CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report on Eviron Road Quarry and Landfill

Air Quality Assessment

October 2011

Revision 1

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

1. Introduction 1
   1.1 Context 1
   1.2 Scope of Work 3
2. Project Description 4
   2.1 Quarry Activities – West Valley and North Valley 4
   2.2 Landfill Activities – Quirks Landfill, West Valley Landfill and North Valley Landfill 6
3. Existing Environment 9
   3.1 Study Area 9
   3.2 Local Meteorology 10
   3.3 Ambient Air Quality 14
4. Emissions Inventory 16
   4.1 Quarrying 16
   4.2 Landfill 21
   4.3 Dust 23
5. Dispersion Modelling Methodology 25
   5.1 The Model 25
   5.2 Source Characterisation 25
   5.3 Assessment Criteria 28
6. Predicted Air Quality Impacts 30
   6.1 Dust 30
   6.2 Impacts from Blast Events 32
   6.3 Predicted Odour Impact 33
   6.4 Summary of Results 34
7. Recommended Mitigation Measures 35
   7.1 Specific Dust Control Measures 35
   7.2 General Dust Control Measures 38
   7.3 Odour Mitigation Measures 39
8. Conclusions 40

9. Limitations 41

Table Index

Table 2-1	Quarry Operating Hours	4
Table 2-2	Landfills – Levels of Waste Acceptance	7
Table 3-1	Identified Sensitive Receptors	9
Table 3-2	Atmospheric Stability Classes – Annual	13
Table 4-1	On-Site Equipment Summary	17
Table 4-2	Process Dust Emission Rates	19
Table 4-3	Estimated Odour Emission Rates - Landfill	22
Table 4-4	Dust Emission Inventory – Landfill	24
Table 5-1	Source Characteristics	25
Table 5-2	Wind Erosion Dust Emission Rates	26
Table 5-3	Dust Deposition Parameters	26
Table 5-4	Assessment Criteria for Dust	28
Table 5-5	NSW DECCW Odour Criteria	28
Table 6-1	Configuration 1 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor	30
Table 6-2	Configuration 2 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor	30
Table 6-3	Configuration 3 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor	31
Table 6-4	Configuration 1 – PM_{10} 24-hour Concentrations – 400 TPH vs. 100 TPH	32
Table 6-5	Predicted Odour Concentration (OU)	33
Table 7-1	Configuration 1 – PM_{10} 24-Hour Predicted Incremental Concentrations – With and Without Water Sprays on Crushers	36
Table 7-2	General Management of Air Emissions	38

Figure Index

Figure 1-1	Study Area and Site Boundary	2
Figure 2-1	Quirks Quarry Operations – 2008	6
Figure 3-1	Study Area	10
Figure 3-2	Annual Wind Rose – Eviron	12
Figure 3-3	Operational Hours Wind Rose – Eviron	12
Figure 3-4	Annual Stability Rose – Eviron	14

Figure 7-1	Quarry PM_{10} Emissions by Equipment – 400 TPH Operations	35
Figure 7-2	Quarry PM_{10} Emissions by Equipment – 400 TPH Operations – with Water Sprays on Crushers	37

Appendices

A Ausplume Output File

B Predicted Dust Impacts

C Dust Concentration Contours

D Odour Concentration Contours

1. Introduction

GHD was engaged by Tweed Shire Council (TSC) to assess the potential for dust and odour impacts from the proposed Eviron Road Quarry and Landfill development, Eviron, NSW.

1.1 Context

Council has developed an overall Concept Plan for the site which comprises a staged project to develop a waste disposal facility within the existing void created by Quirks Quarry, develop two further extractive industries to be used as waste disposal facilities after exhaustion of the quarry resource, and install necessary operational infrastructure such as a haul road and other minor associated facilities. The site and study area can be seen in Figure 1-1.

This proposed method of landfilling in quarry voids is consistent with the method of landfill creation in the Tweed Shire to date. Material won from quarrying is used for road building and other Council civil projects, and overburden stockpiled for road construction, clay liners (where appropriate) and site rehabilitation purposes.

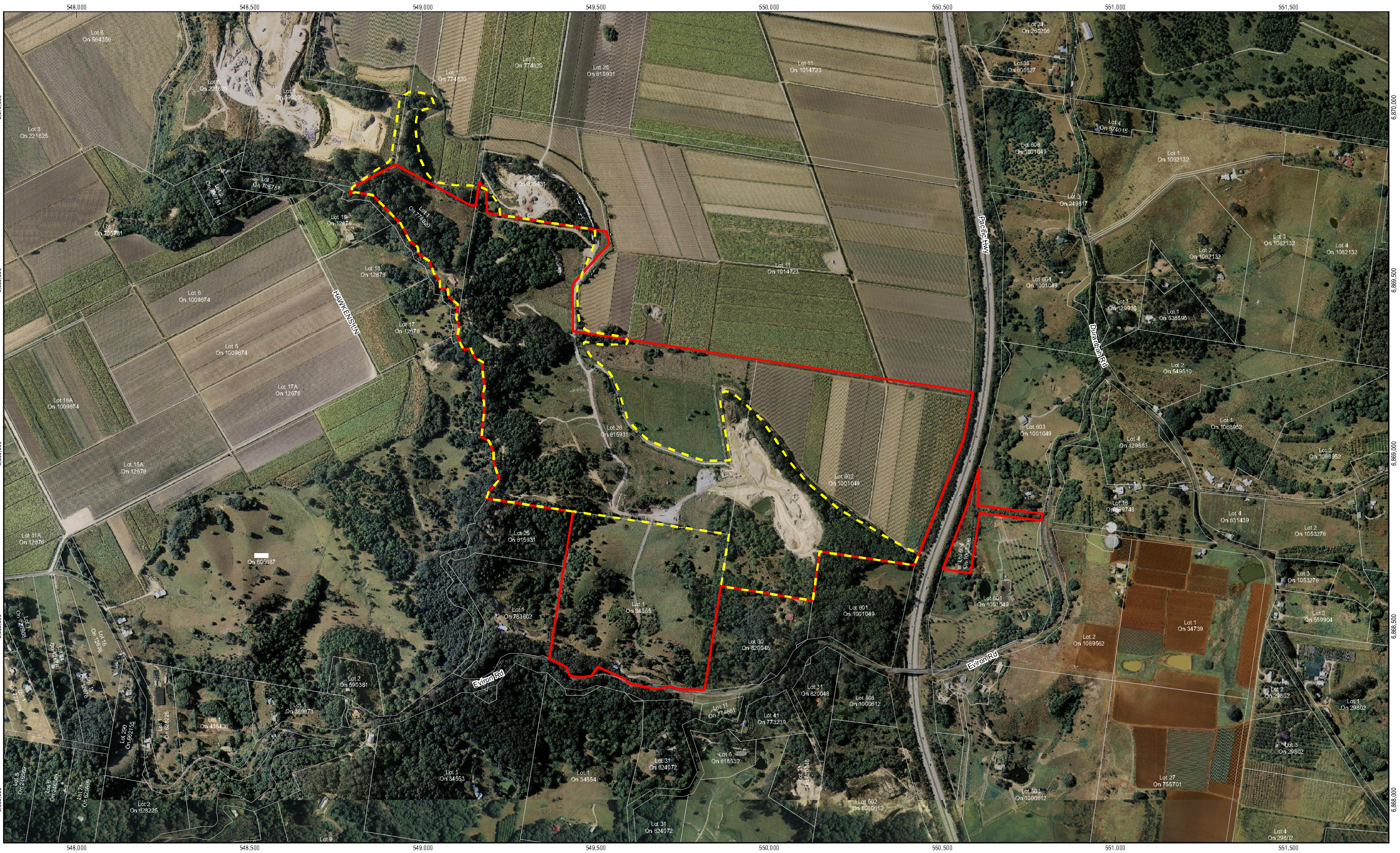
Chronologically, the overall Concept Plan will involve:

- Stage 1 (Project Application):
  - Establishment of a new haul road from Stotts Creek RRC to Quirks Quarry, and development of a landfill within the Quarry void.
  - Progressive rehabilitation of Quirks Quarry landfill.
  - Development of a new quarry in West Valley.
- Future stages may include:
  - Development of a landfill within the void formed from quarrying West Valley.
  - Progressive rehabilitation of the West Valley landfill.
  - Development of a new quarry within North Valley.
  - Development of a landfill within the void formed from quarrying North Valley.
  - Progressive rehabilitation of the North Valley landfill.

The landfills and quarry will operate in sequence and there will be no overlap between landfilling in the Quirks Quarry, West Valley and North Valley, this will also be the case for the quarry operations.

Based on the concept design work and studies undertaken to date the following operational periods have been adopted for the purposes of assessing the potential environmental impacts:

- Quirks Quarry Landfill: 10 years (2012 – 2021).
- West Valley Quarry: 10.5 years (2012-2021).
- West Valley Landfill: 12 years (2022-2033).
- North Valley Quarry: 3.5 years (2022-2026).
- North Valley Landfill: >10 years (2034 -2045).



1:10,000 (at A3)

0 50 100 200 300 400 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Site Boundary

Study Area

GHD

CLIENTS|PEOPLE|PERFORMANCE

Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number	41-20806
Revision	0
Date	10 AUG 2010

The Site

Figure 1

G:\41\20806\GIS\Maps\4120806_00.mxd

54-58 Nerang Street Nerang QLD 4211 Australia T 61 7 5557 1000 F 61 7 5557 1000 E goldcoastmail@ghd.com.au W www.ghd.com.au

Data source: Tweed Shire Council - Aerial Photography (2008). Department of Lands - Cadastre boundary (2009). GHD (2010) - Site Boundary, Study Area.

1.2 Scope of Work

The scope of work undertaken by GHD for the assessment of dust and odour emissions from the proposed development is outlined in the points below. These points are described in greater detail in the subsequent sections of this report.

The following scope of works was undertaken:

- A site inspection of the study area to gain an understanding of local site features and the operation parameters of the existing quarry and landfill.
- Review of available ambient air quality monitoring data to gain an understanding of existing background air quality.
- Synthesise a site-specific meteorological data file with which to use as model input for conducting atmospheric dispersion modelling.
- Compilation of particulate matter (dust) and odour emission rate data with which to derive the emission inventory for conducting atmospheric dispersion modelling.
- Dispersion modelling was conducted using a regulatory atmospheric dispersion model to predict the maximum incremental impact at the nearest sensitive receptors throughout the life of the proposed concept plan.
- Recommend in-principle measures for managing dust and odour emissions with consideration to technical guidelines.

The abovementioned scope of work has been conducted with consideration to the following NSW Office of Environment and Heritage (OEH) guidelines:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (August 2005).
- *Technical framework – Assessment and management of odour from stationary sources in NSW* (November 2006).

2. Project Description

2.1 Quarry Activities – West Valley and North Valley

2.1.1 Level of Production

It is assumed that the maximum rate or level of production will total approximately 200,000 tonnes per year at each quarry. However this will be further determined by the amount of material available for extraction and what is outlined in the approvals process as appropriate for the site.

2.1.2 Hours of Operation

The hours of operation for each quarry will be the same as those currently at Quirks Quarry, as outlined in Table 2-1.

Table 2-1 Quarry Operating Hours

Operation	Operating Days	Start Time	Finish Time
Quarrying	Monday to Friday	7 00	1700
	Saturday	7 00	1200
Blasting	Monday to Friday	9 00	1500
	Saturday	9 00	1200
Hauling	Monday to Friday	7 00	1700
	Saturday	7 00	1200

2.1.3 Description of Operations

The operations in extracting rock from the proposed quarries typically involve the following tasks:

- Pre strip activities and topsoil stockpiling activities.
- Blast-hole Drilling and Blasting (if required).
- Extraction:
  - Primary screening.
  - Primary crushing.
  - Secondary Screening and crushing where required.
- Stockpiling.
- Product Loading and Hauling.

Material extraction will typically be undertaken using a bulldozer or excavator. Blasting would be undertaken on a periodic basis depending upon demand for the resource and when manual extraction becomes too difficult or dangerous. It is expected that blasting would occur a maximum of once per week but would typically only be required once every few months. Drilling would be required as part of blasting operations to allow for down-hole placement of explosives.

Extracted material will then be loaded into a series of mobile crushers and screens for on-site processing or loaded directly into haul trucks and taken off site. Processed products will be segregated and stockpiled ready for use and/or delivery. Based on current operations at Quirks Quarry, all material will be processed on-site unless requested otherwise.

Materials would be stockpiled according to size. Stockpiles will be located away from the main excavation area, close to the work area containing screens and crushers.

The expected products available would be:

- 70-30 mm, 40 mm, 20 mm, 10 mm, 7 mm Drainage Aggregates.
- Cracker Dust.
- “C” Grading Type 2.1 and “B” Grading Type 2.3 Road base.
- Overburden/Fill.
- Screened topsoil (Rescreened from imported spoil).
- Screened Sand (Rescreened from imported spoil).

The exact products to be available from the West Valley and North Valley Quarries have not been determined at this stage, however these products are currently available from the Quirks Quarry site and due to their close proximity should reflect that available at West Valley and North Valley quarries.

Typical quarry operations are shown in Figure 2-1, depicting Quirks Quarry in 2008.

Figure 2-1 Quirks Quarry Operations – 2008

2.2 Landfill Activities – Quirks Landfill, West Valley Landfill and North Valley Landfill

2.2.1 Hours of Operation

The hours of operation at each landfill is expected to be identical to the existing Stotts Creek RRC and will be seven days per week between 7:00 am and 4:00 pm Monday to Friday and between 9:00 am and 4:00 pm Saturday and Sunday.

2.2.2 Facility Layout

Access to each landfill will be via a haul road constructed between the existing Stott's Creek facility and the Quirks Quarry Landfill. Small vehicular traffic (ie domestic and small commercial customers) will continue to utilise the transfer station facility at the Stotts Creek RRC. The waste deposited at the Stotts Creek RRC will subsequently be transferred by TSC to the waste disposal area at the operating landfill via the sealed haul road.

The main features of the landfill site include the following:

- Material drop off area.
- Active landfilling area (for council and contractor vehicles only).
- Sediment basin and stormwater drains.

2.2.3 Waste Acceptance Rates

The levels of waste that are likely to be accepted at each landfill throughout their lifespan are shown in Table 2-2. These figures have been utilised in the air quality impact assessment.

Table 2-2 Landfills – Levels of Waste Acceptance

Landfill	Years of Operation	Waste (tonnes per annum)
Quirks	2012 – 2021	Up to 75,000 tpa
West Valley	2022 – 2033	From 58,000 to 100,000 tpa
North Valley	2034 – 2045	From 100,000 to 145,000 tpa

2.2.4 Staging / Filling of the Landfill

The sequencing of the cell construction and subsequent landfilling operations in all stages will enable progressive capping to be undertaken as each stage is completed. This will allow efficient management of the disturbed areas and minimisation of rainfall infiltration into the landfill and thus generation of leachate.

2.2.5 Leachate Management

A leachate extraction system will be used at the proposed landfills. Leachate will be treated and either transported off-site or disposed of into the active landfill area. The proposed landfills will not use a leachate pond system.

2.2.6 Waste Accepted at Facility

The Landfill will only accept waste in accordance with its EPL. It is proposed that the site will be licensed as a Solid Waste Class 1 Landfill and will be permitted to accept inert waste, solid waste (including putrescible solid waste), asbestos waste and certain clinical waste.

Conservatively, as part of the odour impact assessment, it has been assumed that all waste transported to the landfill will be putrescible.

Grease trap waste and waste oil may be stored, but not disposed of, at the premises. No other hazardous or industrial materials may be stored at the site except where they have been illegally dumped at the tipping face and are stored for subsequent removal.

Liquid wastes received will be stored in a bunded concrete tank on site. Liquid waste removal contractors will periodically empty the tank. No liquid wastes will be disposed of on-site.

No green waste processing will occur at future landfills. Green waste will continue to be processed at the Stotts Creek Landfill Facility and will be managed in accordance with the Stotts Creek Landfill Facility, LEMP.

2.2.7 Covering Layers

Daily Cover

To maintain sanitary conditions and minimise the environmental impact of the landfilling operation, at the end of each working day all exposed waste surfaces will be covered by TSC with a layer of compacted soil or other OEH approved material to a minimum depth of 150 mm. The daily cover layer will be graded to minimise ponding of water.

Waste may be covered throughout the working day, as well as at the end of the day if necessary to prevent environmental impacts such as litter or odour.

The material used for the covering of waste will be clean soil and Virgin Excavated Natural Material (VENM), including material sourced from materials excavated on-site and suitable incoming waste materials. TSC will ensure there is, at all times, sufficient cover material on site for daily covering of the deposited waste. Cover material used for daily covering will be stockpiled at a point convenient to the active waste disposal area. The stockpile will be maintained to provide at least two weeks supply of cover material.

TSC will not source or store clean fill on the site in excess of the site's needs, and will not use excessive amounts of cover in operating the landfill. Silt fences and other approved sediment control measures shall be provided by TSC as required.

Intermediate Cover

Where a filled area has not reached the final landform level, but due to the staging of the filling will remain inactive for a period greater than 90 days, TSC shall apply an intermediate covering layer. The intermediate covering layer shall be a 300 mm thick layer of compacted soil or other suitable material approved by the OEH.

Final Cover

The landfill will be progressively rehabilitated as filling is completed. This will involve placing an engineered cover layer over each tipping area as it is completed, and revegetating the final cover.

3. Existing Environment

3.1 Study Area

Existing land uses in the vicinity of the Eviron Quarry and Landfill site include:

- Stott's Creek RRC.
- Quirks Quarry.
- The Pacific Highway.
- Pasture and agricultural land.

The site is bordered to the north by generally flat areas of agriculture and sugar cane fields. The proposed quarries and landfills are located in areas of undulating topography.

A number of residential properties are located around the proposed site. Details of identified sensitive receptors are shown below in Table 3-1. There is also a property on Hawkens Lane that has recently been purchased by Tweed Shire Council and is currently unoccupied. The future use for this property is not expected to be residential and it has therefore been excluded from the assessment.

An aerial photograph showing the location of the proposed project footprint, the existing landfill and quarry and nearby sensitive receptors is shown in Figure 3-1.

Table 3-1 Identified Sensitive Receptors

Sensitive Receptors	Address Details	Property Details
Receptor 1	751 Eviron Rd, Eviron	Lot 30 on DP 820048
Receptor 2	157 Hawkens Ln, Eviron	Lot 2 on DP 705781
Receptor 3	656 Eviron Rd, Eviron	Lot 25 on DP 615931
Receptor 4	657 Eviron Rd, Eviron	Lot 1 on DP 783802
Receptor 5	726 Eviron Rd, Environ	Lot 30 on DP 706846
Receptor 6	10 Donalyn Crt, Duranbah	Lot 501 on DP 1000612
Receptor 7	Eviron Rd, Duranbah	Lot 603 on DP 1001049

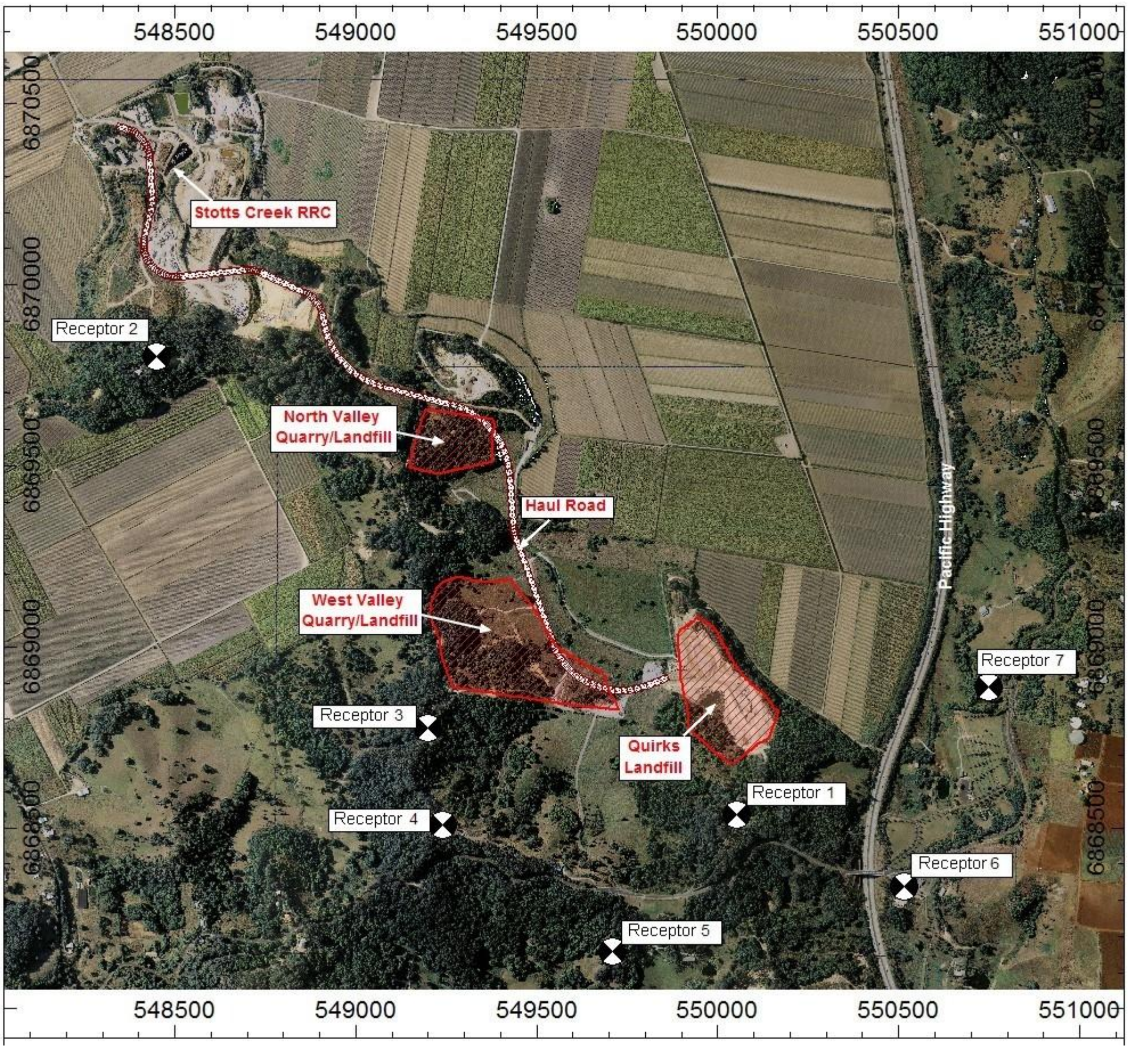


Figure 3-1 Study Area

3.2 Local Meteorology

The transport and dispersion of the air emissions from the proposed development will be influenced by prevailing synoptic flows and vertical temperature profiles that will alter both diurnally and with wind direction.

The nearest Automatic Weather Station (AWS) is located at Coolangatta Airport (approximately 10 km to the north-northeast of the site), and is operated by the Bureau of Meteorology (BoM). However, this data was considered to be unrepresentative to characterise the transport and dispersion of emissions from the development.

Therefore, the regional-scale prognostic meteorological model, TAPM[1], was used to simulate the meteorology over the subject site. TAPM is an approved model for specialist applications and its use, as part of this assessment, is described in the Section 3.2.1.

[1] Hurley, P. The Air Pollution Model (TAPM) version 4. CSIRO Atmospheric Research Paper No. 55.

TAPM output was then used to derive the meteorological data file used to conduct the dispersion modelling – refer to Section 4.

3.2.1 Meteorological Modelling

TAPM (V 4.0.2) was developed at CSIRO Division of Atmospheric Research and is a PC-based prognostic modelling system that can predict regional scale 3D meteorology. It is suitable for use with complex geographic sites and / or for situations when the available site representative meteorological data are not adequate (as is the case for this assessment). TAPM accesses databases of synoptic weather analyses from the BoM. The model then provides the link between the synoptic large-scale flows and local climatology, which, in this case, includes such factors as local land use, topography, atmospheric stability and mixing height.

TAPM was configured with a nested model grid coverage designed to capture:

- Broad scale synoptic flows.
- Regional to local scale wind channeling.
- The influence of local land use.

TAPM was run for the year 2007 using the synoptic data analyses from the BoM.

Specific model settings were as follows:

- Five nested grids at 300 m, 1,000 m, 3,000 m, 10,000 m and 30,000 m resolution, with 45 x 45 grid points.
- Surface vegetation and precipitation processes were included.

3.2.2 Dispersion Meteorology

Figure 3-2 and Figure 3-3 contain wind roses illustrating the distributions of wind speeds and directions for the simulation year 2007, and for just the Quarry / Landfill operational hours within that year (7 am to 6 pm at the extremes) respectively.

Figure 3-2 shows the annual wind climate in the area is dominated by flows from southeast and north, with less frequent flows from the north and northwest. The average wind speed is 2.3 m/s with the highest winds occurring most frequently from the west.

It is the incidence of daytime winds that are of greatest concern in regards to the transport and dispersion of dust emissions from the Quarry/Landfill. Due to the nature of operations, the majority of dust/odour is generated at the site during operational hours when processing activities are occurring. The daytime distribution of wind directions is not significantly different to that for the entire diurnal cycle, however the average wind speed is higher during the day (2.7 m/s).

Wind erosion or dust lift-off can become significant under strong winds (greater than 5 m/s). These stronger winds were shown to occur infrequently.

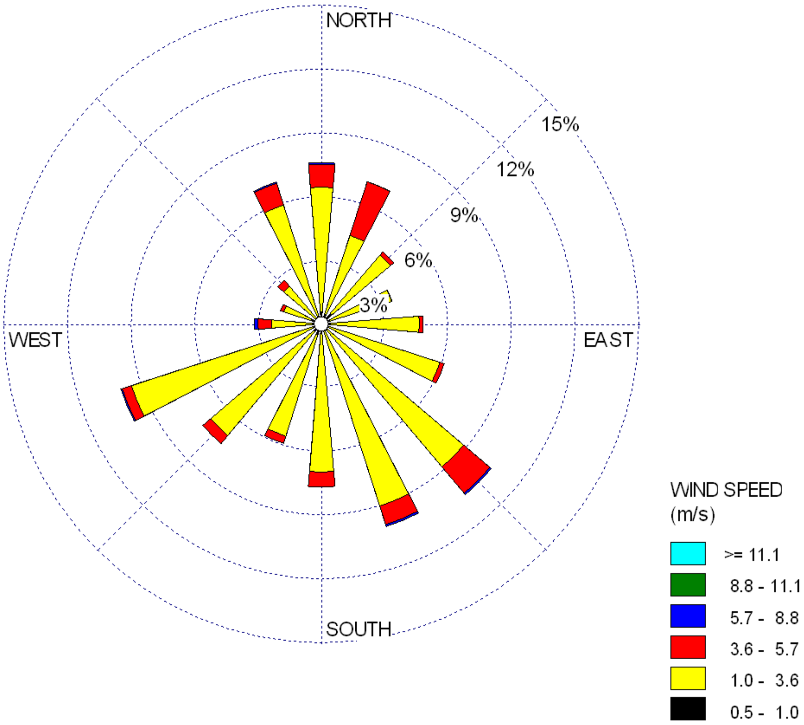


Figure 3-2 Annual Wind Rose – Eviron

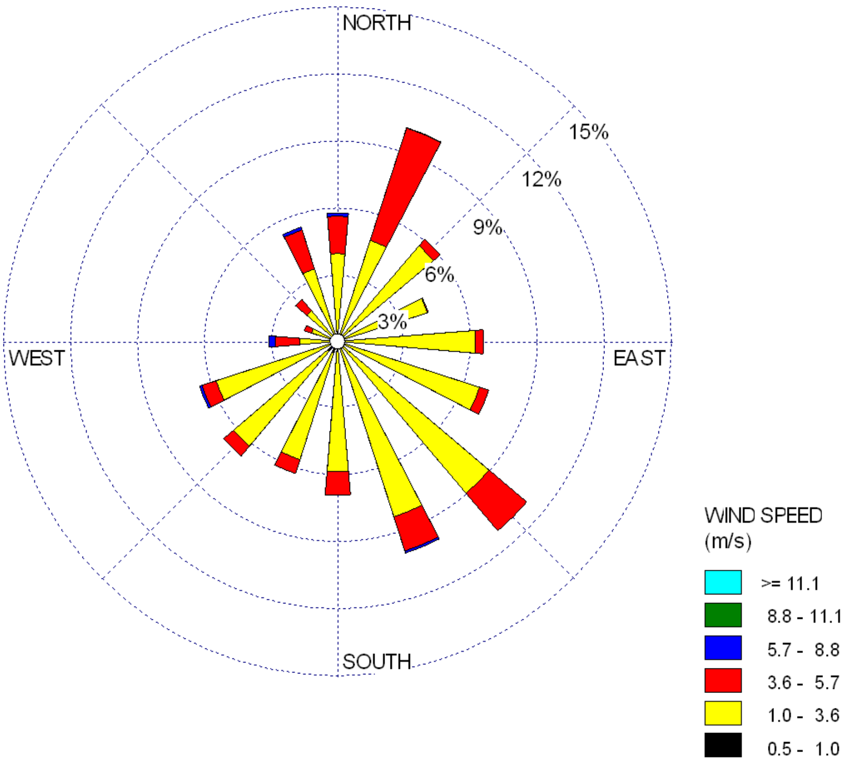


Figure 3-3 Operational Hours Wind Rose – Eviron

A categorised measure of atmospheric stability was also determined by the model. These can be broadly defined as in Table 3-2.

Table 3-2 Atmospheric Stability Classes – Annual

Stability Class	Description	Frequency of Occurrence
A	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud.	<1%
B	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud.	6%
C	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud.	13%
D	Neutral atmospheric conditions occurring during the day or night with stronger winds. Or during periods of total cloud cover, or during the twilight period.	43%
E	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds.	9%
F	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds.	29%

The occurrence of stable air-flows is of significance as these generally provide the conditions for worst-case dispersion of emissions to air, and hence potentially the highest impact to health and amenity. This is due to the limited mixing in the vertical of these light wind air-flows, and hence lowered dilution in the emission plume.

Stable conditions are not likely to occur during the operational period of the proposed site because operations are restricted to the daytime period. Hence, periods of worst case dispersion during the operational periods will correspond with light wind neutral atmospheric conditions occurring during early morning and late afternoon, and, to a lesser extent, for more moderate wind speeds for the period late-morning to early afternoon.

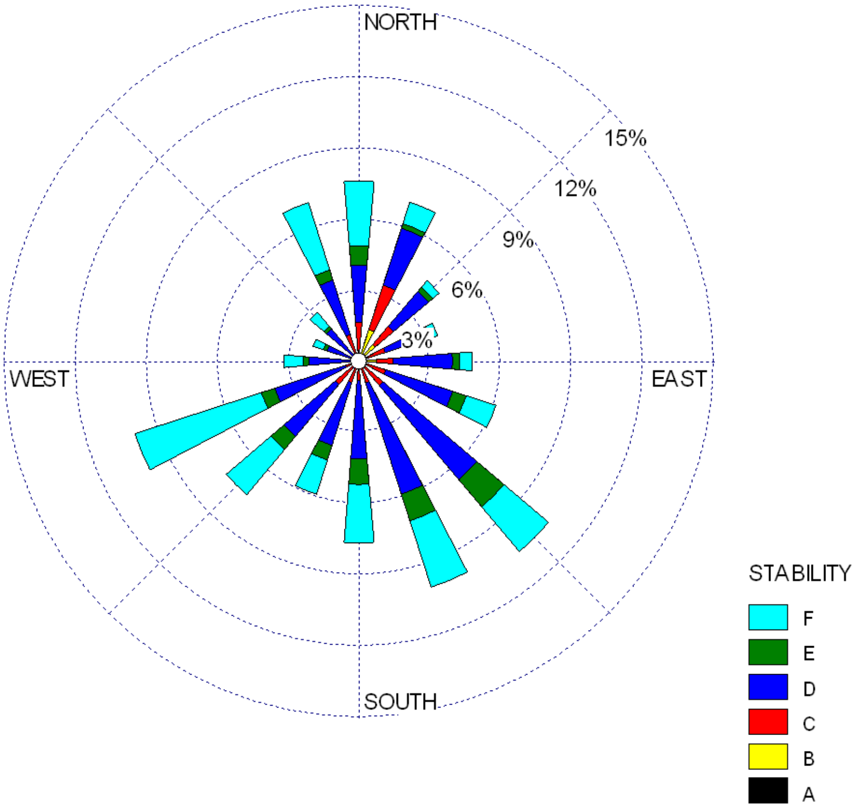


Figure 3-4 Annual Stability Rose – Eviron

3.3 Ambient Air Quality

Site-specific ambient air quality data recorded for total suspended particulate (TSP) matter or fine particulates for the Eviron area was not available at the time of this assessment. The term total suspended particulate (TSP) matter refers to airborne particles typically less than 50 microns (μm) in aerodynamic diameter. The fractions of suspended particles that are less than 10 μm are referred to as PM_{10}.

The NSW OEH does not hold any ambient air quality data available for this region. The closest air quality data for the subject area is in the Lower Hunter Region and Brisbane. These areas typically have an ambient concentration of PM_{10} in the order of 20 – 30 $\mu g/m^3$, however these sites are subjected to additional industrial and urban sources compared to a rural location. In view of this, an ambient concentration 15 – 20 $\mu g/m^3$ for PM_{10} has been assumed for rural coastal NSW areas away from the drier inland, industrial sources and urbanised environments.

It is noted that the study area contains some sugar cane farming land. Harvesting and burning of these crops are likely to cause spikes in the ambient levels of PM_{10} and TSP. As these seasons are generally short in nature, these spikes in ambient levels are not considered representative of typical air quality in the region.

Information regarding ambient odour levels in the areas surrounding the proposed site was not available at the time of this assessment. Ambient levels of odour are expected to be primarily influenced by the existing Stotts Creek Landfill cells and general agriculture in the area.

It is understood there have been no complaints relating to odour from the existing Stotts Creek Landfill. Therefore, it can be assumed that ambient odour levels are not offensive and would be within the OEH recommended limits.

4. Emissions Inventory

4.1 Quarrying

The assessment of air emissions from quarrying activities focuses on dust, being the primary emission with potential for off-site impact. The fractions of interest assessed in this report are airborne concentrations of TSP and fine particulate matter (PM_{10}) as well as total deposited dust.

Quarrying activities will include rock extraction, screening, crushing (to secondary ~7 mm) and transport of the processed rock off-site. Currently, crushing to a tertiary level is not required and is not expected to be required in the future.

The individual processes that generate significant amounts of particulate matter (dust) were identified to be:

- Rock quarrying eg excavation, bulldozer and blasting (if required).
- Material processing and handling eg crushing, screening and loading.
- Vehicle induced dust emissions in pit area.
- Wind erosion of exposed unstable soil surfaces and localised stockpiles.

Emission rates from naturally wind-borne dust and mechanically induced dust were characterised using Emission Factors (EF) provided in the National Pollutant Inventory (NPI) Emission Estimation Technique manual for Mining[2]. The EET used to estimate emissions from mining operations are based primarily on activity rate (e.g. tonnes per hour). The United States Environment Protection Agency Emission Factors and AP 42, *Compilation of Air Pollution Emission Factors* were also utilised, particularly for rock crushing, where they were deemed to be more applicable than the NPI emission factors, which are based on more general mining operations.

Material production at each quarry would be approximately 200,000 tonnes per year, which would include siltstone/conglomerates and overburden (soil and clay material above the base rock).

Based on the operation of the existing Quirk's Quarry, it is understood that the operating quarry could achieve a maximum rock throughput of 400 tonnes per hour (TPH). However, under typical operating conditions the quarry would process between 500 and 1000 tonnes per day, which corresponds to crushers operating at approximately 100 tonnes per hour for 6 hours per day, 6 days per week to process approximately 200,000 tonnes of rock per year.

[2] National pollutant Inventory (NP)I Emission Estimation Technique Manual for Mining, Version 2.3.

Although it is not expected that the quarry will operate at 400 TPH consistently, it is possible that this will occur from time to time, hence, GHD has considered the higher throughput of 400 TPH in this assessment, to represent a worst-case scenario to derive emissions rates with which to assess air quality criteria with short-term averaging periods (eg 24-hour). The average hourly throughput of 100 TPH, which is more representative of the normal production rate, was used to derive dust emission rates with which to assess air quality criteria with long-term averaging periods.

Table 4-1 provides a summary of the quarry equipment considered in this assessment.

Table 4-1 On-Site Equipment Summary

Equipment Type	Number of units
Hard rock drill	1
Excavator	1
Dozer	1
Wheeled loader	2
Primary crusher (including screens, conveyor)	1
Secondary crusher (including screens, conveyor)	1
Water truck	1
Haul trucks (within quarry site at any one time)	2

The following assumptions were made in calculating the emission rates for quarry activities:

- Soil moisture and silt contents were not known at the time of this assessment. Therefore the default emission factor in the NPI Manual for Mining have been adopted.
- Where there was more than one item of the same equipment, the total throughput was split between each item. For example, if there were two loaders operating at once, it was assumed that each loader would have a throughput of 200 TPH under the maximum production rate of 400 TPH.
- The proposed haul road from Stotts Creek RRC to the operating quarry and landfill sites would be sealed, therefore, wheel induced dust emissions from haul trucks along this road were assumed to be negligible and not considered further in this assessment.
- Based on the maximum production rate of 400 TPH, a maximum of 50 haul trucks per day would access the quarry per day. Under normal operations, a total of 26 haul trucks would access the quarry daily. Each haul truck was assumed to travel a 300 metre unsealed path through the quarry before exiting back onto the sealed haul road.
- The use of a water truck has been assumed not to generate dust emissions, as its use will act to suppress emissions. Therefore, the water truck has not been included in the emissions inventory.
- It was assumed that 100% of rock was processed to secondary standard (ie under the maximum production rate 400 tonnes per hour would pass through the secondary crusher).

- Crushing emission factors have been based on low moisture content material because it is understood that water spray systems on crushers and screens have not been proposed.
- GHD has conservatively assumed that the entire quarry pit area consists of unconsolidated areas. Therefore, wind erosion was modelled as acting over the entire pit area.
- It is likely that certain equipment or processes will only operate for short periods throughout each day. It is not known at what times in a shift operations will occur or when there will be stoppages. Therefore, dust emissions for each activity were spread over the full operating day of 10 hours. The scaled emission rates were modelled as occurring uniformly over each shift, sampling the full range of meteorological conditions.
- Conservatively, control factors for pit retention have not been applied (5% PM_{10} and 50% TSP).
- Blasting activities would be an infrequent event at the proposed quarries and as a result have not been included in the dispersion modelling assessment. Further discussion on dust impacts from blasting events can be found in Section 6.2.

Table 4-2 summarises the emission factors adopted and calculated emission rates for each item of equipment and activity within the quarry.

Table 4-2 Process Dust Emission Rates

Equipment and Process	TSP Emission Factor	PM_{10} Emission Factor	Unit	Application	400 TPH		100 TPH [1]	
					TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)	TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)
Crusher – Primary [2]	0.0167	0.0061	kg/t	Operating 6 hours per day	**4.01**	**1.45**	**1.00**	**0.36**
	0.0018 (Controlled)	0.00066 (Controlled)	kg/t	Operating 6 hours per day	**0.42**	**0.16**	**0.11**	**0.04**
Crusher – Secondary [2]	0.0167	0.00605	kg/t	Operating 6 hours per day	**4.01**	**1.45**	**1.00**	**0.36**
	0.0018 (Controlled)	0.00066 (Controlled)	kg/t	Operating 6 hours per day	**0.42**	**0.16**	**0.11**	**0.04**
Loader [1] [3] [4]	0.025	0.012	kg/t	2 loaders, operating 4 hours per day each	**4.00**	**1.92**	**1.00**	**0.48**
Dozer [5]	17	4	kg/h	Operating 5 hours per day	**8.50**	**2.00**	**5.10**	**1.20**
Excavator [1]	0.025	0.012	kg/t	Operating 6 hours per day	**5.00**	**2.40**	**1.25**	**0.60**
Hard rock drill	0.59	0.31	kg/hole	1 hole per hour, 4 hours per day	**0.24**	**0.12**	**0.24**	**0.12**
Trucks [6]	3.88	0.96	kg/VKT	Each truck travels 300 metres	**2.91**	**0.72**	**1.51**	**0.37**
Unloading from stockpiles [3]	0.03	0.013	kg/t	Operating 4 hours per day	**2.40**	**1.04**	**1.20**	**0.26**

1. 100 TPH used to derive emission rate used to assess long-term (i.e. annual) PM10, TSP and dust deposition criteria.
2. Rock crushing emission rates derived from US EPA AP42 Section 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing. Emission factors supplied for tertiary crushing only. Therefore emission rate was adopted for upper limit of primary and secondary crushing. Emission factors include crushing, screening and material transfer (conveyor) process. Process emission rates supplied as uncontrolled (no water sprays) and with controls (standard wet supression techniques).
3. 50% control factor applied when wet suppression used on crushers. Moisture carry over would mean that processed material in stockpiles would also have higher moisture content. Stockpiles are also regularly watered.
4. Loader processes include wheel generated dust emissions and fugitive emissions from loading of material into trucks.
5. Emission factors for PM_{10} and TSP from dozer operations are based on default values of soil moisture content and silt content of 2% and 10% respectively. Without site specific data default factors have been adopted. However, gravel quarries can have much lower silt contents than the default values. For example, if the silt content was 6% and with moisture remaining at 2%, the emissions rates would become 9 kg/h (TSP) and 2 kg/h (PM_{10}). This is approximately half of the adopted emission rates. Therefore, the default emission rates are considered highly conservative.
6. Under the maximum 400 TPH a total of 50 trucks would access the quarry per day. At 100 TPH, 26 trucks were assumed to access the quarry. Each truck to travel 300 metres on unsealed roads. 50% control factor applied for Level 1 watering (2 litres/m^2/hour). Emission rates for wheel generated dust on unpaved roads are based on 10% silt content, 2% moisture content and a gross vehicle mass of 48 tonnes. The average truck mass for the quarry is more likely to be 25 tonnes, therefore, emission factors are considered conservative.

4.2 Landfill

Odour and particulate matter (dust) are generally considered to be the two primary air quality issues associated with waste transfer stations and landfill operations. Other air emissions such as combustion products (eg vehicle exhaust) are generally minimal. In most cases, odour is generally the most significant air quality constraint.

4.2.1 Odour

The most significant potential source of odour will be emissions from mixed putrescibles waste placed at the tipping face of the active landfill cell. The closed landfill cells will continue to contribute as minor odour source via landfill gas release from the restored landfill surface. However, this source is not considered to be a significant odour source, and odorous emissions from the closed (ie capped) landfill cells are not included in the initial assessment of off-site odour impact.

A literature review was performed to ascertain the likely odour emission rates from the identified sources at the proposed facility. Odour emission rates from a similar facility have been sourced from '*Odour Audit: Eastern Creek Stage 2: Holmes Air Sciences, December 2003*'. The Eastern Creek Landfill also accepts putrescible waste (but on a much larger scale) and implements a leachate collection and treatment system, whereby leachate is collected by a series of pipes and biologically treated on site before being either deposited back into the active landfill or safely discharged into the sewer. These adopted odour emission rates are therefore considered representative for the purposes of this assessment.

The odour emission rates adopted for this assessment are summarised in Table 4-3.

Table 4-3 Estimated Odour Emission Rates - Landfill

Landfill	Years of Operation	Waste acceptance (tonnes per annum) (1)	Tipping Face Area (m^2) (2)	Intermediate Cover Area (m^2) (3)	SOER (OU m/s) (4) (5)		
					Tipping face	Daily cover (6)	Intermediate cover (7)
Quirks	2012 – 2021	Up to 75,000	202	13000	7	0.35	0.07
West Valley	2022 – 2033	From 58,000 to 100,000	289	18571	7	0.35	0.07
North Valley	2034 – 2045	From 100,000 to 145,000	418	26929	7	0.35	0.07

1. Upper limit of waste acceptance used in odour modelling.
2. Area of active face was not available. Therefore the area of the active face was based on upper limit of wast acceptance. For example, at Quirks Landfill - 70,000 tonnes/annum divided by 260 days/yr equals approximately 270 t/day to landfill at 0.75 t/m^3 equals ~202 m^3. Assume 1 m high face equals ~202 m^2.
3. Surface area of intermediate cover estimated to be 50% of the total cell area for each stage. Total surface area for the existing Stotts Creek Landfill is 26,100 m^2. Future areas were pro-rated based on waste acceptance rates.
4. Specific odour emission rate as reported in Odour Audit: Eastern Creek Stage 2, Holmes Air Sciences, December 2003. Peak-to-Mean ratios of 2.3 and 1.9 were applied over wind speed/stability times as per Approved methods.
5. The SOER data referenced to Eastern Creek were measured using Isolation flux Chambers (IFCs). Additional odour emission rate data from a Landfill accepting putrescible waste has been compiled by GHD through indirect measurements by downwind profiling and back-calculation using Ausplume in SITA Australia Pty Ltd Proposed SAWT Facility at Hallam Road Landfill, Odour and Dust Impact Assessment, February 2006. Testing was undertaken at SITA's Lyndhurst Landfill. Results showed morning SOER's of ~ 4 OUm/s, and afternoon SOERs of ~ 40 OUm/s. Simulations using these alternative OERs returned off-site odour concentrations almost identical to the reported results.
6. Odour emission rate equal to 5% of the active face odour emission rate was applied to the landfill source in the dispersion modelling outside normal operating hours to account for the application of daily cover over the active face.
7. A specific odour emission rate equal to ~1% of the active face odour emission rate was used to account for emissions from intermediate cover area. This 99% reduction in odour emission rate is based on the relationship between odour emissions from an active face and intermediate cover as reported in Odour Audit: Eastern Creek Stage 2, Holmes Air Sciences, December 2003.

Table 4-3 shows that although the derived odour emission rate from the intermediate cover area is low, the surface area is high, and it is significant odour source. However, in reality it is unlikely that this source would be a major contributor to off-site odour impact because the character and hedonic tone of odour emitted from this source will be less offensive than the emissions from the active tipping face.

It should also be noted that this assessment is inherently conservative because the total waste received per day has been assumed to be 100% putrescible waste and to occupy the entire active face area over the entire duration of operating hours. In reality, there would be a progressive build-up of waste in the active cell over the course of the day.

4.3 Dust

Sources of dust will include:

- Earthworks and waste handling within the landfill.
- Vehicle movements on unsealed roads about the site and on the landfill area.
- Wind erosion from disturbed/unsealed areas on the site.

The following assumptions were made in calculating the dust emission rates for landfill activities:

- It is likely that certain equipment or processes will only operate for short periods throughout each day. It is not known at what times in a shift operations will occur or when there will be stoppages. Therefore, dust emissions for each activity were spread over the full operating day of 9 hours. The scaled emission rates were modelled as occurring uniformly over each shift, sampling the full range of meteorological conditions.
- Wheel induced dust emissions from haul trucks along the sealed haul road from the Stotts Creek RRC were assumed to be negligible and not considered further in this assessment.
- The use of a water truck has been assumed not to generate dust emissions, as its use will act to suppress emissions. Therefore, the water truck has not been included in the emissions inventory.

The emission inventory derived for the Landfill is detailed in Table 4-4.

Table 4-4 Dust Emission Inventory – Landfill

Equipment	Default TSP Emission Factor	Default PM_{10} Emission Factor	Unit	Application	TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)
Stomper	No data	No data				
Dozer	17	4	kg/h	Active 3 hours over 9 hour day	5.7	1.3
Excavator	0.026	0.012	kg/t	Shifting half of waste acceptance per day.	0.6 (1)	0.28 (1)
Trucks	3.88	0.96	kg/VKT	Total operating 2 hours per day at average 20 km/hr equals 40 km. 50% control for watering	8.6	2.1

1. Example for Quirks Landfill - 150 mm of daily cover applied to active face area of 210 m^2 assuming 1.5 t/m^3 equals ~47 tonnes of daily cover per day. Emission rate adjusted based on tipping face area for each stage of the development as per Table 4-3.

5. Dispersion Modelling Methodology

Dispersion modelling was conducted to predict the maximum ground level concentrations of dust (TSP and PM_{10}) and odour resulting from emissions to air from quarry and landfill operations. Dust deposition rates were also predicted. The predicted ground level concentrations (GLC) and dust deposition rates were then assessed against the relevant OEH criteria.

Dispersion modelling of emissions to air requires the selection of an appropriate model and then the selection of three general types of input. These are:

- Hourly site-specific or site representative meteorological data for a period of not less than one year. The meteorological data file used in this assessment is discussed in Section 3.2.
- Source characterisation (which includes an emission rate inventory and source geometry).
- Model configuration – in which the various model settings are selected to best characterise the physical processes specific to this site and to make best use of the available emissions and meteorological data.

The source characterisation and model configuration are detailed below under relevant section headings.

5.1 The Model

Ausplume version 6.0 is a regulatory dispersion model and was used in this assessment.

5.2 Source Characterisation

5.2.1 Mobile and Fixed Plant

Processing equipment and mobile equipment, such as the crushers (with associated screens and conveyors etc), loaders, excavators, the dozer and trucks have been modelled as individual 'volume' sources using the corresponding emission rates presented in Table 4-2. Volume sources are often used to model well mixed fugitive emissions downwind of buildings and stationary plant. Further details of model input are shown in the Ausplume output in Appendix A.

Table 5-1 summarises the source characteristics used as input to the dispersion model.

Table 5-1 Source Characteristics

Source	Horizontal Spread (m)	Vertical Spread (m)	Source Height (m)
Dozer	5	2	0
Crusher	5	3	0
Loader	5	2	0
Excavator	5	3	0

Source	Horizontal Spread (m)	Vertical Spread (m)	Source Height (m)
Haul truck	5	3	0

5.2.2 Wind Erosion

Wind erosion was modelled as an area source over the surface area of the quarry pit area and landfill site based on the proposed footprints for each site. Dust emission rates were set in for each wind speed category proportional to the wind speed cubed as shown in Table 5-2.

Based on current operations at Quirks Quarry, part of the site is regularly watered, especially water spray systems on stockpile areas. However, other parts of the site are unwatered. Conservatively, a control factor for watering has not been applied to wind erosion emission rates.

Table 5-2 Wind Erosion Dust Emission Rates

Wind Speed Category (m/s)	Specific TSP Emission Rate ($kg/hr/m^2$)	Specific PM_{10} Emission Rate ($kg/hr/m^2$)
> 10.80	0.00024	0.00012
8.24 > 10.80	0.00012	0.00006
5.15 > 8.23	0.000041	0.000021
3.10 > 5.14	0.000010	0.000005
1.55 > 3.09	0.0000021	0.0000011
0 > 1.54	0.0000002	0.0000001

5.2.3 Dust Deposition

Dust deposition parameters have been set[3] as provided in Table 5-3.

Table 5-3 Dust Deposition Parameters

Fraction No.	Mass fraction	Particle size (micron)	Particle density (g/cm^3)
1	0.052	1.8	2.6
2	0.140	4.0	2.6
3	0.223	8.0	2.6
4	0.322	17.0	2.6

[3] Based on data provided in the NSW Minerals Council Technical Paper: Particulate Matter and Mining Interim Report, 2000.

Fraction No.	Mass fraction	Particle size (micron)	Particle density (g/cm^3)
5	0.263	31.0	2.6

5.2.4 Model Configuration

Dispersion modelling was undertaken for each of the possible site configurations as outlined in the Concept Plan project description. Based on the proposed time line of the Concept Plan, only one quarry and one landfill would operate at any given time. Therefore, three site configurations were modelled:

- Configuration 1: Quirks Landfill and West Valley Quarry. Stage 1 of the proposed Concept Plan (2012 – 2021).
- Configuration 2: West Valley Landfill and North Valley Quarry. Stage 2 of the proposed Concept Plan (2022 – 2033).
- Configuration 3: North Valley Landfill only (2034 – 2045).

Key components of the Ausplume model configuration used in this assessment are as follows:

- Ground level concentrations (GLC) were predicted over a 2 km by 2 km receptor grid, with a grid resolution of 50 m.
- The depletion option was selected for the TSP model but not selected for PM_{10} model runs (this is a conservative approach and will result in a slight over-estimate of PM_{10} concentration).
- Peak-to-Mean scaling factors for each Pasquill stability category are prescribed in the OEH Approved Methods. These were factored into the component odour emission rates for each relevant source type and for far-field odour assessment to the odour model output (1-hour average) corresponds to peak 1-second average odour concentrations.
- Irwin's 'Rural' wind profile exponents were used.
- Horizontal dispersion was parameterised according to equations for the Pasquill-Gifford curves.
- A roughness height of 0.4 m ('Rolling Rural') was used to represent the land features that surround the site.

Further detail on the Ausplume configuration can be found in the Ausplume output file attached in Appendix A.

5.3 Assessment Criteria

5.3.1 Dust

Air quality impact assessment criteria are prescribed within the NSW OEH Approved methods.

To ensure the environmental outcomes are achieved, emissions from a premise must be assessed against the assessment criteria given in Table 5-4.

Table 5-4 Assessment Criteria for Dust

Pollutant	Averaging Period	Criteria
PM_{10}	24 hours	50 $\mu g/m^3$
	Annual	30 $\mu g/m^3$
TSP	Annual	90 $\mu g/m^3$
Dust deposition	Annual	2 g/m^2/month*

** Maximum Increment. Maximum cumulative impact of 4 g/m^2/month.*

The above criteria are provided as cumulative (incremental plus background) concentration levels.

As there is no background dust level emissions data available for the Eviron area, a background concentration level of 20 $\mu g/m^3$ for PM_{10} was assumed, as discussed in Section 3.3. A Background concentration of TSP was assumed to be 40 $\mu g/m^3$.

5.3.2 Odour

The impact assessment criterion for complex mixtures of odorous air pollutants, prescribed by the OEH Approved Methods adopts a sliding scale (2 to 7 OU, 99 percentile, 1 second average) – dependent on the size of the affected population P. This is expressed in the equation:

Criterion $OU_c = (\log_{10} P - 4.5) \div -0.6$.

Application of the above equation yields a range of odour performance criteria that should be applied at the nearest off site sensitive receptor, as outlined in Table 5-5.

Table 5-5 NSW DECCW Odour Criteria

Population of Affected Community	Odour Criteria* (OU)
Urban (≥2000)	2
~500	3
~125	4
~30	5
~10	6

*Nose response time average, 99^{th} percentile

Note that the criteria outlined in Table 5-5 are required to be met at the nearest off site sensitive receptors at the 99 percentile and at a 1 second peak averaging time.

The proposed site is located in a primarily rural environment and it is assumed that the existing population that may potentially be effected by odorous emissions is in the order of 10 – 30 people, hence an odour impact assessment criterion of 5 OU would apply. However, parts of the area surrounding the proposed Concept Plan are zoned residential so there is potential for the potentially impacted population to grow throughout the Concept Plan lifetime. Therefore, to account for future development, an odour assessment criterion of 2 OU has been adopted.

6. Predicted Air Quality Impacts

6.1 Dust

A summary of the results of the dispersion modelling assessment are presented in Table 6-1, Table 6-2 and Table 6-3. Full results are presented in Appendix B. The maximum predicted ground level concentration and deposition rates at the most impacted sensitive receptor has been added to the adopted background levels to determine the cumulative impact.

Table 6-1 Configuration 1 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor

Pollutant	Averaging Period	Units	Maximum predicted incremental impact [1]	Adopted Back-ground Level	Cumulative Impact	Criteria
Most Exposed Receptor: Receptor 3						
PM_{10}	24-hour	µg/m^3	**95**	20	**115**	50
PM_{10}	Annual	µg/m^3	4	20	24	30
TSP	Annual	µg/m^3	10	40	50	90
Dust deposition -	Annual	g/m^2/month	0.4	2[2]	2.4	4

(1) 24-hour concentration predicted using the maximum quarry throughput of 400 TPH. Annual concentrations predicted using average quarry throughput of 100 TPH.

(2) Conservative background dust deposition level of 2 g/m^2/month adopted.

Table 6-2 Configuration 2 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor

Pollutant	Averaging Period	Units	Maximum predicted incremental impact [1]	Adopted Back-ground Level	Cumulative Impact	Criteria
Most Exposed Receptor: Receptor 3						
PM_{10}	24-hour	µg/m^3	32	20	**52**[2]	50
PM_{10}	Annual	µg/m^3	3	20	23	30
TSP	Annual	µg/m^3	10	40	50	90
Dust deposition -	Annual	g/m^2/month	0.4	2[3]	2.4	4

(1) 24-hour concentration predicted using the maximum quarry throughput of 400 TPH. Annual concentrations predicted using average quarry throughput of 100 TPH.

(2) The OEH Approved Methods allows for the PM10 24 hour criterion to be exceeded up to 5 times per year. The second highest prediction at Receptor 3 would result in a cumulative impact under 50 µg/m3.

(3) Conservative background dust deposition level of 2 g/m2/month adopted.

Table 6-3 Configuration 3 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor

Pollutant	Averaging Period	Units	Maximum predicted incremental impact [1]	Adopted Back-ground Level	Cumulative Impact	Criteria
Most Exposed Receptor: Receptor 2						
PM_{10}	24-hour	$\mu g/m^3$	9	20	29	50
PM_{10}	Annual	$\mu g/m^3$	<1	20	21	30
TSP	Annual	$\mu g/m^3$	2	40	42	90
Dust deposition -	Annual	g/m^2/month	<0.1	2[2]	2.1	4

(1) 24-hour concentration predicted using the maximum quarry throughput of 400 TPH. Annual concentrations predicted using average quarry throughput of 100 TPH.

(2) Conservative background dust deposition level of 2 g/m^2/month adopted.

Table 6-1 shows that, based on the adopted background levels and assumptions made in this assessment, all constituents assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors for the modelled emission rate characteristics, with the exception of PM_{10} (24-hour).

Table 6-2 and Table 6-3 indicate that under Configurations 2 and 3, all constituents assessed over the relevant averaging periods were below their respective assessment criteria at the most affected sensitive receptor.

Further detail on the model results, specifically short term impacts of PM_{10}, are provided in the following sub-section. Contour plots of the predicted impacts are shown in Appendix C.

6.1.1 PM_{10}

Table 6-1 shows that under configuration 1, the maximum predicted total (ie 20 $\mu g/m^3$ background + 95 increment = 115 $\mu g/m^3$ total impact) impact for PM_{10} has the potential to exceed the 24-hour average criterion. Note that this is the maximum predicted impact is based on a 400 TPH production rate and worst case meteorological conditions.

The model sensitivity to a reduction in dust emission rates as a result of lower production rates is shown in Table 6-4. Sensitivity runs have been based on Configuration 1 only, as this has been identified as the stage of the project which poses the greatest potential for dust impacts.

Table 6-4 Configuration 1 – PM_{10} 24-hour Concentrations – 400 TPH vs. 100 TPH

Receptor	400 TPH Quarry Throughput		100 TPH Quarry Throughput	
	Incremental Impact (µg/m^3)	Cumulative Impact (µg/m^3)	Incremental Impact (µg/m^3)	Cumulative Impact (µg/m^3)
1	43	**63**	22	42
2	20	40	8	28
3	95	**115**	30	**50** [1]
4	45	**65**	15	35
5	16	36	6	26
6	26	46	16	36
7	18	38	10	30

(1) The OEH Approved Methods allows for the PM10 24 hour criterion to be exceeded up to 5 times per year. The second highest prediction at Receptor 3 would result in a cumulative impact under 50 µg/m3.

Note: Cumulative impact levels based on adopted background concentration of 20 µg/m^3. PM_{10} criterion is 50 µg/m^3.

Table 6-4 shows that when the model configuration is based on the more typical production rate of 100 TPH the predicted PM_{10} 24-hour concentrations are shown to comply with the criterion of 50 µg/m^3. The maximum predicted incremental impact was found to be roughly 60% of the criterion at the most affected receptor.

Further analysis of the model results for the 400 TPH scenario also revealed that the frequency at which the PM_{10} levels are predicted to exceed 30 µg/m^3 (ie the threshold at which the addition of the adopted background level would exceed the criterion) is less than approximately 30 days per year at the most exposed receptor. The frequency that the predicted incremental PM_{10} (24-hour) concentration exceeds 50 µg/m^3 is less than three times per year. Therefore, it is likely that impact of PM_{10} emissions from operations under Configuration 1 on a day-to-day basis would comply with the PM_{10} criterion. The quarry would operate at 400 TPH infrequently, and when it does operate at 400 TPH, it is unlikely that this event would be coupled with the adverse meteorological conditions required to cause maximum impact.

6.2 Impacts from Blast Events

As previously discussed, blasting will take place a maximum of once per week at the quarries but will typically occur once every few months on an as-need basis. Dust plumes generated from a blast event can be significant, however, they are generally well dispersed within a short time period (in the order of seconds to minutes). Therefore, the contribution to off-site dust levels on a 24-hour averaging period would be negligible. There is no criterion set in NSW for exposure to short-term PM_{10} or TSP over this duration.

The Ausplume dispersion model has a minimum emission rate input of 1-hour blocks. Therefore, an accurate representation of a blast event over a period of approximately 1 minute cannot be made. A hypothetical example of potential dust impacts off site from a blast event is provided below. This example utilises the PM_{10} emission factors for blasting provided in the NPI EET Manual for Mining. The following parameters were used:

- Blast Area = 20 m x 20 m = 400 m^2.
- Hole depth = 5 m.
- Soil Moisture = 2%.
- PM_{10} mass emission rate based on the above = 319 kg/blast.
- One blast per 24-hour period.
- Concentration in dust plume (assume 50 m high) = 319/(20 x 20 x 50) = 0.016 kg/m^3.

A test model run indicated that the maximum impact at the nearest receptor occurred under neutral atmospheric conditions and wind of approximately 3 m/sec. Conservatively assuming this plume does not immediately disperse, it will pass over a receptor on the site boundary for a period of 20/3 = 7 seconds. During this time the receptor would experience high concentration levels of PM_{10}, while for the remainder to the 24-hour period it would receive no impact from the quarry. Therefore, the 24-hour average PM_{10} concentration from a blast event becomes 0.016x7/86400[(4)] = 1.29E-6 kg/m^3, or 1.29 µg/m^3. This concentration is approximately 3% of the PM_{10} 24-hour criterion.

Therefore, due to the short-term duration of blasting and the cessation of other quarry activities during the blast it is highly unlikely that blast dust emissions would have a significant effect on day-to-day dust impacts off site.

6.3 Predicted Odour Impact

The predicted 1-second peak (nose response time) ground level odour concentrations for the proposed landfills under normal operating conditions are shown in Table 6-5. These predicted odour concentrations indicate that the 2 OU criterion would be readily achieved at all sensitive receptors under all three configurations. It is noteworthy that the 1 OU (equivalent to the odour detection threshold) contour is generally confined within approximately 200 metres from the landfill site boundary.

Table 6-5 Predicted Odour Concentration (OU)

Receptor	Odour Concentration (OU)		
	Configuration 1	Configuration 2	Configuration 3
1	<1	<1	<1
2	<1	<1	<1
3	<1	1	<1

[4] Number of seconds in 24 hours.

Receptor	Odour Concentration (OU)		
	Configuration 1	Configuration 2	Configuration 3
4	<1	<1	<1
5	<1	<1	<1
6	<1	<1	<1
7	<1	<1	<1

Compliance with the criterion is such that a conservative safety margin is available to account for potential variations in odorous emissions that may occur, such as changes to the quality of waste or extreme seasonal events.

The 2 OU criterion has been adopted based on the expected future growth of residential areas around the proposed site. Contour plots of the predicted odour concentrations are shown in Appendix D, which may be used for the purposes of guiding future zoning and planning for buffer zones around the landfill areas.

6.4 Summary of Results

A summary of the predicted results are outlined below. Results are based on the assumptions made in the above sections of this report:

- Under Configuration 1, all constituents (dust and odour) assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors, with the exception of PM_{10} 24-hour. The maximum predicted PM_{10} 24-hour average concentration levels have the potential to exceed the OEH criteria at Receptors 1, 3 and 4.
- Under Configuration 2, all constituents (dust and odour) assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors.
- Under Configuration 3, all constituents (dust and odour) assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors.
- Maximum predictions were made using the maximum quarry throughput of 400 TPH. However, based on the more typical throughput of 100 TPH, PM_{10} 24-hour concentration levels were found to comply with the OEH criteria at all receptors under all configurations.
- For maximum impact to occur, the quarry would have to be operating at maximum throughput (400 TPH) during the worst-case meteorological conditions (constant winds throughout the day in the direction of the nearest receptors). While this is possible, it is highly unlikely to occur.
- Options for dust mitigation measures have been provided and analysed in Section 7 of this report.

7. Recommended Mitigation Measures

7.1 Specific Dust Control Measures

Effective management of dust and odour emissions is critical to the successful operations of each quarry and landfill throughout Stage 1 and the Concept Plan. As indicated in the dispersion modelling assessment, dust emissions, in particular fine particulates (PM_{10}) pose the greatest potential for off-site impact during the operations of the Concept Plan. The following sections address some options for further dust control measures with the aim of minimising emissions to achieve compliance with the OEH criteria.

Analysis of the emissions inventory indicates that the major source of dust emissions from the quarry under the maximum throughput of 400 TPH were from activities associated with the processing plant (i.e. crushers, loaders, dozer and excavator). Figure 7-1 shows that contributions from these operations were as high as 79% of total PM_{10} emissions. Therefore, dust mitigation measures as part of these operations will have the biggest impact in reducing overall site emissions.

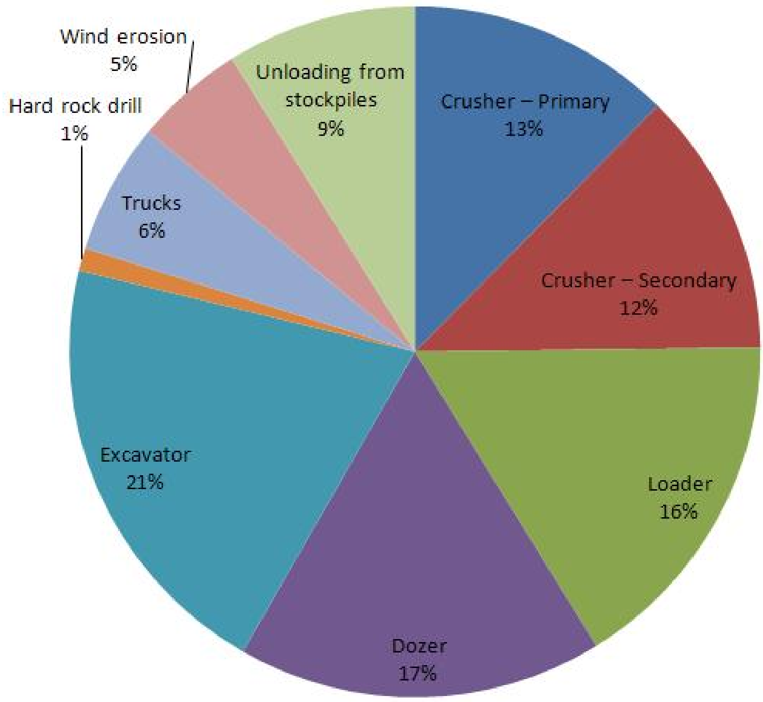


Figure 7-1 Quarry PM_{10} Emissions by Equipment – 400 TPH Operations

The moisture content of the material processed can have a substantial effect on emissions. Water sprays are generally the most simple and effective form of dust suppression on processing activities. Water sprays work by increasing the moisture content of material. The surface wetness causes fine particles to agglomerate on or to adhere to the faces of larger stones, with a resulting dust suppression effect.

While water sprays would be impractical to use with the dozer or excavator, they can be effectively used in crushing and screening plant. Moisture carry over would mean that processed material in stockpiles would also have higher moisture content. In addition, stockpiles are also regularly watered, allowing for a controlled emission factor to be applied to loader and loading operations.

The model sensitivity to reduction in dust emission rates as a result of the implementation of a water spray system on the crushers is shown in Table 7-1. Water sprays would need to increase the moisture content of material to greater than 4% by weight.

Table 7-1 Configuration 1 – PM_{10} 24-Hour Predicted Incremental Concentrations – With and Without Water Sprays on Crushers

Receptor	400 TPH Quarry Throughput – Uncontrolled	400 TPH – Water Spray on Crushers	100 TPH Quarry Throughput – Uncontrolled	100 TPH – Water Spray on Crushers
1	43	28	22	22
2	20	12	8	7
3	95	55	30	23
4	45	25	15	13
5	16	10	6	6
6	26	20	16	16
7	18	12	10	9

Note: Concentration levels that exceed the 24-hour criterion (based on the adopted background levels) are bolded.

Predicted results show that processing high moisture content material (ie moisture content >4% by weight, either naturally or by virtue of added water) could reduce predicted incremental PM_{10} concentrations at the nearest receptors by up to 40%.

Figure 7-2 shows the revised contributions from each operation based on a high moisture content material through the processing plant. The split of contribution indicates that the excavator and dozer become the most significant sources of PM_{10} when dust suppression is implemented in the processing operations.

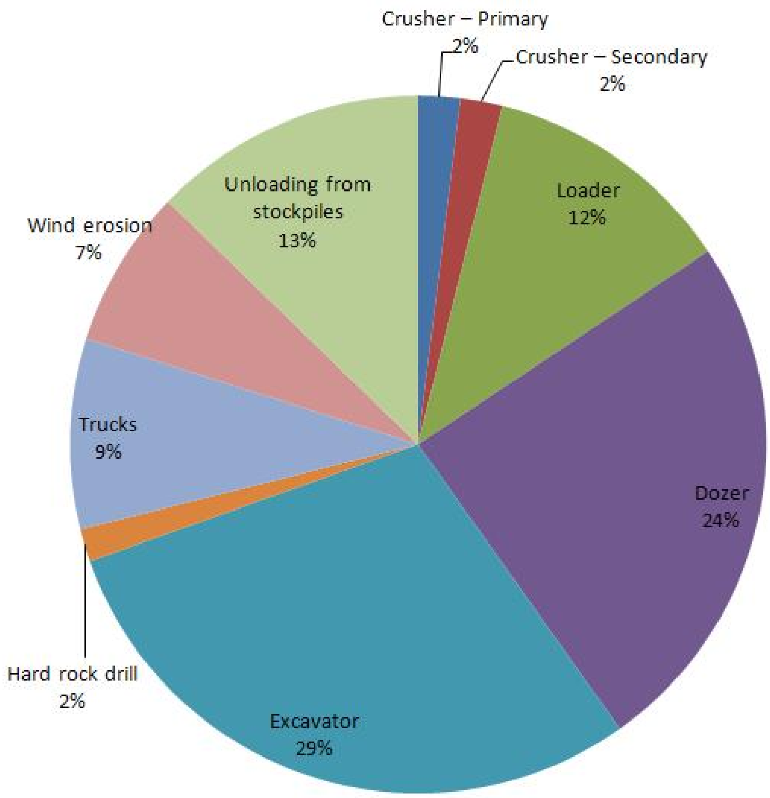


Figure 7-2 Quarry PM_{10} Emissions by Equipment – 400 TPH Operations – with Water Sprays on Crushers

Table 7-1 indicates that even with the use of dust suppression techniques on processing plant, there is still potential for short-term PM_{10} impacts at the nearest receptors under the maximum production rate of 400 TPH. Therefore, improvements to best practice dust management measures should focus on this short-term impact. Examples of additional management measures would be to cease or reduce operations when prevailing winds are in the direction of sensitive receptors, particularly to the south and south-west of the quarry (northerly or north-easterly winds). The use of a real-time reactive dust monitoring at locations representative of the nearest sensitive receptors could also be used to alert the quarry manager when dust levels are high. The quarry manager could then take appropriate actions to ensure dust levels off site are reduced, such as reducing the production rate or excavation and dozer operations until weather conditions are more favourable.

Wind erosion is expected to contribute to approximately 7% of total site emissions. Therefore, in general, over a 24-hour period, wind erosion is not considered to be a problem. However, the sudden onset of weather systems that involve sharp increases in wind speed can have the effect of quickly stripping the fine surface silt content from exposed non-vegetated or non-rehabilitated soil, particularly if the silt content on that soil is high through recent mechanical activity. If not dealt with pro-actively, this can cause short- term (in the order of minutes) peaks in inhalable dust concentrations. It is therefore recommended that the management plan contain a condition that the quarry and landfill managers be provided with daily weather updates (eg the Bureau of Meteorology have a standard daily service) that will contain warnings of the sudden onset of strong winds. In the event of such warning, the quarry and landfill managers could then take steps to ensure that exposed areas that could reasonably be subjected to wind erosion are consolidated by the timely application of water sprays.

7.2 General Dust Control Measures

General measures that will be implemented as part of the existing dust control management plan include:

- Rehabilitated areas will be revegetated as early as possible after completion.
- Newly stripped topsoil stockpiles will be immediately watered and revegetated with a grass cover.
- Access routes to and from the stockpiles will be watered as required, particularly during peak periods of vehicle movements.

Additional dust management measures are provided below in Table 7-2.

Table 7-2 General Management of Air Emissions

Emission Source	Proposed Management
Dust generated from transport activities on-site and off-site	Use of water sprays/trucks and sprays to wet down access roads. Clean sealed roads at access and egress points regularly to minimise the re-suspension of dust on sealed roads
Dust generated from loading, unloading and storage/stockpiling of material on-site	Use water sprays to minimise truck dust emissions. Ensure materials are appropriately stored and contained to prevent releases to the atmosphere (eg wind fences, water sprays)
Dust from movement of fill during operation	Where material is removed from the site or fill brought to the site, trucks will be covered whenever conditions are such that dust nuisance is occurring. This might include windy conditions or when materials being transported have a high level of fine particles.
Dust from Crushing and screening operations	Install spray systems on equipment and the stabilisation of the surface silt content of working surfaces around the processing site through (i) application of water via general wheeled carting and (ii) localised, manually controlled, canon water spraying.

7.3 Odour Mitigation Measures

While adverse odour impacts are not predicted, the following measures should be considered as part of the odour management plant for landfill activities. Odours will be significantly reduced by operating the site in accordance with sanitary landfilling methods and good site management.

Odours will be minimised by:

- Not depositing waste in standing water.
- Depositing wastes in thin layers to optimise compaction.
- Immediately cover waste which is potentially malodorous.
- Covering all exposed waste at the end of each working day with daily cover material.
- Minimising disturbance of previously filled areas.

A record of complaints regarding odours will be kept by TSC in accordance with the complaint management system, and reported to the OEH as required in the Annual Return. Investigations into the source of the odour emission giving rise to the complaint and any corrective actions taken to rectify the cause of complaint would also be documented.

8. Conclusions

An assessment of potential air quality impacts associated with the proposed Eviron Landfill and Quarry Concept Plan, located in Eviron, NSW, has been undertaken. The air quality assessment of the proposed development has led to the following conclusions:

- Compilation of an emissions inventory confirms that the main source of dust emissions will be the operating quarry, while the main source of odour emissions will be the operating landfill.
- The dominant source of dust emissions within each quarry was shown to be the processing activities, consisting of the crushers, dozer, loaders and excavator.
- Configuration 1 was shown to pose the greatest potential for off-site dust impacts, particularly concentration levels of fine particulates (PM_{10}) over a 24-hour averaging period. All other constituents (dust and odour) assessed over the relevant averaging periods were predicted to be below their respective assessment criteria at the nearest sensitive receptors.
- Configurations 2 and 3 were shown to have less potential for off-site dust or odour impacts. In fact, all constituents (dust and odour) assessed over the relevant averaging periods were predicted to be below their respective assessment criteria at the nearest sensitive receptors.
- Predicted PM_{10} 24-hour average concentrations, modelled under a maximum quarry throughput of 400 TPH, indicate that PM_{10} concentrations may potentially exceed the 24-hour criterion at three of the identified sensitive receptors. However, when modelled under the anticipated normal production rate of 100 TPH, the model results indicate that PM_{10} concentrations would comply with the 24-hour criterion at all identified receptors.
- Predicted PM_{10} levels could be reduced at nearby sensitive receptors by up to 40% with the implementation of a water spray system to the rock processing area.
- Further options for dust mitigation measures are provided in Section 7. It is anticipated that through the implementation of these dust management measures and a site specific dust management plan, off-site dust impacts can be minimised and adverse impacts would be unlikely.

This Concept Plan study has been based on the processes and technologies used in quarry and landfill activities at the time of this assessment. The assessment does not take into consideration emerging technologies in heavy vehicle machinery, resource recovery, alternatives to land filling and increased regulation of waste minimisation and landfill diversion targets. As the Concept Plan has an expected life of greater than 30 years, it is highly likely that improvements in technology will see a reduction in air emissions associated with the proposed activities.

9. Limitations

This Air Quality Impact Assessment ("Report"):

- Has been prepared by GHD Pty Ltd ("GHD") for Tweed Shire Council (TSC).
- May only be used and relied on by TSC.
- Must not be copied to, used by, or relied on by any person other than TSC without the prior written consent of GHD.
- May only be used for the purpose of the scope of work outlined in Section 1.2 of this report (and must not be used for any other purpose).

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than TSC arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in Section 1.2 of this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report, including (but not limited to):

- Air dispersion modelling assumptions detailed in Section 5 and 6 of this report.

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation of this Report.

Appendix A

Ausplume Output File

1

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

Concentration or deposition	Concentration
Emission rate units	kg/hour
Concentration units	microgram/m3
Units conversion factor	2.78E+05
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Pasquill-Gifford
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.400m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES
24 hours

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

SOURCE GROUPS

Group No.	Members
1	QWIND QLOAD1 QDOZER QTRUC1 QTRUC2 QDRILL QUNLOA QCRUSH QEXCAV
2	LWIND LDOZER LTRUCK LTRUK2
3	QWIND LWIND LDOZER LTRUCK QLOAD1 QDOZER QTRUC1 QTRUC2 QDRILL QEXCAV QUNLOA QCRUSH LTRUK2
4	QWIND LWIND

1

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

SOURCE CHARACTERISTICS

INTEGRATED POLYGON AREA SOURCE: QWIND

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
549285	6869195	0m	4	1m	0m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	549285	6869195	2	549262	6868894
3	549726	6868834	4	549681	6868932

Emission rates by stability and wind speed, in kg/hour per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability B:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability C:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability D:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability E:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability F:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: LWIND

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
549885	6869036	0m	4	1m	0m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	549885	6869036	2	550034	6868683
3	550171	6868821	4	549950	6869083

Emission rates by stability and wind speed, in kg/hour per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability B:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability C:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability D:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability E:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability F:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04

No gravitational settling or scavenging.

VOLUME SOURCE: LDOZER

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
550038	6868834	0m	0m	5m	2m

```
          Emission rates by hour of day in kg/hour:
       1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
       5 0.00E+00      6 0.00E+00      7 0.00E+00      8 1.30E+00
       9 1.30E+00     10 1.30E+00     11 1.30E+00     12 1.30E+00
      13 1.30E+00     14 1.30E+00     15 1.30E+00     16 1.30E+00
      17 1.30E+00     18 0.00E+00     19 0.00E+00     20 0.00E+00
      21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

              No gravitational settling or scavenging.


               VOLUME SOURCE: LTRUCK

  X(m)     Y(m)      Ground Elevation     Height   Hor. spread   Vert. spread
550094   6868778             0m             0m        5m             3m

          Emission rates by hour of day in kg/hour:
       1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
       5 0.00E+00      6 0.00E+00      7 1.05E+00      8 1.05E+00
       9 1.05E+00     10 1.05E+00     11 1.05E+00     12 1.05E+00
      13 1.05E+00     14 1.05E+00     15 1.05E+00     16 1.05E+00
      17 1.05E+00     18 0.00E+00     19 0.00E+00     20 0.00E+00
      21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

              No gravitational settling or scavenging.


               VOLUME SOURCE: QLOAD1

  X(m)     Y(m)      Ground Elevation     Height   Hor. spread   Vert. spread
549397   6869042             0m             0m         5m             2m

          Emission rates by hour of day in kg/hour:
       1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
       5 0.00E+00      6 0.00E+00      7 0.00E+00      8 1.92E+00
       9 1.92E+00     10 1.92E+00     11 1.92E+00     12 1.92E+00
      13 1.92E+00     14 1.92E+00     15 1.92E+00     16 1.92E+00
      17 1.92E+00     18 0.00E+00     19 0.00E+00     20 0.00E+00
      21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

              No gravitational settling or scavenging.


               VOLUME SOURCE: QDOZER

  X(m)     Y(m)      Ground Elevation     Height   Hor. spread   Vert. spread
549419   6869018             0m             0m        5m             2m

          Emission rates by hour of day in kg/hour:
       1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
       5 0.00E+00      6 0.00E+00      7 0.00E+00      8 2.00E+00
       9 2.00E+00     10 2.00E+00     11 2.00E+00     12 2.00E+00
      13 2.00E+00     14 2.00E+00     15 2.00E+00     16 2.00E+00
      17 2.00E+00     18 0.00E+00     19 0.00E+00     20 0.00E+00
      21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

              No gravitational settling or scavenging.


               VOLUME SOURCE: QTRUC1

  X(m)     Y(m)      Ground Elevation     Height   Hor. spread   Vert. spread
549378   6869068             0m             0m        5m             2m

          Emission rates by hour of day in kg/hour:
       1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
       5 0.00E+00      6 0.00E+00      7 0.00E+00      8 3.50E-01
       9 3.50E-01     10 3.50E-01     11 3.50E-01     12 3.50E-01
      13 3.50E-01     14 3.50E-01     15 3.50E-01     16 3.50E-01
      17 3.50E-01     18 0.00E+00     19 0.00E+00     20 0.00E+00
```

```
        21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

                No gravitational settling or scavenging.


                 VOLUME SOURCE: QTRUC2

  X(m)     Y(m)     Ground Elevation     Height   Hor. spread   Vert. spread
549533  6868982              0m              0m          5m             3m

              Emission rates by hour of day in kg/hour:
         1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
         5 0.00E+00      6 0.00E+00      7 0.00E+00      8 3.50E-01
         9 3.50E-01     10 3.50E-01     11 3.50E-01     12 3.50E-01
        13 3.50E-01     14 3.50E-01     15 3.50E-01     16 3.50E-01
        17 3.50E-01     18 0.00E+00     19 0.00E+00     20 0.00E+00
        21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

                No gravitational settling or scavenging.


                 VOLUME SOURCE: QDRILL

  X(m)     Y(m)     Ground Elevation     Height   Hor. spread   Vert. spread
549426  6868896              0m              0m           1m             1m

              Emission rates by hour of day in kg/hour:
         1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
         5 0.00E+00      6 0.00E+00      7 0.00E+00      8 1.20E-01
         9 1.20E-01     10 1.20E-01     11 1.20E-01     12 1.20E-01
        13 1.20E-01     14 1.20E-01     15 1.20E-01     16 1.20E-01
        17 1.20E-01     18 0.00E+00     19 0.00E+00     20 0.00E+00
        21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

                No gravitational settling or scavenging.


                 VOLUME SOURCE: QCRUSH

  X(m)     Y(m)     Ground Elevation     Height   Hor. spread   Vert. spread
549395  6869042              0m              0m           5m             3m

              Emission rates by hour of day in kg/hour:
         1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
         5 0.00E+00      6 0.00E+00      7 0.00E+00      8 2.90E+00
         9 2.90E+00     10 2.90E+00     11 2.90E+00     12 2.90E+01
        13 2.90E+00     14 2.90E+00     15 2.90E+00     16 2.90E+00
        17 2.90E+00     18 0.00E+00     19 0.00E+00     20 0.00E+00
        21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

                No gravitational settling or scavenging.


                 VOLUME SOURCE: QEXCAV

  X(m)     Y(m)     Ground Elevation     Height   Hor. spread   Vert. spread
549438  6869055              0m              0m           5m             3m

              Emission rates by hour of day in kg/hour:
         1 0.00E+00      2 0.00E+00      3 0.00E+00      4 0.00E+00
         5 0.00E+00      6 0.00E+00      7 0.00E+00      8 2.88E+00
         9 2.88E+00     10 2.88E+00     11 2.88E+00     12 2.88E+00
        13 2.88E+00     14 2.88E+00     15 2.88E+00     16 2.88E+00
        17 2.88E+00     18 0.00E+00     19 0.00E+00     20 0.00E+00
        21 0.00E+00     22 0.00E+00     23 0.00E+00     24 0.00E+00

                No gravitational settling or scavenging.


                 VOLUME SOURCE: QUNLOA
```

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549400	6869050	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	0.00E+00	8	1.04E+00
9	1.04E+00	10	1.04E+00	11	1.04E+00	12	1.04E+00
13	1.04E+00	14	1.04E+00	15	1.04E+00	16	1.04E+00
17	1.04E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: LTRUK2

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549913	6868932	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	1.05E+00	8	1.05E+00
9	1.05E+00	10	1.05E+00	11	1.05E+00	12	1.05E+00
13	1.05E+00	14	1.05E+00	15	1.05E+00	16	1.05E+00
17	1.05E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

1

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):

```
548000.m  548050.m  548100.m  548150.m  548200.m  548250.m  548300.m
548350.m  548400.m  548450.m  548500.m  548550.m  548600.m  548650.m
548700.m  548750.m  548800.m  548850.m  548900.m  548950.m  549000.m
549050.m  549100.m  549150.m  549200.m  549250.m  549300.m  549350.m
549400.m  549450.m  549500.m  549550.m  549600.m  549650.m  549700.m
549750.m  549800.m  549850.m  549900.m  549950.m  550000.m  550050.m
550100.m  550150.m  550200.m  550250.m  550300.m  550350.m  550400.m
550450.m  550500.m  550550.m  550600.m  550650.m  550700.m  550750.m
550800.m  550850.m  550900.m  550950.m  551000.m  551050.m  551100.m
```

and these y-values (or northings):

```
6868000.m 6868050.m 6868100.m 6868150.m 6868200.m 6868250.m 6868300.m
6868350.m 6868400.m 6868450.m 6868500.m 6868550.m 6868600.m 6868650.m
6868700.m 6868750.m 6868800.m 6868850.m 6868900.m 6868950.m 6869000.m
6869050.m 6869100.m 6869150.m 6869200.m 6869250.m 6869300.m 6869350.m
6869400.m 6869450.m 6869500.m 6869550.m 6869600.m 6869650.m 6869700.m
6869750.m 6869800.m 6869850.m 6869900.m 6869950.m 6870000.m 6870050.m
6870100.m 6870150.m 6870200.m 6870250.m 6870300.m 6870350.m 6870400.m
6870450.m 6870500.m
```

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	550053	6868543	0.0	0.0	5	549707	6868158	0.0	0.0
2	548449	6869803	0.0	0.0	6	550513	6868341	0.0	0.0
3	549195	6868773	0.0	0.0	7	550750	6868887	0.0	0.0
4	549238	6868509	0.0	0.0					

METEOROLOGICAL DATA : Environ Met Data _ TAPM V4.02.

Appendix B

Predicted Dust Impacts

B1 – Predicted Dust Impacts at Sensitive Receptors

PM10 24hr (based on 400 tph)							
	Configuration 1		**Configuration 2**		**Configuration 3**		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	43	63	26	46	5	25	**50**
2	20	40	32	52	9	29	**50**
3	95	115	32	52	5	25	**50**
4	45	65	16	36	3	23	**50**
5	16	36	10	30	2	22	**50**
6	26	46	12	32	3	23	**50**
7	18	38	13	33	3	23	**50**

PM10 Annual							
	Configuration 1		**Configuration 2**		**Configuration 3**		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	4	24	<1	20	<1	20	**30**
2	1	21	1	21	<1	20	**30**
3	4	24	3	23	<1	20	**30**
4	2	22	1	21	<1	20	**30**
5	1	21	<1	20	<1	20	**30**
6	1	21	<1	20	<1	20	**30**
7	1	21	<1	20	<1	20	**30**

TSP Annual							
	Configuration 1		**Configuration 2**		**Configuration 3**		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	10	50	3	43	<1	40	**90**
2	3	43	4	44	3	43	**90**
3	10	50	10	50	2	42	**90**
4	5	45	3	43	1	41	**90**
5	3	43	2	42	<1	40	**90**
6	3	43	1	41	<1	40	**90**
7	3	43	1	41	<1	40	**90**

Dust deposition	**Configuration 1**		**Configuration 2**		**Configuration 3**		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	0.4	2.4	<0.1	2.0	<0.1	2.0	**4**
2	0.4	2.4	0.1	2.1	<0.1	2.0	**4**
3	0.4	2.4	0.4	2.4	<0.1	2.0	**4**
4	0.2	2.2	0.2	2.2	<0.1	2.0	**4**
5	0.1	2.1	<0.1	2.0	<0.1	2.0	**4**
6	<0.1	2.0	<0.1	2.0	<0.1	2.0	**4**
7	<0.1	2.0	<0.1	2.0	<0.1	2.0	**4**

Appendix C

Dust Concentration Contours

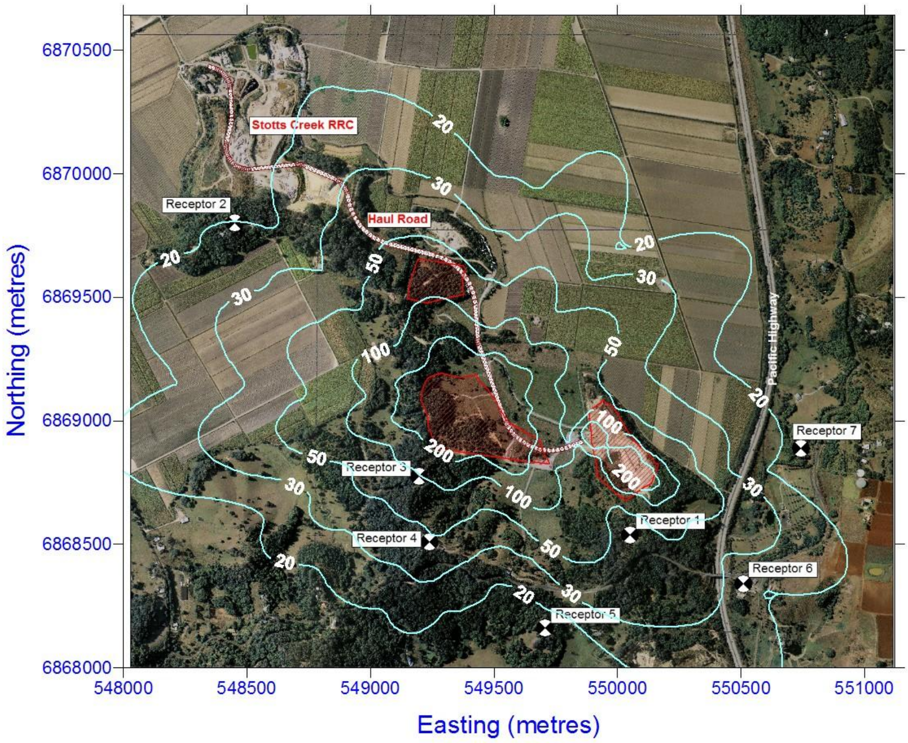


Figure C-1 Configuration 1 – PM_{10} 24 hour Concentration Contours – 400 TPH

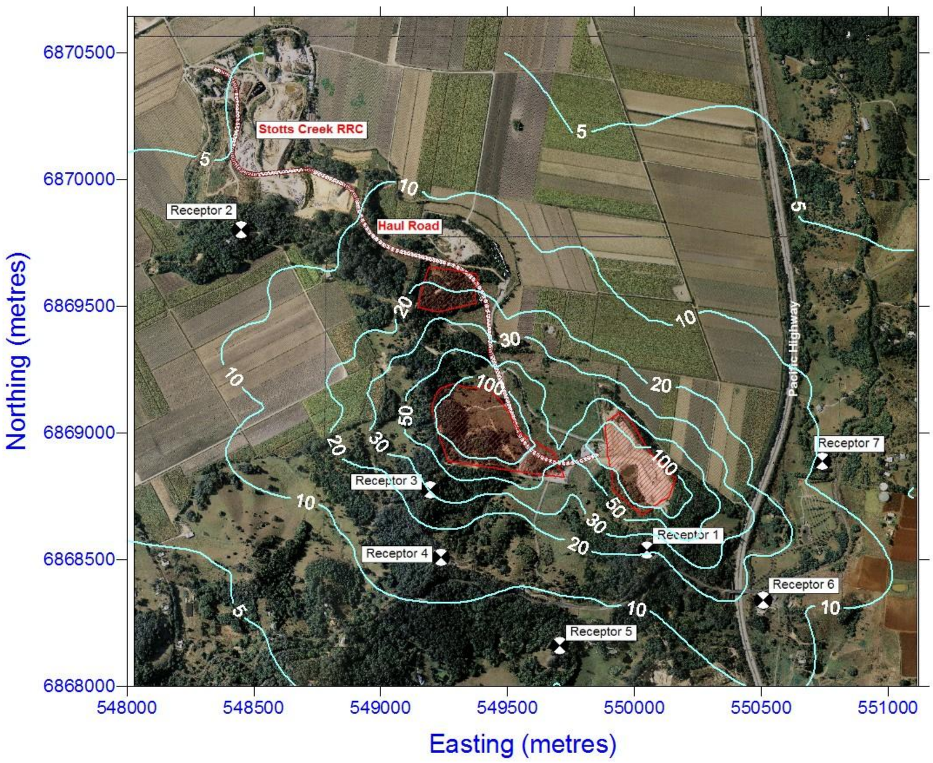


Figure C-2 Configuration 1 – PM_{10} 24 hour Concentration Contours – 100 TPH

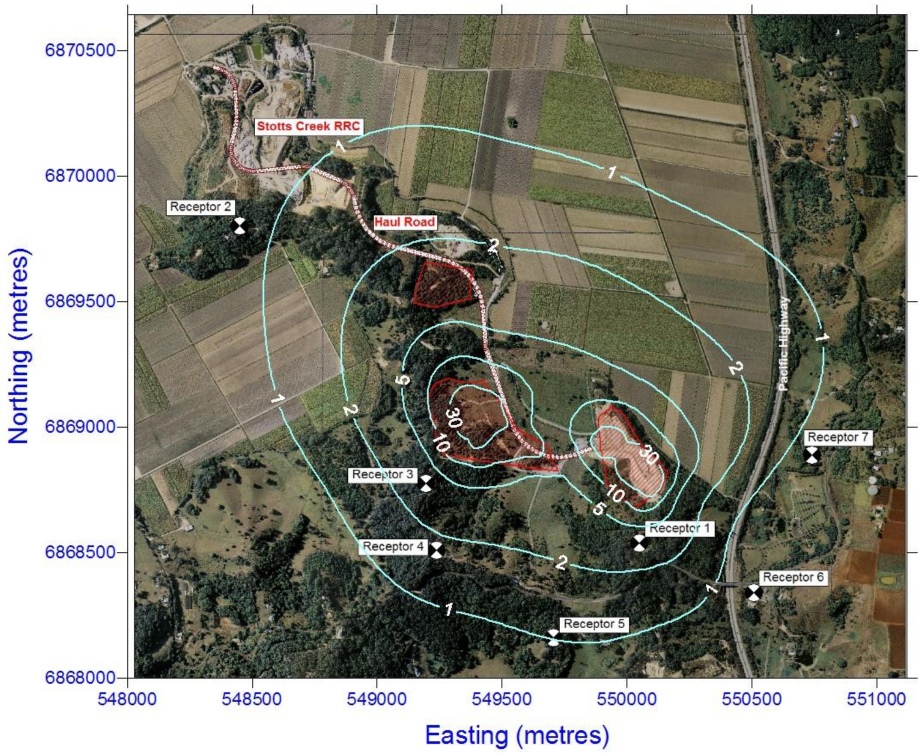


Figure C-3 Configuration 1 – PM_{10} Annual Average Concentration Contours

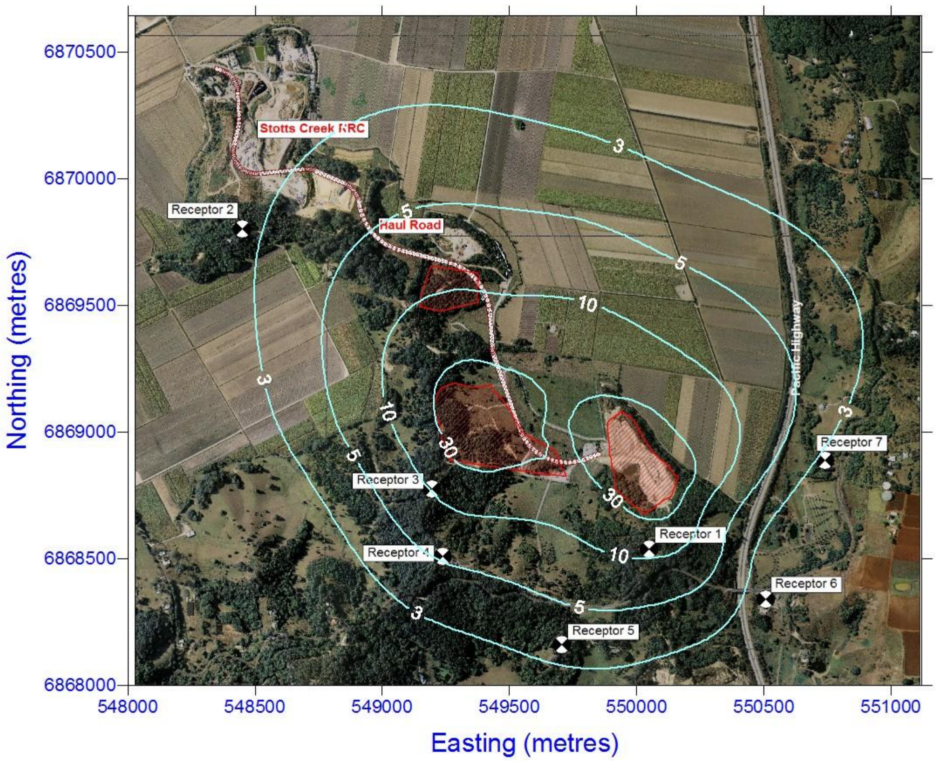


Figure C-4 Configuration 1 – TSP Annual Average Concentration Contours

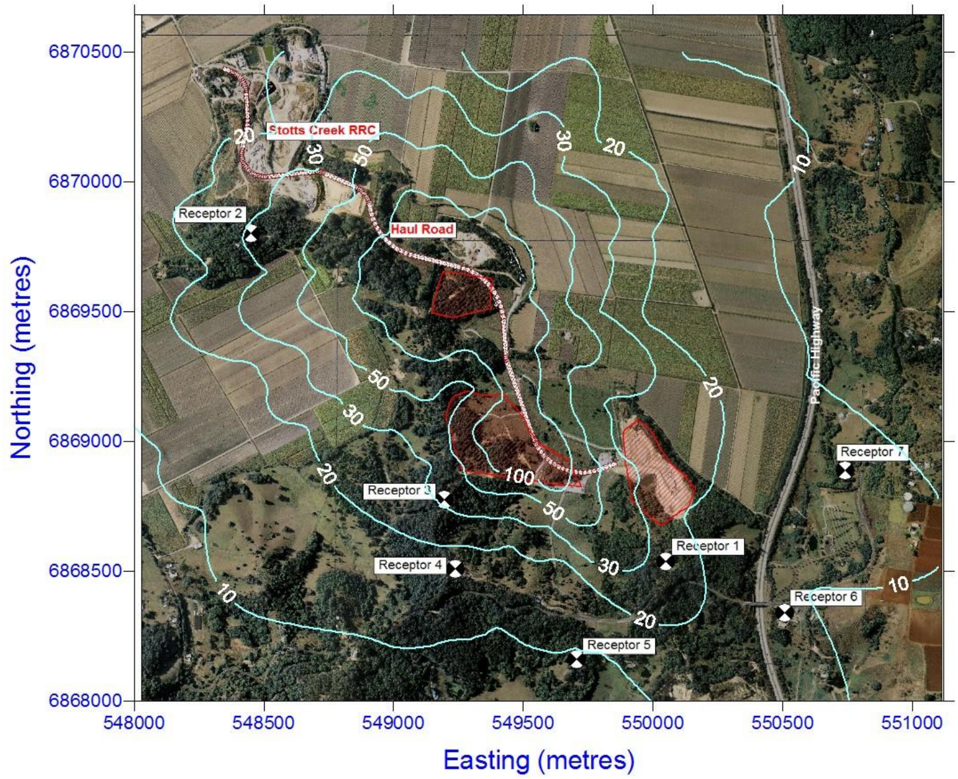


Figure C-5 Configuration 2 – PM_{10} 24 hour Concentration Contours – 400 TPH

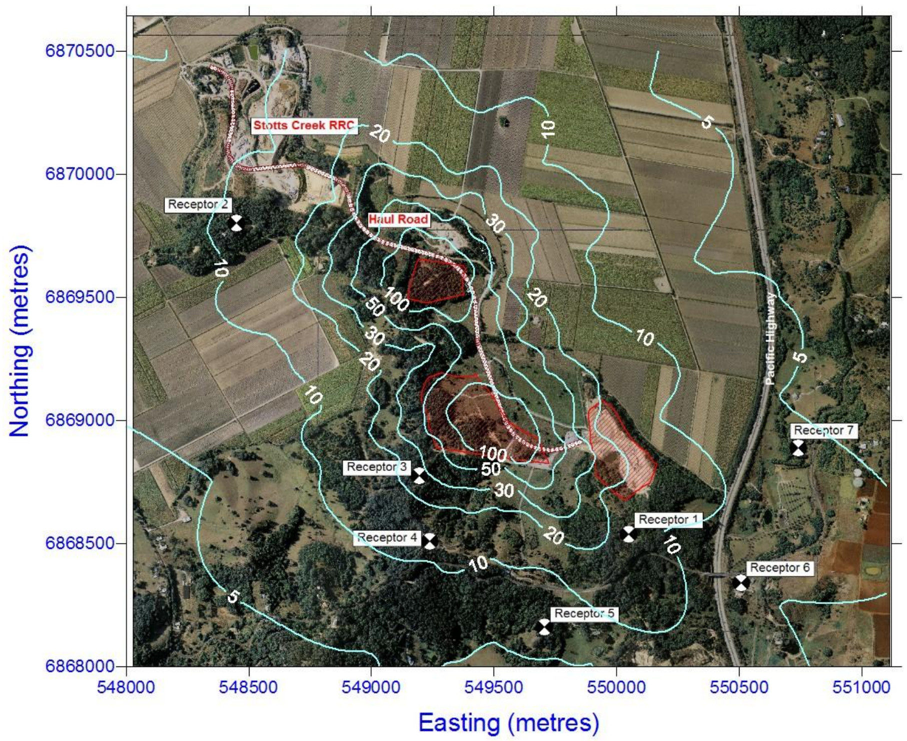


Figure C-6 Configuration 2 – PM_{10} 24 hour Concentration Contours – 100 TPH

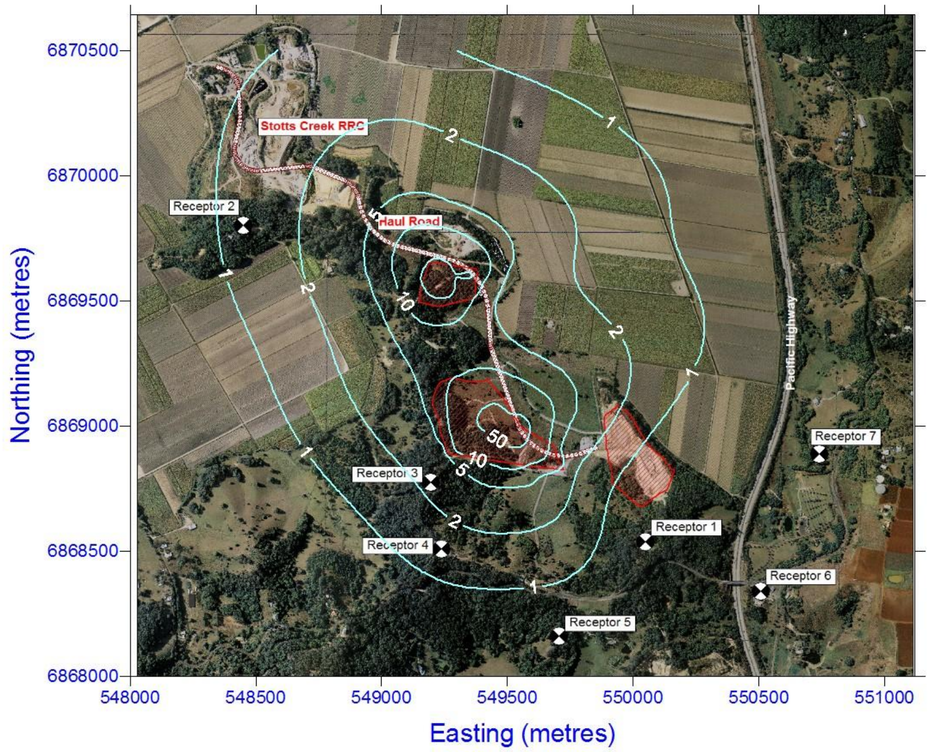


Figure C-7 Configuration 2 – PM_{10} Annual Concentration Contours

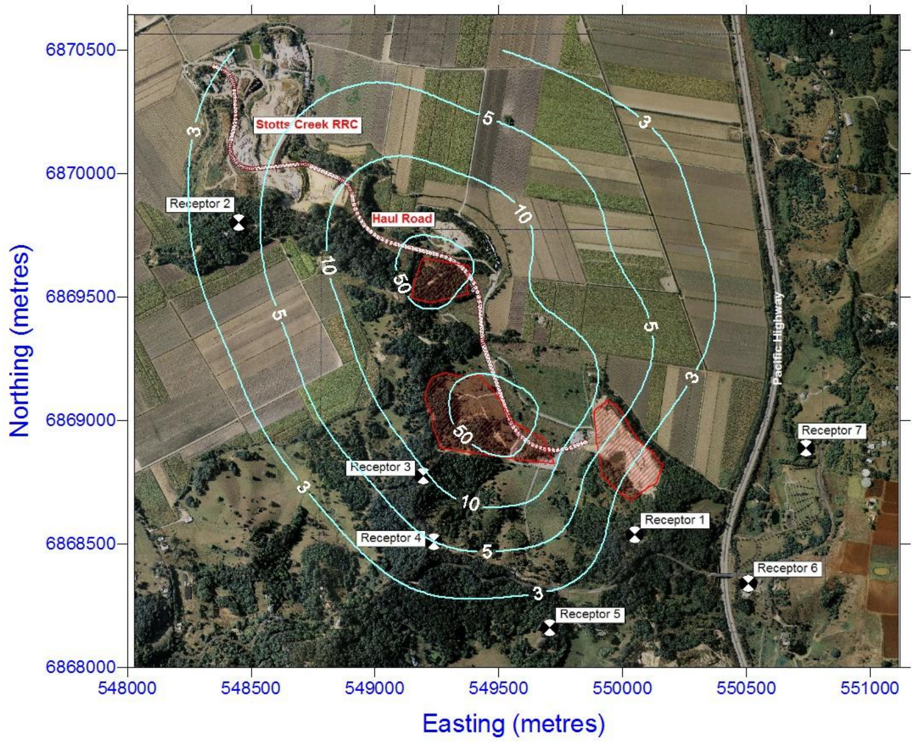


Figure C-8 Configuration 2 – TSP Annual Concentration Contours

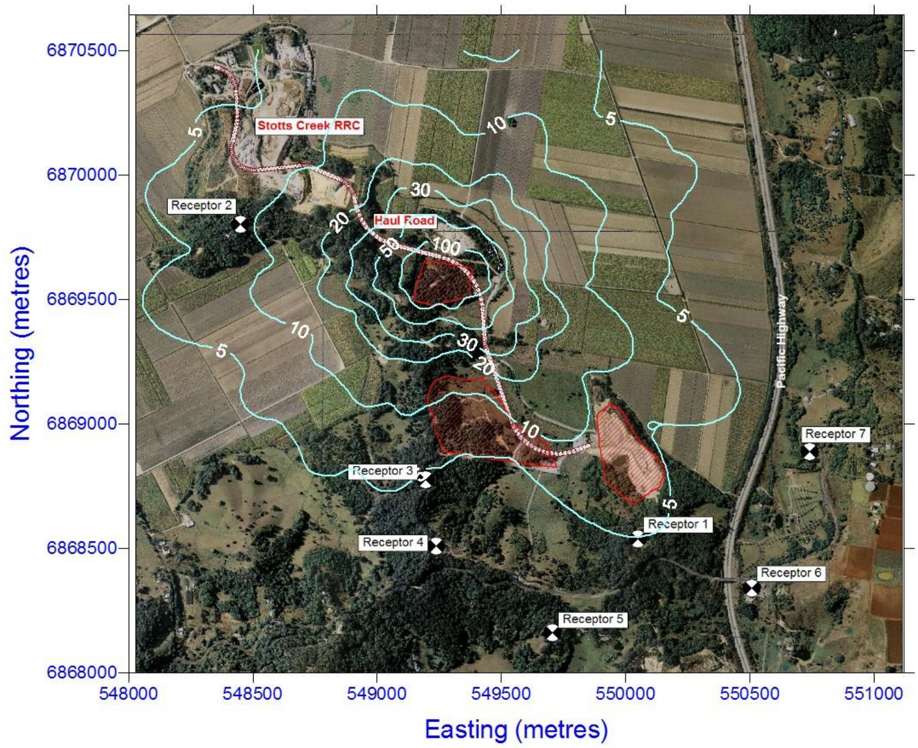


Figure C-9 Configuration 3 – PM_{10} 24 hour Concentration Contours

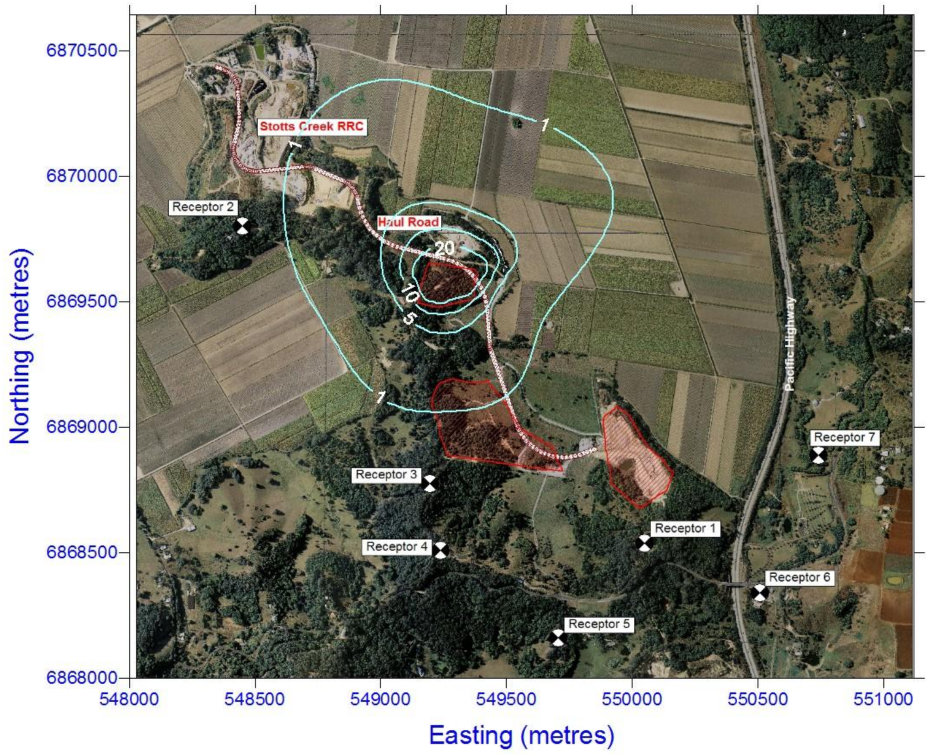


Figure C-10 Configuration 3 – PM_{10} Annual Concentration Contours

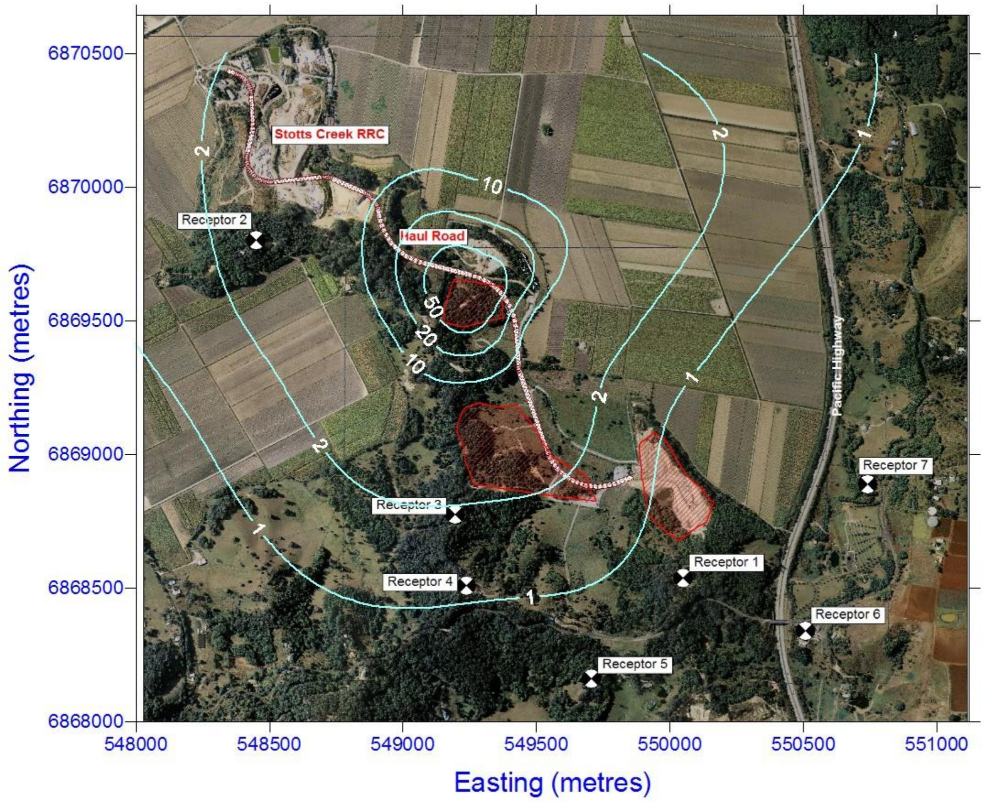


Figure C-11 Configuration 3 – TSP Annual Concentration Contours

Appendix D

Odour Concentration Contours

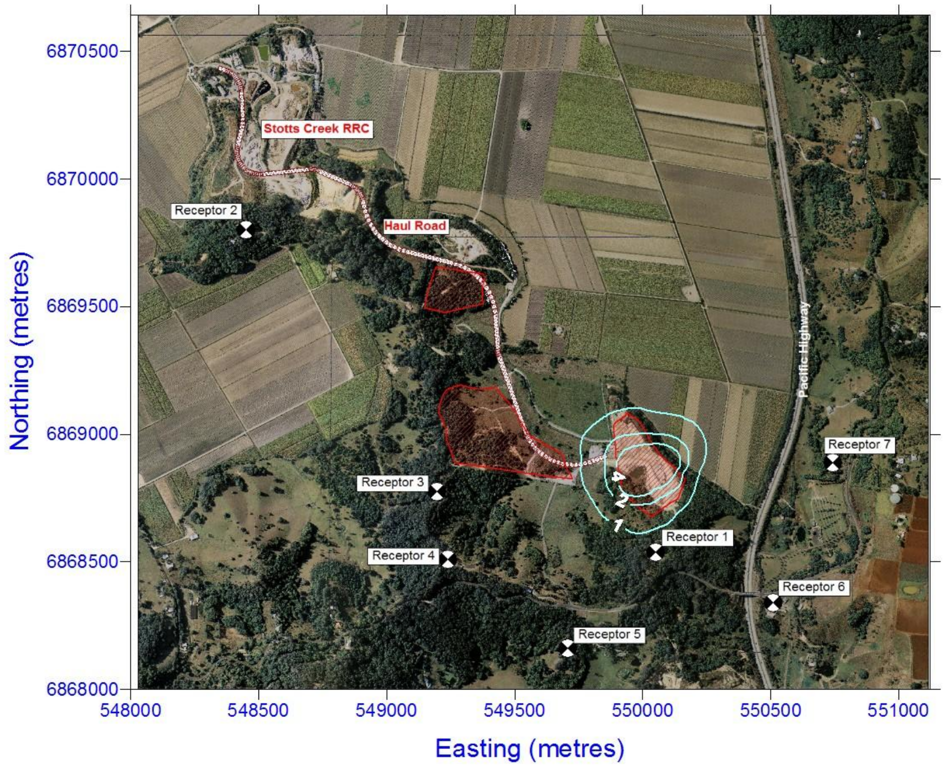


Figure D-1 Configuration 1 – Odour Concentration Contours

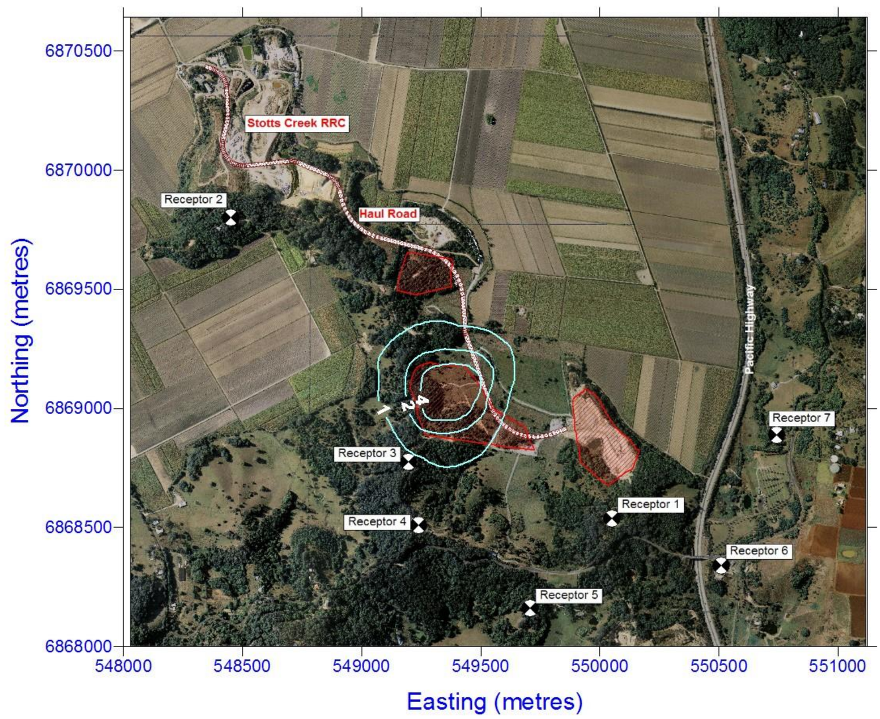


Figure D-2 Configuration 2 – Odour Concentration Contours

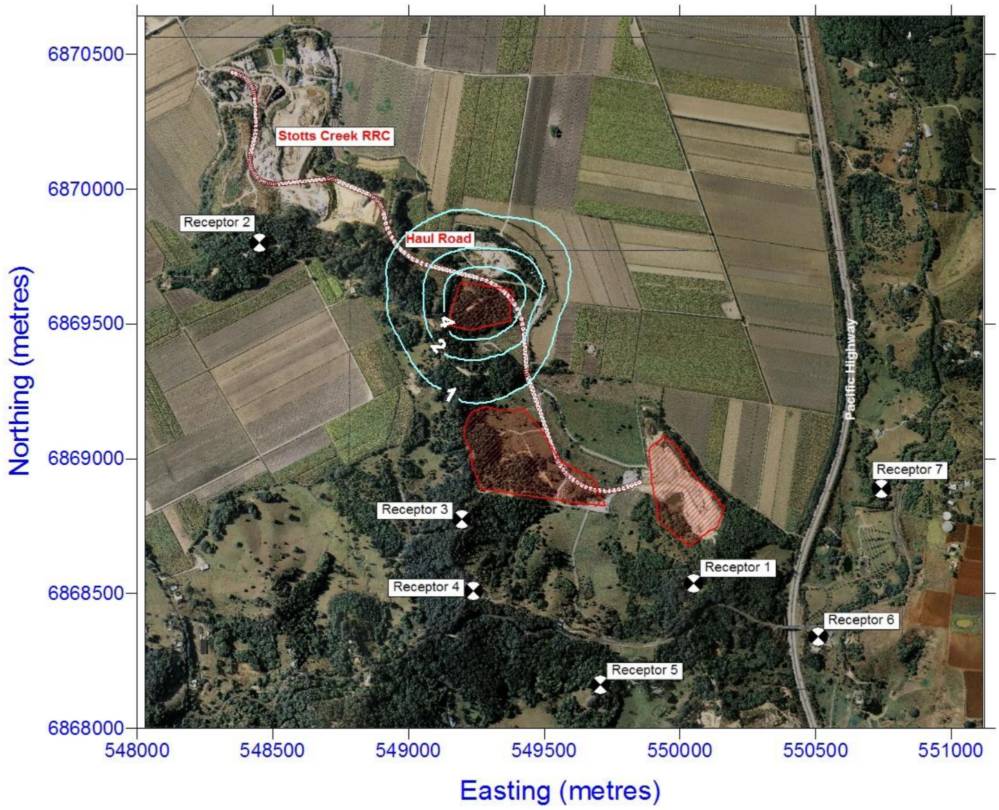


Figure D-3 Configuration 3 – Odour Concentration Contours

GHD

Level 3 GHD Tower 24 Honeysuckle Drive Newcastle NSW 2300
PO Box 5403 Hunter Region Mail Centre NSW 2310
T: (02) 4979 9999   F: (02) 4979 9988   E: ntlmail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T Gribble	T Pollock	*T Pollock*	A Marszalek	*A Marszalek*	24/05/11
1	T Gribble	A Marszalek		A Marszalek		18/10/11