AIR QUALITY IMPACT ASSESSMENT
SHALLOW BAY QUARRY

Ironhide Enterprises Pty Ltd

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Job Number 25021845

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Air Quality Impact Assessment
Shallow Bay Quarry

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Todoroski Air Sciences has prepared this report on behalf of Ironhide Enterprises Pty Ltd for the proposed Shallow Bay Quarry located southwest of Forster, New South Wales (NSW) (hereafter referred to as the Project). The report presents an assessment of potential air quality impacts associated with the Project.

The Project seeks approval for the development of a hard rock quarry at the site with production limited to an annual extraction rate of 30,000 tonnes per annum (tpa). To address the relevant Council requirements, an air dispersion model of the Project activities has been developed to determine the extent of potential air quality impacts and demonstrate the effectiveness of proposed dust mitigation and management measures.

This air quality impact assessment has been prepared in general accordance with the New South Wales (NSW) Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**).

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

- A background to the Project and description of the proposed site and operations;
- A review of the existing meteorological and air quality environment surrounding the site;
- A description of the dispersion modelling approach and emission estimation used to assess potential air quality impacts; and,
- Presentation of the predicted results and discussion of the potential air quality impacts and associated mitigation and management measures.

2 PROJECT BACKGROUND

2.1 Project setting

The Project site is located approximately 10 kilometres (km) southwest of Forster. The area surrounding the site is predominantly comprised of bushland, and semi-rural land with scattered dwellings identified in the surrounding area.

Table 2-1 provides a list of the nearest receptors considered in this assessment. **Figure 2-1** presents the location of the Project with reference to the identified receptors.

Figure 2-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project. The Project site is located on the northern slope of a hill with a northerly aspect, overlooking an undulating small valley which fringes on the Wallis Lake. The area surrounding the Project is characterised by coastal flats and undulating to moderately steep hills.

Table 2-1: Assessed receptors

Assessment location ID	Address	Description
R1	73 Salisbury Way	Residential
R2	466 Shallow Bay Road	Residential
R3	554 Shallow Bay Road	Residential
R4	81 Salisbury Way	Residential
R5	462 Shallow Bay Road	Residential
R6	556 Shallow Bay Road	Residential
R7	570 Shallow Bay Road	Residential
R8	574 Shallow Bay Road	Residential
R9	80 Salisbury Way	Residential
R10	356 Shallow Bay Road	Residential

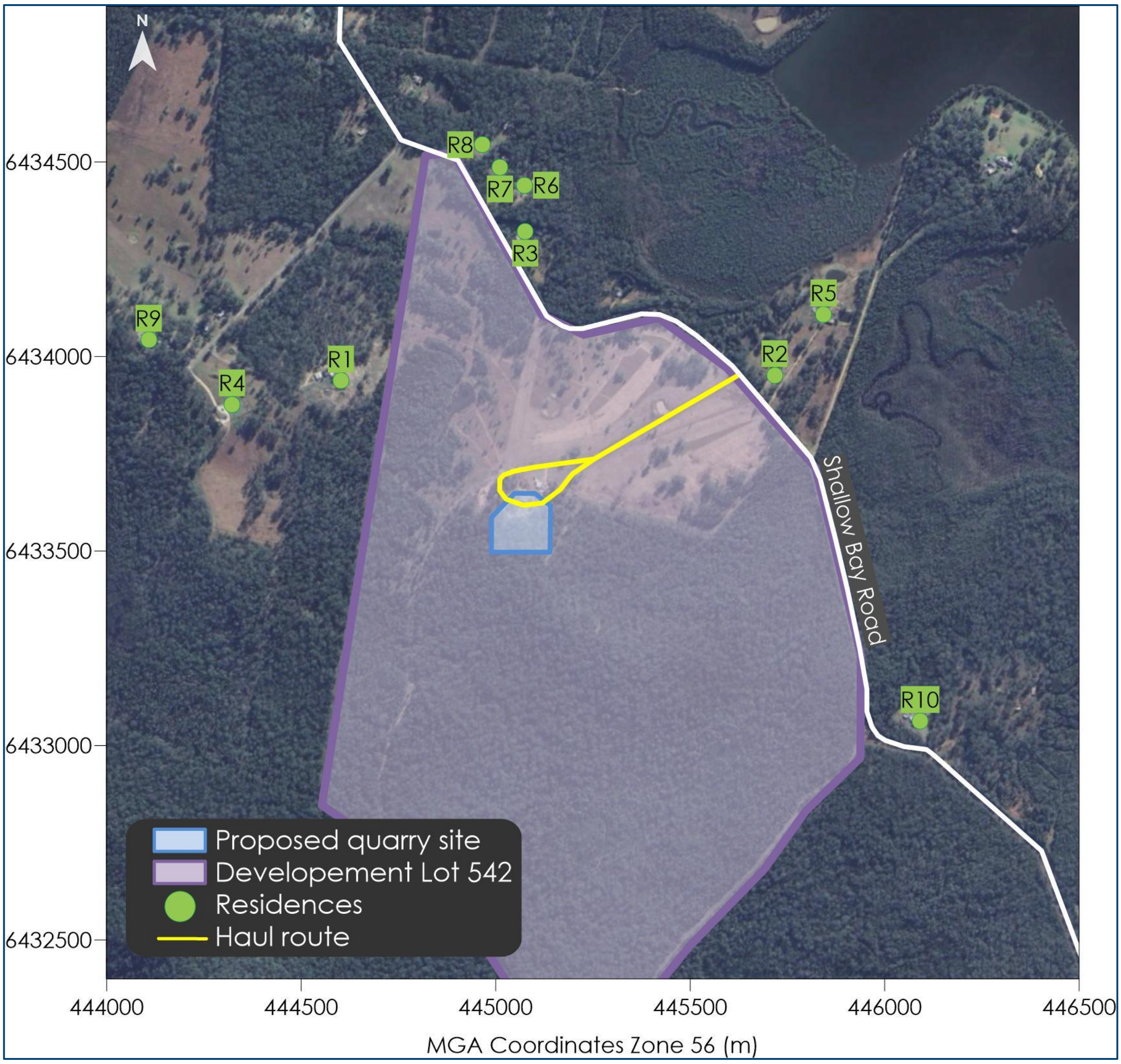

Figure 2-1: Project setting

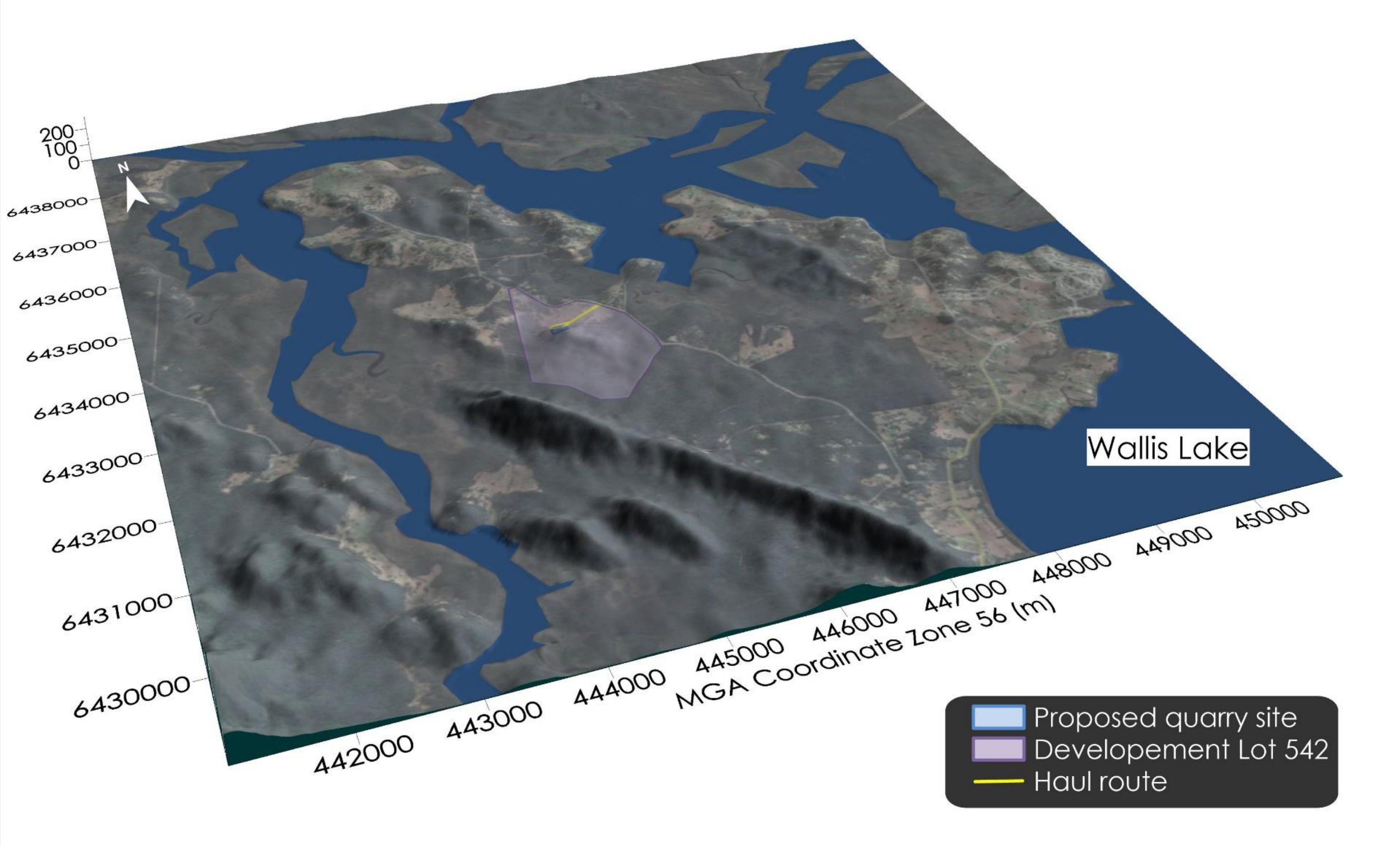

Figure 2-2: Representative visualisation of topography in the area surrounding the Project

2.2 Project description

The Project seeks approval for the development of a small hard rock quarry at the site, covering an area of approximately 2 hectares (ha). It is understood production at the quarry would be limited to:

- Maximum annual extraction rate of 30,000 tonnes (t).
- Maximum daily processing rate for crushing and screening operations of 150 t.

The primary purpose of the Project is to supply quarry products for use as fill, as well as for road construction and maintenance.

Hard rock material would be extracted in a staged progression following drilling and blasting. Material will be extracted using an excavator, and the material will be fed into a mobile jaw crusher located close to the extraction area, for crushing and screening. Processed materials will be then diverted to designated stockpiles on an ongoing basis during processing operations.

Product will be transported off-site to Shallow Bay Road via a private access road located within the site.

Proposed operating hours for the site are outlined in **Table 2-2**.

Table 2-2: Proposed operating hours

<table>
<tr><th>Activity</th><th>Weekdays</th><th>Weekends and public holidays</th></tr>
<tr><td>Extraction, crushing, screening</td><td rowspan="3">7:00AM to 6:00PM</td><td>No work</td></tr>
<tr><td>Loading trucks and shipping</td><td>No work</td></tr>
<tr><td>Maintenance</td><td>No work</td></tr>
<tr><td>Light maintenance and security</td><td colspan="2">All hours</td></tr>
</table>

Figure 2-3 provides an indicative site layout for the Project.

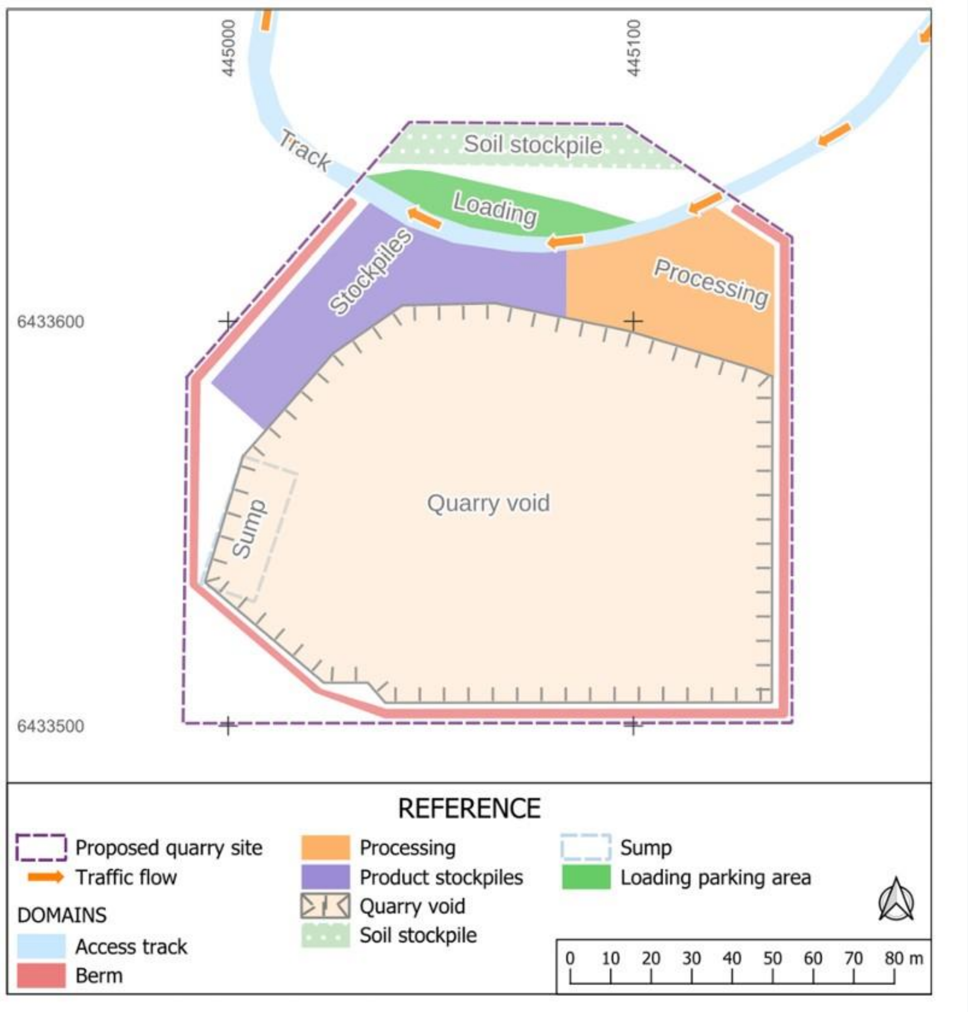

Figure 3.4 – Indicative initial operational domains.

Figure 2-3: Indicative site layout for the Project

3 AIR QUALITY CRITERIA

3.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**).

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

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/m³
PM_{10}	Annual	Total	25 µg/m³
	24 hour	Total	50 µg/m³
$PM_{2.5}$	Annual	Total	8µg/m³
	24 hour	Total	25 µg/m³
Deposited dust	Annual	Incremental	2 g/m²/month
		Total	4 g/m²/month

Source: **NSW EPA, 2022**
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

3.2 Respirable crystalline silica

Silica occurs in nature in a crystalline or amorphous form and may be synthetically produced in amorphous forms. Silica is naturally occurring and commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis (**NIOSH, 1974**).

Various jurisdictions have developed criteria for acceptable levels of exposure to crystalline silica. It is understood that the NSW EPA have advised that the interim impact assessment criteria for respirable crystalline silica (RCS) as outlined in **Table 3-2** are to be applied to the Project.

Table 3-2: Interim NSW Impact assessment criterion for RCS

Pollutant	Averaging period	Criterion
RCS ($PM_{2.5}$ dust fraction)	24-hour	24 µg/m³
	Annual	3 µg/m³

4 EXISTING ENVIRONMENT

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

4.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) weather station at the Taree Airport Automatic Weather Station (AWS) (Site No. 060141) were analysed to characterise the local climate in the proximity of the Project. Taree Airport AWS is located approximately 40km north of the Project.

Table 4-1 and **Figure 4-1** present a summary of data from the Taree Airport AWS collected over a 28 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 29 degrees Celsius (ºC) and July is the coldest month with a mean minimum temperature of 6.7ºC.

Rainfall decreases during the cooler months, with an annual average rainfall of 1156.0 millimetres (mm) over 101.1 days. The data indicate that March is the wettest month with an average rainfall of 195.4mm over 10.7 days and August is the driest month with an average rainfall of 44.6mm over 5.5 days.

Relative humidity levels exhibit variability over the day with limited seasonal fluctuations. Mean 9am relative humidity ranges from 63% in October to 86% in March. Mean 3pm relative humidity levels range from 50% in August to 63% in February.

Wind speeds exhibit seasonal variations with lower afternoon wind speed recorded for colder months compared with the warmer months. Mean 9am wind speeds range from 9.1 kilometres per hour (km/h) in February to 11.7 km/h in October. Mean 3pm wind speeds range from 13.3 km/h in June to 21.5 km/h in January.

Table 4-1: Monthly climate statistics summary – Taree Airport AWS

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (ºC)	29.0	28.4	26.8	24.4	21.4	18.9	18.7	20.3	23.2	24.8	26.0	27.8	24.1
Mean min. temp. (ºC)	18.5	18.3	16.8	13.7	10.1	7.9	6.7	6.9	9.4	12.0	15.0	16.9	12.7
Rainfall													
Rainfall (mm)	98.1	155.9	195.4	104.8	79.5	93.2	66.3	44.6	49.0	83.6	105.0	87.8	1156.0
No. of rain days	9.8	10.1	10.7	9.7	7.7	8.1	6.7	5.5	6.0	7.9	9.8	9.1	101.1
9 am conditions													
Mean temp. (ºC)	23.3	22.5	20.4	18.9	15.3	12.6	11.8	13.3	17.3	19.8	20.5	22.6	18.2
Mean R.H. (%)	74.0	81.0	86.0	79.0	78.0	80.0	77.0	70.0	65.0	63.0	73.0	71.0	75.0
Mean W.S. (km/h)	10.0	9.1	9.2	10.4	11.2	10.7	11.1	11.4	10.9	11.7	10.9	10.2	10.6
3 pm conditions													
Mean temp. (ºC)	27.1	26.7	25.2	22.6	20.0	17.8	17.2	18.6	20.9	22.3	23.5	25.7	22.3
Mean R.H. (%)	60.0	63.0	62.0	62.0	58.0	59.0	56.0	50.0	53.0	55.0	62.0	60.0	58.0
Mean W.S. (km/h)	21.5	19.9	17.8	15.4	13.7	13.3	14.5	16.6	19.4	20.8	20.8	20.9	17.9

Source: **Bureau of Meteorology, 2025**

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

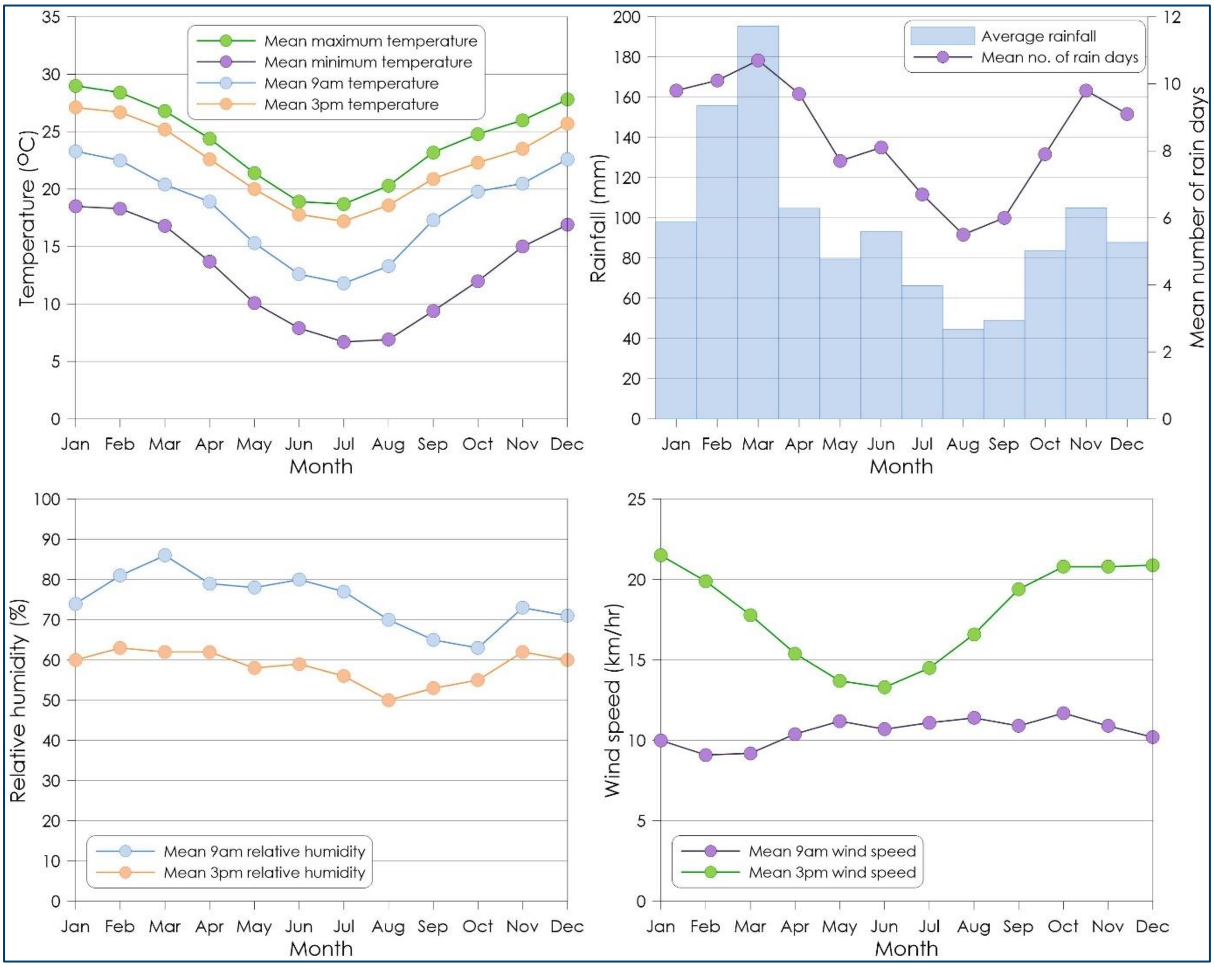

Figure 4-1: Monthly climate statistics summary – Taree Airport AWS

4.2 Local meteorological conditions

Annual and seasonal windroses for the Taree Airport AWS during the 2021 calendar period are presented in **Figure 4-2**.

The 2021 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of long-term data trends in meteorological data recorded and appropriate monitoring data for the area as outlined in **Appendix A**.

Analysis of the annual windrose shows that wind directions are predominantly from the west. In summer, the predominant winds are from the east and west, with varied winds form other directions. In spring the predominant winds are form the northeast and west. The winter and autumn windroses follow a similar distribution as the annual windrose.

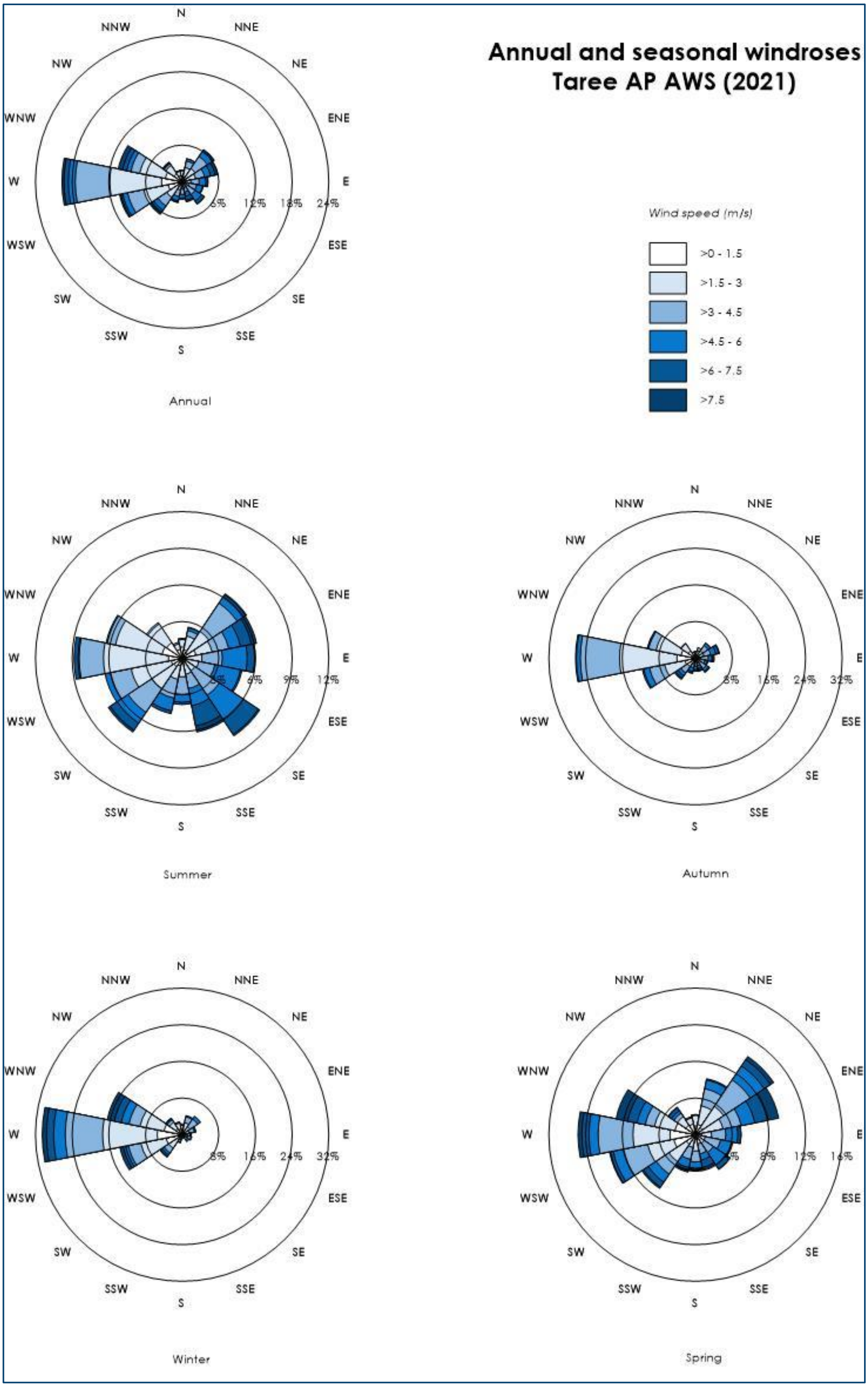

Figure 4-2: Annual and seasonal windroses – Taree Airport AWS (2021)

4.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the Project include emissions from local anthropogenic activities such as motor vehicle exhaust and domestic wood heaters as well as agricultural activities.

Available data from the nearest air quality monitor operated by the New South Wales (NSW) Department of Climate Change, Energy, the Environment and Water (DCCEEW) at Port Macquarie and Beresfield were used to quantify the background air quality levels in the vicinity of the Project site. The Beresfield and Port Macquarie monitoring sites are located approximately 95km southwest and 97km northeast of the Project, respectively.

4.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data from 2019 to 2024 for the Beresfield and Port Macquarie monitoring stations is presented in **Table 4-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-3**.

A review of **Table 4-2** indicates that all monitors were below the relevant annual average PM_{10} criterion of 25µg/m³ for all years of the review period, with the exception of Beresfield in 2019. The maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m³ on occasion from 2019 to 2020 at Beresfield and in 2019 to 2020 and 2024 at Port Macquarie.

Figure 4-3 shows both the Port Macquarie and Beresfield monitors following similar trends with regional events recorded at both monitoring stations. The high PM_{10} concentrations recorded at both monitors in late 2019 to early 2020 is attributed to wildfires and the drought period (**NSW DPIE 2019 & NSW DPIE 2020**).

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

Year	Beresfield	Port Macquarie	Criterion
	Annual average		
2019	**25.9**	- [1]	**25**
2020	18.5	14.4	**25**
2021	15.9	10.8	**25**
2022	14.3	9.1	**25**
2023	17.8	11.9	**25**
2024	16.9	11.2	**25**
Year	**Maximum 24-hour average**		**Criterion**
2019	**136.7**	**480.5**	**50**
2020	**77.7**	**249.9**	**50**
2021	36.3	31.9	**50**
2022	26.2	31.5	**50**
2023	41.0	36.2	**50**
2024	48.5	**57.9**	**50**

[1] Data not available

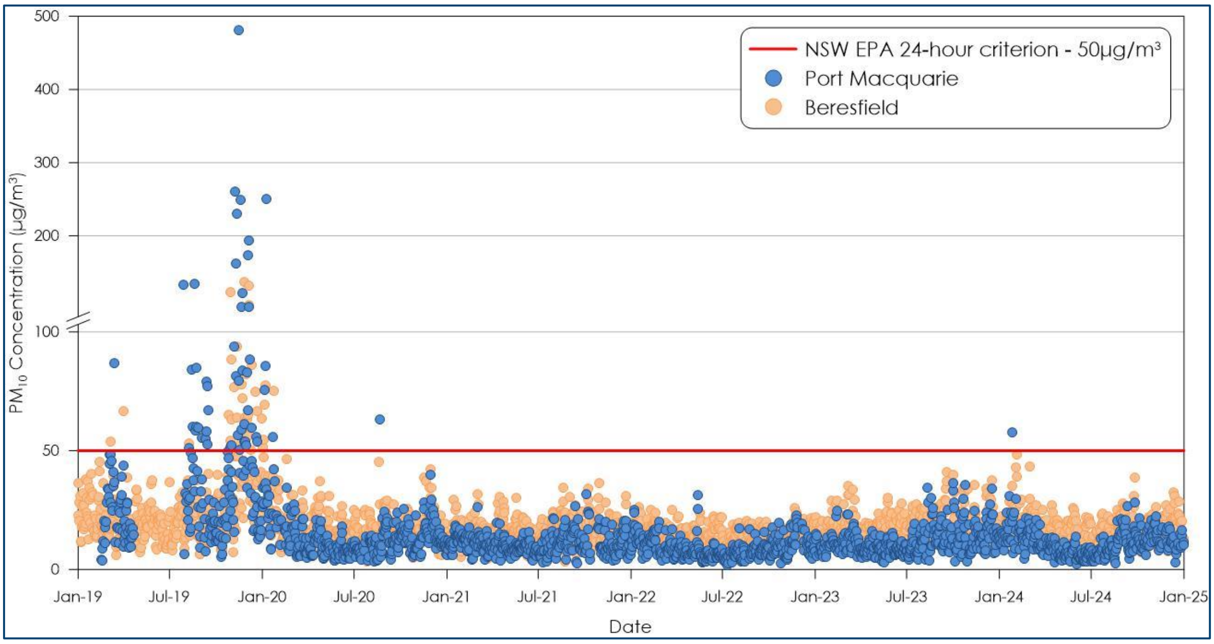

Figure 4-3: 24-hour average PM_{10} concentrations

4.3.2 $PM_{2.5}$ monitoring

A summary of the available data from 2019 to 2024 for the Beresfield and Port Macquarie monitoring stations is presented in **Table 4-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 4-4**.

Table 4-3 indicates that the annual average $PM_{2.5}$ concentrations for both monitoring stations were below the annual average criterion of 8µg/m^3 for all years except for 2019 at Beresfield.

The maximum 24-hour average $PM_{2.5}$ concentrations at the Beresfield monitoring station were found to be above the relevant criterion of 25µg/m^3 in 2019, 2020 and 2024. The Port Macquarie monitor recorded elevated levels from 2019 to 2020 and 2023 to 2024. Similar to the PM_{10} monitoring data, the mass wildfires affecting NSW in 2019 and 2020 are seen in the $PM_{2.5}$ monitoring data.

Table 4-3: Summary of $PM_{2.5}$ levels from monitoring stations (µg/m³)

Year	Beresfield	Port Macquarie	Criterion
	Annual average		
2019	**12.1**	- [1]	**8**
2020	7.7	6.5	**8**
2021	5.9	4.6	**8**
2022	5.0	3.3	**8**
2023	6.7	5.1	**8**
2024	6.5	4.6	**8**
Year	**Maximum 24-hour average**		**Criterion**
2019	**100.5**	**442.7**	**25**
2020	**49.7**	**220.5**	**25**
2021	18.9	14.7	**25**
2022	12.3	9.4	**25**
2023	16.6	**30.5**	**25**
2024	**25.3**	**38.7**	**25**

[1] Data not available

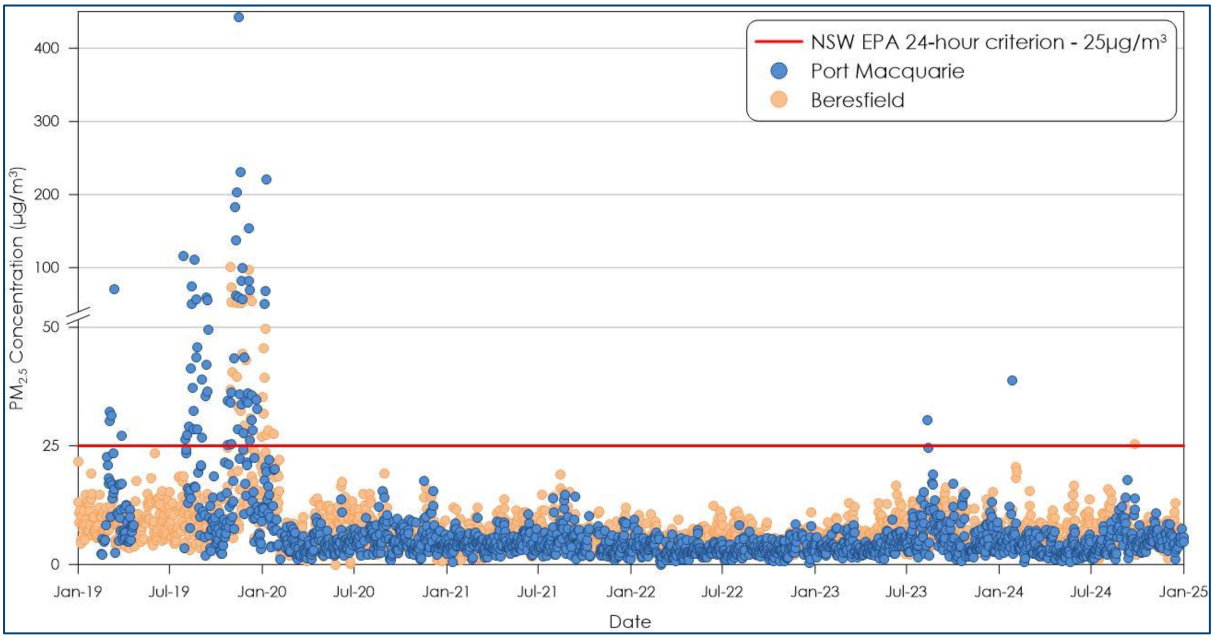

Figure 4-4: 24-hour average $PM_{2.5}$ concentrations

4.3.3 Estimated background levels

As outlined above, there are no readily available site-specific monitoring data, and therefore to assess the potential impacts associated with the Project against the relevant dust criteria outlined in **Section 3**, consideration of background dust levels needs to be applied.

The measured background dust levels from the Beresfield monitor for the 2021 calendar year period correspond to the period selected for the meteorological modelling (as outlined in **Appendix A**) and is chosen to represent the background levels for the Project. The background levels for Beresfield were selected in preference to Port Macquarie, as the Beresfield levels were generally more conservative than those for Port Macquarie.

Estimates of the annual average background TSP concentrations and deposited dust levels have been determined from a relationship with the measured PM_{10} levels. This relationship assumes that an annual average PM_{10} concentration of 25µg/m^3 corresponds to a TSP concentration of 90µg/m^3 and a dust deposition value of 4g/m^2/month.

This assumption is based on the NSW EPA air quality impact criteria. Applying this relationship with the measured annual average PM_{10} concentration of 15.9µg/m^3 during 2021 at Beresfield indicates an approximate annual average TSP concentration of 57.2µg/m^3 and a deposited dust level of 2.5.

The background air quality levels applied in this assessment are summarised in **Table 4-4**.

Table 4-4: Summary of background levels

Pollutant	Background level	Units
Annual average TSP	57.2	µg/m³
24-hour average PM_{10}	36.3	µg/m³
Annual average PM_{10}	15.9	µg/m³
24-hour average $PM_{2.5}$	18.9	µg/m³
Annual average $PM_{2.5}$	5.9	µg/m³
Annual average deposited dust	2.5	g/m²/month

5 DISPERSION MODELLING APPROACH

5.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach applied for the assessment. The CALPUFF is an advanced air dispersion model which can deal with the effects of complex local terrain on the dispersion meteorology over the modelling domain in a three-dimensional, hourly varying time step.

Modelling was undertaken using a combination of the CALPUFF Modelling System and the Weather Research and Forecasting model (WRF). The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

The model was setup in general accord with the methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC**, **2011**).

5.2 Meteorological modelling

The WRF model was applied to the available data to generate a three-dimensional upper air data file for use in CALMET. The centre of analysis for the WRF modelling used is at approximately 445100mE and 6433700mN. The simulation involved an outer grid of 30km, with three nested grids of 9km, 3km, and 1km grid spacing.

The CALMET domain was run on a domain of 10 x 10km with a 0.1km grid resolution. The available meteorological data for the 2021 calendar year from the Taree Airport AWS BoM meteorological monitoring site was included in the simulation. The 2021 calendar year was selected as the representative period for modelling the Project based on a statistical analysis of meteorological conditions from six consecutive years, as outlined in **Appendix A**.

5.3 Meteorological modelling evaluation

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

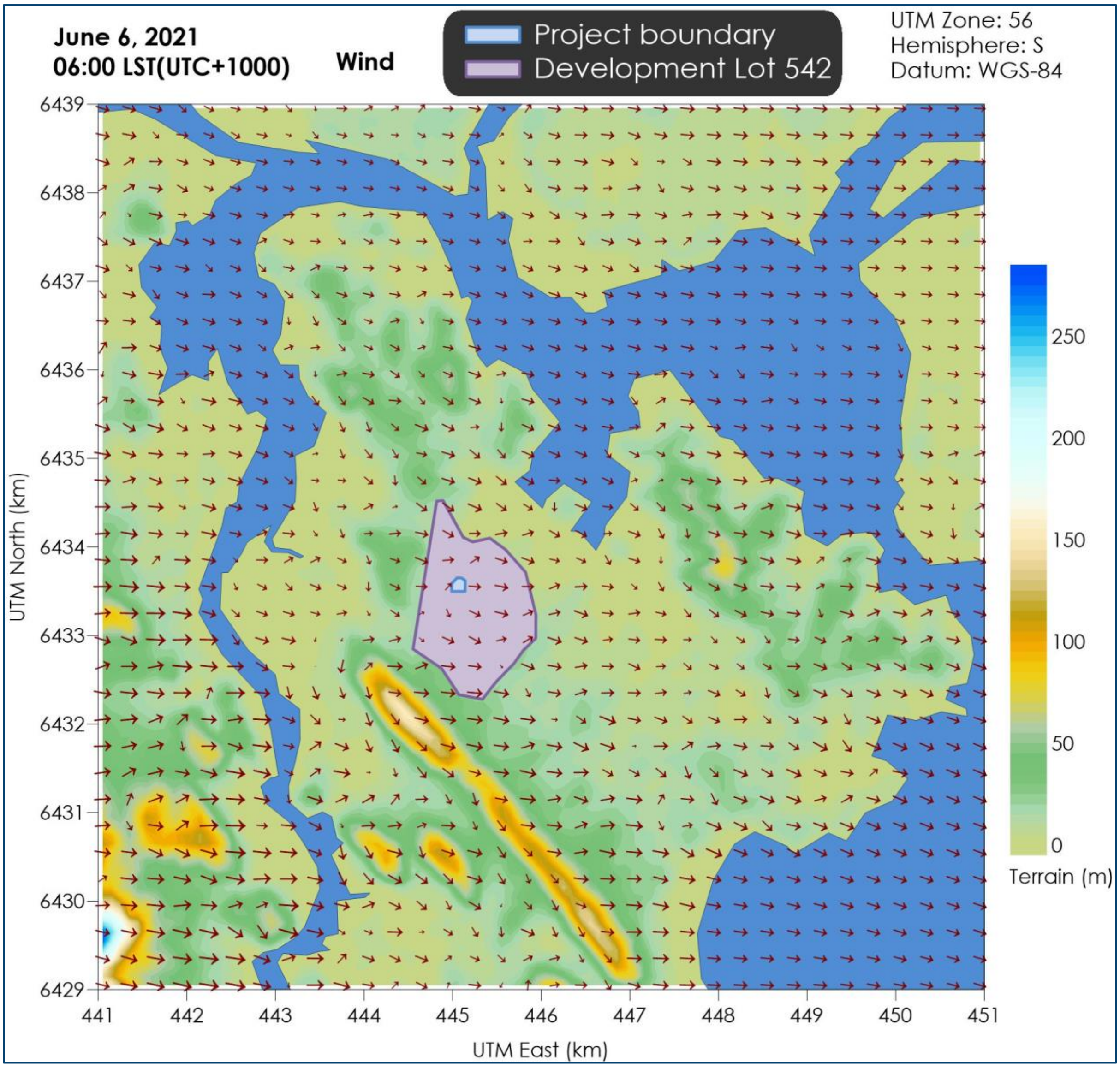

Figure 5-1: Representative 1-hour average snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 5-2** and **Figure 5-3**.

Figure 5-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds.

Figure 5-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

In conclusion, the CALMET generated meteorological data for the year 2021 are considered suitable for use in the air dispersion modelling for the Project.

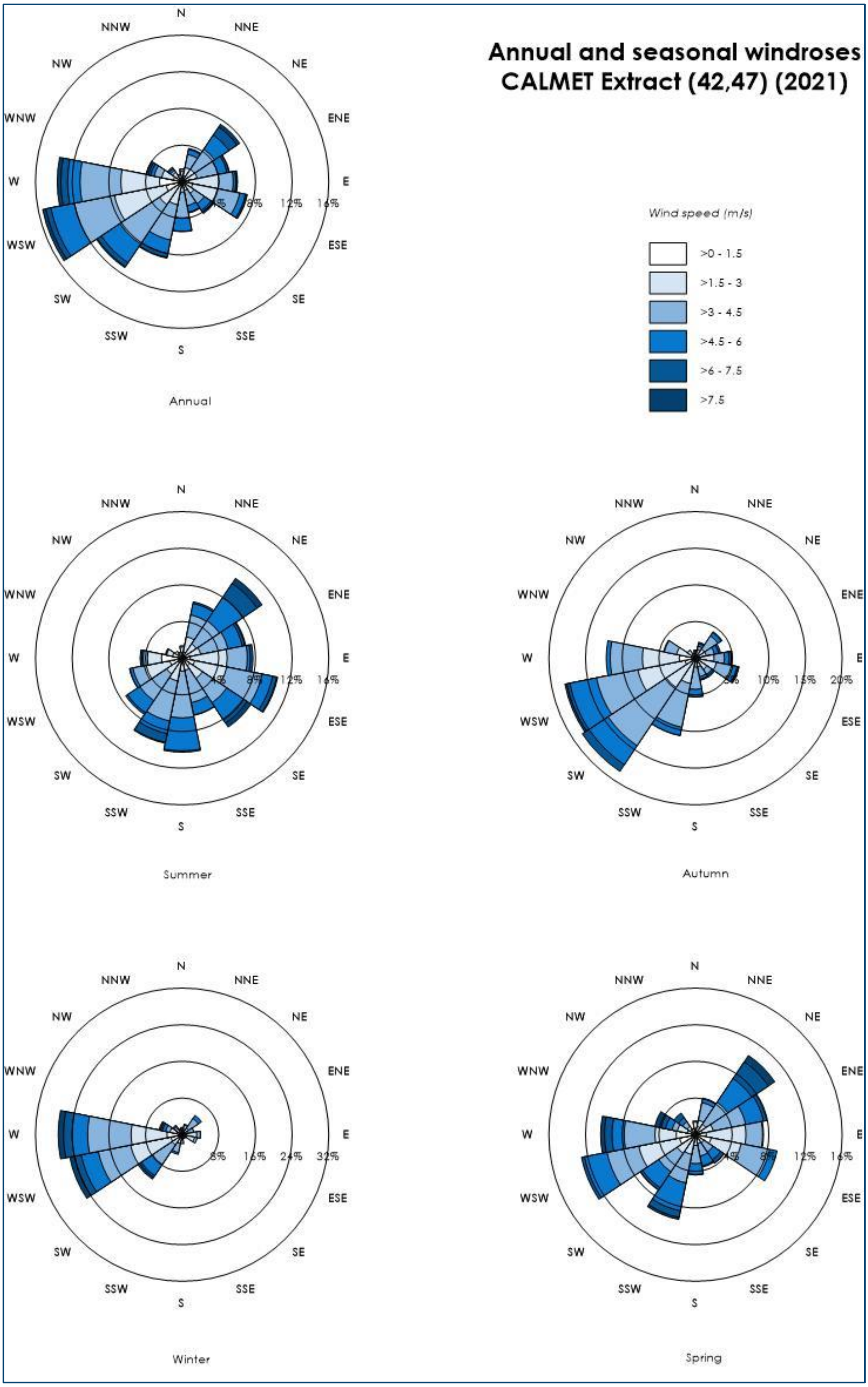

Figure 5-2: Annual and seasonal windroses from CALMET (Cell ref extract 42,47)

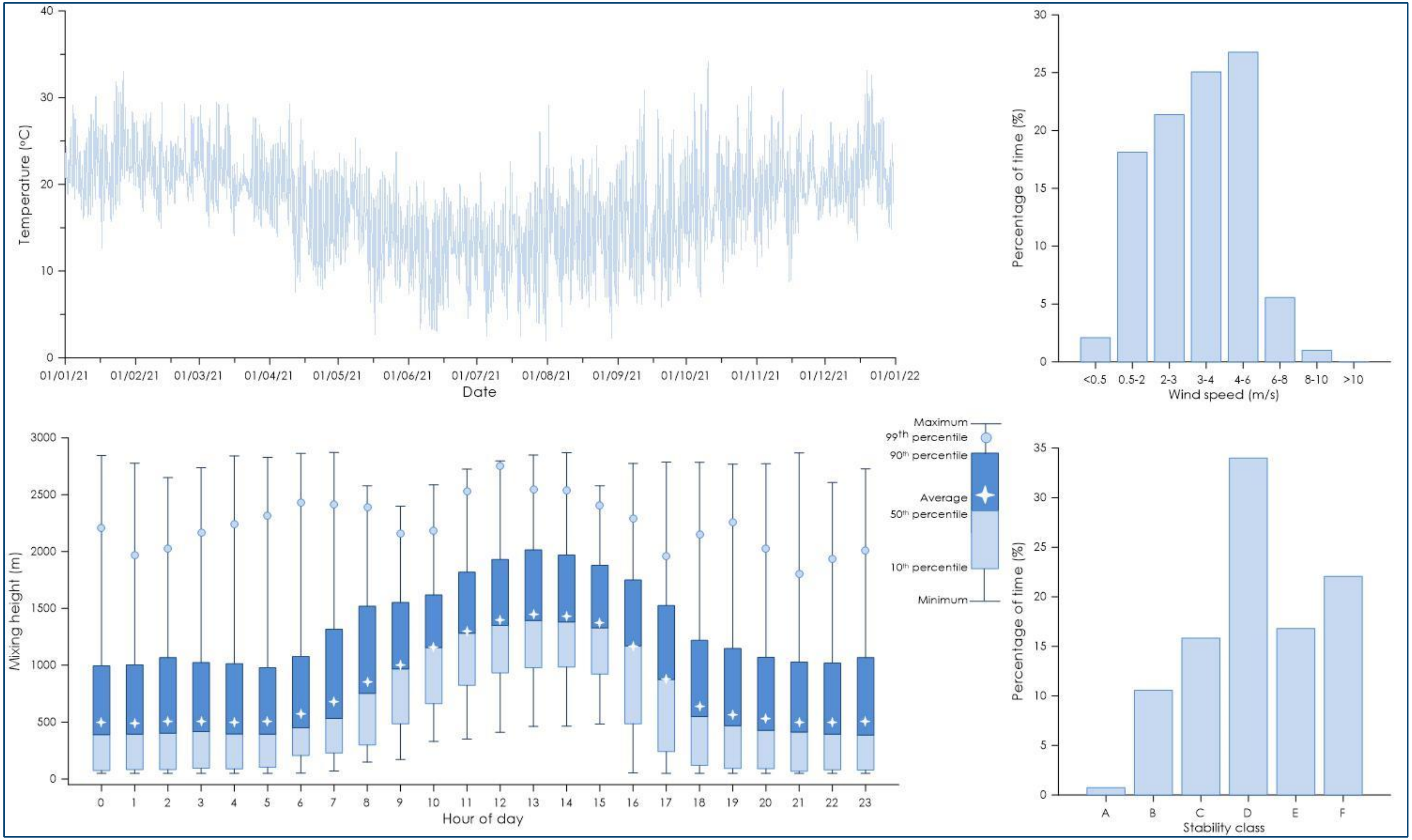

Figure 5-3: Meteorological analysis of CALMET (Cell ref extract 42,47)

5.4 Dispersion modelling

Dust emissions from each operational activity of the Project were represented by a series of volume and line (road) sources and were included in the CALPUFF model via an hourly varying emission file. The volume and line sources are represented in **Figure 5-24** below. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

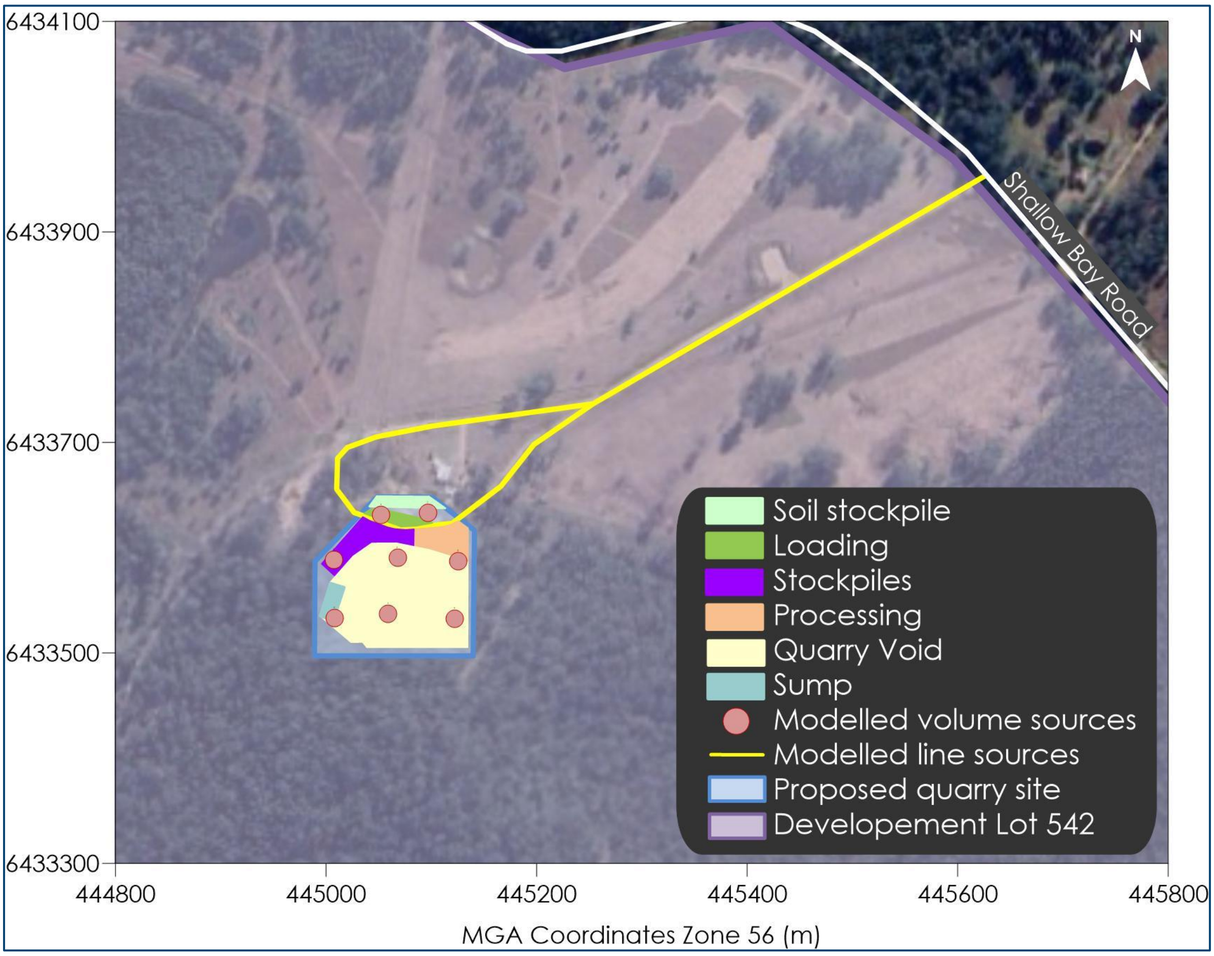

Figure 5-4: Indicative site plan and modelled sources

5.5 Emission estimation

The significant dust generating activities associated with operation of the Project are identified as the stripping and spreading of topsoil by the dozer, drilling and blasting, excavating material, crushing and screening of materials, transporting material and windblown dust from exposed areas and stockpiles. The vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

Dust emission estimates have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emissions sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation.

Average and peak conditions have been assessed for the operation of the Project. The annual average scenario is based on the proposed maximum annual tonnage of 30,000tpa of material processed at the site. To assess the maximum 24-hour peak impacts from the Project, the maximum plant processing rate of 150 tonnes per day (tpd) occurring for every weekday of the year has been applied. In assessing the maximum 24-hour peak impacts, the blasting and drilling was also assumed to occur for every week of the year instead of the maximum expected frequency of once-a-year blasting with a week of drilling beforehand.

A summary of the estimated TSP, PM_{10} and $PM_{2.5}$ emissions is presented in **Table 5-1**. Detailed calculations of the dust emission estimates are provided in **Appendix B**.

Table 5-1: Summary of estimated dust emissions for the Project (kg/yr)

Scenario	TSP emission	PM_{10} emission	$PM_{2.5}$ emission
Annual average	8,103	2,621	740
Peak 24-hour	14,635	5,932	940

6 DISPERSION MODELLING RESULTS

The dispersion model predictions presented in this section include those for the operation of the Project in isolation (incremental impact) and the operation of the Project with consideration of other sources (total cumulative impact). The results show the predicted:

- Maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average $PM_{2.5}$, PM_{10} and TSP concentrations; and,
- Annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations which were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) during the one year long modelling period.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix C**.

Table 6-1 presents the predicted incremental and cumulative particulate dispersion modelling results at each of the assessed residential receptor locations. The cumulative (total) impact is defined as the modelling impact associated with the operation of the Project combined with the estimated ambient background levels in **Section 4.3.3**.

The predicted incremental results show that minimal impacts would arise at the receptor locations due to the Project. The predicted cumulative results indicate that all of the assessed receptors are predicted to experience levels below the relevant criteria for each of the assessed dust metrics.

Table 6-1: Dust dispersion modelling results for assessed receptors

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/mth)	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/mth)
	Incremental						Cumulative					
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria											
	-	-	-	-	-	2	25	8	50	25	90	4
R1	0.3	<0.1	1.4	<0.1	0.1	<0.1	19.2	5.9	37.7	15.9	57.3	2.5
R2	0.2	<0.1	1.1	0.1	0.1	<0.1	19.1	5.9	37.4	16.0	57.3	2.5
R3	0.1	<0.1	0.7	<0.1	0.1	<0.1	19.0	5.9	37.0	15.9	57.3	2.5
R4	0.1	<0.1	0.7	<0.1	<0.1	<0.1	19.0	5.9	37.0	15.9	57.3	2.5
R5	0.1	<0.1	0.6	<0.1	0.1	<0.1	19.0	5.9	36.9	15.9	57.3	2.5
R6	0.1	<0.1	0.6	<0.1	<0.1	<0.1	19.0	5.9	36.9	15.9	57.3	2.5
R7	0.1	<0.1	0.6	<0.1	<0.1	<0.1	19.0	5.9	36.9	15.9	57.3	2.5
R8	0.1	<0.1	0.5	<0.1	<0.1	<0.1	19.0	5.9	36.8	15.9	57.3	2.5
R9	0.1	<0.1	0.4	<0.1	<0.1	<0.1	19.0	5.9	36.7	15.9	57.3	2.5
R10	0.1	<0.1	0.4	<0.1	<0.1	<0.1	19.0	5.9	36.7	15.9	57.3	2.5

*Deposited dust

6.1 Respirable crystalline silica

The assessment results in **Table 6-1** show that the most affected residence (R1) has a total maximum predicted incremental 24-hour and annual average $PM_{2.5}$ concentration level of 0.3µg/m³ and

<0.1µg/m^3, respectively. This level is due to the total dust from the site, and only a small portion of this dust would contain silica.

Even if the entire $PM_{2.5}$ fraction of dust associated with the Project is comprised of RSC, the levels at this receptor would be well below the interim criterion of 24µg/m^3 for 24-hour average and 3µg/m^3 for annual average, and thus there would be no potential for impacts from RSC.

7 DUST MITIGATION AND MANAGEMENT

The proposed operations at the Project have the potential to generate dust emissions. To ensure that activities associated with the Project have a minimal effect on the surrounding environment and at residential receptor locations, it is recommended that all reasonable and practicable dust mitigation measures be utilised.

Mitigation measures are provided in the *Shallow Bay Quarry – Statement of Environmental Effects* (**Quarry Plan NSW, 2025**) and include, but are not limited to:

- Restricting quarry traffic to a maximum speed of 20 km/h along the quarry access track within the development lot;
- Ceasing operations on excessively windy days and/or when gravel/quarry product is very dry;
- Actively suppressing dust with a water cart if operations are necessary during significantly adverse weather or ground conditions; and,
- Using inbuilt misting systems on the crushing and screening plant, to suppress dust, where available and appropriate (expected to be used only when blasted rock has minimal moisture content).

8 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the operations of hard rock extraction at the proposed Shallow Bay Quarry.

Air dispersion modelling was used to predict the potential for off-site dust impacts in the surrounding area due to the operation of the Project. The estimated emissions of dust applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that all the assessed air pollutants generated by the operation of the Project would comply with the applicable assessment criteria at the assessed receptors and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area.

Nevertheless, the site would apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

Overall, the assessment demonstrates that even using conservative assumptions, the Project can operate without causing any significant air quality impact at residential receptors in the surrounding environment.

9 REFERENCES

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Appendix A

Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest six contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Taree Airport AWS weather station, is presented in **Table B-1**.

The standard deviation of the latest six years of meteorological data spanning 2019 to 2024 was analysed against the available measured wind speed, temperature and relative humidity. The analysis indicates that the 2020, 2021 and 2024 datasets are closest to the mean for wind speed, while 2021 is closest for temperature and relative humidity. On the basis of a score weighting analysis, 2021 was found to be most representative.

Table B-1: Statistical analysis results for Taree Airport AWS

Year	Wind speed	Temperature	Relative humidity	Score
2019	0.5	0.9	7.0	8.4
2020	0.2	0.6	3.4	4.2
2021	0.2	0.5	2.9	3.7
2022	0.3	0.7	5.8	6.8
2023	0.3	0.9	3.8	5.0
2024	0.2	0.8	3.9	4.9

Figure B-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2021 year compared with the mean of the 2019 to 2024 data set. The 2021 calendar year data appear to be well aligned with the mean data.

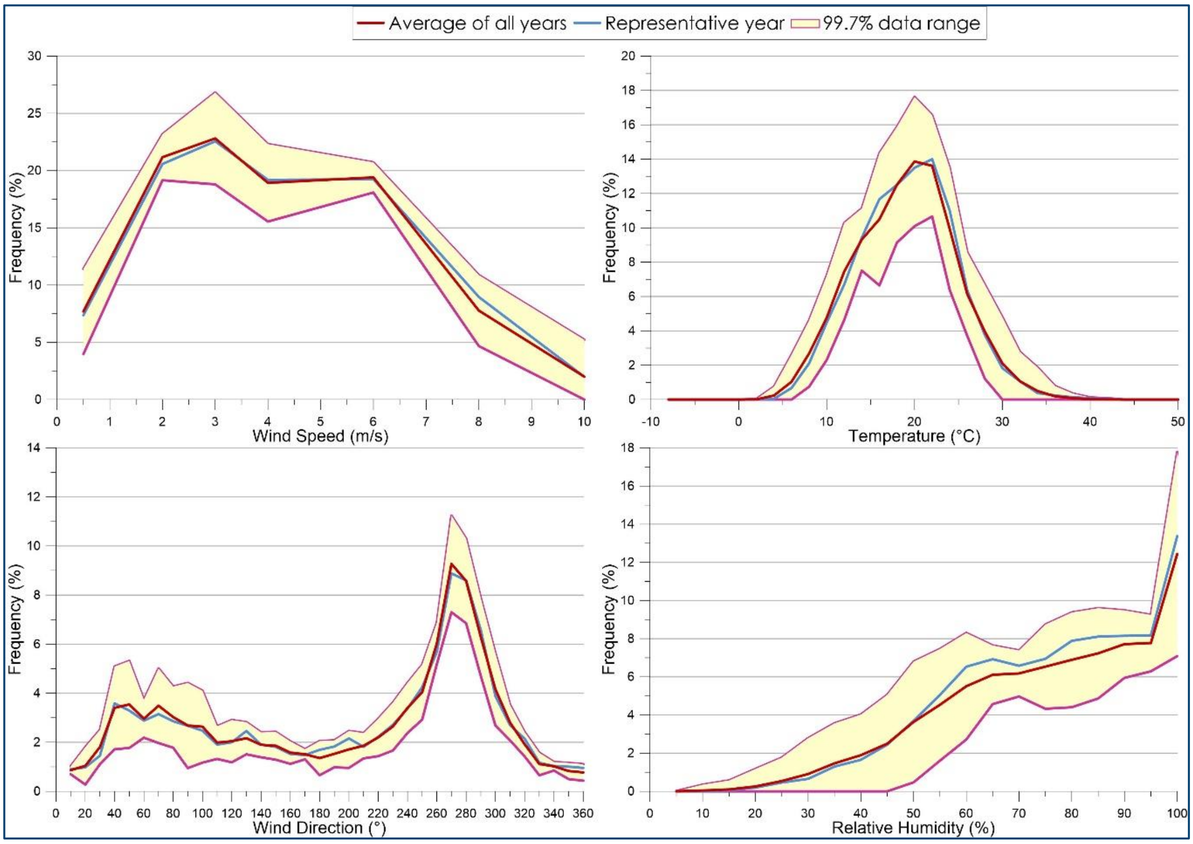

Figure B-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Emission Calculations

Emission Calculation

The dust emissions from the Project have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations and utilising suitable emission and load factors that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: Best Practise Measures for Reducing Non-Road Diesel Exhaust Emissions, Final Report" (**NSW EPA, 2015**).

The emission factor equations used for each dust generating activity are outlined in **Table B-1** below. Detailed dust emission inventories for the modelled scenarios are presented in **Table B-2** to **Table B-3**.

Control factors include the following:

- Hauling on unpaved surfaces – 75% control for watering of trafficked areas

Table B-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Loading / emplacing material	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times W/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times W/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times W/3)^{0.45} kg/VKT$
Drilling overburden	$EF = 0.59\ kg/hole$	$0.52 \times TSP$	$0.03 \times TSP$
Blasting overburden	$EF = 0.00022 \times A^{1.5}$ kg/blast	$0.52 \times TSP$	$0.03 \times TSP$
Tertiary crushing	$EF = 0.0006\ kg/t$	$EF = 0.00027\ kg/t$	$EF = 0.00005\ kg/t$
Screening	$EF = 0.0125\ kg/t$	$EF = 0.0043\ kg/t$	$EF = 0.00032\ kg/t$
Dozers on overburden	$EF = 2.6 \times s^{1.2} / M^{1.3}\ kg/hr$	$EF = (0.45 \times s^{1.5} / M^{1.4}) \times 0.75\ kg/hr$	$EF = (2.6 \times s^{1.2} / M^{1.3}) \times 0.105\ kg/hr$
Wind erosion on exposed areas, stockpiles	$EF = 850\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

A = horizontal area (m^2) with blasting depth ≤ 21m, EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), W = average weight of vehicle (tonne), VKT = vehicle kilometres travelled (km)

Table B-2: Dust Emissions Inventory – Average scenario

Activity	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var 1	Units	Var 2	Units	Var 3 - TSP	Var 3 - PM10	Var 3 - PM2	Units	Var 4	Units	Var 5	Units	Var 6	Units
Dozer stripping, spreading topsoil	4,686	1,132	492	280	hr/yr	16.7353	4.0442	1.7572	kg/h	10	S.C. %	2	M.C. %										
Drilling	105	55	3	178	holes/yr	0.59	0.31	0.018	kg/hole														
Blasting	14	7	0	1	blasts/yr	14.08	7.32	0.42	kg/blast	1,600	area of blast (m2)												
Excavating	65	31	5	30,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Load to processor	65	31	5	30,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Crushing	18	8	2	30,000	t/yr	0.0006	0.0003	0.00005	kg/t														
Load to screening	65	31	5	30,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Screening	375	129	10	30,000	t/yr	0.0125	0.0043	0.00032	kg/t														
Load to truck	65	31	5	30,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Hauling to stockpile (unpaved)	90	26	3	30,000	t/yr	0.012	0.0035	0.00035	kg/t	31	t/load	0.1	km/retu	3.2	0.9	0.09	kg/VKT	10.0	S.C %	23.1	weight (t)	75	C %
Unload to stockpile	65	31	5	30,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Load to export	65	31	5	30,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Hauling export to boundary (unpaved)	672	171	17	30,000	t/yr	0.090	0.023	0.002	kg/t	31	t/load	1.4	km/retu	1.9	0.5	0.05	kg/VKT	4.8	S.C %	23.1	weight (t)	75	C %
Wind erosion - exposed areas and stockpiles	1,690	845	127	1.99	ha	850	425	64	kg/ha/yr														
Diesel usage/Exhaust emissions	61	61	59																				
Total TSP emissions (kg/yr.)	**8,103**	**2,621**	**740**																				

Table B-3: Dust Emissions Inventory – Peak scenario

Activity	TSP emission (kg/y)	PM10 emission (kg/y)	PM25 emission (kg/y)	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var 1	Units	Var 2	Units	Var 3 - TSP	Var 3 - PM10	Var 3 - PM2	Units	Var 4	Units	Var 5	Units	Var 6	Units
Dozer stripping, spreading topsoil	4,686	1,132	492	280	hr/yr	16.7353	4.0442	1.7572	kg/h	10	S.C. %	2	M.C. %										
Drilling	5,454	2,836	164	9,244	holes/yr	0.59	0.31	0.02	kg/hole														
Blasting	732	381	22	52	blasts/yr	14.08	7.32	0.42	kg/blast	1,600	area of blast (m2)												
Excavating	85	40	6	39,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Load to processor	85	40	6	39,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Crushing	23	11	2	39,000	t/yr	0.0006	0.0003	0.000050	kg/t														
Load to screening	85	40	6	39,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Screening	488	168	13	39,000	t/yr	0.0125	0.0043	0.00032	kg/t														
Load to truck	85	40	6	39,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Hauling to stockpile (unpaved)	116	34	3	39,000	t/yr	0.012	0.004	0.000	kg/t	31	t/load	0.1	km/return	3.2	0.9	0.09	kg/VKT	10.0	S.C %	23.1	weight (t)	75	C %
Unload to stockpile	85	40	6	39,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Load to export	85	40	6	39,000	t/yr	0.00218	0.00103	0.00016	kg/t	1.8	<(ws/2.2)^1.3	2	M.C %										
Hauling export to boundary (unpaved)	874	223	22	39,000	t/yr	0.090	0.023	0.002	kg/t	31	t/load	1.4	km/return	1.9	0.5	0.05	kg/VKT	4.8	S.C %	23.1	weight (t)	75	C %
Wind erosion - exposed areas and stockpiles	1,690	845	127	1.99	ha	850	425	64	kg/ha/yr														
Diesel usage/Exhaust emissions	61	61	59																				
Total TSP emissions (kg/yr.)	**14,635**	**5,932**	**940**																				

Appendix C
Isopleth Diagrams

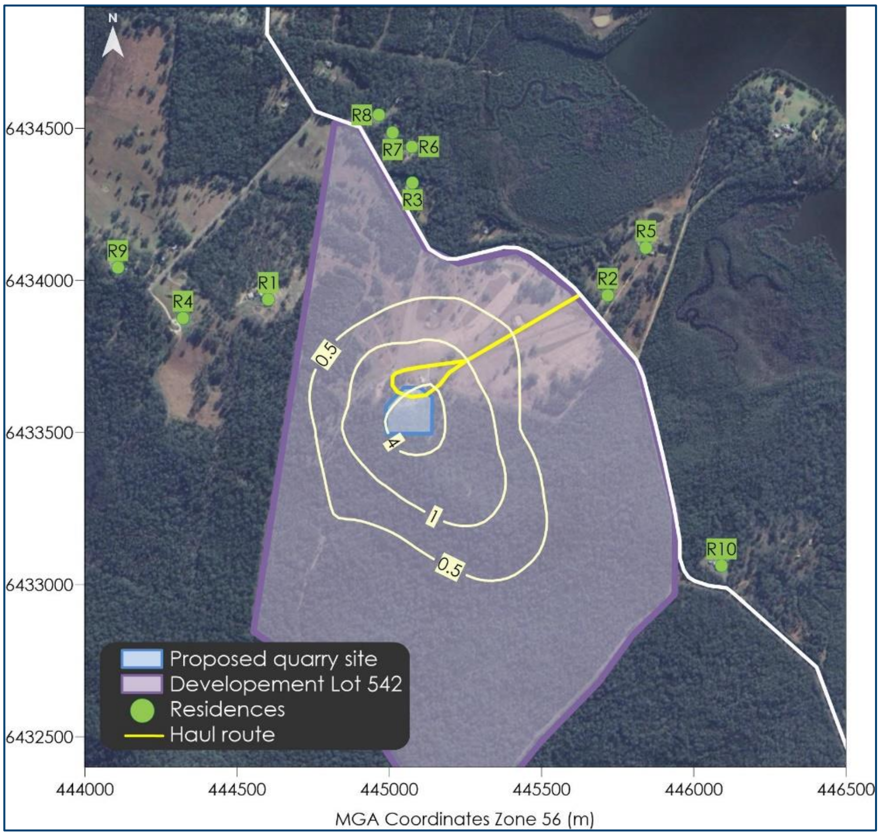

Figure C-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

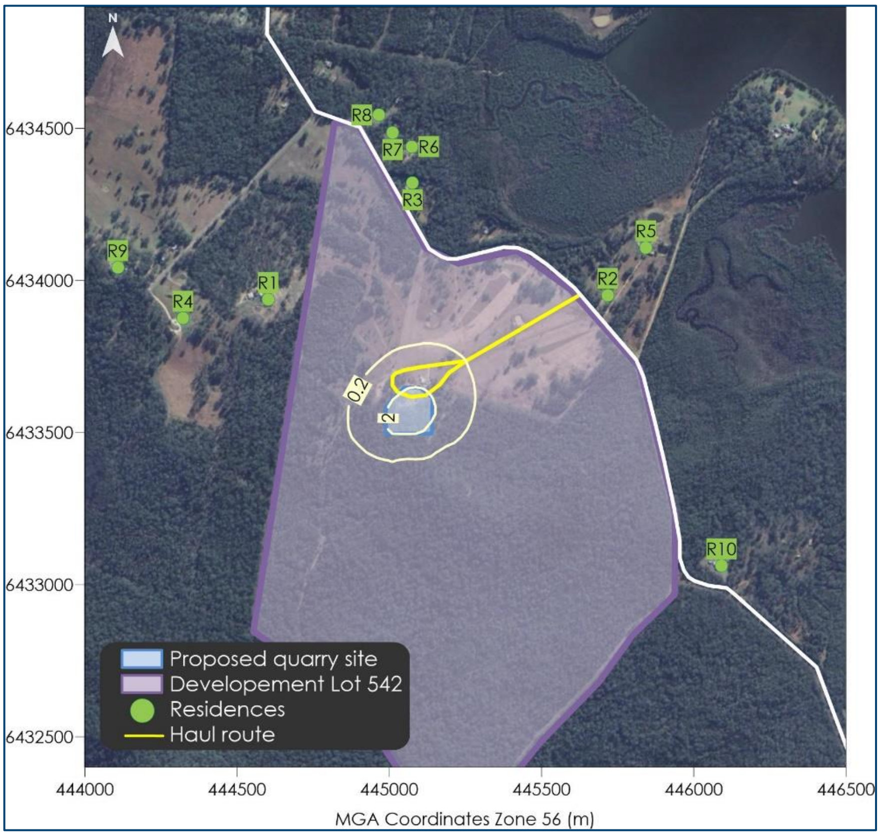

Figure C-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

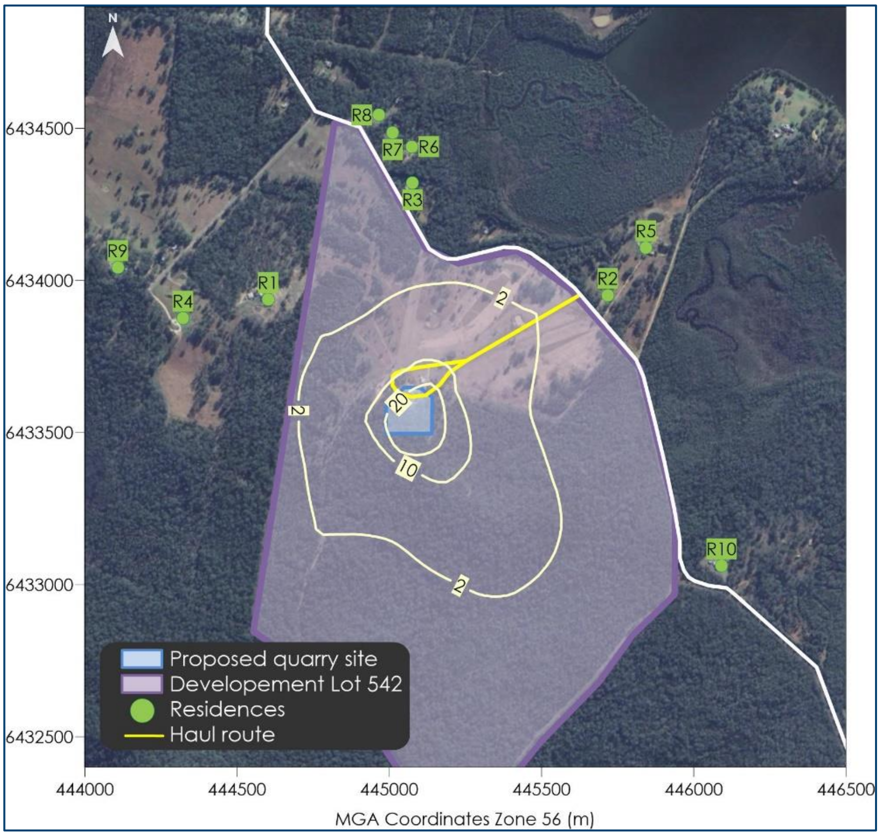

Figure C-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

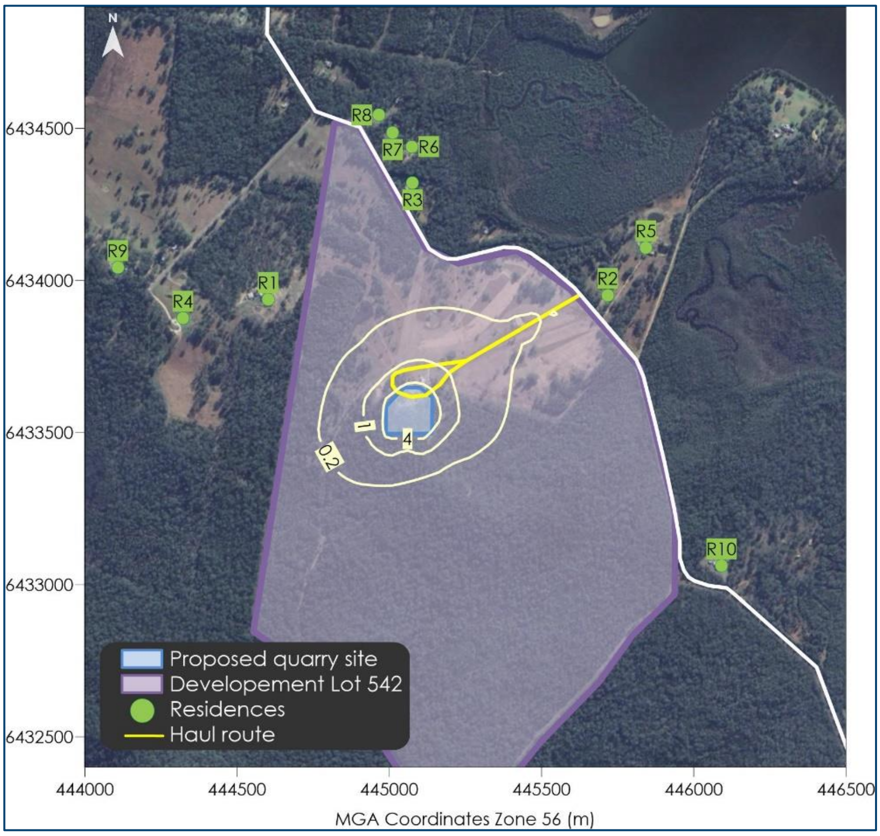

Figure C-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

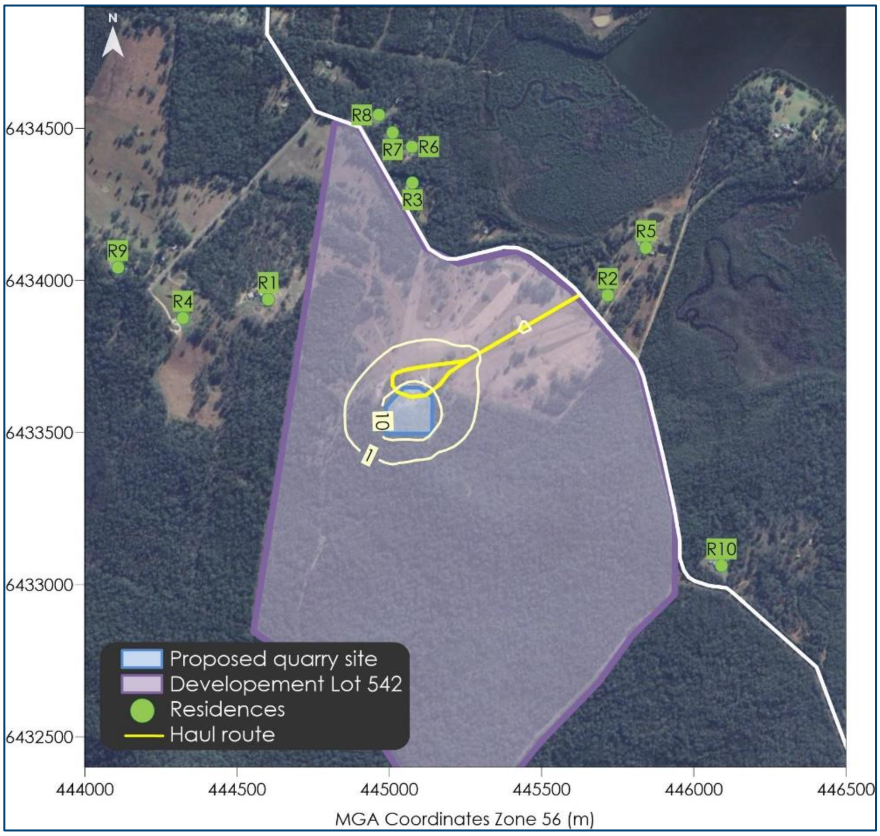

Figure C-5: Predicted incremental annual average TSP concentrations (µg/m³)

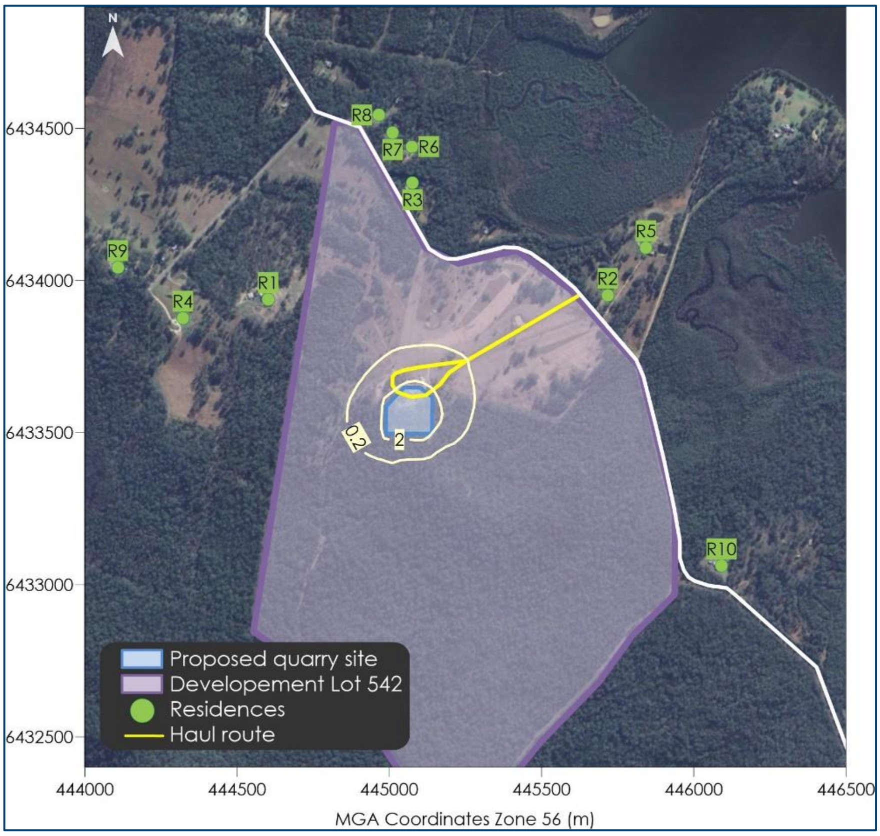

Figure C-6: Predicted incremental annual average dust deposition levels (g/m²/month)