Appendix 14

Air Quality Impact Assessment

ACOUSTICS AND AIR

HODGSON QUARRY PRODUCTS
SAND EXTRACTION
ROBERTS ROAD, MAROOTA

AIR QUALITY IMPACT ASSESSMENT

REPORT NO. 14229
VERSION B

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PREPARED FOR

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TABLE OF CONTENTS

APPENDIX A – Air Quality Management Plan

APPENDIX B – Emissions Inventory

APPENDIX C – PM_{10} Contour Plots

GLOSSARY OF AIR QUALITY TERMS

Air Pollution – The presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects.

Air Quality Standards – The level of pollutants prescribed by regulations that are not to be exceeded during a given time in a defined area.

Air Toxics – Any air pollutant for which a national ambient air quality standard (NAAQS) does not exist (i.e. excluding ozone, carbon monoxide, PM-10, sulphur dioxide, nitrogen oxide) that may reasonably be anticipated to cause cancer; respiratory, cardiovascular, or developmental effects; reproductive dysfunctions, neurological disorders, heritable gene mutations, or other serious or irreversible chronic or acute health effects in humans.

Airborne Particulates – Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. Chemical composition of particulates varies widely, depending on location and time of year. Sources of airborne particulates include dust, emissions from industrial processes, combustion products from the burning of wood and coal, combustion products associated with motor vehicle or non-road engine exhausts, and reactions to gases in the atmosphere.

Area Source – Any source of air pollution that is released over a relatively small area, but which cannot be classified as a point source. Such sources may include vehicles and other small engines, small businesses and household activities, or biogenic sources, such as a forest that releases hydrocarbons, may be referred to as nonpoint source.

Concentration – The relative amount of a substance mixed with another substance. Examples are 5 ppm of carbon monoxide in air and 1 mg/l of iron in water.

Emission – Release of pollutants into the air from a source. We say sources emit pollutants.

Emission Factor – The relationship between the amount of pollution produced and the amount of raw material processed. For example, an emission factor for a blast furnace making iron would be the number of pounds of particulates per ton of raw materials.

Emission Inventory – A listing, by source, of the amount of air pollutants discharged into the atmosphere of a community; used to establish emission standards.

Flow Rate – The rate, expressed in gallons -or litres-per-hour, at which a fluid escapes from a hole or fissure in a tank. Such measurements are also made of liquid waste, effluent, and surface water movement.

Fugitive Emissions – Emissions not caught by a capture system.

Hydrocarbons (HC) – Chemical compounds that consist entirely of carbon and hydrogen.

Hydrogen Sulphide (H_2S) – Gas emitted during organic decomposition. Also, a by-product of oil refining and burning. Smells like rotten eggs and, in heavy concentration, can kill or cause illness.

Inhalable Particles – All dust capable of entering the human respiratory tract.

Nitric Oxide (NO) – A gas formed by combustion under high temperature and high pressure in an internal combustion engine. NO is converted by sunlight and photochemical processes in ambient air to nitrogen oxide. NO is a precursor of ground-level ozone pollution, or smog.

Nitrogen Dioxide (NO_2) – The result of nitric oxide combining with oxygen in the atmosphere; major component of photochemical smog.

Nitrogen Oxides (NO_x) – A criteria air polluant. Nitrogen oxides are produced from burning fuels, including gasoline and coal. Nitrogen oxides are smog formers, which react with volatile organic compounds to form smog. Nitrogen oxides are also major components of acid rain.

Mobile Sources – Moving objects that release pollution; mobile sources include cars, trucks, buses, planes, trains, motorcycles and gasoline-powered lawn mowers.

Particulates; Particulate Matter (PM-10) – A criteria air pollutant. Particulate matter includes dust, soot and other tiny bits of solid materials that are released into and move around in the air. Particulates are produced by many sources, including burning of diesel fuels by trucks and buses, incineration of garbage, mixing and application of fertilizers and pesticides, road construction, industrial processes such as steel making, mining operations, agricultural burning (field and slash burning), and operation of fireplaces and woodstoves. Particulate pollution can cause eye, nose and throat irritation and other health problems.

Parts Per Billion (ppb)/Parts Per Million (ppm) – Units commonly used to express contamination ratios, as in establishing the maximum permissible amount of a contaminant in water, land, or air.

PM10/PM2.5 – PM10 is measure of particles in the atmosphere with a diameter of less than 10 or equal to a nominal 10 micrometres. PM2.5 is a measure of smaller particles in the air.

Point Source – A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g. a pipe, ditch, ship, ore pit, factory smokestack.

Scrubber – An air pollution device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Source – Any place or object from which pollutants are released.

Stack – A chimney, smokestack, or vertical pipe that discharges used air.

Stationary Source – A place or object from which pollutants are released and which does not move around. Stationary sources include power plants, gas stations, incinerators, houses etc.

Total suspended particulates – TSP is the measure of all particles that are suspended in air.

Temperature Inversion – One of the weather conditions that are often associated with serious smog episodes in some portions of the country. In a temperature inversion, air does not rise because it is trapped near the ground by a layer of warmer air above it. Pollutants, especially smog and smog-forming chemicals, including volatile organic compounds, are trapped close to the ground. As people continue driving and sources other than motor vehicles continue to release smog-forming pollutants into the air, the smog level keeps getting worse.

1 INTRODUCTION

Hodgson Quarry Products Pty Ltd have operated a sand extraction facility at Roberts Road, Maroota since approval was granted in May 2000. The approval is due to expire in May 2015; however, the resource has not been completely mined. This report provides a quantitative assessment of potential dust impacts of the proposed continuation of current operations at the existing facility until 2025, based on air quality monitoring results and dispersion modelling predictions. There is no proposed change in the approved extraction quantities.

The facility is located adjacent to the Old Northern Road at Maroota in **Figure 1-1**.

Consideration has been given to the previous air quality assessments and Conditions of Approval.

Figure 1-1 Locality Map

2 SITE DESCRIPTION, CURRENT & PROPOSED OPERATION

2.1 The Existing Site

The existing consent allows 50 laden truck movement per day. The approved hours are 6.00am to 6.00pm, Monday to Friday and 6.00am to 1.00pm on Saturday with the extraction and processing commencing at 7.00am. Loading of trucks is only permitted in the period 6.00am to 7.00am on all days. **Figure 2-2** shows the site truck route in blue.

The present operation involves extraction of material, stockpiling and processing (screening). **Figure 2-1** shows the existing processing plant. **Figure 2-2** shows the current location of the processing plant in green. The extraction on site is conducted with an excavator to win material and two dump trucks to transport to the processing plant. The processing plant includes pumps, screens, conveyers, cyclones.

There is intermittent need to use a dozer to rip the friable sandstone which generally occurs at lower levels within the quarry (RL195 with the exception of the north-western corner where it occurs up to RL205) and also an additional excavator to build mounds, remove topsoil and construct the final landform.

Figure 2-1 Existing Processing Plant

2.2 Surrounding Land Use and Sensitive Receptors

The land surrounding the site is rural, although there are a number of other sand quarries in the area. The nearest existing residences are shown in **Figure 2-2**. Residences are located to the east and south on the corner of Roberts Road and Old Telegraph Road (R1) and on the opposite side of Roberts Road (R2 & R3). One residence (R4) is located near the corner of Old Northern Road and Roberts Road. Residences are also located to the north on either side of Old Northern Road, one on the eastern side (R6) and one on the western side (R5).

Maroota Public School is located approximately 750 metres north of the mine site on Old Northern Road.

Figure 2-2 Sensitive Receptors

2.3 Future Operations

For future operations the extraction plan and excavation process is split into six stages as shown in **Figure 2-3**. The facility will develop further to the west and north for Stages 1-5 over a period of approximately 8 years, at which time the processing plant would be relocated to allow for the extraction of Stage 6 to include a cell near the northern boundary and the material beneath where the existing processing plant is located. It is noted that the lateral extent of the extraction will not exceed that of the approved development.

Operations also require further excavation and the emplacement of material to create the final landform. This would occur intermittently on a campaign basis, typically 2 weeks at a time, possibly once or twice per year, such that equipment / staff not needed to meet the supply of raw material would be utilised to haul material to the emplacement areas and an excavator to form the final landform.

Figure 2-3 Future Stages

The proposed extraction process requires an excavator and truck at surface level to remove the topsoil and overburden which is initially formed into perimeter bunds and remaining material is stockpiled. From this point onwards, the excavator works occur from below the surface and is able to pull material down from above.

The excavator and truck are therefore only at surface level for a small proportion of time (less than 10%) and most of this time it is operating behind a 5m bund wall relative to the nearest boundary.

With the exception of cells with suffix A, there is a need to rip Hawkesbury sandstone in the cells. The extraction operation includes the use of a dozer to rip. This occurs at RL195, with the exception of cells 4C and 6B where it will occur as high as RL205.

The extracted material then gets transported using a dump truck to the processing feed area, where a front end loader manages a few stockpiles to blend the different grades of sand as required before tipping into the power screen. Depending on the haul distance, either one or two dump trucks return to and from the processing plant area.

3 AIR QUALITY ASSESSMENT CRITERIA

3.1 NSW Air Quality Criteria

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The following section identifies the applicable air quality criteria for the potential air emissions that would be generated by the project.

Air quality goals relevant to this study relate to particulate matter and are sourced from the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005).

The air quality goals for the relevant particulate matter pollutants relate to the total pollutant burden in the air and not just the pollutant from the project. As such, consideration of background pollutant levels is required when using these goals to assess potential impacts.

Table 3-1 shows the criteria for each of the relevant dust metrics considered in this assessment.

Table 3-1 NSW EPA Air Quality Impact Assessment Criteria

Pollutant	Averaging Period	Impact	Criterion
Total suspended particulates (TSP)	Annual	Total	90 µg/m^3
Particulate matter ≤ 10µm (PM_{10})	Annual	Total	30 µg/m^3
	24-hour	Incremental	50 µg/m^3
Deposited dust (DD)	Annual	Incremental	2 g/m^2/month
	Annual	Total	4 g/m^2/month

There are currently no air quality goals for particulate matter ≤ 2.5 µm ($PM_{2.5}$) for projects within NSW. However, the National Environmental Protection Council (NEPC) has developed an advisory National Environmental Protection Measure (NEPM) for $PM_{2.5}$, as follows:

- A maximum 24 hour average concentration of 25 µg/m^3; and,
- An annual average concentration of 8 µg/m^3.

The above goals for $PM_{2.5}$ concentrations are considered advisory only.

3.2 Existing Consent

The existing Development Consent has the following conditions that deal with air quality:

Air Quality Criteria

28. The Applicant shall take all practical steps to manage the development so that the ambient air quality goals for total suspended particulates (TSP) of 90 ug/m^3 (annual average) and the dust deposition goal of 4g/m^2 (annual average) are not exceeded as a result of the development, when measured at any monitoring location specified in the Air Quality Management Plan.

Air Quality Management Plan

29. The Applicant shall prepare and implement an Air Quality Management Plan as part of the EMP.

The Air Quality Management Plan shall:

(a) identify existing and potential sources of dust deposition, TSP and fine particulates (PM10 and PM2.5) and specify appropriate monitoring intervals and locations. The purpose of the monitoring is to evaluate, assess and report on these emissions and the ambient impacts with the objective of understanding the development's contribution to levels of dust deposition, TSP and fine particulates in ambient air around the site;
(b) provide a monitoring plan having regard to local meteorology and relevant Australian Standards, identifying the methodologies to be used, including justification for monitoring intervals, weather conditions, seasonal variations, selecting locations, periods and times of measurements;
(c) provide details of dust suppression measures for all sources of dust from the development, including a planting and watering regime to ensure that no more than 3 hectares of the site are exposed and active at any one time. The use of a polymer in the water to minimise dust impacts shall be investigated as part of this Plan;
(d) provide details of actions to ameliorate impacts if they exceed the relevant criteria; and
(e) provide the design of the reactive management system intended to reduce the day to day impacts of dust and fine particulates due to the development.

30. Activities occurring at the premises must be carried out in a manner that will minimise emissions of dust from the premises.

31. The Applicant shall cease offending work at such times when the operations are resulting in visible dust emissions blowing in a direction as to cross onto public roads or lands not owned by the Applicant.

32. The Applicant shall install, operate and maintain a sprinkler system to adequately water all cleared areas and stockpiles so as to minimise dust emissions to acceptable levels.

33. The Applicant shall ensure that all vehicular movements on unsealed areas are restricted to specific routes and that all vehicles within the subject site keep to a speed limit of 30km/h.

34. The Applicant shall ensure that trucks are covered when entering and leaving the premises carrying loads of potentially dust generating material.

The existing Air Quality Management Plan that deals with the Conditions of Consent is presented in Appendix A.

4 LOCAL AIR QUALITY & CURRENT AIR QUALITY IMPACTS

Air quality standards and goals refer to pollutant levels which include the contribution from specific projects and existing sources.

The Development Consent conditions and Air Quality Management Plan required that PM_{10} and dust deposition be monitored to manage dust from the site. PM_{10} and dust deposition has been monitored since sand extraction began on the site. The monitoring locations are shown in **Figure 4-1.**

Figure 4-1 Dust Deposition & High Volume Air Sampler Monitoring Locations

The Project area is predominantly agricultural and mining land, although areas to the east of the site and the National Park are well vegetated. Sources of particulate matter in the area would include traffic on unsealed roads, mining activities, local building and construction activities, animal grazing activities and to a lesser extent traffic on roads.

The PM_{10} and dust deposition levels measured around the mine are summarised in **Table 4-1** and **Table 4-2**, respectively.

Table 4-1 PM_{10} Monitoring Results for the Hodgson Quarry Products Pty Ltd Sand Extraction Facility at Roberts Road

Year	Month	PM_{10} monthly averages 24 hour maximum ($\mu g/m^3$)	
		NW HVAS	SE HVAS
2002	January	-	12
	February	-	12
	March	-	15
	April	-	16
	May	-	5
2008	April	18	33
	May	32	32
2011	November	14	14
	December	12	16
2012	January	4-	5
	February	< 2	< 2
	March	4	4
	April	< 2	4
	May	4	11
	June	11	7
	July	9	7
	August	8	11
	September	17	7
	October	15	16
	November	15	11
	December	6	6
2013	January	13	12
	February	22	17

Table 4-2 Dust Deposition Monitoring (g/m²/month) Results for the Hodgson Quarry Products Pty Ltd Sand Extraction Facility at Roberts Road

Annual Averages	D1 Gate	D2 South East Corner	D3 Bund Wall	D3(a) Bund Wall
2005	5.7	1.5	4.8	-
2006	0.9	0.6	1.6	-
2007	<0.6	<0.6	<0.6	-
2008	1.6	1.3	1.8	-
2009	2.1	1.7	2.8	-
2010	1.2	1.4	1.9	-
2011	0.8	1.1	1.6	-
2012	0.8	1.2	1.30	1.96
2013	2.1	1.1	-	1.68
2014	0.96	1.1	-	2.86

The PM_{10} levels and dust deposition levels monitored for the life of the sand extraction facility indicated compliance with the EPA recommended air quality criteria of 50 µg/m^3 and 4 g/m^2/month.

An exceedance of the dust deposition criterion of 4 g/m^2/month was recorded in 2005; however, the monitoring reports suggest this was atypical due to the extended monitoring time the gauges were subject to, which lead to a build-up of bio-mass in the samples collected.

Typically, PM_{10} levels are approximately less than 50 percent of the TSP levels. As TSP levels were not monitored, and assuming this proportionality, it can be concluded that the TSP criterion of 90 µg/m^3 was also complied with for the life of the sand extraction facility.

5 LOCAL CLIMATE & DISPERSION METEOROLOGY & POTENTIAL DUST IMPACTS

Long-term climatic data from the Bureau of Meteorology weather station at Richmond RAAF were analysed to characterise the local climate in the proximity of the Project. The Richmond RAAF station is located approximately 20km south-west of the Project.

Table 5-1 presents a summary of data from the Richmond RAAF weather station collected over an approximate 30-year period.

The data indicates that January is the hottest month with a mean maximum temperature of 30ºC and July is the coldest month with mean minimum temperature of 3.6ºC.

Humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9.00am humidity levels range from 58 per cent in October to 82 per cent in May. Mean 3.00pm humidity levels vary from 39 per cent in August to 53 per cent in June. Rainfall peaks during the summer months and declines during winter. The data shows February is the wettest month with an average rainfall of 122.9 mm over 8.4 days and July is the driest month with an average rainfall of 28.5 mm over 3.9 days.

Table 5-1 Monthly Climate Statistics Summary – Richmond RAAF

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean max. temperature (ºC)	30.0	29.0	26.8	23.9	20.7	17.9	17.6	19.8	22.9	25.1	26.7	28.5
Mean min. temperature (ºC)	17.6	17.7	15.6	11.5	7.5	5.1	3.6	4.4	8.0	10.9	14.1	15.9
Rainfall												
Rainfall (mm)	75.7	122.9	75.8	48.6	48.9	47.5	28.5	33.2	47.0	50.6	82.7	59.8
Mean No. of rain days (≥1mm)	7.5	8.4	7.9	5.9	5.5	5.6	3.9	3.5	4.5	5.7	7.9	6.4
9am Conditions												
Mean temperature (ºC)	22.1	21.3	19.1	17.0	13.1	10.0	8.9	11.4	15.4	18.3	19.2	20.9
Mean relative humidity (%)	72	78	80	76	82	83	80	69	63	58	68	68
Mean wind speed (km/h)	9.1	8.1	6.6	6.9	5.7	6.3	5.9	8.1	9.9	10.3	9.9	8.9
3pm Conditions												
Mean temperature (ºC)	28.5	27.4	25.8	23.0	19.7	17.0	16.5	18.7	21.5	23.5	25.2	27.5
Mean relative humidity (%)	47	52	52	49	53	53	48	39	39	40	46	44
Mean wind speed (km/h)	16.6	15.6	14.7	14.4	12.6	13.5	14.3	17.7	19.4	19.1	19.0	17.7

Source: Bureau of Meteorology, 2013

As the closest BOM metrological station is at Richmond RAAF, approximately 20km from the site, prognostic meteorological data was generated using The Air Pollution Model (TAPM), developed by the CSIRO to investigate site-specific wind conditions.

The site has a meteorological station; however, this is only used as a reactive dust management tool.

The prognostic modelling domain was centred at 33° 27′ S, 151° 0′ E and involved four nesting grids of 30 km, 10 km, 3 km and 1km with 25 vertical levels.

Observations of wind speed and direction from the BoM AWS at Richmond RAAF were assimilated into the TAPM model to refine details of local winds.

Windrose plots showing the distribution of wind direction and wind speed at Maroota for 2012 are presented for day, night and 24hour day in **Figure 5-1**, **Figure 5-2** and **Figure 5-3** respectively.

The prevailing wind directions for Maroota are presented **Table 5-2**.

Table 5-2 Predominant Maroota Season Wind Direction in the Day & Night

Season	Predominant Wind Direction	
	Day	**Night**
Autumn	North-easterly	North-easterly
Winter	South-westerly	North-westerly
Spring	Easterly	Northerly
Summer	Easterly	North-easterly

Figure 5-1 Windrose Plots – Maroota 2012 - Daytime

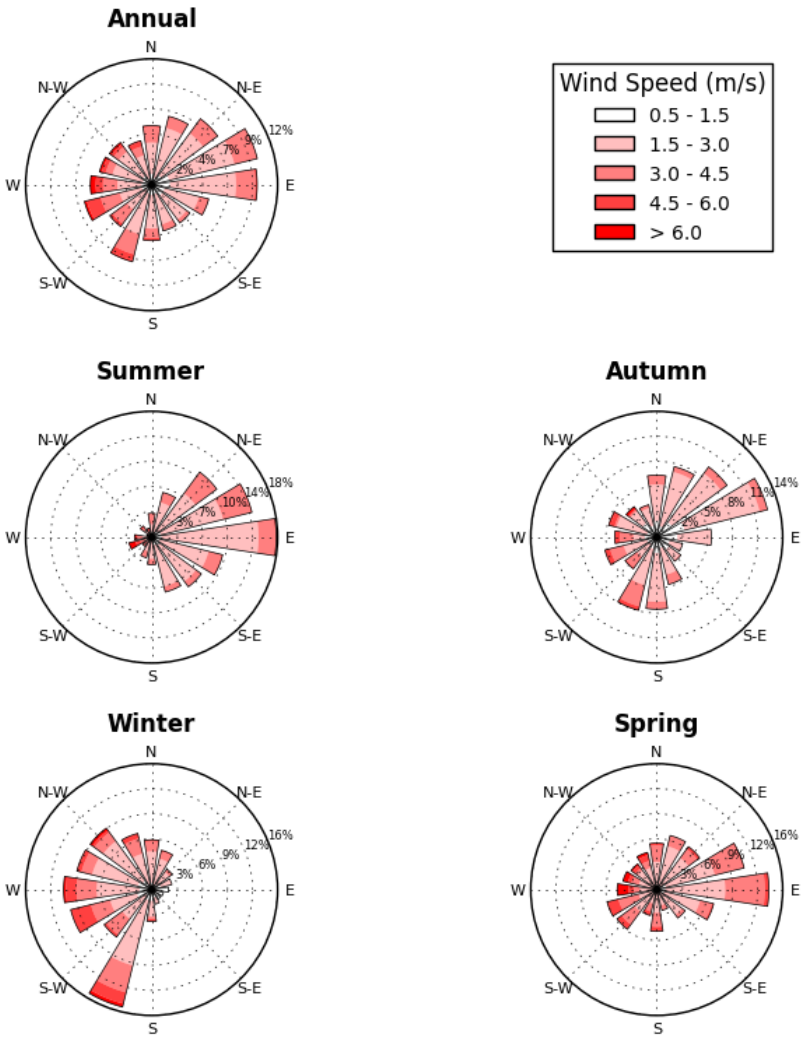


Figure 5-2 Windrose Plots – Maroota 2012 – Night Time

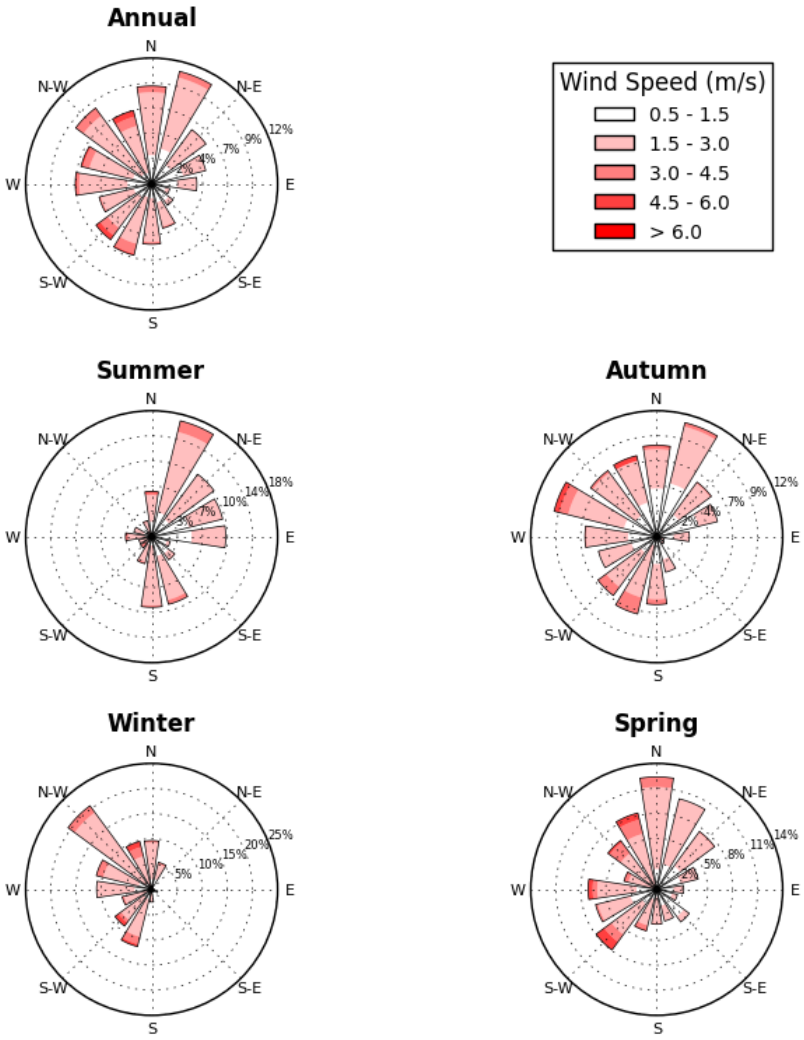
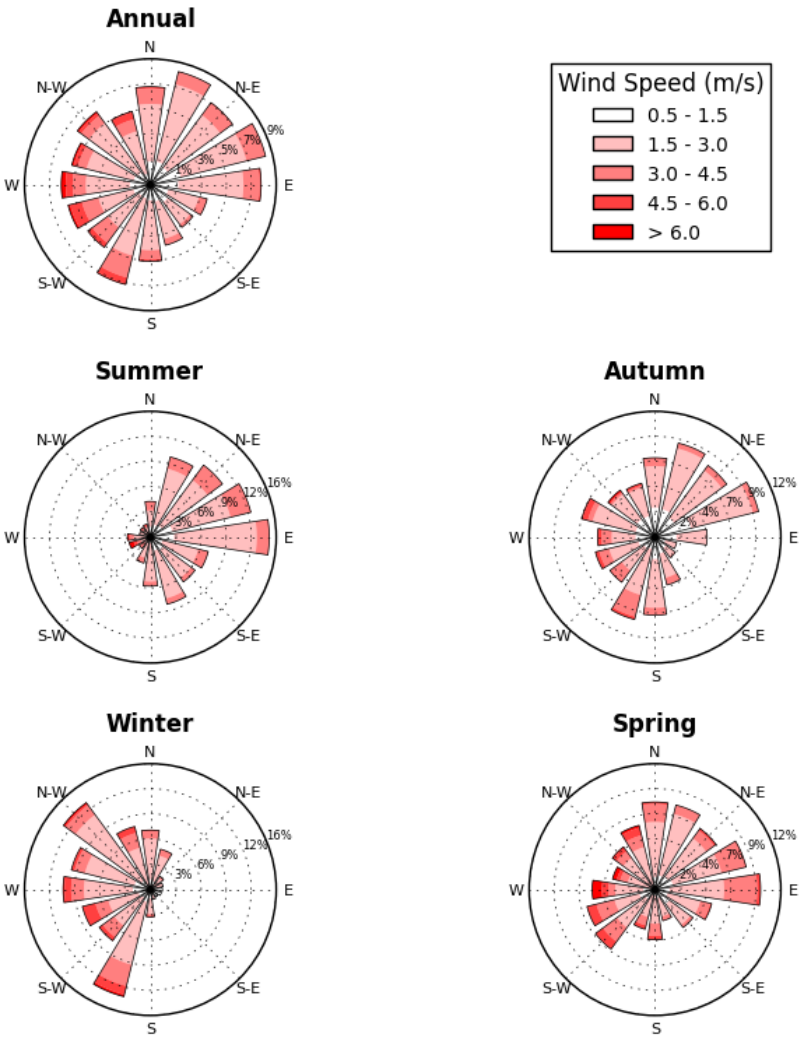


Figure 5-3 Windrose Plots – Maroota 2012 – Annual



6 MODELLING METHODOLOGY

6.1 Meteorological Modelling

6.1.1 TAPM

No meteorological observation data is available for the site. Therefore, site-specific meteorological data was generated through the use of a prognostic model. The prognostic model used was The Air Pollution Model (TAPM), developed and distributed by the Commonwealth Scientific and industrial Research Organisation (CSIRO).

TAPM is an incompressible, non-hydrostatic, primitive equations prognostic model with a terrain-following vertical coordinate for three-dimensional simulations. It predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of large scale meteorology provided by synoptic analyses. TAPM benefits from having access to databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature, and synoptic scale meteorological analyses for various regions around the world.

The prognostic modelling domain was centred at 33° 27′ S, 151° 0′ E and involved four nesting grids of 30 km, 10 km, 3 km and 1km with 25 vertical levels.

The TAPM model included assimilation of data collected at the Richmond RAAF AWS during the year 2012.

6.1.2 AERMET

The TAPM results, including predictions of wind speed, wind direction, temperature, humidity, cloud cover, solar radiation and rainfall, were used as inputs to AERMET – AERMOD's meteorological pre-processor. AERMET uses the TAPM data, along with land use data, to calculate mixing heights and velocity scaling parameters.

6.2 Dispersion Modelling

6.2.1 AERMOD

The dispersion model chosen for this assessment was AERMOD – the US EPA regulatory Gaussian plume air dispersion model.

AERMOD is a steady state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts. It includes treatment of both surface and elevated sources, and both simple and complex terrain.

6.2.2 Building Wake Effects

All emissions associated with this development were modelled using volume sources, which are not affected by building wakes.

7 EMISSIONS TO AIR

Dust emissions from the proposed Project have been estimated for all significant dust generating activities based on information provided by the client, using emission factors sourced from both locally developed and US EPA developed documentation. Total dust emissions from all significant dust generating activities for the Project are presented below. Detailed emission inventory and emission estimation calculations are presented in Appendix B.

Three extraction scenarios have been identified for assessment purposes. These scenarios are considered to represent the range of worst case future site operations. Extraction in the North West and South East corners of the site will bring activities closest to sensitive receptors in those areas, while moving the material processing area to the North East corner of the site will represent the worst case scenario for receptors in that vicinity.

7.1 North West Extraction

Estimated TSP and PM_{10} emissions during the North West extraction scenario are presented below in **Table 7-1**. The source locations adopted in the dispersion modelling for this scenario are shown in **Figure 7-1**.

Table 7-1 Emissions estimation – North West extraction

Activity	Emissions (kg/day)	
	TSP	PM_{10}
Dozer ripping face	13.34	1.99
Loading raw material into dump trucks	0.77	0.36
Dump truck unloading	1.15	0.55
Loading hopper	1.54	0.73
Screening	16.25	5.59
Unloading to stockpile	0.25	0.12
Loading processed material into trucks	1.18	0.56
Haul road - Outgoing	9.38	2.01
Haul road - Raw Material	7.65	1.64
Wind erosion - Extraction Area	2.40	1.20
Wind erosion - Processing Area	4.80	2.40
Total		
	58.73	**17.14**

Figure 7-1 Source locations - North West extraction

7.2 North East Processing

Estimated TSP and PM_{10} emissions during the North East processing scenario are presented below in **Table 7-2**. The source locations adopted in the dispersion modelling for this scenario are shown in **Figure 7-2**.

Table 7-2 Emissions estimation – North East processing

Activity	Emissions (kg/day)	
	TSP	PM_{10}
Dozer ripping face	13.34	1.99
Loading raw material into dump trucks	0.77	0.36
Dump truck unloading	1.15	0.55
Loading hopper	1.54	0.73
Screening	16.25	5.59
Unloading to stockpile	0.25	0.12
Loading processed material into trucks	1.18	0.56
Haul road - Outgoing	7.21	1.54
Haul road - Raw Material	5.89	1.26
Wind erosion - Extraction Area	2.40	1.20
Wind erosion - Processing Area	4.80	2.40
Total		
	54.80	**16.30**

Figure 7-2 Source locations - North East processing

7.3 South East Extraction

Estimated TSP and PM_{10} emissions during the North East extraction scenario are presented below in **Table 7-3**. The source locations adopted in the dispersion modelling for this scenario are shown in **Figure 7-3**.

Table 7-3 Emissions estimation – South East extraction

Activity	Emissions (kg/day)	
	TSP	PM_{10}
Dozer ripping face	13.34	1.99
Loading raw material into dump trucks	0.77	0.36
Dump truck unloading	1.15	0.55
Loading hopper	1.54	0.73
Screening	16.25	5.59
Unloading to stockpile	0.25	0.12
Loading processed material into trucks	1.18	0.56
Haul road - Outgoing	11.90	2.55
Haul road - Raw Material	9.72	2.08
Wind erosion - Extraction Area	2.40	1.20
Wind erosion - Processing Area	4.80	2.40
Total		
	63.31	**18.12**

Figure 7-3 Source locations - South East extraction

8 ASSESSMENT OF IMPACTS

The following section presents the results of dispersion modelling and assesses the potential for air quality impacts in accordance with the impact assessment criteria introduced in Section 3.1.

The calculation of total concentrations requires that the incremental impact, as predicted by the dispersion model, is added to the background concentration for each pollutant of interest. Most importantly, the background concentrations used to predict total impacts should not be influenced by the current site operations.

Based on the range of monitoring results presented in Section 4, the background PM_{10} ground level concentration in the area is approximately 10 µg/m^3.

Estimates of the annual average background TSP concentrations can be determined from a relationship between TSP and PM_{10}. This relationship assumes that PM_{10} accounts for approximately 40% of TSP. This relationship was established as part of a review of ambient monitoring data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (NSW Minerals Council, 2000).

Applying this relationship with the estimated background PM_{10} concentration gives an estimated background TSP concentration of 25 µg/m^3.

To estimate annual average dust deposition levels, a similar process to the TSP estimation method is used. This approach assumes that a TSP concentration of 90µg/m^3 will have an equivalent dust deposition value of 4g/m^2/month.

This relationship indicates a background annual average dust deposition of 1.1g/m^2/month for the area surrounding the project.

8.1 PM_{10} Impact Assessment

The maximum predicted incremental and total 24 hour average ground level concentrations of PM_{10} at each sensitive receptor are presented in **Table 8-1** and **Table 8-2**, respectively.

Table 8-1 24 hour average PM_{10} - incremental impact

Receptor	Ground Level Concentration (µg/m^3)		
	North West	North East	South East
R1	7	31	8
R2	18	39	17
R3	21	18	23
R4	5	7	17
R5	14	10	4
R6	10	6	5

Table 8-2 24 hour average PM_{10} - total impact

Receptor	Ground Level Concentration (µg/m³)			Criteria (µg/m³)	Complies?
	North West	North East	South East		
R1	17	41	18	50	Yes
R2	28	49	27	50	Yes
R3	31	28	33	50	Yes
R4	15	17	27	50	Yes
R5	24	20	14	50	Yes
R6	20	16	15	50	Yes

Review of **Table 8-2** indicates that the total 24 hour average PM_{10} concentrations comply with the impact assessment criterion of 50 µg/m³ at all sensitive receptors.

Contour plots of the incremental 24 hour average PM_{10} impacts due to each extraction scenario are presented in Appendix C.

The maximum predicted incremental and total annual average ground level concentrations of PM_{10} at each sensitive receptor are presented in **Table 8-3** and **Table 8-4**, respectively.

Table 8-3 Annual average PM_{10}– incremental impact

Receptor	Ground Level Concentration (µg/m³)		
	North West	North East	South East
R1	1	4	1
R2	1	5	2
R3	2	4	2
R4	1	1	4
R5	1	0	0
R6	1	0	0

Table 8-4 Annual average PM_{10}– total impact

Receptor	Ground Level Concentration (µg/m³)			Criteria (µg/m³)	Complies?
	North West	North East	South East		
R1	11	14	11	30	Yes
R2	11	15	12	30	Yes
R3	12	14	12	30	Yes
R4	11	11	14	30	Yes
R5	11	10	10	30	Yes
R6	11	10	10	30	Yes

Review of **Table 8-4** indicates that the total annual average PM_{10} concentrations comply with the impact assessment criterion of 30 µg/m³ at all sensitive receptors.

8.2 TSP Impact Assessment

The maximum predicted incremental and total annual average ground level concentrations of TSP at each sensitive receptor are presented in **Table 8-5** and **Table 8-6**, respectively.

Table 8-5 Annual average TSP– incremental impact

Receptor	Ground Level Concentration (µg/m^3)		
	North West	North East	South East
R1	2	8	2
R2	32	10	4
R3	4	8	5
R4	2	1	10
R5	3	1	1
R6	2	1	1

Table 8-6 Annual average TSP– total impact

Receptor	Ground Level Concentration (µg/m^3)			Criteria (µg/m^3)	Complies?
	North West	North East	South East		
R1	27	33	27	90	Yes
R2	57	35	29	90	Yes
R3	29	33	30	90	Yes
R4	27	26	35	90	Yes
R5	28	26	26	90	Yes
R6	27	26	26	90	Yes

Review of **Table 8-6** indicates that the total annual average TSP concentrations comply with the impact assessment criterion of 90 µg/m^3 at all sensitive receptors.

8.3 Deposited Dust

The maximum predicted incremental and total annual average dust deposition levels at each sensitive receptor are presented in **Table 8-7** and **Table 8-8**, respectively.

Table 8-7 Annual average deposited dust– incremental impact

Receptor	Ground Level Concentration (g/m^2/month)			Criteria (g/m^2/month)	Complies?
	North West	North East	South East		
R1	0.1	0.6	0.1	2	Yes
R2	0.1	0.6	0.2	2	Yes
R3	0.2	0.4	0.3	2	Yes
R4	0.1	0.1	0.5	2	Yes
R5	0.2	0.0	0.1	2	Yes
R6	0.1	0.0	0.0	2	Yes

Review of **Table 8-7** indicates that the annual average incremental dust deposition levels comply with the impact assessment criterion of 2 g/m^2/month at all sensitive receptors.

Table 8-8 Annual average deposited dust– total impact

Receptor	Ground Level Concentration (g/m^2/month)			Criteria (g/m^2/month)	Complies?
	North West	North East	South East		
R1	1.2	1.7	1.2	4	Yes
R2	1.2	1.7	1.3	4	Yes
R3	1.3	1.5	1.4	4	Yes
R4	1.2	1.2	1.6	4	Yes
R5	1.3	1.1	1.2	4	Yes
R6	1.2	1.1	1.1	4	Yes

Review of **Table 8-8** indicates that the annual average total dust deposition levels comply with the impact assessment criterion of 4 g/m^2/month at all sensitive receptors.

9 CONCLUSIONS

This study has assessed the potential dust impacts associated with the proposed continuation of the Hodgson Quarry Products Pty Ltd sand extraction facility at Roberts Road, Maroota.

For existing sand extraction operations, PM_{10} and dust deposition levels recorded from approximately 2002 have been reviewed. It was found that the TSP, PM_{10} and dust deposition levels monitored for the life of the sand extraction facility indicated compliance with the EPA recommended air quality criteria of 50 µg/m^3 and 4 g/m^2/month.

Dispersion modelling results for the three worst case future extraction scenarios indicated that the continued operation of the site is unlikely to impact on sensitive receptors providing that the application of dust mitigation measures identified in the existing air quality management plan continues.

APPENDIX A

AIR QUALITY MANAGEMENT PLAN

Air Quality Management Plan

1. Objectives

- To minimise and manage dust generated from the operation and maintain dust levels below EPA criteria.

2. Targets

- No complaints received, with monitoring showing that criteria are being met.

3. Air Quality Goals

- Total suspended particulates (TSP) not to exceed 90 µg/m3 (annual average).
- Fine particulates (PM10) not to exceed 50 µg/m3 (24 hour).
- Dust deposition not to exceed 4 g/m2/mth (annual average).

4. Licences/ Permits

- Development consent issued by Minister for Urban Affairs and Planning (Ref 598/00772) issued 31 May, 2000.
- Modification to development consent 598/00772 issued by the Minister for Urban Affairs and Planning on 29 November, 2000.
- EPA Licence 6535 - expiring 12 March 2012.

5. References

- Consent conditions 28, 29, 30, 31, 32, 33, 34, 35, 36, 37;
- EIS (1999) Sections 3.4, 6.2, 7.6, 8.2 and Appendix 10.

6. Existing Environment and Background

Examination of aerial photography from 1998 indicates approximately 7 to 8 hectares of area was exposed at this site at this time. At present approximately 2.6 Ha are regularly trafficked as the remainder is either not in use or inaccessible. Consent conditions granted in the year 2000 stipulate that no more than 3 hectares of area is to be exposed. Clearly the site was never compliant with this condition but the intention of the condition was to ensure dust levels remained below guideline levels.

HB Maroota is required under the Conditions of Consent to manage dust emissions such that they do not exceed 90 µg/m3 (annual average) for TSP and dust deposition is not to exceed 4 g/m2/mth (annual average). There are no specific limits set under the EPA licence.

It has been past practice to monitor the site for fine particulates (PM10) by High Volume Air Sampling (HVAS) however HVAS's have not been monitored regularly to assess the effectiveness of control measures and seasonal variations. This has been noted in the most recent site Audit undertaken by Umwelt Pty Ltd in 2011. At the time of this report writing further testing is underway and results to date are attached. Results indicate the quarry is compliant with the limits set.

Regular depositional dust monitoring has been undertaken monthly.

There have been no dust complaints received by the quarry. Both the Depositional Dust Gauge monitoring and High Volume Air Sampling indicate that although the area exposed is greater than 3 hectares the dust mitigation measure are working.

The compliance of the depositional dust monitoring gauges with the Australian Standards was reviewed in the Umwelt 2011 Audit and several issues must be addressed. It was noted that some gauges do not have a 120 degree clear sky angle and that a review of the dust gauge locations should be undertaken. In Addition some of the gauges pose a safety risk to personnel due to their accessibility. In this regard new locations will be implemented as soon as practicable and are shown on Figure Thirteen.

A new metrological station measuring wind speed and direction is in the process of being installed on the site as previous instruments have malfunctioned. The OEH has been informed of the position of the station (see Figure Four) via correspondence date the 28th of July 2011. The letter stated that if no response was received within 14 days that it would be assumed that the matter is acceptable to the Office. Since no response was forthcoming the proposed site has now been deemed acceptable to the Office.

7. Dust Sources

- Bulldozer on the clay extraction areas and front-end loader on the quarry floor;
- Front-end loader loading product sand into trucks;
- Trucks transporting product sand off site;
- wind erosion from exposed clay drying areas, clay and sand stockpiles.
- Dry stockpiles.

8. Proposed Activities and Procedures

8.1. Extraction and Processing

- No more than 3 hectares is to be exposed and active at any one time.
- Progressively rehabilitate the site, where possible, to minimise the area exposed to wind erosion (Refer to Appendix J Rehabilitation Plan)
- Potential dust generating material is to be processed and stored in a damp condition.
- A water cart is to be used to water internal roads, stockpiles and cleared areas to reduce dust generating potential.
- If monitoring finds that criteria are not being met, installation of a fixed sprinkler system to water cleared areas and stockpiles will be investigated.
- A polymer in the water to assist in minimising dust impacts will be used if dust monitoring indicates that targets are not being met.

8.2. Transportation

- All vehicle movements on unsealed areas are to be restricted to internal haul roads and working areas.
- Vehicle speeds on the quarry site are to be restricted to 20 km/hr.
- All trucks entering and leaving quarry which are carrying loads to be covered.

8.3. Wind Breaks and Bunds

- Wind breaks of natural vegetation around the boundary of the site are to be established and maintained in accordance with the Rehabilitation Plan.
- Bund walls are to be constructed at the corner of Roberts Road and Old Northern Road.

9. Summary of Progress

Table 1. Progress to Date

Item	Activity	Completed
Extraction and Processing	· No more than 3 hectares is to be exposed and active at any one time	Incomplete
	· Progressively rehabilitate the site to minimise the area exposed to wind erosion	Ongoing
	· Potential dust generating material is to be processed and stored in a damp condition	Ongoing
	· A water cart is to be used to water internal roads, stockpiles and cleared areas to reduce dust generating potential	Ongoing
	· If monitoring finds that criteria are not being met, installation of a fixed sprinkler system to water cleared areas and stockpiles will be investigated.	Not required as yet
	· A polymer in the water to assist in minimising dust impacts will be used if dust monitoring indicates that targets are not being met.	Not required as yet
Transportation	· All vehicle movements on unsealed areas are to be restricted to internal haul roads and working areas.	Ongoing
	· Vehicle speeds on the quarry site are to be restricted to 20 km/hr.	Ongoing
	· All trucks entering and leaving quarry which are carrying loads to be covered	Ongoing
Windbreaks and Bunds	· Wind breaks of natural vegetation around the boundary of the site are to be established and maintained in accordance with the Rehabilitation Plan.	Incomplete
	· Bund walls are to be constructed at the corner of Roberts Road and Old Northern Road.	Completed 2001
Monitoring	· Monthly independent Depositional Dust monitoring	Ongoing
	· Monitoring of HVAS to determine compliance with predictions from EIS. Discuss results with OEH and DPI.	Ongoing
	· A weather station measuring wind speed and direction is to be installed and operated continuously.	Ongoing

Item	Activity	Completed
	· location will be discussed with the OEH to confirm appropriateness prior to installation	Completed 14/8/2011
	· A flashing light or similar notification will be installed on the station to show when wind speeds are above 10 metres/second	Incomplete

10. Monitoring

- Dust deposition is to monitored monthly at the gauge locations shown on Figure Twelve.
- Indicative positions of relocated dust deposition gauges are shown in Figure Thirteen. Exact positions will be recorded by GPS Co-ordinates when positions are finalised.
- High volume air samplers (TSP, PM10) are to be installed for a period of three months (commencing in October 2011) to determine compliance with predictions from EIS (that predicted operations would be below criteria). TSP and PM10 are to be monitored for a period of 24 hours every six days. At the end of the three month period results will be discussed with the OEH and DPI to determine the need for ongoing monitoring.
- A weather station measuring wind speed and direction is to be installed and operated continuously at the location shown on the Figure Four. This location will be discussed with the OEH to confirm appropriateness prior to installation. Information from this station will be used in the assessment of HVAS results, to ensure that a variety of representative wind conditions was experienced during the trial period. A flashing light or similar notification will be installed on the station to show when wind speeds are above 10 metres/second. This will alert operators to consider more frequent use of the water truck or a reduction in dust generating activities.
- All staff are to be trained in methods to reduce dust and to notify the Plant Manager or delegate of activities generating excessive dust.
- Any complaints regarding dust are to be recorded in the complaints logbook (refer Section 6.5).

11. Reporting

- Conditions Compliance Report to the DPI annually for 2001, 2001, 2003 to report monthly dust deposition results, HVAS results and interpretation and discussion of results and any complaints received relating to dust and actions taken to mitigate complaints.
- Annual Return to the EPA to be submitted 11 May each year (60 days after licence renewal date of 12 March), including monitoring and complaints summary and Statement of Compliance.

12. Emergency Response

- Works to cease when the operation is resulting in visible dust blowing across public roads or lands not owned by Dr L.S.Martin.

- Operating procedures to be reviewed after works ceased to minimise dust generation - e.g.: extraction or processing to cease.

13. Responsibility

- Plant Manager - for monitoring dust and implementing measures to reduce dust, e.g.: deploying water truck.
- Truck drivers on site - for adhering to speed restrictions and covering loads.
- All staff - for identifying excessive dust generating activities and reducing dust accordingly.

APPENDIX B

EMISSIONS INVENTORY

B.1 Particulate Emission Factor Equations

Haul roads

Wheel generated particulate emissions associated with material haulage are estimated using the following US EPA emission factors (US EPA, 1985 and updates):

$$E[kg/VKT] = 0.2819 \times a \times \left(\frac{s}{12}\right)^{b} \times \left(\frac{1.1023 \times W}{3}\right)^{0.45}$$

Where:

a = 4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$

b = 0.7 for TSP and 0.9 for PM_{10} and $PM_{2.5}$

s = silt content [%] of road surface

W = weight of vehicle [t]

Particulate emissions from vehicles travelling along sealed haul roads have been estimated using the above equations, and including a control factor of 90%.

Loading / unloading / transferring material

Each tonne of material handles will generate quantities of particulate matter that will depend on the wind speed and the moisture content of the material according to the US EPA emission factor (US EPA, 1985 and updates) shown below:

$$E[kg/t] = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2.0}\right)^{1.4}}\right)$$

Where:

k = 0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$

U = wind speed [ms^{-1}]

M = moisture content [%]

The wind speed is taken as the average wind speed from the TAPM dataset.

Dozers shaping fill material

Particulate emissions for dozers have been estimated using US EPA emission factor equations (US EPA, 1985 and updates) for dozers on overburden as follows:

$$E[kg/h] = a \times \left(\frac{s^b}{M^c}\right)$$

Where:

a = 2.6 for TSP, 0.8775 for PM_{10} and 0.273 for $PM_{2.5}$

b = 1.2 for TSP, 1.5 for PM_{10} and 1.2 for $PM_{2.5}$

c = 1.3 for TSP, 1.4 for PM_{10} and 1.3 for $PM_{2.5}$

s = silt content [%]

M = moisture content [%]

Wind erosion

Particulate emission factors for wind erosion, taken from the NPI (NPI, 2012), are 0.4 kg/ha/h for TSP and 0.2 kg/ha/h for PM_{10}

Screening

Particulate emission factors for screening concrete have been taken from the US EPA (US EPA, 1985 and updates) and are summarised below:

Activity	Emission Factor [kg/t]		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Screening (uncontrolled)	0.0125	0.0043	*

* No emissions data available

B.2 Emission Estimates

Table B-1 Summary of TSP Emissions – North West extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	13.34	11	hours/day	2.426	kg/hr	1.0	machines	2.425885778	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.77	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	4.68	24	trucks/day	0.396	kg/truck	0.3	km/trip (one way)	1.524329448	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	1.15	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	2.97	24	trucks/day	0.251	kg/truck	0.3	km/trip (one way)	0.966894584	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	1.54	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	16.25	1300	t/day	0.0125	kg/t									
unloading to stockpile	0.25	1000	t/day	0.000254321	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	3.55	31	trucks/day	0.227	kg/truck	0.3	km/trip (one way)	0.874519749	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	1.18	1000	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	5.82	31	trucks/day	0.373	kg/truck	0.3	km/trip (one way)	1.433752493	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	4.80	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					
Wind Erosion - Pit	2.40	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					50
TOTAL	**58.73**													

Table B-2 Summary of PM_{10} Emissions – North West extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	1.99	11	hours/day	0.362	kg/hr	1.0	machines	0.361723544	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.36	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	1.00	24	trucks/day	0.085	kg/truck	0.3	km/trip (one way)	0.33	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	0.55	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	0.64	24	trucks/day	0.054	kg/truck	0.3	km/trip (one way)	0.21	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	0.73	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	5.59	1300	t/day	0.0043	kg/t									
unloading to stockpile	0.12	1000	t/day	0.000120287	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	0.76	31	trucks/day	0.049	kg/truck	0.3	km/trip (one way)	0.19	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	0.56	1000	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	1.25	31	trucks/day	0.080	kg/truck	0.3	km/trip (one way)	0.31	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	2.40	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					
Wind Erosion - Pit	1.20	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					50
TOTAL	**17.14**													

Table B-3 Summary of TSP Emissions – North East processing

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	13.34	11	hours/day	2.426	kg/hr	1.0	machines	2.425885778	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.77	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	3.60	24	trucks/day	0.305	kg/truck	0.2	km/trip (one way)	1.524329448	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	1.15	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	2.29	24	trucks/day	0.193	kg/truck	0.2	km/trip (one way)	0.966894584	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	1.54	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	16.25	1300	t/day	0.0125	kg/t									
unloading to stockpile	0.25	1000	t/day	0.000254321	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	2.73	31	trucks/day	0.175	kg/truck	0.2	km/trip (one way)	0.874519749	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	1.18	1000	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	4.48	31	trucks/day	0.287	kg/truck	0.2	km/trip (one way)	1.433752493	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	4.80	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					
Wind Erosion - Pit	2.40	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					50
TOTAL	**54.80**													

Table B-4 Summary of PM_{10} Emissions – North East processing

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	1.99	11	hours/day	0.362	kg/hr	1.0	machines	0.361723544	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.36	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	0.77	24	trucks/day	0.065	kg/truck	0.2	km/trip (one way)	0.33	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	0.55	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	0.49	24	trucks/day	0.041	kg/truck	0.2	km/trip (one way)	0.21	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	0.73	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	5.59	1300	t/day	0.0043	kg/t									
unloading to stockpile	0.12	1000	t/day	0.000120287	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	0.58	31	trucks/day	0.037	kg/truck	0.2	km/trip (one way)	0.19	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	0.56	1000	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	0.96	31	trucks/day	0.061	kg/truck	0.2	km/trip (one way)	0.31	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	2.40	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					
Wind Erosion - Pit	1.20	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					50
TOTAL	**16.30**													

Table B-5 Summary of TSP Emissions – South East extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	13.34	11	hours/day	2.426	kg/hr	1.0	machines	2.425885778	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.77	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	5.94	24	trucks/day	0.503	kg/truck	0.3	km/trip (one way)	1.524329448	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	1.15	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	3.77	24	trucks/day	0.319	kg/truck	0.3	km/trip (one way)	0.966894584	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	1.54	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	16.25	1300	t/day	0.0125	kg/t									
unloading to stockpile	0.25	1000	t/day	0.000254321	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	4.51	31	trucks/day	0.289	kg/truck	0.3	km/trip (one way)	0.874519749	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	1.18	1000	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	7.39	31	trucks/day	0.473	kg/truck	0.3	km/trip (one way)	1.433752493	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	4.80	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					
Wind Erosion - Pit	2.40	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					50
TOTAL	**63.31**													

Table B-6 Summary of PM_{10} Emissions – South East extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	1.99	11	hours/day	0.362	kg/hr	1.0	machines	0.361723544	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.36	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	1.27	24	trucks/day	0.108	kg/truck	0.3	km/trip (one way)	0.33	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	0.55	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	0.81	24	trucks/day	0.068	kg/truck	0.3	km/trip (one way)	0.21	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	0.73	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	5.59	1300	t/day	0.0043	kg/t									
unloading to stockpile	0.12	1000	t/day	0.000120287	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	0.96	31	trucks/day	0.062	kg/truck	0.3	km/trip (one way)	0.19	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	0.56	1000	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	1.58	31	trucks/day	0.101	kg/truck	0.3	km/trip (one way)	0.31	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	2.40	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					
Wind Erosion - Pit	1.20	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					50
TOTAL	**18.12**													

APPENDIX C

CONTOUR PLOTS

Figure C-1 24 hour PM_{10} Concentration [µg/m³] – North West extraction

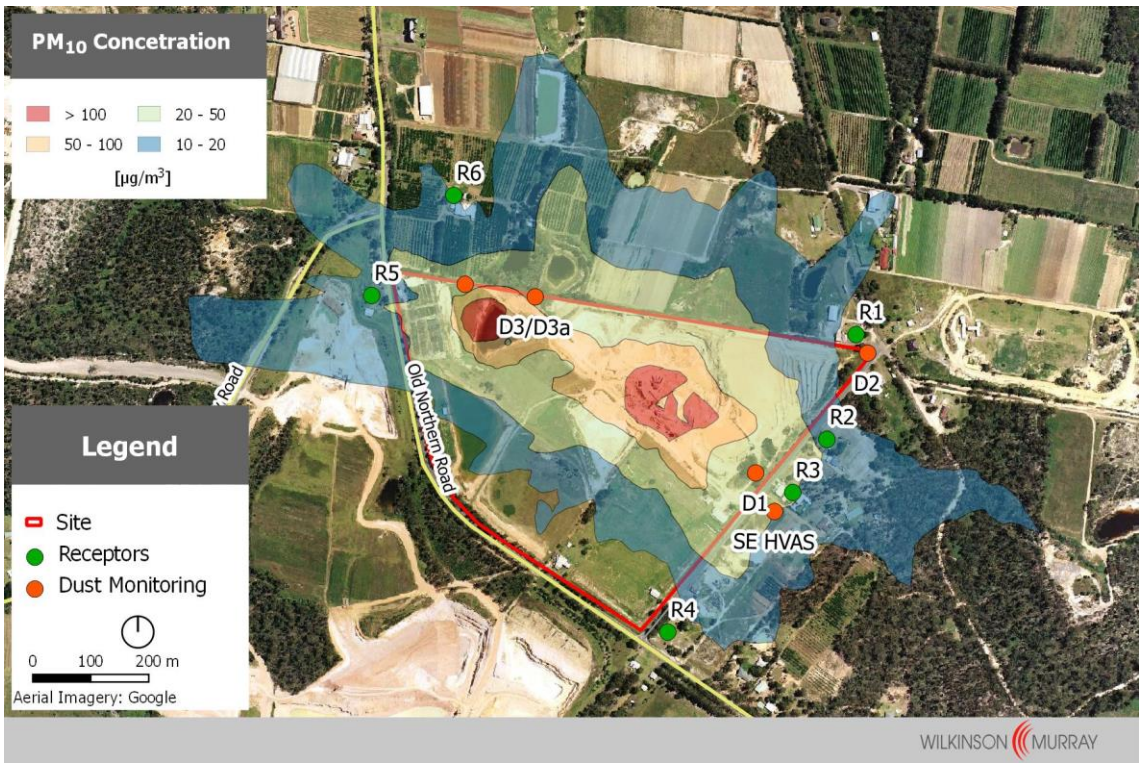


Figure C-2 24 hour PM_{10} Concentration [µg/m³] – North East processing

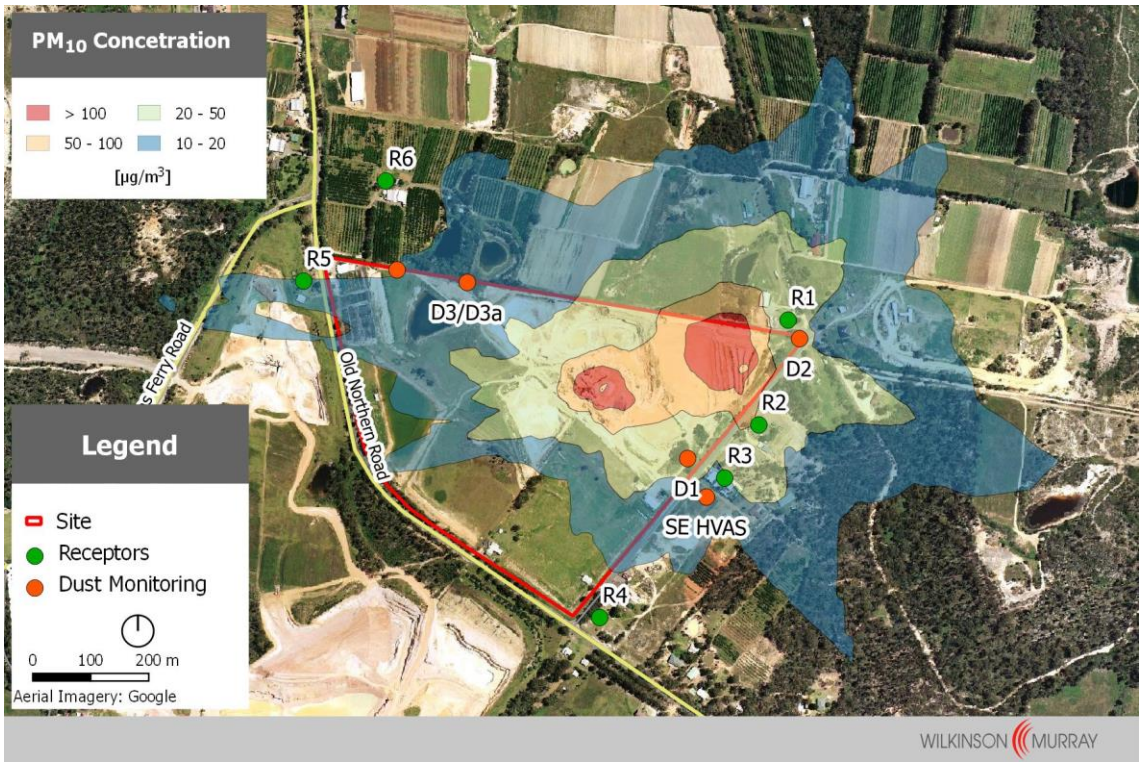


Figure C-3 24 hour PM_{10} Concentration [µg/m³] – South East extraction