



Designated Development Application

251 Adelaide Street, Raymond Terrace NSW

Cut and Fill Operations

Air Quality Impact Assessment

Raymond Terrace Parklands
01 October 2021

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A VIRID IFC REPORT

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Executive Summary

Virid IFC Pty Ltd were commissioned by Raymond Terrace Parklands to undertake an air quality impact assessment concerning a Designated Development Application at 251 Adelaide Street, Raymond Terrace, NSW 2324.

Approval is being sought for the importation, placement, and retention of fill to mitigate flood risk for future rezoning and residential development at the site which was formerly sand quarry.

As the application is a Designated Development, Secretary Environmental Assessment Requirements (SEAR) have been issued which includes a quantitative assessment of air quality impacts from the proposed cut and fill operations.

A Level 2 impact assessment has been conducted in accordance with the EPA publication - '*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*'.

Emission rates for particulate matter (which has been identified as the key pollutant), have been estimated for all dust generating activities using published emission factors. Impacts at the nearest sensitive receptors have been predicted using the CALPUFF dispersion model and the meteorology driving the dispersion of pollutants has been developed using a combination of the TAPM and CALMET meteorological models.

Modelling shows that particulate concentrations for all the modelled size fractions (TSP, PM₁₀, PM_{2.5}) and deposited dust levels are well below the respective assessment criteria across all the sensitive receptors. It is also noted that specific contribution from the operations at the project site to the overall air quality levels is very low.

Given that the operations at the project site comply with the relevant impact assessment criteria and taking into consideration the minimal contribution to the cumulative concentrations, it can be concluded that the proposed cut and fill operations at the 251 Adelaide Street site are not expected to have an adverse impact on the existing air quality levels, and therefore, are not considered to be a critical issue with respect to air quality matters.

1 Introduction

Raymond Terrace Parklands engaged Virid IFC Pty Ltd (Virid IFC) to undertake an air quality impact assessment for the Designated Development at 251 Adelaide Street, Raymond Terrace, NSW 2324.

As per information provided by Raymond Terrace Parklands, approval is being sought for the importation, placement, and retention of fill to mitigate flood risk for future rezoning and residential development at a former quarry site located at 251 Adelaide Street, Raymond Terrace, NSW 2324 within the Port Stephens Local Government Area (LGA) (hereafter 'the project').

It is anticipated that the project would take approximately 12 months to complete and during that time approximately 40,000 m³ of material would be cut and approximately 60,000 m³ of fill material would be imported for the fill operations to mitigate flood risk and allow for future rezoning and development.

As per the NSW Department of Planning Industry & Environment (NSW DPI&E), the project is both an Integrated and a Designated Development, and therefore an Environmental Impact Statement (EIS) is to be accompanied along with the application to assess the impacts from the projects. Secretary Environmental Assessment Requirements (SEAR 1571) have been issued by the NSW DPI&E for the project, which include a detailed quantitative assessment of potential air quality / odour impacts resulting from the project activities.

This report issued by Virid IFC forms a part of the EIS, which is to be submitted to the NSW DPI&E seeking approval for the project.

To assess potential impacts from the project, a Level 2 impact assessment has been conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, NSW Environment Protection Authority – January 2017 (hereafter 'the Approved Methods').

As per Section 9 of the Approved Methods, the NSW – Environment Protection Authority (EPA) has listed out minimum requirements regarding information contained within an impact assessment report which are specified below. The relevant sections of this report which address the minimum requirements are mentioned alongside:

- Site plan – Section 4.
- Description of the activities carried out on the site – Section 4.
- Emissions inventory – Section 8.
- Meteorological data – Section 9.
- Background air quality data – Section 7.
- Dispersion modelling – Section 10, Section 11; and
- Bibliography – Section 13.

As the project is a Designated Development, Secretary Environmental Assessment Requirements (SEARs) have been issued by the NSW DPI&E – SEAR No 1571 on 11 May 2021 for the project, which include an assessment of air quality and odour issues. SEARs issued for air quality and odour matters relating to the Designated Development, and sections of this report addressing those relevant SEARs are summarised below:

- a description of all potential air emission sources during infill operations – Section 4.

- a quantitative assessment of the potential air quality and dust impacts of the development in accordance with relevant Environment Protection Authority guidelines – all relevant sections of this report.
- a description and appraisal of air quality impact mitigation and monitoring measures, in line with International Best Practice – Section 8, Section 11.

As per Schedule 1 of the NSW Protection of the Environment Operations Act 1997 (POEO Act), the EPA is the relevant regulatory authority for assessment of air quality matters. The EPA have identified air quality matters for the Designated Development which are listed below. Sections of this report addressing those matters are presented alongside:

- Identify the existing air quality environment and identify applicable air quality goals (i.e. ground level concentrations for pollutants and odour assessment criteria) in line with relevant guidance/standards; and (Section 6, Section 7).
- Identify potential air quality and odour sources and impacts (including point source emissions from any site-based plant and equipment and/or fugitive dust or other emissions) during both construction and operational stages and identify best practice mitigation measures (pollution control) and strategies to minimise point and/or fugitive and/or odour emissions/impacts (with proposed timing), including monitoring, in line with relevant guidance/standards; and (Section 8, Section 11).
- Include an emission inventory of all sources of air emissions. (Section 8).

2 Objective

The objective of this air quality assessment report is to quantitatively determine potential air quality and odour impacts from the various activities at the project and to ensure that the pollutants released from the project would comply with the relevant regulatory guidelines.

To achieve this objective, air dispersion modelling has been conducted in accordance with the guidance provided in the Approved Methods. Modelling has been conducted using the EPA approved CALPUFF puff dispersion modelling suite.

The assessment has been informed by the relevant guideline documents:

- Secretary Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning & Environment (DOP&E) (SEAR No: 1571).
- NSW-EPA requirements - DOC21/289757-1, issued 28 April 2021.
- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, Environment Protection Authority, January 2017 (NSW-EPA, 2017); and
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia'* (NSW-OEH, 2011).

3 Methodology

To assess potential air quality and odour impacts from the project, the following has been completed.

- Detailed review of the operations proposed at the project site and identifying key pollutants of concern.
- Determination of relevant air quality objectives / assessment criteria for the identified pollutants.
- Estimation of pollutant emission rates from activities undertaken at the project site.
- Characterisation of the study area including identification of sensitive receptors.

- assessment of existing background concentrations for the concerned pollutants for determining cumulative concentrations (i.e. combined impacts from the project along with the existing background levels).
- Development of a 3-D meteorological model using the TAPM and CALMET models.
- Modelling of estimated pollutant emissions using the CALPUFF dispersion model.
- Prediction of incremental (i.e. impacts from the project only) and cumulative (incremental + background) ground-level concentrations at all sensitive receptors for all the modelled pollutants.
- Comparison of the cumulative pollutant concentrations with the assessment criteria outlined in the Approved Methods to assess compliance;
- Presentation of modelled pollutant concentrations in the form of tables and concentration isopleths.
- Recommendation of additional mitigation measures (where required).
- Preparation of the air quality assessment report.

4 Project Overview

The project site located at 251 Adelaide Street, Raymond Terrace falls within the floodplain of Windeyers Creek, which is upstream of the Hunter River. The project site is surrounded by the Raymond township to the north and bounded by the elevated road embankments of Adelaide Street and Pacific Highway. The primary site of the development is situated in the north-western corner of the project site.

Location of the project site along with the primary area of development on the north-western corner as referenced from the Earthworks Report (Australian Consulting Engineers, April 2020) is shown below in Figure 1.

The project requires compacted filling to raise the ground elevation, currently between 1.5m and 2.0m AHD to the flood planning level of 5.7m AHD.

This will be achieved through a combination of cut to fill (approximately 40,000 m³) and import of an additional 60,000 m³ of excavated natural material (ENM) and virgin excavated natural material (VENM). This is summarised in the concept *Cut and Fill Plan* referenced from the Earthworks Report (refer Figure 2).

The southern portion of the development site is intended to be raised with compacted fill of up to 2 metres. Cut and compacted fill operations within the development area will be undertaken in accordance with the necessary regulations and standards for residential and commercial developments.

The cut and fill operations are expected to occur over a period of 12 months on a 7-day roster from 7am-5pm.

The main air pollutant of concern is anticipated to be dust / particulate matter emissions generated from the various earth-moving and handling operations. Based on discussions with Raymond Terrace Parklands, sources / activities that have the potential to generate fugitive dust emissions include:

- Handling of the cut material, including loading and unloading operations.
- Unloading of imported ENM and VENM material on the development site.
- Fill activities on the southern side portion of the development site to achieve the required flood planning level of 5.7m AHD.
- Wind erosion emissions from the temporary stockpiles located within the development site.

Particulate emissions for the various size fractions – total particulates (TSP), particulate matter less than 10 microns (PM_{10}) and particulate matter less than 2.5 microns ($PM_{2.5}$) were estimated using approved emission factors for the above operations. Emissions were based on an annual material handling rate of 100,000 m³ of material (40,000 m³ cut to fill + 60,000 m³ imported). Impacts from the above activities were predicted at the nearest sensitive receptors which are discussed in the following section.



Figure 1: Facility Layout (Source: ACE, April 2020)

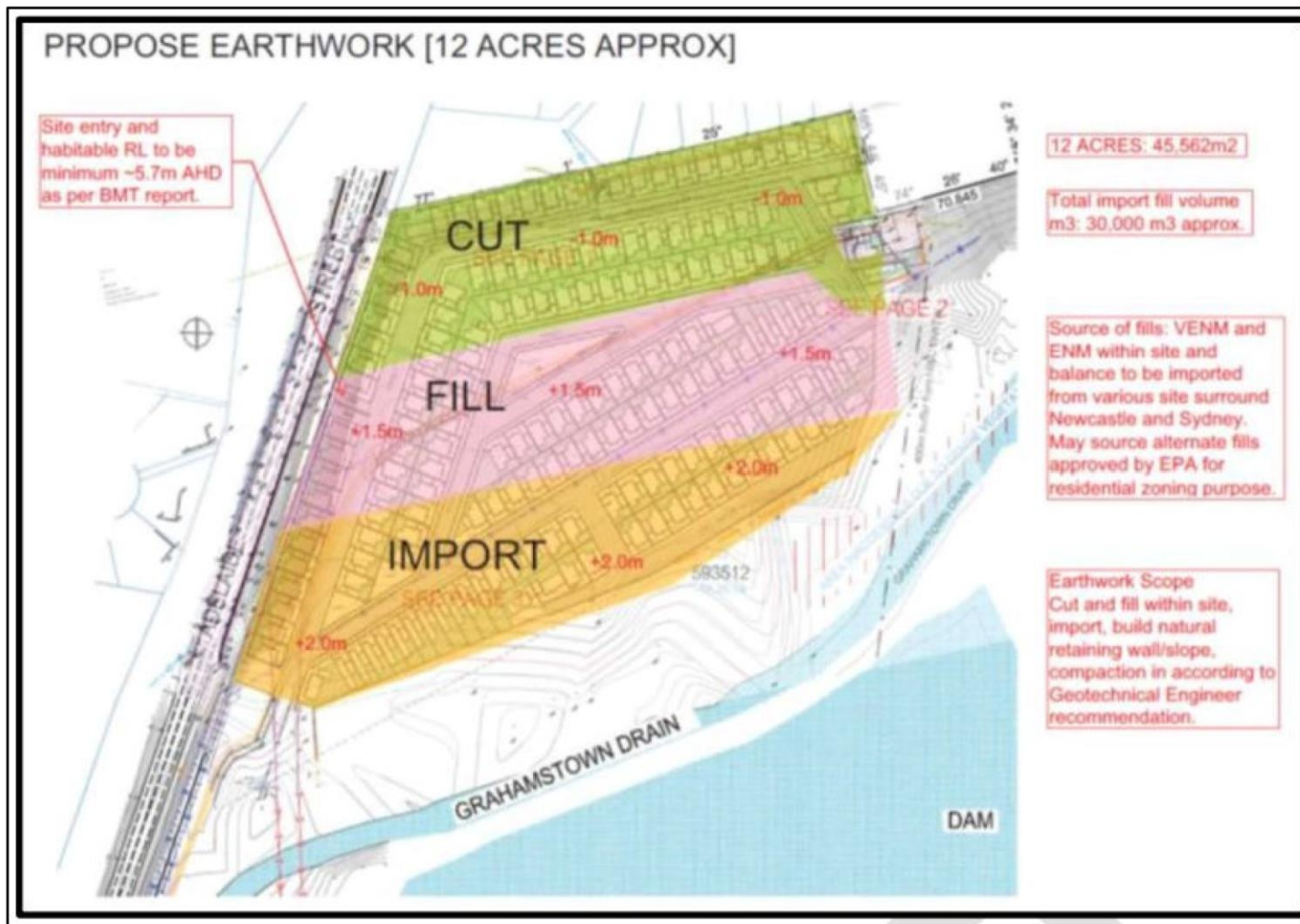


Figure 2: Concept Plan – Cut and Fill Operations (Source: ACE, April 2020)

5 Study Area and Surrounds

5.1 Existing Land Use and Topography

The project site is a former sand quarry located south of the township of Raymond Terrace. The development site as shown in Figure 2 encompasses a total area of approximately 5 hectares across which most of the cut and fill operations would be conducted. The site is bounded by Adelaide Street to the west and the Pacific Highway to the south. There is dense existing residential development immediately to the north of the project site. The Raymond Terrace Wastewater Treatment Plant is due east at a distance of approximately 150-200m from the closest boundary of the project site. The treatment plant has been considered as a sensitive receptor for this assessment. There are existing industrial developments towards the south of the project site within the township of Heatherbrae.

A 3-dimensional representation of the topographical features over a 10km x 10km extent centred around the project site is shown in Figure 3. It is evident that the terrain in the immediate surrounds of the project site is relatively flat with elevations gradually increasing to the north.

5.2 Sensitive Receptors

To predict impacts from the cut and fill operations on the surrounding environment, a set of sensitive receptors representing both residential and non-residential developments were identified for the assessment. Model predicted incremental (i.e. project only) and cumulative (incremental + background) particulate concentrations for the various size fractions along with deposited dust levels were determined across each of these receptors and compared against the relevant assessment criteria to assess compliance.

Sensitive receptors selected for this assessment are visually illustrated in Figure 4 and tabulated in Table 1.

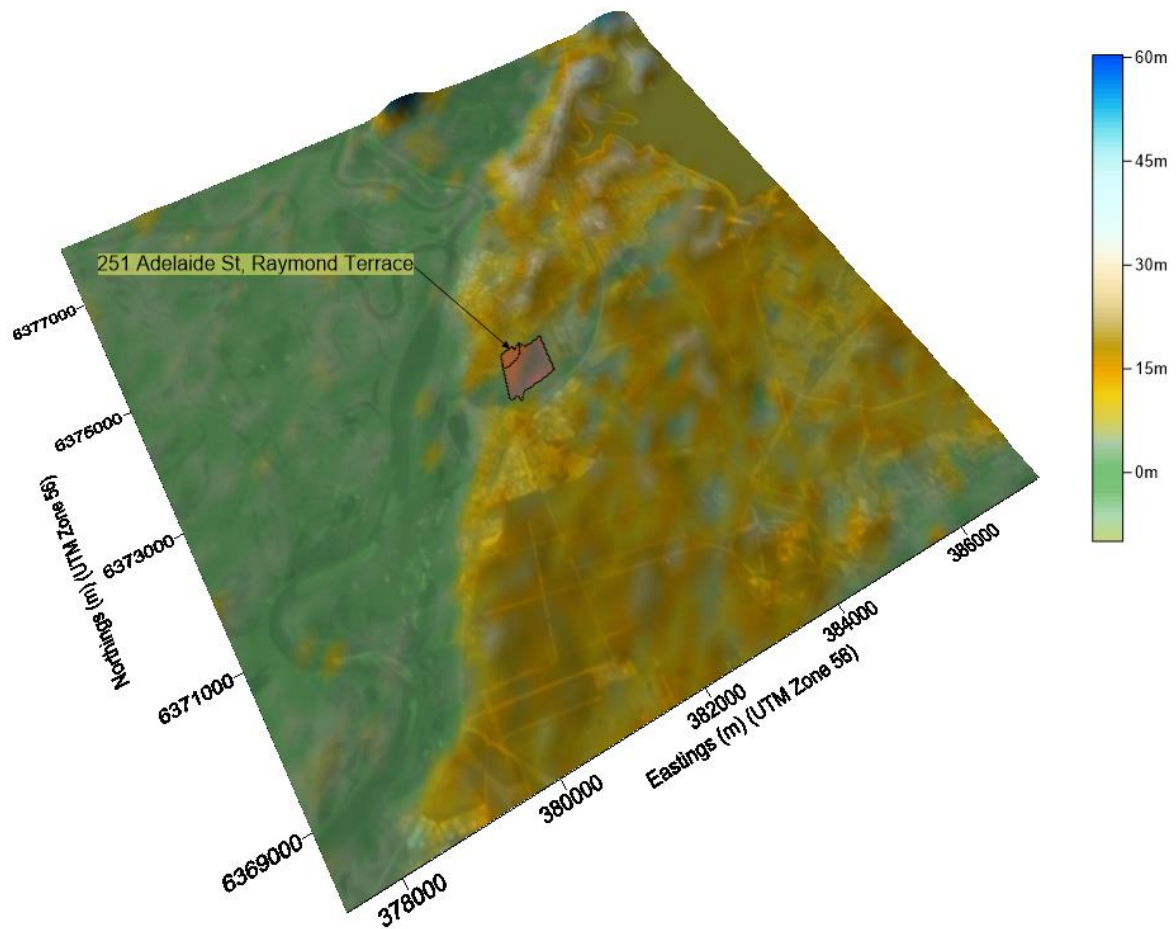
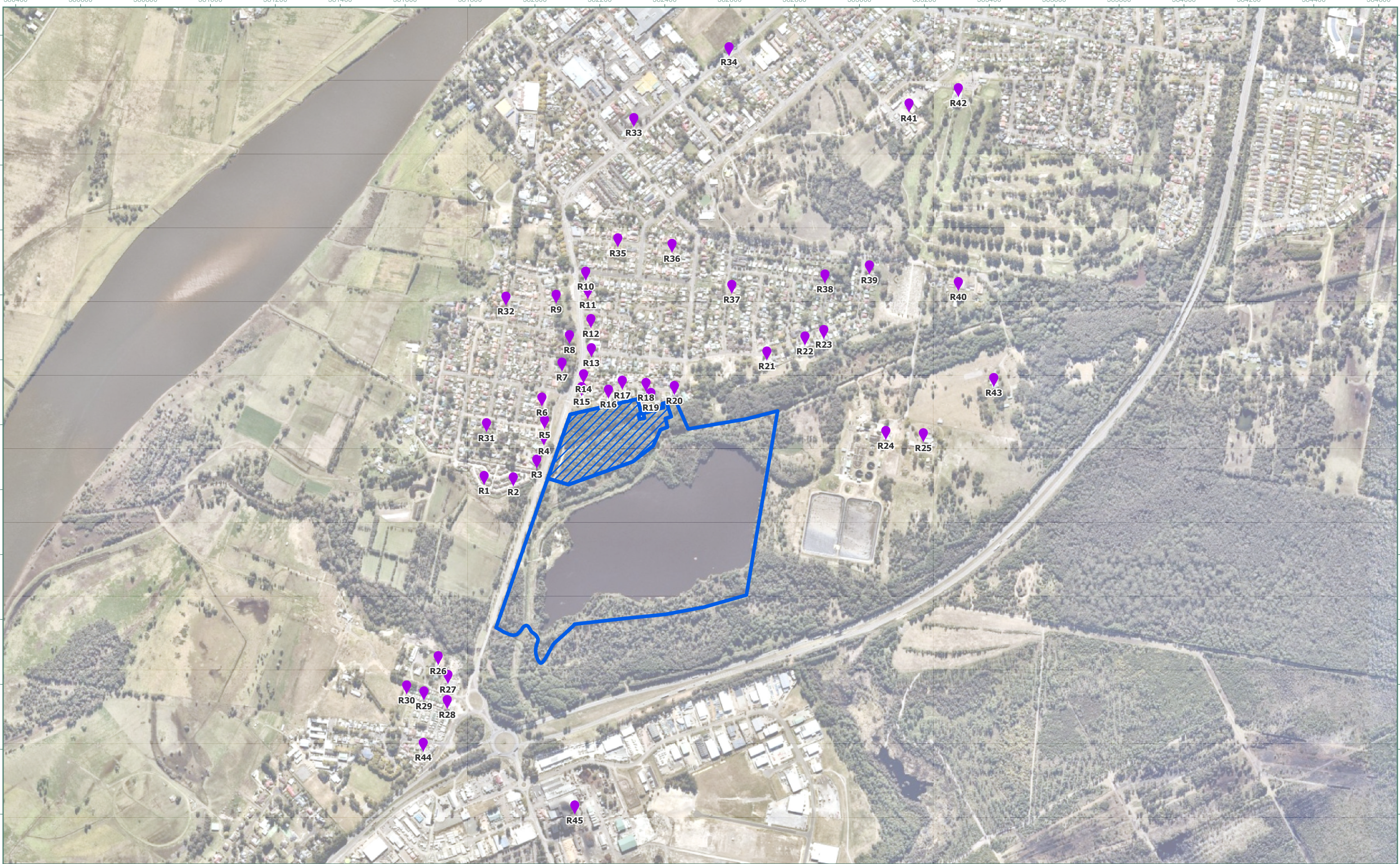


Figure 3: 3-Dimensional Representation of Terrain Features Surrounding the Project Site

Table 1: Details of Identified Sensitive Receptors

Receptor I.D.	Easting (m) (UTM Zone 56)	Northing (m) (UTM Zone 56)
R1	381843	6373013
R2	381933	6373009
R3	382006	6373064
R4	382027	6373135
R5	382030	6373186
R6	382021	6373255
R7	382083	6373363
R8	382106	6373447
R9	382065	6373572
R10	382156	6373643
R11	382163	6373586
R12	382172	6373497
R13	382174	6373407
R14	382150	6373327
R15	382144	6373287
R16	382227	6373279
R17	382269	6373307
R18	382342	6373300
R19	382357	6373269
R20	382430	6373291
R21	382715	6373397
R22	382832	6373443
R23	382890	6373463
R24	383081	6373152
R25	383197	6373145
R26	381702	6372458
R27	381732	6372400
R28	381730	6372323
R29	381658	6372350
R30	381605	6372368
R31	381851	6373176
R32	381911	6373566
R33	382305	6374116
R34	382598	6374334
R35	382255	6373746

Receptor I.D.	Easting (m) (UTM Zone 56)	Northing (m) (UTM Zone 56)
R36	382422	6373728
R37	382607	6373602
R38	382894	6373634
R39	383031	6373662
R40	383305	6373611
R41	383153	6374161
R42	383305	6374208
R43	383414	6373315
R44	381656	6372191
R45	382123	6371998



 Sensitive Receptors



Figure 4: Spatial Illustration of Sensitive Receptors Selected for the Assessment

6 Ambient Air Quality Criteria

Dust / particulate matter emissions are the key pollutant generated from the operations at the project site. Airborne particulate matter typically consists of dust particles of varying size fractions. From a health and nuisance perspective, particles are categorised primarily by size as total suspended particulates (TSP), PM₁₀ and PM_{2.5} and deposited dust levels.

Although, TSP is defined as the total mass of all particles suspended in air, an effective upper limit of 30 microns aerodynamic diameter is assigned. Within the TSP matter, lie two sub-categories; particulate matter with an equivalent diameter of 10 microns or less (PM₁₀) and particulate matter with an equivalent diameter of 2.5 microns or less (PM_{2.5}).

Dust deposition rate is the mass of particulate matter that collects over an area for a certain time period (usually monthly). Dust deposition is used as a measure of the potential for dust to affect amenity.

For the air quality assessment, impacts from all the particulate size fractions i.e. TSP, PM₁₀ and PM_{2.5} along with deposited dust levels have been assessed.

6.1 Air Quality Legislation in NSW

In NSW, air pollution is regulated by Part 5.4 – Air Pollution of the Protection of the Environment Operations Act 1997 (POEO 1997). The impact assessment criteria for the modelled pollutants are defined within the Approved Methods.

The Approved Methods specifies air quality assessment criteria to determine whether emissions from a particular premise will comply with the appropriate environmental outcomes adopted by the EPA.

As per the Approved Methods, cumulative impact of emissions from nearby sources and existing environment needs to be considered along with the emissions from the facility for the following pollutants – sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), lead (Pb), particles (PM₁₀, PM_{2.5}), total suspended particulates (TSP), deposited dust, carbon monoxide (CO) and hydrogen fluoride (HF).

For these pollutants, model predicted cumulative concentrations are to be presented as the 100th percentile value (i.e. maximum) at the nearest sensitive receptor.

6.2 Summary of Impact Assessment Criteria

Impact assessment criteria adopted from the Approved Methods for the pollutants of interest is summarised in Table 2. Maximum predicted cumulative pollutant concentrations at the sensitive receptors have been compared against the impact assessment criteria to assess compliance.

Table 2: Summary of Impact Assessment Criteria for the Modelled Pollutants

Pollutant	Impact Assessment Criteria	Averaging Period	Assessment	Reporting Percentiles
Total suspended particulates (TSP)	90 µg/m ³	Annual	Cumulative	n.a.
PM ₁₀	50 µg/m ³	24 hours	Cumulative	100 th percentile
	25 µg/m ³	Annual	Cumulative	n.a.
PM _{2.5}	25 µg/m ³	24 hours	Cumulative	100 th percentile
	8 µg/m ³	Annual	Cumulative	n.a.
Deposited Dust Levels	2 g/m ² /month – max. increase in deposited dust level	Annual	Incremental	
	4 g/m ² /month – max. total deposited dust level	Annual	Cumulative	

7 Existing Air Quality

Characterising the background concentrations allows for the determination of cumulative pollutant concentrations. The Approved Methods requires determination of cumulative pollutant concentrations for TSP, PM₁₀ and PM_{2.5} size fractions, and therefore it is imperative to undertake a detailed characterisation of the existing particulate concentrations within the airshed of the study area.

The NSW – Office of Environment and Heritage (OEH) manages a network of ambient air quality monitoring stations (NEPM station) across various parts of NSW. Data from the stations are recorded as ambient concentrations and air quality category ratings. A subset of the stations are NEPM-designated and data from these stations are reported annually through the *NSW Annual National Environment Protection Measure (NEPM) Compliance Report*.

Across the Lower Hunter region, there are three (3) NEPM monitoring stations – at Beresfield, Newcastle and Wallsend. For the purposes of this assessment, the monitoring station at Beresfield was selected, as it is the closest to the project site and the land-use surrounding the monitoring station is similar to the study area land-use.

24-hour average PM₁₀ and PM_{2.5} concentrations measured at the Beresfield monitoring station between January – December 2020 are visually presented as timeseries plots in Figure 5 and Figure 6 respectively.

From the measured concentrations, it is observed that several exceedances of the 24-hour average PM₁₀ and PM_{2.5} concentrations have been recorded in 2020, especially during the month of January.

These exceedances can be attributed to the severe bushfires experienced in NSW during the summer of 2019-20.

As per the Approved Methods, the conventional approach of determining 24-hour average cumulative concentrations at sensitive receptors is to predict the maximum incremental impact from the project operations and arithmetically add the maximum measured background concentration for the modelled year. If this approach were to be adopted, there would be exceedances of the 24-hour average cumulative PM₁₀ and PM_{2.5} concentrations due to background levels being already over the ambient air quality assessment criteria.

When dealing with these elevated background concentrations, Section 5.1.3 of the Approved Methods states the following – “existing ambient air pollutant concentrations may exceed the impact assessment criteria from time to time in some locations. In such circumstances, a licensee must demonstrate that no additional exceedance of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical”.

From the timeseries presented in Figure 5, it is noted that the 24-hour average ambient PM₁₀ concentrations measured at the Beresfield monitoring station in 2020 exceeded the assessment criteria of 50 µg/m³ on 6 occasions, and similarly as seen from Figure 6, a total of 8 exceedances of the PM_{2.5} concentrations were observed. As per the Approved Methods, compliance can be achieved, as long as the project operations are not causing additional exceedances of the assessment criteria.

Therefore, 24-hour average cumulative PM₁₀ and PM_{2.5} concentrations were determined at the sensitive receptors through a contemporaneous assessment and compliance with the assessment criteria was assessed by demonstrating that the project operations do not contribute to additional exceedances of the assessment criteria for both the 24-hour average PM₁₀ and PM_{2.5} concentrations.

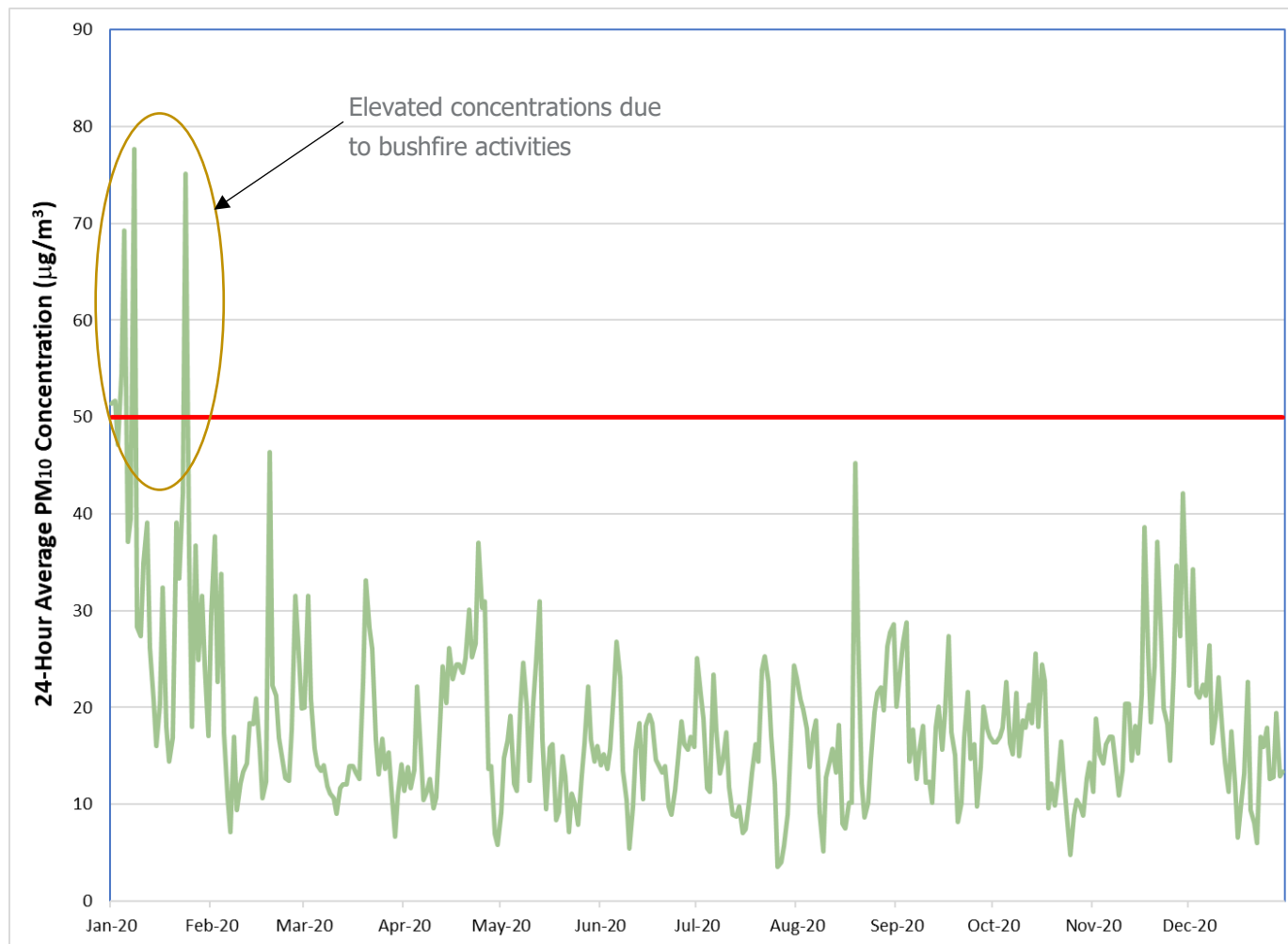


Figure 5: 24-hour Average Ambient PM₁₀ Concentrations Measured at the Beresfield Monitoring Station - 2020

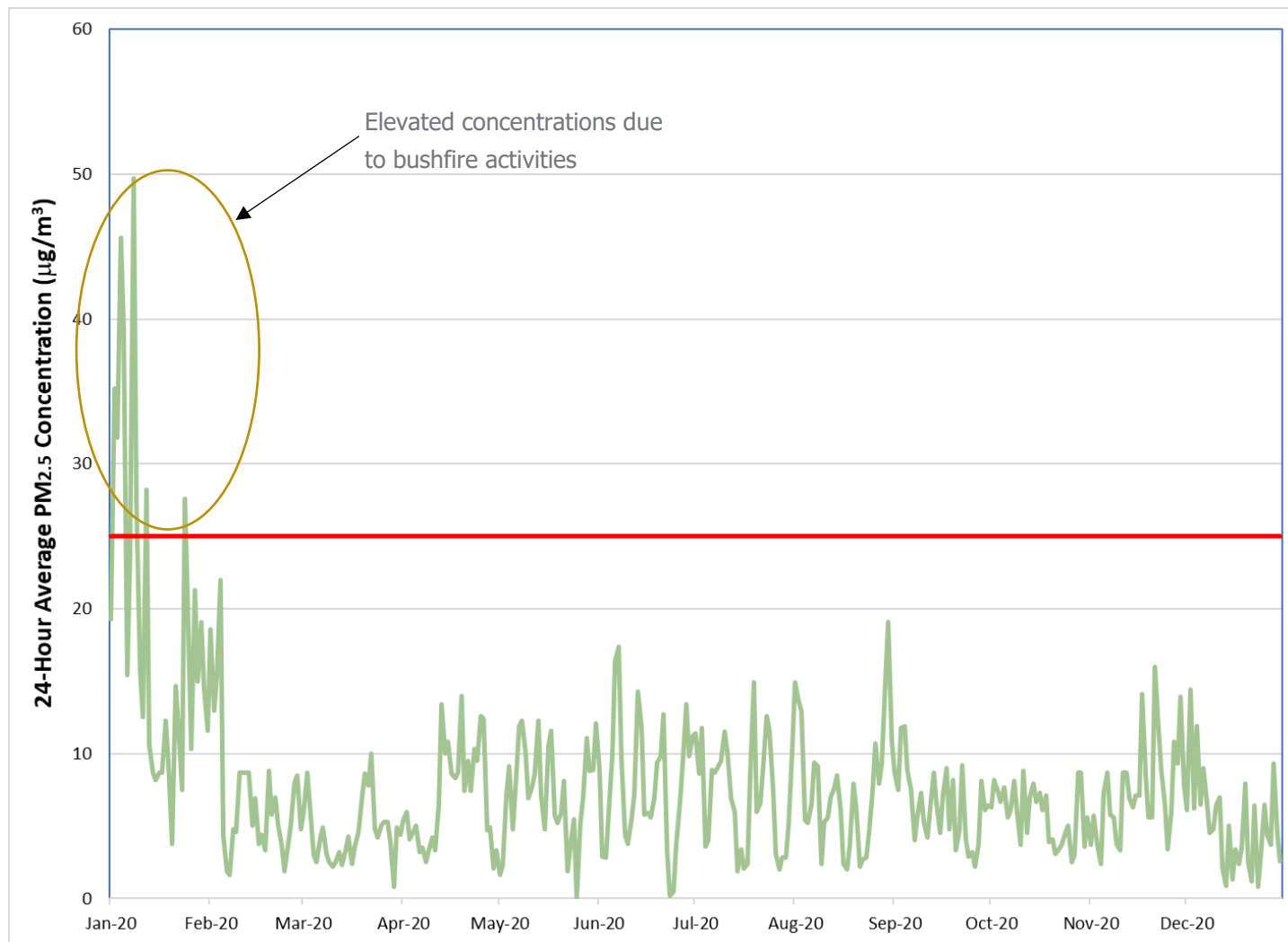


Figure 6: 24-hour Average Ambient PM_{2.5} Concentrations Measured at the Beresfield Monitoring Station - 2020

Annual average PM₁₀ concentration of 18.5 µg/m³ measured at the monitoring station in 2020 complied with the assessment criteria of 25 µg/m³ and similarly the annual average PM_{2.5} concentration of 7.7 µg/m³ was just below the assessment criteria of 8 µg/m³.

A summary of the background air quality levels adopted for this assessment are presented in Table 3.

Table 3: Summary of Background Concentrations Adopted for the Cumulative Assessment

Pollutant	Averaging Period	Background Concentration	Units	Notes
Total suspended particulates (TSP)	Annual	46.3	µg/m ³	No monitoring data available, therefore TSP concentration determined from the annual average PM ₁₀ based on the assumption that 40% of TSP is PM ₁₀ size fraction.
PM ₁₀	24 hours	Daily varying	µg/m ³	Assessed contemporaneously with daily varying PM ₁₀ background levels measured at the Beresfield monitoring station in 2020
	Annual	18.5	µg/m ³	Annual average PM ₁₀ concentration measured at the Beresfield monitoring station in 2020
PM _{2.5}	24 hours	Daily varying	µg/m ³	Assessed contemporaneously with daily varying PM _{2.5} background levels measured at the Beresfield monitoring station in 2020
	Annual	7.7	µg/m ³	Annual average PM _{2.5} concentration measured at the Beresfield monitoring station in 2020
Deposited Dust	Annual	2	g/m ² /month	Conservative assumption – consistent with other air quality assessments

8 Emission Estimates

Based on discussions with Raymond Terrace Parklands, sources / activities that have the potential to generate fugitive dust emissions include:

- Handling of the cut material, including loading and unloading operations.
- Unloading of imported ENM and VENM material on the development site.
- Fill activities on the southern side portion of the development site to achieve the required flood planning level of 5.7m AHD; and
- Wind erosion emissions from the temporary stockpiles located within the development site.

Raymond Terrace Parklands have informed Virid IFC that trucks importing fill material would enter the site through Adelaide Street, unload the material at the north-western entry point before exiting. There would be no truck movement within the site and the material would be moved by the loaders on site. As-such, wheel generated dust emissions from haul trucks were not estimated. Also, no crushing and screening operations are expected at the project site and therefore have been excluded from the emissions inventory.

Water sprays on stockpiles would be implemented for the duration of the cut and fill operations. Dust reduction factors for this control measure have been adopted from the emission factor literature databases.

The following assumptions were considered for estimating fugitive dust emissions from the cut and fill operations. These assumptions were determined through discussions with Raymond Terrace Parklands.

- A total of 100,000 m³ of material would be utilised for the cut and fill operations.
- 40,000 m³ of material would be cut from the north-western portion of the development site.
- 60,000 m³ of material would be imported for the fill activities.
- 1m³ of material ~ 1.6 tonnes
- Operating hours - 7 days of the week from 7am-5pm
- Maximum height of material stockpiles – 3m
- Maximum combined footprint of material stockpiles – 1ha
- Annual average concentrations were determined from average daily material movement rate of 440 tonnes per day (160,000 tonnes per annum / 365 days)
- 24-hour average concentrations were estimated based on a peak daily material movement rate of approximately 640 tonnes per day (1.5 times the average daily movement rate)

Pollutant emission rates have been estimated from emission factors published in the following:

- US-EPA AP 42 – Compilation of Air Pollutant Emission Factors, Chapter 11.9 – Western Surface Coal Mining, October 1998.
- US-EPA AP 42 – Compilation of Air Pollutant Emission Factors, Chapter 13.2.4 – Aggregate Handling and Storage Piles, November 2006.

Fugitive emissions estimated from the above activities are tabulated in Table 4. As seen from the emission estimates, wind erosion emissions constitute a significant portion of the total annual emissions for all the size fractions – TSP, PM₁₀ and PM_{2.5}. As noted above, water sprays would be deployed on stockpiles during dry and windy conditions and reduction factors relevant to application of water sprays on stockpiles has been accounted for in estimating the wind erosion emissions.

Detailed calculations of the fugitive dust emission estimates for the TSP, PM₁₀ and PM_{2.5} size fractions are presented in Appendix A.

Combustion of diesel or petrol fuels (from vehicle movements and mobile machinery) generates emissions of particulate matter, CO, SO₂, NO_x and VOCs. Based on the relatively limited duration of the project (12 months), emissions from vehicle exhaust and mobile machinery are not likely to cause adverse impacts on surrounding sensitive receptors and therefore have been excluded from the assessment.

As per the SEARs (SEAR No: 1571), potential odour emissions from the project operations are to be addressed. Upon reviewing the activities associated with the cut and fill operations, no odour generating sources have been identified and therefore, a quantitative assessment of odour impacts is not warranted and has not been conducted.

Table 4: Estimated Annual Fugitive Dust Emission Rates from the Project Operations

Activity	TSP Emissions (kg/year)	PM ₁₀ Emissions (kg/year)	PM _{2.5} Emissions (kg/year)
Material handling operations	117.9	55.8	8.4
Wind erosion emissions – material stockpiles	425	212.5	31.9
Total Annual Emissions (kg/year)	542.9	268.3	40.3

9 Meteorological Modelling

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. The local meteorology at the site plays a significant role in understanding the pollutant transport and dispersion mechanisms, and to adequately characterise the local meteorological conditions, information is needed on key parameters such as prevailing wind regime, mixing depth, atmospheric stability, ambient temperatures, rainfall and relative humidity. The following sections outline the methodology for characterising the meteorological conditions at the project site. Meteorological modelling was conducted using a combination of 'The Air Pollution Model (TAPM) (Version 4) and CALMET meteorological models.

Meteorological modelling was conducted using the TAPM and CALMET models for five (5) calendar years from 2016 through to 2020. An interannual comparison of the wind fields predicted by across the five (5) calendar years was undertaken, details of which are presented in Appendix B. Based on the interannual analysis, the 2020 calendar year was selected for modelling emissions from the operations at the project site and predicting impacts at the identified sensitive receptors.

9.1 TAPM

For this modelling assessment, the meteorological model 'The Air Pollution Model (TAPM) (Version 4.0.5)' was used to generate the prognostic output. TAPM facilitates the development of localised meteorological datasets based on synoptic weather conditions. The model predicts the regional flows that are important to atmospheric dispersion of pollutants, such as sea breezes and terrain induced

flows, against a background of larger-scale meteorology provided by synoptic analyses. The TAPM output provides a meteorological dataset suitable for use in a diagnostic meteorological model (CALMET for this assessment).

The 3D prognostic data was derived using TAPM (Version 4.05). The model was configured with a series of nested grids chosen to provide an appropriate communication and transfer of information from the broad synoptic to the local scale. The model was configured to use a domain consisting of 30 x 30 x 25 grid points with nesting spacings of 30 km, 10 km, 3 km and 1 km.

Hourly average meteorological observations (wind speed and direction) measured at the Bureau of Meteorology (BoM) Automatic Weather Station at the Williamtown RAAF Base (AWS No: 061078) for the last five (5) calendar years (2016-2020) were assimilated into TAPM.

Summary of the TAPM settings is presented in Table 5.

Table 5: Summary of TAPM Settings

Parameter	Value
Year of Analysis	2016-2020
Grid Centre Coordinates (lat, long)	-32deg -46.5min 151deg 44.5min
Number of grids (spacing)	30 x 30 (30km, 10km, 3km, 1km)
Grid dimensions (nx, ny, nz)	30, 30, 30
Data assimilation	Yes – BoM AWS at Williamtown RAAF

9.2 CALMET

CALMET (version 6.4.0) was used to derive higher resolution meteorological fields at 250m resolution over a 10km x 10km modelling domain centred over the project site. CALMET was run in no-observations mode (NOOBS = 2) with prognostic output from TAPM used as an input to the CALMET model. The CALMET model settings were in general accordance with the '*Generic Guidance and Optimum Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia'*' (OEH, 2011).

The geophysical dataset for CALMET contains terrain and land use information for the modelling domain. For this assessment, terrain data for the CALMET grid was extracted from 1- arc second (30m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000 (downloaded from USGS website). The land use or land cover data for the modelling domain was based on the USGS Global Land Cover Classification (USGS GLCC). The geotechnical parameters for the land use classification were adopted from the default CALMET corresponding land use categories.

Summary of the CALMET model settings is presented in Table 6.

Table 6: Summary of CALMET Model Configuration

Parameter	Value
Year of Analysis	2016-2020
Number of Grid Cells (NX, NY)	41,41
Grid spacing (DGRIDKM) (km)	0.25
XORIG (km), YORIG (km)	377.214 6367.976
Vertical Levels (NZ)	12
Meteorological Data Option	NOOBS = 2
Upper Air and Surface Data	TAPM generated MM4/MM5/3D
Geophysical Datasets	USGS GLCC (land-use) and SRTM1 arc second for terrain

9.3 Meteorological Modelling Outputs

Hourly wind speeds and direction for the 2020 calendar year were extracted from the CALMET output at the centre of the project site and are visually presented in the form of wind roses in Figure 7. Justification for selection of the 2020 year as the modelling year is presented in Appendix B.

Annual wind rose in Figure 7 shows that winds are predominantly from the north-west direction (approximately 15% of the time) and to a lesser extent from the other directions. Calm conditions (wind speeds <0.5 m/sec) are predicted to occur for about 1.3% of the entire year

As seen from Figure 7, seasonal variation in wind profile is evident with prevalent winds shifting to the east and north-east during spring and summer seasons.

A frequency distribution of the 2020 CALMET generated wind speeds at the centre of project site is presented in Figure 8.

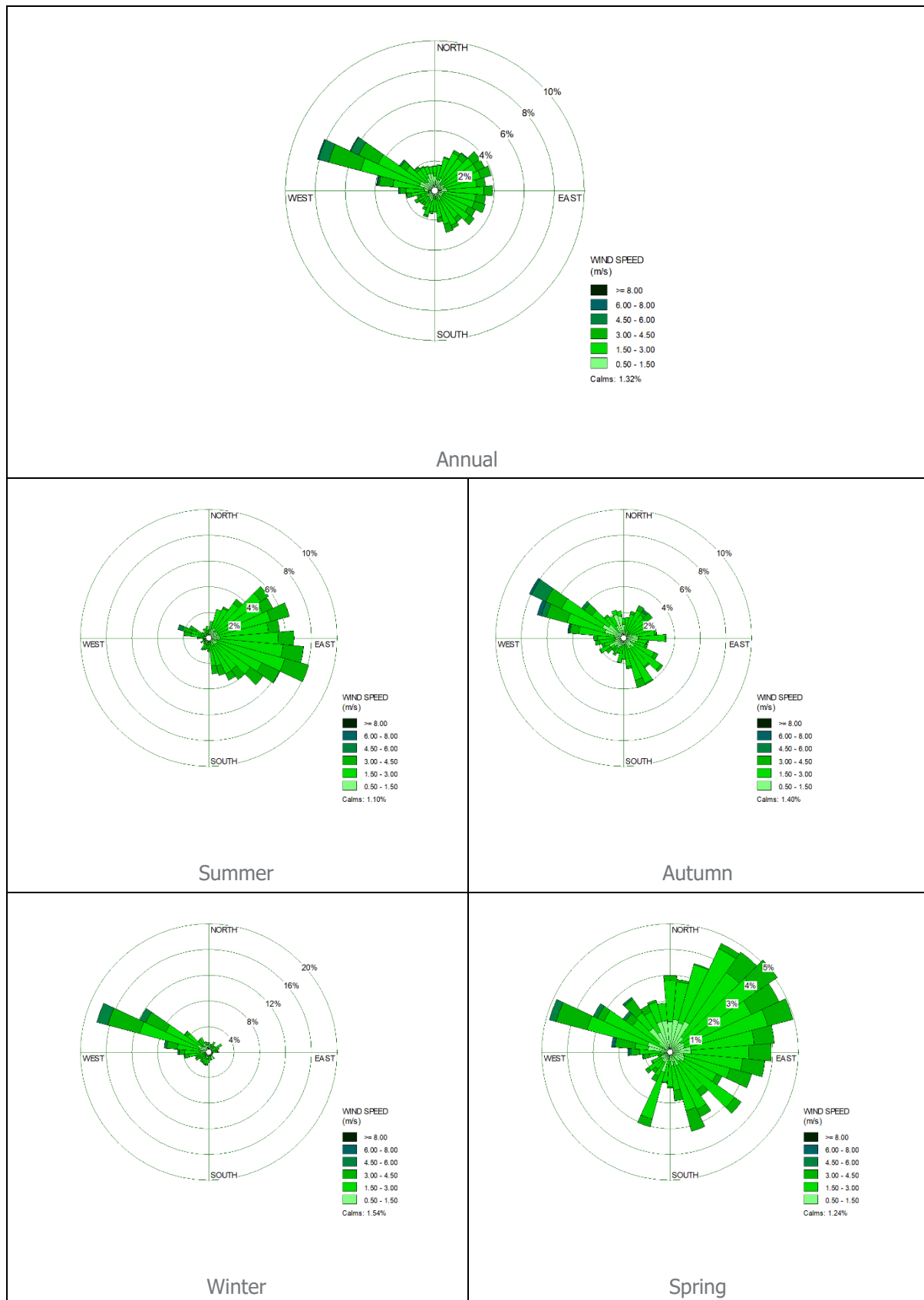


Figure 7: CALMET Predicted Annual and Seasonal Wind Roses – 2020

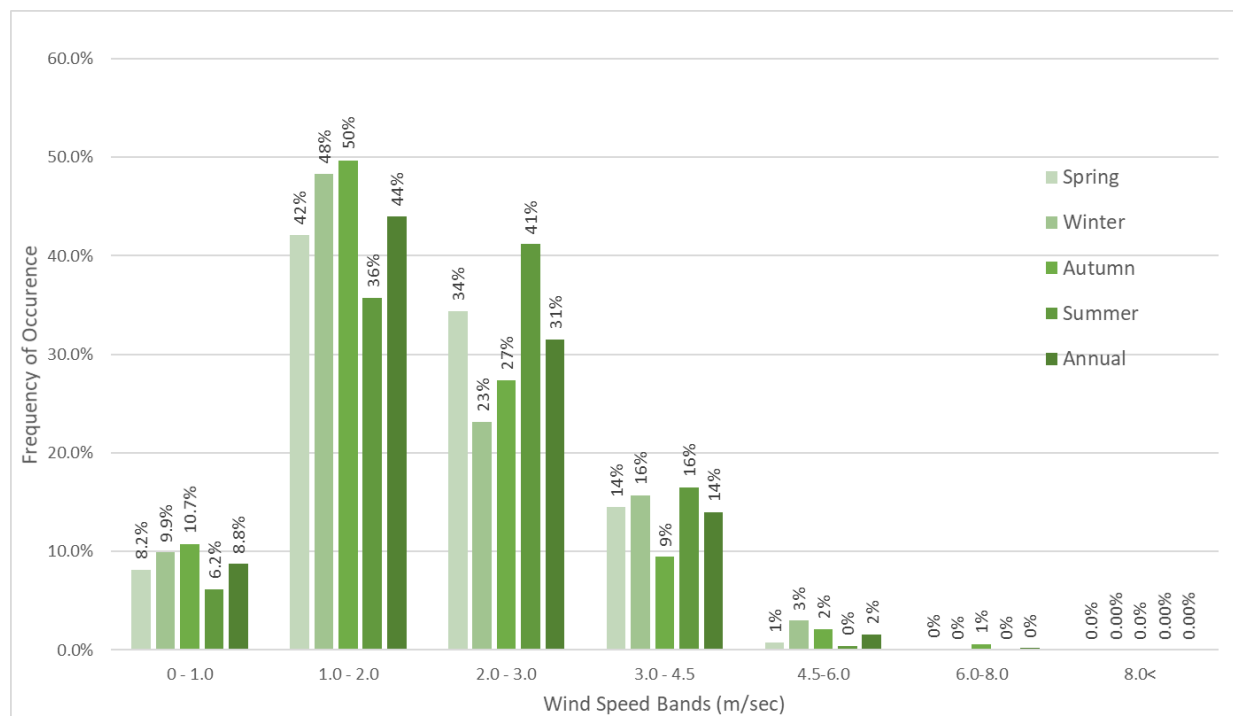


Figure 8: CALMET Predicted Wind Speed Frequency Distribution - 2020

Stability of the atmosphere is determined by a combination of horizontal turbulence caused by the wind and vertical turbulence caused by the solar heating of the ground surface. Stability cannot be measured directly; instead, it must be inferred from available data, either measured or numerically simulated. The Pasquill-Gifford scale defines stability on a scale from A to G, with stability class A being the least stable, occurring during strong daytime sun and stability class G being the most stable condition, occurring during low wind speeds at night. For any given wind speed, the stability category may be characterised by two or three categories depending on the time of day and the amount of cloud present. In meteorological models such as CALMET, the stability classes F and G are combined.

A summary of the numerically simulated hourly stability class data using CALMET for 2020 is presented in Figure 9. A higher frequency (41%) of stability class D followed by 31% for F class are predicted indicating that the dominant conditions are moderately to very stable, with very little lateral and vertical diffusion.

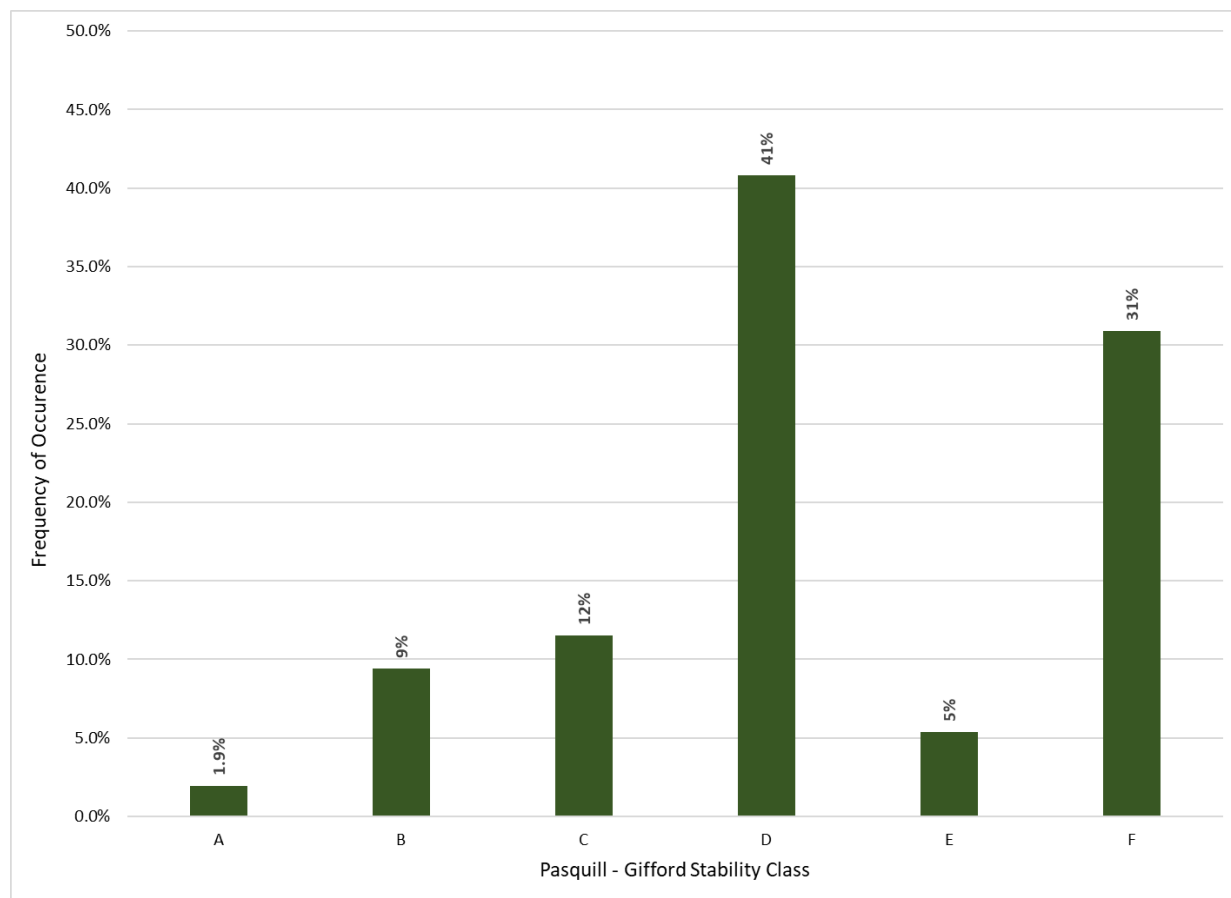


Figure 9: CALMET Predicted Frequency of Atmospheric Stability - 2020

The mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that cannot be measured directly. The mixing height decreases in the late afternoon, particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight. Low mixing heights typically translate to stagnant air with little vertical motion, while high mixing heights allow vertical mixing and good dispersion of pollutants.

CALMET simulated hourly mixing height data for the year 2020 is shown in Figure 10. The data presented in Figure 10 shows the mixing height as a function of the hour of the day at the proposed location of the subject site. The graph represents the typical growth of the boundary layer, whereby the mixing height is generally lowest during the night and into the early morning and highest during the late afternoon.

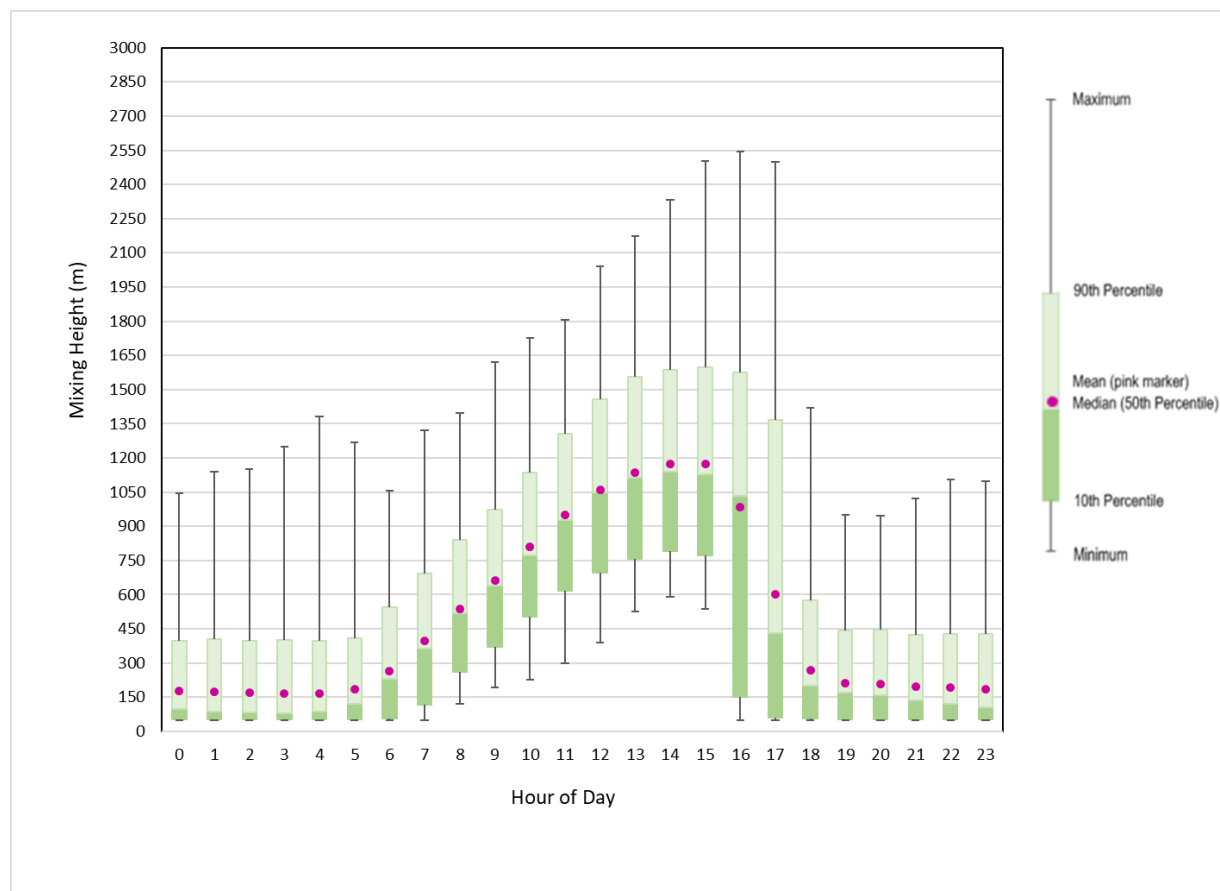


Figure 10: CALMET Predicted Mixing Height Profile - 2020

10 CALPUFF Model Configuration

To predict impacts from the estimated emissions (refer Table 4), dispersion modelling was conducted using the CALPUFF non-steady state puff dispersion model. The CALPUFF model is an approved and an accepted dispersion model as outlined in the Approved Methods.

The CALPUFF model treats emissions as a series of puffs. These puffs are then dispersed throughout the modelling area and allowed to grow and bend with spatial variations in meteorology. This method allows the model to retain a memory of the plume's movement throughout each hour while approximating the effects of complex air flows.

CALPUFF uses the meteorological processing and prediction model CALMET to provide 3D wind field predictions for the modelled area. The final wind field developed by the model includes an approximation of the effects of local topography, the effects of varying surface temperatures (as is observed in land and sea bodies) and surface roughness (resulting from varied land uses and vegetation cover in an area). The CALPUFF model simulates complex terrain influences on local wind fields including consideration of katabatic flows and terrain blocking.

The CALPUFF computational grid had a similar extent as the CALMET domain – 10km x 10km, with a 250m grid spacing. The sampling grid was set up as a sub-set of the CALMET model domain, with the grid extents spanning 3.5km x 3.5km centred at the project site location and with a resolution of 50m.

(using a nesting factor of 5). Impacts from the modelled pollutants have been predicted across the entire sampling grid in addition to the sensitive receptors identified for the assessment (refer Table 1 and Figure 4).

CALPUFF model settings were referenced from the '*Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia*' (NSW-OEH, 2011). General run control parameters and technical options that were selected in the CALPUFF model are summarised in Table 7.

Table 7: Summary of CALPUFF Model Configuration

Parameter	Value
CALPUFF version	6.42
Year modelled	2020
Computational grid size	10km x 10km
Sampling grid size	3.5km x 3.5km
Gridded receptors used	Yes – entire sampling grid
Nesting factor for gridded receptors - MESHDN	5 (receptors every 50m)
Discrete receptors modelled	Yes (refer Table 1 and Figure 4)

11 Model Outcomes

Model predicted incremental and cumulative TSP, PM₁₀, PM_{2.5} concentrations and deposited dust levels at the nearest sensitive receptors are presented in this section.

As noted earlier, a Level 2 contemporaneous assessment has been undertaken for the 24-hour averaging pollutants and compliance has been determined by demonstrating that there are no additional exceedances of the assessment criteria.

For the annual averaging pollutants, the cumulative concentrations have been determined through a summation of the incremental impacts predicted from the project operations plus the existing background concentrations as presented in Section 6.

Incremental pollutant isopleths are presented in Appendix C which illustrate a spatial distribution of ground level concentrations across the study area because of the cut and fill operations at the development site.

11.1 Total Solid Particulate (TSP) Concentrations

Incremental and cumulative TSP ground level concentrations predicted at each of the nominated sensitive receptors are summarised in Table 8.

Modelling shows that the cumulative ground level concentrations, which include a background concentration of 46.3 $\mu\text{g}/\text{m}^3$ are well below the assessment criteria of 90 $\mu\text{g}/\text{m}^3$.

Maximum contribution from the project operations is 0.7 $\mu\text{g}/\text{m}^3$ (at Receptor R4), which is less than 1% of the assessment criteria.

As-such, the project operations are not expected to have a discernible contribution on the overall TSP concentrations.

Table 8: Incremental and Cumulative Annual Average TSP Concentrations Predicted at Sensitive Receptors

Receptor I.D.	Incremental Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Cumulative Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Compliance Achieved
R1	0.12	46.37	Yes
R2	0.19	46.44	Yes
R3	0.41	46.66	Yes
R4	0.70	46.95	Yes
R5	0.68	46.93	Yes
R6	0.39	46.64	Yes
R7	0.20	46.45	Yes
R8	0.10	46.35	Yes
R9	0.05	46.30	Yes
R10	0.03	46.28	Yes
R11	0.04	46.29	Yes
R12	0.07	46.32	Yes
R13	0.14	46.39	Yes
R14	0.30	46.55	Yes
R15	0.49	46.74	Yes
R16	0.38	46.63	Yes
R17	0.22	46.47	Yes
R18	0.14	46.39	Yes
R19	0.15	46.40	Yes
R20	0.08	46.33	Yes
R21	0.02	46.27	Yes
R22	0.01	46.26	Yes
R23	0.01	46.26	Yes
R24	0.01	46.26	Yes

Receptor I.D.	Incremental Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Cumulative Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Compliance Achieved
R25	0.01	46.26	Yes
R26	0.02	46.27	Yes
R27	0.02	46.27	Yes
R28	0.01	46.26	Yes
R29	0.01	46.26	Yes
R30	0.01	46.26	Yes
R31	0.14	46.39	Yes
R32	0.04	46.29	Yes
R33	0.01	46.26	Yes
R34	0.00	46.25	Yes
R35	0.02	46.27	Yes
R36	0.02	46.27	Yes
R37	0.01	46.26	Yes
R38	0.01	46.26	Yes
R39	0.00	46.25	Yes
R40	0.00	46.25	Yes
R41	0.00	46.25	Yes
R42	0.00	46.25	Yes
R43	0.00	46.25	Yes
R44	0.01	46.26	Yes
R45	0.01	46.26	Yes
<i>Highest concentration across all sensitive receptors</i>	<i>0.70</i>	<i>46.95</i>	

11.2 PM₁₀ Concentrations

Maximum 24-hour average incremental PM₁₀ concentrations predicted at each of the identified sensitive receptors are summarised in Table 9. Across all the sensitive receptors, maximum concentration is approximately 2.7 µg/m³, which is predicted at receptor R16. This maximum concentration is approximately 5.4% of the assessment criteria.

Compliance with the 24-hour average assessment criteria of 50 µg/m³ is assessed by demonstrating that the project operations would not result in additional exceedances of the assessment criteria.

As seen below in Table 10, the total number of exceedances of the 24-hour average PM₁₀ concentration in the background dataset for the modelled year is six (6) and inclusion of the project operations does not result in any additional exceedances.

As-such, the limited contribution (as evidenced from the incremental concentrations) combined with no additional exceedances reported for the 24-hour average PM₁₀ concentrations across any of the sensitive receptors, demonstrates compliance with the 24-hour average PM₁₀ assessment criteria.

The maximum annual average incremental PM₁₀ ground level concentration predicted across all the sensitive receptors as shown in Table 11 is 0.4 µg/m³, which is less than 2% of the assessment criteria. When the background concentration of 18.5 µg/m³ is added to the predicted concentrations, the overall cumulative concentrations across all the sensitive receptors are well below the assessment criteria of 25 µg/m³.

Based on the above discussions, it can be observed that the project operations are not expected to make a sizeable contribution to the overall PM₁₀ concentrations in the study area.

Table 9: Maximum Incremental 24-hour Average PM₁₀ Concentrations Predicted at Sensitive Receptors

Receptor I.D.	Maximum Incremental 24-hour Average Concentration (µg/m ³)	Incremental Concentration - % of Assessment Criteria
R1	0.59	1.2%
R2	0.87	1.7%
R3	1.52	3.0%
R4	2.19	4.4%
R5	2.26	4.5%
R6	1.90	3.8%
R7	1.00	2.0%
R8	0.58	1.2%
R9	0.35	0.7%
R10	0.35	0.7%
R11	0.43	0.9%
R12	0.64	1.3%
R13	0.99	2.0%
R14	1.50	3.0%
R15	2.02	4.0%
R16	2.70	5.4%
R17	1.86	3.7%
R18	1.22	2.4%
R19	1.12	2.2%
R20	0.64	1.3%
R21	0.23	0.5%
R22	0.18	0.4%
R23	0.16	0.3%
R24	0.15	0.3%
R25	0.13	0.3%
R26	0.16	0.3%
R27	0.15	0.3%
R28	0.13	0.3%
R29	0.14	0.3%
R30	0.14	0.3%
R31	0.76	1.5%
R32	0.36	0.7%
R33	0.16	0.3%
R34	0.11	0.2%

Receptor I.D.	Maximum Incremental 24-hour Average Concentration ($\mu\text{g}/\text{m}^3$)	Incremental Concentration - % of Assessment Criteria
R35	0.32	0.6%
R36	0.34	0.7%
R37	0.28	0.6%
R38	0.13	0.3%
R39	0.10	0.2%
R40	0.07	0.1%
R41	0.07	0.1%
R42	0.05	0.1%
R43	0.09	0.2%
R44	0.11	0.2%
R45	0.11	0.2%
<i>Highest concentration across all sensitive receptors</i>	<i>2.7</i>	<i>5.4%</i>

Table 10: Assessment of Additional Exceedances of the 24-hour Average PM₁₀ Concentrations due to the Project Operations

Receptor I.D.	Existing Environment (without Project)	Existing Environment + Contributions from the Project	Number of Additional Exceedances
	Number of Exceedances of the Assessment Criteria	Number of Exceedances of the Assessment Criteria	
R1	6	6	0
R2	6	6	0
R3	6	6	0
R4	6	6	0
R5	6	6	0
R6	6	6	0
R7	6	6	0
R8	6	6	0
R9	6	6	0
R10	6	6	0
R11	6	6	0
R12	6	6	0
R13	6	6	0
R14	6	6	0
R15	6	6	0
R16	6	6	0
R17	6	6	0
R18	6	6	0
R19	6	6	0
R20	6	6	0
R21	6	6	0
R22	6	6	0
R23	6	6	0
R24	6	6	0
R25	6	6	0
R26	6	6	0
R27	6	6	0
R28	6	6	0
R29	6	6	0
R30	6	6	0
R31	6	6	0

Receptor I.D.	Existing Environment (without Project)	Existing Environment + Contributions from the Project	Number of Additional Exceedances
	Number of Exceedances of the Assessment Criteria	Number of Exceedances of the Assessment Criteria	
R32	6	6	0
R33	6	6	0
R34	6	6	0
R35	6	6	0
R36	6	6	0
R37	6	6	0
R38	6	6	0
R39	6	6	0
R40	6	6	0
R41	6	6	0
R42	6	6	0
R43	6	6	0
R44	6	6	0
R45	6	6	0

Table 11: Incremental and Cumulative Annual Average PM₁₀ Concentrations Predicted at Sensitive Receptors

Receptor I.D.	Incremental Annual Average Concentration (µg/m ³)	Cumulative Annual Average Concentration (µg/m ³)	Compliance Achieved
R1	0.09	18.59	Yes
R2	0.13	18.63	Yes
R3	0.25	18.75	Yes
R4	0.40	18.90	Yes
R5	0.39	18.89	Yes
R6	0.24	18.74	Yes
R7	0.13	18.63	Yes
R8	0.08	18.58	Yes
R9	0.04	18.54	Yes
R10	0.03	18.53	Yes
R11	0.04	18.54	Yes
R12	0.06	18.56	Yes
R13	0.09	18.59	Yes
R14	0.18	18.68	Yes
R15	0.29	18.79	Yes
R16	0.22	18.72	Yes
R17	0.14	18.64	Yes
R18	0.09	18.59	Yes
R19	0.10	18.60	Yes
R20	0.06	18.56	Yes
R21	0.02	18.52	Yes
R22	0.01	18.51	Yes
R23	0.01	18.51	Yes
R24	0.01	18.51	Yes
R25	0.01	18.51	Yes
R26	0.02	18.52	Yes
R27	0.02	18.52	Yes
R28	0.02	18.52	Yes
R29	0.02	18.52	Yes
R30	0.02	18.52	Yes
R31	0.10	18.60	Yes
R32	0.03	18.53	Yes
R33	0.01	18.51	Yes
R34	0.01	18.51	Yes

Receptor I.D.	Incremental Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Cumulative Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Compliance Achieved
R35	0.02	18.52	Yes
R36	0.02	18.52	Yes
R37	0.02	18.52	Yes
R38	0.01	18.51	Yes
R39	0.01	18.51	Yes
R40	0.01	18.51	Yes
R41	0.00	18.50	Yes
R42	0.00	18.50	Yes
R43	0.01	18.51	Yes
R44	0.01	18.51	Yes
R45	0.01	18.51	Yes
<i>Highest concentration across all sensitive receptors</i>	<i>0.40</i>	<i>18.90</i>	

11.3 PM_{2.5} Concentrations

Maximum 24-hour average incremental PM_{2.5} concentrations predicted at each of the identified sensitive receptors are summarised in Table 12. Across all the sensitive receptors, maximum concentration is approximately 0.4 µg/m³, which is predicted at receptor R16. This maximum concentration is less than 2% of the assessment criteria.

Similar to the PM₁₀ concentrations, compliance with the 24-hour average PM_{2.5} assessment criteria of 25 µg/m³ is assessed by demonstrating that the project operations would not result in additional exceedances of the assessment criteria.

As seen below in Table 13, the total number of exceedances of the 24-hour average PM_{2.5} concentration in the background dataset for the 2020 calendar year is eight (8) and inclusion of the project operations, does not result in any additional exceedances.

As-such, the limited contribution (as evidenced from the incremental concentrations) combined with no additional exceedances of the 24-hour average PM_{2.5} concentrations across any of the sensitive receptors, demonstrates compliance with the 24-hour average PM_{2.5} assessment criteria.

The maximum annual average incremental PM_{2.5} ground level concentration predicted across all the sensitive receptors as shown in Table 14 is 0.06 µg/m³, which is less than 1% of the assessment criteria. When the relatively high background concentration of 7.7 µg/m³ is added to the predicted concentrations, the overall cumulative concentrations across all the sensitive receptors are still below the assessment criteria of 8 µg/m³, which clearly demonstrates the limited impacts expected from the project operations.

Based on the above discussions, it can be observed that the project operations are not expected to make a sizeable contribution to the overall PM_{2.5} concentrations in the study area.

Table 12: Maximum Incremental 24-hour Average PM_{2.5} Concentrations Predicted at Sensitive Receptors

Receptor I.D.	Maximum Incremental 24-hour Average Concentration (µg/m ³)	Incremental Concentration - % of Assessment Criteria
R1	0.09	0.4%
R2	0.14	0.6%
R3	0.24	1.0%
R4	0.34	1.4%
R5	0.35	1.4%
R6	0.30	1.2%
R7	0.16	0.7%
R8	0.09	0.4%
R9	0.06	0.2%
R10	0.06	0.2%
R11	0.07	0.3%
R12	0.10	0.4%
R13	0.15	0.6%
R14	0.23	0.9%
R15	0.31	1.2%
R16	0.42	1.7%
R17	0.29	1.2%
R18	0.19	0.8%
R19	0.18	0.7%
R20	0.10	0.4%
R21	0.04	0.2%
R22	0.03	0.1%
R23	0.03	0.1%
R24	0.03	0.1%
R25	0.02	0.1%
R26	0.03	0.1%
R27	0.03	0.1%
R28	0.02	0.1%
R29	0.03	0.1%
R30	0.03	0.1%
R31	0.12	0.5%
R32	0.06	0.2%
R33	0.03	0.1%
R34	0.02	0.1%

Receptor I.D.	Maximum Incremental 24-hour Average Concentration ($\mu\text{g}/\text{m}^3$)	Incremental Concentration - % of Assessment Criteria
R35	0.05	0.2%
R36	0.06	0.2%
R37	0.05	0.2%
R38	0.02	0.1%
R39	0.02	0.1%
R40	0.01	0.1%
R41	0.01	0.1%
R42	0.01	0.0%
R43	0.02	0.1%
R44	0.02	0.1%
R45	0.02	0.1%
<i>Highest concentration across all sensitive receptors</i>	<i>0.42</i>	<i>1.7%</i>

Table 13: Assessment of Additional Exceedances of the 24-hour Average PM_{2.5} Concentrations due to the Project Operations

Receptor I.D.	Existing Environment (without Project)	Existing Environment + Contributions from the Project	Number of Additional Exceedances
	Number of Exceedances of the Assessment Criteria	Number of Exceedances of the Assessment Criteria	
R1	8	8	0
R2	8	8	0
R3	8	8	0
R4	8	8	0
R5	8	8	0
R6	8	8	0
R7	8	8	0
R8	8	8	0
R9	8	8	0
R10	8	8	0
R11	8	8	0
R12	8	8	0
R13	8	8	0
R14	8	8	0
R15	8	8	0
R16	8	8	0
R17	8	8	0
R18	8	8	0
R19	8	8	0
R20	8	8	0
R21	8	8	0
R22	8	8	0
R23	8	8	0
R24	8	8	0
R25	8	8	0
R26	8	8	0
R27	8	8	0
R28	8	8	0
R29	8	8	0
R30	8	8	0
R31	8	8	0

Receptor I.D.	Existing Environment (without Project)	Existing Environment + Contributions from the Project	Number of Additional Exceedances
	Number of Exceedances of the Assessment Criteria	Number of Exceedances of the Assessment Criteria	
R32	8	8	0
R33	8	8	0
R34	8	8	0
R35	8	8	0
R36	8	8	0
R37	8	8	0
R38	8	8	0
R39	8	8	0
R40	8	8	0
R41	8	8	0
R42	8	8	0
R43	8	8	0
R44	8	8	0
R45	8	8	0

Table 14: Incremental and Cumulative Annual Average PM_{2.5} Concentrations Predicted at Sensitive Receptors

Receptor I.D.	Incremental Annual Average Concentration (µg/m ³)	Cumulative Annual Average Concentration (µg/m ³)	Compliance Achieved
R1	0.014	7.71	Yes
R2	0.020	7.72	Yes
R3	0.039	7.74	Yes
R4	0.062	7.76	Yes
R5	0.060	7.76	Yes
R6	0.037	7.74	Yes
R7	0.021	7.72	Yes
R8	0.012	7.71	Yes
R9	0.006	7.71	Yes
R10	0.005	7.70	Yes
R11	0.006	7.71	Yes
R12	0.009	7.71	Yes
R13	0.015	7.72	Yes
R14	0.029	7.73	Yes
R15	0.044	7.74	Yes
R16	0.035	7.73	Yes
R17	0.022	7.72	Yes
R18	0.015	7.71	Yes
R19	0.016	7.72	Yes
R20	0.010	7.71	Yes
R21	0.003	7.70	Yes
R22	0.003	7.70	Yes
R23	0.002	7.70	Yes
R24	0.002	7.70	Yes
R25	0.002	7.70	Yes
R26	0.003	7.70	Yes
R27	0.003	7.70	Yes
R28	0.003	7.70	Yes
R29	0.003	7.70	Yes
R30	0.003	7.70	Yes
R31	0.016	7.72	Yes
R32	0.006	7.71	Yes
R33	0.002	7.70	Yes
R34	0.001	7.70	Yes

Receptor I.D.	Incremental Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Cumulative Annual Average Concentration ($\mu\text{g}/\text{m}^3$)	Compliance Achieved
R35	0.003	7.70	Yes
R36	0.003	7.70	Yes
R37	0.003	7.70	Yes
R38	0.002	7.70	Yes
R39	0.001	7.70	Yes
R40	0.001	7.70	Yes
R41	0.001	7.70	Yes
R42	0.001	7.70	Yes
R43	0.001	7.70	Yes
R44	0.002	7.70	Yes
R45	0.002	7.70	Yes
<i>Highest concentration across all sensitive receptors</i>	<i>0.062</i>	<i>7.76</i>	

11.4 Deposited Dust Levels

Incremental and cumulative deposited dust levels predicted at each of the nominated sensitive receptors are summarised in Table 15.

It is evident from the modelling results that the project operations would not make any sizeable contribution to the overall deposited dust levels and therefore do not warrant a detailed discussion.

Table 15: Incremental and Cumulative Annual Average Deposited Dust Flux Predicted at Sensitive Receptors

Receptor I.D.	Incremental Annual Average Deposited Dust Flux (g/m ² /month)	Cumulative Annual Average Deposited Dust Flux (g/m ² /month)	Compliance Achieved
R1	0.025	2.02	Yes
R2	0.037	2.04	Yes
R3	0.083	2.08	Yes
R4	0.174	2.17	Yes
R5	0.167	2.17	Yes
R6	0.093	2.09	Yes
R7	0.047	2.05	Yes
R8	0.022	2.02	Yes
R9	0.011	2.01	Yes
R10	0.006	2.01	Yes
R11	0.008	2.01	Yes
R12	0.014	2.01	Yes
R13	0.026	2.03	Yes
R14	0.055	2.05	Yes
R15	0.097	2.10	Yes
R16	0.090	2.09	Yes
R17	0.055	2.06	Yes
R18	0.037	2.04	Yes
R19	0.041	2.04	Yes
R20	0.023	2.02	Yes
R21	0.005	2.01	Yes
R22	0.004	2.00	Yes
R23	0.003	2.00	Yes
R24	0.004	2.00	Yes
R25	0.003	2.00	Yes
R26	0.003	2.00	Yes
R27	0.003	2.00	Yes
R28	0.003	2.00	Yes
R29	0.002	2.00	Yes
R30	0.002	2.00	Yes
R31	0.035	2.04	Yes
R32	0.011	2.01	Yes
R33	0.001	2.00	Yes
R34	0.001	2.00	Yes

Receptor I.D.	Incremental Annual Average Deposited Dust Flux (g/m ² /month)	Cumulative Annual Average Deposited Dust Flux (g/m ² /month)	Compliance Achieved
R35	0.004	2.00	Yes
R36	0.004	2.00	Yes
R37	0.004	2.00	Yes
R38	0.002	2.00	Yes
R39	0.002	2.00	Yes
R40	0.001	2.00	Yes
R41	0.001	2.00	Yes
R42	0.001	2.00	Yes
R43	0.002	2.00	Yes
R44	0.002	2.00	Yes
R45	0.001	2.00	Yes
<i>Highest concentration across all sensitive receptors</i>	<i>0.174</i>	<i>2.17</i>	

12 Conclusion

Virid IFC were engaged by Raymond Terrace Parklands to conduct an air quality impact assessment for the designated development application at 251 Adelaide Street, Raymond Terrace, NSW 2324. The application corresponds to a cut and fill operation at the development site to mitigate flood risk and allow for future rezoning and development. The project requires raising the development site height from 1.5m to 2.0m AHD to the flood planning level of 5.7m AHD.

The above activity has the potential to generate dust emissions, and therefore an assessment of air quality impacts has been requested. A Level 2 impact assessment has been conducted in accordance with the regulatory guideline – *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*.

Particulate emissions from various activities were estimated and modelling was conducted using the CALPUFF dispersion model. Impacts from the operations at the project site were predicted at the nearest sensitive receptors along with inclusion of existing background concentrations.

Modelling shows that all the assessed pollutants are well below the respective assessment criteria across the entire study area. Moreover, it is evident from the modelling that contributions from the operations at the project site to the overall air quality concentrations is very low.

As-such, it can be concluded that cut and fill operations at the 251 Adelaide Street site are not expected to have an adverse impact on the existing air quality levels, and therefore, are not considered to be a critical issue with respect to air quality matters.

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Appendix A

Fugitive Particulate Emission Estimates

Activity	TSP Emissions (kg/year)	Intensity	Units	TSP Emission Factor	Units	Variable 1	Units	Variable 2	Units	Control Efficiency	Units	Operational Hours
Loader / excavator operations on the Cut site - 1	9.8	32,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Cut site - 2	9.8	32,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Emplacing material from the cut at the material stockpile area	19.7	64,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Trucks unloading import material at the material stockpile area	29.5	96,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 1	12.3	40,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 2	12.3	40,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 3	12.3	40,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 4	12.3	40,000	tonnes per annum	0.00031	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Wind erosion emissions from the material stockpile	425.0	1.0	ha	850	kg/ha/yr					50	% Control	Continuous
Total TSP Emissions (kg/year)	542.9											

Figure A-1: Annual Fugitive TSP Emission Estimates – kg/year

Activity	PM10 Emissions (kg/year)	Intensity	Units	PM10 Emission Factor	Units	Variable 1	Units	Variable 2	Units	Control Efficiency	Units	Operational Hours
Loader / excavator operations on the Cut site - 1	4.6	32,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Cut site - 2	4.6	32,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Emplacing material from the cut at the material stockpile area	9.3	64,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Trucks unloading import material at the material stockpile area	13.9	96,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 1	5.8	40,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 2	5.8	40,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 3	5.8	40,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 4	5.8	40,000	tonnes per annum	0.00015	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Wind erosion emissions from the material stockpile	212.5	1.0	ha	425	kg/ha/yr					50	% Control	Continuous
Total PM10 Emissions (kg/year)	268.3											

Figure A-2: Annual Fugitive PM₁₀ Emission Estimates – kg/year

Activity	PM2.5 Emissions (kg/year)	Intensity	Units	PM2.5 Emission Factor	Units	Variable 1	Units	Variable 2	Units	Control Efficiency	Units	Operational Hours
Loader / excavator operations on the Cut site - 1	0.7	32,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Cut site - 2	0.7	32,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Emplacing material from the cut at the material stockpile area	1.4	64,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Trucks unloading import material at the material stockpile area	2.1	96,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 1	0.9	40,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 2	0.9	40,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 3	0.9	40,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Loader / excavator operations on the Fill site - 4	0.9	40,000	tonnes per annum	0.00002	kg/t	0.94	average (wind speed /2.2)^1.3 in (m/sec)	3.61	(moisture content /2)^1.4	0		7AM-5PM, seven days
Wind erosion emissions from the material stockpile	31.9	1.0	ha	63.75	kg/ha/yr					50	% Control	Continuous
Total PM2.5 Emissions (kg/year)	40.3											

Figure A-3: Annual Fugitive PM_{2.5} Emission Estimates – kg/year

Appendix B

Selection of the Meteorological Modelling Year

- Meteorological modelling was conducted using the TAPM and CALMET models for five (5) calendar years from 2016 through to 2020.
- Observations from the AWS at Williamstown RAAF Base (AWS No: 067018) were assimilated into the TAPM model.
- CALMET simulation was conducted for five years from 2016 through to 2020.
- CALMET was run in no-observations mode (NOOBS = 2) with prognostic output from TAPM used as an input to the CALMET.

Interannual CALMET predicted wind fields at the Project site are shown in Figure B-1. From the wind roses shown below in Figure B-1, it is observed that there appears to be good consistency and similarities in the wind fields predicted across the five modelled years from 2016 through to 2020. Across all the modelled years, the dominant wind vectors are from the north-west direction and wind speeds are typically characterised as light – moderate gentle breeze across all the modelled years.

There is also a good level of consistency in the percentage of calm winds predicted by the CALMET model across the five years, with percentages ranging from 0.9% (in 2017) to 1.65% (in 2016).

Due to the strong similarities in the wind fields predicted at the Project site across the last five (5) calendar years, the most recent calendar year – 2020 was selected for modelling of emissions from the Project operations.

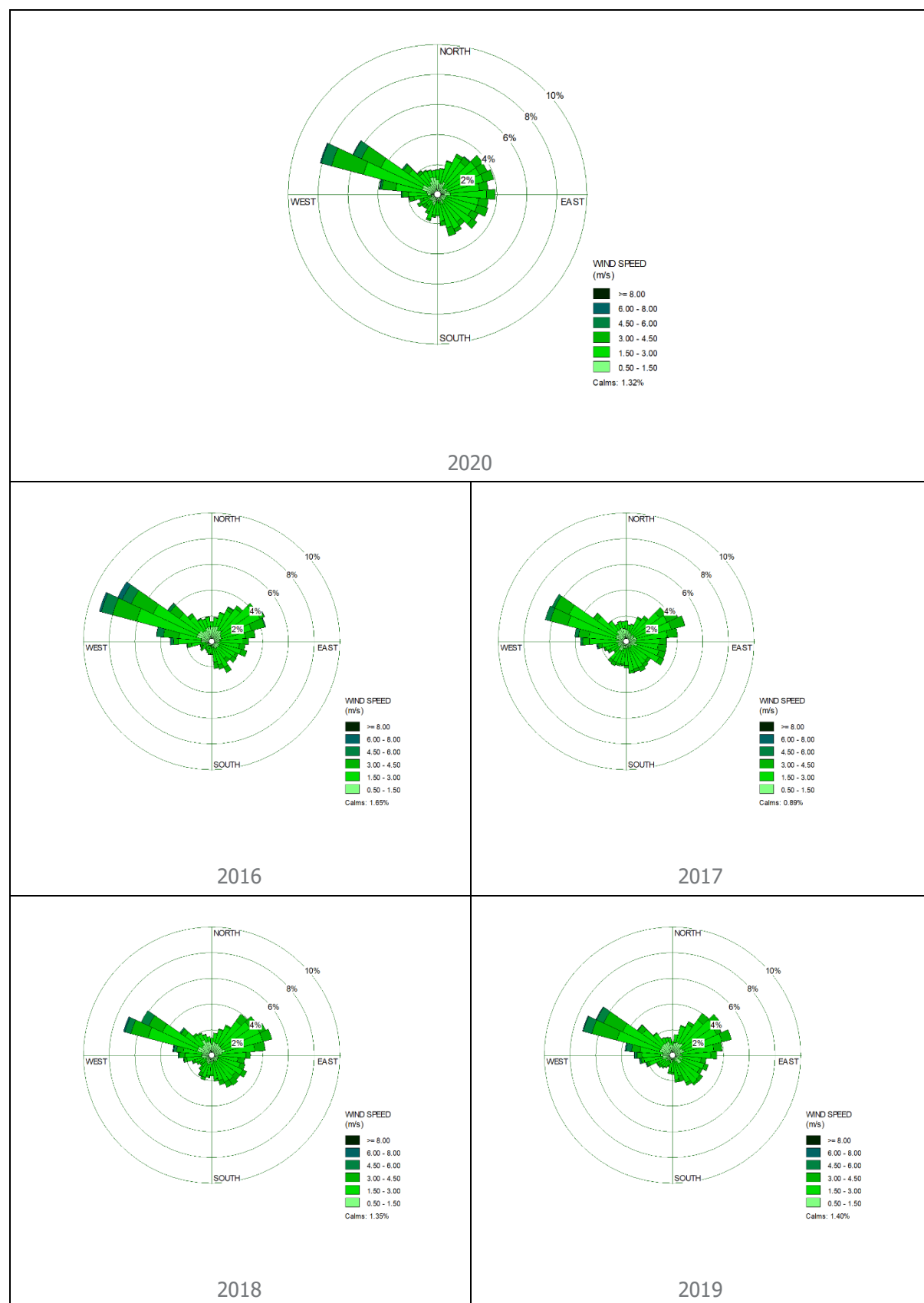


Figure B-1: CALMET Predicted Interannual Wind Roses – 2016-2020

Appendix C

Model Predicted Incremental Concentration Isopleths – All Pollutants



0 50 100 200 300 400 500 Meters



Incremental 24-hr PM₁₀

ViridIFC



0 50 100 200 300 400 500
Meters



Incremental Annual PM₁₀

ViridIFC



Incremental 24-hr PM_{2.5}

ViridIFC



0 50 100 200 300 400 500
Meters



Incremental Annual PM_{2.5}

ViridIFC



Incremental Annual average TSP