest sensitive receptors	Considered low risk, monitoring of combustion pollutants not required.
Movement of vehicles to and from site on sealed roads	Combustion emissions from vehicles	Lowered air quality due to increased presence of combustion air pollutants [5]	POSSIBLE	MINOR	MEDIUM	Ensure vehicle maintenance, optimise scheduling and travel distances, minimising idling, use biodiesel where practicable.	UNLIKELY	MINOR	LOW	Emissions of combustion pollutants to air will comply with the EPA limits at the nearest sensitive receptors	Considered low risk, monitoring of combustion pollutants not required.
Removal of material	Generation of air dust from removal, extraction	Lowered air quality due to increased presence of	ALMOST CERTAIN	MINOR	HIGH	Wet suppression and water sprays, minimisation of drop heights, water suppression is equipped to drill rigs	UNLIKELY	MINOR	LOW	Emissions of dust and particles will comply with the EPA limits at the	Continuation of ambient PM_{10}, dust deposition and meteorological

Risk event		Sensitive receptors [1]	Inherent risk assessment			Control measures and performance standards [2]	Residual risk assessment			Monitoring and ongoing management	
Aspect	Source	How hazard may harm or damage receptor, and evidence to support assessment [4]	Likelihood	Consequences	Risk rating		Likelihood	Consequences	Risk rating	Aspect to be monitored and managed	Details of monitoring and ongoing management, and details of risk treatment plan [3]
	and transfer of topsoil, overburden and basalt, including drilling and blasting	particulate matter [4]								nearest sensitive receptors	monitoring program in accordance with EMP
Processing of basalt	Generation of dust from crushing, screening and stockpiling of basalt (raw and product)	Lowered air quality due to increased presence of particulate matter [4]	ALMOST CERTAIN	MINOR	HIGH	Water sprays on conveyors, wet suppression, minimisation of drop heights, dust collectors, spray stockpiles with water cart or sprinklers	UNLIKELY	MINOR	LOW	Emissions of dust and particles will comply with the EPA limits at the nearest sensitive receptors	Continuation of ambient PM_{10}, dust deposition and meteorological monitoring program in accordance with EMP
Wind erosion	Generation of dust from wind erosion of stockpiles and exposed areas	Lowered air quality due to increased presence of particulate matter [4]	ALMOST CERTAIN	MINOR	HIGH	Wet suppression, rehabilitation (vegetation), minimise exposed areas where possible	UNLIKELY	MINOR	LOW	Emissions of dust and particles will comply with the EPA limits at the nearest sensitive receptors	Continuation of ambient PM_{10}, dust deposition and meteorological monitoring program in accordance with EMP

Table note:

[1] Sensitive receptors defined as neighbouring residences, for location and proximity to site refer to Section 5.3 of Katestone Air Quality Assessment report

[2] Performance standards for all risk events include: Environment Protection Act 2017, Environment Protection Regulations 2021, Environment Reference Standard and Guide to the Environment Reference Standard Publication 1992 June 2021, National Environment Protection (Ambient Air Quality) Measure 2021 (Air NEPM), The Mt Shamrock Quarry Environmental Management Plan (EMP)

[3] For detailed risk treatment plan, where relevant, refer to Quarry EMP

[4] Where relevant, air quality modelling completed by Katestone on proposed Expansion and provided as support

[5] Considered low risk, combustion emissions from vehicles/generators/etc. not assessed in air quality modelling.

Table E 2 Mt Shamrock Quarry proposed Extension Risk Management Plan: Air Quality Hazards for rehabilitation phase

Risk event		Sensitive receptors [1]	Inherent risk assessment			Control measures and performance standards [2]	Residual risk assessment			Monitoring and ongoing management	
Aspect	Source	How hazard may harm or damage receptor, and evidence to support assessment [4]	Likelihood	Consequences	Risk rating		Likelihood	Consequences	Risk rating	Aspect to be monitored and managed	Details of monitoring and ongoing management, and details of risk treatment plan [3]
Movement of haul trucks on site	Generation of dust from use of unsealed roads	Lowered air quality due to increased presence of particulate matter [6]	POSSIBLE	MINOR	MEDIUM	Ensure vehicle maintenance, optimise scheduling and travel distances, reduce vehicle speed to 40km/hr maximum, during dry conditions use water tanker on internal roads, restrict vehicle movement to watered roads where possible, undertake street sweeping on internal sealed roads, train staff on measures to reduce dust generation.	UNLIKELY	MINOR	LOW	Emissions of dust and particles will comply with the EPA limits at the nearest sensitive receptors	Continuation of ambient PM_{10}, dust deposition and meteorological monitoring program in accordance with EMP
Movement of haul trucks on site	Combustion emissions from vehicles	Lowered air quality due to increased presence of combustion air pollutants [5]	UNLIKELY	MINOR	LOW	Ensure vehicle maintenance, optimise scheduling and travel distances, minimising idling, use biodiesel where practicable.	RARE	MINOR	LOW	Emissions of combustion pollutants to air will comply with the EPA limits at the nearest sensitive receptors	Considered low risk, monitoring of combustion pollutants not required.
Movement of vehicles to and from site on sealed roads	Combustion emissions from vehicles	Lowered air quality due to increased presence of combustion air pollutants [5]	UNLIKELY	MINOR	LOW	Ensure vehicle maintenance, optimise scheduling and travel distances, minimising idling, use biodiesel where practicable.	RARE	MINOR	LOW	Emissions of combustion pollutants to air will comply with the EPA limits at the nearest sensitive receptors	Considered low risk, monitoring of combustion pollutants not required.
Transfer, deposit and	Generation of dust from transfer,	Lowered air quality due to increased	POSSIBLE	MINOR	MEDIUM	Wet suppression and water sprays, minimisation of drop	UNLIKELY	MINOR	LOW	Emissions of dust and particles will	Continuation of ambient PM_{10}, dust

Risk event		Sensitive receptors [1]	Inherent risk assessment			Control measures and performance standards [2]	Residual risk assessment			Monitoring and ongoing management	
Aspect	**Source**	**How hazard may harm or damage receptor, and evidence to support assessment [4]**	**Likelihood**	**Consequences**	**Risk rating**		**Likelihood**	**Consequences**	**Risk rating**	**Aspect to be monitored and managed**	**Details of monitoring and ongoing management, and details of risk treatment plan [3]**
spread material	deposit and spreading of overburden, soil and primary vegetation	presence of particulate matter [7]				heights, minimise handling during high winds				comply with the EPA limits at the nearest sensitive receptors	deposition and meteorological monitoring program in accordance with EMP
Wind erosion	Generation of dust from wind erosion of remaining stockpiles and exposed areas	Lowered air quality due to increased presence of particulate matter [8]	POSSIBLE	MINOR	MEDIUM	Wet suppression, rehabilitation (vegetation), minimise exposed areas where possible	UNLIKELY	MINOR	LOW	Emissions of dust and particles will comply with the EPA limits at the nearest sensitive receptors	Continuation of ambient PM_{10}, dust deposition and meteorological monitoring program in accordance with EMP

Table note:

[1] Sensitive receptors defined as neighbouring residences, for location and proximity to site refer to Section 5.3 of Katestone Air Quality Assessment report

[2] Performance standards for all risk events include: Environment Protection Act 2017, Environment Protection Regulations 2021, Environment Reference Standard and Guide to the Environment Reference Standard Publication 1992 June 2021, National Environment Protection (Ambient Air Quality) Measure 2021 (Air NEPM), The Mt Shamrock Quarry Environmental Management Plan (EMP)

[3] For detailed risk treatment plan, where relevant, refer to Quarry EMP

[4] Where relevant, air quality modelling completed by Katestone on proposed Expansion and provided as support

[5] Considered low risk, combustion emissions from vehicles/generators/etc. not assessed in air quality modelling.

[6] Air quality modelling for operational phase completed by Katestone. Onsite haul/vehicle movement and risk to receptors will be greatest during operational phase. Emissions and risk from onsite haul/vehicle movement lower for rehabilitation phase and modelling to assess risks not required.

[7] Air quality modelling for operational phase completed by Katestone. Material handling and risk to receptors will be greatest during operational phase. Emissions and risk to receptors from material handling lower for rehabilitation phase and modelling to assess risks not required.

[8] Air quality modelling for operational phase completed by Katestone. Wind erosion areas (exposed and stockpiles) and risk to receptors will be greatest during operational phase. Emissions and risk to receptors from wind erosion lower for rehabilitation phase and modelling to assess risks not required.