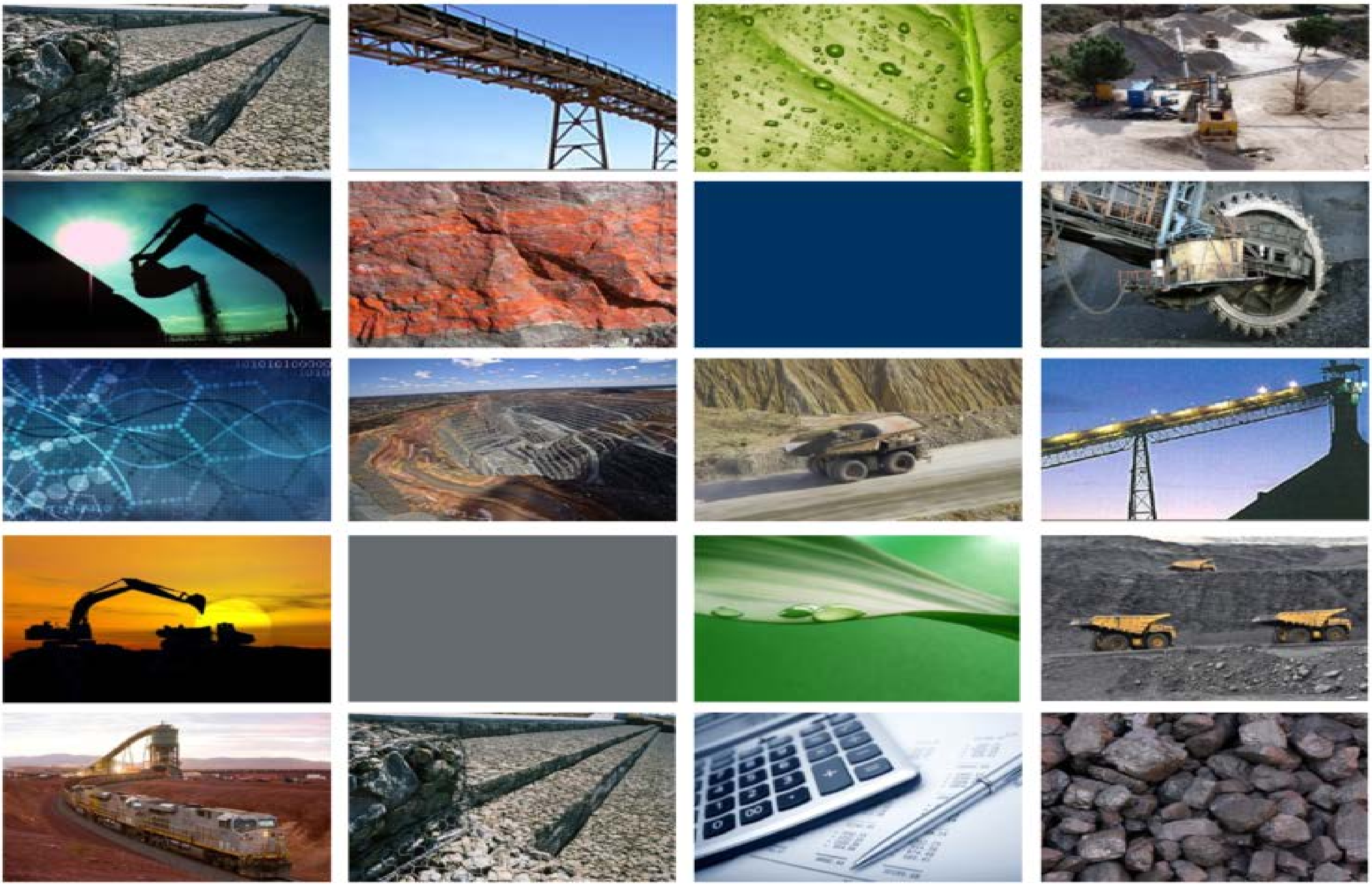

PF Formation Pty Ltd- Old Northern Road Modification – Air Quality Assessment

PF Formation Pty Ltd

2 September 2019

Project No.: 0516347

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2 September 2019

PF Formation Pty Ltd – Old Northern Road Modification - Air Quality Assessment

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1. INTRODUCTION

PF Formation Pty Ltd (the Proponent) operate a sand quarry at 4713 and 4751 Old Northern Road, Maroota, NSW (the Quarry). The Quarry currently has approval to extract 195,000 tonnes of sand per annum (tpa) through to 2030. The proposed modification (the Proposal) seeks to increase the approved extraction rate to 250,000 tpa.

Holmes Air Sciences (now ERM) completed an air quality assessment (AQA) in 2008 to support the original approval for a maximum production rate of 195,000 tpa (Holmes Air Sciences, 2008). The dispersion modelling for the 2008 AQA used a dispersion model known as ISC. A significant amount of time has elapsed since the original AQA was prepared and NSW Environment Protection Authority (NSW EPA) no longer supports this model.

ERM has prepared this AQA for the Proponent to assess the air quality impacts associated with the Proposal in general accordance with the NSW EPA "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", hereafter referred to as the *Approved Methods* (NSW EPA, 2017).

2. PROPOSAL DESCRIPTION

The approved extraction areas are situated within Lot 3 DP 567166 (Pit 5) and the adjacent Lot 2 DP 510812 (Pit 15) at Maroota. The two lots have a combined area of approximately 60.7 hectares (ha) situated east of Old Northern Road as shown on Figure 2-1 The boundaries for Pit 5 and Pit 15 were extracted via Google Earth using NSW Globe[1]. There appears to be minor error on NSW Globe with the boundary of Pit 5 (Lot 3 DP 567166) as the actual location of haul road in is inside the lot boundary. PF Formation Pty Ltd completed a boundary survey on 11 October 2018 that confirms this (see Figure 2-2).

Site operations and extraction of material commenced in January 2013 and is subject to the conditions in Development Consent No. 578/2009B and the requirements of NSW EPA Environment Protection Licence (EPL) No. 3829.

The proposed increase in production to 250,000 tonnes per annum of material extracted would be achieved with use of existing plant and machinery within the approved extraction area and for transport of material. There would be no increase in operating hours (7am to 6pm Monday to Saturday); or the maximum of 35 truck loads of material permitted to be removed from the site each day averaged over one month; or the maximum depth of allowable excavation of 177 metres AHD and the retention of a 2 metre buffer above the wet weather high water table (Environmental Planning Pty Ltd, 2018).

[1] http://globe.six.nsw.gov.au/.

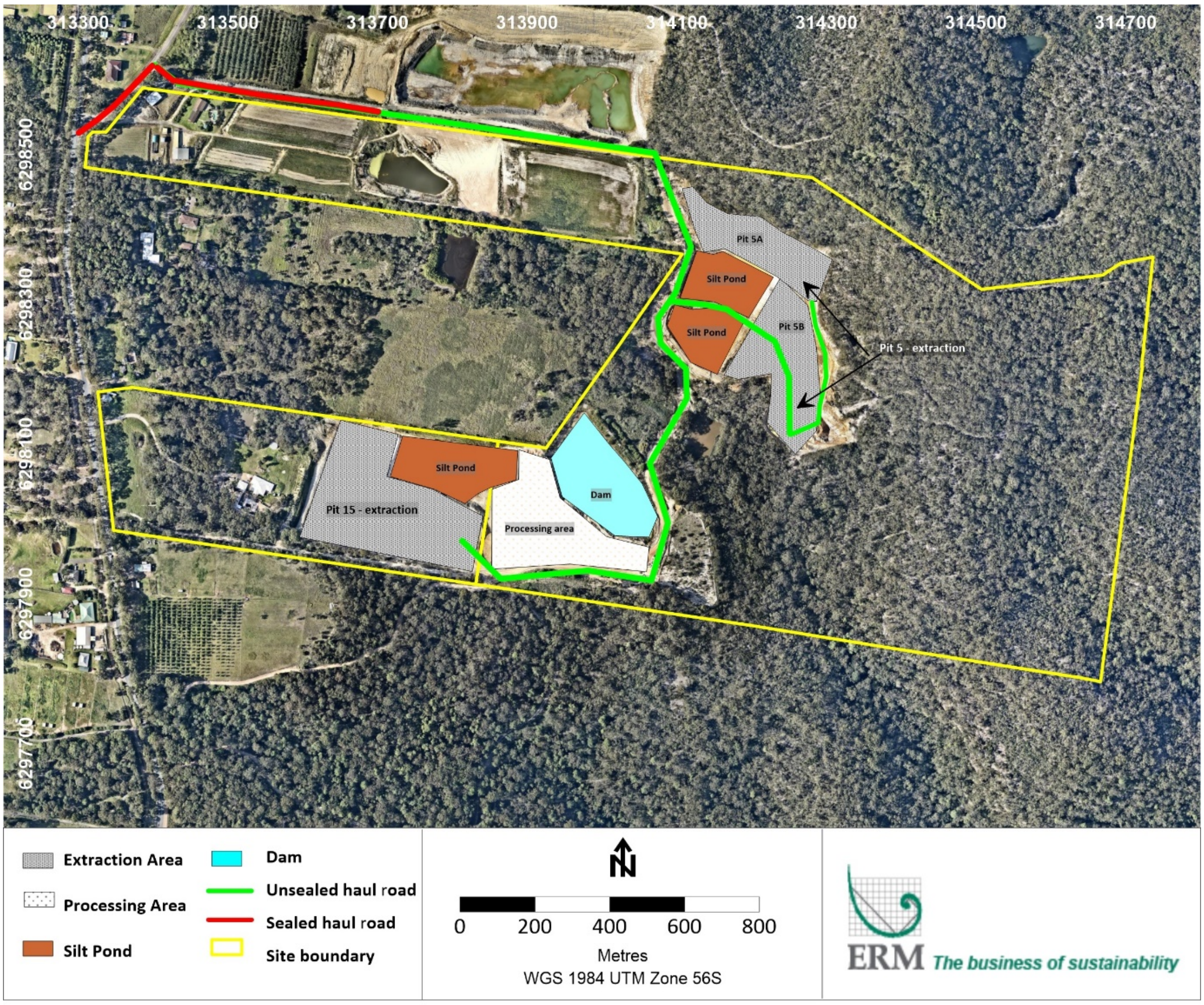


Figure 2-1 Site layout

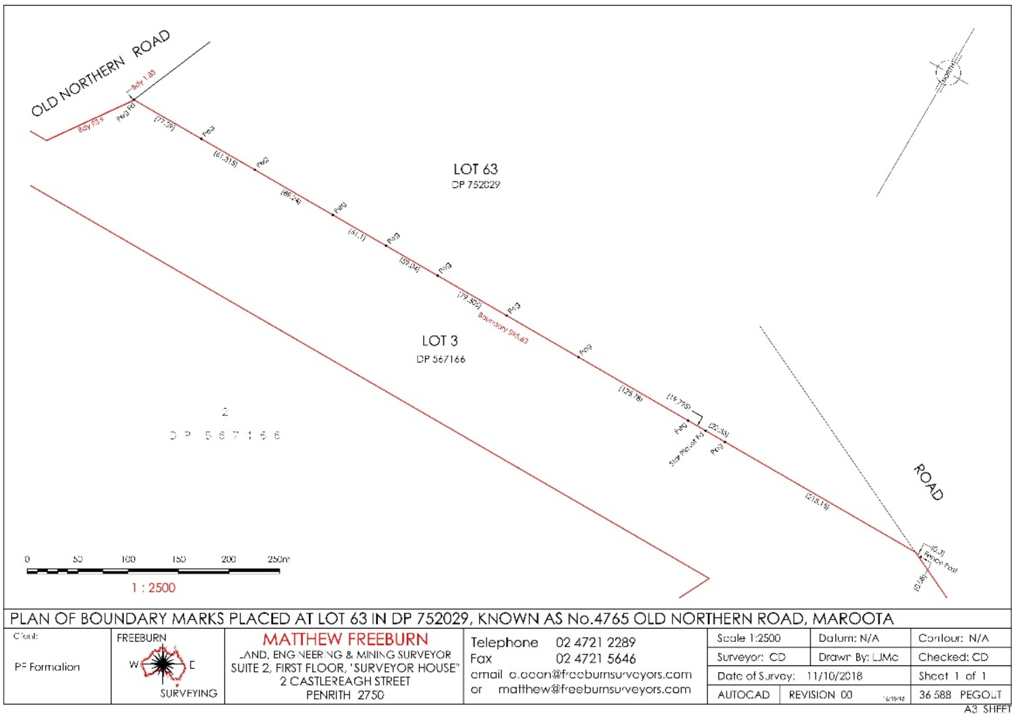


Figure 2-2 Boundary survey

3. LOCAL SETTING

The land use in the area surrounding the proposed development is primarily rural, although there is significant sand extraction activity in the area, by both PF Formation Pty Ltd and other companies. The closest discrete receptor locations are presented in Table 3-1. The sensitive receivers identified by PF Formation Pty Ltd (some of which are owned by Dixon Sand and PF Formation, as stated) represent assessment locations in the vicinity of the Proposal (see Figure 3-1).

Figure 3-1 also shows the location of the meteorological station, TEOM and Dixon Sand dust deposition gauge which are located at Maroota Public School, and two PF Formation Pty Ltd dust deposition gauges located in proximity to the Quarry (see Section 5 for further details).

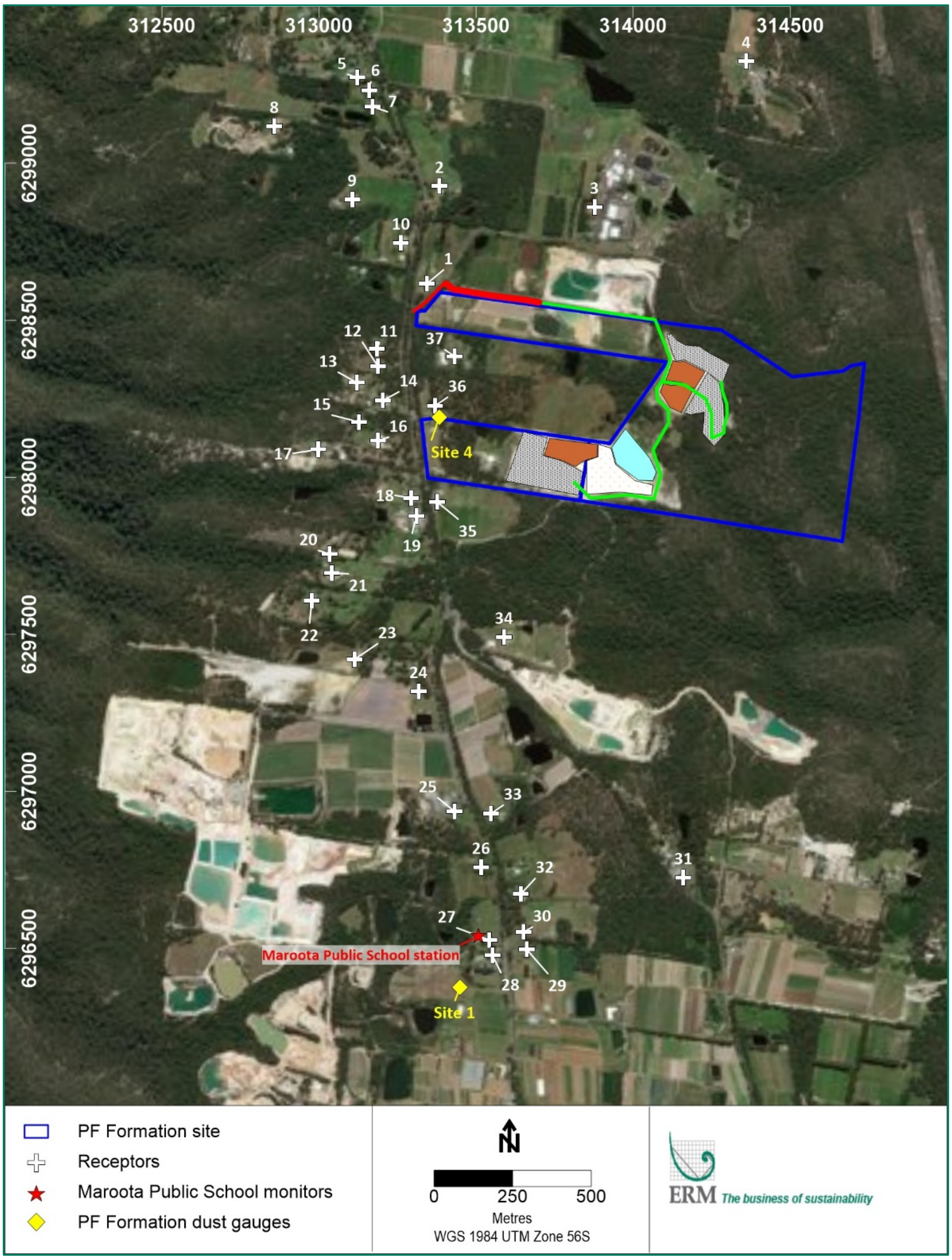


Figure 3-1: Location of PF Formation Pty Ltd quarry and sensitive receptors

Table 3-1: Receptor Locations

ID	Ownership/Type (where known)	MGA Zone 56	
		Easting (m)	Northing (m)
1	Trovato/ Private residence	313344	6298617
2	Dominello/ Private residence	313384	6298927
3	Ridley/Rendering factory	313877	6298861
4	Camilleri/ Private residence	314360	6299325
5	Private residence	313122	6299274
6	Private residence	313160	6299232
7	Private residence	313171	6299180
8	Harper/ Private residence	312858	6299118
9	Private residence	313106	6298885
10	Private residence	313261	6298747
11	Private residence	313185	6298409
12	Private residence	313187	6298354
13	Private residence	313120	6298302
14	Private residence	313204	6298245
15	Private residence	313128	6298176
16	Private residence	313188	6298117
17	Private residence	312998	6298089
18	Private residence	313294	6297934
19	Private residence	313310	6297876
20	Private residence	313034	6297756
21	Private residence	313040	6297695
22	Private residence	312977	6297607
23	Private residence	313114	6297421
24	Private residence	313317	6297319
25	Private residence	313432	6296936
26	Private residence	313516	6296759
27	Owned by Dixon/ Private residence	313542	6296527
28	Private residence	313552	6296478
29	Private residence	313661	6296497
30	Private residence	313651	6296552
31	Francis/ Private residence	314160	6296726
32	Owned by Dixon/ Private residence	313643	6296674
33	Gouscos/ Private residence	313547	6296929
34	Cherry/ Private residence	313589	6297492
35	Camilleri/ Private residence	313376	6297922
36	Private residence	313370	6298228
37	Several private residences	313432	6298385

4. AIR QUALITY CRITERIA

The potential emissions to air from the Proposal are summarised as follows:

- Modification activities described in Section 2 have the potential to generate fugitive dust emissions, particularly from sand extraction, hauling, processing and site rehabilitation.
- Combustion of diesel in quarrying equipment will result in emissions of fine fractions of particulate matter (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2) and organic compounds. This assessment focuses on the key pollutants of PM_{10} and $PM_{2.5}$.

4.1 NSW EPA Impact Assessment Criteria

The Approved Methods specifies air quality assessment criteria relevant for assessing impacts from air pollution (NSW EPA, 2017). The impact assessment criteria for pollutants relevant to this assessment refer to the total pollutant load in the environment and impacts from new sources of these pollutants must be added to existing background levels for compliance assessment. In other words, consideration of background dust levels needs to be made when using the goals outlined in the Approved Methods to assess potential impacts.

These criteria are health-based (i.e. they are set at levels to protect against health effects) and for PM_{10} and $PM_{2.5}$ are consistent with the National Environment Protection Measure for Ambient Air Quality (Ambient Air-NEPM) (NEPC, 2016). In addition, the Approved Methods include other measures of air quality, namely dust deposition and total suspended particulates (TSP) which are not stated in the Ambient Air-NEPM.

Table 4-1 summarises the air quality criteria for concentrations of particulate matter that are relevant to this study. It is important to note that these criteria are applied to the cumulative impacts due to the Proposal and other sources.

Table 4-1 NSW EPA impact assessment criteria for particulate matter concentrations

Pollutant	Criteria	Averaging period	Source
TSP	90 µg/m^3	Annual	NSW EPA (2017)
PM_{10}	50 µg/m^3	24-Hour	NSW EPA (2017)
	25 µg/m^3	Annual	
$PM_{2.5}$	25 µg/m^3	24-Hour	NSW EPA (2017)
	8 µg/m^3	Annual	

Notes: µg/m^3 – micrograms per cubic metre.

Airborne dust also has the potential to cause nuisance dust effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fallout relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance amenity impacts.

Table 4-2 shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust deposition levels are set to protect against nuisance impacts (NSW EPA, 2017).

Table 4-2 NSW EPA impact assessment criteria for deposited dust

Pollutant	Averaging period	Maximum increase (due to Proposal)	Maximum total deposited dust level	Source
Deposited dust (Insoluble Solids)	Annual	2 g/m^2/month	4 g/m^2/month	NSW EPA (2017)

4.2 Crystalline Silica

Whilst dust generated from the Proposal may contain silica dust, and long-term inhalation of silica dust may lead to the formation of scar tissue in the lungs, which can result in silicosis, a serious lung disease, silicosis is a work place issue associated with long-term exposure to high levels of respirable crystalline silica (RCS).

The World Health Organization's Concise International Chemical Assessment Document on Crystalline Silica, Quartz (CICAD, 2000) states that "there are no known adverse health effects associated with the non-occupational exposure to quartz". In addition, an Australian Government Senate Committee (2006) report identified that there are no reports in the international literature of individuals developing silicosis as a result of exposure to non-occupational levels (i.e. levels outside the work place) of silica dust, and an expert appearing before the committee confirmed the potential for such an occurrence as being very remote.

A literature review on the potential impacts to health from exposure to crustal material in Port Hedland, WA, states "exposure to airborne quartz carries the risk of silicosis, but only with prolonged exposure to concentrations greater than 200 µg/m3" (Department of Health, 2007). As detailed in Section 8.2 the maximum cumulative annual average PM10 concentrations (of which RCS would be a small fraction) at the most affected residence is predicted to be 17 µg/m3 (of which 13.8 µg/m3 is due to existing background levels), significantly below levels that may be of concern. For this reason, RCS has not been considered further in this assessment. It is noted that PF Formation Pty Ltd regularly monitors its workforce for exposure to respirable silica.

4.3 Other Legislative Requirements

4.3.1 Protection of the Environment Operations (POEO) Act, 1997

If approved, the current Environment Protection Licence (EPL) may be varied by NSW EPA. Relevant to air quality, the EPL would outline the Proposal's requirements to minimise dust emissions and specify air quality monitoring requirements. The Protection of the Environment Operations (Clean Air) Regulations 2010 (POEO (Clean Air) Regulation) sets out standards of concentration for emissions to air from scheduled activities. The maximum pollution levels allowed under the regulations for general activities are provided in Table 4-3.

Table 4-3 POEO Maximum Allowable Emission Levels

Air Impurity	Activity or Plant	Standard of Concentration
Solid Particles	Any process emitting solid particles	50 mg/m^3

5. EXISTING ENVIRONMENT

5.1 Local Climatic Conditions

Table 5-1 presents the temperature, humidity and rainfall data for the Bureau of Meteorology site located at Peats Ridge (Site number 061351), approximately 25 km northeast of the site. Humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

The annual average maximum and minimum temperatures recorded at the Peats Ridge station are 21.8°C and 11.3 °C respectively. On average, January is the hottest month, with an average maximum temperature of 27.0°C. July is the coldest month, with average minimum temperature of 6.1°C. The annual average relative humidity reading collected at 9 am from the Peats Ridge station is 75% and at 3 pm the annual average is 62%. The months with the highest relative humidity on average are February and March with 9 am averages of 82% and the month with the lowest relative humidity is September with a 3 pm average of 54%.

Rainfall data collected at the Peats Ridge station shows that February is the wettest month, with an average rainfall of 154.3 mm over an average of 14.1 rain days. The average annual rainfall is 1248.6 mm with an average of 137 rain days per year.

Table 5-1 Climate Averages for the Peats Ridge Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Dry-bulb and Wet-bulb Temperatures (ºC) and Relative Humidity (%)													
Dry-bulb	21.1	20.5	19.0	17.2	14.1	11.3	10.5	12.1	15.2	17.6	18.4	20.2	16.4
Humidity	78.0	82.0	82.0	78.0	79.0	78.0	75.0	69.0	65.0	65.0	72.0	74.0	75.0
3pm Mean Dry-bulb and Wet-bulb Temperatures (ºC) and Relative Humidity (%)													
Dry-bulb	25.3	24.8	23.1	20.4	17.5	15.0	14.4	16.3	18.7	20.8	22.1	24.1	20.2
Humidity	64.0	66.0	66.0	66.0	67.0	66.0	60.0	55.0	54.0	58.0	61.0	63.0	62.0
Daily Maximum Temperature (ºC)													
Mean	27.0	26.4	24.6	22.0	19.1	16.4	15.8	17.7	20.5	22.8	24.1	25.8	21.8
Daily Minimum Temperature (ºC)													
Mean	16.3	16.4	14.6	12.0	9.5	7.2	6.1	6.6	8.7	10.9	13.0	14.8	11.3
Rainfall (mm)													
Mean	113.3	154.3	135.9	123.0	89.7	99.5	62.7	74.0	69.1	85.3	100.7	92.4	1248.6
Rain days (Number)													
Mean	13.8	14.1	14.1	11.3	11.4	10.5	9.7	8.4	8.3	10.6	12.4	12.7	137.3

Source: BOM (2019) Climate averages for Station: 061351; Commenced: 1981 – Last Record 05/05/2015; Latitude: 33.31°S; Longitude: 151.24 °E

5.2 Local Meteorology

5.2.1 Wind Speed and Direction

Air quality impacts are influenced by meteorological conditions, primarily in the form of gradient wind flow regimes, and by local conditions that are generally driven by topographical features and interactions with coastal influences, such as the sea breeze. Wind speed, wind direction, temperature and relative humidity all affect the potential dispersion and transport of plumes and are basic input requirements for dispersion modelling.

Wind speed and direction data have been collected locally at Maroota Public School, approximately 0.7 km north-east of the PF Formation Pty Ltd site. The air quality assessment completed for the Site used meteorological data from Maroota Public School for the period 2017. This year was selected on the basis that, as discussed below, there is little variation year-on-year, but as detailed in Section 5.3, 2017 is most representative with respect to existing air quality in the area.

The annual and seasonal 2017 windroses of the data collected at Maroota Public School are presented in Figure 5-1. The wind speeds recorded at the site are very light with an average wind speed for the period of 1.2 m/s. The percentage of calms (wind speeds below 0.5 m/s) for the station are relatively high at 17.3%.

On an annual basis, the predominant winds are from the south- south- west, east and north quadrants. Summer and spring winds are predominantly from the east while for winter the winds are mainly from the south-south-west, west-north-west and north, and for autumn the winds are primarily from the south-south-west and south-west.

Figure 5-2 presents windroses of the data collected at Maroota Public School for 2014, 2015, 2016 and 2018. Whilst there are minor variations year-on-year, the prevailing winds are similar between years.

Given the lack of cloud data at Maroota Public School, these data were produced using The Air Pollution Model (TAPM) and along with the other appropriate meteorological parameters were used in the modelling (see Section 6).

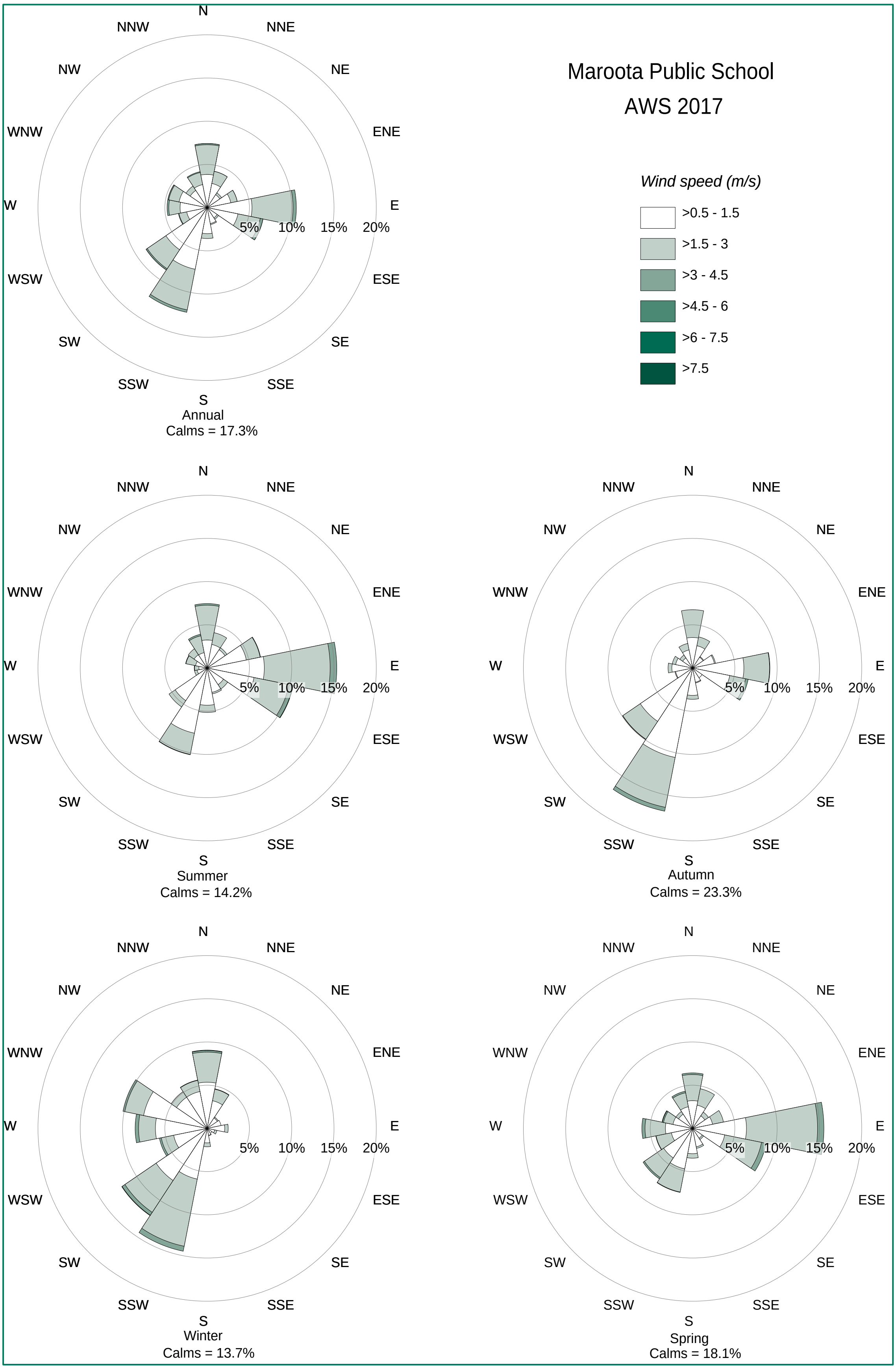
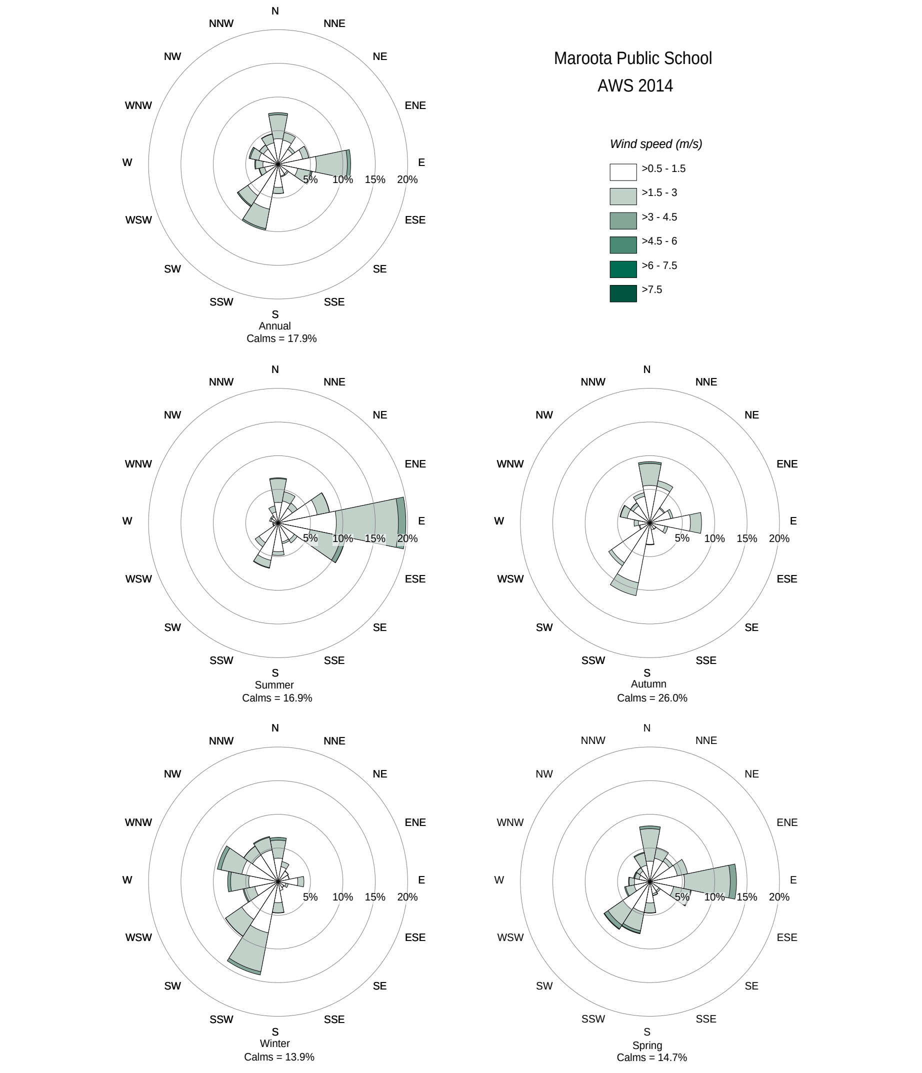
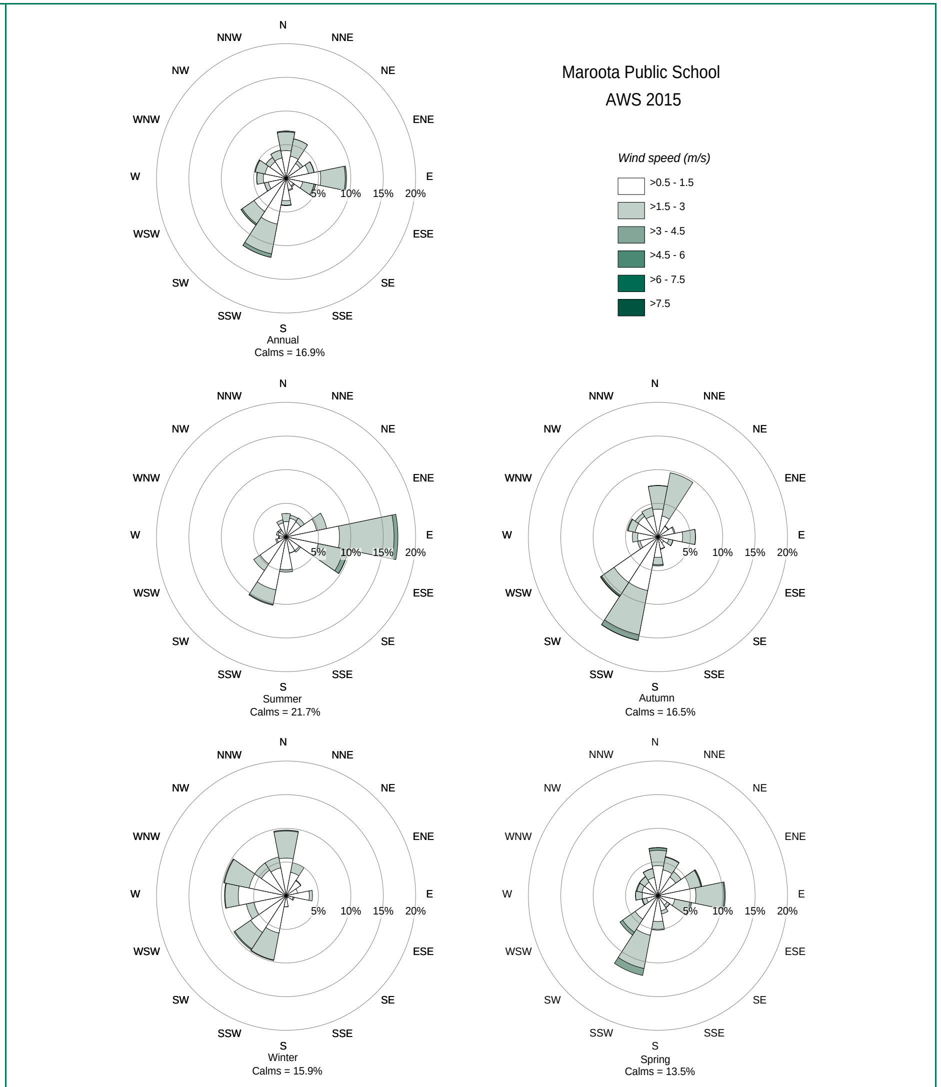


Figure 5-1 Annual and seasonal windroses for Maroota Public School (2017)


Maroota Public School
AWS 2014
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
5%
10%
15%
20%
Annual
Calms = 17.9%
Summer
Calms = 16.9%
Autumn
Calms = 26.0%
Winter
Calms = 13.9%
Spring
Calms = 14.7%

2014


Maroota Public School
AWS 2015
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
5%
10%
15%
20%
Annual
Calms = 16.9%
Summer
Calms = 21.7%
Autumn
Calms = 16.5%
Winter
Calms = 15.9%
Spring
Calms = 13.5%

2015

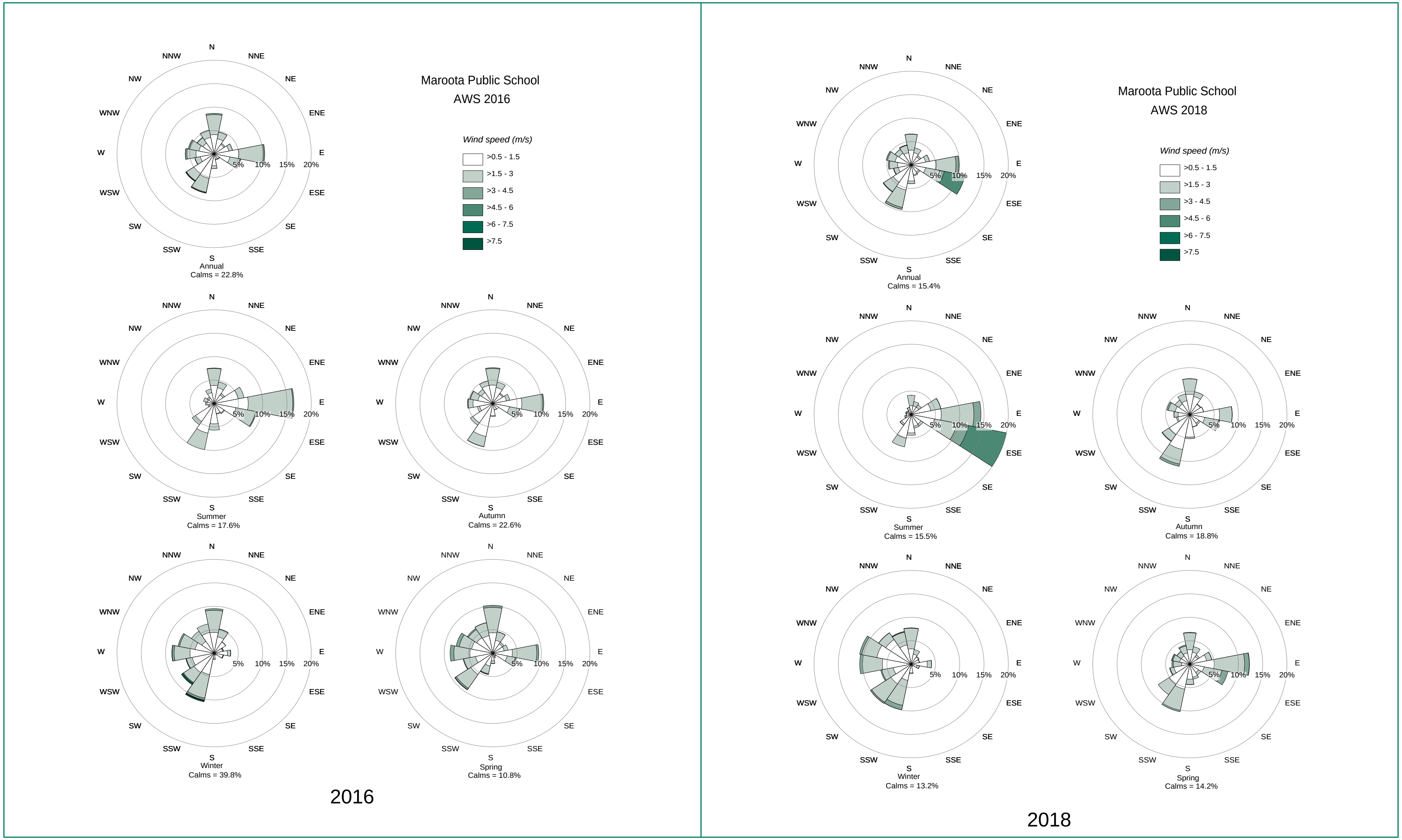


Figure 5-2 Annual and seasonal windroses for Maroota Public School (2014, 2015, 2016 & 2018)

5.2.2 Atmospheric Stability

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

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

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

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

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

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

Figure 5-3 shows the hourly averaged 1/L for the site computed from all data in the AERMET extract file. Based on Table 5-2 this plot indicates that, as to be expected, the PBL is stable overnight and becomes unstable as radiation from the sun heats the surface layer of the atmosphere and drives convection. The changes from positive to negative occur at the shifts between day and night. This indicates that the diurnal patterns of stability are realistic.

Table 5-2 Inverse of the Monin-Obukhov length L with respect to Atmospheric Stability

1/L	Atmospheric Stability
Negative	Unstable
Zero	Neutral
Positive	Stable

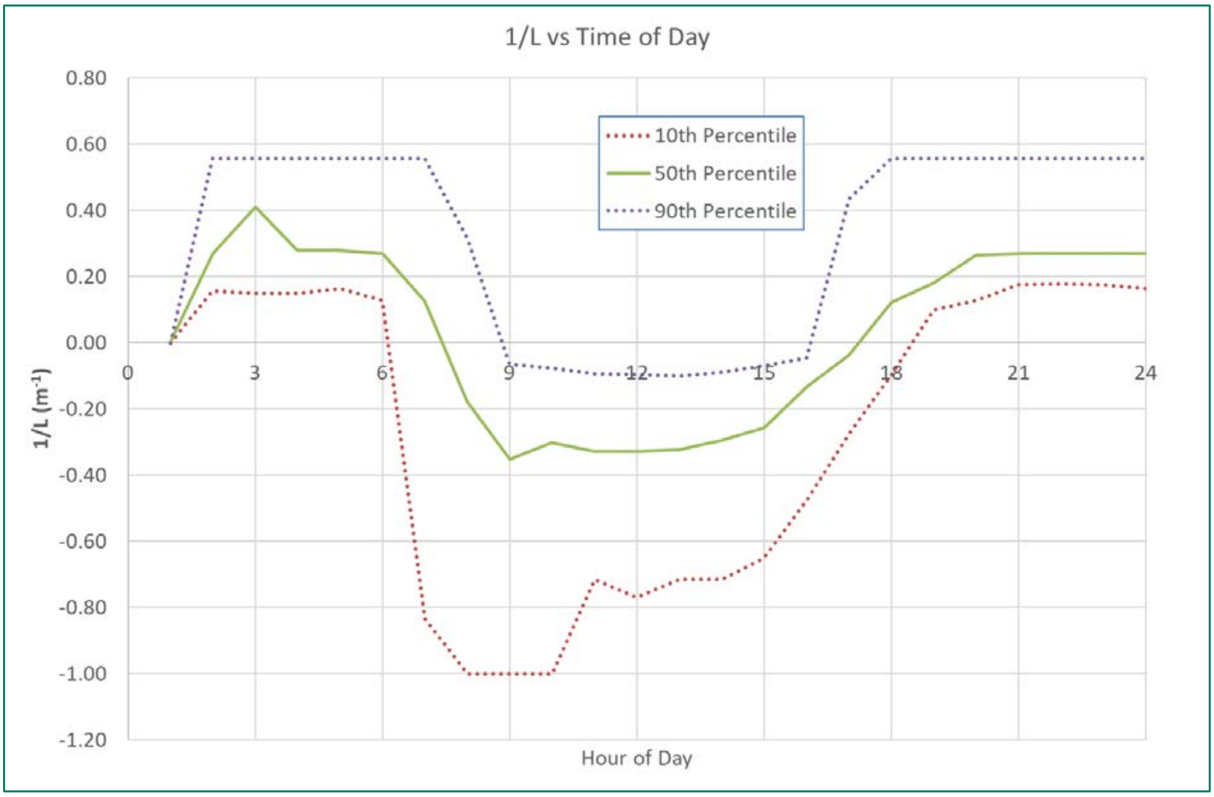


Figure 5-3 Annual Statistics of 1/L by Hour of the Day

5.3 Existing Air Quality

Air quality standards and goals refer to pollutant levels, which include the contribution from proposed projects as well as other sources. To fully assess impacts against all the relevant air quality standards and goals it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the project is likely to contribute to these levels.

5.3.1 PM_{10} Concentrations

PF Formation Pty Ltd has an agreement with Dixon Sand to be advised if the rolling 24-hour average PM_{10} impacts at Maroota Public School reach 42.5 µg/m^{3}.

Figure 5-4 shows the PM_{10} concentrations measured by a Tapered Element Oscillating Microbalance (TEOM) at Maroota Public School, the annual and 24-hour average assessment criterion (see Section 4).

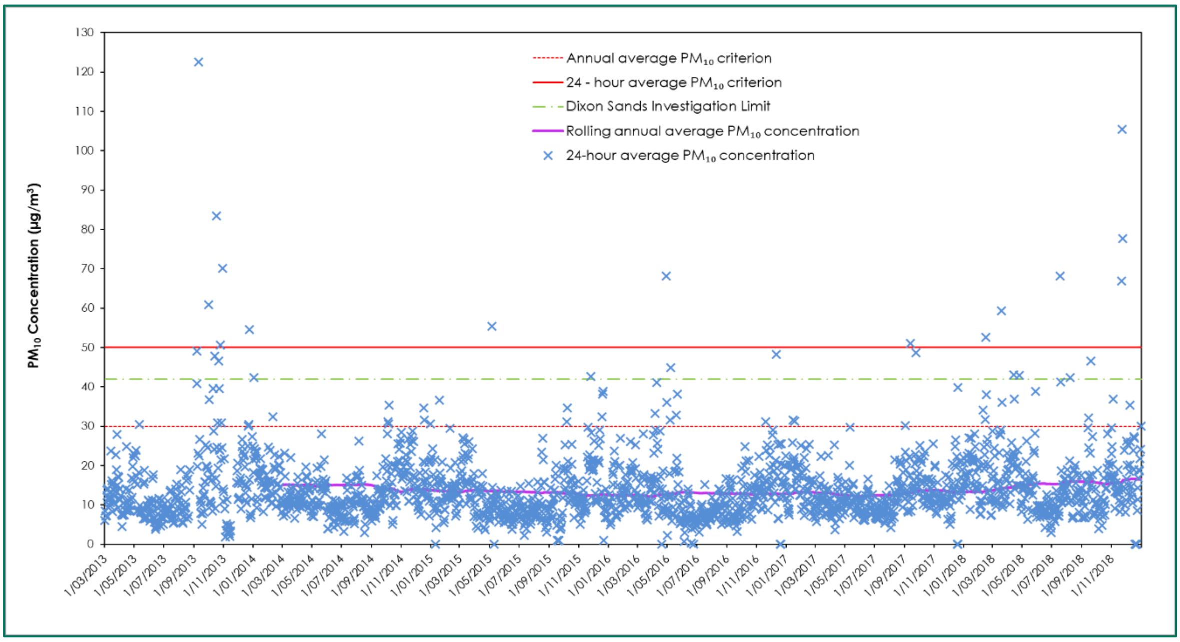


Figure 5-4 Measured PM_{10} for Maroota Public School TEOM

The 24-hour average PM_{10} impact assessment criterion of 50 µg/m³ has been exceeded on fifteen occasions since January 2013, none of which were directly attributable to sand quarrying in the area, as shown in Table 5-3 below.

Table 5-3 24-hour average PM_{10} concentrations exceedances for Maroota Public School TEOM

Exceedance	Date	Reason	Source
122.5 µg/m³	10/09/2013	There was widespread and severe bushfire activity across eastern NSW during this period which saw 19 areas declared as natural disaster areas and will have contributed significantly to measured dust levels at that time	BoM (2013)
60.8 µg/m³	01/10/2013		
83.4 µg/m³	17/10/2013		
50.6 µg/m³	25/10/2013		
70.1 µg/m³	29/10/2013		
54.5 µg/m³	23/12/2013		
55.5 µg/m³	06/05/2015	Dust storm event from fires at nearby residences	Dixon Sand (2015)
68.2 µg/m³	29/04/2016	Hazard reduction burning	OEH (2016)
51.1 µg/m³	13/09/2017	Local dust sources	OEH (2017)
52.6 µg/m³	15/02/2018	Agricultural burning	OEH (2018)
59.3 µg/m³	19/03/2018	Dust storm	OEH (2018)
68.2 µg/m³	18/07/2018	Agricultural burning	OEH (2018)
66.9 µg/m³	21/11/2018	Dust storm	OEH (2018)
105.5 µg/m³	22/11/2018		
77.7 µg/m³	23/11/2018		

Table 5-4 shows the annual average of PM_{10} concentrations at Maroota Public School for the period 2014 to 2018. It is noted that the measured concentrations in 2018 are substantially higher than the other years. An increase was observed at all the NSW Office of Environment and Heritage (OEH) monitoring stations during 2018 and per NSW Annual Air Quality Statement for 2018 (OEH, 2018) this is predominately due to more frequent exceptional events, such as dust storms, bushfires and hazard reduction burning.

For this assessment, the 5-year average of 13.8 µg/m³ is assumed. This is considered to be a conservative assumption as the measured concentrations already include the contribution from the approved activities at the site.

Table 5-4 Annual average PM_{10} concentrations at Maroota Public School

2014	2015	2016	2017	2018	5-year average
PM_{10}					
13.8	12.5	12.9	13.2	16.6	**13.8**

5.3.2 $PM_{2.5}$ Concentrations

There are no $PM_{2.5}$ data collected near the site with the closest OEH sites located at Richmond (PM_{10} and $PM_{2.5}$), Vineyard (PM_{10} only) and Wyong (PM_{10} and $PM_{2.5}$). All these sites are located between 25 km and 45 km from the site, and are also located in more urban areas compared with the site.

Table 5-5 presents the annual averages of both the PM_{10} and $PM_{2.5}$ concentrations measured at these sites between 2014 and 2018.

The average PM_{10} concentrations recorded across the three sites is 15.8 µg/m^3 and the average $PM_{2.5}$ concentration is 6.6 µg/m^3. The $PM_{2.5}$ to PM_{10} ratio is approximately 0.41.

Given that the annual average PM_{10} concentrations measured at the OEH stations are similar to the measured concentrations at Maroota Public School, this ratio has been applied to the assumed PM_{10} background level of 13.8 µg/m^3 to give an assumed annual average background $PM_{2.5}$ concentration of 5.7 µg/m^3.

Table 5-5 PM_{10} and $PM_{2.5}$ concentrations at OEH monitoring sites

OEH site	2014	2015	2016	2017	2018	Average all data
Annual average PM_{10} concentration (µg/m^3)						
Wyong	15.1	14.9	15.2	16.1	18.0	16.0
Richmond	15.4	12.8	16.0	16.0	18.7	
Vineyard	16.3	15.9	17.0	No data		
Annual average $PM_{2.5}$ concentration (µg/m^3)						
Wyong	5.5	5.2	5.7	5.8	6.8	6.6
Richmond	6.7	7.7	7.9	7	8.1	

5.3.3 TSP Concentrations

There are no measurements of TSP available for the site. Estimates of annual average TSP concentrations have been made from the PM_{10} measurements by assuming that 40% of the TSP is PM_{10}.

This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for long periods of time in the Hunter Valley (NSW Minerals Council, 2000). Although this ratio is based on Hunter Valley data, in the absence of site specific data this provides an indicative estimate of the ambient TSP.

Use of this relationship on the adopted PM_{10} annual average of 13.8 µg/m^3 gives an existing annual average TSP concentration of approximately 34.5 µg/m^3.

5.3.4 Dust Deposition

Table 5-6 shows annual average insoluble solids deposition rates from two of PF Formation Pty Ltd's dust deposition gauges (Site 1 and Site 4), and Dixon Sand's dust deposition gauge located at Maroota Public School. The locations of the dust deposition gauges are presented in Figure 3-1.

A background dust deposition level of 2.1 g/m^2/month was assumed based on the average of the data presented in Table 5-6.

Table 5-6 Annual Average Dust Deposition Data (g/m²/month)

Year	PF Formation Pty Ltd Site 1	PF Formation Pty Ltd Site 4	Dixon Sands Maroota Public School
2015	2.0	3.0	0.9
2016	2.6	2.4	0.7
2017	2.7	2.5	1.3
2018	2.5	2.8	1.9
Average all sites = 2.1			

5.3.5 Background Values

In summary, for the purposes of assessing potential air quality impacts, the following existing air quality levels are assumed for assessment against the long-term criteria. PM_{10} is also assessed against a short-term (24-hour average) criteria.

- Annual average PM_{10} concentration of 13.8 µg/m³ based on the 5-year average of data collected at Maroota Public School.
- Annual average $PM_{2.5}$ concentration of 5.7 µg/m³ calculated by applying the $PM_{2.5}$:PM_{10} ratio of data collected at OEH sites to the 5-year average PM_{10} concentration.
- Annual average TSP concentration of 34.5 µg/m³ calculated based on the assumption that 40% of TSP is PM_{10}.
- Annual average dust deposition of 2.1 g/m²/month based on average of data from PF Formation Pty Ltd and Dixon Sand dust deposition gauges.
- 24-hour average PM_{10} concentration – varies daily (Maroota Public School 2017 daily data).
- 24-hour average $PM_{2.5}$ concentration – varies daily ($PM_{2.5}$:PM_{10} ratio of 0.41 applied to Maroota Public School 2017 daily data).

6. MODELLING APPROACH

The overall approach to the assessment generally follows the Approved Methods which specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentrations from the Proposal.

It is important to note that dispersion models are not 100% accurate but are a tool which uses the best-available science to guide policy making decisions in reviewing the potential air quality impacts of a proposed source, as no practical alternative exists. As noted in the 2005 US Environmental Protection Agency Guideline on Air Quality Models:

- Models are more reliable for estimating longer time-averaged concentrations (e.g. annual averages) than for estimating short-term concentrations at specific locations (e.g. 24-hour averages).
- Whilst the models are reasonably reliable in estimating the magnitude of highest short-term concentrations occurring sometime, somewhere within an area, they are not so reliable at determining precisely when and where this maximum concentration will occur.

In addition, as discussed in Section 7.2, the operational scenario assessed is considered to be a conservative representation.

6.1 Modelling System

The air dispersion modelling conducted for this assessment is based on an advanced modelling system using the AERMET/AERMOD model. AERMOD was chosen as the most suitable model due to the source types, location of nearest receptors and nature of local topography. AERMOD is the US-EPA's recommended steady-state plume dispersion model for regulatory purposes. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it incorporates more recent, and potentially more accurate, algorithms to represent both meteorological interactions and air quality dispersion.

A significant feature of AERMOD is the Pasquill-Gifford stability based dispersion is replaced with a turbulence-based approach that uses the Monin-Obukhov length scale to account for the effects of atmospheric turbulence based dispersion.

The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation of terrain data. Terrain data were sourced from NASA's Shuttle Radar Topography Mission (SRTM) Data (1 arc-second (~30m) resolution) and processed within AERMAP to create the necessary input files.

AERMET requires surface and upper air meteorological data as inputs. Surface data were sourced from the meteorological station at Maroota Public School, approximately 0.7 km south-east of the PF Formation Pty Ltd site.

Given the lack of cloud data available from the Maroota Public School, data were produced using The Air Pollution Model (TAPM) for use in the development of the AERMET file.

Appropriate values for three surface characteristics are required for AERMET as follows:

- Surface roughness, which is the height at which the mean horizontal wind speed approaches zero, based on a logarithmic profile.
- Albedo, which is an indicator of reflectivity of the surface.
- Bowen ratio, which is an indicator of surface moisture.

Values of surface roughness, albedo and Bowen ratio were determined based on a review of aerial photography for a radius of 3 km centred on the site. Default values for cultivated land use were chosen to represent the surrounding area.

A summary of the model set-up is presented in Appendix A.

7. EMISSIONS TO AIR

7.1 Dust Control Measures

Table 7-1 provides an overview of the relevant applicable best practice management measures currently in place. In the absence of specific best practice guidance for sand quarrying, these controls are compared to recommendations of the NSW Coal Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining (Donnelly et al, 2011), a study that was commissioned by the EPA, hereafter referred to as “the Best Practice Report”.

Table 7-1 Best Practice Measures

OEH Best Practice Report reference		Mining Activity	Best Practice Control		Applied at site?	Level of control applied to emission calculations	Comments
Section	Table						
9.2	66	Hauling on Unsealed Roads	Vehicle restrictions	Speed reduction from 75 km/h to 50 km/h	N		
				Speed reduction from 65 km/h to 30 km/h	Y	N/A	Not quantifiable in emission calculations
				Grader speed reduction from 16 km/h to 8 km/h	N/A		
			Surface improvements	Pave the surface	Y	N/A	Part of access road - emission equation contains parameter for silt loading of road. Value of 0.4 g/m^2 used.
				Low silt aggregate	Y	N/A	Emission equation contains parameter for silt content of road. Conservative value of 6.4% used for unsealed roads.
			Surface treatments	Watering (standard procedure)	N		
				Watering Level 1 (2 $L/m^2/h$)	N	75%	
				Watering Level 2 (>2 $L/m^2/h$)	Y		
				Watering grader routes	N		
				Watering twice a day for industrial unpaved road	N		
				Dust suppressants (please specify)	N		
			Other	Use of larger vehicles	N		Not feasible to use large trucks on site
				Conveyors	N/A		

OEH Best Practice Report reference		Mining Activity	Best Practice Control		Applied at site?	Level of control applied to emission calculations	Comments
Section	Table						
9.3	71	Wind Erosion on Exposed Areas & Overburden Emplacements	Avoidance	Minimise pre-strip	Y	N/A	Not quantifiable in emission calculations
			Surface stabilisation	Watering	N		
				Chemical suppressants	N		
				Paving and cleaning	N		
				Application of gravel to stabilise disturbed open areas	N		
				Rehabilitation goals	Y	N/A	Per approved Rehabilitation Plans
			Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump	N		
				Vegetative ground cover	N		
9.3	72	Wind Erosion and Maintenance - Coal Stockpiles	Avoidance	Bypassing stockpiles	N		
			Surface stabilisation	Water sprays	Y	50%	Processing area stockpiles
				Chemical wetting agents	N		
				Surface crusting agent	N		
			Enclosure	Silo with bag house	N		
				Cover storage pile with a tarp during high winds	N		
			Wind speed reduction	Vegetative windbreaks	N		
				Reduced pile height	N		
				Wind screens/fences	N		
				Pile shaping/orientation	Y	N/A	Not quantifiable in emission calculations
				Erect 3-sided enclosure around storage piles	N		

OEH Best Practice Report reference		Mining Activity	Best Practice Control		Applied at site?	Level of control applied to emission calculations	Comments
Section	Table						
9.4	76	Bulldozers on Overburden (OB)	Minimise travel speeds and distance				
			Travel routes and material kept moist		Y	50%	Dozer activity
9.5	81	Blasting and drilling	Blasting	Delay shot to avoid unfavourable weather conditions	N/A		
				Minimise area blasted			
	82		Drilling	Fabric filters			
				Cyclone			
				Water injection while drilling			
9.6	85	Draglines	Minimise drop height	Reduce from 30m to 5m	N/A		
			Minimising drop height	Reduce from 10m to 5m			
			Modify activities in windy conditions				
			Water sprays				
			Minimise side casting				
9.7	90	Loading and dumping overburden	Excavator	Minimise drop height	Y	30%	
			Truck dumping	Minimise drop height	Y	30%	
				Water application	N		
				Modify activities in windy conditions	Y	N/A	Not quantifiable in emission calculations
9.8	95	Loading and dumping Run-of_Mine (ROM) coal	Avoidance	Bypass ROM stockpiles - dumping	N/A		
				Bypass ROM stockpiles - forming stockpiles (e.g. dozer push)			
			Truck or loader dumping coal	Minimise drop height (10m to 3m)			
				Water sprays on ROM pad			

OEH Best Practice Report reference		Mining Activity	Best Practice Control		Applied at site?	Level of control applied to emission calculations	Comments
Section	Table						
			Truck or loader dumping to ROM bin	Water sprays on ROM bin or ROM pad			
				Three sided and roofed enclosure of ROM bin			
				Three sided and roofed enclosure of ROM bin + water sprays			
				Enclosure with control device			
9.9	96	Conveyors and transfers	Conveyors	Application of water at transfers	N/A		
				Wind shielding - roof OR side wall			
				Wind shielding - roof AND side wall			
				Belt cleaning and spillage minimisation			
			Transfers	Enclosure	N		
9.1	97	Stacking and reclaiming product coal	Avoidance	Bypass coal stockpiles	N		
			Loading coal stockpiles	Variable height stack	N		
				Boom tip water sprays	N		
				Telescopic chute with water sprays	N		
			Unloading coal stockpiles	Bucket-wheel, portal or bridge reclaimer with water application	N		
9.11	-	Train and truck load out and transportation	Limit load size to ensue coal is below sidewalls		N/A		
			Maintain a consistent profile				
			Water sprays				
			Use bed liners to minimise seepage				

OEH Best Practice Report reference		Mining Activity	Best Practice Control		Applied at site?	Level of control applied to emission calculations	Comments
Section	Table						
			Cover load with tarpaulin				
			Utilise truck wheel wash				

7.2 Operational Scenarios

A worst-case operating scenario has been assessed, based on the assumption that all the potential activities occur simultaneously, namely:

- Sand extraction and processing of material from Pit 15, Pit 5A, and Pit 5B.

In order to assess the effect of all meteorological conditions, the emission calculations and dispersion modelling conservatively assume activities occur concurrently between the hours of 7am and 6pm, 7-days per week, compared with the approved 6-days per week[2] .

In reality it is also unlikely that all activities would occur concurrently, nor would they all occur during each hour approved for activities.

7.3 Emissions Summary

The operations of the Proposal have been analysed and estimates of dust emissions for the key dust generating activities have been made.

Emission rates of TSP, PM_{10} and $PM_{2.5}$ have been calculated using emission factors developed both within NSW and by the US EPA. Modelling of TSP, PM_{10} and $PM_{2.5}$ was undertaken using the particle size specific inventories and was assumed to emit and deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mass of the particle size range.

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

The locations of the volume sources, used to represent the quarry, are shown in Appendix B together with detailed emission inventories.

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

[2] With the exception of wind erosion which occurs 24-hours per day

Table 7-2 Estimated TSP, PM_{10} and $PM_{2.5}$ annual emissions for the Proposal (kg/y)

ACTIVITY	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Pit 5A			
Dozer clearing topsoil and breaking up sandstone) - Pit 5A	1,791	417	188
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5A	6	3	0.4
Hauling from Pit 5A extraction area to Raw Material Stockpile at Processing Area (unsealed)	5,212	1,646	165
Unloading to Raw Material Stockpile	6	3	0.4
Pit 5B			
Dozer clearing topsoil and breaking up sandstone) - Pit 5B	1,791	417	188
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5B	6	3	0.4
Hauling from Pit 5B extraction area to Raw Material Stockpile at Processing Area	3,644	1,150	115
Unloading to Raw Material Stockpile	6	3	0.1
Pit 15			
Dozer clearing topsoil and breaking up sandstone) - Pit 15	1,791	417	188
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 15	12	6	1
Hauling from Pit 15 extraction area to Raw Material Stockpile at Processing Area	4,537	1,432	143
Unloading to Raw Material Stockpile	12	6	1
Processing Area			
Loading from Raw Material Stockpile to Screen	25	12	2
Screening (uncontrolled)	3,125	1,075	1,075
Unloading from Screen to Product stockpile	25	12	2
Transfer from (Screen to Crusher) [conveyor transfer point]	1	0.3	0.04
Crushing (uncontrolled)	488	188	188
Unloading from Crusher to Wash plant	1	1	0.1
Wet Processing (no expected emissions)	-	-	-
Transfer to product stockpile	0.3	0.1	0.02
Product Sand			
Loading sand from Product Stockpile to haul trucks	33	16	2
Hauling out of Site (unsealed)	27,318	8,624	862
Hauling out of site (sealed)	114	22	5
Wind Erosion			
WE - Extraction Area (Pit 5A)	978	489	73
WE - Extraction Area (Pit 5B)	1,330	665	100
WE - Extraction Area (Pit 15)	2,285	1,142	171
WE - Processing Area including Stockpile	1,442	721	108
TOTAL	**55,979**	**18,468**	**3,579**

Notes: WE – wind erosion, kg/year – kilograms per year

8. OPERATIONAL PHASE IMPACT ASSESSMENT

8.1 Introduction

Dispersion model predictions made for the Proposal are presented in the sections below.

Contour plots of particulate concentrations show the areas that are predicted to be affected by dust at different levels. It is important to note that the contour figures are presented to provide a visual representation of the predicted impacts. To produce the contours, it is necessary to make interpolations, and as a result the contours will not always match exactly with predicted concentration at any specific location. They are nevertheless useful to establish indicative particulate concentrations from the Proposal.

The actual predicted particulate concentrations/levels at the surrounding residences/receptors are also presented in tabular form.

In the case of maximum 24-hour average concentrations, it is important to note that individual contour plots do not represent one moment in time, but rather they show the maximum 24-hour average concentration that could potentially occur at a sensitive receptor over the period of a year.

8.2 Annual Average Concentrations

Table 8-1 presents the predicted annual average concentrations and levels at each of the sensitive receptor locations for both the Proposal alone and when including background concentrations. The assumed background concentrations have been outlined previously in Section 5.3.5.

There are no predicted exceedances of any of the relevant assessment criteria detailed in Section 4.

Contour plots of the predicted annual average concentrations due to the Proposal alone and cumulatively are presented in Figure 8-1 to Figure 8-8.

Table 8-1 Predicted annual average concentrations and levels due to the Proposal alone and cumulatively

Pollutant	TSP		PM_{10}		$PM_{2.5}$		Dust deposition	
Averaging period	Annual							
	Assessment criteria							
	Increment	*Cumulative*	*Increment*	*Cumulative*	*Increment*	*Cumulative*	*Increment*	*Cumulative*
Receptor IDs	*-*	*90 µg/m³*	*-*	*25 µg/m³*	*-*	*8 µg/m³*	*2 g/m²/month*	*4 g/m²/month*
1	3.3	38	1.3	15	0.2	6	0.28	2.4
2	0.5	35	0.2	14	0.0	6	0.04	2.1
3	1.2	36	2.0	16	0.3	6	0.10	2.2
4	0.5	35	0.3	14	0.1	6	0.04	2.1
5	0.2	35	0.2	14	0.0	6	0.02	2.1
6	0.2	35	0.2	14	0.0	6	0.02	2.1
7	0.2	35	0.2	14	0.0	6	0.02	2.1
8	0.2	35	0.6	14	0.1	6	0.02	2.1
9	0.4	35	0.9	15	0.1	6	0.03	2.1
10	0.8	35	0.5	14	0.1	6	0.07	2.2
11	0.9	35	0.8	15	0.1	6	0.07	2.2
12	0.9	35	0.7	15	0.1	6	0.07	2.2
13	0.9	35	2.8	17	0.5	6	0.07	2.2
14	1.0	35	1.1	15	0.2	6	0.08	2.2
15	1.2	36	2.7	16	0.5	6	0.09	2.2
16	1.1	36	1.1	15	0.2	6	0.09	2.2
17	0.8	35	3.2	17	0.6	6	0.06	2.2
18	0.8	35	0.5	14	0.1	6	0.07	2.2
19	0.7	35	0.4	14	0.1	6	0.06	2.2
20	0.4	35	0.6	14	0.1	6	0.03	2.1
21	0.3	35	0.5	14	0.1	6	0.03	2.1
22	0.3	35	0.5	14	0.1	6	0.02	2.1
23	0.3	35	1.9	16	0.4	6	0.02	2.1
24	0.4	35	1.7	15	0.3	6	0.03	2.1
25	0.3	35	0.7	15	0.1	6	0.02	2.1

Pollutant	**TSP**		**PM_{10}**		**$PM_{2.5}$**		**Dust deposition**	
Averaging period	**Annual**							
	Assessment criteria							
	Increment	*Cumulative*	*Increment*	*Cumulative*	*Increment*	*Cumulative*	*Increment*	*Cumulative*
Receptor IDs	*-*	*90 µg/m³*	*-*	*25 µg/m³*	*-*	*8 µg/m³*	*2 g/m²/month*	*4 g/m²/month*
26	0.3	35	0.3	14	0.0	6	0.02	2.1
27	0.2	35	0.4	14	0.1	6	0.02	2.1
28	0.2	35	0.3	14	0.1	6	0.02	2.1
29	0.2	35	0.2	14	0.0	6	0.02	2.1
30	0.2	35	0.2	14	0.0	6	0.02	2.1
31	0.3	35	1.6	15	0.3	6	0.02	2.1
32	0.3	35	0.2	14	0.0	6	0.02	2.1
33	0.3	35	0.4	14	0.1	6	0.02	2.1
34	0.8	35	3.4	17	0.7	6	0.05	2.2
35	0.8	35	0.4	14	0.1	6	0.08	2.2
36	1.4	36	1.1	15	0.2	6	0.12	2.2
37	2.0	36	3.7	17	0.6	6	0.16	2.3

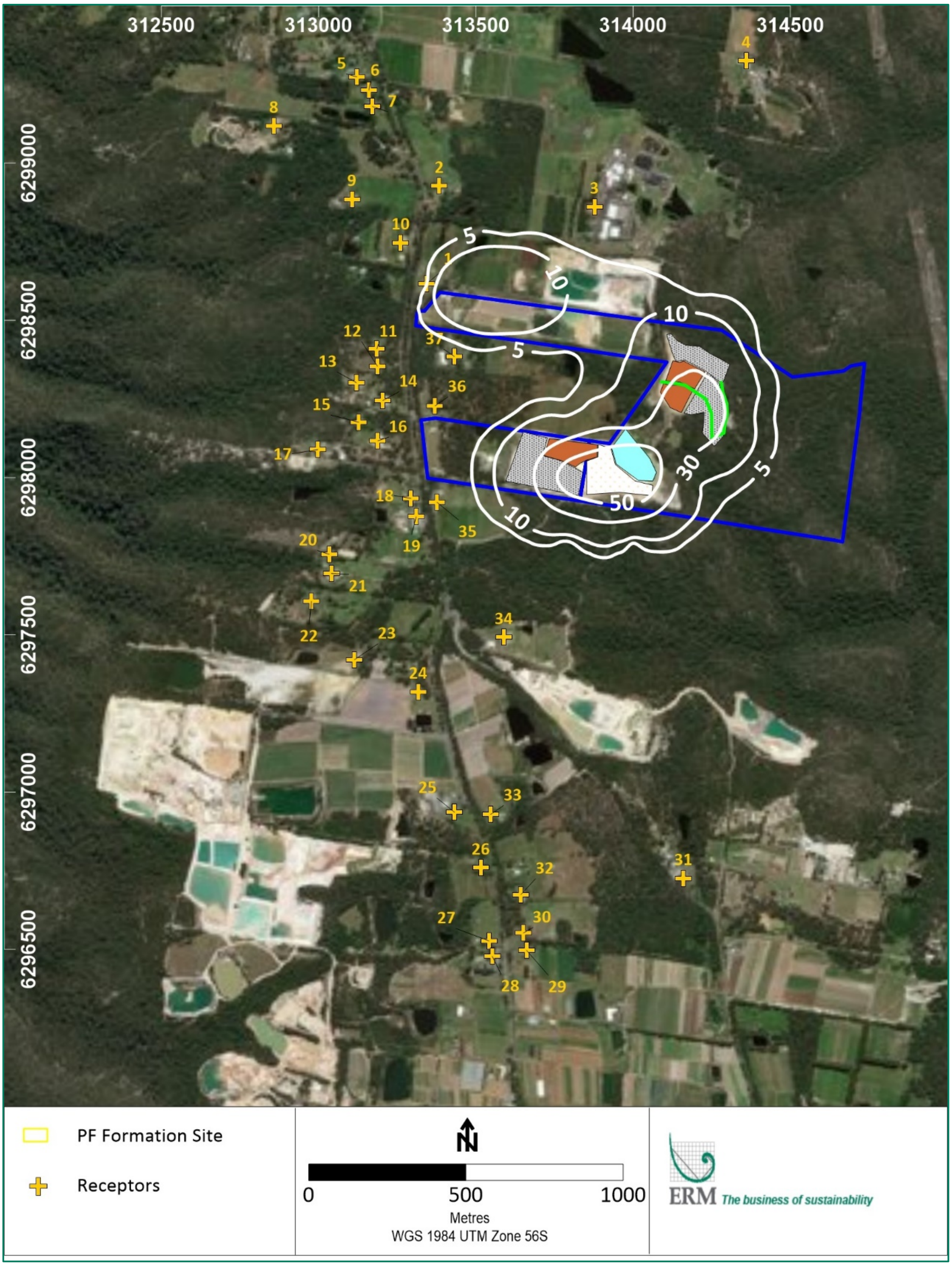


Figure 8-1 Predicted annual average TSP concentrations - Proposal alone (µg/m³)

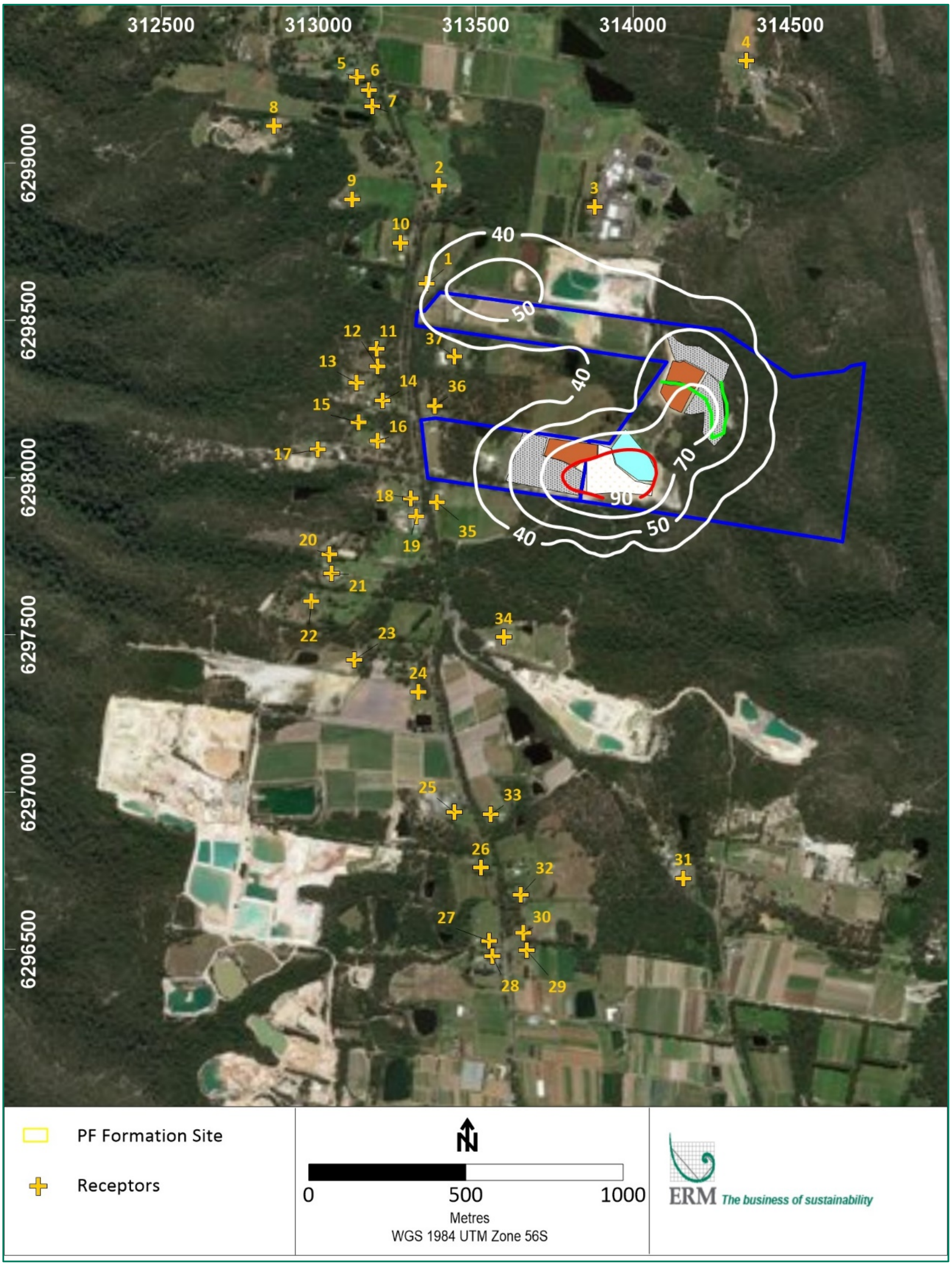


Figure 8-2 Predicted annual average TSP concentrations - cumulative (µg/m³)

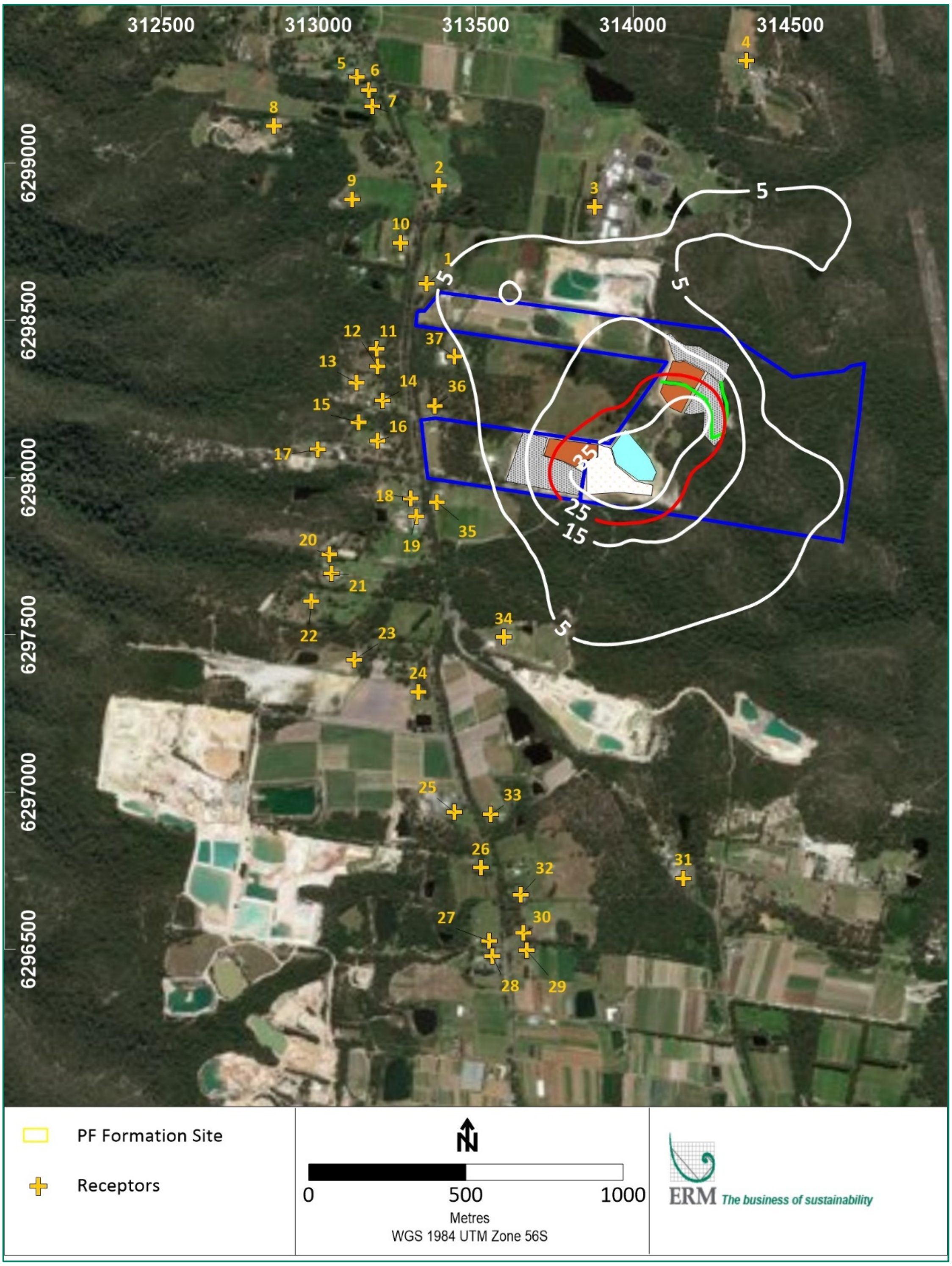


Figure 8-3 *Predicted annual average PM_{10} concentrations - Proposal alone ($\mu g/m^3$)*

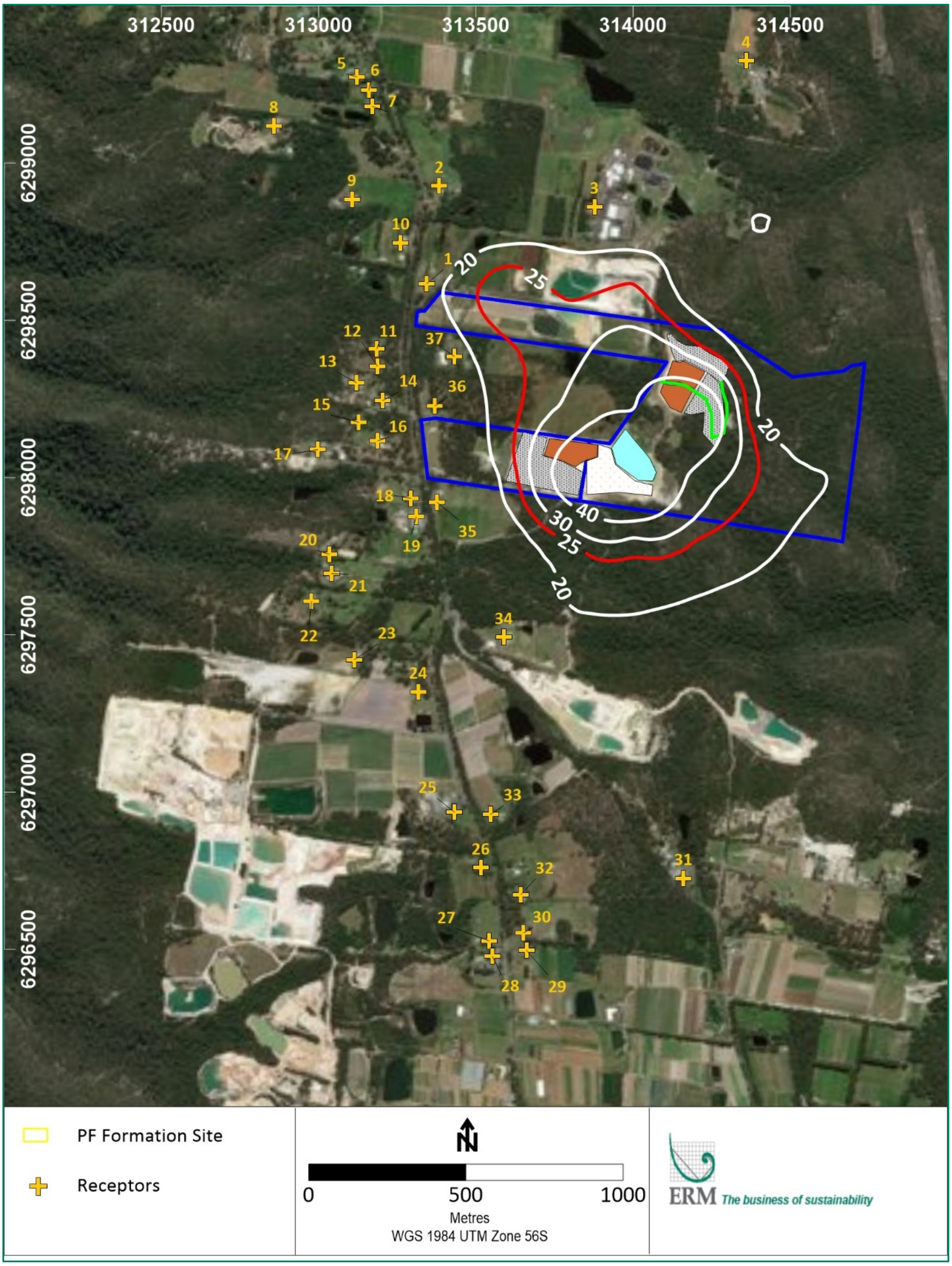


Figure 8-4 *Predicted annual average PM_{10} concentrations - cumulative (µg/m^3)*

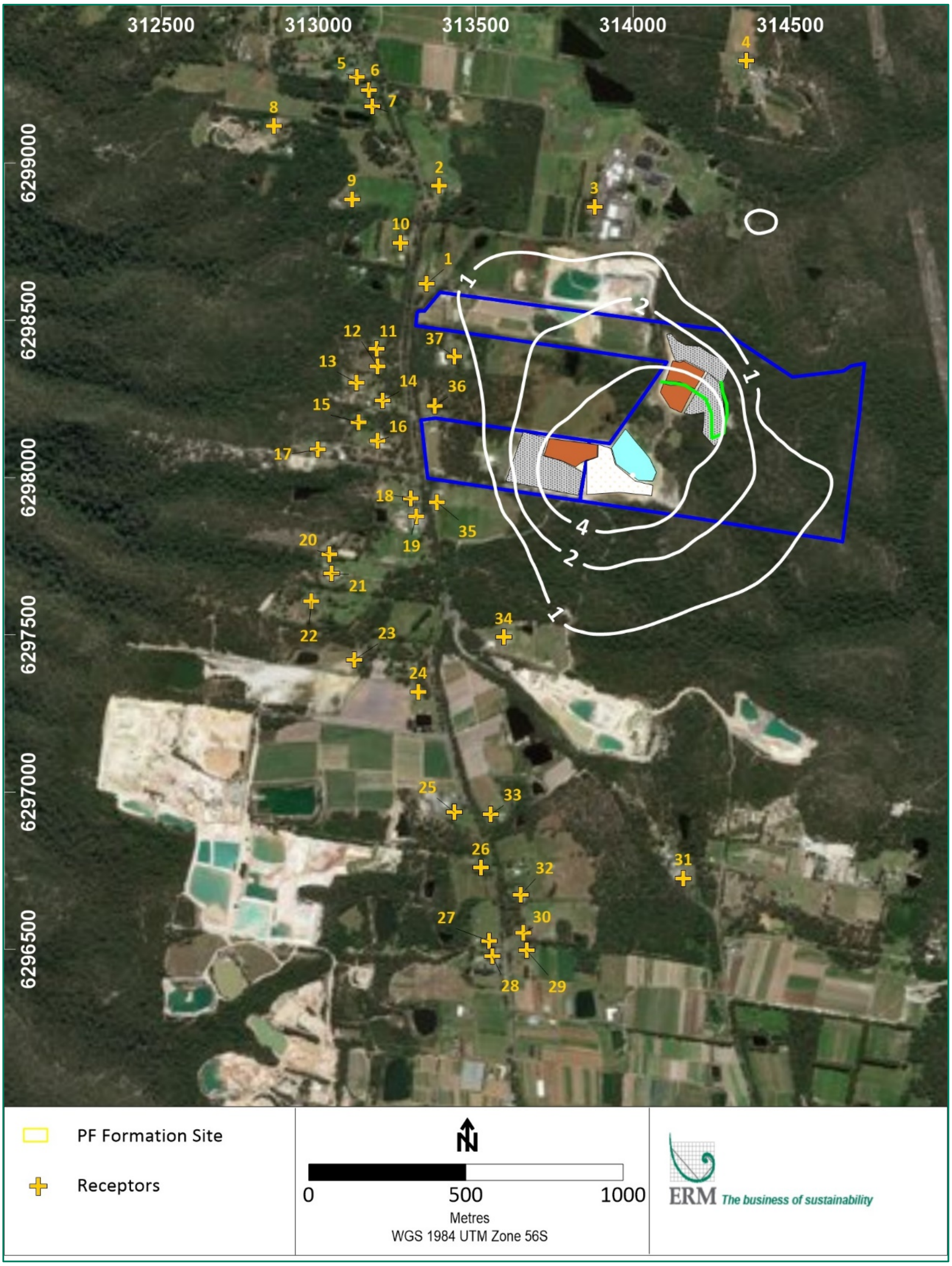


Figure 8-5 *Predicted annual average $PM_{2.5}$ concentrations - Proposal alone (µg/m³)*

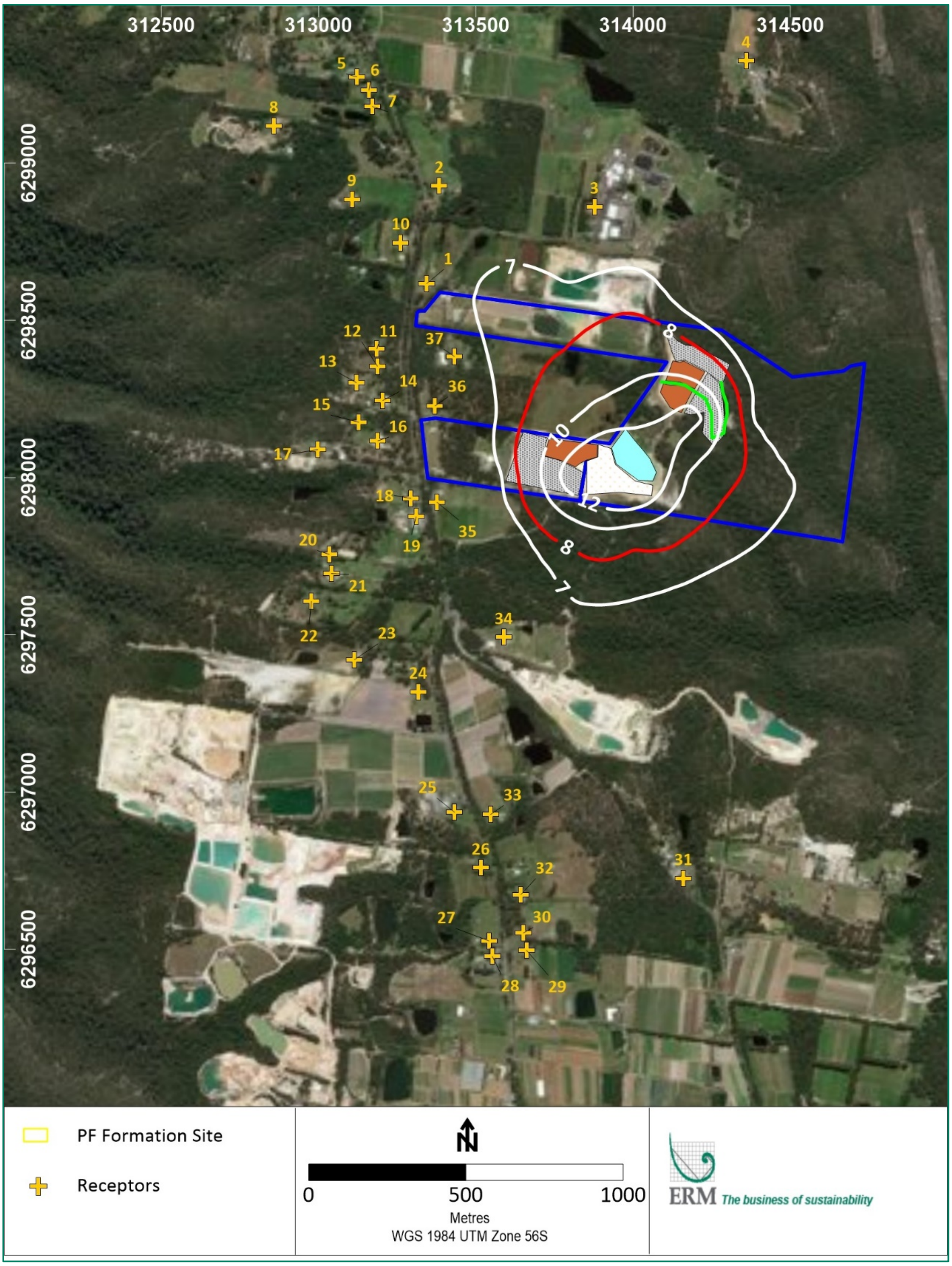


Figure 8-6 *Predicted annual average $PM_{2.5}$ concentrations - cumulative ($\mu g/m^3$)*

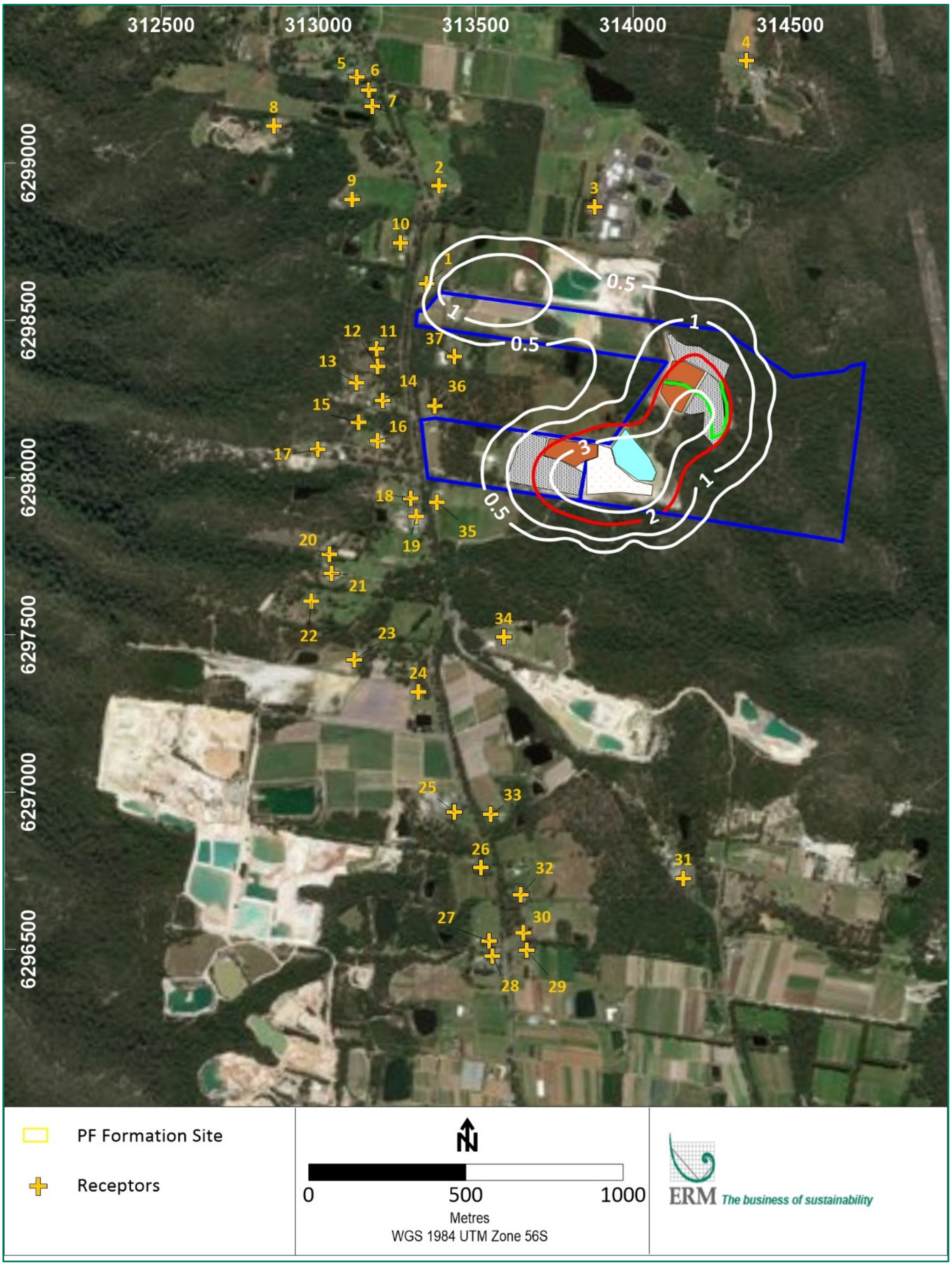


Figure 8-7 *Predicted annual average dust deposition levels – Proposal alone (g/m²/month)*

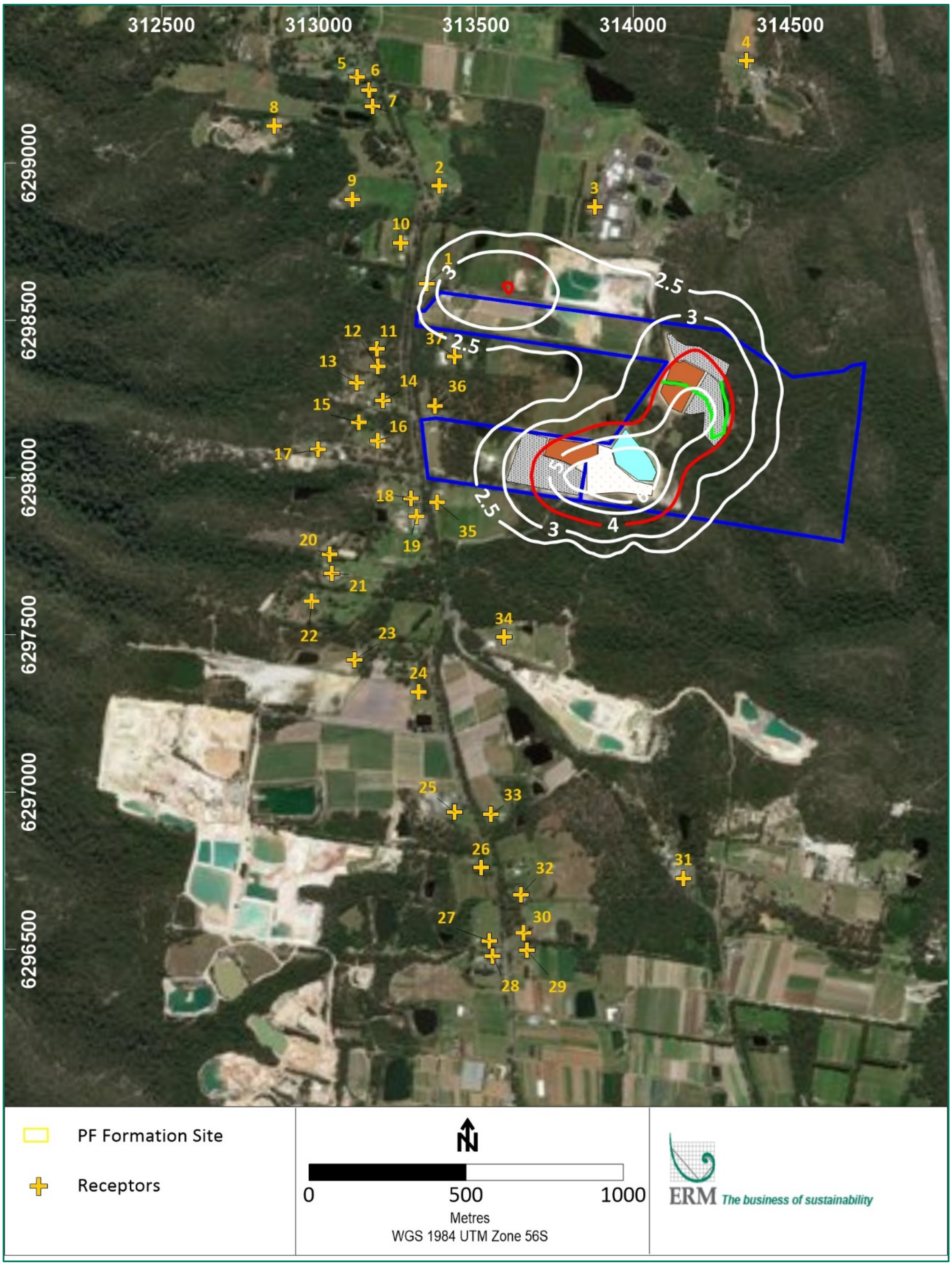


Figure 8-8 *Predicted annual average dust deposition levels –cumulative (g/m²/month)*

8.3 24-hour Average Concentrations

8.3.1 Introduction

It is important to note the difficulty in accurately predicting both the Proposal-only contribution, and the cumulative, maximum 24-hour average concentrations. This is due to a combination of the limitations of the modelling, day-to-day variability in existing ambient dust levels, and the spatial and temporal variation in any other anthropogenic activity in the vicinity e.g. agricultural activity, bushfires, and other dust-generating activity in the future. As the existing air quality data showed (see Section 5.3), the worst-case 24-hour PM10 concentrations measured at Maroota Public School have been strongly influenced by other sources in the area, such as bushfires and dust storms, which are essentially unpredictable.

The following sections present maximum 24-hour average predictions for PM10 and PM2.5 due to the Proposal alone and cumulatively.

8.3.2 24-Hour Average PM_{10}

Table 8-2 presents the maximum predicted 24-hour average PM10 concentrations due to the Proposal alone and cumulatively.

The cumulative concentrations were calculated by adding the predicted 24-hour average concentration due to the Proposal, to the corresponding concentration measured at Maroota Public School on the same day for the representative year (2017).

Contour plots of the maximum predicted 24-hour average PM10 concentrations due to the Proposal alone are presented in Figure 8-9.

There was one day during 2017 when the 24-hour average PM10 concentrations at Maroota Public School exceeded 50 µg/m3 (see Section 5.3.1 for further details). As the maximum contribution from the Proposal alone does not occur on the same day as this, the maximum predicted cumulative concentration is the same at most of the receptors.

There are no predicted exceedances due to the Proposal alone or cumulatively of the cumulative criterion of 50 µg/m3.

Table 8-2 Maximum predicted 24-hour average PM_{10} concentrations due to the Proposal and cumulatively

Pollutant	PM_{10}				
Averaging period	Maximum 24-hour				
Receptor IDs	*Assessment criteria*		*No. of days > 50 µg/m³*		
	Increment	*Cumulative*			
Northing (m)	-	*50 µg/m³*	*Total no. of days > 50 µg/m³*	*Monitoring data no. of days > 50 µg/m³*	*No. of additional days > 50 µg/m³*
1	10	**51**	1	1	0
2	2	**51**	1	1	0
3	9	**51**	1	1	0
4	2	**51**	1	1	0
5	2	**51**	1	1	0
6	2	**51**	1	1	0
7	2	**51**	1	1	0
8	6	**51**	1	1	0
9	6	**51**	1	1	0
10	4	**51**	1	1	0
11	3	**51**	1	1	0
12	3	**51**	1	1	0
13	12	**51**	1	1	0
14	6	**51**	1	1	0
15	13	**51**	1	1	0
16	5	**51**	1	1	0
17	14	**51**	1	1	0
18	3	**51**	1	1	0
19	3	**51**	1	1	0
20	5	**51**	1	1	0
21	4	**51**	1	1	0
22	4	**51**	1	1	0
23	24	**51**	1	1	0
24	13	**51**	1	1	0
25	5	**51**	1	1	0
26	3	**51**	1	1	0
27	4	**51**	1	1	0
28	3	**51**	1	1	0
29	2	**51**	1	1	0
30	2	**51**	1	1	0
31	14	**51**	1	1	0
32	2	**51**	1	1	0
33	4	**51**	1	1	0
34	23	**51**	1	1	0
35	3	**51**	1	1	0
36	5	**51**	1	1	0
37	15	**51**	1	1	0

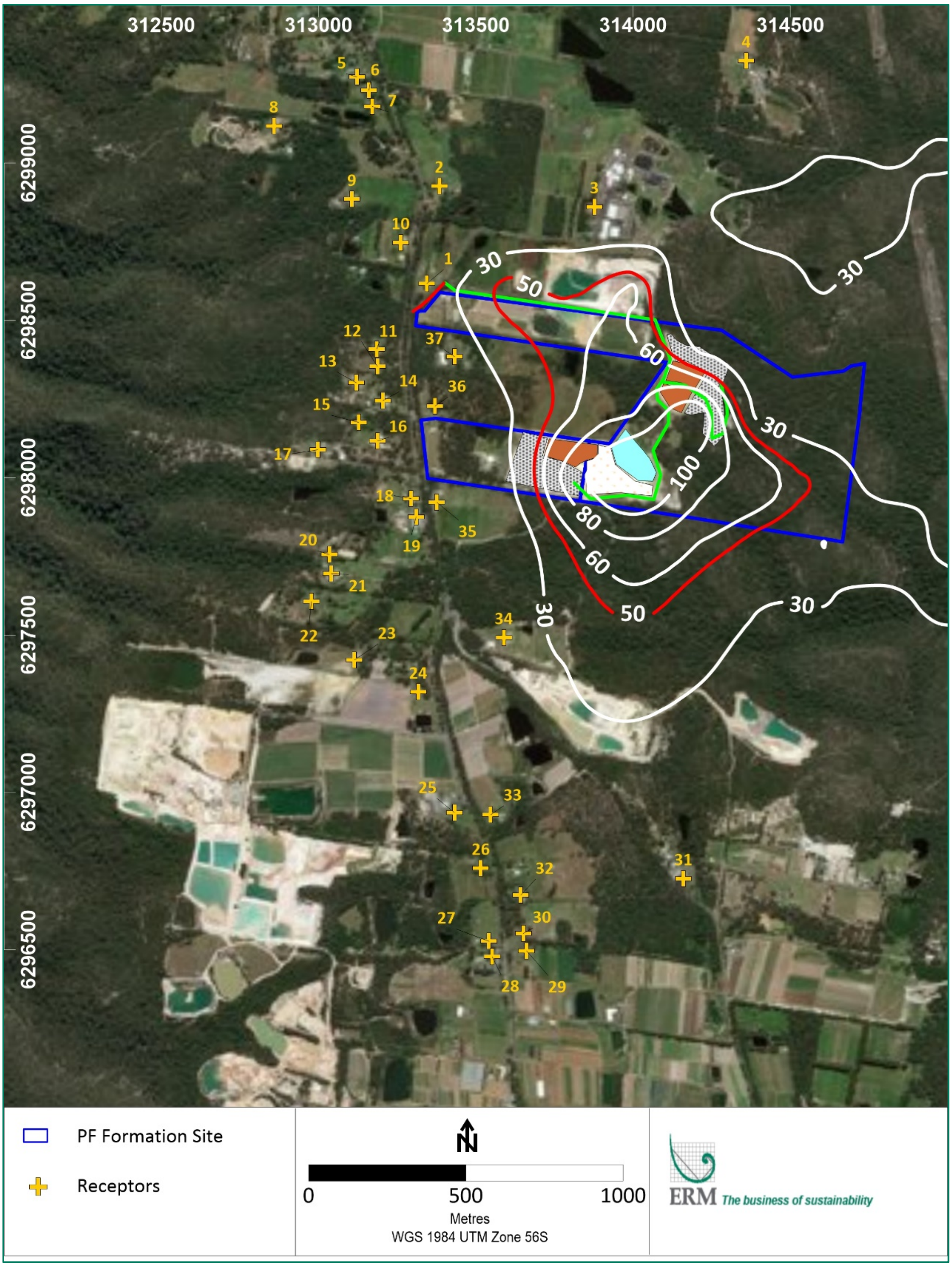


Figure 8-9 *Maximum predicted 24-hour average PM_{10} concentrations – Proposal only*

8.3.3 24-Hour Average $PM_{2.5}$

Table 8-3 presents the maximum predicted 24-hour average PM2.5 concentrations due to the Proposal alone and cumulatively.

The cumulative concentrations were calculated by adding the predicted 24-hour average concentration due to the Proposal-alone, to the corresponding concentration determined by applying the PM2.5:PM10 ratio of 0.41 (see Section 5.3.2) to the measured PM10 concentrations at Maroota Public School on the same day for the representative year (2017).

Contour plots of the maximum predicted 24-hour average PM2.5 concentrations due to the Proposal alone are presented in Figure 8-10.

There are no predicted exceedances due to the Proposal alone or cumulatively of the criterion of 25 µg/m3.

Table 8-3 Maximum predicted 24-hour average $PM_{2.5}$ concentrations due to the Proposal and cumulatively

Pollutant	$PM_{2.5}$				
Averaging period	Maximum 24-hour				
Receptor IDs	*Assessment criteria*		*No. of days > 25 µg/m³*		
	Increment	*Cumulative*			
Northing (m)	-	*25 µg/m³*	*Total no. of days > 25 µg/m³*	*Monitoring data no. of days > 25 µg/m³*	*No. of additional days > 25 µg/m³*
1	1	21	0	0	0
2	1	21	0	0	0
3	2	21	0	0	0
4	1	21	0	0	0
5	0	21	0	0	0
6	0	21	0	0	0
7	0	21	0	0	0
8	1	21	0	0	0
9	1	21	0	0	0
10	1	21	0	0	0
11	1	21	0	0	0
12	1	21	0	0	0
13	4	21	0	0	0
14	2	21	0	0	0
15	3	21	0	0	0
16	1	21	0	0	0
17	3	21	0	0	0
18	1	21	0	0	0
19	1	21	0	0	0
20	1	21	0	0	0
21	1	21	0	0	0
22	1	21	0	0	0
23	8	21	0	0	0
24	3	21	0	0	0
25	1	21	0	0	0
26	1	21	0	0	0
27	1	21	0	0	0
28	1	21	0	0	0
29	1	21	0	0	0
30	1	21	0	0	0
31	5	21	0	0	0
32	1	21	0	0	0
33	1	21	0	0	0
34	10	21	0	0	0
35	1	21	0	0	0
36	2	21	0	0	0
37	3	21	0	0	0

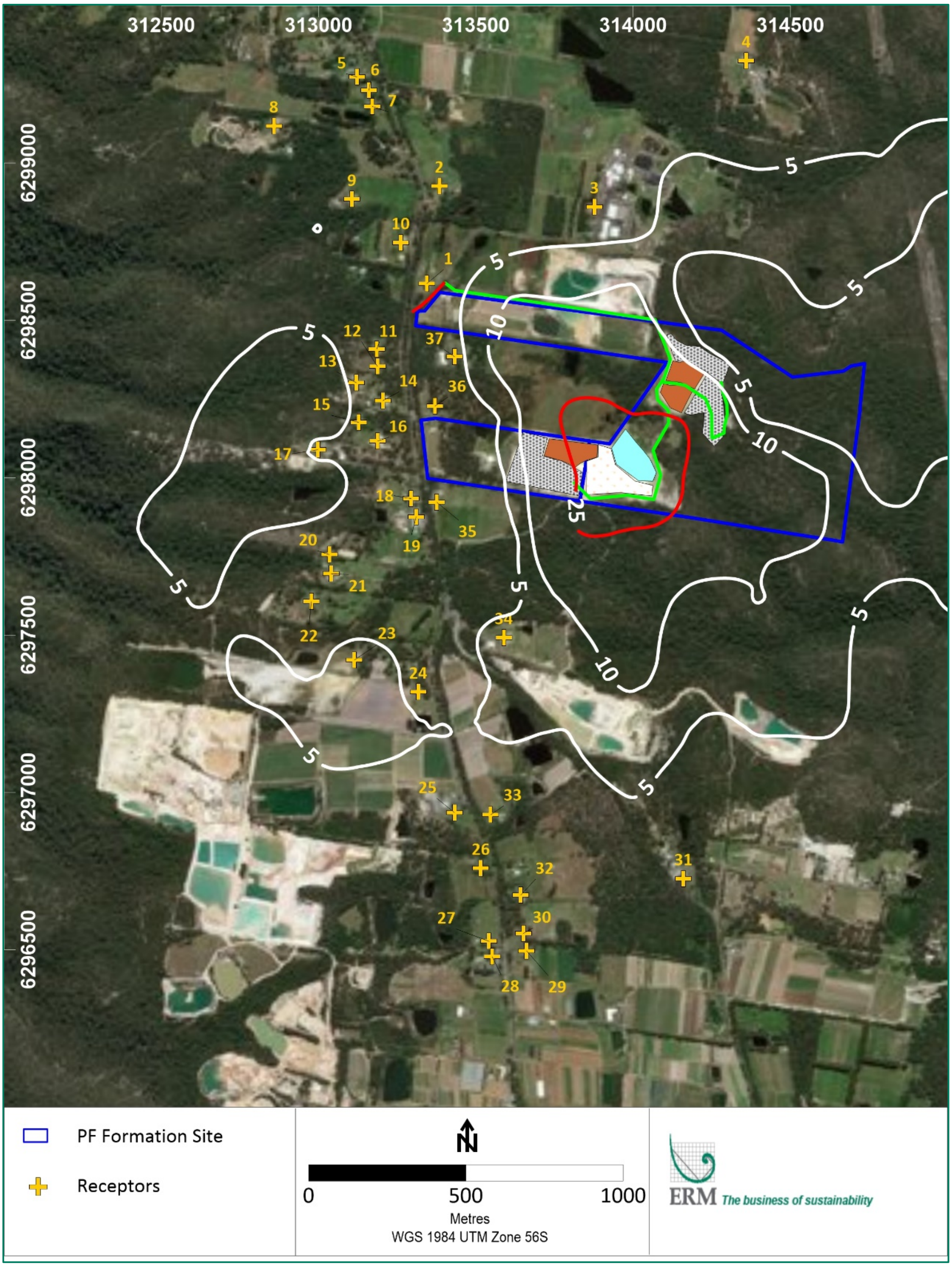


Figure 8-10 *Maximum predicted 24-hour average $PM_{2.5}$ concentrations – Proposal only*

9. CONCLUSION

ERM has completed an air quality assessment for PF Formation Pty Ltd for the proposed modification of the existing sand quarry at Old Northern Road in Maroota NSW.

A worst-case operational stage has been modelled based on proposed maximum annual production with concurrent activity in both Pit 15 and the two areas of Pit 5.

The results of the modelling indicate that the predicted annual average PM_{10}, $PM_{2.5}$, TSP and dust deposition at the closest sensitive receivers due to both the Proposal alone and cumulatively all comply with the impact assessment criteria.

When considering 24-hour averages, there are no predicted exceedances of the relevant assessment criteria for PM_{10} or $PM_{2.5}$ (either due to both the Proposal alone or cumulatively).

It is important to note that dispersion models are not 100% accurate but are a tool which uses the best-available science to guide policy making decisions in reviewing the potential air quality impacts of a proposed source, as no practical alternative exists.

10. REFERENCES

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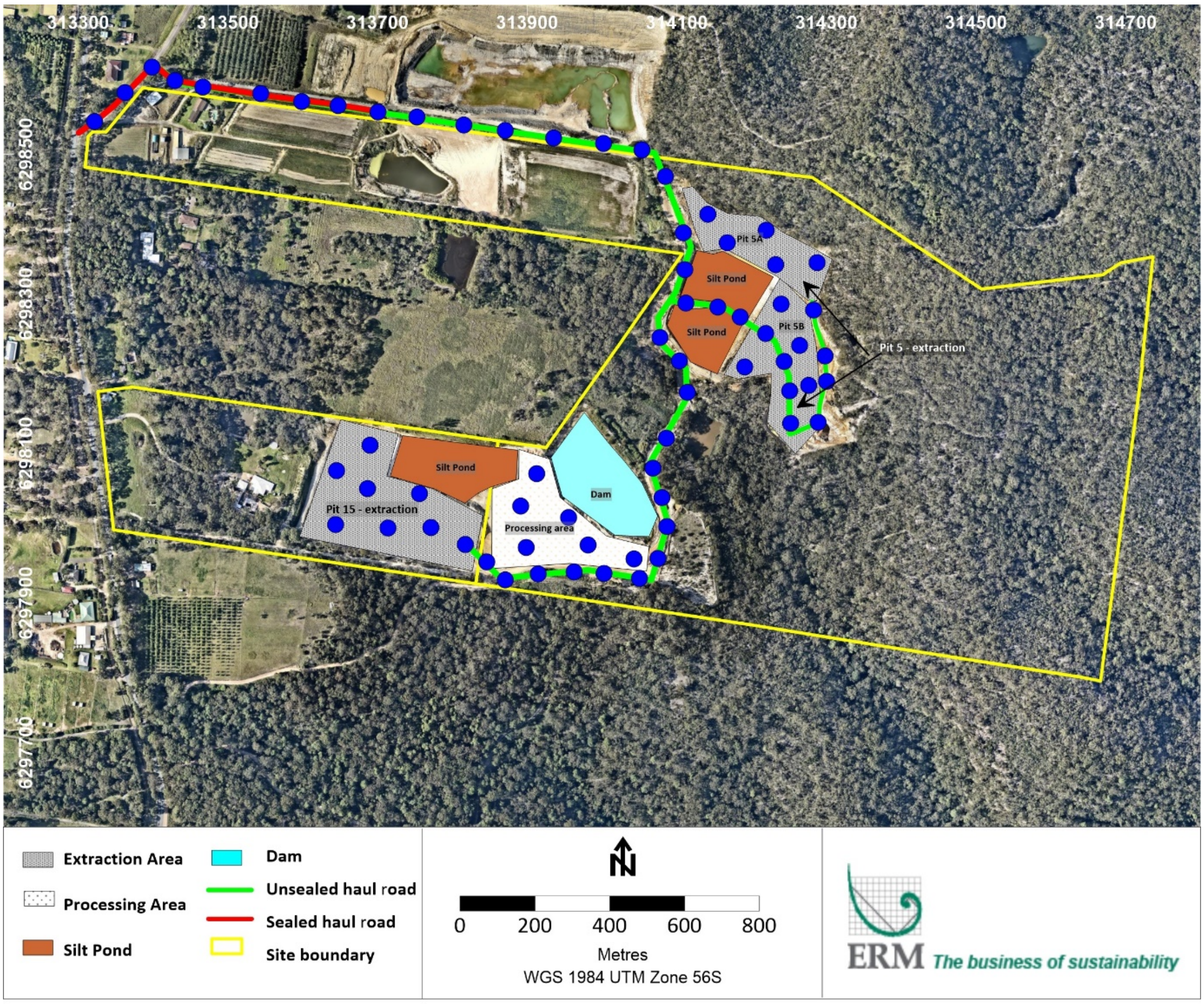
APPENDIX A MODEL SET UP

Meteorology				
Meteorological data for Surface (Samson) File	Maroota Public School Meteorological Station • Air temperature • Relative Humidity • Wind speed • Wind direction • Station Pressure TAPM: • Cloud cover • Cloud height			
Land Use	• Cultivated Land (Albedo – 0.28, Bowen ratio – 0.75 and Surface roughness – 0.0725)			
AERMET PFL	Upper Air estimator			
Year of analysis	January 2017 - December 2017			
Model Set up				
South-west corner of domain (easting, northing)	309500, 6291700			
MGA coordinate zone	56 H			
Grid domain size	5.6 km x 6.8 km			
Grid spacing	200 m			
Number of grid points	29 x 35			
Terrain data	SRTM3 at 30m resolution			
Rural/Urban Mode	Rural			
Particle parameters				
Particle type	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Dust deposition**
Particle Method	Method 1	Method 1	Method 1	Selected
Particle diameter (microns)	17	5	1	17
Mass Fraction	1	1	1	1
Particle Density	2.5	2.5	2.5	2.5
Dry depletion	Selected	Selected	Selected	Selected

APPENDIX B SOURCE LOCATIONS AND EMISSION INVENTORIES

The location of the sources for the modelling are as shown below:



TSP Emission Inventory

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Control	Units	Assumed control
Pit 5A																		
Dozer clearing topsoil and breaking up sandstone) - Pit 5A	1,791	867	h/y	4.1	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5A	6	62,500	t/y	0.00010	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 5A extraction area to Raw Material Stockpile at Processing Area (unsealed)	5,212	62,500	t/y	0.334	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	2.1	km/return trip	5.73	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	6	62,500	t/y	0.000	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Pit 5B																		
Dozer clearing topsoil and breaking up sandstone) - Pit 5B	1,791	867	h/y	4.1	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5B	6	62,500	t/y	0.00010	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 5B extraction area to Raw Material Stockpile at Processing Area	3,644	62,500	t/y	0.233	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	1.5	km/return trip	5.73	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	6	62,500	t/y	0.000	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Pit 15																		
Dozer clearing topsoil and breaking up sandstone) - Pit 15	1,791	867	h/y	4.1	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 15	12	125,000	t/y	0.00010	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 15 extraction area to Raw Material Stockpile at Processing Area	4,537	125,000	t/y	0.145	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	0.9	km/return trip	5.73	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	12	125,000	t/y	0.000	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Processing																		
Loading from Raw Material Stockpile to Screen	25	250,000	t/y	0.0001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Screening (uncontrolled)	3,125	250,000	t/y	0.01250	kg/t													
Unloading from Screen to Product stockpile	25	250,000	t/y	0.0001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Transfer from (Screen to Crusher) [conveyor transfer point]	1	25,000	t/y	0.0001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)							75	% control	Watering Level 2 (>2 L/m2/h)
Crushing (uncontrolled)	488	25,000	t/y	0.0195	kg/t													
Unloading from Crusher to Washplant	1	12,500	t/y	0.00010	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Wet Processing (<u>no expected emissions</u>)	-																	
Transfer to product stockpile	0	12,500	t/y	0.000	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)							75	% control	Watering Level 2 (>2 L/m2/h)
Product Sand																		
Loading sand from Product Stockpile to haul trucks	33	250,000	t/y	0.000	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	6.5	moisture content (%)									
Hauling out of Site (unsealed)	27,318	250,000	t/y	0.437	kg/t	30	t/load	31	Vehicle mean mass (t)	2.852	km/return trip	4.60	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Hauling out of site (sealed)	114	250,000	t/y	0.000	kg/t	30	t/load	31	Vehicle mean mass (t)	0.266	km/return trip	0.05	kg/VKT	0.4	g/m2 silt loading			
Wind Erosion																		
WE - Extraction Area (Pit 5A)	978	1.2	ha	850	kg/ha/y													
WE - Extraction Area (Pit 5B)	1,330	1.6	ha	850	kg/ha/y													
WE - Extraction Area (Pit 15)	2,285	2.7	ha	850	kg/ha/y													
WE - Processing Area including Stockpile	1,442	1.8	ha	850	kg/ha/y											50	% control	Water sprays on stockpile applied to 10% of area on
TOTAL TSP EMISSIONS	**55,979**																	

PM_{10} Emission Inventory

ACTIVITY	PM_{10} (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Control	Units	Asumed Control
Pit 5A																		
Dozer clearing topsoil and breaking up sandstone) - Pit 5A	417	867	h/y	1.0	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5A	3	62,500	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 5A extraction area to Raw Material Stockpile at Processing Area (unsealed)	1,646	62,500	t/y	0.105	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	2.1	km/return trip	1.81	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	3	62,500	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Pit 5B																		
Dozer clearing topsoil and breaking up sandstone) - Pit 5B	417	867	h/y	1.0	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5B	3	62,500	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 5B extraction area to Raw Material Stockpile at Processing Area	1,150	62,500	t/y	0.074	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	1.5	km/return trip	1.81	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	3	62,500	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Pit 15																		
Dozer clearing topsoil and breaking up sandstone) - Pit 15	417	867	h/y	1.0	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 15	6	125,000	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 15 extraction area to Raw Material Stockpile at Processing Area	1,432	125,000	t/y	0.046	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	0.9	km/return trip	1.81	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	6	125,000	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Processing																		
Loading from Raw Material Stockpile to Screen	12	250,000	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Screening (uncontrolled)	1,075	250,000	t/y	0.00430	kg/t													
Unloading from Screen to Product stockpile	12	250,000	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Transfer from (Screen to Crusher) [conveyor transfer point]	0	25,000	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)							75	% control	Watering Level 2 (>2 L/m2/h)
Crushing (uncontrolled)	188	25,000	t/y	0.0075	kg/t													
Unloading from Crusher to Washplant	1	12,500	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Wet Processing (<u>no expected emissions</u>)	-																	
Transfer to product stockpile	0	12,500	t/y	0.00005	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)							75	% control	Watering Level 2 (>2 L/m2/h)
Product Sand																		
Loading sand from Product Stockpile to haul trucks	16	250,000	t/y	0.0001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	6.5	moisture content (%)									
Hauling out of Site (unsealed)	8,624	250,000	t/y	0.14	kg/t	30	t/load	31	Vehicle mean mass (t)	2.852	km/return trip	1.45	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Hauling out of site (sealed)	22	250,000	t/y	0.0001	kg/t	30	t/load	31	Vehicle mean mass (t)	0.266	km/return trip	0.01	kg/VKT	0.4	g/m2 silt loading			
Wind Erosion																		
WE - Extraction Area (Pit 5A)	489	1.2	ha	425	kg/ha/y													
WE - Extraction Area (Pit 5B)	665	1.6	ha	425	kg/ha/y													
WE - Extraction Area (Pit 15)	1,142	2.7	ha	425	kg/ha/y													
WE - Processing Area including Stockpile	721	1.8	ha	425	kg/ha/y											50	% control	Water sprays on stockpile applied to 10% of area only
TOTAL PM_{10} EMISSIONS	**18,468**																	

$PM_{2.5}$ Emission Inventory

ACTIVITY	$PM_{2.5}$(kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Control	Units	Asumed Control
Pit 5A																		
Dozer clearing topsoil and breaking up sandstone) - Pit 5A	188	867	h/y	0.4	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5A	0	62,500	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 5A extraction area to Raw Material Stockpile at Processing Area (unsealed)	165	62,500	t/y	0.011	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	2.1	km/return trip	0.18	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	0	62,500	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Pit 5B																		
Dozer clearing topsoil and breaking up sandstone) - Pit 5B	188	867	h/y	0.4	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 5B	0	62,500	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 5B extraction area to Raw Material Stockpile at Processing Area	115	62,500	t/y	0.007	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	1.5	km/return trip	0.18	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	0	62,500	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Pit 15																		
Dozer clearing topsoil and breaking up sandstone) - Pit 15	188	867	h/y	0.4	kg/h	14	silt content in %	8.0	moisture content (%)							50	% control	Keep travel routes and material moist
Excavator loading sandstone to trucks for transfer to Raw Material Stockpile - Pit 15	1	125,000	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Hauling from Pit 15 extraction area to Raw Material Stockpile at Processing Area	143	125,000	t/y	0.005	kg/t	36.3	t/load	50.5	Vehicle mean mass (t)	0.9	km/return trip	0.18	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Unloading to Raw Material Stockpile	1	125,000	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Processing																		
Loading from Raw Material Stockpile to Screen	2	250,000	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Screening (uncontrolled)	1,075	250,000	t/y	0.0043	kg/t													
Unloading from Screen to Product stockpile	2	250,000	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Transfer from (Screen to Crusher) [conveyor transfer point]	0	25,000	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)							75	% control	Watering Level 2 (>2 L/m2/h)
Crushing (uncontrolled)	188	25,000	t/y	0.0075	kg/t													
Unloading from Crusher to Washplant	0	12,500	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)									
Wet Processing (no expected emissions)	-																	
Transfer to product stockpile	0	12,500	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content (%)							75	% control	Watering Level 2 (>2 L/m2/h)
Product Sand																		
Loading sand from Product Stockpile to haul trucks	2	250,000	t/y	0.00001	kg/t	0.58	average of (wind speed/2.2)^1.3 in m/s	6.5	moisture content (%)									
Hauling out of Site (unsealed)	862	250,000	t/y	0.01	kg/t	30	t/load	31	Vehicle mean mass (t)	2.852	km/return trip	0.15	kg/VKT	14	% silt content	75	% control	Watering Level 2 (>2 L/m2/h)
Hauling out of site (sealed)	5	250,000	t/y	0.0000	kg/t	30	t/load	31	Vehicle mean mass (t)	0.266	km/return trip	0.002	kg/VKT	0.4	g/m2 silt loading			
Wind Erosion																		
WE - Extraction Area (Pit 5A)	73	1.2	ha	64	kg/ha/y													
WE - Extraction Area (Pit 5B)	100	1.6	ha	64	kg/ha/y													
WE - Extraction Area (Pit 15)	171	2.7	ha	64	kg/ha/y													
WE - Processing Area including Stockpile	108	1.8	ha	64	kg/ha/y											50	% control	Water sprays on stockpile applied to 10% of area only
TOTAL $PM_{2.5}$ EMISSIONS	**3,579**																	

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