Shenstone Park PSP

Separation Distances for Dust and Odour

28 October 2020

Project No.: 0568335

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ERM

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28 October 2020

Shenstone Park PSP

Separation Distances for Dust and Odour

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1. PLANNING PANELS VICTORIA STATEMENT

Dr. Iain Cowan of Environmental Resources Management Australia Pty Ltd (ERM) was instructed by Ponte – Business Lawyers for Business (Ponte), acting on behalf of Barro Group Pty Ltd (Barro), to prepare and present expert witness testimony to Planning Panels Victoria in relation to impact to appropriate separation distances for the Woody Hill and Phillips Quarries as well as the proposed Wollert Sewage Treatment Works in relation to the proposed Shenstone Park PSP.

This statement is focussed on impacts related to the particulate matter impacts from the quarries, but also considers the potential for odour impact from the proposed Wollert Sewage Treatment Plant which was included in the original PSP but is now nominally located to the south of the PSP. The assessment of particulate matter impact is based on atmospheric dispersion modelling to assess the air quality impact to the surrounding land use as a result of the continuing quarry operations combined with worst case meteorological conditions to define an appropriate separation distance.

1.1 Name and Address

Dr. Iain Cowan
c/- Environmental Resources Management
Level 6, 99 King Street
MELBOURNE VICTORIA, 3000

1.2 Qualifications, Experience and Areas of Expertise

Details of my qualifications, experience and areas of expertise are detailed in my curriculum vitae which may be found in Appendix C.

1.3 Expertise in Preparing This Report

I have undertaken numerous studies over a period of twenty years in the field of atmospheric dispersion modelling. This has incorporated projects in relation to particulate matter emissions from mines, quarries, port facilities, earth movement, grain storage and construction sites. In relation to odour, I have completed numerous studies on facilities including waste water treatment plants, landfills, compost facilities, broiler farms, sales yards and cow / goat dairies.

1.4 Relationship Between The Expert Witness And The Party For Who The Report is Prepared

I am employed by Environmental Resources Management Australia Pty Ltd (ERM), who has a commercial relationship for the provision of this expert witness statement with Barro Group Pty Ltd. This statement has been prepared independently of Barro Group Pty Ltd, and forms my opinion of the required separation distance to prevent impact to sensitive land uses within the Shenstone Park PSP.

1.5 Instructions That Define The Report

In preparing this statement, instructions were received to consider:

> "*the appropriateness of the dust and odour buffers (see Plan 15 – Buffers of the PSP) for the Woody Hill and Phillips Quarries*".

Reference was made within the instructions to two GHD reports dated December 2017 and September 2019 on which the odour and dust separation distances contained in the PSP are based.

1.6 Facts, Matters and All Assumptions On Which The Report Proceeds

The facts and assumptions on which this report proceeds are outlined through the document.

1.7 Referenced Documents

A list of documents referenced in this expert witness report may be found in *Section* 8 of this statement.

1.8 Identity and Qualifications of The Person Who Carried Out Any Tests Or Experiments Upon Which The Expert Relied In Making The Report

Tests to determine the concentration of respirable crystalline silica (RCS) in respirable dust were completed on behalf of Barro Group during crushing of the mudstone. Provision of the results has been provided to the author of this report verbally and no verification of the methodology or validity of the results has been undertaken and have been used as provided.

1.9 Statement

This expert witness statement has considered:

- Site visits to Woody Hill Quarry and Wyndhamvale Quarry to understand the existing operations and the planned future expansion for the Phillips Quarry;
- Work completed by GHD to define the appropriate separation distance;
- Standard separation distances applied in accordance with EPA Publication 1518;
- An environmental risk assessment to determine whether the impact to the surrounding land use requires a different separation distance compared to the standard approach taking consideration the likely changes to ambient air quality standards.

1.9.1 Site Visit

The site visits were used to understand both current activities at the Woody Hill Quarry and the enclosed crushing plant which is proposed for the Phillips Quarry.

1.9.2 GHD Assessments

In reviewing the assessments completed by GHD, it was identified that the assessment was not completed in accordance with the relevant guidance:

- The trigger for undertaking a variation of the standard separation distance was misinterpreted meaning that the incorrect approach was used to define an alternative separation distance;
- Atmospheric dispersion modelling used meteorological data from 17 km away from the site, when EPA Publication 1550 states that meteorological data must be recorded within 5 km of the site or prognostic modelling used;
- Atmospheric dispersion modelling used a meteorological file which assumed that the surrounding land use was scrub land. Under the PSP, the land will be developed so will have different characteristics to those used;
- The extent of the area modelled was 5 km X 5 km, however EPA Publication 1551 states in flat terrain this area should be 10 km X 10 km (it is acknowledged however that the major impacts will be defined within the area modelled);
- The percentile selected to define a meteorology impacted separation distance is inappropriate as the averaging period for particulate matter is 24 hours when the SEPP(AQM) states that the 100th percentile must be used not a 3-minute average which is used for odour when the 99.9th percentile should be used. Use of the 99.5th percentile in any circumstance has no basis in legislation or guidance;
- The assessment has not considered RCS which is present in the mudstone and for which Woody Hill Quarry has a specific health and safety policy when quarrying and crushing is in operation. (It

is acknowledged however, that consideration of this aspect is not a material consideration to the required separation distance);

- The assessment has assumed that roads only receive level 1 watering, when level 2 watering is adopted on site making the results ultra conservative;
- The assessment assumed throughput of 200 tonnes per hour, the site instructed that the maximum capacity of the plant is 3000 tonnes per day which is a throughput 25% greater than modelled;
- Modelling assumed a site wide emission rate of 0.2 kg/ha/hour. The approach assumes that there is wind blown emissions for every hour of the year and that this emission rate is constant. In reality, for the majority of the time the wind speed is not sufficient to generate wind blown emissions and the level of dust generation increases with wind speed. The impact will therefore be underestimated on high wind event days and over estimated during calm conditions; and
- In the September 2019 assessment, GHD assumed that the crushing plant would be moved twice with the expansion of the Woody Hill Quarry, however this is not the intended plan of operation.

1.9.3 Standard Separation Distances

Operations at the Woody Hill Quarry and proposed Phillips Quarry will change over time consequently, the required separation distances will change over time. The standard separation distances have been selected in accordance with Clause 53.10 of the Victoria Planning Provisions and EPA Publication 1518. The separation distances have been applied in accordance with the urban method as described in EPA Publication 1518. The standard separation distances for each stage of the use of the Quarries is shown in Figure 1-1.

The separation distance for the proposed Wollert Sewage Treatment plant adopted in the GHD study is considered to be the appropriate separation distance at this time, as there is not additional detail available on which to base a revision of that separation distance.

1.9.4 Revised Separation Distances

EPA Publication 1518 provides 6 potential criteria for the variation of separation distances from the defaults. It is considered that the criteria which apply to the alteration of the separation distance are:

- Environmental risk assessment – An environmental risk assessment of IRAEs has been completed that demonstrates a variation is justified; and
- Likelihood of industrial residual air emissions (IRAEs) – Particular IRAEs are either highly likely or highly unlikely to occur.

Atmospheric dispersion modelling was therefore completed for the various stages of the use of the Woody Hill Quarry, the Woody Hill Quarry Expansion and the Phillips Quarry. The 70^{th} percentile for 24 hour and the annual mean background concentrations have been added to the predicted quarry contribution.

These predicted concentrations have been compared to:

- Current air quality standards for quarry operations contained in the Protocol for Environmental Management for the Mining and Extractive Industry; and
- Proposed future air quality standards expressed by EPA in the draft Exposure ERS which are expected to be applied upon commencement of the Environment Protection Amendment Act, 2018 expected to occur on or before June 2021.

It is recommended that separation distances are set on the basis of the future air quality standards, as there is minimal additional mitigation that the quarries can apply once the crushing plant has been enclosed. It is these standards against which Barro will need to comply in the future to meet their General Environmental Duty under the new Act. Use of a separation distance which allows more sensitive use in a predicted area of impact between the current and future air quality standards risks the operational ability of the quarries.

Figure 1-2 shows the recommended separation distances that will be required over the changing quarry operations.

It is considered that the area set aside within the PSP for:

- Industrial use to the north and east of the Woody Hill Quarry;
- Utility facility to the west of the Woody Hill Quarry;
- BSC conservation area to the north of the Phillips Quarry; and
- Postponing future residential use to the east of the Woody Hill Quarry and the immediate north of the BSC conservation area until such time as the extraction in the Woody Hill and Phillips Quarries, as the case may be, is occurring 500 m from that residential land.

is sufficient to prevent impact to sensitive land use and to contain the buffers required for the continued operation of the quarries.

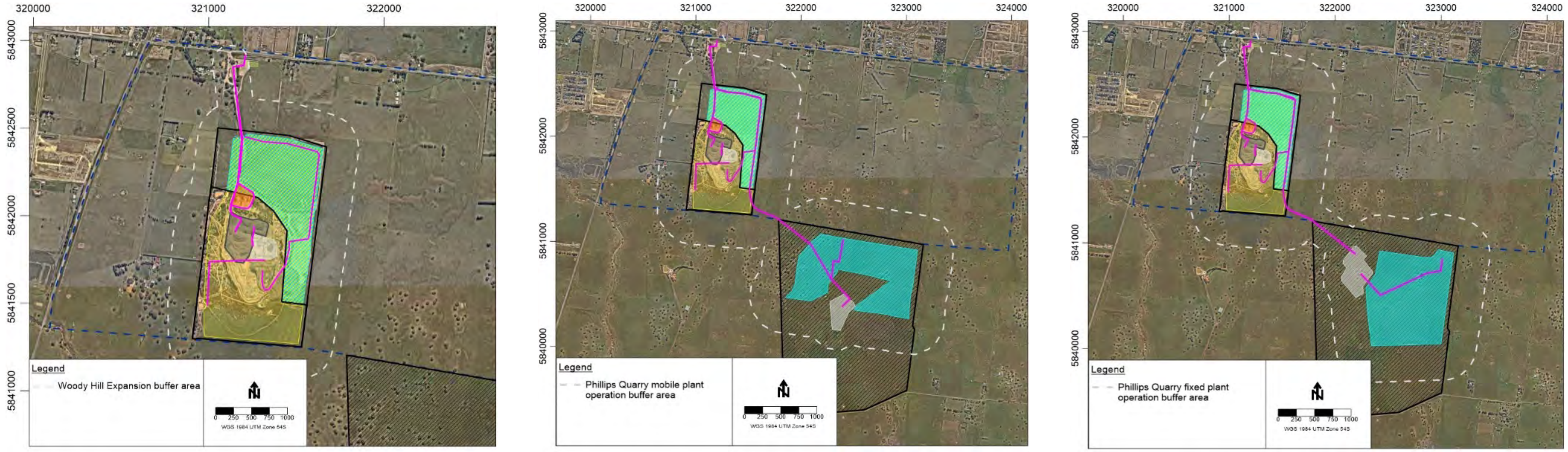
During extraction of the northern expansion at the very northern extent, there is potential for impact beyond Donnybrook Road, however this impact can be mitigated through:

- Ensuring blasting does not occur when the wind is from the southerly direction; and
- Placing reactive monitoring along the northern extent to determine when elevated concentrations as a result of operations are occurring and moving operations to other locations within the pit when trigger levels are exceeded.

Such management measures can be contained within an environment management plan which are typically required as part of the work authority application or the planning permit to demonstrate that impacts to the surrounding land use can be controlled to acceptable standards.

It must be considered that the recommended separation distances for this study are for residual atmospheric emissions only and greater separation distances may be required for other environmental impacts.

Within the GHD assessments and the exhibited PSP dated September 2019 a separation distance for the proposed sewage treatment plant was calculated in accordance with EPA Publication 1519. It is noted that in the more recent ‘track changes panel version’ of the PSP dated 12 October 2020, the separation distance for the sewage treatment plant has been removed and a nominal location for its position provided. The approach that GHD used to calculate the required separation distance was in accordance with EPA Publication 1518 and, at this stage, it is considered that there is no justification, as outlined in EPA Publication 1518, for adjusting that separation distance at this stage due to the lack of information about the planned infrastructure. The changes in the PSP, as noted on the version dated 12 October 2020, indicate at this time, it may not be clear where the sewage treatment plant will be located, however when the location is finalised it will need to be in a location that does not impact the PSP and assessments can be undertaken at that time.

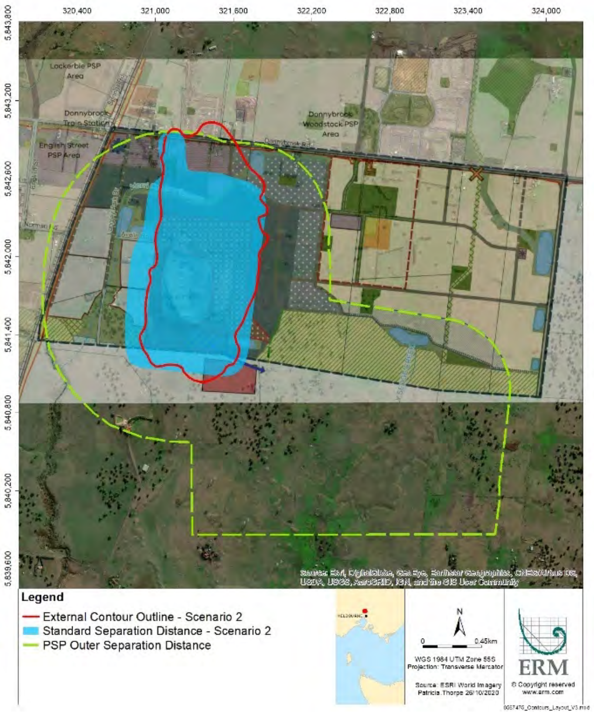


Current Operations with Woody Hill Expansion

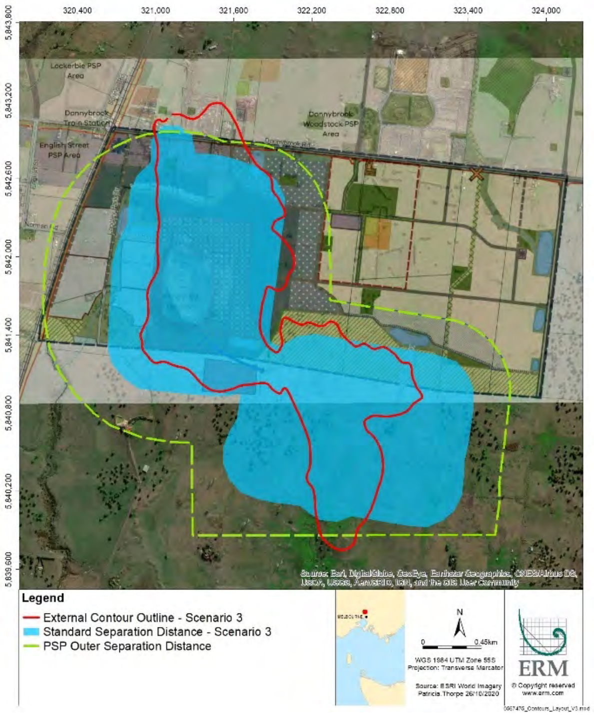
Phillips Quarry Expansion with Mobile Crushing Plant

Phillips Quarry Expansion with Enclosed Crushing Plant

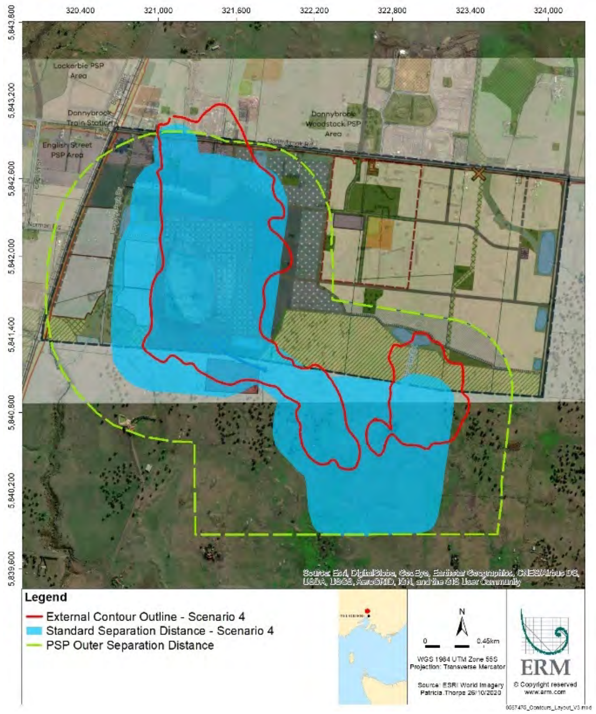
Figure 1-1 Standard Separation Distances for Various Stages of the Woody Hill and Phillips Quarry Operational Life



Current Operations with Woody Hill Expansion



Phillips Quarry Expansion with Mobile Crushing Plant



Phillips Quarry Expansion with Enclosed Crushing Plant

Figure 1-2 Proposed Adjusted Separation Distances for Various Stages of the Woody Hill and Phillips Quarry Operational Life

1.10 Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

Dr Iain Cowan

2. INTRODUCTION

Dr Iain Cowan of Environmental Resources Management Australia Pty Ltd (ERM) was engaged by Barro Group (Barro) to review the proposed separation distances, within the Shenstone Precinct Structure Plan (PSP), for the Woody Hill proposed Phillips Quarries. The intent of the study is to determine whether the proposed separation distances for air emissions within the assessments completed by GHD for the Victorian Planning Authority (VPA) are appropriate to prevent impact to the surrounding land use.

The scope of work for this assessment was as follows:

- Undertake a site visit to the Woody Hill Quarry;
- Undertake a site visit to Barro's Wyndhamvale Quarry on which the processing plant for the Phillips Quarry will be based;
- Consider whether there is cause for the default separation distances within EPA Publication 1518 to be altered in accordance with the reasons outlined within the EPA Guidance;
- Review the GHD assessments to determine if the approach used was appropriate for the current and future operations;
- Undertake an Environmental Risk Assessment (ERA) to determine for the current and proposed operations whether an alternative separation distance is required compared to that determined by GHD;
- Consider the separation distance for the proposed sewage treatment plant buffer and whether additional mitigation could be used to minimise this emission.

This expert witness statement considers the required separation distances for dust and odour in accordance with EPA Publication 1518. Larger separation distances to sensitive uses, than considered in this statement, may be required for other environmental impacts such as noise. The greatest extent of the separation distances from all environmental studies should be selected in determining an appropriate separation distance to allow the continued operation of the quarries, the operation of a waste water treatment plant alongside a developing area. Such additional considerations outside of particulate matter from the quarries and odour from the waste water treatment plant are beyond the area of expertise of this assessment.

2.1 Site Visits

A site visit to the Wyndhamvale Quarry and the Woody Hill Quarry were completed on 14 and 15 September 2020. A site tour of each facility was undertaken to understand the site operations, processes and mitigation approaches used at each site.

3. LEGISLATION

3.1 Separation distance requirements

In relation to the Shenstone precinct, the following documents establish separation distance requirements for industrial residual air emissions:

- Clause 53.10 'Uses with Adverse Amenity Potential' of the Victorian Planning Scheme; and
- EPA Publication 1518 'Recommended separation distances for industrial residual air emissions'.

These two documents were reviewed to establish the required separation distances.

3.1.1 Clause 53.10

Clause 53.10 does not provide any separation distances for sand or Basalt quarries, the only applicable separation distance requirement is:

- Concrete batching plant producing more than 5,000 tonnes per year – 300 metres.

A concrete batching plant is located within the current Woody Hill site which produces greater than this threshold.

3.1.2 EPA Publication 1518

EPA Publication 1518 recommends the following separation distances in relation to quarries:

- Without blasting – 250 metres;
- With blasting – 500 metres; and
- With respirable crystalline silica (RCS) – 500 metres.

These separation distances are related to quarrying, crushing, screening, stockpiling and conveying of rock.

It is considered that with respect to the Woody Hill and proposed Phillips Quarries, the 500 metres separation distance applies as:

- The Woody Hill mudstone resource contains RCS; and
- Blasting takes place both currently at the Woody Hill Quarry and the proposed Phillips Quarry.

For concrete plants (production of concrete) for plants producing more than 5000 tonnes per year, EPA publication 1518 requires a separation distance of 100 m, this is less than required under Clause 53.10 of the Victorian Planning Scheme and as such the requirement of Clause 53.10 has been considered further in this assessment.

Figure 3-1 shows the standard separation distances for the existing and proposed operations as applied within the PSP dated 12 October 2020.

A discussion on the application of these separation distances is included in Sections 6.2 and 7.1.

3.1.2.1 Variation of Default Separation Distances

EPA Publication 1518 states:

> *"In some instances, the appropriate separation distance may vary from that recommended in this guideline as a result of site-specific operational or environmental conditions. In such cases, a detailed assessment and a resultant proposal that satisfies EPA will be required before a variation can be given planning approval"* (EPA Victoria, 2013).

Agent of Change

Section 9.1 of EPA Publication 1518 states that it is the responsibility of the agent of change to undertake an assessment to determine whether a variation in the default separation distance should apply (EPA Victoria, 2013). In the case of the Shenstone Precinct Structure Plan, an assessment has been completed by the Victorian Planning Authority.

The adjusted separation distances within the Shenstone Precinct Structure Plan are shown in Figure 3-1.

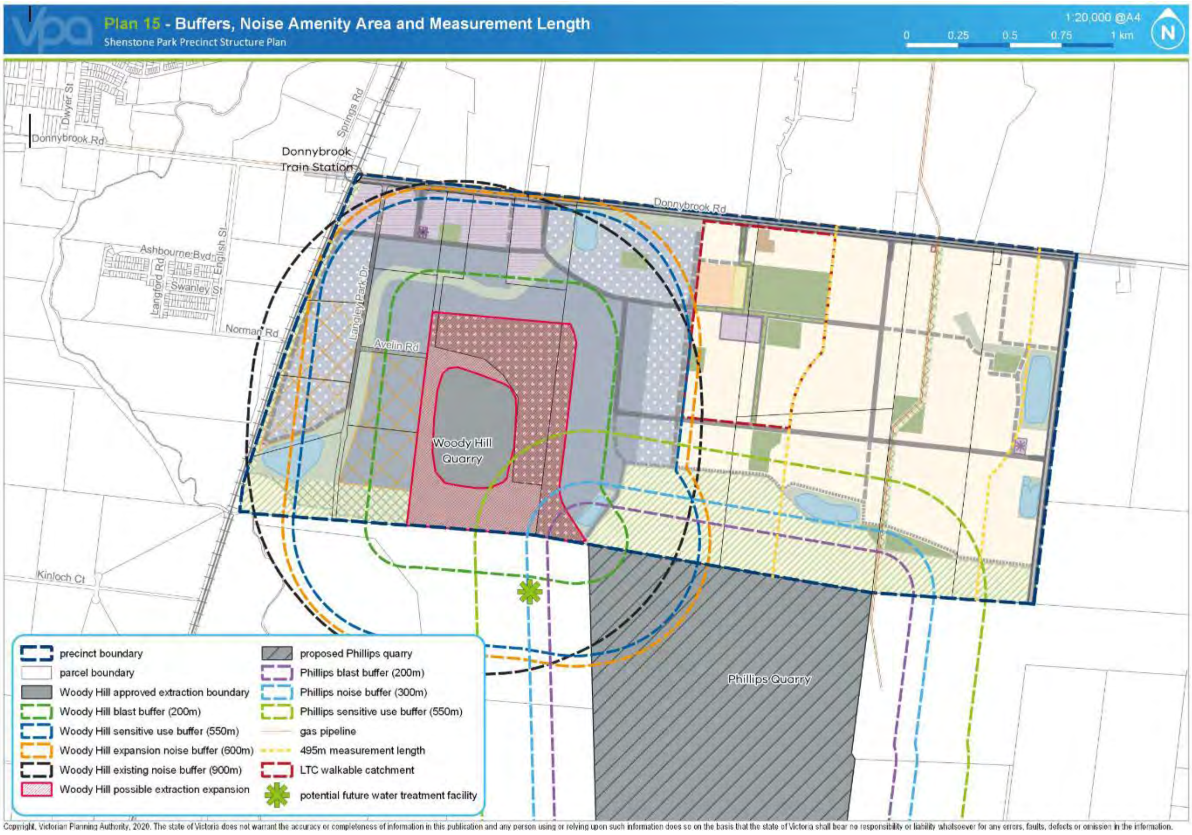


Figure 3-1 Separation Distances within the Shenstone Precinct Structure Plan (Victorian Planning Authority, 2020)

As outlined in Section 5 of this assessment however, there are concerns with the approach adopted by the Victorian Planning Authority consultants in defining the appropriate separation distances in relation to dust impact, due to their understanding of potential future activities and a more robust approach in accordance with the requirements of EPA Publication 1518 is required.

Considerations for Site Specific Variation

Section 9.2 of EPA Publication 1518 provides the following criteria for a site specific variation:

- Transitioning of industry – Existing industry has formally indicated that it will transition out of an area and over a specified timeframe.
- Plant equipment and operation – The industrial plant and equipment have an exceptionally high standard of emission control technology.
- Environmental risk assessment – An environmental risk assessment of IRAEs has been completed that demonstrates a variation is justified.
- Size of the plant – The plant is significantly smaller or larger than comparable industries.

- Topography or meteorology – There are exceptional topographic or meteorological characteristics which will affect dispersion of IRAEs.
- Likelihood of IRAEs – Particular IRAEs are either highly likely or highly unlikely to occur.

Each of these considerations are evaluated in the following sections.

Transitioning of Industry

There is no intention of the Woody Hill and Phillips Quarries ceasing operation in the short to medium term. It is expected that the lifetimes of the resources will be as follows:

- Existing Woody Hill Quarry with southern expansion – more than 30 years;
- Woody Hill Quarry northern expansion – more than 25 years;
- Phillips Quarry – more than 50 years.

Plant Equipment and Operation

Currently, the Woody Hill Quarry undertakes the following operations as shown in Figure 3-3:

- Importation of Basalt;
- Movement of Basalt from the drop off area to the primary crusher;
- Crushing of the Basalt through a primary, secondary and tertiary crusher;
- Stockpiling of crushed Basalt;
- Outloading to truck of sold crushed Basalt;
- Blasting of mudstone every two weeks;
- Movement of blasted mudstone to the crusher for a period every two weeks;
- Crushing of the mudstone through a primary, secondary and tertiary crusher;
- Stockpiling of crushed mudstone;
- Outloading to truck of sold crushed mudstone;
- Importation of sand, aggregates and cement to the cement batching plant;
- Outloading to agitator trucks of the batched concrete;
- Movement of trucks on unsealed haul roads.

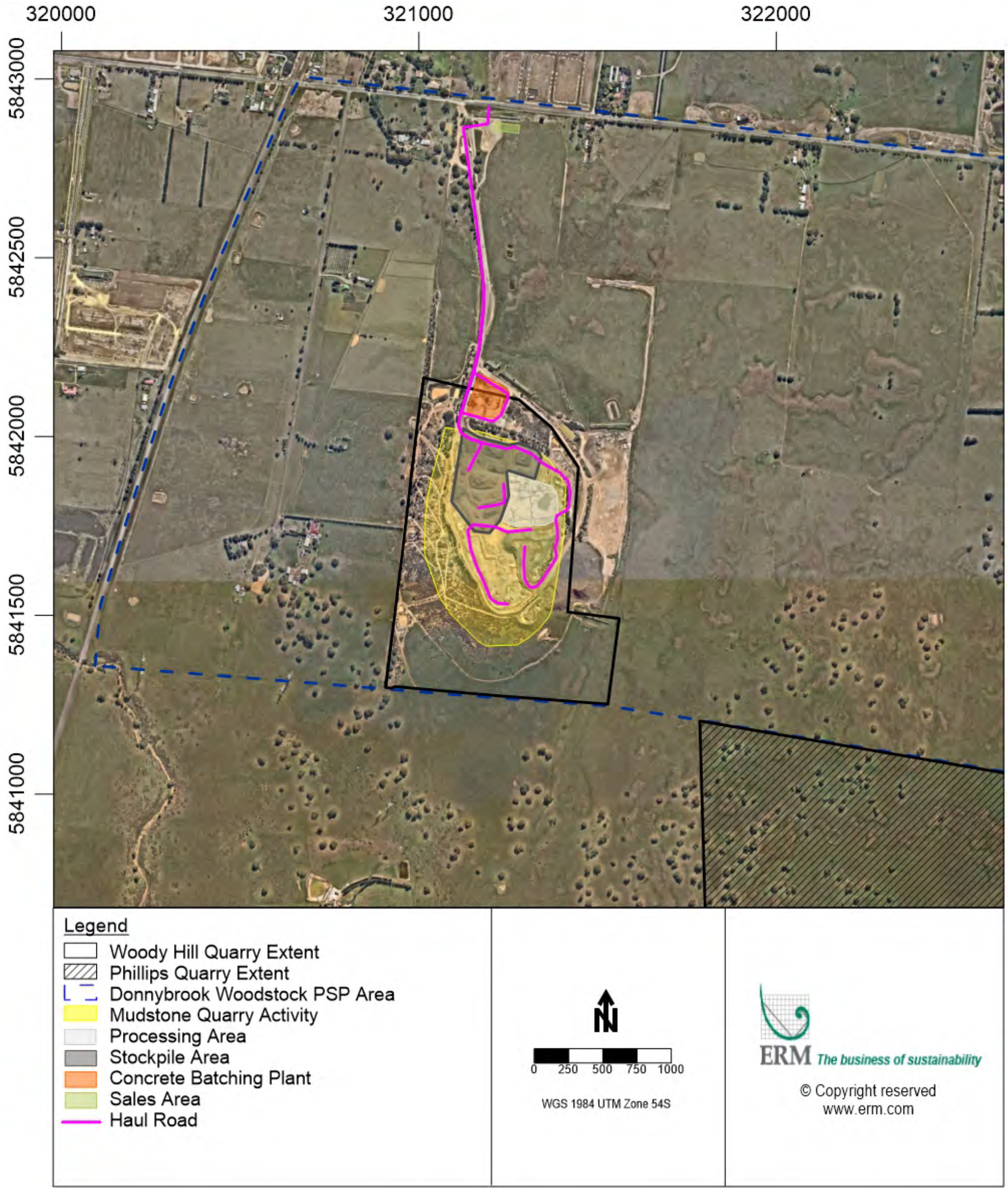


Figure 3-2 Current Site Operation

Under WA 6437, the Woody Hill Quarry will expand to extract resource from an area to the north and east of the existing operations. The resource within this location is mudstone overlain by basalt. Consequently, initially, the extraction will be of basalt and later in the life of WA 6437 mudstone will be expanded. Operations in this expanded area will include blasting of resource, loading the truck and hauling to the Woody Hill processing plant (Figure 3-3). At this time, the amount of imported stone will be reduced from current levels, however all other operations listed above will continue.

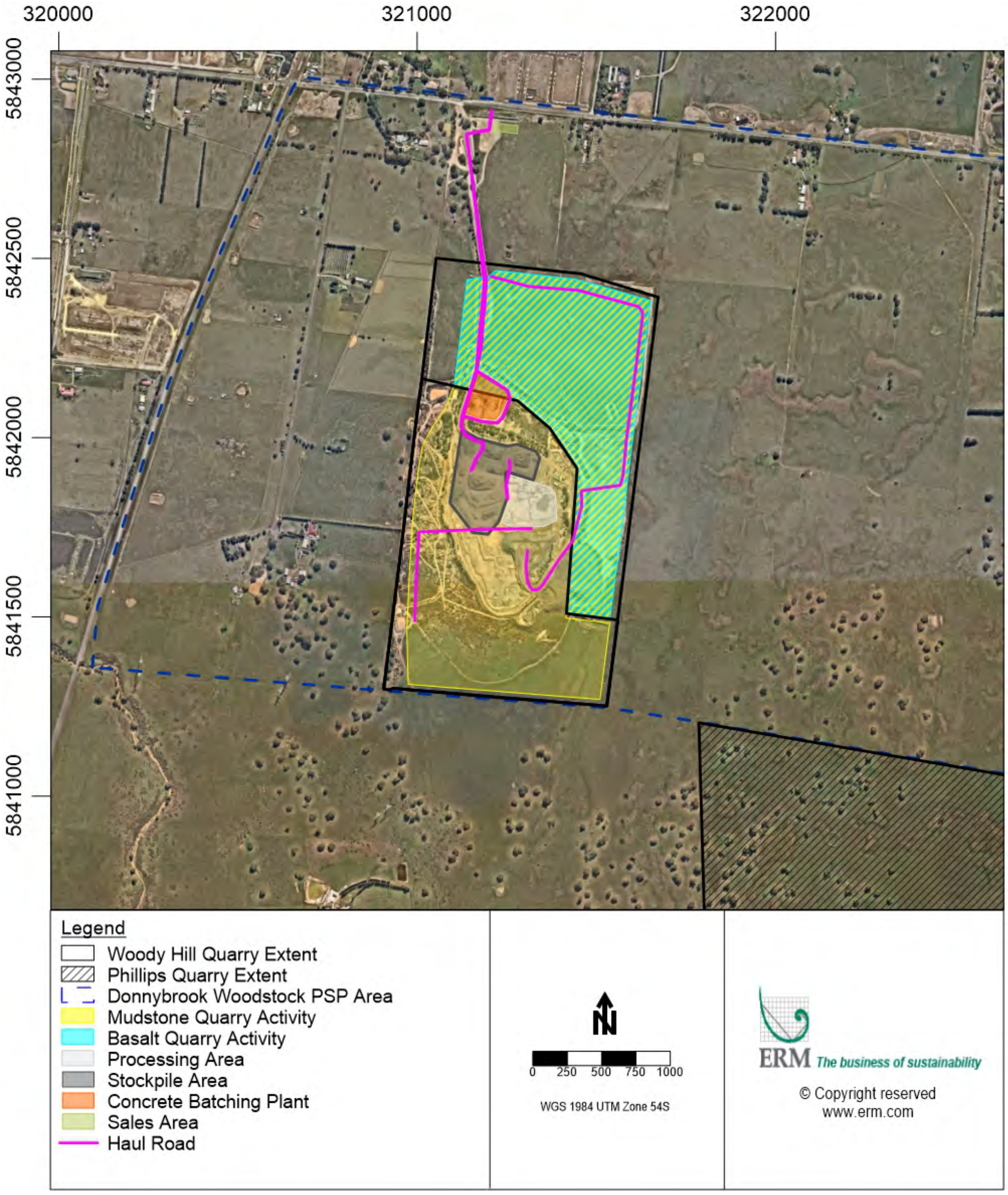


Figure 3-3 Woody Hill Expansion Operation (WA492 and WA6437)

The planned Phillips Quarry (WA 6852) is a new basalt quarry located to the southeast of the Woody Hill Quarry. Basalt will be extracted from the new Phillips Quarry through blasting. Initially, a mobile crushing plant will be located adjacent to the new pit (Figure 3-4).

Basalt from the Phillips Quarry will be crushed at the mobile processing plant during stage 1 of the development. This enables the area which will eventually be the location of the permanent processing plant to be extracted prior to the construction of the permanent plant. Processed material from the plant will then use the connecting haul road network to the haul road to the east of the Woody Hill northern extension (WA 6437) to exit the site.

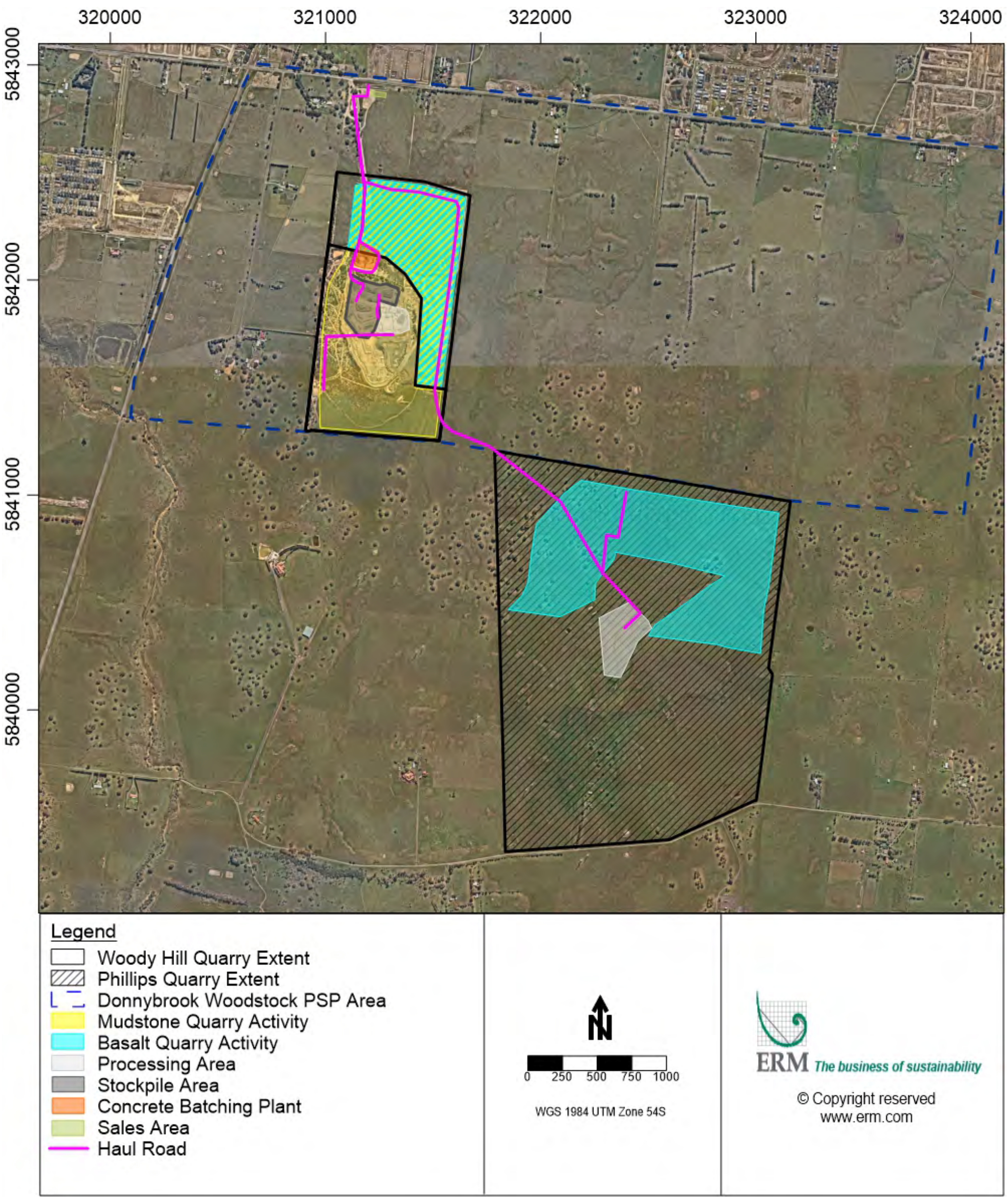


Figure 3-4 Phillips Quarry Mobile Crushing Plant Operation

As the Phillips Quarry progresses, a new crushing plant will be installed. This new plant will have an improved level of mitigation over the existing and mobile crushing plant. It will be located within a building and will have a baghouse on the air vent outlet to prevent emissions to the surrounding land use. It is understood that the baghouse will have inbuilt redundancy such that if one bag were to split, there would not be significant release to the environment. The conveyors used at the new crushing plant would be semi-enclosed which is an improvement in mitigation levels compared to current and mobile plant operations which both have open conveying systems (Figure 3-5).

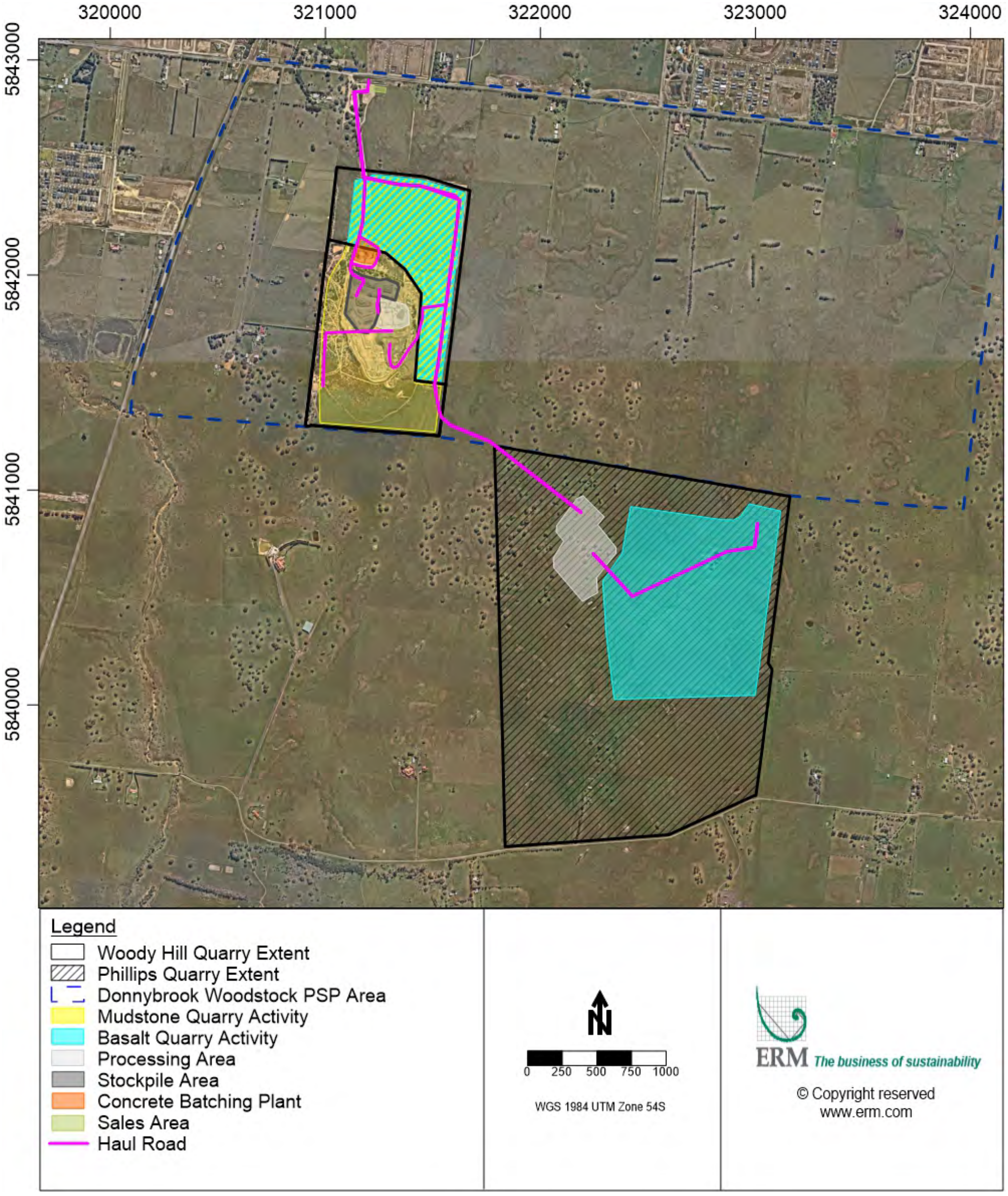


Figure 3-5 Phillips Quarry Fixed Crushing Plant Operation

EPA Publication 1518 states that separation distances may be reduced where industrial plant and equipment have an exceptionally high standard of emission control technology. Consequently, it is feasible that the separation distance may be able to be reduced once the fixed crushing plant operation is in place as:

- The location of operations will change; and
- The level of mitigation on crushing operations will be increased resulting in lower emissions from crushing operations.

Any reduction in separation distance will only be related to the Phillips Quarry and only for the separation distance around the crushing plant, thus any reduction in separation distance will be minimal, and may only be important once extraction in the Phillips Quarry moves further towards the south.

Environmental Risk Assessment

The use of an environmental risk assessment through atmospheric dispersion modelling to demonstrate that the separation distance can be varied forms the substantive part of this report.

Size of the Plant

The size of the quarrying operations at the Woody Hill Quarry, the planned expansion and Phillips Quarry operations are considered to be of similar size to quarry operations throughout Victoria. A variation in the separation distance on the basis of the quarries being smaller in size than other facilities in Victoria is considered not to be valid in this instance.

Topography and Meteorology

The topography in the surrounding region is fairly flat and there is therefore no significant topography that would warrant adjustment of the separation distances.

Meteorological modelling has been completed to derive a five year meteorological dataset for this site using the WRF model (see Section 6.4.1). Wind roses are a graphical representation of the wind speed and direction at a location. The typical wind conditions presented in Section 4.2 show a spread of wind directions and wind speeds that are characteristic for Victoria, with a fairly consistent spread of northerly round to south-easterly winds though the western direction with a very infrequent occurrence of easterly winds. It is considered that these are not unusual wind conditions for the Melbourne area and as such, the alteration of separation distances as a result of unusual meteorological conditions is not warranted.

Likelihood of Industrial Residual Air Emissions IRAEs

In quarrying, there is potential for dust emissions from the quarrying operations and haul roads even after mitigation has been applied to a best practice level. Consequently, there is a likelihood of industrial residual air emissions from the operations, meaning that the default separation distances cannot be reduced for this reason in this instance.

3.2 Current Legislation

As discussed in EPA Publication 1518, it is the intent of Separation Distances to prevent impact to the surrounding land use as a result of upset conditions due to either process upsets or unusual meteorological conditions. In practice, separation distances are also used for industry where despite best practice being applied to emission sources industrial residual emissions continue to occur.

To determine the appropriate Separation Distance, the potential for impact of particulate matter to the surrounding land use must be assessed through the application of the appropriate assessment criteria. This section provides an overview of the current legislation in relation to acceptable particulate concentrations as a result of extractive industry operations.

The *Environment Protection Act, 1970* (the Act) provides the main legislative instrument for the protection of the environment within the State of Victoria. The Act provides for the development of *Regulations and State Environment Protection Policies* (SEPPs) that specify the requirements for compliance under the Act.

With respect to ambient air quality, there are two SEPPs that must be considered:

- SEPP for Ambient Air Quality (AAQ); and
- SEPP for Air Quality Management (AQM).

The SEPP(AAQ) provides the regional air quality objectives, whilst the SEPP(AQM) establishes a framework for managing emissions from industry and sets out a program for action to protect the air environment in order to achieve the goals of the SEPP(AAQ). In terms of assessing impact to local air quality from industrial operations, the SEPP(AQM) is therefore the prevalent SEPP.

Under the SEPP(AQM) atmospheric emissions need to be managed to ensure that residual ground level concentrations are at acceptable concentrations. Emissions with direct health impacts need to be controlled either to best practice or to the maximum extent achievable and comply with ground level design criteria in off-site locations, and at all times.

3.2.1 SEPP(AAQ)

The purpose of the SEPP(AAQ) is to adopt the requirements of the National Environment Protection Council (Ambient Air Quality) Measure and incorporate components of the State environment protection policy (The Air Environment) to include all ambient air quality objectives relevant to Victoria. The SEPP(AAQ) contains Environmental Quality Objectives for Environmental Indicators, which were developed to demonstrate compliance of the populations greater than 25,000 people with the National Environment Protection Council (Ambient Air Quality) Measure. As these objectives are not industry-specific criteria, these are not considered relevant to this assessment.

3.2.2 SEPP(AQM)

The Policy aims of the SEPP(AQM) are:

- to ensure that the environmental air quality objectives of the SEPP(AAQ) are met;
- to drive continuous improvement in air quality and achieve the cleanest air possible having regard to the social and economic development of Victoria; and
- to support Victorian and national measures to address the enhanced greenhouse effect and depletion of the ozone layer.

The stated policy intent of the SEPP(AQM) is the management of "*Emissions to the air environment…so that the beneficial uses of the air environment are protected*". The SEPP(AQM) defines the beneficial uses as including protection of the life, health and well-being of humans, protection of local amenity and aesthetic enjoyment (Environment Protection Authority of Victoria, 2001).

In defining acceptable criteria for modelling assessment purposes the protection of local amenity and aesthetic enjoyment, the SEPP(AQM) defines design criteria for a variety of chemical compounds and particulate matter that are regularly emitted from industry. In relation to the operations at the Site, the SEPP(AQM) specifies design criteria in relation to:

- TSP (nuisance dust of particles less than 50 µm in aerodynamic diameter);
- Particles as PM_{10} (particles less than 10 µm in aerodynamic diameter); and
- Particles as $PM_{2.5}$ (particles less than 2.5 µm in aerodynamic diameter).

Total Suspended Particulate (TSP) is the total size fraction of particulate matter that, once released into the atmosphere, may stay suspended for a period of time without falling immediately to the ground. PM_{10} and $PM_{2.5}$ are fractions of TSP where the particulate matter particles are less than 10 µm and 2.5 µm in aerodynamic diameter respectively. Particles less than 10 µm in aerodynamic diameter (PM_{10} and $PM_{2.5}$) are able to enter the human respiratory system and therefore have the potential to result in health effects, whilst particles greater than 10 µm in aerodynamic diameter cannot enter the human respiratory system.

The design criteria for TSP, PM_{10} and $PM_{2.5}$ contained within the SEPP(AQM) are noted to apply to '*point sources*' only. 'Point sources' is a modelling term which refers to stacks or chimneys from industrial sources. The notes under the design criteria state that for non-point sources, reference should be made to the relevant industry PEM (Protocol for Environmental Management). The only PEM in existence that considers fugitive emissions of dust is the PEM for Mining and Extractive Industries (Mining PEM). The Mining PEM was considered as the relevant industry PEM and adopted for this assessment (Environment Protection Authority Victoria, 2007).

3.2.2.1 PEM for Mining and Extractive Industries

The Mining PEM is an incorporated document to the SEPP(AQM), which means that the requirements within the Mining PEM become requirements under the SEPP(AQM) and thus under the Act.

The Mining PEM states that (Environment Protection Authority Victoria, 2007):

> "Identification of all indicators of concern and assessment of these indicators must be conducted. In doing this assessment all sources need to be considered including emissions from haul roads, crushers, generators, processing operations (including leaching), mining operations and any other plant operations on the site".

Table 3.1 provides the assessment criteria contained in the Mining PEM, relevant to the dust generation at the Site. In accordance with the direction of the Mining PEM, the assessment criteria adopted from this document were applied to all emission sources. It is noted that the criteria in Table 3.1 are the same as the intervention criteria specified in the Schedule B of the SEPP(AQM), which are stated to be protective of the beneficial use of the atmosphere, the policy intent of the SEPP(AQM).

Table 3.1: Assessment criteria from the Mining PEM

Indicator	Criteria	Averaging Period
PM_{10}	60 µg/m^3	24-hour
$PM_{2.5}$	36 µg/m^3	24-hour
RCS	3 µg/m^3	Annual

Source: (Environment Protection Authority Victoria, 2007)

In addition to the criteria specified in Table 3.1, the Mining PEM discusses the assessment of dust deposition, which can be assessed if the dust deposition rate is known. The dust deposition rate is proportionate to the size fraction of the particles within the TSP. These data are known through available literature, and the amount of dust deposition can be estimated. The Mining PEM provides standards for the monitoring of dust deposition, which are set at:

- 4 g/m^2/month; and
- no more than 2 g/m^2/month above background.

As the background dust deposition level is not known for the local area a criterion of 2 g/m^2/month has been used as indicative of a nuisance value for dust deposition.

3.3 Future Legislation

The Environment Protection Amendment Act, 2018 (EP Amendment Act) and subordinate legislation was scheduled to commence July 2020, however due to COVID-19, the Victorian Government is postponing the commencement until 1 July 2021. This is to ease the burden on business and industries during the pandemic (Victoria State Government, 2020). The expected lifetime of the Woody Hill and Phillips Quarries is expected to be in excess of 30 years and 50 years respectively. As operation of the quarries is expected to extend well beyond the introduction of the EP Amendment Act, it is considered prudent to consider setting the separation distances on the basis of that legislation where it is expected that criteria for particulate matter will be tightened.

3.3.1 Environmental Protection Amendment Act 2018

The Environment Protection Amendment Act, 2018 (EP Amendment Act) and subordinate legislation was scheduled to commence July 2020, however due to COVID-19, the Victorian Government is postponing the commencement until 1 July 2021. This is to ease the burden on business and industries during the pandemic (Victoria State Government, 2020).

The EP Amendment Act and subordinate legislation adopt environmental reference standards (ERS). In respect of mining, emissions are dominated by particulate matter from the handling of overburden and resources as well as the movement of vehicles on haul roads. The relevant ERS document for the Site is the ERS – Exposure, Part 2. This is currently available in draft format.

The proposed environmental values of the ambient air environment are:

- Life, health and well-being of humans;
- Life, health and well-being of other forms of life, including the protection of ecosystems and biodiversity;
- Local amenity and aesthetic enjoyment;
- Visibility;
- The useful life and aesthetic appearance of buildings, structures, property and materials; and
- Climate systems that are consistent with human development, the life, health and well-being of humans and the protection of ecosystems and biodiversity.

The proposed indicators for the ambient air environment are summarised in Table 3.2. These standards are referenced to the National Environmental Protection (Ambient Air Quality) Measure (NEPM).

Table 3.2: Assessment criteria from Exposure ERS

Indicator	Criteria	Averaging Period
PM_{10}	50 µg/m^3	24-hour
	25 µg/m^3	Annual
$PM_{2.5}$	25 µg/m^3	24-hour
	8 µg/m^3	Annual

Source: (Exposure ERS, 2019)

In this assessment, the draft Exposure ERS standards have been taken as indicative of risk to human health or the environment that need to be prevented under the general environmental duty.

3.4 Adopted Air Quality Criteria

In order to understand the overall impact of the mining activities into the future, comparison has been made both to the current legislation (Mining PEM), and the proposed indicators presented in the Draft Exposure ERS.

Table 3.3: Adopted assessment criteria

Indicator	Legislation	Criteria	Averaging Period	Reference
PM10	Current	60 µg/m^3	24-hour	(Environment Protection Authority Victoria, 2007)
	Future	50 µg/m^3	24-hour	(Exposure ERS, 2019)
		25 µg/m^3	Annual	
PM2.5	Current	36 µg/m^3	24-hour	(Environment Protection Authority Victoria, 2007)
	Future	25 µg/m^3	24-hour	(Exposure ERS, 2019)
		8 µg/m^3	Annual	
RCS	Current	3 µg/m^3	Annual	(Environment Protection Authority Victoria, 2007)
Dust Deposition	Current	2 g/m^2/month	Annual	(Environment Protection Authority Victoria, 2007)

4. ENVIRONMENTAL SETTING

The Woody Hill and proposed Phillips quarries are located within Melbourne's urban growth zone adjacent to an area of high residential development. The area to the east and west of Woody Hill Quarry and to the north of the proposed Phillips Quarry is part of the Shenstone Precinct Structure plan. An area of residential development to the north of Woody Hill Quarry is already underway.

The area to the south of both Woody Hill and Phillips quarries is currently open farm land. Aproximately 3.6 km to the south-west of Woody Hill Quarry is the urban area of Craigieburn, whilst the urban edge of Epping is located approximately 6 km south east.

4.1 Climate

The Shenstone Park Precinct is located in a temperate environment. Table 4.1 provides an overview of the climatic extremes as recorded by the Bureau of Meteorology (BoM) between the years 1984 and 2020 at Melbourne Airport, located approximately 17 kilometres south-west of the Site. This BoM site represents the nearest meteorological station, which expected to be representative of the climate at the Site.

Overall, the local area is characterised by:

- annual average rainfall of 531.3 mm;
- average maximum temperature of 26.6°C in January and February;
- average minimum temperature of 5.5°C in July;
- average maximum 9 am relative humidity of 83% in June; and
- average minimum 3 pm relative humidity of 44% in January and February.

Table 4.1: Mean climatic conditions at Melbourne Airport

Statistic Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Start Year	End Year
Mean maximum temperature (°C)	26.6	26.6	24.2	20.4	16.7	13.7	13.2	14.4	16.7	19.5	22.1	24.7	19.9	1970	2020
Mean minimum temperature (°C)	13.9	14.2	12.8	10.2	8.3	6.2	5.5	5.9	7.1	8.5	10.4	12.1	9.6	1970	2020
Mean rainfall (mm)	41.2	41.5	37.2	44.8	40.0	40.3	35.2	44.3	46.1	52.6	61.7	51.0	531.3	1970	2020
Mean 9am temperature (°C)	18.1	18.0	16.6	14.2	11.3	8.7	8.0	9.1	11.3	13.6	15.0	16.8	13.4	1970	2010
Mean 9am relative humidity (%)	65	69	70	72	79	83	81	77	72	66	67	64	72	1970	2010
Mean 9am wind speed (km/h)	18.5	17.0	16.9	16.7	17.2	18.3	20.2	21.6	22.1	21.8	19.0	18.7	19.0	1970	2010
Mean 3pm temperature (°C)	24.3	24.8	22.5	19.0	15.6	12.6	12.0	13.2	15.2	17.6	20.2	22.4	18.3	1970	2010
Mean 3pm relative humidity (%)	44	44	47	52	60	67	65	59	56	52	49	45	53	1970	2010
Mean 3pm wind speed (km/h)	22.3	21.2	20.6	19.9	19.7	20.8	22.7	23.9	24.4	23.5	22.4	22.7	22.0	1970	2010

Source: (BoM, 2020)

4.2 Typical Wind Conditions

Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (north, north-north-east, north-east etc). The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the colour and width of the bar sections correspond to wind speed categories, as per the legend. Using these wind rose plots it is possible to visualise how often winds of a certain direction and strength occur over any period of time.

Presented in Table 4.2 and Figure 4-1 are the wind rose statistics and wind roses for the processed meteorological data for the past five years (2015 to 2019 inclusive) as predicted at the Site. Further details on the meteorological modelling is presented in Section 6.4.1.

4.3 Atmospheric Stability

An important aspect of pollutant dispersion is the level of turbulence in the lowest 1 km or so of the atmosphere, known as the planetary boundary layer (PBL). Turbulence controls how effectively a plume is dispersed into the surrounding air and hence diluted. It acts by increasing the cross-sectional area of the plume due to random motions. With stronger turbulence, the rate of plume dispersion increases. Weak turbulence limits dispersion and contributes to high plume concentrations downwind of a source.

Turbulence is generated by both thermal and mechanical effects to varying degrees. Thermally driven turbulence occurs when the surface is being heated, in turn transferring heat to the air above by convection. Mechanical turbulence is caused by the frictional effects of wind moving over the earth's surface, and depends on the roughness of the surface as well as the flow characteristics.

Turbulence in the boundary layer is influenced by the vertical temperature gradient, which is one of several indicators of stability. Plume models use indicators of atmospheric stability in conjunction with other meteorological data to estimate the dispersion conditions in the atmosphere.

Stability can be described across a spectrum ranging from highly unstable through neutral to highly stable. A highly unstable boundary layer is characterised by strong surface heating and relatively light winds, leading to intense convective turbulence and enhanced plume dispersion. At the other extreme, very stable conditions are often associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind. Neutral conditions are linked to windy and/or cloudy weather, and short periods around sunset and sunrise, when surface rates of heating or cooling are very low.

The stability of the atmosphere plays a large role in determining the dispersion of a plume and it is important to have it correctly represented in dispersion models. Current air quality dispersion models (such as AERMOD and CALPUFF) use the Monin-Obukhov Similarity Theory (MOST) to characterise turbulence and other processes in the PBL. One of the measures of the PBL is the Monin-Obukhov length (L), which approximates the height at which turbulence is generated equally by thermal and mechanical effects (Seinfeld & Pandis, 2006). It is a measure of the relative importance of mechanical and thermal forcing on atmospheric turbulence.

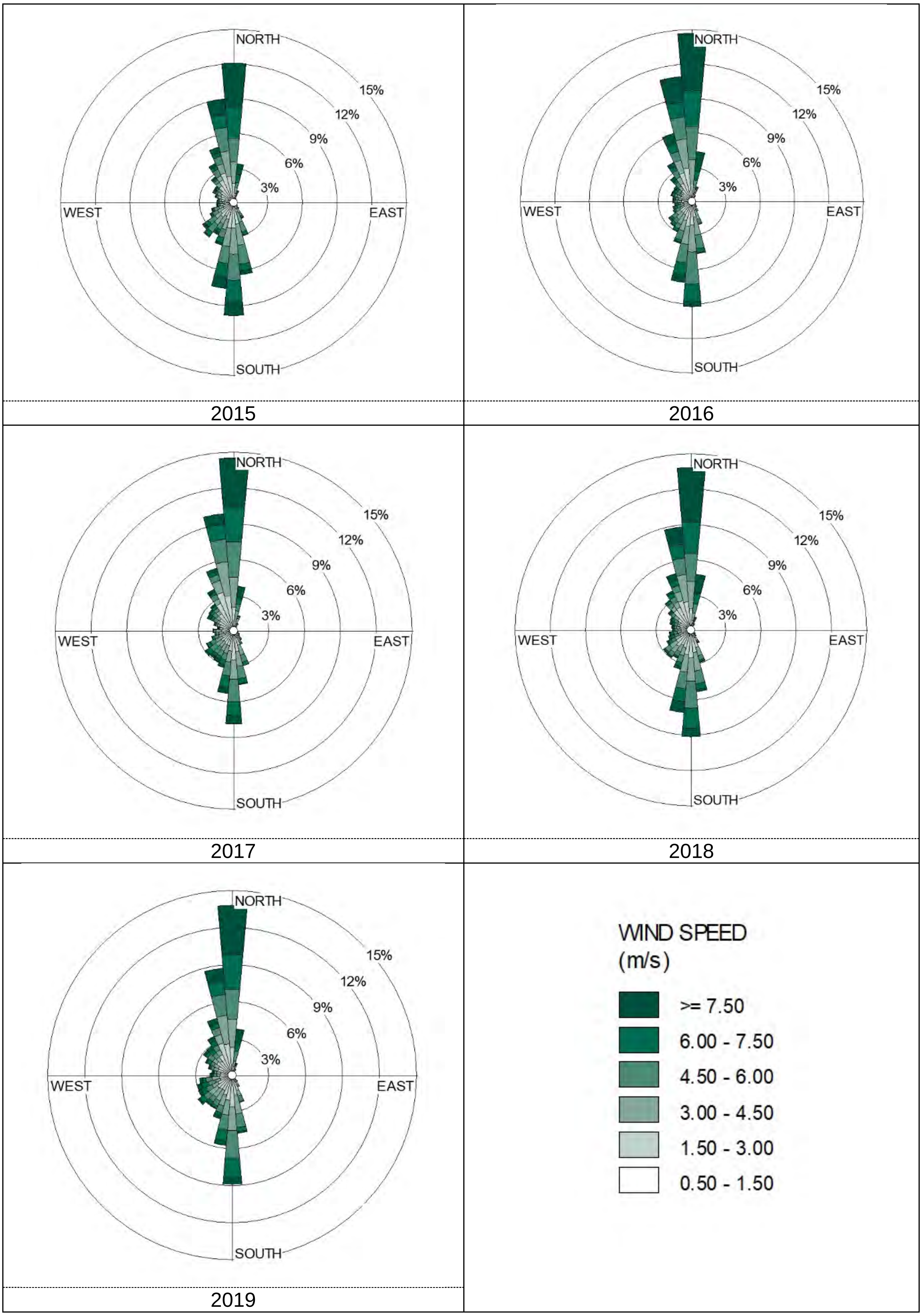


Figure 4-1 Derived Site Specific Wind Roses for 2015 to 2019

Table 4.2: Annual wind rose statistics (2015-2019) at Site

Year	Average Wind Speed (m/s)	Calms (%)
2015	4.18	1.82
2016	4.42	1.64
2017	3.98	2.16
2018	4.19	2.26
2019	4.11	1.89

Because values of L diverge to + and - infinity as stability approaches neutral from the stable and unstable sides, respectively, it is often more convenient to use the inverse of L (i.e., 1/L) when describing stability. Table 4.3 summarises these affinities with respect to atmospheric stability.

Figure 4-2 shows the variations in stability over the year by hour of the day, with reference to the widely known Pasquill-Gifford classes of stability. The relationship between L and stability classes is based on values derived by (Golder, 1972) and set out in (NSW EPA, 2017). Note that the reference to stability categories here is only for convenience in describing stability. The model uses calculated values of L across a continuum.

Table 4.3: Inverse of the Monin-Obukhov length L with respect to Atmospheric stability

1/L	Atmospheric Stability
Negative	Unstable
Zero	Neutral
Positive	Stable

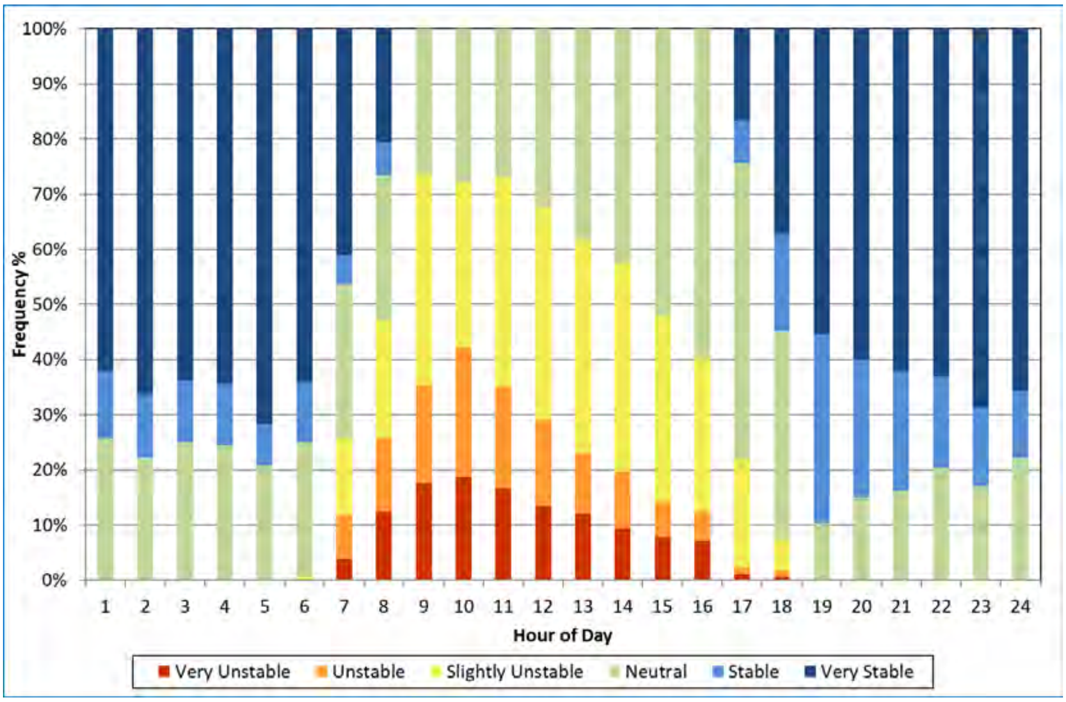


Figure 4-2: Stability class frequency

Figure 4-2 shows that stable and very stable conditions occur for about 30% of the time, which is typical for inland locations. Atmospheric instability increases during the day and reaches a peak around noon as solar-driven convective energy peaks. A stable atmosphere is prevalent during the night. These profiles indicate that pollutant dispersion is most effective during the daytime and least effective at night.

4.4 Background Data

There are very few EPA monitoring stations close to the subject area. The closest PM_{10} and $PM_{2.5}$ monitoring station is at Alphington. The closest representative PM_{10} monitoring station is located at Mooroolbark.

It is acknowledged that these stations are surrounded by urban areas, however they are the closest monitoring stations available with appropriate data

Table 4.4 and Table 4.5 summarises the PM_{10} and $PM_{2.5}$ annual statistics of the existing background data at the surrounding EPA monitoring stations. Negative values were removed from the dataset for this analysis.

A number of exceedances of the existing Mining PEM criteria and the proposed Exposure ERS criteria were recorded for both PM_{10} and $PM_{2.5}$, and annual mean $PM_{2.5}$ has been above the Exposure ERS standard for the past five years.

Some of the recorded exceedances of PM_{10} and $PM_{2.5}$ concentrations observed in 2019 were likely due to the wide spread Australian wide bushfires.

Table 4.4: Annual PM_{10} statistics - Mooroolbark

Year	Concentration – 24-hour average (µg/m³)				Number of Exceedances of 24-hour average	
	Annual Average	Maximum	90th Percentile	70th Percentile	PEM (60 µg/m³)	Exposure ERS (50 µg/m³)
2015	16.13	41.96	23.08	17.63	0	0
2016	13.13	44.68	21.54	15.24	0	0
2017	14.14	55.45	20.45	16.28	0	2
2018	16.02	136.30	24.25	17.84	2	2
2019	16.51	72.18	30.16	17.91	1	4

Table 4.5: Annual $PM_{2.5}$ statistics - Alphington

Year	Concentration – 24-hour average (µg/m³)				Number of Exceedances of 24-hour average	
	Annual Average	Maximum	90th Percentile	70th Percentile	PEM (36 µg/m³)	Exposure ERS (25 µg/m³)
2015	8.67	29.96	13.83	9.52	0	2
2016	7.62	33.62	12.02	8.16	0	2
2017	9.20	35.94	16.06	9.95	0	8
2018	8.37	42.01	13.67	8.50	2	8
2019	7.76	30.65	13.35	8.68	0	2

In this assessment, the 70th percentile 24 hour average value for each year has been adopted and when comparing to the Exposure ERS standards the annual average concentrations have also been used.

5. REVIEW OF GHD ASSESSMENTS

To assist with preparation of the Shenstone Park PSP, GHD has prepared two reports considering the appropriate separation distance for the current and proposed quarrying operations at Woody Hill and Phillips Quarry. The assessments consider air emissions as well as noise and vibration impacts to define the appropriate separation distance. In reviewing these assessments, consideration has only been given in this report to the assessment of emissions to atmosphere.

The two reports completed by GHD were:

Impact Assessment Report for the Shenstone Park Precinct Structure Plan dated December 2017 which considered the appropriate separation distance for:

- Woody Hill Quarry;
- Phillips Quarry; and
- Future Yarra Valley Water Wollert Sewage Treatment Plant.

Shenstone Park Woody Hill Addendum dated September 2019 which considered an amended appropriate separation distance as a result of:

- Expansion to the south of the existing extraction area within the Work Authority 492 boundary;
- Expansion of the work authority boundary and subsequently the extraction boundary to the north of the existing work authority boundary;
- Expansion of the work authority boundary and subsequently the extraction boundary to the east of the existing work authority boundary (as identified on the Future Urban Structure Plan); and
- Expansion 20 m below ground level.

Comments made in this assessment are by exception. That is, where there is a contention on the approach used, comment has been made.

5.1 Impact Assessment Report for the Shenstone Park Precinct Structure Plan dated December 2017

5.1.1 Selection of Default Separation Distances

In selecting the appropriate separation distance for the processing plant without blasting occurring, a 250 m separation distance has been selected in accordance with EPA Publication 1518 for processes without RCS. This approach was selected, as it was considered that the Basalt that is crushed contains only a small percentage of RCS which is not liberated in the crushing process.

For Basalt, this assumption is correct, however Woody Quarry also currently extracts and crushes mudstone on a fortnightly basis. During the site induction, health and safety advice was provided on the potential for exposure to RCS during the crushing of the mudstone, which was not occurring at the time of the visit. Further instruction from Barro provided information that the mudstone contains approximately 19.6% RCS in respirable dust (see Section 6.4.3.2) and in accordance with EPA Publication 1518, the appropriate separation distance for the crushing plant is therefore 500 m rather than 250 m.

The locations of specific activities for the various phases of the Woody Hill and Phillips quarries is also not correct meaning that the adopted default separation distances are not quite in the right location (see Section 6.2).

5.1.2 Justification for Buffer Distance Adjustment

Section 6.4 of GHD's December 2017 discusses the adjustment of default separation distances under the guidance set out in EPA Publication 1518. The section incorrectly paraphrases the guidance and due to this incorrect paraphrasing does not appropriately select the correct method to undertake the Buffer Distance Adjustment.

GHD state that the Guidance (presumed to be EPA Publication 1518) allows for site specific variation under the criteria of:

> "*Topography and Meteorology – Site-representative meteorology can be used to produce directional buffers. Refer to Section 6.4.4 for all the identified constraining industries nearby*".

Section 6.4.4 doesn't discuss constraining industries, but does discuss topography and meteorology and then uses a method which produces a contour equivalent to the 99.5th percentile to provide the same enclosed area as the 500 m radius circle used in the default separation distance.

Table 4 of EPA publication 1518 states that a variation to the standard separation distance on the basis of topography and meteorology can be completed only where:

> "*There are exceptional topographic or meteorological characteristics which will affect dispersion of IRAEs*."

This means that the topography or meteorology has to be substantially different to what is experienced elsewhere in Victoria. The surrounding topography is flat and therefore there is no limit on dispersion in any direction. Figure 4-1 shows that there is a clear north south dominant wind direction of higher wind speeds, which typically result in greater dispersion. Closer inspection of the wind roses indicates that there are light winds from the west and very little easterly winds, this is considered typical for Melbourne and indeed much of Victoria.

Under this provision, therefore, it is considered that there is nothing unusual about the meteorology or the topography and therefore the approach used by GHD is not appropriate.

5.1.3 Buffer Distance Adjustment

Whilst it is considered that GHD's selection of the provision for adjustment on meteorology is invalid, it is also important to consider the approach that has been used and determine whether this in itself is appropriate. This has been considered in terms of:

- Meteorological file generation;
- Percentile selection;

5.1.3.1 Meteorological File Generation

Selection of Meteorological Data

GHD has used meteorological observations from Melbourne Airport which is approximately 17.5 km to the south-west of Woody Hill quarry. EPA Publication 1550 states that:

> "*The directly measured parameters (a), (b) and (c) must be site-specific (must within 5 KM radius of the application site) and the rest of measured parameters should be site-representative*".

Parameters (a), (b) and (c) are listed as:

- Scalar wind speed (m/s) at wind reference height (e.g. 10m).
- Wind direction (degrees measured clockwise from true north) at wind reference height.
- Ambient temperature (°K) at screen level height (e.g. 2m).

The distance of Melbourne Airport is significantly outside of the required 5 km radius. In these circumstances, EPA Publication 1550 states:

> "*Meteorological files constructed using meteorological data generated by prognostic models such as TAPM or MM5 may also be acceptable in situations where there are no measured mandatory data within a 5 km radius of the application site*."

It is considered that this is the approach that should have been used by GHD in accordance with the guidance.

Surrounding Land Use

In generating the meteorological file for use in AERMOD, GHD has adopted a bowen ratio, albedo and surface roughness for scrub land. This is the historical land use surrounding the quarries in this area, however land use is rapidly changing and is not the proposed land use under the PSP.

As discussed in Appendix A, in this assessment a more realistic land use has been adopted given the planned surrounding land use.

Comparison of Meteorological Datasets

Figure 5-1 provides a comparison of the windrose generated by GHD for the period 2012 to 2016 from Melbourne Airport with surrounding land use being scrub land, and that derived for this study for the period 2015 to 2019 using meteorological modelling and the proposed land use characteristics.

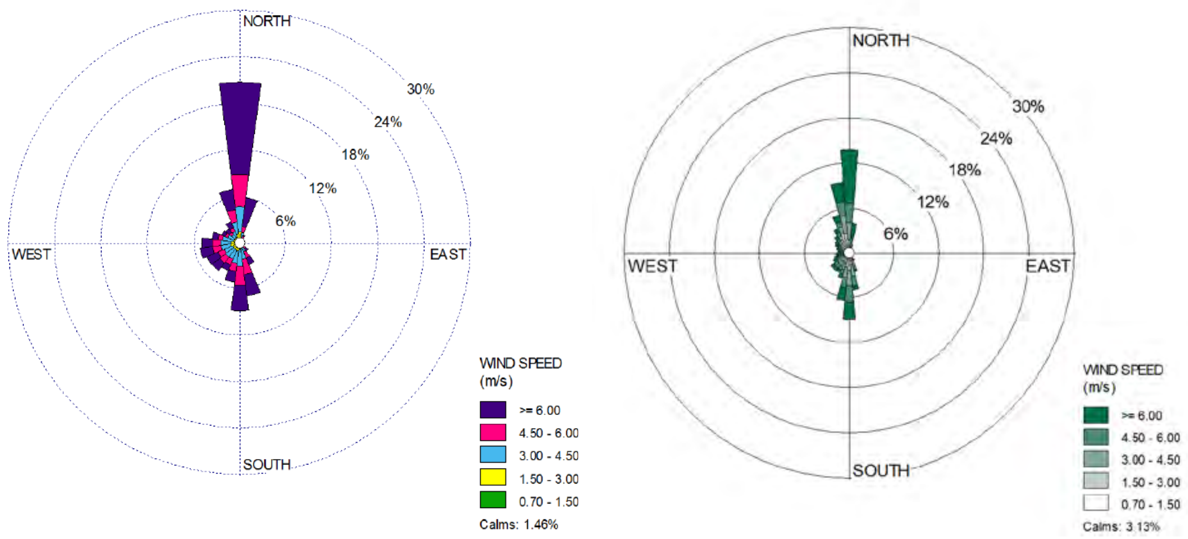


Figure 5-1 Comparison of GHD wind rose (left) and that prepared for this study (right)

From a comparison of these wind roses, it can be seen that it is likely that GHD's approach has under estimated the frequency of calms (less than 0.7 m/sec) and over estimated the frequency of the elevated wind speeds, especially from the north. In addition, the frequency of the winds from the south-west appears to be over represented in this location and that winds from the SW direction occur nearer to 3% of the time than 6% of the time.

There is potential, therefore that the data used by GHD in the assessment is not representative of the site and could result in a separation distance which is not appropriate.

5.1.3.2 Model Domain

The model domain has been set as 5 km X 5 km. EPA Publication 1551 states that:

> "*A domain size (centred on the emission sources) of up to 10 km for flat terrain, and up to 5 km for elevated terrain*".

Thus the domain modelled should have been 10 km X 10 km centred on the sources to be in compliance with the guidance.

It is acknowledged, however, that it is likely that the 5 km X 5 km domain selected would be likely to contain the maximum peaks in concentrations given that modelled emissions are all from near ground sources.

5.1.3.3 Percentile Selection

This approach used by GHD to adjust the separation distance with meteorology has typically been used with odour rather than with dust generation. Under the SEPP(AQM), odour has a criterion of 1 Odour Unit expressed at the 99.9th percentile. GHD's approach considers that the 99.9th percentile is too cautious for upset conditions which should be of short duration and result in large separation distances and the 99.5th percentile provides a more realistic separation distance.

When considering particulate matter under the Mining PEM, the standard is a 24 hour averaging period and the modelling percentile used under the SEPP(AQM) is the 100th percentile. This is because over a 24 hour period the model is less susceptible to short peaks in concentration and the 100th percentile (maximum predicted concentration) can be considered.

For particulate matter, therefore, it is not considered appropriate to use the 99.5th percentile 24 hour average area when determining the meteorology impacted contour and the 100th percentile should have been adopted.

- GHD have used criteria in the SEPP(AQM), these are for point sources not for surface sources and are therefore not relevant;

5.1.4 Modelling of Normal Operations

In completing the modelling of normal operations to determine whether IRAEs result in a requirement for a greater separation distance than the standard separation distance, a number of assumptions have been made which are considered not appropriate:

- The meteorology and model domain are the same as those identified in Sections 5.1.3.1 and 5.1.3.2 and are therefore not developed in accordance with EPA Publications 1550 and 1551;
- Assumption that RCS is sufficiently low to be non-existent when the site processes mudstone which contains RCS and the site has a specific RCS health and safety policy in place;
- Roads only receive level 1 watering, when level 2 watering is adopted;
- An assumed throughput of 200 tonnes per hour, the site instructed that the maximum capacity of the plant for basalt is 3000 tonnes per day which is a throughput 25% greater than modelled;
- Modelling assumed a site wide emission rate of 0.2 kg/ha/hour. The approach assumes that there is wind blown emissions for every hour of the year and that this emission rate is constant. In reality, for the majority of the time the wind speed is not sufficient to generate wind blown emissions and the level of dust generation increases with wind speed. The impact will therefore be underestimated on high wind event days and over estimated during calm conditions.

5.2 Impact Assessment Report for the Shenstone Park Precinct Structure Plan dated September 2019

The 2019 GHD assessment considers the proposed expansion of the Woody Hill Quarry. The issues identified with the 2017 assessment have been repeated and, in addition, the assessment has assumed that the crushing plant will be moved twice times initially to the south-east of the Woody Hill Quarry, then to the north-east of the Woody Hill Quarry.

It is understood that the crushing plant at Woody Hill will remain in its current location for the lifetime of the quarry (in excess of 30 years) and will be used for the processing of all products from the Woody Hill Quarry.

A new processing plant (initially mobile and subsequently fixed and enclosed) will be used to process all material extracted from Phillips Quarry.

6. APPROACH TO DETERMINATION OF THE APPROPRIATE SEPARATION DISTANCE FOR DUST

This section describes the:

- Current operations;
- Woody Hill expansion;
- Combined operation of the Phillips and Woody Hill Quarries;
- Concrete batching plant;
- Sales area;
- The standard required separation distance;
- The options for considering a variation to the standard separation distance; and
- The approach used to determine whether the separation distances can be adjusted.

6.1 Considered Operations

6.1.1 Woody Hill Quarry

Current operations at Woody Hill Quarry occur under WA 492 with existing use rights. The existing Site Layout Plan for the work plan variation of WA 492, statutorily endorsed on February 3, 2020, for the extension of the extraction area generally to the south of the existing extraction area of WA 492.

Within the Woody Hill Quarry, every two weeks, blasting of mudstone occurs within the extraction area. The blasted mudstone is taken to the crushing plant area by front end loader, a digger then picks up the mudstone and loads the primary crusher. The material then passes through a primary, secondary and tertiary crusher depending on the size of stone that is required. The crushing of the blasted material takes approximately one week to complete.

Basalt is currently imported to the Woody Hill Quarry and is deposited in a location immediately above the crushing plant or in an over-flow area to the east of the main drop off area. When mudstone is not being crushed, the basalt is then either pushed via front end loader over the edge of the drop off area to the crushing plant area below or trucked from the over-flow area to the crushing plant. Where material is pushed over the edge from the drop off area, it is then picked up by front end loader and placed beside the crushing plant. A digger then picks up the basalt and loads the primary crusher. The material then passes through a primary, secondary and tertiary crusher depending on the size of stone that is required.

6.1.2 Woody Hill Expansion

There are two planned expansions to the Woody Hill Quarry.

The northern expansion of the Woody Hill Quarry will occur generally to the north and east of the existing extraction area of WA 492. The Site Layout Plan for the work plan for WA 6437 was statutorily endorsed on August 16, 2019 for the extension of the extraction area.

The resource in this location is mudstone overlain by Basalt, which will be extracted by blasting. The rock will then be loaded into trucks and hauled to the existing crushing plant.

During the period when the Basalt is being extracted from the northern expansion, the site will continue to process the mudstone on a fortnightly basis. When the Basalt has finished being extracted, the underlying mudstone will be extracted and processed in the same plant at Woody Hill.

The resource of Woody Hill itself will result in an expansion to the south of the current extraction area under a variation to work plan for WA492 statutorily endorsed on February 3, 2020. This resource is primarily of mudstone and will continue to be extracted and processed at the crushing plant as currently occurs from this expanded extraction area.

6.1.3 Woody Hill and Phillips Quarry Combined Operations

The Phillips Quarry is a Basalt quarry located to the south-east of the Woody Hill Quarry. On commencement of operations, a mobile crushing plant will be placed on the north-western side of the pit during stage 1 of the development.

An enclosed crushing plant will then be built adjacent to this location with air from the building passed through a bag house. Once the enclosed crushing plant is built, the mobile crushing plant will cease to operate.

During operation of the Phillips Quarry, the Woody Hill expansion will continue to operate as described in Section 6.1.2.

6.1.4 Sales Yard

Planning permit 715902 was issued on October 30, 2017 for the development of a trade supplies area. The permit was extended, meaning development must commence by October 30, 2021. The trade supplies area is located adjacent to Donnybrook Road approximately 100 m east of the current entrance.

The area consists of a number of concrete bays which will contain crushed produce to sale to trade buyers similar to crushed rock sales in a garden supplies business.

6.1.5 Concrete Batching Plant

Planning Permit 710157 amended January 28, 2009 allows for the use of a concrete batching plant. The concrete batching plant is located just to the north of WA 492 to the east of the main site access road. The concrete batching plant produces approximately 600 m^3 of concrete per day.

6.2 Standard Separation Distances

EPA Publication 1518 considers how separation distances should be applied. As the PSP and surrounding residential subdivisions will develop this area from a rural to an urbanised area, it is considered appropriate to use the urban method (Figure 6-1).

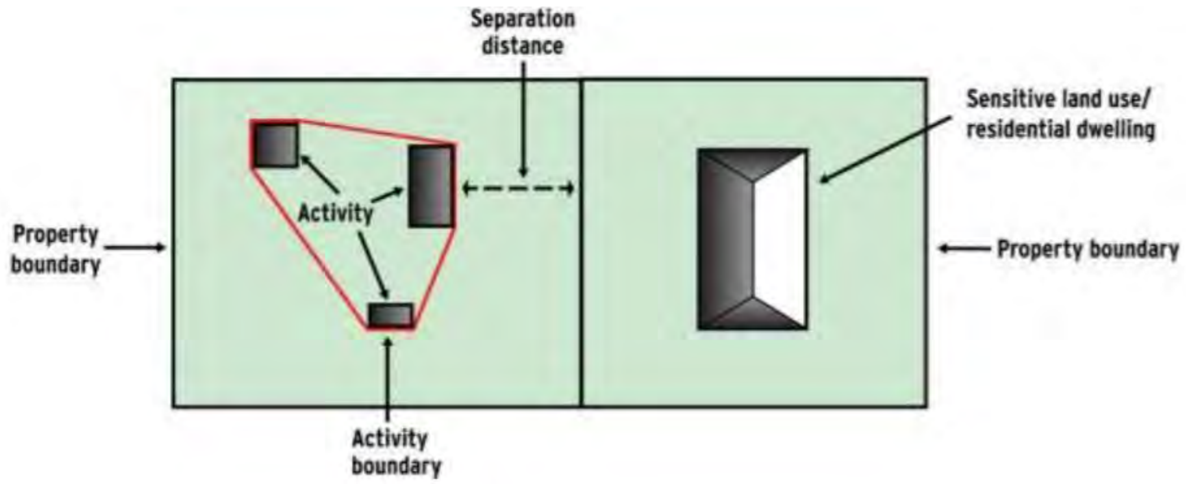


Figure 6-1 Urban Method of Separation Distance Application from EPA Publication 1518

As discussed in Section 3.1.2, there are a number of differing separation distances for different activities, each of these has been taken individually and applied. The maximum external extent of the buffers combined buffers has then been selected as the standard separation distance.

6.3 Options for Adjusting Separation Distances under EPA Publication 1518

As discussed in Section 3.1.2.1, there are 6 reasons for the adjustment of the default separation distances provided for under EPA Publication 1518:

- Transitioning of industry – Existing industry has formally indicated that it will transition out of an area and over a specified timeframe.
- Plant equipment and operation – The industrial plant and equipment have an exceptionally high standard of emission control technology.
- Environmental risk assessment – An environmental risk assessment of IRAEs has been completed that demonstrates a variation is justified.
- Size of the plant – The plant is significantly smaller or larger than comparable industries.
- Topography or meteorology – There are exceptional topographic or meteorological characteristics which will affect dispersion of IRAEs.
- Likelihood of IRAEs – Particular IRAEs are either highly likely or highly unlikely to occur.

6.3.1 Transitioning of Industry

There is no plan to cease operation or substantially change planned operations at the Woody Hill or proposed Phillips Quarries in the near future with expected lifetimes in excess of 30 years and 50 years respectively.

6.3.2 Plant equipment and operation

Current plant equipment have a standard level of mitigation technology for a quarry of this type. Once the crushing plant at the Phillips Quarry is built, however, this plant has a higher level of dust control than for other quarry crushing facilities therefore there is consideration that the operation of the new plant may bring with it a need for a smaller separation distance.

6.3.3 Environmental risk assessment

Separation distances are used to prevent surrounding land use during upset conditions. An environmental risk assessment considers operations and determines the potential for upset conditions to occur. Where the potential for upset is less than envisaged when setting the standard separation distances, there is potentially a reason for reducing those separation distances.

When considering current operations at the site, the following are considered to be potential upset conditions:

- Breakdown of the crushing plant;
- Breakdown of mobile plant;
- Breakdown of the water cart;
- Breakthrough of the concrete batching plant bag house; and
- Unusual meteorological conditions.

Breakdown of the crushing plant or mobile plant would result in a lower level of dust emissions from the facility and this upset condition does not therefore generate particulate emissions for which a separation distance would be required.

Breakdown of the water cart has the potential to result in increased emissions as trucks keep using the haul roads. The breakdown of a water cart is rare and for the two sites visited, neither could recall this happening in the operation of the site. Water carts are also available for hire, and so if the water cart were to break down a replacement could be found. Thus the risk of a breakdown of the watercart is not considered a significant risk.

Individual bags within the concrete batching plant bag house will tear from time to time. The baghouse is not comprised of a single bag, however, but a series of bags. The tearing of an individual bag would therefore not result in significant emissions. The likelihood of multiple bags tearing at the same time is considered to be low.

Elevated wind speeds driving significant dust generation from exposed area sources, or lighter wind speeds dispersing normally generated dust slowly is considered a risk that could impact the required separation distance. An assessment of this has therefore been completed (Section 6.4)

When considering operations at the combined Woody Hill and Phillips Quarry, the risks for upset conditions remain low and dominated by unusual meteorological conditions. As discussed in Section 6.1.3, once the Phillips Quarry crushing plant is built, there will be a higher level of mitigation, thereby reducing emissions from crushing operations at Phillips Quarry only. Within the proposed indoor crushing facility, the air will be passed through a baghouse with upwards of 200 bags. The tearing of an individual bag is therefore not considered to be a large risk.

Consequently, an environmental risk assessment for normal operations considering the past five years of meteorological conditions has been completed as the environmental risk assessment (Section 6.4).

6.3.4 Size of Plant

It is considered that the size of the Woody Hill Quarry and the Phillips Quarry are of comparable size to quarries in Victoria and a derivation of the separation distance is not valid on this basis.

6.3.5 Topography or Meteorology

As discussed in Section 5.1.2 it is considered that as the surrounding area is flat with no terrain impeding dispersion and the meteorology is typical for northern Melbourne, there is no justification under this provision for the alteration of the separation distance.

6.3.6 Likelihood of IRAEs

The likelihood of industrial residual air emissions (IRAEs) is tied to the environmental risk assessment. If there is a lower or higher likelihood of an IRAE, this is related to the associated environmental risk assessment that considers the remnants of that risk. The likelihood of impact as a result of those continued emissions is therefore assed within the risk assessment. The use of a risk assessment to determine where the separation distance should be combining the meteorology with the IRAE is therefore considered an appropriate approach to determine the required separation distance.

6.4 Environmental Risk Assessment

6.4.1 Meteorological Modelling

The nearest Bureau of Meteorology (BoM) stations to the Shenstone Park precinct are located more than 15 kilometres away. In accordance with EPA Publication 1550, where meteorological observation stations are more than 5 km from the subject site, meteorological modelling has been used to construct a site specific meteorological file. Meteorological modelling was undertaken for most recent five years (2015-2019 inclusive).

ERM developed three-dimensional micro-meteorological model for the site using a combination of the following meteorological model and processing methods:

- Weather Research and Forecasting model (WRF); and
- MMIF extraction tool; and
- AERMET for updated land use.

Details of the approach used are contained in Appendix A.

Discussion on the site specific meteorology which was derived from this approach is provided in Section 4.

6.4.2 Considered Scenarios

As discussed in Section 6.2, separation distances need to be considered in terms of the operation for which the site is being used. For example when mudstone crushing is occurring a 500 m separation distance is recommended, but when Basalt crushing is occurring a 250 m separation distance is required.

In addition, as the site develops and additional expansion of the Woody Hill and Phillips quarries occurs, the location of operations will change and various scenarios are therefore required to be considered.

In completing an environmental risk assessment, seven emissions scenarios were investigated and are described in Table 6-1.

Currently, the site accepts basalt, extracts mudstone and processes basalt and mudstone in alternate product 'runs'. In Scenario 1, only the mudstone extraction and crushing has been considered, alongside basalt delivery, which occurs at the same time as mudstone processing. Mudstone extraction and processing alongside basalt delivery has been modelled in lieu of basalt delivery and processing to provide the most conservative assessment as:

- Mudstone extraction includes the use of blasting (there is no blasting during current basalt processing);
- Mudstone extraction activities occurs nearer to the southern boundary whilst basalt processing occurs at the crushing plant in the centre south of the site;
- Mudstone contains approximately 20% RCS in respirable dust whilst RCS in basalt is minimal and so presented an opportunity to consider the worst case impact for this species.

Table 6-1: Summary of investigation scenarios

Scenario	Activity
1 – Current Operations	■ Mudstone drilling blasting and processing in Woody Hill ■ Transfer to processing plant ■ Crushing and screening ■ Materials handling ■ Wind erosion ■ Basalt Receipt ■ No Basalt processing (considered that for TSP, PM10 and PM2.5 emission rates will be similar to those from mudstone processing) ■ Trade sales ■ CBP operational (doesn't receive any aggregate from quarries)
2A – Woody Hill Northern Expansion	■ Basalt drilling blasting and processing in Woody Hill expansion ■ Transfer to processing plant ■ Crushing and screening ■ Materials handling ■ Wind erosion ■ Trade sales ■ CBP operational (doesn't receive any aggregate from quarries)
2B – Woody Hill Southern Expansion	■ Mudstone drilling blasting and processing in Woody Hill ■ Transfer to processing plant ■ Crushing and screening ■ Materials handling ■ Wind erosion ■ Basalt Receipt ■ No Basalt processing (considered that for TSP, PM10 and PM2.5 emission rates will be similar to those from mudstone processing) ■ Trade sales ■ CBP operational (doesn't receive any aggregate from quarries)
3A – Woody Hill Northern Expansion plus Stage 1 Phillips Quarry	As Scenario 2A plus: ■ Basalt drilling blasting and processing in Phillips Quarry Stage 1 area ■ Transfer to mobile processing plant in Phillips Quarry ■ Crushing and screening in Phillips Quarry ■ Materials handling in Phillips Quarry ■ Wind erosion in Phillips Quarry
3B – Woody Hill Southern Expansion plus Stage 1 Phillips Quarry	As Scenario 2B plus: ■ Basalt drilling blasting and processing in Phillips Quarry Stage 1 area ■ Transfer to mobile processing plant in Phillips Quarry ■ Crushing and screening in Phillips Quarry ■ Materials handling in Phillips Quarry ■ Wind erosion in Phillips Quarry
4A – Woody Hill Northern Expansion plus Stage 2 Phillips Quarry	As Scenario 2A plus: ■ Basalt drilling blasting and processing in Phillips Quarry Stage 2 area ■ Transfer to Permanent processing plant in Phillips Quarry ■ Screening in Phillips Quarry (crushing plant enclosed) ■ Materials handling in Phillips Quarry ■ Wind erosion in Phillips Quarry
4B – Woody Hill Southern Expansion plus Stage 2 Phillips Quarry	As Scenario 2B plus: ■ Basalt drilling blasting and processing in Phillips Quarry Stage 2 area ■ Transfer to Permanent processing plant in Phillips Quarry ■ Screening in Phillips Quarry (crushing plant enclosed) ■ Materials handling in Phillips Quarry ■ Wind erosion in Phillips Quarry

6.4.3 Emission Estimation

The operations of the Project have been analysed and estimates of particulate matter (PM) emissions for the key PM generating activities have been made.

Emission rates of TSP, PM_{10} and $PM_{2.5}$ have been calculated using emission factors developed both within Australia and by the United States Environment Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998).

Modelling of TSP, PM_{10} and $PM_{2.5}$ was undertaken using the particle size specific inventories and was assumed to emit and deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the particle size range.

6.4.3.1 Particulate matter emissions

Estimates of emissions for each source were developed on an hourly time step taking into account activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended on the level of activity and the wind speed. Dust generating activities were represented by a series of volume sources situated according to the location of activities. The locations of the volume sources, used to represent the Project activities, are shown in Appendix B.

The information used for developing the inventories has been based on the operational descriptions and drawings and used to determine haul road distances and routes, activity operating hours, truck sizes and other details that are necessary to estimate dust emissions.

Not every activity will occur at each source location and some source locations will see significantly more activities than others.

Table 6.2 presents the emissions inventory by activity for the different particle size fractions for both the Scenarios 1, 2A and 2B.

Table 6.3 provides the emission rates for Scenarios 3A, 3B, 4A and 4B.

It is noted that for wind sensitive activities, such as loading and wind erosion the hourly wind speed was taken into consideration. Further detail on the approach is provided in Appendix B.

6.4.3.2 Respirable Crystalline Silica

During the health and safety induction for the site, discussion with site representatives was held on the potential for exposure to RCS when crushing of mudstone was taking place. This was not a concern for the day of the visit, however, as mudstone crushing was not occurring.

From instructions received, it was determined that the knowledge of the potential risk came from occupational air quality monitoring which was completed downwind of the crushing plant during mudstone processing on behalf of Barro Group. The results from this monitoring indicated that ambient concentrations of RCS in respirable dust (PM_7) comprised 19.6% of measured dust (measured RCS concentration of 11 µg/m^3, total respirable dust 56 µg/m^3). These values have been provided in a verbal communication and the approach and monitoring results have not been reviewed, rather the concentrations have been used as provided.

Whilst these values have not been independently verified, it is noted that the maximum modelled results for RCS assuming all sources of $PM_{2.5}$ to be comprised of 19.6% RCS were below the relevant standard. Even where the RCS percentage were 100% of $PM_{2.5}$, which is an ultra conservative and unrealistic assumption for mudstone, the relevant contour would still be within the PM_{10} 24 hour contour. The separation distance defined by the dust deposition and PM_{10} 24 hour contours is therefore conservative of any potential contour for RCS.

Table 6.2: Estimated TSP, PM_{10} and $PM_{2.5}$ emissions scenarios 1, 2A and 2B

ACTIVITY	1 Particulate emissions (g/s)			2A Particulate emissions (g/s)			2B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
QUARRY - MUDSTONE - Drilling rock	1.1E-01	5.6E-02	3.2E-03	N/A			1.1E-01	5.6E-02	3.2E-03
QUARRY - MUDSTONE - Blasting rock	3.6E+00	1.8E+00	1.1E-01				3.6E+00	1.8E+00	1.1E-01
QUARRY - MUDSTONE - Excavators on Quarry Floor	Hourly varying						Hourly varying		
QUARRY - MUDSTONE - Truck Rear Dumping	Hourly varying						Hourly varying		
QUARRY - MUDSTONE - FELS	Hourly varying						Hourly varying		
QUARRY - MUDSTONE - Primary crushing	2.2E-01	9.7E-02	4.1E-03				2.2E-01	9.7E-02	4.1E-03
QUARRY - MUDSTONE - Secondary crushing	2.2E-01	9.7E-02	4.1E-03				2.2E-01	9.7E-02	4.1E-03
QUARRY - MUDSTONE - Tertiary crushing	2.2E-01	9.7E-02	4.1E-03				2.2E-01	9.7E-02	4.1E-03
QUARRY - MUDSTONE - Primary screening	1.0E+00	3.5E-01	2.0E-03				1.0E+00	3.5E-01	2.0E-03
QUARRY - MUDSTONE - Conveyor Transfer Points (5)	2.5E-01	1.2E-01	1.8E-02				2.5E-01	1.2E-01	1.8E-02
QUARRY - MUDSTONE - Conveyor Drop Points (3)	1.5E-01	7.2E-02	1.1E-02				1.5E-01	7.2E-02	1.1E-02
QUARRY - MUDSTONE - Rock Truck - Pit to processing - Loaded, Onsite (Unsealed)	6.2E-01	1.4E-01	1.4E-02				6.2E-01	1.4E-01	1.4E-02
QUARRY - MUDSTONE - Rock Truck - Pit to Processing - Unloaded, Onsite (Unsealed)	3.8E-01	8.7E-02	3.1E-03				3.8E-01	8.7E-02	3.1E-03
QUARRY - BASALT DELIVERY - Truck and Dog - Loaded (Unsealed)	1.5E+00	3.5E-01	3.5E-02				N/A		
QUARRY - BASALT DELIVERY - Truck and Dog - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00						
QUARRY - BASALT DELIVERY - Truck and Dog - Unloaded (Unsealed)	9.5E-01	2.2E-01	2.2E-02						
QUARRY - BASALT DELIVERY - Truck and Dog - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00						

ACTIVITY	1 Particulate emissions (g/s)			2A Particulate emissions (g/s)			2B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
QUARRY - BASALT - Drilling rock	N/A			1.5E-01	7.9E-02	4.6E-03	N/A		
QUARRY - BASALT - Blasting rock				5.9E+00	3.1E+00	1.8E-01			
QUARRY - BASALT - Excavators on Quarry Floor				Hourly varying					
QUARRY - BASALT - Truck Rear Dumping				Hourly varying					
QUARRY - BASALT - FELS				Hourly varying					
QUARRY - BASALT - Primary crushing				2.5E-01	1.1E-01	4.6E-03			
QUARRY - BASALT - Secondary crushing				2.5E-01	1.1E-01	4.6E-03			
QUARRY - BASALT - Tertiary crushing				2.5E-01	1.1E-01	4.6E-03			
QUARRY - BASALT - Primary screening				1.2E+00	4.0E-01	2.3E-03			
QUARRY - BASALT - Conveyor Transfer Points (5)				7.6E-01	3.6E-01	5.5E-02			
QUARRY - BASALT - Conveyor Drop Points (3)				4.6E-01	2.2E-01	3.3E-02			
QUARRY - BASALT - Rock Truck - Pit to processing - Loaded, Onsite (Unsealed)				1.9E+00	4.2E-01	4.2E-02			
QUARRY - BASALT - Rock Truck - Pit to Processing - Unloaded, Onsite (Unsealed)				1.2E+00	2.6E-01	2.6E-02			
QUARRY – MUDSTONE/BASALT - Truck and Dog - Processing to Stockpiles - Loaded (Unsealed)	1.4E-01	1.4E-01	3.2E-02	1.4E-01	3.4E-02	3.2E-03	1.4E-01	3.1E-02	3.1E-03
QUARRY – MUDSTONE/BASALT - Truck and Dog - Processing to Stockpiles - Unloaded (Unsealed)	8.5E-02	8.6E-02	1.9E-02	8.6E-02	2.1E-02	1.9E-03	8.5E-02	1.9E-02	1.9E-03
QUARRY - Truck and Dog - Aggregate to sales area - Loaded (Unsealed)	1.1E+00	1.3E+00	2.9E-01	1.3E+00	3.1E-01	2.9E-02	1.1E+00	2.5E-01	2.5E-02
QUARRY - Truck and Dog - Aggregate to sales area - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

ACTIVITY	1 Particulate emissions (g/s)			2A Particulate emissions (g/s)			2B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
QUARRY - Truck and Dog - Aggregate to sales area - Unloaded (Unsealed)	6.8E-01	7.8E-01	1.8E-01	7.8E-01	1.9E-01	1.8E-02	6.8E-01	1.5E-01	1.5E-02
QUARRY - Truck and Dog - Aggregate to sales area -Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SALES AREA - MUDSTONE - FELS handling Material	1.3E-03	2.5E-01	9.3E-05	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05
SALES AREA - MUDSTONE - FELS dumping Material	1.3E-03	2.5E-01	9.3E-05	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05
SALES AREA - BASALT - FELS handling Material	1.6E-03	2.5E-01	1.2E-04	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04
SALES AREA - BASALT - FELS dumping Material	1.6E-03	1.2E+00	1.2E-04	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04
WE - Stockpiles and conveyors	Hourly varying								
WE - Pit	Hourly varying			N/A					
WE - WH Northern Expansion	N/A			Hourly varying					
WE - WH Southern Expansion	N/A			Hourly varying					
WE - CBP	Hourly varying								
CBP - Coarse Aggregate - Truck Rear Dumpings	4.9E-03	2.3E-03	3.5E-04	4.9E-03	2.3E-03	3.5E-04	4.9E-03	2.3E-03	3.5E-04
CBP - Sand - Truck Rear Dumping	4.1E-03	1.9E-03	2.9E-04	4.1E-03	1.9E-03	2.9E-04	4.1E-03	1.9E-03	2.9E-04
CBP - Transfer of Aggregate	9.9E-04	4.7E-04	7.1E-05	9.9E-04	4.7E-04	7.1E-05	9.9E-04	4.7E-04	7.1E-05
CBP - Transfer of Sand	8.2E-04	3.9E-04	5.9E-05	8.2E-04	3.9E-04	5.9E-05	8.2E-04	3.9E-04	5.9E-05
CBP - Cement unloading to elevated storage silo	1.4E-03	4.7E-04	4.7E-04	1.4E-03	4.7E-04	4.7E-04	1.4E-03	4.7E-04	4.7E-04
CBP - Truck and Dog - Coarse aggregate - Loaded (Unsealed)	1.8E-01	4.1E-02	4.1E-03	1.8E-01	4.1E-02	4.1E-03	1.8E-01	4.1E-02	4.1E-03
CBP - Truck and Dog - Coarse aggregate - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

ACTIVITY	1 Particulate emissions (g/s)			2A Particulate emissions (g/s)			2B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
CBP - Truck and Dog - Coarse aggregate - Unloaded (Unsealed)	1.0E-01	2.4E-02	2.4E-03	1.0E-01	2.4E-02	2.4E-03	1.0E-01	2.4E-02	2.4E-03
CBP - Truck and Dog - Coarse aggregate - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Truck and Dog - Sand - Loaded (Unsealed)	1.5E-01	3.4E-02	3.4E-03	1.5E-01	3.4E-02	3.4E-03	1.5E-01	3.4E-02	3.4E-03
CBP - Truck and Dog - Sand - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Truck and Dog - Sand - Unloaded (Unsealed)	8.7E-02	2.0E-02	2.0E-03	8.7E-02	2.0E-02	2.0E-03	8.7E-02	2.0E-02	2.0E-03
CBP - Truck and Dog - Sand - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Tanker - Cement Supplement - Loaded (Unsealed)	3.6E-02	8.2E-03	8.2E-04	3.6E-02	8.2E-03	8.2E-04	3.6E-02	8.2E-03	8.2E-04
CBP - Tanker - Cement Supplement - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Tanker - Cement Supplement - Unloaded (Unsealed)	2.1E-02	4.7E-03	4.7E-04	2.1E-02	4.7E-03	4.7E-04	2.1E-02	4.7E-03	4.7E-04
CBP - Tanker - Cement Supplement - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Agitator truck - Loaded (Unsealed)	3.4E-01	7.8E-02	7.8E-03	3.4E-01	7.8E-02	7.8E-03	3.4E-01	7.8E-02	7.8E-03
CBP - Agitator truck - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Agitator truck - Unloaded (Unsealed)	2.4E-01	5.4E-02	5.4E-03	2.4E-01	5.4E-02	5.4E-03	2.4E-01	5.4E-02	5.4E-03
CBP - Agitator truck - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Table 6.3: Estimated TSP, PM_{10} and $PM_{2.5}$ emissions scenarios 3A, 3B, 4A and 4B

ACTIVITY	3A Particulate emissions (g/s)			3B Particulate emissions (g/s)			4A Particulate emissions (g/s)			4B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
WH QUARRY - BASALT - Drilling rock	1.5E-01	7.9E-02	4.6E-03	NA			1.5E-01	7.9E-02	4.6E-03	N/A		
WH QUARRY - BASALT - Blasting rock	5.9E+00	3.1E+00	1.8E-01				5.9E+00	3.1E+00	1.8E-01			
WH QUARRY - BASALT - Excavators on QUARRY Floor	Hourly varying						Hourly varying					
WH QUARRY - BASALT - Truck Rear Dumping	Hourly varying						Hourly varying					
WH QUARRY - BASALT - FELS	Hourly varying						Hourly varying					
WH QUARRY - BASALT - Primary crushing	2.5E-01	1.1E-01	4.6E-03				2.5E-01	1.1E-01	4.6E-03			
WH QUARRY - BASALT - Secondary crushing	2.5E-01	1.1E-01	4.6E-03				2.5E-01	1.1E-01	4.6E-03			
WH QUARRY - BASALT - Tertiary crushing	2.5E-01	1.1E-01	4.6E-03				2.5E-01	1.1E-01	4.6E-03			
WH QUARRY - BASALT - Primary screening	1.2E+00	4.0E-01	2.3E-03				1.2E+00	4.0E-01	2.3E-03			
WH QUARRY - BASALT - Conveyor Transfer Points (5)	7.6E-01	3.6E-01	5.5E-02				7.6E-01	3.6E-01	5.5E-02			
WH QUARRY - BASALT - Conveyor Drop Points (3)	4.6E-01	2.2E-01	3.3E-02				4.6E-01	2.2E-01	3.3E-02			
WH QUARRY - BASALT - Rock Truck - Pit to processing - Loaded, Onsite (Unsealed)	1.9E+00	4.2E-01	4.2E-02				1.9E+00	4.2E-01	4.2E-02			
WH QUARRY - BASALT - Rock Truck - Pit to Processing - Unloaded, Onsite (Unsealed)	1.2E+00	2.6E-01	2.6E-02				1.2E+00	2.6E-01	2.6E-02			
WH QUARRY - BASALT - Truck and Dog - Processing to Stockpiles - Loaded (Unsealed)	1.4E-01	3.2E-02	3.2E-03				1.4E-01	3.2E-02	3.2E-03			
WH QUARRY - BASALT - Truck and Dog - Processing to Stockpiles - Unloaded (Unsealed)	8.6E-02	1.9E-02	1.9E-03				8.6E-02	1.9E-02	1.9E-03			
WH QUARRY - MUDSTONE - Drilling rock	N/A			1.1E-01	5.6E-02	3.2E-03	N/A			1.1E-01	5.6E-02	3.2E-03
WH QUARRY - MUDSTONE - Blasting rock				3.6E+00	1.8E+00	1.1E-01				3.6E+00	1.8E+00	1.1E-01

ACTIVITY	3A Particulate emissions (g/s)			3B Particulate emissions (g/s)			4A Particulate emissions (g/s)			4B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
WH QUARRY - MUDSTONE - Excavators on QUARRY Floor				Hourly varying						Hourly varying		
WH QUARRY - MUDSTONE - Truck Rear Dumping				Hourly varying						Hourly varying		
WH QUARRY - MUDSTONE - FELS				Hourly varying						Hourly varying		
WH QUARRY - MUDSTONE - Primary crushing				2.2E-01	9.7E-02	4.1E-03				2.2E-01	9.7E-02	4.1E-03
WH QUARRY - MUDSTONE - Secondary crushing				2.2E-01	9.7E-02	4.1E-03				2.2E-01	9.7E-02	4.1E-03
WH QUARRY - MUDSTONE - Tertiary crushing				2.2E-01	9.7E-02	4.1E-03				2.2E-01	9.7E-02	4.1E-03
WH QUARRY - MUDSTONE - Primary screening				1.0E+00	3.5E-01	2.0E-03				1.0E+00	3.5E-01	2.0E-03
WH QUARRY - MUDSTONE - Conveyor Transfer Points (5)				2.5E-01	1.2E-01	1.8E-02				2.5E-01	1.2E-01	1.8E-02
WH QUARRY - MUDSTONE - Conveyor Drop Points (3)				1.5E-01	7.2E-02	1.1E-02				1.5E-01	7.2E-02	1.1E-02
WH QUARRY - MUDSTONE - Rock Truck - Pit to processing - Loaded, Onsite (Unsealed)				6.2E-01	1.4E-01	1.4E-02				6.2E-01	1.4E-01	1.4E-02
WH QUARRY - MUDSTONE - Rock Truck - Pit to Processing - Unloaded, Onsite (Unsealed)				3.8E-01	8.7E-02	8.7E-03				3.8E-01	8.7E-02	8.7E-03
WH QUARRY - MUDSTONE - Truck and Dog - Processing to Stockpiles - Loaded (Unsealed)				1.4E-01	3.1E-02	3.1E-03				1.4E-01	3.1E-02	3.1E-03
WH QUARRY - MUDSTONE - Truck and Dog - Processing to Stockpiles - Unloaded (Unsealed)				8.5E-02	1.9E-02	1.9E-03				8.5E-02	1.9E-02	1.9E-03
WH QUARRY - Truck and Dog - Aggregate to sales area - Loaded (Unsealed)	1.3E+00	2.9E-01	2.9E-02	1.1E+00	2.5E-01	2.5E-02	1.3E+00	2.9E-01	2.9E-02	1.1E+00	2.5E-01	2.5E-02
WH QUARRY - Truck and Dog - Aggregate to sales area - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WH QUARRY - Truck and Dog - Aggregate to sales area - Unloaded (Unsealed)	7.8E-01	1.8E-01	1.8E-02	6.8E-01	1.5E-01	1.5E-02	7.8E-01	1.8E-01	1.8E-02	6.8E-01	1.5E-01	1.5E-02

ACTIVITY	3A Particulate emissions (g/s)			3B Particulate emissions (g/s)			4A Particulate emissions (g/s)			4B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
WH QUARRY - Truck and Dog - Aggregate to sales area -Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
PH QUARRY - BASALT - Drilling rock	1.7E-01	8.7E-02	5.0E-03	1.7E-01	8.7E-02	5.0E-03	1.7E-01	8.7E-02	5.0E-03	1.7E-01	8.7E-02	5.0E-03
PH QUARRY - BASALT - Blasting rock	5.9E+00	3.1E+00	1.8E-01	5.9E+00	3.1E+00	1.8E-01	5.9E+00	3.1E+00	1.8E-01	5.9E+00	3.1E+00	1.8E-01
PH QUARRY - BASALT - Excavators on Quarry Floor	Hourly varying											
PH QUARRY - BASALT - Truck Rear Dumping	Hourly varying											
PH QUARRY - BASALT - FELS	Hourly varying											
PH QUARRY - BASALT - Primary crushing	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03
PH QUARRY - BASALT - Secondary crushing	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03
PH QUARRY - BASALT - Tertiary crushing	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03	2.7E-01	1.2E-01	5.1E-03
PH QUARRY - BASALT - Primary screening	1.3E+00	4.3E-01	2.5E-03	1.3E+00	4.3E-01	2.5E-03	1.3E+00	4.3E-01	2.5E-03	1.3E+00	4.3E-01	2.5E-03
PH QUARRY - BASALT - Conveyor Transfer Points (2)	8.3E-01	3.9E-01	6.0E-02	8.3E-01	3.9E-01	6.0E-02	8.3E-01	3.9E-01	6.0E-02	8.3E-01	3.9E-01	6.0E-02
PH QUARRY - BASALT - Conveyor Drop Points (8)	5.0E-01	2.4E-01	3.6E-02	5.0E-01	2.4E-01	3.6E-02	5.0E-01	2.4E-01	3.6E-02	5.0E-01	2.4E-01	3.6E-02
PH QUARRY - BASALT - Rock Truck - Pit to processing - Loaded, Onsite (Unsealed)	1.1E+00	2.5E-01	2.5E-02	1.1E+00	2.5E-01	2.5E-02	1.1E+00	2.5E-01	2.5E-02	1.1E+00	2.5E-01	2.5E-02
PH QUARRY - BASALT - Rock Truck - Pit to Processing - Unloaded, Onsite (Unsealed)	6.8E-01	1.5E-01	1.5E-02	6.8E-01	1.5E-01	1.5E-02	6.8E-01	1.5E-01	1.5E-02	6.8E-01	1.5E-01	1.5E-02
PH QUARRY - Truck and Dog - Aggregate to sales area - Loaded (Unsealed)	4.5E+00	1.0E+00	1.0E-01	4.5E+00	1.0E+00	1.0E-01	4.5E+00	1.0E+00	1.0E-01	4.5E+00	1.0E+00	1.0E-01
PH QUARRY - Truck and Dog - Aggregate to sales area - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
PH QUARRY - Truck and Dog - Aggregate to sales area - Unloaded (Unsealed)	2.8E+00	6.3E-01	6.3E-02	2.8E+00	6.3E-01	6.3E-02	2.8E+00	6.3E-01	6.3E-02	2.8E+00	6.3E-01	6.3E-02
PH QUARRY - Truck and Dog - Aggregate to sales area -Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

ACTIVITY	3A Particulate emissions (g/s)			3B Particulate emissions (g/s)			4A Particulate emissions (g/s)			4B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
SALES AREA - MUDSTONE - FELS handling Material	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05
SALES AREA - MUDSTONE - FELS dumping Material	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05	1.3E-03	6.1E-04	9.3E-05
SALES AREA - BASALT - FELS handling Material	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04
SALES AREA - BASALT - FELS dumping Material	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04	1.6E-03	7.7E-04	1.2E-04
WE - Stockpiles and conveyors	Hourly varying											
WE - WH Northern Expansion	Hourly varying											
WE - WH Southern Expansion	Hourly varying											
WE - Philips Quarry Stockpile Area (Mobile)	Hourly varying						N/A					
WE – Philips Quarry Stockpile Area (Fixed)	N/A						Hourly varying					
WE - Philips Quarry Stage 1	Hourly varying						N/A					
WE – Philips Quarry Stage 2	N/A						Hourly varying					
WE - CBP	Hourly varying											
CBP - Coarse Aggregate - Truck Rear Dumpings	4.9E-03	2.3E-03	3.5E-04	4.9E-03	2.3E-03	3.5E-04	4.9E-03	2.3E-03	3.5E-04	4.9E-03	2.3E-03	3.5E-04
CBP - Sand - Truck Rear Dumping	4.1E-03	1.9E-03	2.9E-04	4.1E-03	1.9E-03	2.9E-04	4.1E-03	1.9E-03	2.9E-04	4.1E-03	1.9E-03	2.9E-04
CBP - Transfer of Aggregate	9.9E-04	4.7E-04	7.1E-05	9.9E-04	4.7E-04	7.1E-05	9.9E-04	4.7E-04	7.1E-05	9.9E-04	4.7E-04	7.1E-05
CBP - Transfer of Sand	8.2E-04	3.9E-04	5.9E-05	8.2E-04	3.9E-04	5.9E-05	8.2E-04	3.9E-04	5.9E-05	8.2E-04	3.9E-04	5.9E-05
CBP - Cement unloading to elevated storage silo	1.4E-03	4.7E-04	4.7E-04	1.4E-03	4.7E-04	4.7E-04	1.4E-03	4.7E-04	4.7E-04	1.4E-03	4.7E-04	4.7E-04
CBP - Truck and Dog - Coarse aggregate - Loaded (Unsealed)	1.8E-01	4.1E-02	4.1E-03	1.8E-01	4.1E-02	4.1E-03	1.8E-01	4.1E-02	4.1E-03	1.8E-01	4.1E-02	4.1E-03

ACTIVITY	3A Particulate emissions (g/s)			3B Particulate emissions (g/s)			4A Particulate emissions (g/s)			4B Particulate emissions (g/s)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
CBP - Truck and Dog - Coarse aggregate - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Truck and Dog - Coarse aggregate - Unloaded (Unsealed)	1.0E-01	2.4E-02	2.4E-03	1.0E-01	2.4E-02	2.4E-03	1.0E-01	2.4E-02	2.4E-03	1.0E-01	2.4E-02	2.4E-03
CBP - Truck and Dog - Coarse aggregate - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Truck and Dog - Sand - Loaded (Unsealed)	1.5E-01	3.4E-02	3.4E-03	1.5E-01	3.4E-02	3.4E-03	1.5E-01	3.4E-02	3.4E-03	1.5E-01	3.4E-02	3.4E-03
CBP - Truck and Dog - Sand - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Truck and Dog - Sand - Unloaded (Unsealed)	8.7E-02	2.0E-02	2.0E-03	8.7E-02	2.0E-02	2.0E-03	8.7E-02	2.0E-02	2.0E-03	8.7E-02	2.0E-02	2.0E-03
CBP - Truck and Dog - Sand - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Tanker - Cement Supplement - Loaded (Unsealed)	3.6E-02	8.2E-03	8.2E-04	3.6E-02	8.2E-03	8.2E-04	3.6E-02	8.2E-03	8.2E-04	3.6E-02	8.2E-03	8.2E-04
CBP - Tanker - Cement Supplement - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Tanker - Cement Supplement - Unloaded (Unsealed)	2.1E-02	4.7E-03	4.7E-04	2.1E-02	4.7E-03	4.7E-04	2.1E-02	4.7E-03	4.7E-04	2.1E-02	4.7E-03	4.7E-04
CBP - Tanker - Cement Supplement - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Agitator truck - Loaded (Unsealed)	3.4E-01	7.8E-02	7.8E-03	3.4E-01	7.8E-02	7.8E-03	3.4E-01	7.8E-02	7.8E-03	3.4E-01	7.8E-02	7.8E-03
CBP - Agitator truck - Loaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CBP - Agitator truck - Unloaded (Unsealed)	2.4E-01	5.4E-02	5.4E-03	2.4E-01	5.4E-02	5.4E-03	2.4E-01	5.4E-02	5.4E-03	2.4E-01	5.4E-02	5.4E-03
CBP - Agitator truck - Unloaded (Sealed)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

6.4.4 Dispersion Model Setup

The impact of air emissions from the site on the surrounding area was evaluated through atmospheric dispersion modelling. The dispersion modelling was undertaken using the version 19191 of the regulatory model AERMOD and in accordance with the EPA Publication 1551 (EPA Victoria, 2013).

As required by EPA publications 1550 and 1551, atmospheric dispersion modelling was undertaken for five recent years of meteorology. Emissions scenarios were considered as described in Section 36. The methodological approach to AERMOD dispersion modelling is detailed in Figure 6-2

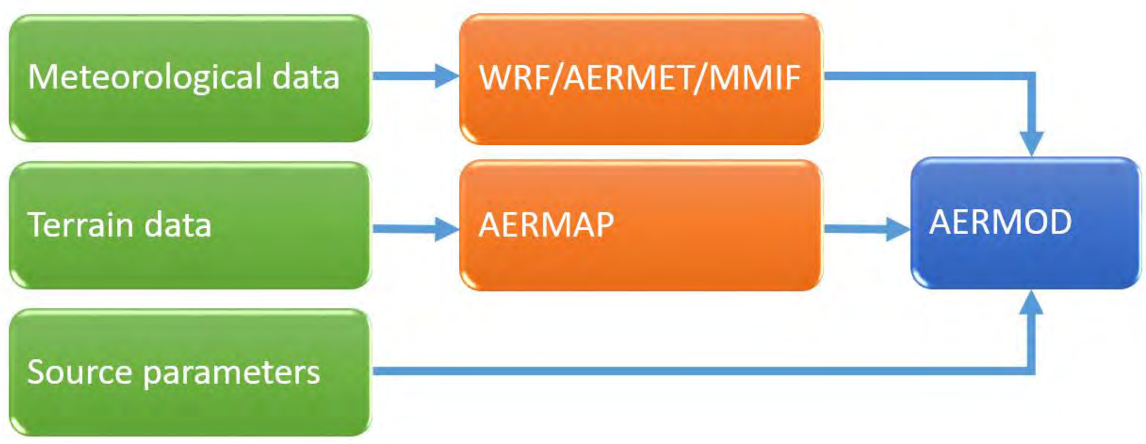


Figure 6-2: Approach to modelling methodology

Table 6.4: AERMOD modelling parameters

Parameter	Value
Grid size	10km x 10km (distance from source)
Grid spacing	50m
Southwest corner of AERMOD domain	316200mE 5836800mN (UTM coordinates Zone 55)
Regulatory options	Default
Terrain	Flat and elevated
Dispersion coefficient	Rural

7. ASSESSMENT OF APPROPRIATE SEPARATION DISTANCE

7.1 Standard Separation Distances

7.1.1 Current Operations

Figure 7-1 shows the separation distances for the mudstone blasting and processing operations and the concrete batching plant operations at the current time using the default separation distances contained in EPA Publication 1518.

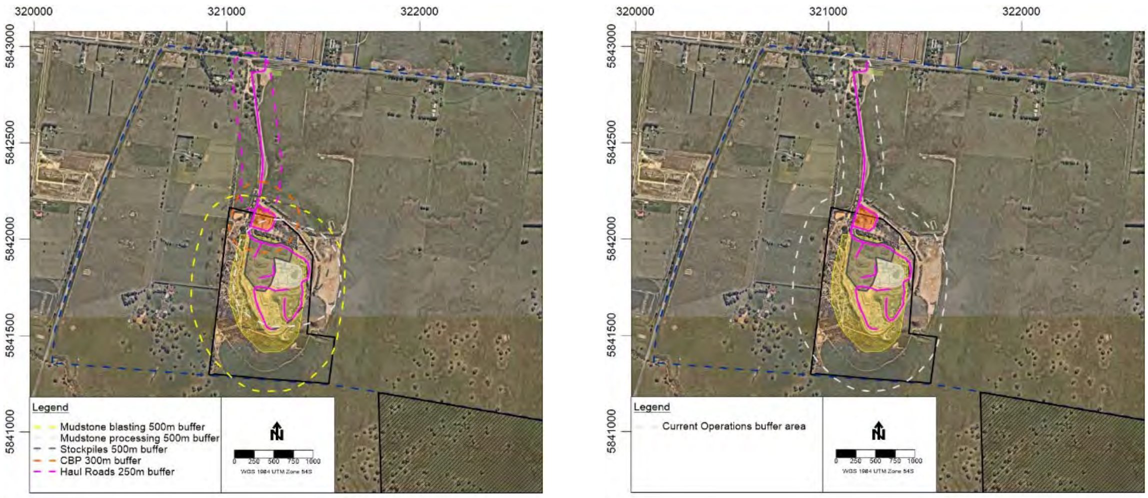


Figure 7-1 Standard Separation Distances for Current Operations for separate activities (left) and combined activities (right)

7.1.2 Woody Hill Expansion

Figure 7-2 shows the required separation distance for the current operations plus the Woody Hill expansion to extract Basalt from the northern extraction area and mudstone from the southern area.

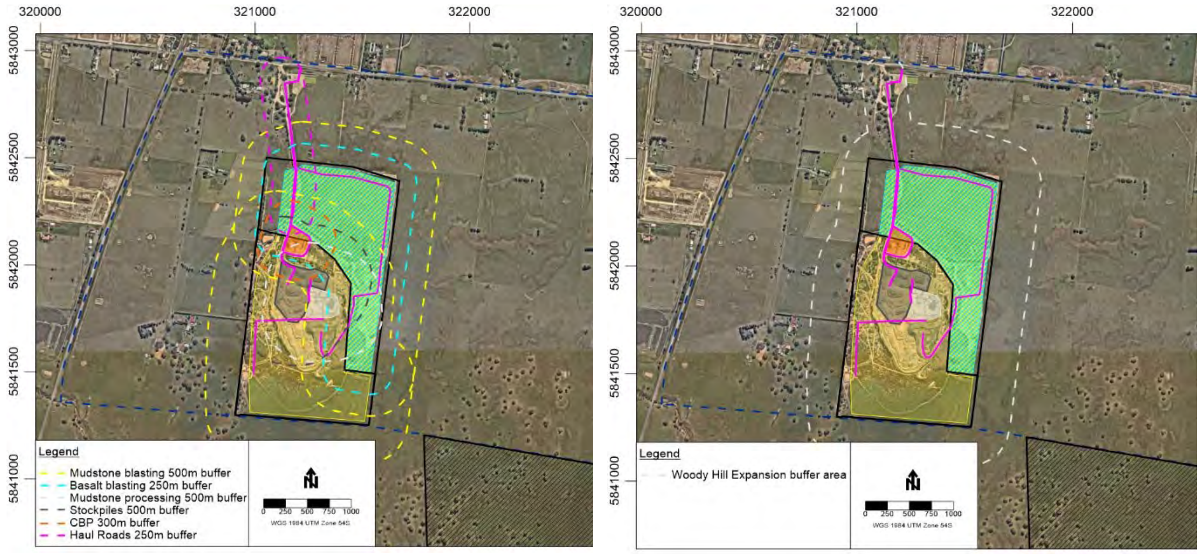


Figure 7-2 Standard Separation Distances for Woody Hill Expansion for separate activities (left) and combined activities (right)

7.1.3 Phillips Quarry and Woody Hill Operations Stage 1

Figure 7-3 shows the standard separation distances when the Phillips Quarry commences operations, a mobile crushing plant is used and there are continued operations at the Woody Hill Quarry. During this period, the standard separation distances remain the same for Woody Hill Quarry and extend slightly to the north of the Phillips Quarry into the PSP area.

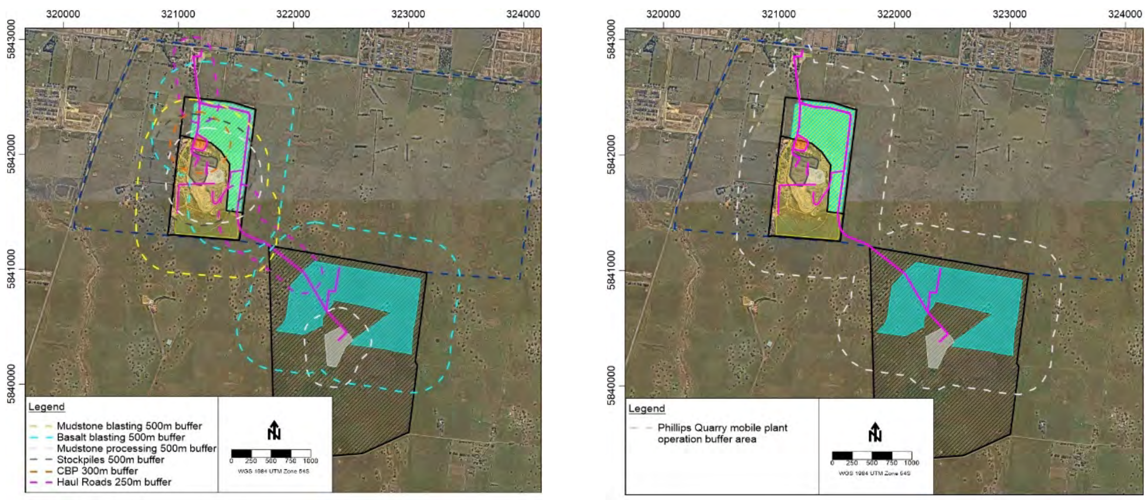


Figure 7-3 Standard Separation Distances when the mobile plant is operating in Phillips Quarry for separate activities (left) and combined activities (right)

7.1.4 Phillips Quarry and Woody Hill Operations Stage 2

Figure 7-4 shows the standard separation distances when the fixed processing plant at the Phillips Quarry commences operations, and there are continued operations at the Woody Hill Quarry. During this period, the standard separation distances remain the same for Woody Hill Quarry and the separation distance for the Phillips Quarry extend north into the PSP area.

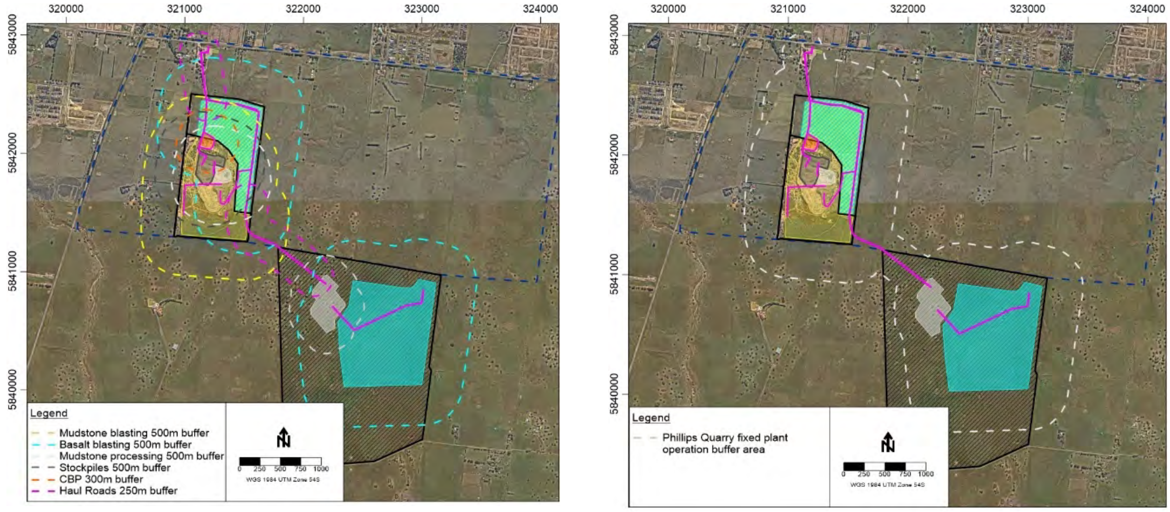


Figure 7-4 Standard Separation Distances when the fixed plant is operating in Phillips Quarry for separate activities (left) and combined activities (right)

7.1.5 Proposed Wollert Sewage Treatment Plant

The PSP published for public comment included a separation distance which was calculated in accordance with the requirements of EPA Publication 1518 by GHD.

From the GHD assessment it is understood that there are a variety of sizes proposed for the Wollert Sewage Treatment Plant as the surrounding population grows and depending on whether they have an industrial customer to take recycled water.

It is noted that in the update to the PSP issued on 12 October 2020, a separation distance for the sewage treatment plant no longer exists and only a nominal location for the plant has been provided.

When a planning application for the sewage treatment plant is submitted, it will need to be located in a position where the appropriate separation distance can be achieved based on the existing or known proposed land use surrounding it. The design of the sewage treatment plant can be adapted to reduce the required separation distance using the options for adjusting separation distances contained in EPA Publication 1518. It is therefore considered that a separation does not need to be set at the current time as so little is known about the plans for the treatment plant. Once greater detail is known about the waste water treatment plant, the technology to be used and the likelihood of industrial residual air emissions, the agent of change could at that point undertake a risk assessment to determine whether the default separation distance should be updated.

7.2 Separation Distances Derived from the ERA

As discussed in Section 6.3.3 there are limited opportunities for increased emissions from the quarrying operations as a result of upset conditions. Increased impacts therefore have the potential to occur as a result of unusual meteorological conditions or due to the fact that there are residual industrial air emissions which cannot be further mitigated. The modelled Scenarios consider:

- Scenario 1 – Current Operations once the sale yard is open;
- Scenario 2 – Expansion of the Woody Hill Quarry in the northern, eastern and southern directions;
- Scenario 3 – Stage 1 of the Phillips Quarry in combination with the expansion of the Woody Hill Quarry in the northern, eastern and southern directions; and

- Scenario 4 – Stage 2 of the Phillips Quarry in combination with the expansion of the Woody Hill Quarry in the northern, eastern and southern directions.

Within each scenario, the modelled concentrations have been added to adopted background concentrations to derive:

- 24 hour and annual mean PM_{10} and $PM_{2.5}$;
- Maximum monthly deposition;
- RCS concentrations as 19.6% of annual mean $PM_{2.5}$ for scenarios where mudstone is being extracted and processed.

The maximum modelled RCS concentrations for Scenarios 1, 2B, 3B and 4B were below the criterion for RCS within the Mining PEM meaning that a contour could not be derived and hence is not presented within the plots. The approach used to derive the RCS concentrations was, in any case, inherently conservative as it considered all $PM_{2.5}$ sources, including the roads which are not major sources of RCS. Thus it is considered that RCS is not a material consideration to the required separation distance, despite the requirement for a larger separation distance where RCS is present.

7.2.1 Scenario 1 - Current Operations

Figure 7-5 shows the extent of the criteria contours for current operations when extracting and processing mudstone. This scenario was chosen to represent the worst case of current operations due to the blasting. From this it can be seen that for current operations a separation distance that is, for the most part, equivalent to the dust deposition contour (pink dashed line), with the exception of the area north-east of the operations where the 24 hour average PM_{10} Exposure ERS criterion (yellow dashed line) would be appropriate. Use of this outer area as the separation distance would prevent impact to sensitive land uses under the legislation due to come into force next year, but only for current operations.

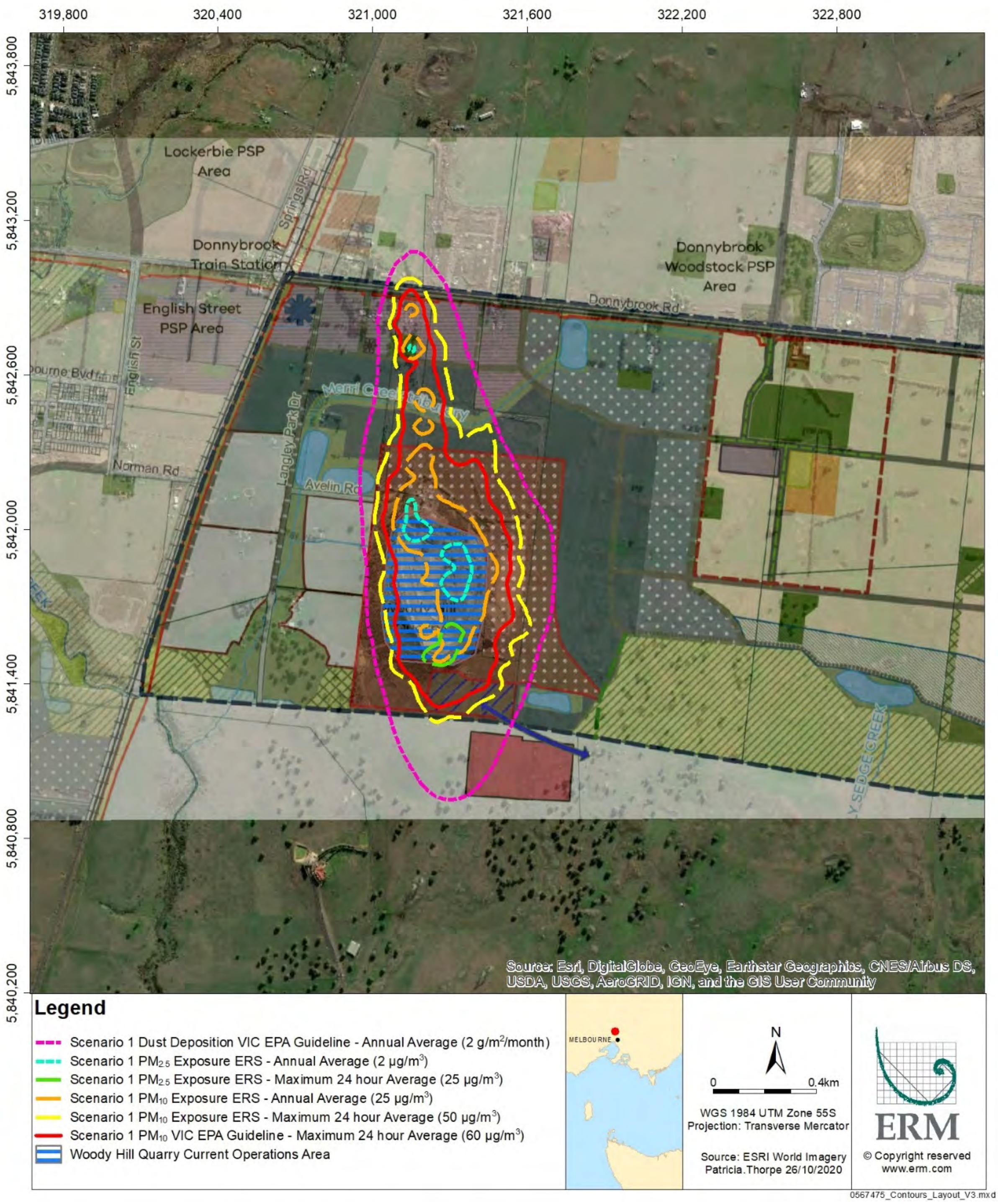


Figure 7-5 Extent of Impact for current Operations

In Scenario 1, the impacts beyond the site boundaries and in to areas of residential use to the north of the site. At the present time, the site accepts basalt from off-site locations in addition to trucks coming to site to pick up product. Once the northern expansion occurs, the acceptance of basalt from off-site locations will reduce, the number of truck movements will reduce and the contribution of particulate matter from the haul roads will also reduce (See Section 7.2.2). This reduction in traffic volume along the site entrance haul road will therefore reduce impact from current operations to the north of Donnybrook Road:

7.2.2 Scenario 2 - Woody Hill Expansion

As discussed in Section 6.1.2, there are two stages to the Woody Hill Expansion. The northern expansion under WA 6437, statutorily endorsed on August 16, 2019 and the southern expansion under a variation to work plan for WA492 statutorily endorsed on February 3, 2020.

7.2.2.1 Scenario 2A – Woody Hill Northern Expansion

Figure 7-6 indicates that during the northern Woody Hill expansion a larger separation distance will be needed to prevent concentrations, during unusual meteorological conditions from being in excess of the expected standard to be in place from July 2021. The recommended separation distance (yellow dotted line towards the north and pink dotted line towards the south) extends over an area designated as industrial within the PSP, this is considered appropriate.

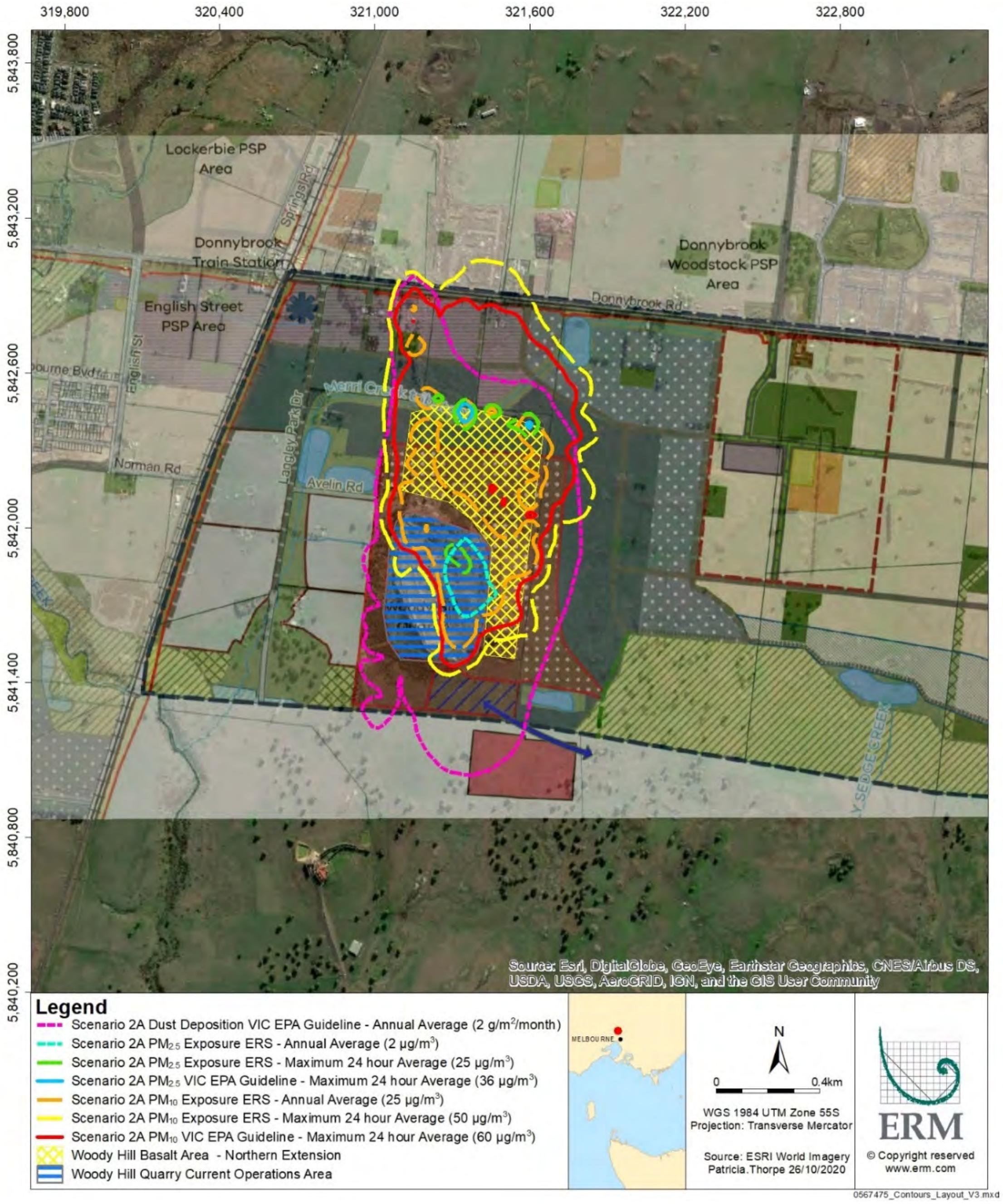


Figure 7-6 Extent of Impact during the Woody Hill Northern Expansion for Basalt Extraction and Processing

It should be noted that the predicted impact beyond Donnybrook Road is the maximum 24 hour concentration over five modelled years. The predicted impact may only occur where extraction is occurring at the very northern extents of the extraction area and favourable meteorological conditions are coincident. Prevention of impact to these areas can be achieved through:

- Not blasting in the northerly extension when there is a southerly wind to reduce the potential for impact beyond the northern boundary; and
- Using monitoring on the site boundaries to understand the background concentration coming on to site and the concentration leaving the site using trigger levels, set in accordance with the EPA Airwatch criteria, to reduce dust generating activities with the intent of protecting the 24 hour criterion.

An environmental management plan (EMP) is a usual requirement for quarry operations either under the planning permit and/or the work approval. Additional work can be undertaken for either of these stages to determine the exact controls needed to manage emissions to minimise impact.

7.2.2.2 Scenario 2B – Woody Hill Southern Expansion

Figure 7-7 shows the predicted impact to the surrounding land use as a result of processing and crushing of the southern expansion of the Woody Hill Quarry. Here it can be seen that the extent of the area of impact is less than Scenario 2A. This is because the area blasted and the quantity of material being processed per hour when processing mudstone is slightly lower than when blasting and processing basalt, which results in a smaller area of impact. Thus generally speaking the extent of the area of impact shown for Scenario 2A (Figure 7-6) is also sufficient for Scenario 2B.

In Scenario 2B there is a predicted concentration above the adopted assessment criteria beyond the site boundaries, these impacts could be reduced through implementation through the environment management plan for:

- Not blasting in the southern extension when there is a northerly wind;
- Using monitoring on the site boundary to understand the background concentration coming on to site and the concentration leaving the site using trigger levels, set in accordance with the EPA Airwatch criteria, to reduce dust generating activities with the intent of protecting the 24 hour criterion.

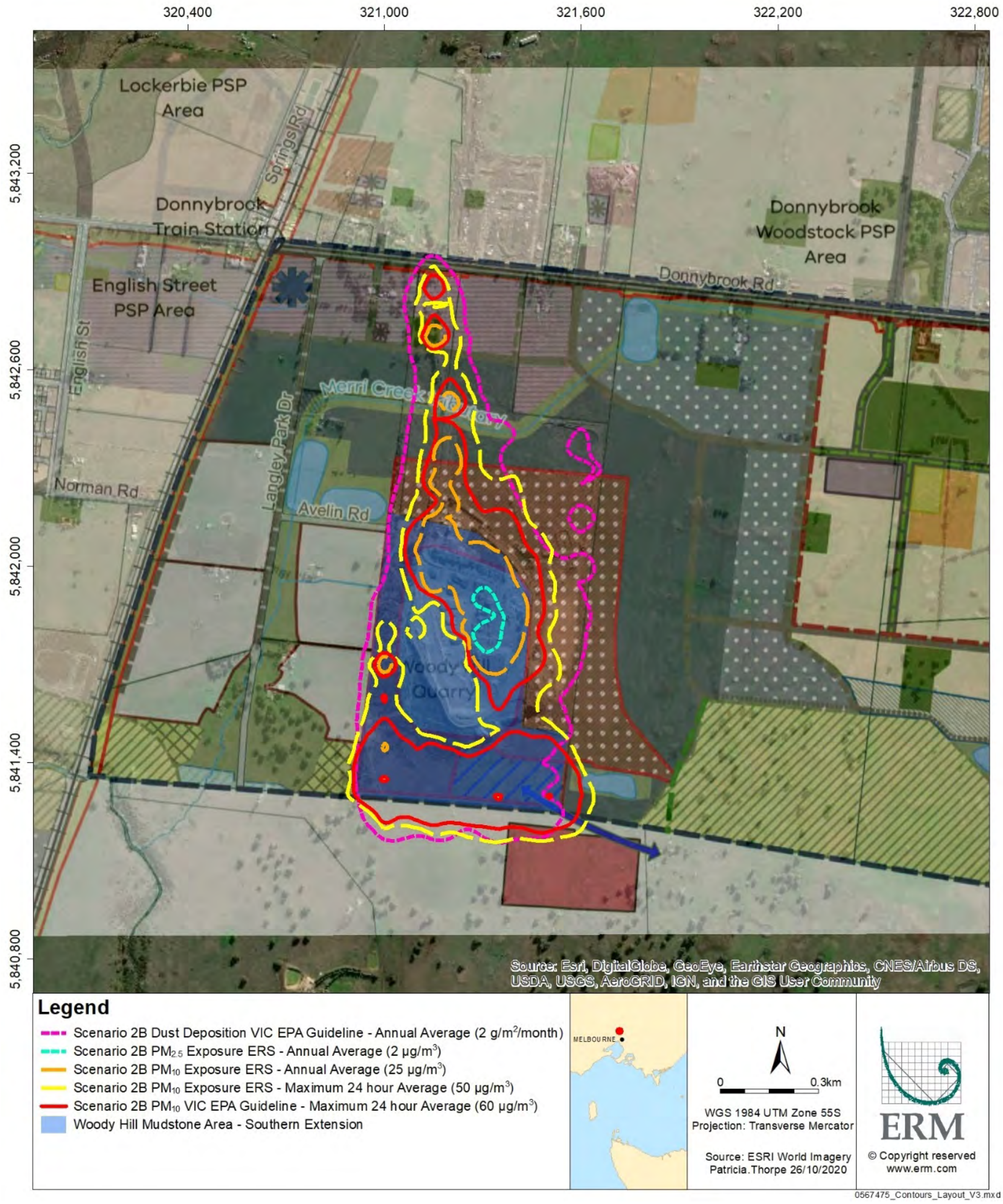


Figure 7-7 Extent of Impact during the Woody Hill Southern Expansion for Mudstone Extraction and Processing

7.2.3 Scenario 3 - Woody Hill Operations Phillips Quarry and Stage 1

The two stages of the Woody Hill expansion were modelled independently with the commencement of operations in Stage 1 of the Phillips Quarry. Material extracted at the Woody Hill quarry will continue to be crushed at the Woody Hill Quarry, whilst material extracted from the Phillips Quarry will be crushed at a mobile plant within the Phillips Quarry.

7.2.3.1 Scenario 3A - Woody Hill Northern Expansion with Phillips Quarry Stage 1

Figure 7-8 shows the area of expected maximum impact during operation of the northern expansion of the Woody Hill Quarry and Stage 1 of the Phillips Quarry. In comparison with Scenario 2A, the separation distance required extends to the north of Donnybrook Road. This is the result of additional trucks on the haul road which skirts the northern expansion area plus extraction at the northern end of the quarry.

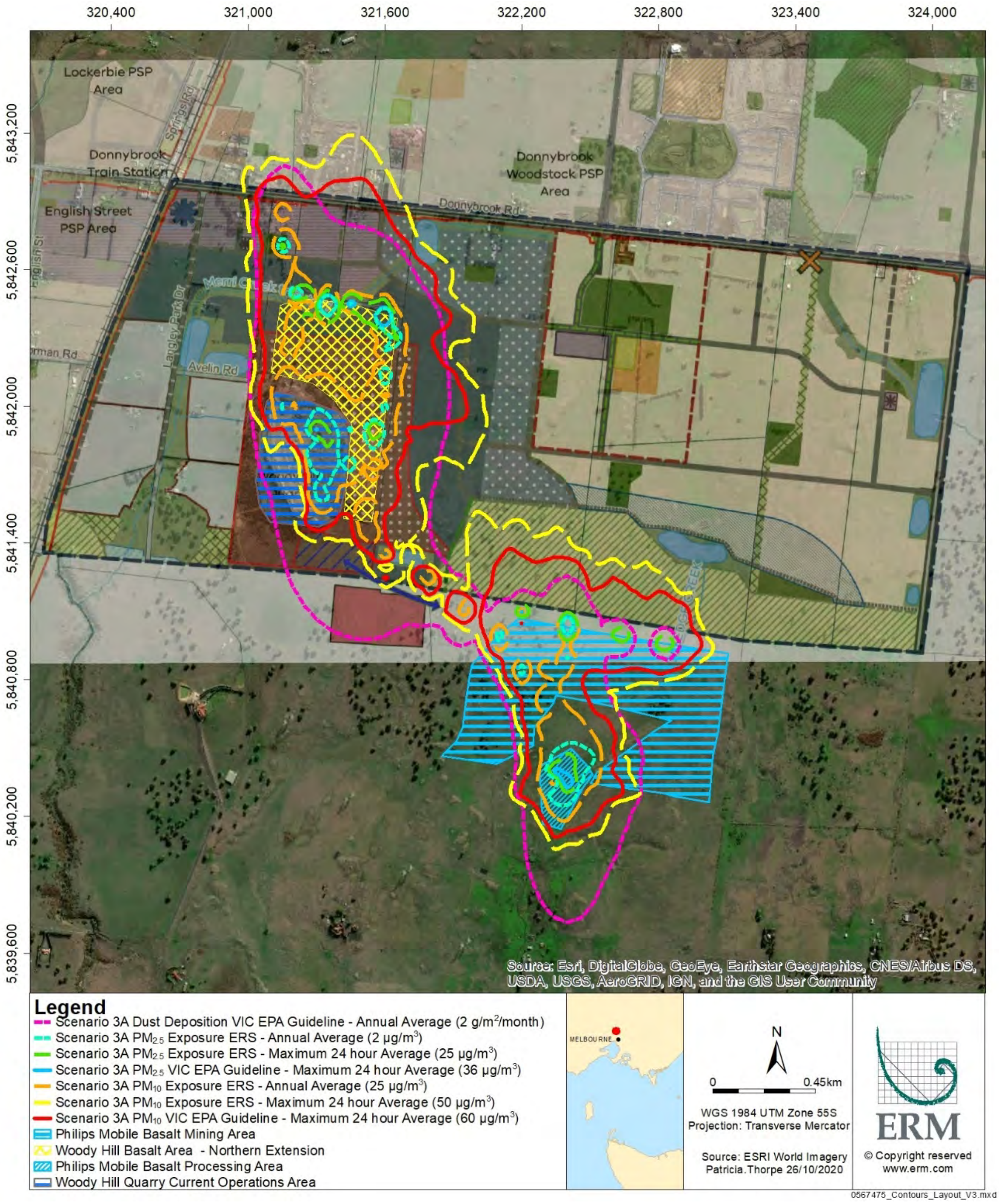


Figure 7-8 Extent of Impact during the Woody Hill Northern Expansion for Basalt Extraction and Processing with Phillips Quarry Stage 1

It should be noted that this predicted impact beyond Donnybrook Road is the maximum 24 hour concentration over five modelled years. The predicted impact may only occur where extraction is occurring at the very northern extents of the extraction area and favourable meteorological conditions are coincident. Prevention of impact to these areas can be achieved through:

- Ensuring blasting does not occur in the Woody Hill Quarry when the wind is from the southerly direction (predictions for the Phillips Quarry indicate that the blast impacts are contained within the proposed separation distance); and
- Placing reactive monitoring along the site boundaries to determine when elevated concentrations as a result of operations are occurring and moving operations to other locations within the pit when trigger levels are exceeded.

An environmental management plan (EMP) is a usual requirement for quarry operations either under the planning permit and/or the work approval. Additional work can be undertaken for either of these stages to determine the exact controls needed to manage emissions to minimise impact.

7.2.3.2 Scenario 3B - Woody Hill Southern Expansion with Phillips Quarry Stage 1

Figure 7-9 shows the area of expected maximum impact during operation of the southern expansion of the Woody Hill Quarry and Stage 1 of the Phillips Quarry.

From this prediction, it can be seen that all areas of impact are within the area designated for industrial use within the PSP or over unpopulated areas to the south of the quarries. This is considered appropriate.

Mitigation of the slight protrusion extending beyond Donnybrook Road could be achieved by sealing of the haul road from the weighbridge to the north-western corner of the northern expansion with regular sweeping to prevent drying mud on the paved surface.

7.2.4 Scenario 4 - Woody Hill Operations Phillips Quarry and Stage 2

The two stages of the Woody Hill expansion were modelled independently with the commencement of operations in Stage 2 of the Phillips Quarry. Material extracted at the Woody Hill quarry will continue to be crushed at the Woody Hill Quarry, whilst material extracted from the Phillips Quarry will be crushed at the enclosed plant within the Phillips Quarry.

7.2.4.1 Scenario 4A - Woody Hill Northern Expansion with Phillips Quarry Stage 2

Figure 7-10 shows the area of expected maximum impact during operation of the northern expansion of the Woody Hill Quarry and Stage 2 of the Phillips Quarry. In comparison with Scenario 3A, the separation distance around the Woody Hill Quarry is the same, however the required separation distance around the Phillips Quarry has reduced.

This is to be expected as the operations in the Woody Hill Quarry for Scenarios 3A and 4A are the same, and it is the addition of activity in the Phillips Quarry that provides the difference in the scenarios.

In consideration of the impact around the Phillips Quarry, this is less than in Scenario 3A as the area of extraction is further to the south and the crushing area is now enclosed. It should also be noted that as the area of extraction moves even further south within Phillips Quarry, eventually, it is likely that there will be no impact beyond the northern boundary of the quarry and the requirement for a separation distance could be removed at that time.

It should be noted that this predicted impact beyond Donnybrook Road is the maximum 24 hour concentration over five modelled years. The predicted impact may only occur where extraction is occurring at the very northern extents of the extraction area and favourable meteorological conditions are coincident. Prevention of impact to these areas can be achieved through:

- Ensuring blasting does not occur in the Woody Hill Quarry when the wind is from the southerly direction (predictions for the Phillips Quarry indicate that the blast impacts are contained within the proposed separation distance); and
- Placing reactive monitoring along the site boundaries to determine when elevated concentrations as a result of operations are occurring and moving operations to other locations within the pit when trigger levels are exceeded.

An environmental management plan (EMP) is a usual requirement for quarry operations either under the planning permit and/or the work approval. Additional work can be undertaken for either of these stages to determine the exact controls needed to manage emissions to minimise impact.

7.2.4.2 Scenario 4B - Woody Hill Southern Expansion with Phillips Quarry Stage 2

Figure 7-11 shows the area of expected maximum impact during operation of the southern expansion of the Woody Hill Quarry and Stage 1 of the Phillips Quarry. During these operations, the area of impact around the Woody Hill Quarry stays the same as it does during Scenario 2B, whilst the impact around the Phillips Quarry remains the same as it does in Scenario 4A. During these operations all impact is to land either designated as industrial or to non-populated areas.

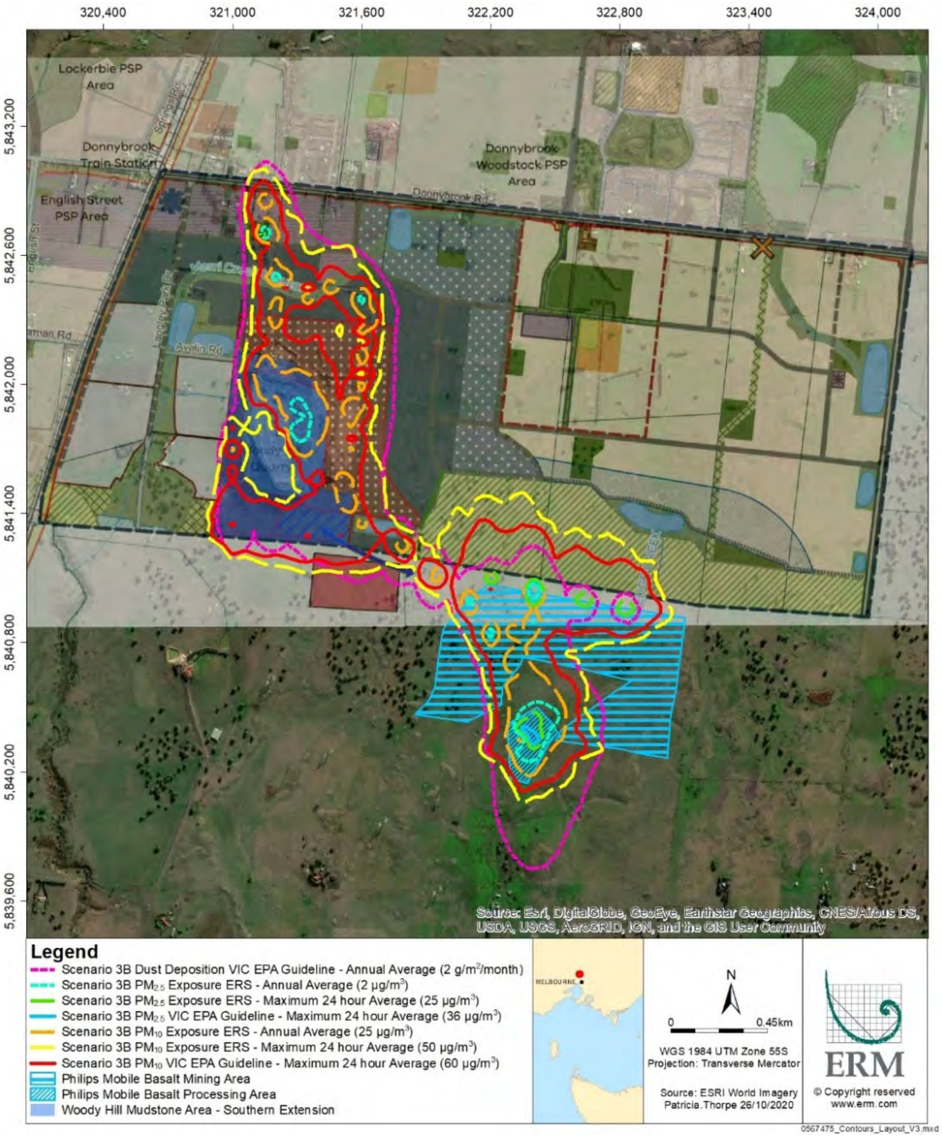


Figure 7-9 Extent of Impact during the Woody Hill Southern Expansion for Mudstone Extraction and Processing with Phillips Quarry Stage 1

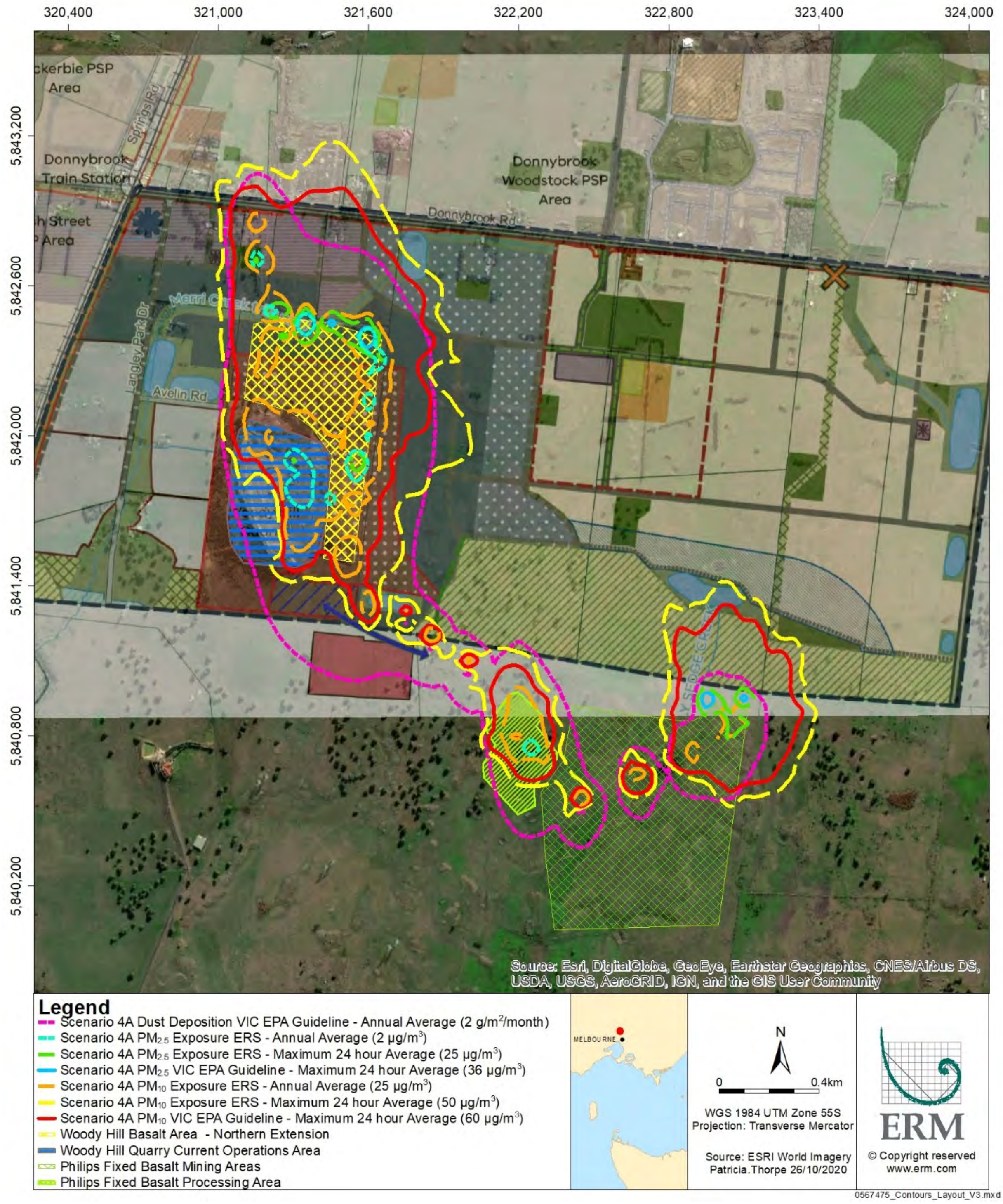


Figure 7-10 Extent of Impact during the Woody Hill Northern Expansion for Basalt Extraction and Processing with Phillips Quarry Stage 2

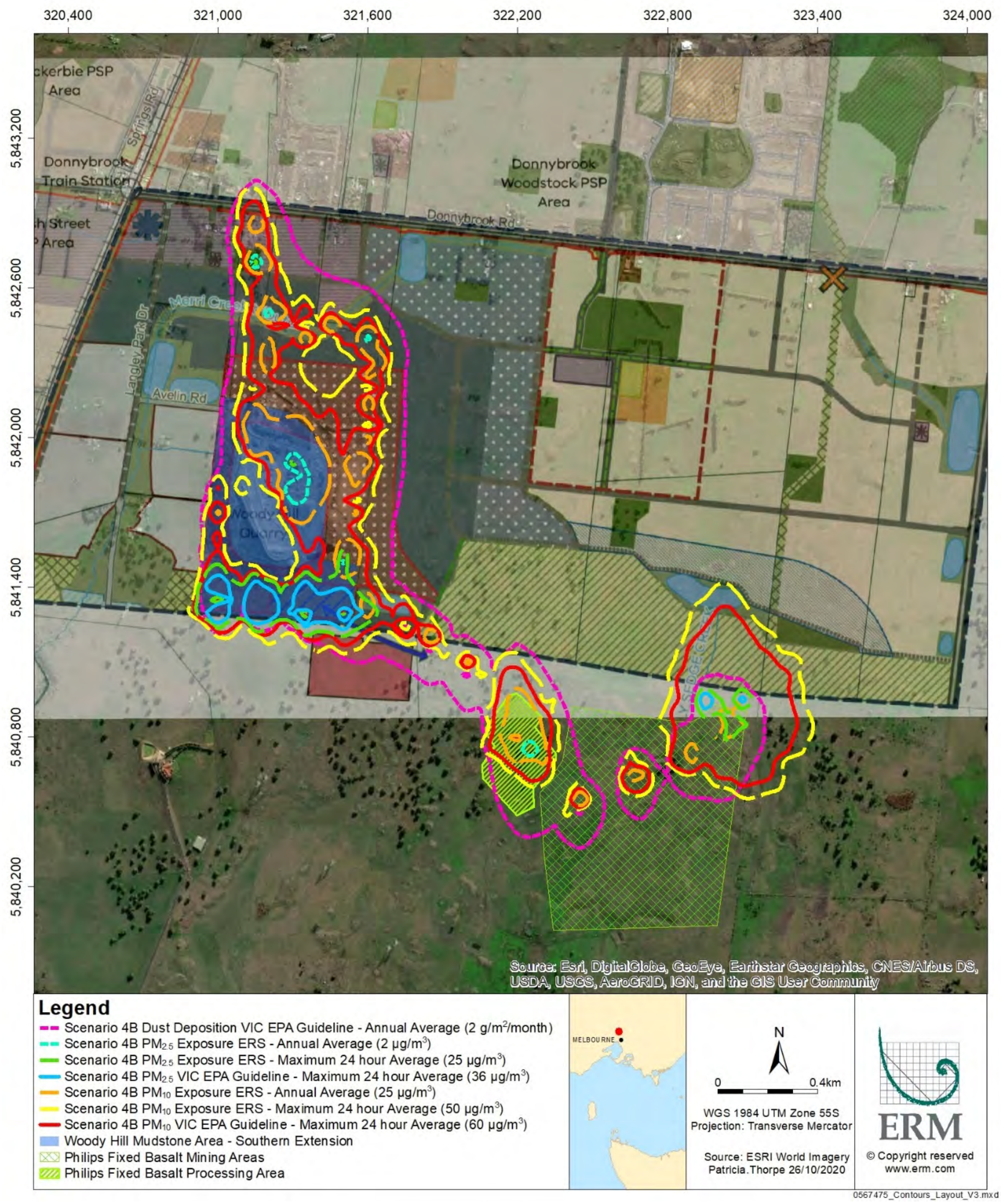


Figure 7-11 Extent of Impact during the Woody Hill Southern Expansion for Mudstone Extraction and Processing with Phillips Quarry Stage 2

7.2.5 Recommended Separation Distances

Figure 7-12 shows the modelled extent of area for each of the scenarios required to contain ambient air quality standards to acceptable concentrations compared to the standard separation distances.

As discussed it is considered that the extension to the north of Donnybrook Road can be reduced under Scenarios 3 and 4 through the limitation of blasting to when the wind is not from the south and through the use of boundary monitoring and reactive management.

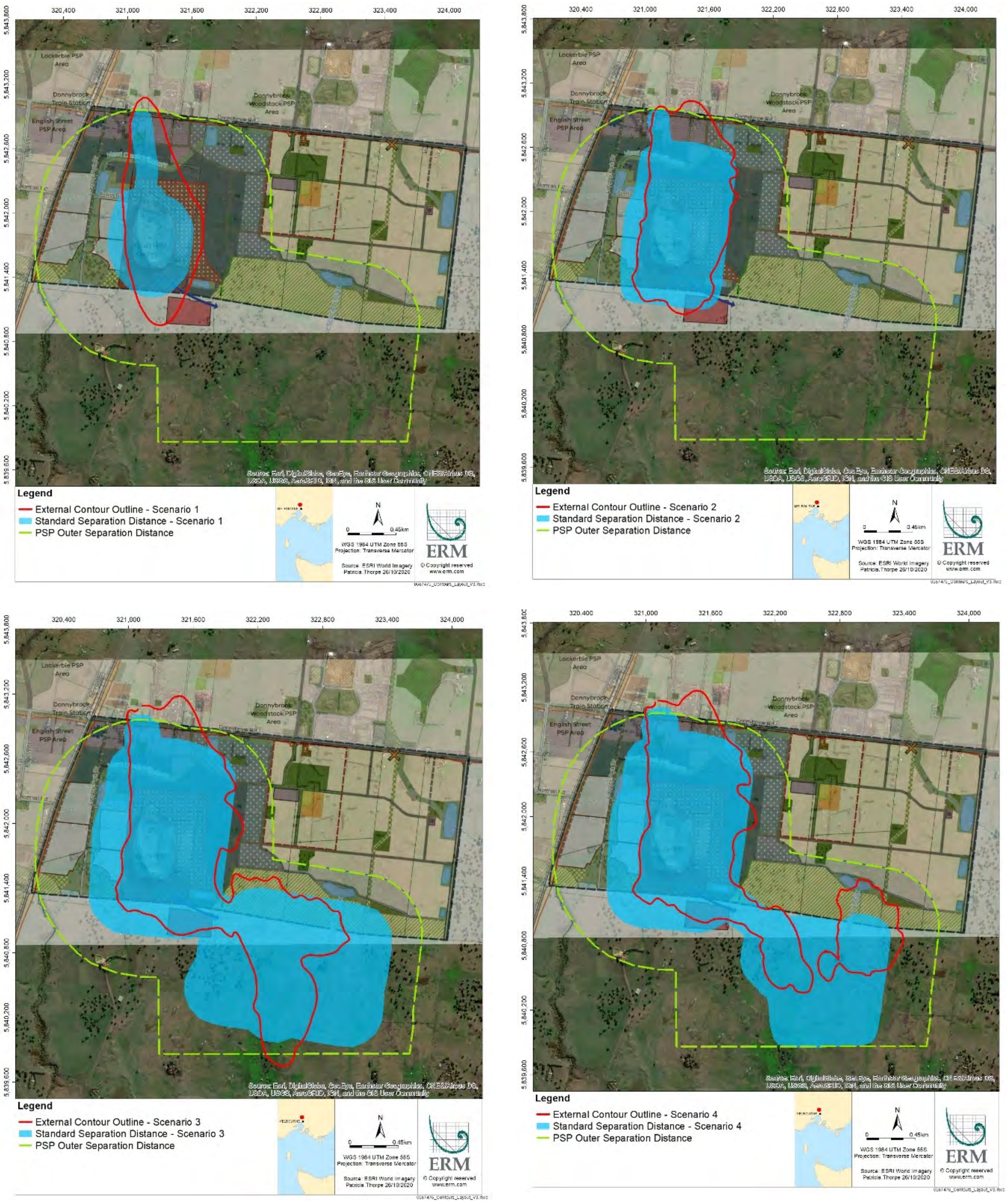


Figure 7-12 Modelled extent of area required to contain likely future ambient air quality standards to acceptable concentrations compared to the standard separation distances

Overall, therefore, the area set aside within the PSP for:

- Industrial use to the north and east of the Woody Hill Quarry;
- Utility facility to the west of the Woody Hill Quarry;
- BSC conservation area to the north of the Phillips Quarry; and

- Postponing future residential use to the east of the Woody Hill Quarry and the immediate north of the BSC conservation area until such time as the extraction in the Woody Hill and Phillips Quarries, as the case may be, is occurring 500 m from that residential land,

is sufficient to prevent impact to sensitive land use.

During extraction of the northern expansion at the very northern extent, there is potential for impact beyond Donnybrook Road, however this impact can be mitigated through:

- Ensuring blasting does not occur when the wind is from the southerly direction; and
- Placing reactive monitoring along the northern extent to determine when elevated concentrations as a result of operations are occurring and moving operations to other locations within the pit when trigger levels are exceeded.

It must be considered that the recommended separation distances for this study are for residual atmospheric emissions only and greater separation distances may be required for other environmental impacts.

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APPENDIX A METEOROLOGICAL MODELLING

1. APPENDIX A

The nearest Bureau of Meteorology (BoM) stations to the Shenstone Park precinct are located more than 15 kilometres away. In accordance with EPA Publication 1550, where meteorological observation stations are more than 5 km from the subject site, meteorological modelling has been used to construct a site specific meteorological file. Meteorological modelling was undertaken for most recent five years (2015-2019 inclusive).

ERM developed three-dimensional micro-meteorological model for the site using a combination of the following meteorological model and processing methods:

- Weather Research and Forecasting model (WRF);
- MMIF extraction tool; and
- AERMET for updated land use.

1.1 WRF

Meteorological modelling was first undertaken using Weather Research and Forecasting model (WRF). WRF is a three-dimensional numerical meteorological model which can be used to generate three dimensional gridded meteorological data through the treatment and assimilation of available surface/upper air/precipitation observations in addition to very specific and local land use characteristics.

WRF modelling was conducted for the five year period (2015-2019 inclusive) to simulate meteorological conditions across the modelling domains. The process of developing the WRF datasets involved a nested approach as described below. Initially, a broader geographical domain was selected to span the State of New South Wales and Victoria at a horizontal grid resolution (spacing) of 27 kilometres (km). The next three iterations of the WRF modelling was conducted to reduce the horizontal resolution to 9 km, 3 km and 1 km (in accordance with EPA publication 1551 . The model was centred at 37.641°S and 144.47°E and a Lambert conformal conic (LCC) map projection was used to account for the curvature (degree of distortion) of the earth.

1.1.1 Initialization Datasets

WRF meteorological datasets were developed for the period using data ERA5 dataset published by the European Centre for Medium-Range Weather Forecasts (ECMWF) as the initial guess and boundary fields. ERA5 data are available every three hours on a 27 km grid and resolves the atmosphere from the surface up to a height of 80 km at 137 levels.

1.1.1.1 Geospatial WRF Inputs

WRF inputs are available from NCAR with default sets of static geospatial data for terrain, vegetation/land use and soil type. At the latitude of the site, the datasets have a resolution of about 0.45 km.

These data were assigned to ERM's WRF simulations based on the resolution of the simulation domain. In addition to the above inputs, other features available from the University Corporation for Atmospheric Research (UCAR) were used in the prognostic modelling.

1.1.1.2 Land Use

In addition to the default databases, for this study for the inner grids at resolution of 9 km, 3 km and 1 km an approach to utilize land use at 50 m resolution was developed. Land use inputs to the WRF model were obtained from the Dynamic Land Cover Dataset (DLCD) published by Geoscience Australia.

1.1.1.3 Terrain

For terrain, the terrain data at 30 m for the final refined grid (Domain-04 at 1 km) was utilised. Terrain inputs to the WRF model at 30-m resolution were obtained from the SRTM elevation model.

1.1.1.4 WRF Options

In addition to the domain-wide characteristics noted above, the following discussion describes the physical schemes available within the WRF system and how they were adapted for use by ERM in the modelling analysis. The WRF model user has the choice of numerous options for running the model and its pre-processors. Table 1-1 provides a listing of the primary options, and provides notes including the reasoning behind selecting each option.

Table 1-1 WRF Options selected

WRF Treatment	Option Selected	Reason & Notes
Microphysics	Thompson	A new bulk microphysical parameterization (BMP) has been developed for use with WRF. Compared to earlier single-moment BMPs, the new scheme incorporates a large number of improvements to both physical processes and employs numerous techniques found in far more sophisticated spectral/bin schemes using look-up tables. This scheme is a new scheme with ice, snow and graupel processes suitable for high-resolution simulations.
Shortwave & Longwave Radiation	Rapid Radiation Transfer Model (RRTMG)	This a recent version of RRTM with random cloud overlap. RRTMG provides more sophisticated cloud treatment and better suited for climate applications than RRTM (option 1). RRTMG also handles cloud fraction whereas RRTM is 1/0. Based on available guidance, this scheme is considered to be highly accurate and efficient method. This scheme also incorporates the effects of the comprehensive absorption spectrum taking water vapor, carbon dioxide and ozone into account. This scheme handles better cloud interactions with Thompson MP scheme.
Land Surface Model	NOAH	To incorporate the air-soil interaction in the WRF simulation, the Noah Land-Surface Model (LSM) was chosen. Seasonally varying vegetation and soil type are used in the model to handle evapotranspiration. The LSM model also has the effects such as soil conductivity and gravitational flux of moisture. The land-surface model is capable of predicting soil moisture and temperature in four layers (10, 30, 60 and 100 cm thick), as well as canopy moisture and water-equivalent snow depth.
Planetary Boundary Layer (PBL)	Yonsei University (YSU)	This scheme has the enhanced stable boundary layer diffusion algorithm is also devised that allows deeper mixing in windier conditions. It has the ability to predict & simulates vertical mixing. This scheme also seems to show better performance during stable conditions. This scheme was used for WRF analyses with resolutions less than 1.33 km grid resolution.

WRF Treatment	Option Selected	Reason & Notes
Cumulus Parameterization	Kain-Fritsch in 36 km, 12 km, 4km	This scheme generally focuses on column moisture, temperature tendencies and surface convective rainfall. It is recommended that cumulus parameterization should not used at grid sizes < 5-10 km, as the smaller grid size is sufficient to resolve updrafts and downdrafts. Therefore, this scheme was used for WRF analyses with resolutions less than 4 km grid resolution.

1.2 MMIF

MMIF is a tool developed by the United States EPA to extract an AERMOD compatible meteorological file at the closest model grid point to the subject Site. MMIF was used with default inputs to extract a meteorological file at the following coordinates.

1.3 AERMET

Surrounding land use has an impact on three parameters known as surface roughness, albedo and Bowen ratio. Each of these impact how dispersion and dilution occurs following emission from a source. Using the wrong surrounding land use can impact how the dispersion will occur.

The land use from the DLCD database is for landuse from January 2014 to December 2015 which would provide the incorrect parameters within the AERMOD model as the surrounding land use would be grassland rather than industrial or built up use.

To overcome this issue, the following parameters were extracted from the AERMOD surface files generated by MMIF:

- Wind speed;
- Wind direction;
- Temperature;
- Humidity;
- Rainfall; and
- Surface pressure.

EPA Publication 1550 requires that the surface roughness is selected based on directional land use. To describe the directional land use, five sections have been used as shown in Figure 1-1.

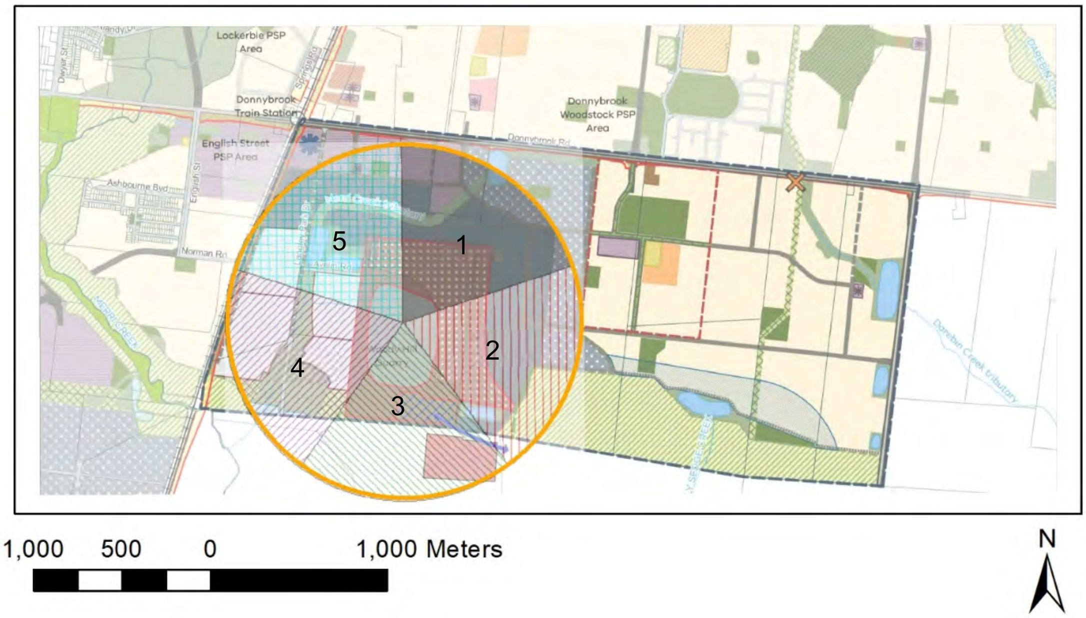

Figure 1-1 Surface Roughness Sectors Overlaid on PSP

The percentage of land use within each sector has been estimated and the surface roughness calculated in accordance with the guidance in EPA Publication 1550. The final used surface roughness is shown in Table 1-2.

Table 1-2 Adopted Landuse percentages and Surface Roughness Parameters

Sector	Adopted Percentage Land use	Final Surface Roughness			
		Summer	Autumn	Winter	Spring
1	25% Quarry 75% Industrial	0.6	0.6	0.6	0.6
2	25% Quarry 60% Industrial 15% Grassland	0.51	0.51	0.4965	0.5025
3	50% Quarry 50% Grassland	0.2	0.2	0.155	0.175
4	20% Quarry 40% Grassland 40% Industrial	0.38	0.38	0.344	0.36
5	20% Quarry 80% Industrial	0.62	0.62	0.62	0.62

For albedo and bowen ratio, EPA Publication 1550 states that you need to consider the land use within a 10 km radius and take the arithmetic mean of the estimated land use and the parameters contained within the guidance. Figure 1-2 shows a distance of 10 km from Woody Hill Quarry.

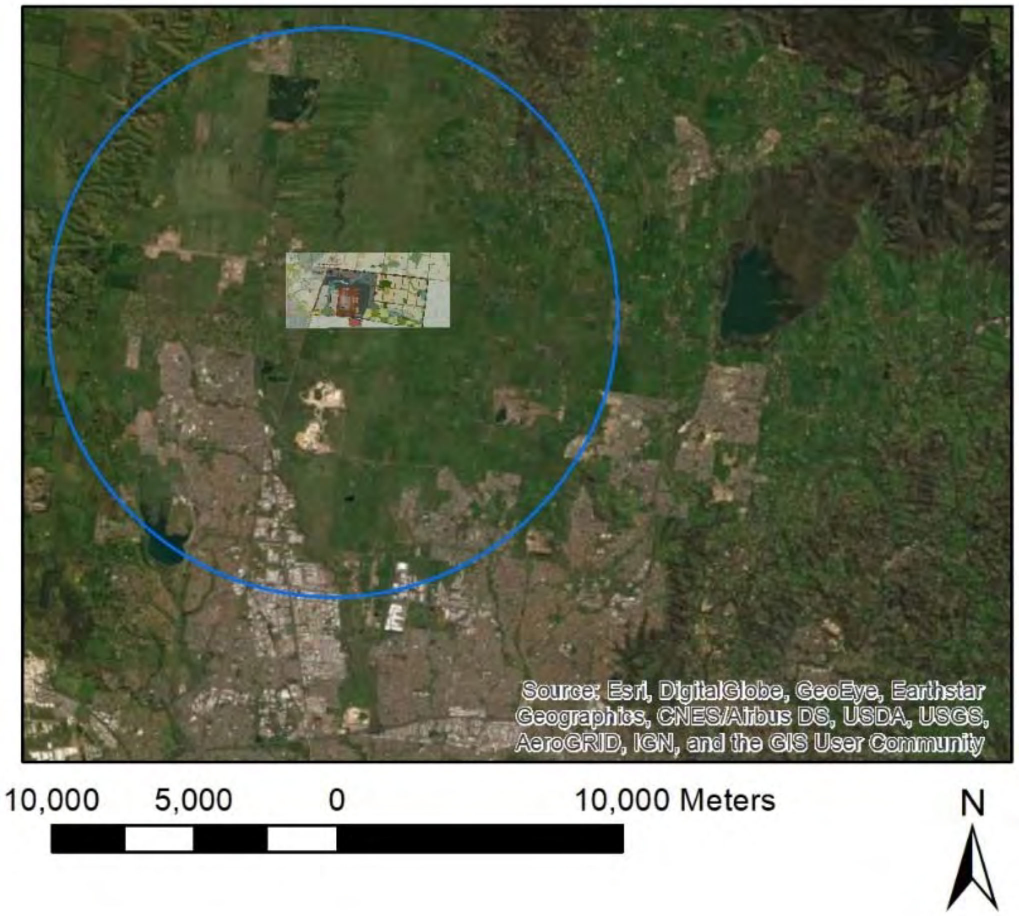

Figure 1-2 Landuse within 10 km for Selection of Bowen Ratio and Albedo

From Figure 1-2 it was estimated that the land used within a 10 km radius of the site was:

- 5% quarrying;
- 10% industrial;
- 45% low intensity residential; and
- 40% grassland.

For the Bowen Ratio an average level of rainfall was selected. This resulted in the adoption of the albedo and Bowen Ratios shown in Table 1-3.

Table 1-3 Adopted Albedo and Bowen Ratio

Parameter	Final Surface Roughness			
	Summer	Autumn	Winter	Spring
Albedo	0.172	0.172	0.189	0.172
Bowen Ratio	0.905	1.075	1.075	0.745

AERMET was then run and the generated surface files used in the dispersion modelling. The upper air profiles were taken from the output from MMIF.

It should be noted that as a limitation of AERMOD only one meteorological file can be used per model run to represent the meteorological parameters. It has therefore been assumed by AERMOD that the adopted meteorology derived for Woody Hill Quarry is equally applicable for Phillips Quarry. It is considered that whilst, in reality there will be some difference to the direction of the surface roughness, as the Bowen ration and albedo are set for a large area these will be equally representative.

APPENDIX B EMISSION ESTIMATION

1. APPENDIX B

The operation of the Project has been analysed and estimates dust emissions for the key dust generating activities have been made. Emission factors developed in Australia, and by the United States Environment Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998), have been applied to estimate the amount of dust produced by each activity. The emission factors are considered to be the most reliable, contemporary methods for determining dust generating rates.

1.1 Quarry

1.1.1 Drilling

Chapter 11.9 of the United States Environment Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) provides default emission factor of:

- 0.59 kg/hole of TSP;
- 0.31 kg/hole of PM_{10}; and
- 0.02 kg/hole of $PM_{2.5}$

At the site, 120 drill holes are drilled per blast of mudstone (120 holes for a blast area of 1,500 m^2) and 170 holes are drilled per blast of basalt (170 holes for a blast area of 2,100 m^2). Drilling was assumed to occur immediately before blasting. Assuming that blasting is likely to be only allowed between 7am and 6pm, drilling was assumed to occur for a maximum of 12 and 11 hours for each quarry respectively.

The quarry does not have a dust extraction system and a 0% emission control has been assumed for drilling. Emission estimation for drilling was therefore calculated using Equation 1. The calculated emission rates of 1.78 g/sec of TSP and 0.93 g/sec of PM_{10} were adopted in the dispersion modelling. United States Environment Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) indicates that $PM_{2.5}$ emissions from blasting constitute approximately 3% of TSP emissions. In the absence to data related to drilling, it was assumed that in drilling $PM_{2.5}$ emissions also constitute 3% of TSP emissions. The calculated emission rate of 0.05 g/sec of $PM_{2.5}$ was therefore adopted in the dispersion modelling.

Equation 1 Emission estimation for drilling

$$ER_i = \frac{EF_i \times N \times 1{,}000}{11 \times 3{,}600} \times \left(\frac{100 - C}{100}\right)$$

Where

ER_i is emission rate for TSP/PM_{10}/$PM_{2.5}$ (g/sec)

EF_i is emission factor for TSP/PM_{10}/$PM_{2.5}$ (kg/hole)

N is number of holes

C is control factor

1.1.2 Blasting

Chapter 11.9 of the United States Environment Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) provides default emission factor of TSP emissions factors for blasting.

US EPA AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) indicates that PM_{10} emissions from blasting constitutes approximately 52% of TSP emissions, and $PM_{2.5}$ emissions from blasting constitutes approximately 3% of TSP emissions.

Blasting at the site occurs once or twice a month. Current operations at the quarry involve blasting of mudstone. A blast area of 1,500 m^2 per blast of mudstone has been provided. The emission factor of 12.78 kg of TSP were calculated using **Equation 2**. Using the ratios provided by the US EPA AP-42, the emission rates of 6.65 kg of PM_{10} and 0.38 kg of $PM_{2.5}$ were calculated respectively. The emission rates adopted in the dispersion modelling was therefore 0.32 g/sec of TSP, 0.16 g/sec of PM_{10} and 0.1 g/sec of $PM_{2.5}$.

Future operations at the quarry could involve extraction of basalt. A blast area of 2,100 m^2 per blast of basalt has been provided. The emission factor of 21.17 kg of TSP were calculated using Equation 2. Using the ratios provided by the US EPA AP-42, the emission rates of 11.01 kg of PM_{10} and 0.64 kg of $PM_{2.5}$ were calculated respectively. The emission rates adopted in the dispersion modelling was therefore 0.53 g/sec of TSP, 0.28 g/sec of PM_{10} and 0.02 g/sec of $PM_{2.5}$.

Equation 2 Calculation of TSP emission factor for blasting (Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2012)

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

Where

EF_{TSP} is emission factor for TSP (kg/blast)

A is area blasted (m^2)

1.1.3 Loading/unloading and transfer of basalt and mudstone

Chapter 13.2.4 of the United States Environment Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) provides default emission factor of TSP, PM_{10} and $PM_{2.5}$ emission factors from loading. Time varying emission factors were estimated using hourly wind speed.

Equation 3 Emission factor for loading/unloading (US EPA) AP-42: Compilation of Air Emissions Factors

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

Where:

EF is emission factor (kg of pollutant/tonne of material)

k is a constant equal to 0.74 for particles less than 30 μm aerodynamic diameter, 0.35 for particles less than 10 μm aerodynamic diameter and 0.053 for particles less than 2.5 μm aerodynamic diameter

U is mean wind speed in m/sec

M is moisture content (6% for mudstone, 3% for basalt)

Equation 4 was then used to estimate TSP, PM_{10} and $PM_{2.5}$ emission rates for loading/unloading t the quarry (mudstone and basalt). The calculation adopted volume of mudstone of 3,500 tpd and volume of basalt of 4,000 tpd handled over 12 and 11 hours for each quarry respectively.

Equation 4 Loading emission rate estimation

$$ER = EF \times Q \times \frac{1,000}{365 \times 11 \times 3,600}$$

Where:

ER is emission rate (g/sec)

EF is emission factor (kg/tonne)

Q is quantity of material (tpa)

1.1.4 Wheel movements on haul roads

The NPI Emission Estimation Technique Manual for Mining Version 3.1 (Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2012) provides Equation 5 for calculating emissions factors for wheel generated dust emissions from unpaved roads at industrial sites. This equation has been lifted from the US EPA AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998), which includes k-values for TSP, PM_{10} and $PM_{2.5}$.

Equation 5 Wheel generated dust emission factor (kg/vehicle km travelled) (Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2012)

$$EF = \frac{0.4536}{1.6093} \times k \times \left(\frac{S}{12}\right)^{a} \times \left(\frac{W \times 1.1023}{3}\right)^{b}$$

Where:

EF is emission factor (kg/vehicle kilometre travelled)

k is value equal to 4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$*

S is silt content of the road material (%)

W is vehicle mass (t)

a is an empirical constant equal to 0.7 for TSP and 0.9 for PM_{10} and $PM_{2.5}$

b is an empirical constant equal to 0.45

There are eight primary haul routes at the Site:

- Woody Hill Pit operations to processing plant (WH_PO_PP)
- Woody Hill processing plant product to stockpiles (WH_PP_SP)
- Woody Hill stockpiled material to offsite (WH_SP_OFF)
- Phillips Quarry pit operations to processing plant (PQ_PO_PP) – Scenarios 3 and 4 only
- Philips Quarry processing plant product to stockpiles (PQ_PP_SP) – Scenarios 3 and 4 only
- Offsite basalt delivery to processing plant (BS_PP) – Scenario 1 only
- Offsite aggregate, sand and cement delivery to CBP (OFF_CBP)
- CBP concrete to offsite (CBP_OFF)

In addition, the entrance to the Site contains a stretch of sealed road approximately 120 m in length. In accordance with the NPI Emission Estimation Technique Manual for Mining Version 3.1 (Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2012), a 100% control on emissions has been assumed for all vehicle movements along the sealed road.

Due to the evolving nature of the Site, the distances and locations of each of these haul routes varies with each modelled scenario.

Table 1.2 presents emission factors calculated for the types of trucks used at the quarry, for each scenario, using Equation 5 and site-specific information provided in Table 1.1. The locations of the haul roads for each scenario are shown in Figure 1.1 to Figure 1.7.

Table 1.1 Site-specific parameters used for estimation of emission factors for wheel generated emissions

Site-specific parameters	Value	Units
Site road silt content	2.7[1]	percent
Unloaded weight of onsite rock truck	17[2]	tonnes
Loaded weight of onsite rock truck	50[2]	tonnes
Unloaded weight of offsite truck and dog	17[2]	tonnes
Loaded weight of offsite truck and dog	50[2]	tonnes
Unloaded weight of agitator truck	3[3]	tonnes
Loaded weight of agitator truck	12.2[3]	tonnes
Site road mitigation	75[4]	percent

1. Average silt content of haul roads (PAEHolmes, 2013)
2. Based on indicative information provided during the site visit
3. Based on industry standardised weight of agitator truck
4. Level 2 watering (>2 litres/m^2/h)) as per Table 4, NPI Mining (Australian Government Department of the Environment, 2014)

Table 1.2 Road lengths used for estimation of emission factors for wheel generated emissions

Scenario	Haul Road	Value	Units
Scenario 1	WH_PO_PP length	0.44[1]	km
	BS_PP length	1.40[1]	km
	PP_SP length	0.13[1]	km
	SP_OFF length	1.00[1]	km
	OFF_CBP length	0.95[1]	km
	CBP_OFF length	0.89[1]	km
Scenario 2A	WH_PO_PP length	1.48[1]	km
	PP_SP length	0.11[1]	km
	SP_OFF length	1.00[1]	km
	OFF_CBP length	0.95[1]	km
	CBP_OFF length	0.89[1]	km
Scenario 2B	WH_PO_PP length	0.56[1]	km
	PP_SP length	0.11[1]	km
	SP_OFF length	1.08[1]	km
	OFF_CBP length	0.95[1]	km
	CBP_OFF length	0.89[1]	km
Scenario 3A	WH_PO_PP length	1.48[1]	km
	WH_PP_SP	0.11[1]	km
	WH_SP_OFF	1.00[1]	km

	PQ_PO_PP length	0.80[1]	km
	PQ_SP_OFF	3.29[1]	km
	OFF_CBP length	0.95[1]	km
	CBP_OFF length	0.89[1]	km
Scenario 3B	WH_PO_PP length	0.56[1]	km
	WH_PP_SP	0.11[1]	km
	WH_SP_OFF	1.00[1]	km
	PQ_PO_PP length	0.80[1]	km
	PQ_SP_OFF	3.29[1]	km
	OFF_CBP length	0.95[1]	km
	CBP_OFF length	0.89[1]	km
Scenario 4A	WH_PO_PP length	1.48[1]	km
	WH_PP_SP	0.11[1]	km
	WH_SP_OFF	1.00[1]	km
	PQ_PO_PP length	1.00[1]	km
	PQ_SP_OFF	2.68[1]	km
	OFF_CBP length	0.95[1]	km
	CBP_OFF length	0.89[1]	km
Scenario 4B	WH_PO_PP length	0.56[1]	km
	WH_PP_SP	0.11[1]	km
	WH_SP_OFF	1.00[1]	km
	PQ_PO_PP length	1.00[1]	km
	PQ_SP_OFF	2.68[1]	km
	OFF_CBP length	0.95[1]	km
	CBP_OFF length	0.89[1]	km

1. Calculated using satellite imagery of site and assuming the maximum output of the quarry

Table 1.3 Emission factors estimated for wheel generated dust from unpaved roads by trucks at the quarry

Truck type	TSP (kg/VKT[1])	PM_{10} (kg/VKT)	$PM_{2.5}$ (kg/VKT)
Unloaded rock truck (onsite)	1.109	0.252	0.025
Loaded rock truck (onsite)	1.801	0.409	0.041
Unloaded truck and dog (onsite)	1.109	0.252	0.025
Loaded truck and dog (onsite)	1.801	0.409	0.041

Truck type	TSP (kg/VKT[1])	PM_{10} (kg/VKT)	$PM_{2.5}$ (kg/VKT)
Unloaded agitator truck	0.955	0.217	0.022
Loaded agitator truck	1.474	0.335	0.033

1. VKT stands for Vehicle Kilometre Travelled

TSP, PM_{10} and $PM_{2.5}$ emission rates in grams per second per meter were then calculated using Equation 6 and the information provided in Table 1.2 and Table 1.3.

Equation 6 Wheel generated dust emission rate estimation (g/m/sec)

$$ER = \frac{EF \times L}{W} \times Q \times C \times \frac{1000}{365 \times 11 \times 3600}$$

Where:
ER is emission rate (g/m/sec)
EF is emission factor (kg/vehicle kilometre travelled)
L is road length (km)
W is standard weight of vehicle load (t/load)
Q is quantity of material (tonnes per year)
C is activity control level

1.1.5 Wind erosion

For wind generated dust the dispersion modelling adopted a time-varying emission file which has accounted for local wind speed. Firstly, annual TSP emissions were estimated using the default TSP emission factor of 0.1 kg/ha/hr as provided in Chapter 11.9 and 13.2.5 of the AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998).

US EPA AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) indicates that PM_{10} emissions from wind erosion constitutes approximately 50% of TSP emissions, and $PM_{2.5}$ emissions from wind erosion constitutes approximately 7.5% of TSP emissions.

For hours where these conditions are met, the annual emissions were allocated proportionally using wind erosion potential (Equation 7) in accordance with the power law (Shao, 1996).

Equation 7 Calculation of wind erosion

$$E_i = \left(E_{ann} \times \frac{u_i^3}{\sum_{i=1}^{N} u_i^3}\right)$$

Where:
E_{ann} = the estimated annual emission in kg/year
u_i = hourly average wind speed for the i^{th} hour
N = the number of hours of valid wind data

Table 1.4 summarises the areas exposed to wind erosion for each of the eight scenarios investigated in this assessment. It has been assumed that on any one day, the whole quarry stage will not be susceptible to wind erosion, but rather approximately 20% of this area and has been incorporated into the calculations accordingly.

Table 1.4: Area of area exposed to wind erosion

Scenario	Description	Area susceptible to wind erosion (ha)
1	Woody Hill stockpiles and conveyers	1.1
	Active pit	3.8
	CBP	0.1
2A/2B	Woody Hill stockpiles and conveyers	1.1
	Woody Hill Pit Northern Expansion	5.3
	Woody Hill Pit Southern Expansion	6.9
	CBP	0.1
3A/3B	Woody Hill stockpiles and conveyers	1.1
	Woody Hill Pit Northern Expansion	5.3
	Woody Hill Pit Southern Expansion	6.9
	Phillips Quarry stockpiles and conveyors (mobile plant processing area)	1.1
	Phillips Quarry Pit Stage 1	9.2
	CBP	0.1
4A/4B	Woody Hill stockpiles and conveyers	1.1
	Woody Hill Pit Northern Expansion	5.3
	Woody Hill Pit Southern Expansion	6.9
	Phillips Quarry stockpiles and conveyors (fixed plant processing area)	1.7
	Phillips Quarry Pit Stage 2	12.4
	CBP	0.1

1.1.6 Crusher

Chapter 11.19.2 of Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) provides emission factors of 0.0027 kg/tonne of TSP, 0.0012 kg/tonne of PM_{10} and 0.00005 kg/tonne of $PM_{2.5}$. Emission rates of 0.24 g/sec of TSP, 0.11 g/sec of PM_{10} and 0.004 g/s of $PM_{2.5}$ were therefore calculated using throughput through crusher for mudstone of 3,500 tpd and basalt of 4,000 tpd over a period of 12 and 11 hours for each quarry respectively.

1.1.7 Screening

Chapter 11.19.2 of Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) provides emission factors of 0.0125 kg/tonne of TSP, 0.000025 kg/tonne of PM_{10} and 0.00005 kg/tonne of $PM_{2.5}$. Emission rates of 1.11 g/sec of TSP, 0.38 g/sec of PM_{10} and 0.002 g/s of $PM_{2.5}$ were therefore calculated using throughput through crusher for mudstone of 3,500 tpd and basalt of 4,000 tpd over a period of 12 and 11 hours for each quarry respectively.

1.2 Concrete Batching Plant Operations

1.2.1 Loading/unloading and transfer of sand and aggregate

Chapter 13.2.4 of the United States Environment Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) provides default emission factor of TSP, PM_{10} and $PM_{2.5}$ emission factors from loading. Time varying emission factors were estimated using hourly wind speed using Equation 3 and a moisture content of 9% for sand and aggregate.

Equation 8 was then used to estimate TSP, PM_{10} and $PM_{2.5}$ emission rates for loading/unloading of the concrete batching plant (sand, aggregate and concrete). The calculation adopted quantity of sand of 500 tpd and quantity of aggregate of 600 tpd over 12 hours.

Equation 8 Loading emission rate estimation

$$ER = EF \times Q \times \frac{1{,}000}{365 \times 12 \times 3{,}600}$$

Where:

ER is emission rate (g/sec)

EF is emission factor (kg/tonne)

Q is quantity of material (tpa)

The NPI Emission Estimation Technique manual for Concrete Batching and Concrete Product Manufacturing (Australian Government Department of Agriculture, Water and Environment, 1999) provides a control factor of 80% for concrete batching activities taking place within a facility with a bag filter.

1.2.2 Cement unloading to elevated storage silo (controlled)

Chapter 11.12 of Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) provides emission factors of 0.0.0005 kg/tonne of TSP, 0.00017 kg/tonne of PM_{10}. Emission rates of 0.0014 g/sec of TSP, 0.0005 g/sec of PM_{10} were calculated using throughput of 120 tpd over a period of 12 hours. No emission factor for PM2.5 is available, therefore it has conservatively been assumed that $PM_{2.5}$ emissions would be equivalent to PM_{10} emissions.

1.2.3 Wind erosion

For wind generated dust the dispersion modelling adopted a time-varying emission file which has accounted for local wind speed. Firstly, annual TSP emissions were estimated using the default TSP emission factor of 0.1 kg/ha/hr as provided in Chapter 11.9 and 13.2.5 of the AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998).

US EPA AP-42: Compilation of Air Emissions Factors (United States Environmental Protection Agency, 1998) indicates that PM_{10} emissions from wind erosion constitutes approximately 50% of TSP emissions, and $PM_{2.5}$ emissions from wind erosion constitutes approximately 7.5% of TSP emissions.

The hourly varying emissions have been calculate din accordance with **Equation 7**. The area of the concrete batching plant exposed to wind erosion is 0.05 ha, for all investigation scenarios.

1.3 Timing of emissions

The following hours of operation were adopted in the modelling:

- Woody Hill quarry operations 6am – 6pm (12 hours);
- Phillips quarry operations 7am – 6pm (11 hours);

- Aggregate sales area 7am – 5pm (10 hours);
- Wind erosion sources: 24 hour a day (24 hours); and
- Concrete batching plant: 6am – 6pm (12 hours).

Source locations

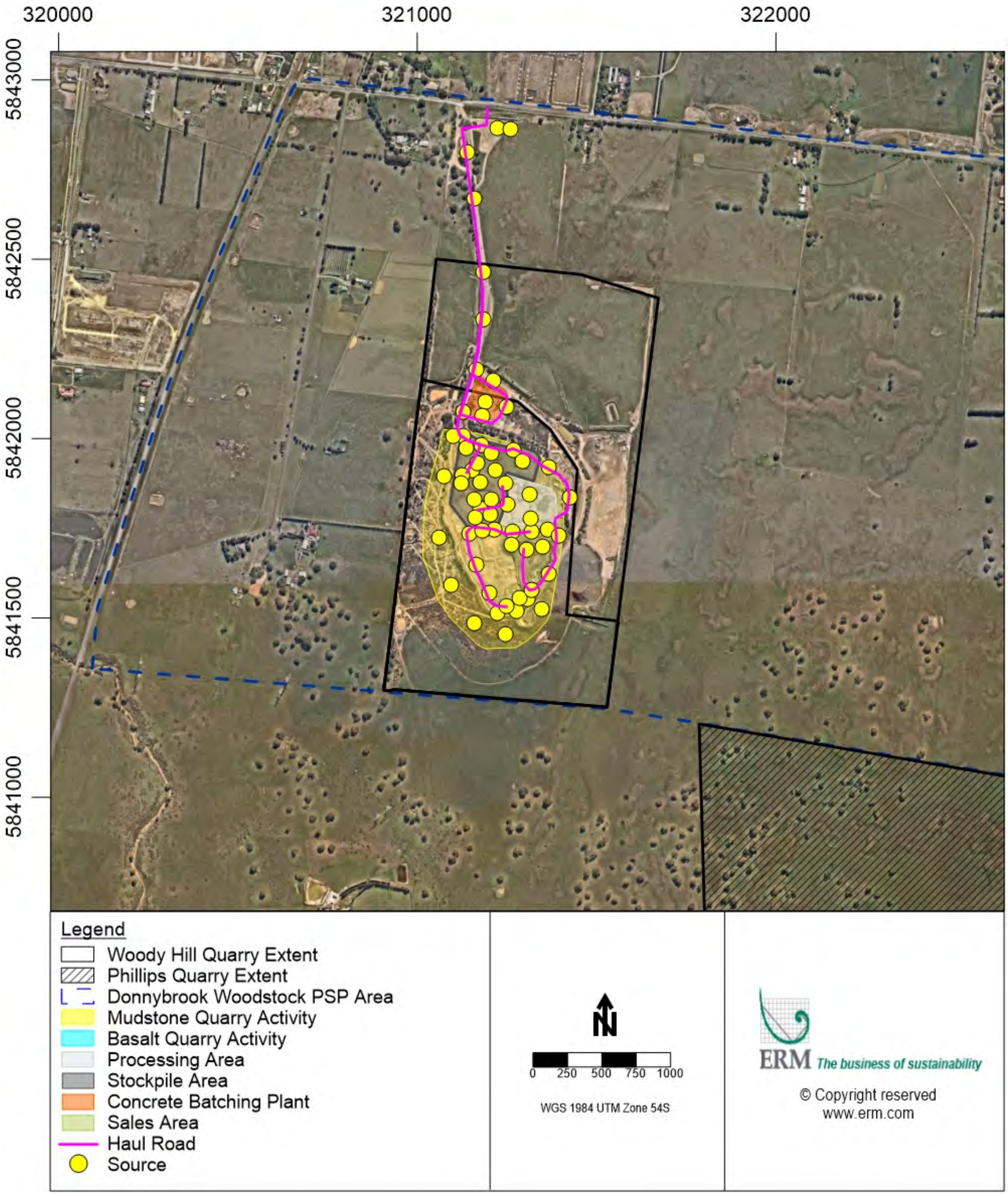

Figure 1.1 Scenario 1 Source Locations

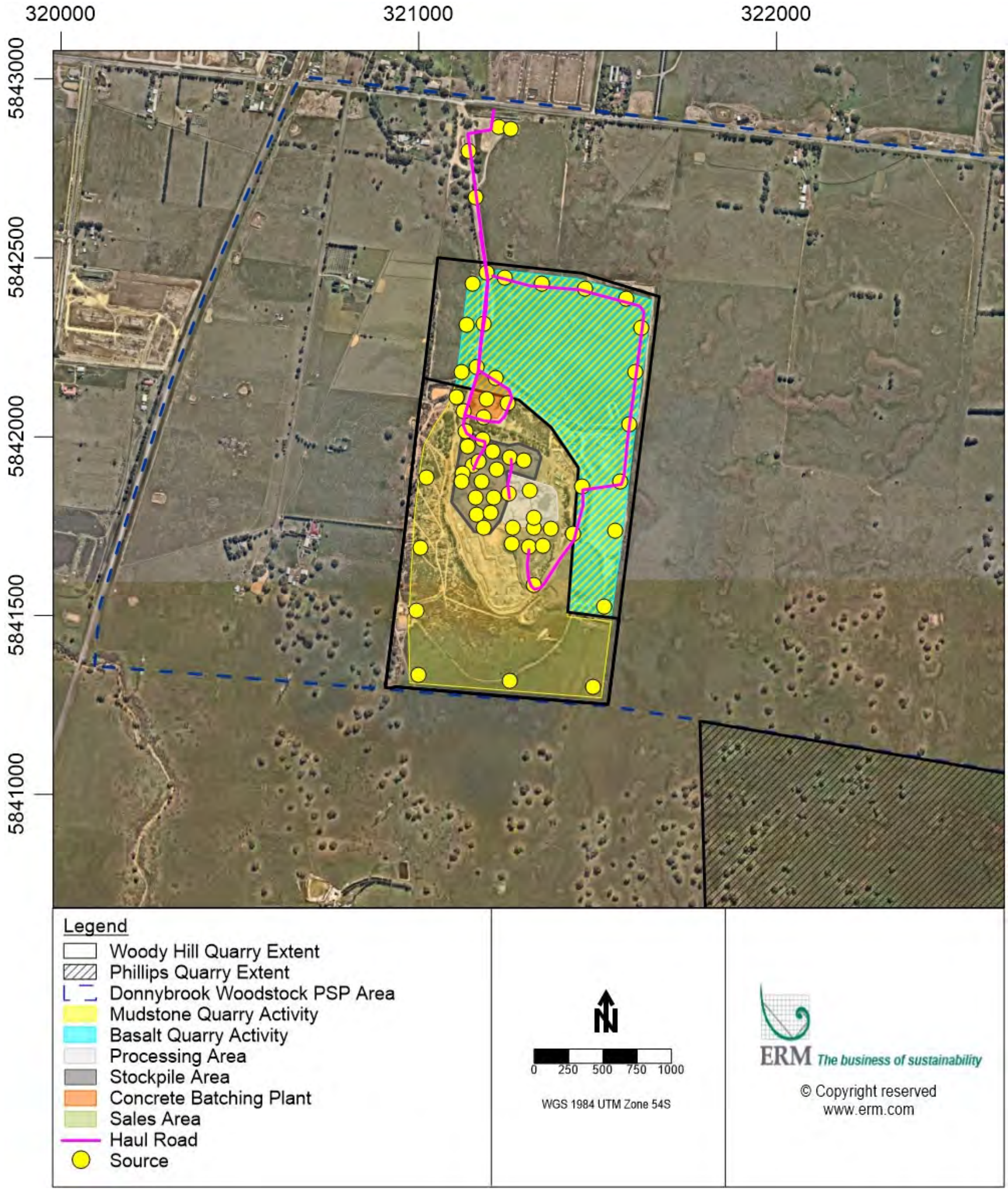

Figure 1.2 Scenario 2A Source Locations

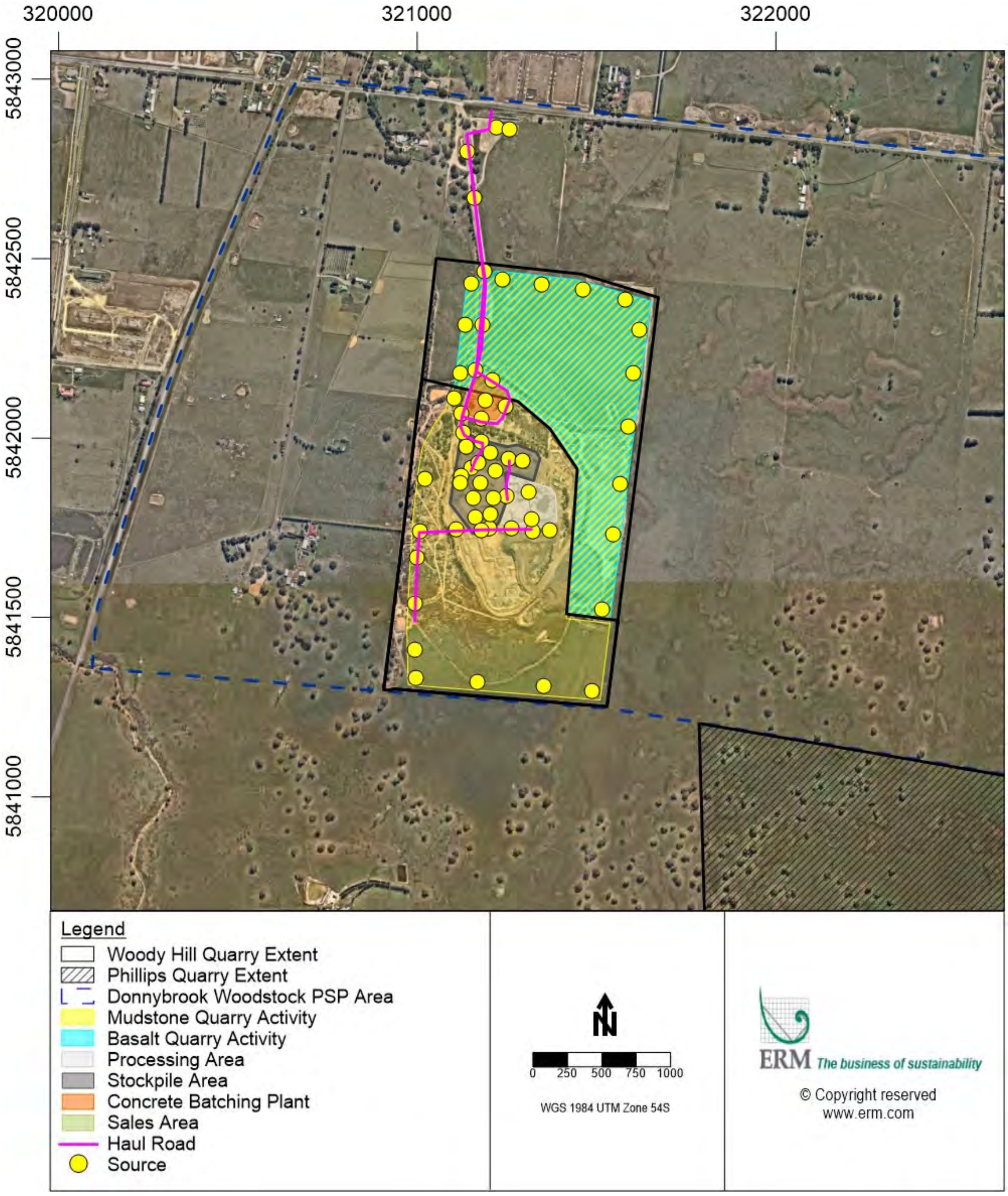

Figure 1.3 Scenario 2B Source Locations

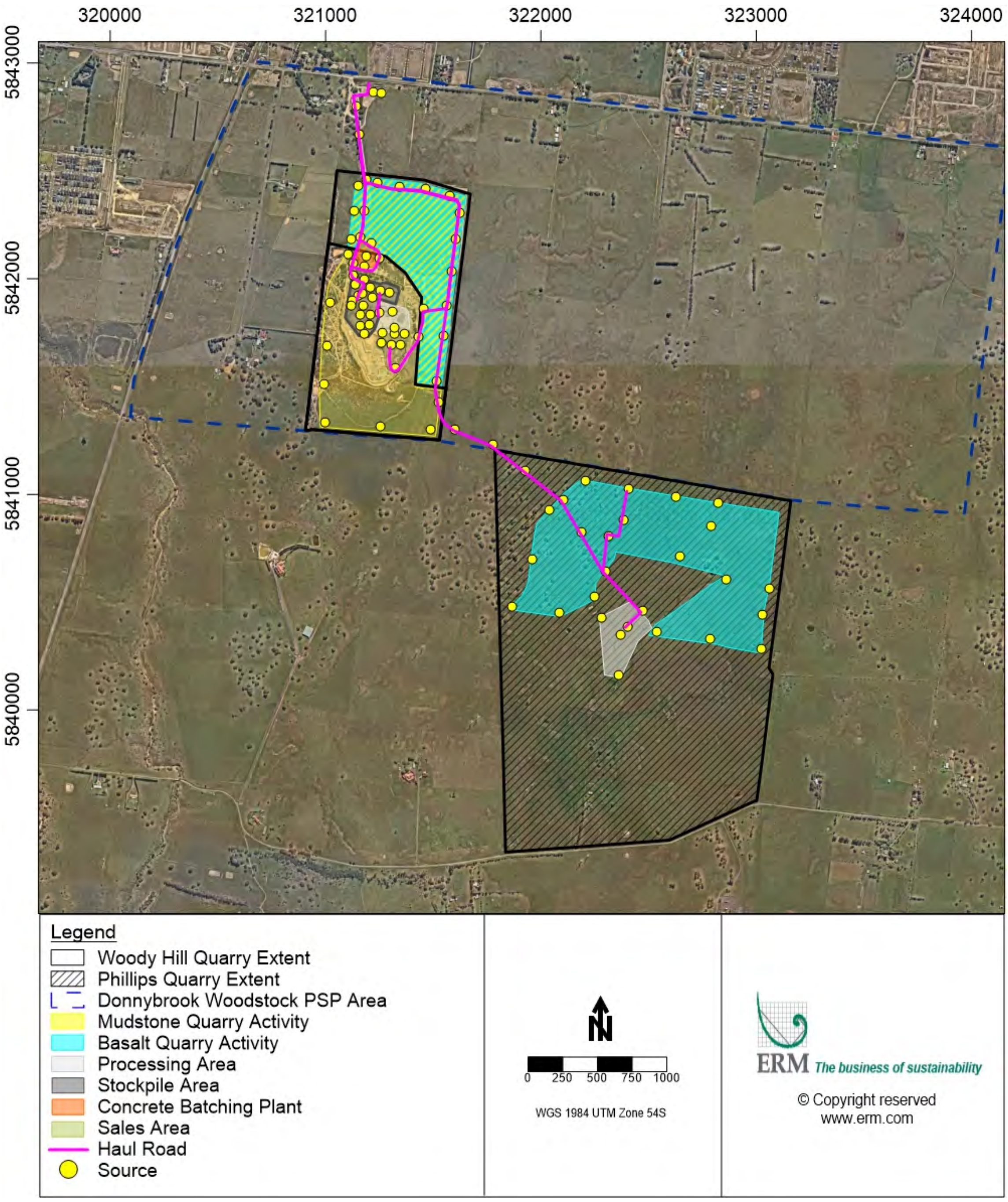

Figure 1.4 Scenario 3A Source Locations

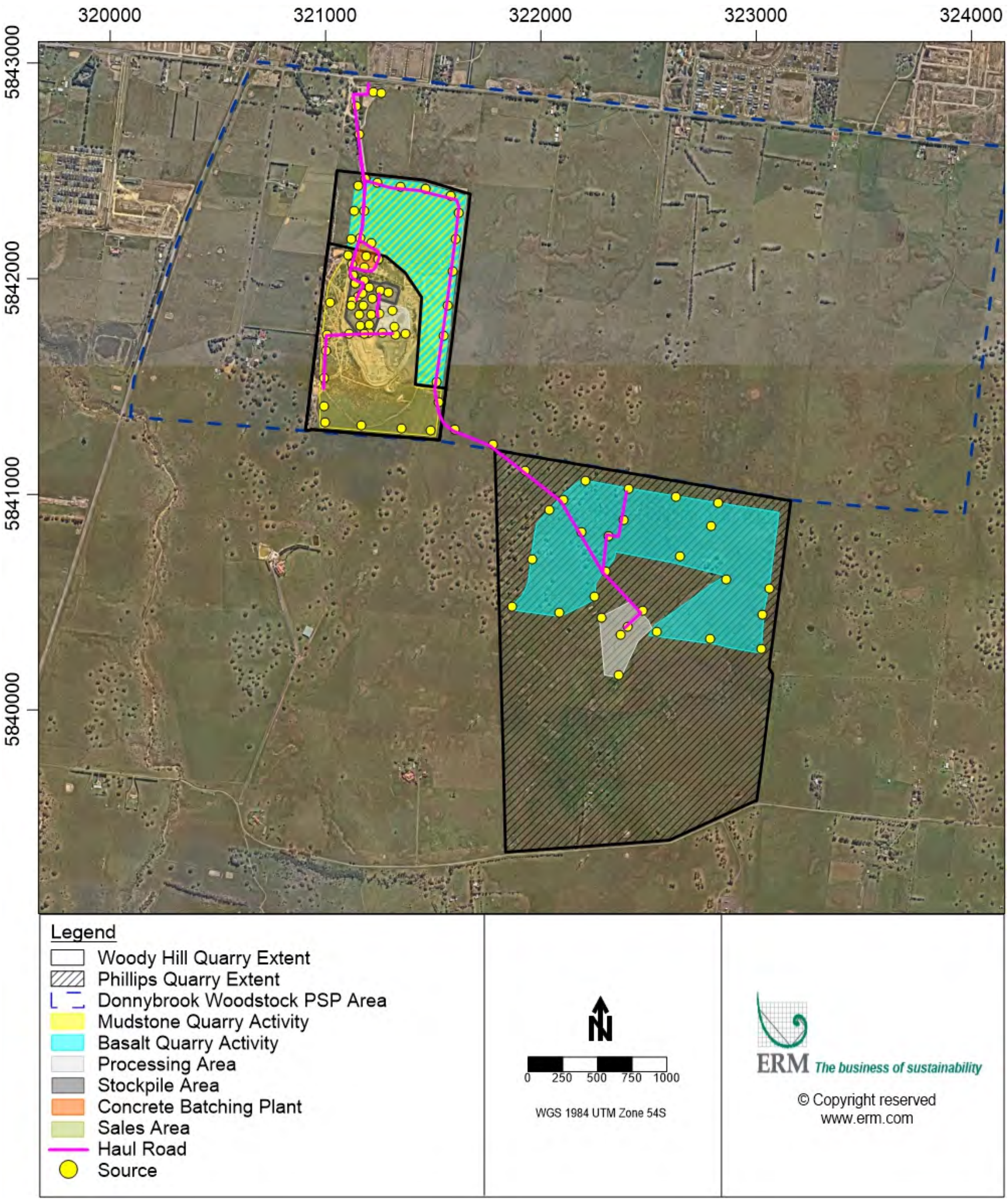

Figure 1.5 Scenario 3B Source Locations

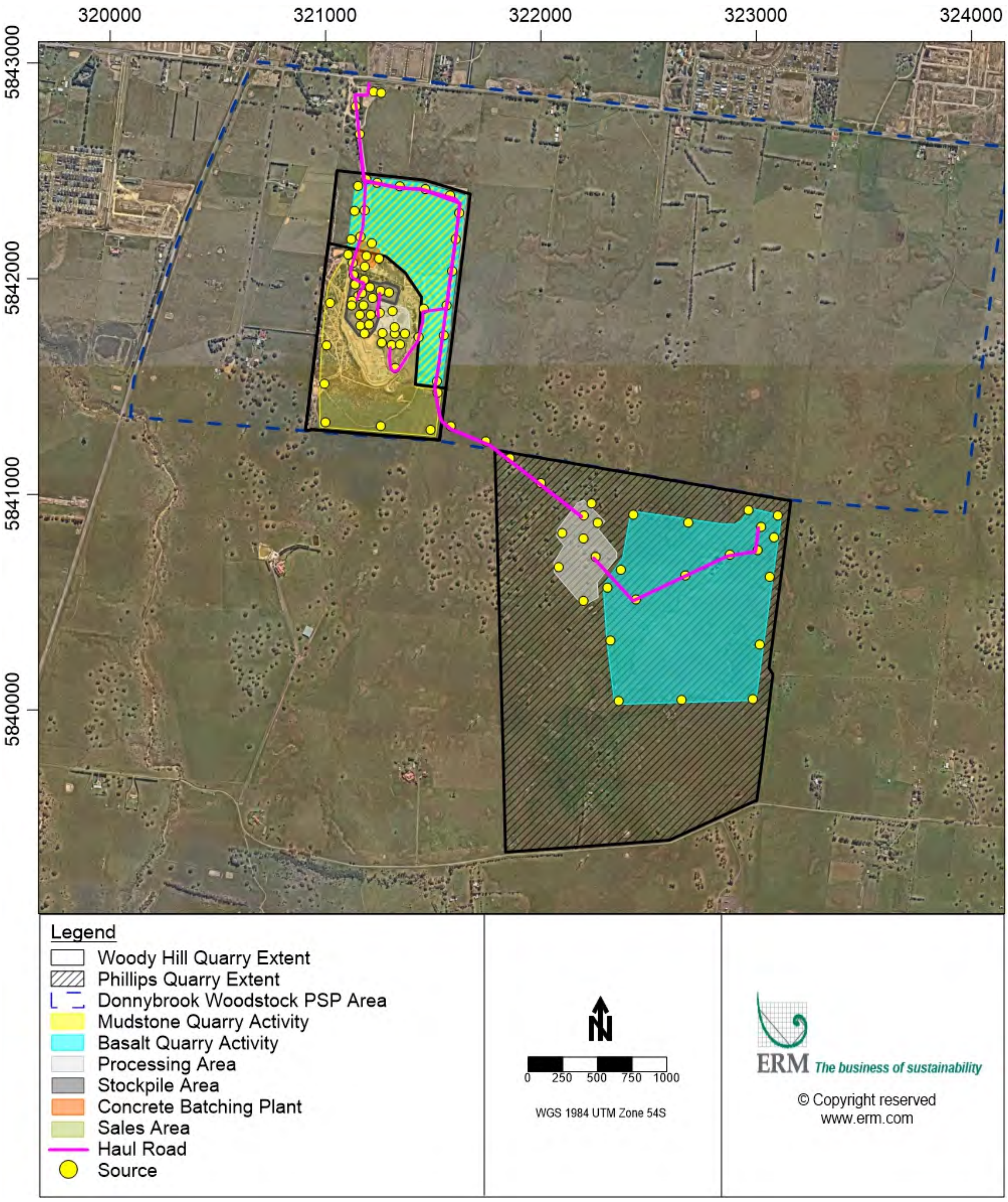

Figure 1.6 Scenario 4A Source Locations

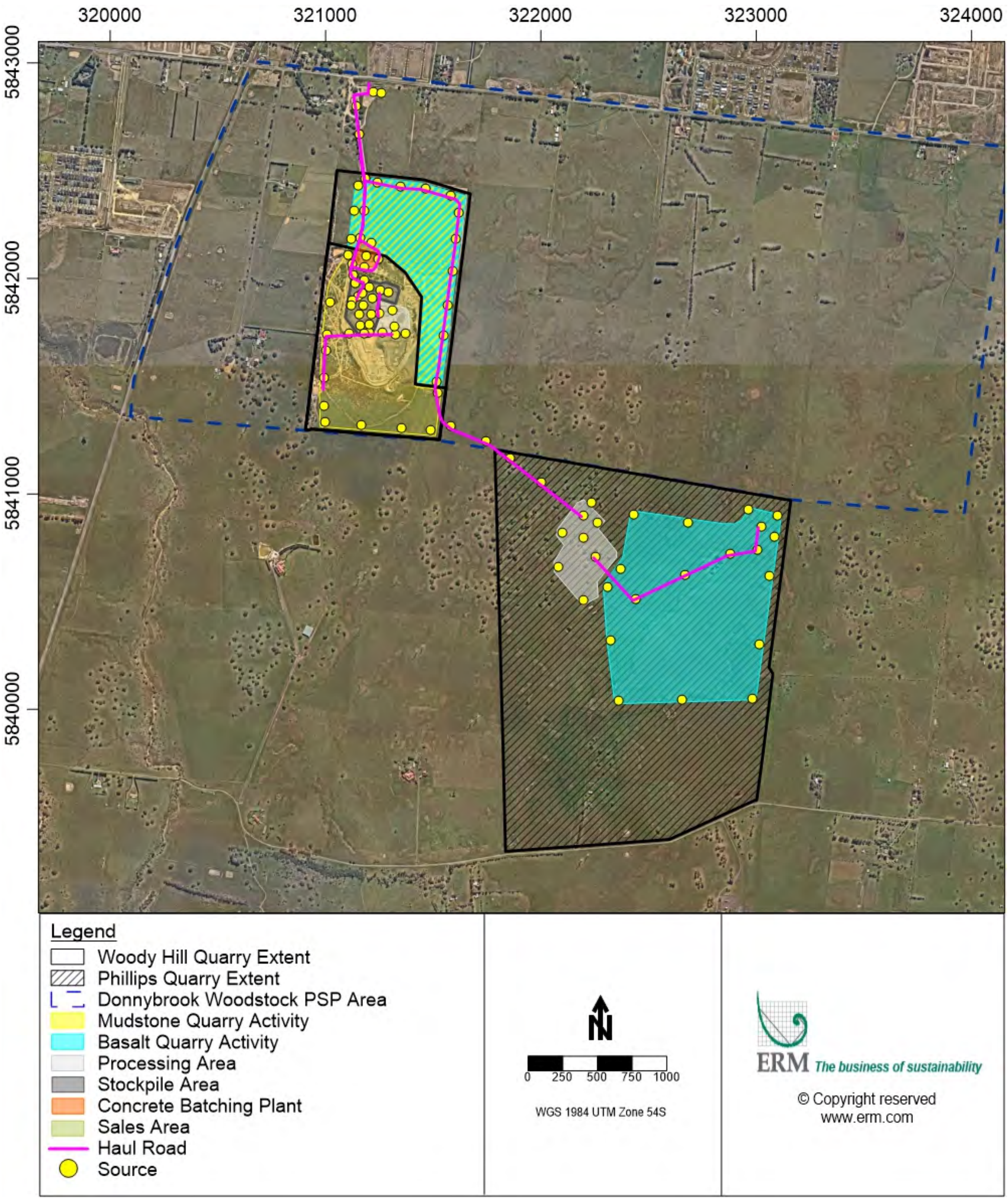

Figure 1.7 Scenario 4B Source Locations

APPENDIX C CURRICULUM VITAE

Iain Cowan

Technical Fellow

Dr. Cowan is a Technical Fellow within ERM's Melbourne office, and a Certified Air Quality Professional by the Clean Air Society of Australia and New Zealand. Providing more than 20 years' experience in the estimation of emissions, dispersion modelling and monitoring of ambient air quality, greenhouse gas species and odour, Dr Cowan has extensive experience with several advanced atmospheric dispersion modelling packages including CALPUFF, Ausplume, AERMOD, TAPM, ADMS-Urban, EDMS, CHARM, and AusRoads. In addition, Iain has extensive experience with measurement of ambient air quality for the establishment of baseline in remote locations. Dr Cowan regularly undertakes expert witness work in Australia.

Experience: 20 years' experience in mining and quarrying, odorous industries, transport sources, power generation and oil & gas processing

LinkedIn: https://www.linkedin.com/in/iain-cowan-056a1332/

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Professional Affiliations & Registrations

- Member of the Clean Air Society of Australia and New Zealand
- Certified Air Quality Professional by the Clean Air Society of Australia and New Zealand since inception in 2016

Fields of Competence

- Dispersion modelling using CALPUFF, AERMOD, TAPM, Ausplume, AusRoads, ADMS and Charm.
- Transport related emissions
- Measurement and monitoring of ambient air quality
- Mining emissions
- Industrial emissions
- Power generation emissions
- Odorous emissions
- Emissions Inventory Generation
- Expert witness testimony
- Flux hood measurements

Education

- PhD Environmental Engineering, University of Surrey, UK, 2004
- BSc Honours, Environmental Geology, Royal Holloway College, University of London, UK, 2000

Languages

- English, native speaker
- French, conversational

Key Industry Sectors

- Transportation
- Mining
- Oil and gas
- Power generation
- Chemical production
- Manufacturing
- Contaminated land
- Waste (landfills, composting and water)
- Expert Witness Testimony

Honours & Awards

- Clean Air Society of Australia and New Zealand Young Achiever Award
- EPSRC Stipend for PhD Research

Publications

- Cowan, I., Balanova, E., 2019. Comparison Of Recent AERMOD Versions And CALPUFF To

Determine Variance In Assessment Outcomes For Surface Based Emissions. Clean Air Society for Australia and New Zealand Conference, 6-18 September, 2019

- Balanova, E., Cowan, I., 2019. Dispersion Modelling Using One-minute Meteorological Data Versus Standard One-hour Average Meteorological Dataset for Assessment of Transient Odour Impacts. Clean Air Society for Australia and New Zealand Conference, 6-18 September, 2019
- Cowan, I., Balanova, E., 2017. Use of AERMOD for the Evaluation of Odour Impacts During Low Wind Speed Conditions. Clean Air Society for Australia and New Zealand Conference, 15-18 October 2017
- Balanova, E., 2017. A Comparison of Meteorological Data Generated by Prognostic Model TAPM and a Diagnostic 3-Dimentional Model CALMET for the Generation of AERMOD Compatible Meteorological Files. Clean Air Society for Australia and New Zealand Conference, 15-18 October 2017
- Cowan, I., Garrison, M., 2015. A comparison of default and regulatory settings when using TAPM to generate AERMOD files. Clean Air Society for Australia and New Zealand Conference, 20-23 September, 2015
- Todoroski, A., Cowan, I., 2015. Odour measurement data for composting of green waste with the addition of food organics or grease trap waste using gore covers. Clean Air Society for Australia and New Zealand Conference, 20-23 September, 2015
- Cowan, I.M., Lo, S., 2013. Development of an odour environmental risk assessment methodology for the evaluation of broiler farm impacts. Clean Air Society for Australia and New Zealand Conference, 7 – 11 September, 2013.
- Cowan, I.M., Radford, A.L. and Grynberg, H., 2011. Use of Dispersion Models in the Assessment of Impacts from Spray Evaporation. Clean Air Society for Australia and New Zealand Conference, 31 July – 2 August 2011, Auckland, New Zealand
- Radford, A.L., Cowan, I.M., 2011. 'Comparison of Near Field Impacts of Emergency Release Determined by Ausplume and Charm. Clean Air Society for Australia and New Zealand Conference, 31 July – 2 August 2011, Auckland, New Zealand
- Corbet, L.C; Cowan, I.M; Stella, N. and Brooke. A.; 2009, The Integration of two regulatory dispersion models for a holistic approach to air quality assessment; Clean Air Society for Australia and New Zealand Conference, 6th – 10th September 2009; Perth, Australia
- Cowan, I.M.; 2007, Use of GIS as an air quality screening tool for planners and policy makers – Partnerships between local government and academia; International Union of Air Pollution Professionals World Congress, 10th-13th September 2007; Brisbane, Australia
- Cowan, I.M.; 2004; The Development and Application of and Advanced Screening Model to Predict Air Quality Thesis (PhD). University of Surrey

Key Projects

Expert Witness Testimony

- Banyule, Boroondara, Manningham and Whitehorse city councils - ERM was engaged by Banyule, Boroondara, Manningham and Whitehorse city councils to provide a review and expert witness statement / testimony to the North East Link Joint Inquiry and Advisory Committee. The review provided a comprehensive evaluation of the emission estimation, modelling and methodology of incorporation of background air quality into the assessment, with recommendations for improvement of the approach used.
- Maribrynong City Council – Expert witness statement to the independent inquiry and advisory committee on the West Gate Tunnel Project. Statement included the use of atmospheric dispersion modelling using the AERMOD dispersion model and emissions modelling using COPERT Australia.
- Maryvale W2E Facility – Provision of an expert witness statement on the proposed Waste to Energy facility at Australian Paper's facility at Maryvale. The assessment included dispersion modelling using the AERMOD and CALPUFF models for cumulative impacts from the Australian Paper facility and the proposed W2E facility. Case settled before proceeding to VCAT.
- Foley – Expert witness at VCAT regarding the potential for odour generation from an expanded broiler farm impacting an individual dwelling
- Lewis – Expert witness at VCAT regarding potential for odour generation impacting a local community from a proposed broiler farm in central north Victoria. Micrometeorological modelling of complex terrain was used to determine whether there non-standard meteorology occurs in the local area and whether the standard separation distance should apply and if not what would be an appropriate separation distance.
- Maribrynong City Council – Expert witness statement to the independent inquiry and advisory committee on the West Gate Tunnel Project. Statement included the use of atmospheric dispersion modelling using the AERMOD dispersion model and emissions modelling using COPERT Australia.
- Nuchev Pty Ltd – Expert at VCAT regarding the potential for odour and dust impact to surrounding land use as a result of a proposed goat dairy in central Victoria. Evidence was given as to the potential for odour impact, dust generation and transference to nearby sensitive receptors. Assessment of the impacts was undertaken based on odour flux hood monitoring at a goat farm and using the AERMOD dispersion model adopting the low wind speed option to capture worst case dispersion conditions.
- Calleja Property Pty Ltd – Expert witness at VCAT regarding the potential for dust generation during land reprofiling on a former landfill. Evidence given as to the methods that would be needed to overcome issues in relation to dust generation. Preparation of witness testimony included the use of dispersion modelling to assess potential impact from dust generating activities.
- Regional Infrastructure Pty Ltd – Expert witness at Planning Panels Victoria hearing regarding the proposed development of a livestock exchange in Miners Rest, Western Victoria. Atmospheric dispersion modelling was completed using CALPUFF to demonstrate that the impact to the local community was at acceptable levels.
- Barringhup Community Group – Expert witness at VCAT regarding the potential for odour generation from a proposed broiler farm cluster in Barringhup Victoria. This involved micro-meteorological modelling to determine the potential for gully flows which have been shown to result in significant impact from broiler farms in nearby locations.
- Biomix Pty Ltd – Expert witness at VCAT regarding potential for odour generation from a proposed composting facility in northern Victoria.
- Maddingley Brown Coal – Expert witness at VCAT regarding potential for odour generation from composting activities for permit amendment application.
- Anonymous – Expert witness at VCAT regarding potential for odour generation impacting a local community from a proposed broiler farm in central north Victoria. Dispersion modelling incorporated

micrometeorological modelling of complex terrain and odour dispersion in a river valley system.

- Wodonga City Council – Expert witness at VCAT regarding the application for secondary consent for a drying and dewatering facility on a prescribed waste handling and composting facility.
- Gadens Lawyers – Expert witness at Planning Panels Victoria regarding the requirement of a buffer for an existing egg laying farm within the urban growth boundary.
- Innova Soil Technology – Expert witness at VCAT for proposed thermal soil remediation facility. Services included review of the application and opinion as to whether the application met the legislative requirements for meeting control of emissions to best practice and maximum extent achievable.
- EPA – Expert witness at VCAT hearing for two proposed broiler farms adjacent to four existing broiler farms near to Nagambie, Victoria. Dispersion modelling using CALPUFF of odour from the existing and proposed broiler farms was undertaken to demonstrate existing and future impact with the proposed farms. Dispersion modelling of odour from the broiler farms was undertaken using the CALPUFF modelling system to take advantage of the lower thresholds for wind speed that can result in high odour impact. Modelling using five years of meteorology was undertaken to assess the impact from highly variable broiler growth cycles.
- Brimbank City Council – Expert witness at VCAT for a proposed solid inert waste landfill adjacent to an existing concrete batching / crushing plant in north-east Melbourne. In preparation for the VCAT hearing. Three months of dust deposition monitoring were undertaken, and dispersion modelling using CALPUFF of the existing concrete crushing / batching plant and proposed development of a solid inert waste landfill.
- Yarra Ranges Shire Council – Expert witness at VCAT hearing for compost odour impacting a local community. Flux hood measurements of odour emissions from compost piles were used with dispersion modelling using CALPUFF of odour from the compost facility to determine impact to the surrounding community.
- Otway Shire Council – Expert witness at VCAT hearing for proposed broiler farm with potential to impact on local community. Review of dispersion modelling undertaken by the proponent and dispersion modelling to show impact using alternative modelling methodologies.
- Grinders Coffee – Expert witness at VCAT hearing for proposed expansion of operation at a coffee roasting facility. Preparation of expert witness testimony included dispersion modelling of proposed emissions from the facility, and assessment of impacts on the surrounding community.

Mining / Quarries

- Hanson Pty Ltd – ERM completed atmospheric dispersion modelling as part of environmental approvals for a quarry expansion in NSW. In addition to the expansion of the quarry area, the tonnage of the project was proposed to increase as well as the introduction of an asphalt plant and concrete batching plant. Through the use of the dispersion modelling, ERM worked effectively with the proponent to ensure a compliant development through the use of effective mitigation measures.
- BHP Ltd – ERM completed a review of results from LiDAR monitoring undertaken in Port Hedland to understand the relationship between LiDAR results and ambient air quality monitoring.
- Newcrest Mining Ltd – Dispersion modelling of projected emissions resulting in a proposed change of fuel for the electricity power stations at one of Newcrest's mines. Dispersion modelling was undertaken using the CALPUFF dispersion model.
- Newcrest Mining Ltd – ERM undertook atmospheric dispersion modelling of odour emissions from the xanthate floatation plant to determine impact to the surrounding community. The atmospheric dispersion modelling, using CALPUFF, assisted in identifying the float plant as the likely cause of odour complaints and use of a variance in pH reduced the odour generation.
- Volcanic Construction – Atmospheric dispersion modelling study for the expansion of a quarry in

northern New South Wales to provide material for the Pacific Highway duplication. Dispersion modelling was undertaken using CALPUFF taking account of dust emissions from handling, vehicle movement, crushing and windblown emissions. Time varying emissions were used to represent realistic emissions from operation of the facility.

- Hanson Construction Materials – Dispersion modelling study for the expansion of a quarry in northern New South Wales. Dispersion modelling was conducted using CALPUFF, and taking account of dust emissions from handling, vehicle movement, crushing and windblown emissions. Time varying emissions were used to represent realistic emissions from operation of the facility.
- MMG Pty Ltd – ERM developed emission estimation spreadsheets for the Kinsevre and the Las Bambas mines. The emission estimation spreadsheets were developed to assist with corporate reporting and used emission estimation techniques taken from the NPI and NGERs for emissions of general chemicals and also GHGs. The spreadsheets incorporate macros that facilitate the estimation of emissions from general site data which is input on a weekly basis.
- Weda Bay Nickel – Dispersion modelling study as part of ESIA to determine impact from mining and process plant activities. Dispersion modelling considered multiple scenarios for variation throughout the mining schedule and included deposition of metals associated with particulate matter within the ore on the surrounding land area.
- Rio Tinto –Review of potential climate and meteorological impacts determined by the UK Meteorological office as a result of the proposed mine adjacent to the Simandou Ridge in Guinea, West Africa.
- Cedar Point –Assessment of impact from dust for a proposed quarry in New South Wales. Dispersion modelling used the CALPUFF modelling system and required development of a meteorological model for the local area followed by emission estimation and dispersion modelling.
- Xstrata Zinc – Internal technical peer review and guidance for an impact assessment for a five million tonne per annum zinc-lead and silver deposit.
- Lihir Gold Limited – Comprehensive impact assessment as part of an EIA for expansion of the mine processing area. The project included emissions inventory generation and modelling for power generation, process plant, unmade road dust generation, tailpipe emissions. Complex dispersion modelling was undertaken using the CALPUFF modelling system to account for steep terrain surrounding the site on three sides and the ocean on the fourth side.
- Bendigo Mining Limited – Revised operational procedures required the modelling of particulate and hydrogen cyanide emissions using Ausplume from operations at a proposed mine for comparison with the approved program.
- BHPB – Dispersion modelling of dust generation for a proposed mine expansion in Queensland. Dispersion modelling included development of a meteorological model for the local area, emissions estimation for a number of sources and dispersion modelling using CALPUFF.

Construction and Demolition

- ENGIE Australia Pty Ltd – Forecasting Impacts – using inputs used to determine specific meteorological conditions developed forecasting suite which combined the Weather Research Forecasting Model (WRF) with CALPUFF and GIS to provide up to the minute forecasts on the best window for demolition to take place.
- ENGIE Australia Pty Ltd – Hazelwood Stacks – Determined the likely impact for dust, asbestos and respirable crystalline silica from the demolition of eight 137 m high stacks at the former Hazelwood Power Station in Victoria to demonstrate this could be completed without impact to surrounding land use under specific meteorological conditions.

- Delta Group – Kurri Kurri Stack Demolition – Measurement and back calculation of emission rates from the explosive fell demolition of a 135 m high stack at a former aluminium smelter. The work included the use of WRF to forecast the wind directions for the day of the fell in order to lay out the monitors in the correct location. Atmospheric dispersion modelling was then used to determine the emission rate that would have given rise to the measured concentrations on the day of the demolition.

Planning Scheme Amendments

- Bacchus Marsh Developments Pty Ltd – Merrimu Investigation Area – ERM was engaged to undertake an assessment of three sand quarries adjacent to an area proposed for residential development to determine the appropriate separation distance for sensitive uses.

Transport

- WestConnex North Sydney and Beaches Link – Completed the emission estimation for the North Sydney and Beaches link project as a result of updated PIARC factors which had the potential to alter the outcome of the assessment.
- Anonymous – Independent third party review of air quality impact assessment from a major road tunnel infrastructure project in New South Wales as part of environmental due diligence review team.
- Arcadis – Technical air quality expert to the State Independent Reviewer and Environmental Auditor on the WestGate Tunnel Project to provide comment on the development of the construction environment management plan and to ensure changes in design are in accordance with the planning permit and approvals.
- Maribrynong City Council – Expert witness statement to the independent inquiry and advisory committee on the WestGate Tunnel Project. Statement included the use of atmospheric dispersion modelling using the AERMOD dispersion model and emissions modelling using COPERT Australia.
- Singapore Cross Island Line – Internal technical peer review of baseline measurements and qualitative impact assessment for the construction of the proposed Cross Island Line in Singapore.
- Brent Cross Shopping Centre – Assessment of traffic impacts on roads as a result of road realignment and construction of new roads for a shopping centre upgrade in north London. The assessment used the emission estimation model published by the UK Department of Transport together with ADMS-Roads to predict impacts at nearby sensitive receptors.
- Goodman – Assessment of a traffic impacts on roads surrounding a proposed transport interchange depot (rail to road) in Slough, UK. The assessment UK emission factors for the vehicle fleet together with ADMS-Roads to assess the impacts of the increase in trucks to the air quality in the local environment.
- Cikampek-Palimanan Toll Road – Assessment of a proposed toll road in Indonesia. Modelling included determination of diurnal emission rates followed by dispersion modelling using CALQ3HCR.
- Hoddle Street Study – High level qualitative option review and detailed dispersion modelling of options for the redevelopment of Hoddle Street in Melbourne. Qualitative review of multiple options based on vehicle numbers / traffic mix and expected relative emissions from the options. Detailed modelling undertaken using AusRoads and AusVeh emission factors for anticipated traffic volumes for three potential route options.
- Melbourne Airport Limited – Undertook complete modelling exercise of airport pollution sources including the aircraft, roads, parking facilities, jet engine testing and training fires to develop a concentration map of pollution using US FAA dispersion model EDMS. Modelling incorporated all aircraft movements from the terminals to the runway, take-off and landing and use of runway / taxiways varying with wind direction.

- Bankstown Airport - Assessment of the impact on local air quality of moving the engine run-up bay from the current position to a new location at the north-eastern end of Bankstown airport. The assessment has used the regulatory dispersion model AUSPLUME to model concentrations of oxides of nitrogen (NOX), carbon monoxide (CO) and oxides of sulphur (SOX).
- London Development Agency – Assessment of the impacts of traffic generation, construction and on site sources of the London Olympic Bid to the surrounding population. Modelling undertaken using ADMS-Roads.
- Highways Agency – Design Manual for Roads and Bridges (DMRB) Impact assessment of the extension of the M6 to the Scottish border.
- Welsh Development Agency – Guidance on Multi-Modal Assessment (GOMMS) Impact assessment for the construction of a bypass
- Wiltshire County Council – Development of a specialised emissions inventory for modelling of transport emissions in a town with roads at high gradient. Modelling was undertaken using ADMS-Roads and used to assess options for reducing ground level concentrations by changing traffic flows on the road network.
- Highways Agency – Secondment to the Highways Agency (major road regulator within England) to assist with the implementation and development of policy with regard to the assessment of the impacts of road projects on local air quality.
- Bristol NHS Trust – Impact assessment using ADMS-Roads of the redevelopment of two hospitals on local air quality incorporating the increase in vehicle numbers and the use of emissions control technologies for new generators.

Odour Assessments

- Regional Infrastructure Pty Ltd – ERM undertook extensive monitoring of odour emissions from a wide variety of sources at the Central Victorian Livestock Exchange. These measurements were used to develop an atmospheric dispersion model which considered various options for reducing odorous emissions including more regular cleaning, increased surface roughness around the site and extension of the roofed area.
- Anonymous – Completion of comprehensive odour measurement at an intensive animal farm in New South Wales and detailed atmospheric dispersion modelling to determine dominant source contribution to sensitive receptors with a view to minimising odour impact to surrounding land use.
- Golden Plains Shire Council – Third Party review of an odour assessment for a proposed open green waste compost facility in central west Victoria
- Evans Road Development – Audit support in determining potential odour impact from active municipal waste landfill to a proposed residential development.
- SELX Pty Ltd – ERM completed an odour environmental risk assessment (OERA) for the proposed livestock exchange at Mortlake. The OERA comprised atmospheric dispersion modelling using AERMOD. The OERA was incorporated to the Works Approval Application and Planning Application for the development. ERM additionally provided representation to EPA regarding the approach to the modelling, ensuring a suitable outcome for the development.
- Regional Infrastructure Pty Ltd – ERM completed an odour environmental risk assessment (OERA) for the proposed livestock exchange at Miners Rest. The OERA comprised atmospheric dispersion modelling using CALPUFF. The OERA was incorporated to the Works Approval Application for the development. ERM additionally provided representation to EPA regarding the approach to modelling and the modelling results ensuring a suitable outcome for the development.
- Enviromix Pty Ltd – ERM completed an odour impact assessment for an organics recycling facility in eastern Victoria. The proposed facility is located adjacent to an existing broiler and dairy farm. Source apportionment of the source groups was used to understand the likely relevant contribution from the sources to overall odour impacts and thus determine the risk from an additional odour source.
- EPA Victoria – Development of a guideline for undertaking a environmental odour risk assessment for proposed broiler farms.

- Anonymous – Industrial odour assessment for a Halal Abattoir within Melbourne. Assessment required the generation of a site odour emissions inventory and modelling using Ausplume.
- Mobil Oil Australia – Works Approval Application for Mobil Oil Australia for odour treatment system for delivery and storage of fuel oil. Dispersion modelling was completed using Ausplume.
- Mobil Oil Australia – Numerous odour dispersion modelling studies using Ausplume for different grades of fuel oil delivered to terminal, to determine potential impact on surrounding community.
- Norfolk Environment Waste Services – Odour assessment for landfill site. Odour emissions inventory for open and capped cells and landfill gas turbines. Modelled and assessed the impacts of odour using AERMOD.

Emissions Estimation

- Qantas Airways Ltd –NPI reporting for Qantas Airways for sites across Australia since 2009. Annual reviews product usage at all Qantas facilities across Australia to determine the reporting requirements. Emission estimation of NPI species to air, land, water and transfers are then reported to NPI on behalf of Qantas.
- Shell Australia Pty –NPI reporting for Shell's distribution and airport terminals for the 2008/2009 reporting year. Review of product usage at all Shell facilities across Australia to determine the reporting requirements. Emission estimation of NPI species to air, land, water and transfers are then reported to NPI on behalf of Shell.
- Ford Motor Company of Australia –NPI reporting for Ford's Geelong facility. Review of product usage to determine reporting requirements and estimates emission of NPI species to air, land, water and transfers. The emission estimates are then reported to NPI on behalf of Ford.
- South-East Water –NPI reporting for South-East Water. Reviews of processes at all of South-East Water's treatment plants and estimates emissions to air, land and water for reporting to NPI.

Industrial

- BPFL – Impact assessment of acid deposition resulting from emissions from a proposed ammonium nitrate plant on the Burrup Peninsula, WA. The study included consideration of atmospheric chemistry within CALPUFF, dry and wet deposition in addition to atmospheric formation of secondary particulate matter.
- Holcim Cement – Impact assessment of emissions from a concrete batching plant in Margaret River, WA. Emissions estimation of particulate matter arising from material deliveries, movement and loading of concrete to the mixture trucks was undertaken and dispersion modelling completed using CALPUFF.
- Orica Mining Services – Impact assessment of emissions from a proposed Ammonium Nitrate Emulsion plant near to Port Hedland, WA. Emission estimation was completed using manufacturer guarantees and dispersion modelling completed using CALPUFF.
- Sun Metals Limited – Impact assessment of spray drift on surrounding land use from the use of spray evaporators within tailings ponds to reduce pond levels. Dispersion modelling was conducted using the CALPUFF modelling system on a sub-hourly basis using local ground level and upper air meteorological observations as a basis for dispersion modelling.
- Holcim Cement – Impact assessment of emissions from a cement manufacture plant in New Zealand. Local terrain with a bluff adjacent to the stack meant that complex dispersion modelling using the CALPUFF modelling system was required. Local surface and upper air meteorological observations were used with terrain and land use to develop a CALPUFF compatible meteorological file that was able to account for the local geography.
- CSL Limited – Generation of emissions inventory and completion of dispersion modelling using Ausplume in the assessment of formaldehyde release to atmosphere following the sterilisation of laboratories at two facilities.

LNG Facilities

- ExxonMobil – ERM completed atmospheric dispersion modelling for a proposed gas processing facility in Vietnam and three associated power stations. Dispersion modelling was completed using the CALPUFF dispersion model, with information from the model results used as input to the design process to ensure an IFC compliant design. Modelling incorporated the use of ABFlare to correctly assess emissions from flares and impacts to ground level concentrations.
- Senex Pty Ltd – ERM completed screening dispersion modelling and a GHG assessment for a proposed gas development in the Surat basin. At the time of the assessment the exact location of the equipment was unknown, and dispersion modelling was used to understand the required exclusion zone to facilitate development of the field and central compression stations for this unconventional gas resource.
- Origin Energy Pty Ltd – ERM has assisted Origin Energy over a number of years regarding emissions from two facilities in Victoria. ERM has undertaken atmospheric dispersion modelling using both AERMOD and CALPUFF for these facilities and estimated acute and chronic impacts to the surrounding land use for submission to EPA. ERM has also assisted Origin in determining the impact to surrounding land use from a flare blowdown event using ABFlare in combination with the AERMOD dispersion model.
- REPSOL – ERM undertook an assessment of the potential for mercury impacts to the surrounding land use from the proposed development of a gas extraction, processing and gas to energy facility in PNG. ERM used CALPUFF together with ABFlare for intermittent flare use to determine the impact to the surrounding land use.
- BLNG – Assessment of the potential for impact to surrounding sensitive receptors from flaring operations. Dispersion modelling was undertaken using CALPUFF adopting the ABFlare methodology to ensure appropriate estimation of flare impacts to surrounding land use.
- QGCLNG – Greenhouse gas assessment for the Surat North Gas Field Project for Scope 1 and 2 emissions were quantified for the project lifecycle in accordance with the NGERs technical guidelines and compared to State and national greenhouse gas inventories at peak emission production.
- BSPL – Assessment of atmospheric emissions from Brunei Shell operations across Brunei. Operations were reviewed to determine likely emissions and using meteorological data define a monitoring regime to define baseline concentrations around BSPL.
- ExxonMobil – Screening assessment of coastline impact from a proposed FLNG. Dispersion modelling used CALPUFF with a coarse grid at sea and fine resolution grids around the coastline to demonstrate potential for impact from NOx emissions.
- Anonymous – Air Quality assessment as part of EIS for new LNG plant in Queensland. TAPM and CALMET used to generate local meteorological conditions with CALPUFF used for dispersion modelling.
- PNG LNG – Air quality dispersion modelling using CALPUFF for two potential suppliers to the PNG LNG facility to the west of Port Moresby in Papua New Guinea. The assessment comprised sourcing local meteorology and land use information. Developing appropriate meteorological files for the site through the use of TAPM and CALMET, and dispersion modelling of all sources using CALPUFF.
- BHP –Screening assessment of the proposed Macedon LNG facility in northern WA was undertaken to determine the potential impact from operation on surrounding facilities using Ausplume.
- BOC –Air quality impact assessment of a proposed LNG facility in northern Tasmania as part of an effect statement. TAPM was used with locally measured meteorological data to generate inputs to Ausplume and Ausroads. Assessments of emissions from industry were undertaken using Ausplume, whilst emissions from vehicles using the local road network were modelled using AusRoads. The combination of results from Ausplume and AusRoads, for a small local

network, enabled the provision of a cumulative impact assessment for sources with changed emissions.

- Anonymous – An initial screening assessment for a proposed domestic gas facility in northern WA was undertaken to determine the potential impact from operation on surrounding facilities using Ausplume.

Offshore Gas Facilities

- Brunei Shell Pty Ltd – Atmospheric Dispersion modelling was undertaken using the CALPUFF dispersion modelling to determine the contribution from platform operations to ambient concentrations on the shoreline.

Emergency Release Modelling

- Orica – Emergency release assessment of emissions from the nitric acid stack and consideration of potential of impact on other site buildings through the use of near field dispersion modelling at an ammonium nitrate plant.
- Anonymous – Emergency release modelling of CO2 storage facility to determine potential impact from the puncture of CO2 tanks on surrounding housing, roads, stock, fauna and flora.
- Gasnet Pty Ltd – Emergency release modelling of natural gas from a gas compression station on a second by second basis to define the development of the plume area over the period of the release and classify the extent of the hazardous area.
- Australian Pipeline Association – Emergency release modelling of natural gas at a gas compression station from within a building. The study was used to determine the time taken for gas to exit the building during an accidental release, and to determine whether concentrations would be elevated in locations where sensors had been placed as part of the emergency shut-down mechanism.

Ambient Monitoring

- Calleja Properties Pty Ltd – Expert witness testimony on the impacts of dust from the regrading of a landfill cap to accommodation future use. Assessment incorporated the design and recommendation of a monitoring system to prevent impact to nearby sensitive receptors.
- Anonymous – Baseline monitoring plan development and implementation for the redevelopment of a large tourist attraction in Singapore. Project involved consideration of siting for monitoring during baseline measurement, analysis of results and development of an environmental management plan for construction.
- Brunei Shell Company Pty Ltd – Design and implementation of ambient monitoring of particulate and volatile organic compound concentrations during a routine flaring event at a nearby school. ERM selected the monitoring equipment and undertook monitoring throughout the flaring event to determine impact at a sensitive use location nominated by community.
- Singapore Cross Island Line – Baseline monitoring plan development and implementation to inform Environmental Management Plan for tunnel shaft construction within a national park.
- Sell & Parker – Air quality assessment as part of an EIS which included atmospheric dispersion modelling and design of a boundary monitoring plan with trigger levels to prevent impact to the surrounding land use.
- Orica Mining Services – Development of an ambient monitoring plan for use during construction to ensure ambient concentrations of dust generation were in acceptable limits. Work included sourcing and specification of monitoring equipment and discussion / sign-off from the regulator.
- Singapore North-South Expressway - Internal technical peer review for baseline measurements and qualitative impact assessment for the Singapore North South Expressway.

Power Generation

- Van Phong - Development of meteorological dataset for a power station in Vietnam through the use of WRF and atmospheric dispersion modelling using CALPUFF.
- VPower – Development of meteorological datasets for three power stations in Myanmar through the use of WRF and review of the atmospheric dispersion modelling completed for the assessment.

- Dung Quat – Development of meteorological dataset for a power station in Vietnam through the use of WRF and atmospheric dispersion modelling using CALPUFF.
- Energy Australia – Independent review as part of environmental due diligence on the emission concentrations from two gas fired power stations in Victoria and the potential for constraint of operation as a result of environment protection licence limits.
- Java 1 – Assessment of a proposed power station in Indonesia adjacent to the coastline. Modelling was completed using the CALPUFF dispersion model to account for the proximity of the coastline and the potential for coastal fumigation.
- Newcrest Mining Ltd –ERM undertook atmospheric dispersion modelling using CALPUFF to determine the potential impact to the surrounding land use from a change in fuel oil source with a higher sulphur content. The modelling incorporated emissions from three power plant generation areas within the production facility at Lihir.
- AGL Limited – Assessment of proposed peak loading gas fired power station in the west of Victoria. Advanced dispersion modelling used the CALPUFF modelling system, and has incorporated observed ground level and upper air observed meteorological conditions. The assessment has considered start-up conditions on a sub-hourly basis and base load operations on an hourly basis, in addition to taking account of a further proposed base load power station by another operator in the vicinity. Following submission of the Works Approval Application to EPA, a presentation of the potential impacts was made to the Victorian Planning Panel.
- SCB PTES – Assessment of a proposed expansion to a based load and peak load power generation facility in Sulawesi Selatan.
- AGL Limited– Assessment of proposed change in operating hours from peak loading to base load capacity for a gas fired power station in northern Melbourne using Ausplume.
- Origin Energy – Impact assessment of a proposed change in fuel use and construction of a new turbine at a facility in northern Queensland using the Ausplume dispersion model. The assessment incorporated the generation of a meteorological dataset, dispersion modelling and assessment and the use of a regulatory airshed model for the local city.
- Origin Energy – Determination of minimum stack height for the redevelopment of a gas fired power station in central Queensland. The assessment incorporated the development of a meteorological dataset and the modelling of emissions from a variety of stack heights, taking in to account building downwash to finalise the redevelopment design.

Contaminated Land Management

- Viva – Evaluation of VOC and odorous emissions from contaminated land during excavation and treatment through windrow volatilisation for a former storage facility in NSW. Sampling was undertaken via collection of soil samples and delivery to a laboratory for odour and volatile analysis through flux hood samples. Dispersion modelling was undertaken using CALPUFF. The results of the assessment were used to define the remediation action plan in terms of the area of land that could be excavated.
- Roche – Evaluation of VOC and odorous emissions from contaminated land during remediation activites to evaluate the need for capture within a marquee and treatment options. Monitoring undertaken through collection of samples and delivery to a laboratory for odour and volatile analysis through flux hood samples. Dispersion modelling for proposed remedial action plan using CALPUFF.
- Jemena – Evaluation of emissions from contaminated sediments during remediation activities to evaluate potential for odour impacts during remediation activities. Project included measurement of odorous emissions from the contaminated sediments using flux measurements and dispersion modelling using CALPUFF.

- Anonymous – Evaluation of emissions from land contaminated with TCE during renewal of a concrete slab within an industrial facility. Assessment of impact undertaken using dispersion modelling to determine impact on surrounding sensitive receptors.
- Exxon Mobil – Evaluation of emissions from an air stripper and thermal oxidiser for the remediation of contaminated ground water in Melbourne. Evaluation included the use of Ausplume to demonstrate potential for impacts to surrounding land use.
- Shell – Evaluation of emissions from a mobile thermal oxidiser used to treat contaminated ground water in rural New South Wales.
- Anonymous – Evaluation of emissions from contaminated land during remediation activities for the construction of a new hardware store. Assessment included fluxhood monitoring of emissions from the contaminated soil, dispersion modelling and recommendation for minimisation of impact during remediation.

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