BIG ISLAND MINING PTY LTD

ABN 12 112 787 470

Dargues Reef Gold Project

AIR QUALITY AND GREENHOUSE GAS Assessment

Prepared by

PAEHolmes

JULY 2010

Specialist Consultant Studies Compendium
Volume 2, Part 7

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AIR QUALITY & GREENHOUSE GAS Assessment

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July 2010

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[1] It is noted that the Project Site boundary presented in these figures varies slightly from that illustrated in the *Environmental Assessment*. This has no influence on the assessment or conclusions made in this report.

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EXECUTIVE SUMMARY

This report has been prepared by PAEHolmes for R.W. Corkery & Co. Pty Limited on behalf of Big Island Mining Pty Ltd. The purpose of the study is to assess the likely air quality impacts of the proposed Dargues Reef Gold Project ("the Project"), located in the Southern Tableland region of New South Wales. The Project involves the mining of the Dargues Reef ore body using traditional underground mining techniques and would require the development and operation at surface of a temporary waste rock emplacement area (WRE), a tailings storage facility, a ROM pad and processing plant and internal roads.

Dispersion modelling completed to assess the likely impact of the Project on local air quality, receptors when the generation of dust is likely to be at its maximum, shows that the predicted 24-hour and annual average PM_{10}, TSP and dust deposition levels at the nearest sensitive would be below the New South Wales Department of Environment, Climate Change and Water assessment criteria, even when existing background levels are included.

A greenhouse gas assessment has been conducted using the National Greenhouse Accounts Factors. For the life of the Project, it has been estimated that the Project would release approximately 0.24Mt/y CO_2-e. The maximum annual increase of emissions would be during Year 3 of the Project which would represent approximately 0.03% (all emission scopes) of baseline NSW 2007 emissions.

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1. INTRODUCTION

This report has been prepared by PAEHolmes for R.W. Corkery & Co. Pty Limited on behalf of Big Island Mining Pty Ltd ("the Proponent"). The purpose of this study is to assess the likely air quality impacts of the proposed Dargues Reef Gold Project (hereafter referred to as "the Project"), located in the Southern Tableland region of New South Wales.

The Proponent proposes to mine the Dargues Reef ore body using traditional underground mining techniques. The Project would require the development of a box cut to provide access to the underground mine, as well as surface facilities for processing the ore into a gold concentrate. The ore processing circuit would include crushing, grinding, gravity and flotation circuits. The proposed processing operations would not require the use of cyanide to extract the gold from the ore.

In summary, this report provides information on:

- relevant air quality criteria;
- meteorological and climatic conditions in the area;
- a discussion of the existing air quality conditions in the area;
- the methods used to estimate dust emissions from on-site activities;
- the expected dispersion and dust fallout patterns due to emissions from the Project and a comparison with the New South Wales Department of Environment, Climate Change and Water (DECCW) assessment criteria; and
- a greenhouse gas assessment.

2. LOCAL SETTING AND PROJECT DESCRIPTION

2.1 LOCAL SETTING

Figure 1 presents the location of the Project on the western slopes of the Great Dividing Range, approximately 60km southeast of Canberra. The "Project Site" is to be located on freehold land owned by a Company associated with the Proponent to the north of Majors Creek and approximately 13km south of Braidwood. The Dargues Reef Gold Project forms part of the larger Majors Creek Project which encompasses the Majors Creek (Elrington) Goldfield, the Jembaicumbene alluvial Goldfield and a small portion of the Araluen alluvial Goldfield approximately 60km southeast of Canberra, and 12km south of Braidwood in the Southern Tableland region of New South Wales.

The Project Site is located in an area of undulating hills between two arms of the Great Dividing Range. **Figure 2** shows a pseudo 3-dimensional plot of the local terrain. The terrain directly around the Project Site is generally flat with some mountainous terrain of up to 1 000m occurring to the north, east and west. Approximately 2km to the south of the Project Site is an area of steeply incised valleys where Majors and Araluen Creeks converge.

The area surrounding the Project Site is predominantly rural and is relatively sparsely populated. The village of Majors Creek is located approximately 2km south of the proposed on-site activities, with the closest major residential area being the town of Braidwood, approximately 13km to the north. The nearest sensitive receptors are shown on **Figure 3.**

The local dispersion meteorology and local climatic conditions in the area are described in Section 4.

2.2 PROJECT DESCRIPTION

The Proponent proposes to mine the Dargues Reef ore body using traditional underground mining techniques. The Project would include the following components (**Figure 3**).

- Extraction of waste rock and ore material from the Dargues Reef deposit using underground sublevel open stope mining methods with a suitable crown pillar to prevent surface subsidence.
- Construction and use of surface infrastructure required for the underground mine, including a box cut, portal and decline, magazines, fuel store, ventilation rise and power and water supply.
- Construction and use of a processing plant and office area which would include an integrated Run-of-Mine (ROM) pad/temporary waste rock emplacement, crushing and grinding, gravity separation and floatation circuits, Proponent and mining contractor site offices, workshop, laydown area, ablutions facilities, stores, car parking, and associated infrastructure.
- Construction and use of a tailings storage facility.
- Construction and use of a water management system, including construction and use of eight dams and associated water reticulation system, to enable the harvesting and supply of water for mining-related operations. It is noted that the proposed water harvesting operations would be consistent with the Proponent's harvestable right.
- Construction and use of a site access road and intersection to allow site access from Majors Creek Road.
- Transportation of sulphide concentrate from the Project Site to the Proponent's customers via public roads surrounding the Project Site using covered semi-trailers.
- Construction and use of ancillary infrastructure, including soil stockpiles, core yards, internal roads and tracks and surface water management structures.
- Construction and rehabilitation of a final landform that would be geotechnically stable and suitable for a final land use of nature conservation and/or agriculture.

It is noted that during the life of the Project the Proponent proposes to undertake additional exploration drilling to further define identified mineralisation and identify additional mineralisation. Extraction of those resources does not form a part of this application. As a result, a subsequent application for approval to extract any identified resources may be prepared once sufficient information is available to adequately identify the proposed activities.

3. AIR QUALITY ASSESSMENT CRITERIA

In its modelling and assessment guidelines, the DECCW specifies air quality assessment criteria relevant for assessing impacts from dust generating activities (NSW DEC, 2005).

These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Air-NEPMs (see NEPC, 1998)). However, the DECCW's criteria include averaging periods which are not included in the Air-NEPMs and references to other measures of air quality, namely dust deposition and total suspended particulate matter (TSP).

Table 3.1 summarises the air quality goals for dust that are relevant to the Project.

Table 3.1
Air Quality Impact Assessment Criteria for Particulate Matter Concentrations

Pollutant	Averaging period	Criteria	AGENCY
Total suspended particulate matter (TSP)	Annual mean	90μg/m^3	National Health and Medical Research Council (NHMRC)
Particulate matter < 10μm (PM_{10})	24-hour maximum	50μg/m^3	NSW DECCW
	Annual mean	30μg/m^3	NSW DECCW long-term reporting goal

The National Environment Protection Council (NEPC) has also developed a set of NEPM advisory reporting standards goals for $PM_{2.5}$ as shown in **Table 3.2** (NEPC, 2003). These goals have not been adopted in NSW for assessment of projects.

Table 3.2
Advisory Reporting Standards for $PM_{2.5}$ Concentrations

Pollutant	Averaging period	Criteria	AGENCY
Particulate matter < 2.5μm ($PM_{2.5}$)	Annual mean	8μg/m^3	NEPM*
	24-hour maximum	25μg/m^3	NEPM*
**Not included as assessment criteria for projects in NSW*			

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces and/or on vegetation/crops. **Table 3.3** shows the dust deposition criteria set out in the DECCW procedures for modelling air pollutants from sources (NSW DEC, 2005).

Table 3.3
NSW DECCW Criteria for Dust (Insoluble Solids) Fallout

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Deposited dust	Annual	2g/m^2/month	4g/m^2/month

4. CLIMATE AND METEROLOGY

This section describes the local dispersion meteorology and local climatic conditions in the area.

4.1 LONG-TERM CLIMATE AVERAGES

4.1.1 Data Source

A range of climatic information is collected from the Bureau of Meteorology (BOM) meteorological station at Braidwood Racecourse AWS (located approximately 14km from the Project). A summary of the data collected is presented in **Table 4.1** (Bureau of Meteorology, 2010). Temperature and humidity data consist of monthly averages of 9am and 3pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of rain days per month.

4.1.2 Temperature

The annual average maximum and minimum temperatures experienced at Braidwood Racecourse AWS are 19.2°C and 6.0°C respectively. On average January is the hottest month with an average maximum temperature of 26.6°C. July is the coldest month, with an average minimum temperature of 0.1°C.

Table 4.1
Temperature, Humidity and Rainfall Data for Braidwood Racecourse AWS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Temperature (°C) and Relative Humidity (%)													
Dry-bulb	18.2	17.0	14.8	12.6	9.1	6.1	5.2	7.0	10.8	13.5	14.8	16.9	12.2
Humidity	75	83	82	79	83	86	84	78	70	66	72	71	77
3pm Mean Temperature (°C) and Relative Humidity (%)													
Dry-bulb	24.8	23.9	21.5	18.2	14.7	11.5	11.0	12.6	15.2	17.3	19.9	22.8	17.8
Humidity	50	54	52	51	55	61	57	50	50	52	53	49	53
Daily Maximum Temperature (°C)													
Mean	26.6	25.4	23.0	19.5	15.9	12.6	12.0	13.6	16.4	18.9	21.6	24.5	19.2
Daily Minimum Temperature (°C)													
Mean	12.1	12.2	9.7	5.7	3.0	0.9	0.1	0.4	3.3	5.7	8.3	10.3	6.0
Rainfall (mm)													
Monthly mean -mm	57.1	57.6	41.9	45.4	44.4	52.6	32.7	46.0	52.8	57.6	75.3	60.0	626.1
Raindays (Number)													
Mean no. of raindays	6.5	4.9	5.8	4.8	4.5	5.1	4.6	5.1	6.2	6.6	7.6	5.8	67.5
Source: Bureau of Meteorology (2010)													

4.1.3 Relative Humidity

The annual average relative humidity reading collected at 9am from the Braidwood Racecourse AWS site is 77% and at 3pm the annual average is 53%. The month with the highest relative humidity on average is June with a 9am average of 86%. The month with the lowest relative humidity is December with a 3pm average of 49%.

4.1.4 Rainfall

Rainfall data collected at Braidwood Racecourse AWS show that November is the wettest month with an average rainfall of 75.3mm over 7.6 days. The average annual rainfall is 626.1mm with an average of 67.5 raindays.

4.2 METEOROLOGICAL DATA

4.2.1 Wind Speed and Direction

DECCW have listed requirements for meteorological data that are used for air dispersion modelling in the document "*Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*" (DEC, 2005). The requirements are as follows:

- data must span at least one year;
- data must be at least 90% complete; and
- data must be representative of the area in which emissions are modelled.

A meteorological station was installed on the Project Site in late March 2009 and continues to collect meteorological data. **Figure 1** shows the location of this site. The weather station collects hourly records of temperature, wind speed, wind direction and sigma-theta (a measure of the fluctuation of the horizontal wind direction). The data have been processed into a form suitable for the use in the ISCMOD dispersion model.

Figure 4 presents the annual and seasonal wind roses compiled from the data collected from the Project Site meteorological station for the period March 2009 to March 2010. On an annual basis, the data show a high frequency of winds from the south-southeast and from the northwest directions. In summer and autumn, winds are predominantly from the south-southeast and to a lesser extent from the northwest direction. In winter and spring, the dominant winds are from the northwest, with dominant winds also from the south-southeast in spring. On an annual basis, the mean wind speed for the Project Site is 3.7m/s and the percentage of calms (wind speeds less than 0.5m/s) is 3.6%.

The data contains 8,209 usable hourly records which satisfy the DECCW's requirement of 90% data recovery in the year.

4.2.2 Atmospheric Stability

Gaussian dispersion models require information about the dispersion characteristics of the area. In particular, data are required on topography, wind speed, wind direction, atmospheric stability class[2] and mixing height[3]. Mixing height was determined using a scheme defined by Powell (1976) for day time conditions and an approach described by Venkatram (1980) for night time conditions.

[2] In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes: A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[3] The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

To use the wind data to assess dispersion, it is also necessary to have available data on atmospheric stability. **Table 4.2** shows the frequency of occurrence of the stability categories from the data collected from the Project Site meteorological station for the period March 2009 to March 2010.

The most common stability class for the Project Site was determined to be class D at 60%. This would suggest that the dispersion conditions are such that dust emissions disperse rapidly for a significant proportion of the time. The frequency of E and F class conditions (slow dispersal conditions) are lower at 23% (combined).

Table 4.2
Frequency of atmospheric stability classes

Pasquill Gifford stability class	Frequency (%)
A	2
B	3
C	12
D	60
E	19
F	4
TOTAL	**100**

Joint wind speed, wind direction and stability class frequency tables for the Project Site are presented in **Appendix 1**.

5. EXISTING AIR QUALITY

5.1 INTRODUCTION

No air quality measurements have been made specifically for the Project and there are no DECCW monitoring sites located in the vicinity. However, as the Project Site is situated in a rural area with no major sources of air pollution, the local air quality is likely to be good and concentrations of pollutants are unlikely to exceed any of the air quality criteria.

Although there are no available monitoring data in the vicinity of the Project Site, it is useful to assess the nearest available monitoring data and/or data from a similar land-use site to gain an understanding of what background concentrations may be around or near the Project Site.

The air quality on and surrounding the Project Site is likely to be similar to other rural areas in NSW. The DECCW collects PM_{10} data in the rural areas of Albury, Bathurst and Wagga Wagga. These data were collected using a TEOM (Tapered Element Oscillating Microbalance), which provides continuous recordings of PM_{10} concentrations. PM_{10} concentrations in rural areas are heavily influenced by agricultural activities and the use of solid fuel heaters. Monitoring data from these rural sites are presented below in Section 5.2.

In addition to the DECCW monitoring sites, the Ambient Air Quality National Environment Protection Measure (NEPM) releases annual reports which summarise monitoring data from stations in each state. The closest NEPM site to the Project Site is located at the Monash performance monitoring station (PMS) in the ACT approximately 60km to the northwest. Annual monitoring reports are available for this site between 2002 and 2008. These reports

present annual summary statistics for 24-hour PM_{10} data monitored by a TEOM at the Monash PMS. It is important to note that the Monash PMS is located on vacant land less than 500m from densely populated residential areas (ACT NEPM, 2002). Due to its location, it is likely that PM_{10} concentrations at this site would be influenced by traffic, industry and local dust-generating activities. Therefore, these data would not be considered representative of existing air quality in the rural area of the Project Site and as such have not been investigated further.

5.2 DECCW PM_{10} RURAL MONITORING DATA

Table 5.1 presents a summary of recent PM_{10} data collected by the DECCW in the rural areas of Albury, Bathurst and Wagga Wagga. The annual average PM_{10} concentrations at all three locations are within the DECCW criteria of 30$\mu g/m^3$. The average PM_{10} concentration over all sites and all years is 21$\mu g/m^3$.

The monthly maximum 24-hour concentrations are generally below the DECCW criteria of 50$\mu g/m^3$ at Albury and Bathurst. Wagga Wagga shows more exceedances of the criteria. It is likely, however, that many of the exceedances experienced over all three sites are due to significant environmental events such as bushfires and dust storms, or agricultural activities such as when broad acre cultivation and/or the preparation of land for cropping takes place. For example, the high maximum 24-hour concentration average recorded at all three sites in January 2007 was most likely the result of severe bushfires around Dubbo, Berridale and various other parts of NSW at the time (BOM, 2010). The unusually high maximum 24-hour concentration average value of 2 114 $\mu g/m^3$ recorded at the Bathurst station in September 2009 was most likely the result of the severe dust storms experienced over most of Sydney and other parts of NSW around this time.

5.3 SUMMARY OF BACKGROUND DATA

When TSP and PM_{10} concentration monitoring data are not available, it becomes difficult to quantify the existing air quality. There is, however, an approximate relationship between annual dust deposition and annual TSP concentrations. Monitoring data from areas in the Hunter Valley where co-located TSP and PM_{10} monitors have been operated for a reasonably long periods of time indicate that long term average PM_{10} concentrations are approximately 40% of the corresponding long-term TSP concentration (NSW Minerals Council, 2000). Further to this, areas experiencing 4g/m^2/month typically experience annual TSP concentrations of 90$\mu g/m^3$. Adopting a similar approach here is reasonable given that the type of dust to be generated is crustal dust and not particles from sources such as combustion. Therefore, in the absence of dust concentration measurements, it has been assumed that the same factors will apply for the Project Site.

Annual average PM_{10} concentrations at the DECCW rural monitoring sites vary between 15$\mu g/m^3$ and 30$\mu g/m^3$ with an overall average of 21$\mu g/m^3$ (see **Table 5.1**). Assuming the relationship between PM_{10}, TSP and deposited dust nominated above, it has conservatively been assumed that the following background concentrations apply at the nearest residences.

- Annual average TSP of 53$\mu g/m^3$.
- Annual average PM_{10} of 21$\mu g/m^3$.
- Annual average dust deposition of 2.4g/m^2/month.

Table 5.1
PM_{10} TEOM Data from DECCW Rural Monitoring Sites

	Albury		Bathurst		Wagga Wagga	
	Monthly average	Maximum 24-hr average	Monthly average	Maximum 24-hr average	Monthly average	Maximum 24-hr average
Month	**2007**					
January	46	198	24	66	36	105
February	23	49	17	37	42	86
March	27	101	15	25	31	76
April	33	95	20	40	37	69
May	18	32	14	47	26	59
June	11	16	9	14	17	30
July	11	20	9	21	15	29
August	13	24	12	20	18	35
September	15	22	17	31	20	37
October	20	36	28	33	33	68
November	14	30	13	49	19	31
December	*15*	*28*	*12*	*21*	*19*	*56*
Annual average	*21*	-	*16*	-	*26*	-
Annual maximum	-	*198*	-	*66*	-	*105*
Month	**2008**					
January	21.7	37.2	16.3	27.1	25.0	64.3
February	18.2	56.1	13.3	40.5	14.7	53.6
March	27.3	54.2	17.1	31.2	36.5	64.6
April	32.1	124.8	14.8	41.9	2.1	294.9
May	-	-	-	-	24.1	49.9
June	11.8	22.5	9.2	22.1	18.2	35.0
July	9.9	36.1	11.3	41.7	15.9	53.6
August	10.0	18.2	10.3	40.6	15.1	28.5
September	18.5	105.1	16.3	63.0	30.9	245.9
October	18.9	40.6	15.7	33.7	30.1	59.0
November	13.3	24.0	13.1	27.2	19.2	48.3
December	14.8	124.2	15.9	30.9	21.4	68.6
Annual average	*18*	-	*14*	-	*21*	-
Annual maximum	-	*124.8*	-	*63*	-	*294.9*
Month	**2009**					
January	21.7	128.9	17.3	26.9	34.3	88.2
February	45.3	249.7	18.7	52.4	58.1	224.0
March	23.7	65.7	23.9	51.5	40.3	100.3
April	23.6	105.7	24.3	224.4	-	-
May	17.1	27.0	13.6	24.4	30.1	56.2
June	9.6	16.1	8.4	29.2	11.7	33.9
July	11.1	15.6	8.3	19.8	14.3	26.9
August	12.7	21.0	14.2	31.6	17.0	30.5
September	13.3	26.5	92.9	2114.4	27.7	162.2
October	13.3	29.4	14.4	42.4	17.8	53.8
November	27.5	143.4	27.2	96.6	44.6	297.4
December	15.8	58.5	19.1	61.4	23.8	120.9
Annual average	*20*	-	*24*	-	*29*	-
Annual maximum	-	*249.7*	-	*2114.4*	-	*297.4*
Month	**2010**					
January	20.8	53.9	18.1	43.3	27.9	52.0
February	11.8	24.1	10.2	19.9	16.8	43.5
March	19.1	60.8	14.6	39.4	23.8	64.9
April	14.8	26.1	12.3	28.1	17.8	39.3
Annual average	*17*	-	*14*	-	*22*	-
Annual maximum	-	*60.8*	-	*43.3*	-	*64.9*
Annual average over all years	***19***		***18***		***25***	
Average over all sites and all years	***21***					

6. APPROACH TO ASSESSMENT

This section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

The model to be used is a modified version of the US EPA ISCST3 model (ISCMOD). ISCST3 is fully described in the user manual and the accompanying technical description (US EPA, 1995a).

The ISCST3 model has a tendency to overestimate short-term (24-hour) PM_{10} concentrations (Holmes *et al*., 2007). To overcome this difficulty it has been modified to create ISCMOD. ISCMOD is identical to ISC except that the horizontal plume spreading dispersion curves have been modified to adopt the recommendations of the American Meteorological Society's (AMS) expert panel on dispersion curves (Hanna, 1977) and the suggestions made by Arya (1999). The suggested changes were recommended because, as the AMS panel notes, the original horizontal dispersion curves relate to an averaging time of three minutes and they recommend that these be adjusted to the one hour curves required by ISC. The change involves increasing the horizontal plume widths by a factor of 1.82 (60 minutes / 3 minutes) $^{0.2}$. The modifications improve the performance of the model in predicting 24-hour concentrations and make almost no difference to the annual average predictions.

A similar adjustment has been applied to account for the local surface roughness being different at the sites compared with the site where the original curves were developed. The sites have been taken to have a surface roughness of 0.3 m compared with 0.03 m for the original curves. The adjustment leads to an increase in the horizontal and vertical curves by a factor of (0.3 m/ 0.03 m) $^{0.2}$ namely 1.6.

The modelling was based on the use of three particle-size categories (0 to 2.5μm - referred to as $PM_{2.5}$, 2.5 to 10μm - referred to as CM (coarse matter) and 10 to 30μm - referred to as the Rest). Emission rates of TSP will be calculated using emission factors developed both within NSW and by the US EPA (see Appendix 2).

The distribution of particles will be derived from measurements published by the NSW State Pollution Control Commission (SPCC) (SPCC, 1986). While these measurements were taken around coal mines in the Hunter Valley, NSW, in the absence of any other information, these values have been deemed appropriate. The distribution of particles in each particle size range is:

- $PM_{2.5}$ (FP) is 4.7% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

Modelling was completed using three ISC source groups with each group corresponding to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1μm.

Concentrations in the three plot output files for each group were then combined according to the weightings in the dot points above to determine the concentration of PM_{10} and TSP.

The ISC model also has the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on mining operations where wind speed is an important factor in determining the rate at which dust is generated.

Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISC model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at a site would correspond with periods of low dust generation because wind erosion and other wind dependent emissions rates will be low. Light winds also correspond with periods of poor dispersion. If these measures are not taken into account, the model has the potential to significantly overstate impacts.

Year 3 of the proposed mining operations has been modelled as this represents the year of greatest material movement and production, ie. the year likely to generate the highest emissions from the Project Site. The location of volume sources during Year 3 are presented in **Figure 5** and represent the following concurrent activities.

1. Stripping topsoil from the Tailings Storage Facility.
2. Stripping topsoil from the Tailings Storage Facility.
3. Placement of topsoil in stockpiles surrounding the Tailings Storage Facility.
4. Operation of a grader on the Tailings Storage Facility access road.
5. Wind erosion from soil stockpiles.
6. Wind erosion from soil stockpiles.
7. Wind erosion from soil stockpiles.
8. Wind erosion from soil stockpiles.
9. Haulage of ore from the underground to the ROM Pad and waste rock from the Waste Rock Emplacement back underground.
10. Haulage of ore from the underground to the ROM Pad and waste rock from the Waste Rock Emplacement back underground.
11. Haulage of ore from the underground to the ROM Pad and waste rock from the Waste Rock Emplacement back underground.
12. Haulage of ore from the underground to the ROM Pad and waste rock from the Waste Rock Emplacement back underground.
13. Haulage of ore from the underground to the ROM Pad, tipping of ore on the ROM Pad and loading of ore to the ROM hopper.
14. Haulage of topsoil to the Waste Rock Emplacement and spreading of soil over the final landform.
15. Operation of the primary crusher and ball mill.
16. Unloading of crushed and processed material (concentrate) to stockpile.
17. (to 32) Haulage of concentrate from the Processing Area to Majors Creek Road.

Dust concentrations and deposition rates have been predicted in the vicinity of the Project Site for the scenario that was modelled. The local terrain has been taken into consideration for the modelling.

The modelling has been performed using the meteorological data discussed in Section 4.1.3 and the dust emission estimates provided in Section 7. As an example, an ISCMOD input file is provided in Appendix 3.

All activities, except for topsoil removal activities which have been assumed to occur between the hours of 7am and 6pm, have been modelled for 24 hours per day. Section 7 provides details of dust emissions and allocation of sources for each activity.

To assess the air quality impacts of the proposed mining operations alone, the activities associated with the Project have been modelled in isolation. Contour plots were created, with the results at specific receptor locations also determined in order to assess the contribution of mining activities to local air quality. Model predictions were then compared to the DECCW criteria for deposited dust and 24-hour PM_{10}.

For assessment of the cumulative impacts of the proposed mining operations, a separate set of model results have been presented which consider the contribution of other dust sources in the area through the use of a constant background level for annual average TSP, PM_{10} and dust deposition (see Section 5.3).

7. ESTIMATED EMISSIONS OF PARTICULATE MATTER

The operation of the Project has been analysed and estimates of dust emissions for the individual activities for the modelled scenario have been made. Total dust emissions due to the Project have been estimated by analysing the proposed activities during modelled year of operation (Year 3).

The identified activities have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. The plans for the Project have been analysed and detailed emissions inventories have been prepared for each of the three scenarios.

Table 7.1 presents the results of an emission inventory completed for the modelled scenario. The emission inventory provides information on the equations used, the basic assumptions about material properties (e.g. moisture content, silt content etc), information on the way in which equipment would be used to undertake different operations and the quantities of materials that would be handled in each operation. Figure 5 shows the numbered locations that represent dust sources assumed in the modelling. The activities that are associated with each of the numbered locations are summarised in Section 6 (as well as **Appendix 2**).

Table 7.1
Estimated Dust Emissions of the Project (Year 3)

ACTIVITY	TSP emission in (kg/yr)
Topsoil Removal - Dozers/Excavators stripping topsoil	179
Topsoil Removal - Wheeled loader loading topsoil from TSF	53
Topsoil Removal - Emplacing topsoil at stockpile near to WRE	53
Topsoil Removal - Loading topsoil from stockpile near WRE to trucks	1
Topsoil Removal - Hauling topsoil to WRE	11
Topsoil Removal - Emplacing/respreading topsoil at WRE	1
WASTE (rock) - Loading rock from WRE to trucks	21
WASTE (rock) - Hauling from WRE to underground	696
ORE - Hauling ROM ore to ROM pad	5,940
ORE - Unloading ROM to stockpile	453
ORE - Wheeled loader rehandle ore to ROM bin	453
ORE - Primary Crushing	66,000
ORE - Ball milling	-
ORE - Screening	26,400
ORE - Unloading of crushed / processed ore (concentrate) to stockpile	6
ORE - Wheeled loader loading from concentrate stockpile to vehicles	12
ORE - Hauling concentrate off-site	5,360
WE - Waste Rock Emplacement/ROM pad (incl. ROM stockpiles)	3,154
WE - Soil Stockpile Areas	17,170
WE - Concentrate stockpile	876
Grading roads	43,132
Total	**169,969**
WE – Wind Erosion	

8. ASSESSMENT OF IMPACTS

8.1 INTRODUCTION

The air quality criteria used for identifying which sensitive receptors are likely to experience air quality impacts are those specified by the DECCW and discussed in Section 3.

The following sub-sections provide a summary of the modelling results for Year 3 operations at each of the sensitive receptors in the proximity of the Project Site. The locations of these receptors are shown in Figure 3. The results include predicted impacts from the Project alone and the cumulative impacts with existing background levels as outlined in Section 5.3.

Dust concentrations due to extraction and processing operations have been presented as isopleth diagrams showing the following.

- Predicted maximum 24-hour average PM_{10} concentration.
- Predicted annual average PM_{10} concentration.
- Predicted annual average TSP concentration.
- Predicted annual average dust deposition.

In examining the maximum 24-hour average contour plots, it should be noted that plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that would occur at each location for the worst day during Year 3 operations. The maxima are used to show concentrations which can possibly be reached under the modelled conditions. It should also be noted that the plots show the assessment criteria as a red contour line. Plots which consist of very low concentrations do not show the assessment criteria contour.

8.2 EMISSIONS OF THE PROJECT

Figure 6 shows the predicted maximum 24-hour average PM_{10} concentration for operations in Year 3. **Figure 7** to **Figure 12** show the predicted annual average PM_{10}, TSP concentrations and dust deposition levels for operations in Year 3 for the Project alone, as well as cumulative emissions of the Project and other background sources.

Table 8.1 presents a summary of the predicted concentrations at each of the nearby sensitive receptors, due to the operations of the Project alone, as well as cumulative emissions of the Project and other background sources.

Modelling results for Year 3 show no exceedances of the air quality criteria at any sensitive receptor surrounding the Mine Site.

8.3 24-HOUR PM_{10} CUMULATIVE IMPACTS

Where contemporaneous and continuous monitoring data are not available in the vicinity of a Project, it is difficult to establish a reliable background for short-term PM_{10} effects.

Section 5.2 assessed average monthly PM_{10} and maximum monthly 24-hour PM_{10} concentrations at rural DECCW sites in Albury, Bathurst and Wagga Wagga. Concentrations between 2007 and 2010 show that annual average PM_{10} concentrations at all sites are below the DECCW criteria of 30µg/m^3. Many of the maximum 24-hour PM_{10} concentrations were above the assessment criteria at all sites. It was found that many of these exceedances were extremely high and were often due to severe weather events such as bushfires and dust storms around NSW. Many of the higher values may have also been the result of agricultural activities and the use of solid fuel heaters in these areas. It would therefore be misleading to use any of these maximums in a cumulative assessment of PM_{10} 24-hour predictions from the dispersion modelling.

However, **Table 8.1** shows very low predictions of 24-hour PM_{10} concentrations at the sensitive receptors surrounding the Project Site. The highest prediction from operations at the Project alone is 9µg/m^3 which represents 18% of the assessment criteria. As the Project Site is situated in a rural area with no major sources of air pollution, the local air quality is likely to be good and background concentrations of pollutants are likely to be low and within the assessment criteria. However, as would currently occur, the criterion is likely to be exceeded on occasions where significant weather events such as bushfires and dust storms occur.

Table 8.1
Model predictions due to the Project alone and the Project and other sources

Private Receptor ID	Year 3 – Project Only				Year 3 - Cumulative Emissions		
	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust Deposition (g/m^2/month)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	Dust Deposition (g/m^2/month)
	24-hour	Annual	Annual	Annual	Annual	Annual	Annual
	Assessment Criteria						
	50	***N/A***	***N/A***	***2***	***30***	***90***	***4***
R1	6	0.3	0.4	0.03	21	53	2.4
R2	4	0.4	0.4	0.03	21	53	2.4
R3	2	0.1	0.2	0.01	21	53	2.4
R4	2	0.1	0.2	0.01	21	53	2.4
R5	2	0.1	0.2	0.01	21	53	2.4
R6	4	0.4	0.4	0.03	21	53	2.4
R7	4	0.4	0.4	0.03	21	53	2.4
R8	4	0.4	0.4	0.03	21	53	2.4
R9	5	0.3	0.4	0.03	21	53	2.4
R10	4	0.4	0.5	0.04	21	53	2.4
R11	5	0.4	0.4	0.03	21	53	2.4
R12	6	0.3	0.3	0.02	21	53	2.4
R13	5	0.3	0.3	0.02	21	53	2.4
R14	5	0.3	0.3	0.02	21	53	2.4
R15	2	0.2	0.2	0.02	21	53	2.4
R16	4	0.5	0.6	0.04	21	54	2.4
R17	4	0.5	0.6	0.05	21	54	2.4
R18	4	0.5	0.6	0.05	22	54	2.5
R19	4	0.5	0.6	0.05	21	54	2.4
R20	4	0.6	0.7	0.05	22	54	2.5
R21	4	0.6	0.7	0.05	22	54	2.5
R22	4	0.6	0.7	0.05	22	54	2.5
R23	4	0.6	0.7	0.06	22	54	2.5
R24	6	0.8	0.9	0.07	22	54	2.5
R25	6	0.7	0.9	0.07	22	54	2.5
R26	6	0.8	0.9	0.07	22	54	2.5
R27	8	1.1	1.3	0.11	22	54	2.5
R28	6	0.8	1.0	0.07	22	54	2.5
R29	8	0.7	0.9	0.07	22	54	2.5
R30	9	0.6	0.7	0.05	22	54	2.5
R31	8	0.7	0.9	0.07	22	54	2.5
R32	3	0.2	0.3	0.02	21	53	2.4
R33	2	0.2	0.2	0.02	21	53	2.4
R34	4	0.1	0.1	0.01	21	53	2.4
R35	2	0.2	0.2	0.01	21	53	2.4
R36	2	0.1	0.1	0.01	21	53	2.4
R37	3	0.5	0.5	0.04	21	54	2.4
R38	3	0.3	0.3	0.02	21	53	2.4
R39	3	0.3	0.3	0.02	21	53	2.4
R40	3	0.3	0.4	0.02	21	53	2.4
R41	3	0.3	0.4	0.03	21	53	2.4
R42	3	0.3	0.4	0.03	21	53	2.4
R43	3	0.3	0.3	0.02	21	53	2.4
R44	3	0.3	0.4	0.03	21	53	2.4
R45	3	0.3	0.4	0.03	21	53	2.4
R46	3	0.3	0.4	0.03	21	53	2.4
R47	3	0.4	0.4	0.03	21	53	2.4
R48	3	0.4	0.4	0.03	21	53	2.4
R49	3	0.4	0.5	0.03	21	53	2.4
R50	3	0.4	0.5	0.03	21	53	2.4
R51	3	0.4	0.5	0.03	21	53	2.4
R52	3	0.4	0.5	0.03	21	53	2.4

Table 8.1 (Cont)
Model predictions due to the Project alone and the Project and other sources

Private Receptor ID	Year 3 – Project alone				Year 3 - Project and other sources		
	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust Deposition (g/m^2/month)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	Dust Deposition (g/m^2/month)
	24-hour	Annual	Annual	Annual	Annual	Annual	Annual
	Assessment Criteria						
	50	***N/A***	***N/A***	***2***	***30***	***90***	***4***
R53	4	0.5	0.6	0.04	22	54	2.4
R54	4	0.5	0.6	0.04	22	54	2.4
R55	4	0.6	0.6	0.05	22	54	2.4
R56	4	0.5	0.6	0.04	22	54	2.4
R57	3	0.5	0.6	0.04	21	54	2.4
R58	5	0.6	0.7	0.05	22	54	2.5
R59	5	0.6	0.7	0.05	22	54	2.5
R60	4	0.5	0.6	0.04	21	54	2.4
R61	3	0.4	0.5	0.04	21	53	2.4
R62	3	0.4	0.5	0.04	21	53	2.4
R63	3	0.3	0.4	0.03	21	53	2.4
R64	3	0.3	0.3	0.02	21	53	2.4
R65	3	0.3	0.4	0.03	21	53	2.4
R66	3	0.3	0.4	0.03	21	53	2.4
R67	3	0.3	0.3	0.03	21	53	2.4
R68	3	0.3	0.4	0.03	21	53	2.4
R69	3	0.5	0.6	0.04	22	54	2.4
R70	4	0.4	0.5	0.04	21	53	2.4
R71	4	0.6	0.7	0.05	22	54	2.5
R72	5	0.6	0.7	0.05	22	54	2.5
R73	3	0.1	0.2	0.01	21	53	2.4
R74	3	0.2	0.2	0.01	21	53	2.4
R75	3	0.2	0.2	0.01	21	53	2.4
R76	3	0.1	0.2	0.01	21	53	2.4
R77	3	0.2	0.2	0.01	21	53	2.4
R78	3	0.2	0.2	0.01	21	53	2.4
R79	3	0.2	0.2	0.01	21	53	2.4
R80	3	0.2	0.2	0.02	21	53	2.4
R81	3	0.2	0.2	0.01	21	53	2.4
R82	2	0.2	0.2	0.02	21	53	2.4
R83	2	0.2	0.3	0.02	21	53	2.4
R84	3	0.2	0.3	0.02	21	53	2.4
R85	3	0.2	0.3	0.02	21	53	2.4
R86	3	0.3	0.3	0.02	21	53	2.4
R87	3	0.3	0.3	0.02	21	53	2.4
R88	3	0.3	0.3	0.02	21	53	2.4
R89	3	0.1	0.2	0.01	21	53	2.4
R90	3	0.2	0.2	0.01	21	53	2.4
R91	3	0.3	0.3	0.02	21	53	2.4
R92	1	0.1	0.1	0.01	21	53	2.4
R93	4	0.3	0.4	0.03	21	53	2.4
R94	4	0.3	0.3	0.03	21	53	2.4
R95	1	0.1	0.1	0.00	21	53	2.4
R96	1	0.1	0.1	0.00	21	53	2.4
R97	1	0.1	0.1	0.00	21	53	2.4
R98	1	0.1	0.1	0.00	21	53	2.4
R99	1	0.1	0.1	0.00	21	53	2.4
R100	1	0.1	0.1	0.00	21	53	2.4
R101	1	0.1	0.1	0.01	21	53	2.4
R102	1	0.1	0.1	0.01	21	53	2.4
R103	1	0.1	0.1	0.01	21	53	2.4
R104	1	0.1	0.1	0.01	21	53	2.4
R105	2	0.1	0.2	0.01	21	53	2.4
R106	3	0.2	0.2	0.01	21	53	2.4
R107	4	0.3	0.3	0.02	21	53	2.4

9. MITIGATION MEASURES

9.1 INTRODUCTION

The modelling results presented above are based on the assumption that the Proponent applies the control measures discussed in following sections to minimise dust emissions. This section outlines procedures proposed for the management and control of dust emissions.

9.2 PROPOSED DUST MANAGEMENT AND CONTROL PROCEDURES

The term "best practice" is frequently used in pollution control and pollution management. However, what constitutes "best practice" is difficult to define in practical situations. Environment Australia has published a series of booklets to assist the mining industry with incorporating best practice environmental management through all phases of mineral production from exploration through construction and eventual closure. In the booklet for Dust Control (Environment Australia, 1998) "best practice" is defined as follows.

> *"Best Practice can be defined as the most practical and effective methodology that is currently in use or otherwise available. Best practice dust management can be achieved by appropriate planning in the case of new or expanding mining operations and by identifying and controlling dust sources during the active phases of all mining operations."*

This document has since been updated by the Department of Energy, Resources and Tourism (DERT) which published the handbook *Leading Practice Sustainable Development Program for the Mining Industry* (DERT, 2009). This new handbook introduces the term "leading practice", which is defined as follows.

> *"...considers the latest and most appropriate technology applied in order to seek better financial, social and environmental outcomes for present stakeholders and future generations.*"

The following procedures are recommended for the management of dust emissions from the Project. The aim of these is to minimise the emission of dust in a cost effective manner. The effects of these controls are included in the model simulations. Dust can be generated from two primary sources:

- wind blown dust from exposed areas; and
- dust generated by mining activities.

The proposed controls have been considered against those determined to be best or leading practice in the Environment Australia booklet for Dust Control.

Table 9.1, **Table 9.2** and **Table 9.3** list the mine design, wind-blown and mining-generated dust sources respectively and associated controls. These have been incorporated in the analysis, where relevant.

Table 9.1
Best Practice Control Procedures for Wind-blown Dust

Source	Control Procedures
Areas Disturbed by Mining	• Disturb only the minimum area necessary for mining. • Reshape, topsoil and rehabilitate completed waste rock emplacement areas as soon as practicable after the completion of waste rock tipping. As the Waste Rock Emplacement of the Project is to be a temporary structure, reshaping, topsoiling and rehabilitation activities of the remaining structure (ROM Pad batter) should be undertaken as soon as practical after the excavation and haulage of the waste rock is complete.
Ore Handling Areas/Stockpiles	• Maintain ore handling areas / stockpiles in a moist condition as required using water carts to minimise wind-blown and traffic-generated dust.
Stockpiles	• Have available water sprays/water carts on stockpiles to minimise the generation of dust.

Table 9.2
Best Practice Controls for Mine Design

Source	Control Procedures
Transport of ore	• Use the largest practical truck size to reduce the number of movements necessary to transport the ore. • Use the shortest route possible. • Use conveyors within the processing plant. • Establish and use water sprays on key transfer points within the processing plant.
Waste Rock Emplacement	• Orient the Waste Rock Emplacement to minimise profile exposure to receptors. • Profile all surfaces to reduce surface speed. • Contour the final landform shape to avoid strong wind flows and smooth gradients to reduce turbulence at surface.
Revegetation	• Complete as soon as practical after disturbance. • Apply vegetation as widely as practical.

Table 9.3
Best Practice Controls for Mine-generated Dust

Source	Control Procedures
Haul Road Dust	• All roads and trafficked areas should be watered as required using water trucks to minimise the generation of dust. • All haul roads should have edges clearly defined with marker posts or equivalent to control their locations, especially when crossing large areas of non-descript disturbance. • Obsolete roads should be ripped and re-vegetated.
Minor Roads	• Development of minor roads should be limited and the locations of these clearly defined. • Minor roads used regularly for access, etc. should be watered. • Obsolete roads should be ripped and re-vegetated.
Topsoil Stripping	• Access tracks used by topsoil stripping equipment during their loading and unloading cycle should be watered.
Topsoil Stockpiling	• Long term topsoil stockpiles not regularly used should be re-vegetated.
Processing	• Establish and use water sprays on key transfer points within the processing plant. • Minimise drop heights from the ROM bin to the primary crusher.

10. GREENHOUSE GAS ASSESSMENT

10.1 INTERNATIONAL FRAMEWORK

10.1.1 Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is a panel established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP), to provide independent scientific advice on climate change. The panel was asked to prepare, based on available scientific information, a report on all aspects relevant to climate change and its impacts and to formulate realistic response strategies. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC).

Since the UNFCCC has entered into force, the IPCC remains the pivotal source for its scientific, technical and socio-economic information.

The stated aims of the IPCC are to assess scientific information relevant to:

- human-induced climate change;
- the impacts of human-induced climate change; and
- options for adaptation and mitigation.

The fourth IPCC assessment report was released in 2007 (IPCC, 2007). IPCC reports are widely cited in climate change debates and policies, and are generally regarded as authoritative.

10.1.2 United Nations Framework Convention on Climate Change (UNFCCC)

10.1.2.1 Introduction

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource, the stability of which can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 183 countries (Parties) having ratified the contained treaty, the Kyoto Protocol (see **Section 10.1.2.2**). Australia ratified the Kyoto Protocol in December 2007.

Under the UNFCCC, governments:

- gather and share information on greenhouse gas emissions, national policies and best practices;
- launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and
- co-operate in preparing for adaptation to the impacts of climate change.

10.1.2.2 Kyoto Protocol

The Kyoto Protocol entered into force on 16 February 2005.

The Kyoto Protocol builds upon the UNFCC by committing Annex I Parties to individual, legally-binding targets to limit or reduce their GHG emissions for the following gases:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulfur hexafluoride (SF_6).

The emission reduction targets are calculated based on a Party's domestic emission greenhouse inventories (which include the sectors land use change and forestry clearing, transportation, stationary energy, etc). Domestic inventories require approval by the Kyoto Enforcement Branch. The Kyoto Protocol requires developed countries to meet national targets for greenhouse gas emissions over a five year period between 2008 and 2012.

To achieve their targets, Annex I Parties must put in place *domestic policies and measures.* The Kyoto Protocol provides an indicative list of policies and measures that might help mitigate climate change and promote sustainable development.

Under the Kyoto Protocol, developed countries can use a number of flexible mechanisms to assist in meeting their targets. These are trading-based market mechanisms which include:

- Joint Implementation (JI) – where developed countries invest in GHG emission reduction projects in other developed countries; and
- Clean Development Mechanism (CDM) – where developed countries invest in GHG emission reduction projects in developing countries.

Annex I countries that fail to meet their emissions reduction targets during the 2008-2012 period may be liable for a 30 percent penalty, to be made up in the post 2012 commitment period.

10.2 AUSTRALIAN CONTEXT

10.2.1 Australia and the Kyoto Protocol

10.2.1.1 Introduction

The aim of the Protocol is to reduce global greenhouse gas emissions by requiring developed countries to meet national targets for greenhouse gas emissions over the five year period from 2008 to 2012. Australia's annual target is 108% of the 1990 emissions.

Countries are required to take on a range of monitoring and reporting commitments, which are designed to ensure they remain on track to meet their obligations and to measure the overall success of the Protocol.

10.2.1.2 National Greenhouse and Energy Reporting Act

The *National Greenhouse and Energy Reporting (NGER) Act 2007* was passed in September 2007. The NGER Act establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production. The NGER scheme consolidates existing greenhouse reporting schemes.

The NGER Act is underpinned by a number of legislative instruments that provide greater detail about obligations, which in conjunction with the NGER Act, form the National Greenhouse and Energy Reporting System, as follows:

- The *National Greenhouse and Energy Reporting Regulations 2008*;
- The *National Greenhouse and Energy Reporting (Measurement) Determination 2008*; and,
- The proposed External Audit Legislative Instrument which is still under development.

NGER is seen as an important first step in the establishment of a domestic emissions trading scheme. This intention is explicitly stated in the objectives for the NGER scheme, which are to:

- establish a baseline of emissions for participants in a future Australian emissions trading scheme;
- inform the Australian public;
- meet international reporting obligations; and,
- assist policy formulation of all Australian governments while avoiding duplication of similar reporting requirements.

Companies must register and report if they emit greenhouse emissions or produce/consume energy at or above the following trigger thresholds:

- if they own facilities that emit greater than 25kt greenhouse emissions (expressed as CO_2-e) or produce consume greater than 100 TJ of energy; and,
- if the corporate group emits greater than 125kt of greenhouse emissions (expressed as CO_2-e) or produce consume greater than 500TJ of energy.

A project is required to report to the NGER system if it will emit greater than 25kt of greenhouse emissions. As such, the Project would be subject to the reporting under the system (see Section 10.5).

10.2.1.3 Carbon Pollution Reduction Scheme

A green paper detailing Australia's plans to implement a domestic emissions trading scheme was released on the 16 July 2008 (DCC, 2008a). A subsequent white paper was released in December 2008 (DCC, 2008b) with the intent that a Carbon Pollution Reduction Scheme (CPRS) would commence in July 2010. On 27 April 2010, the Prime Minister announced that

the Government had decided to delay the implementation of the CPRS until after the end of the current commitment period of the Kyoto Protocol and only when there is greater clarity on the action of other major economies including the US, China and India. Legislation was introduced to Parliament in May 2009, but at the time of writing had not been finalised.

The CPRS is 'cap and trade' emissions trading mechanism scheme whereby emitters of greenhouse gases greater than 25,000t carbon dioxide-equivalent (CO_2-e) are required to purchase a permit for every tonne of greenhouse gas that they emit. As such, the Project would be subject to the scheme.

10.3 GREENHOUSE GAS INVENTORIES

Greenhouse gas inventories are calculated according to a number of different methods. The procedures specified under the Kyoto Protocol United Nations Framework Convention on Climate Change are the most common.

CO_2 would be the most significant gas emitted by the Project as it is generated and released during the combustion of diesel fuel with relative minor amounts of CH_4 and NO_2. It would be liberated when fuels are burnt in diesel powered equipment and in the generation of the electrical energy that will be used at the site.

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The estimated emissions are referred to in terms of CO_2-equivalent (CO_2-e) emission by applying the relevant global warming potential.

10.4 GREENHOUSE EMISSION CALCULATION METHODOLOGY

10.4.1 Introduction

The greenhouse gas assessment has been conducted in accordance with the methodologies established by the various policies and guidelines which are detailed in Section 10.1 and Section 10.2 and using the National Greenhouse Accounts (NGA) Factors, published by the Department of Climate Change (DCC, 2009a). The DCC defines three 'scopes' (or emission categories).

- Scope 1 covers direct emissions from sources within the Project Site boundary such as fuel combustion and manufacturing processes.
- Scope 2 covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.
- Scope 3 includes all other indirect emissions that are a consequence of the organisations activities but are not from sources owned or controlled by the organisations, eg. extraction of diesel fuel, off-site transport of the product, or staff travel etc.

For the purposes of this assessment Project-related greenhouse gas sources include the following.

- Diesel combustion during mine operations – Scope 1.
- Indirect emissions resulting from off-site diesel extraction and transport – Scope 3.
- Indirect emissions resulting from the consumption of purchased electricity i.e.:
  - The consumption of purchased electricity – Scope 2; and
  - Electricity lost through transport of purchased electricity – Scope 3.

10.4.2 Emission factors

Data provided in the National Greenhouse Accounts (NGA) Factors, published by the Commonwealth Department of Climate Change (DCC) (DCC, 2009a) were used. DCC defines three 'scopes' (or emission categories):

Table 10.1 provides a summary of the emission factors used.

Table 10.1
Summary of Emission Factors for Greenhouse Gas Assessment

Emission Source	Emission factor		Scope	Source
Diesel - Non-transport activities	69.5	kg CO_2-e/GJ	1	Table 3 (DCC, 2009a)
	5.3	kg CO_2-e/GJ	3	Table 38 (DCC, 2009a)
Electricity	0.89	kg CO_2-e/kWh	2	Table 39 (DCC, 2009a)
	0.18	kg CO_2-e/kWh	3	Table 3 (DCC, 2009a)

10.4.3 Scope 1 Emissions

10.4.3.1 Fuel Consumption

Based on information provided by the Proponent, **Table 10.2** presents a summary of annual on-site diesel usage.

Table 10.2
Summary of On-site Diesel Usage (L/y)

Operational Year	Diesel Usage per Year (L)
Year 1	1,117,314
Year 2	1,473,228
Year 3	1,475,820
Year 4	955,800
Year 5	635,607
Total (L)	**5,657,769**
Source: Big Island Mining Pty Ltd	

The energy content of diesel was taken to be 38.6GJ/kL (DCC, 2009a).

The following formula (DCC, 2009a) was used to estimate the greenhouse gas emissions from fuel usage:

$$GHG\ Emissions\ (tCO_2 - e) = \frac{Q \times EC \times EF}{1000}$$ Equation 1

Where:
Q = quantity of fuel in tonnes or thousands of litres
EC = energy content of the fuel in GJ/tonne or GJ/kL
EF = relevant emission factor in kg CO_2-e/GJ

The fuel consumption emission factor used for Scope 1 emissions is provided in **Table 10.1**.

The projected GHG emissions from diesel usage are presented in **Table 10.3**.

Table 10.3
Estimated (Scope 1) CO_2-e Emissions from Consumption of Diesel on the Project Site

Operational Year	Diesel CO_2-e Emissions (t CO_2-e/y)
Year 1	2,997
Year 2	3,952
Year 3	3,959
Year 4	2,564
Year 5	1,705
Total	**15,178**

10.4.4 Scope 2 Emissions

10.4.4.1 Electricity Consumption

Based on information provided by the Proponent, **Table 10.4** presents a summary of purchased electricity consumption.

Table 10.4
Summary of consumption of purchased electricity (kWh)

Operational Year	Electricity Consumption per Year (kWh)
Construction - 4 months	206,681
Year 1	36,238,204
Year 2	45,241,750
Year 3	46,567,613
Year 4	46,662,513
Year 5	34,818,947
Total	**209,735,707**
Source: Big Island Mining Pty Ltd	

To calculate emissions from electricity usage, the following equation was used:

$$GHG\ Emissions\ (tCO_2 - e) = Q \times \frac{EF}{1000}$$ Equation 2

Where:
Q = electricity consumed in kWh
EF = relevant emission factor in kg CO_2-e/GJ

Electricity consumption (Scope 2) emission factors used are provided in **Table 10.1**.

The projected GHG emissions from purchased electricity usage are presented in **Table 10.5**.

Table 10.5
Estimated (Scope 2) CO_2-e Emissions from Electricity Consumption

Operational Year	Electricity CO_2-e Emissions (t CO_2-e/y)
Construction – 4 months	184
Year 1	32,252
Year 2	40,265
Year 3	41,445
Year 4	41,530
Year 5	30,989
Total	**186,665**

10.4.5 Scope 3 Emissions

10.4.5.1 Diesel Extraction and Transport

Scope 3 emissions for diesel are calculated to estimate the emissions which arise as a result of the extraction of the diesel and transport to the Project Site. Scope 1 emissions for the use of diesel at the Project Site have been calculated in Section 10.4.3.

Based on information provided by the Proponent, **Table 10.2** presents a summary of diesel consumption at the Project Site. Equation 1 in Section 10.4.3.1 was used to calculate emissions from diesel extraction and transport.

Diesel extraction and transport (Scope 3) emission factors used are provided in **Table 10.1**.

The projected GHG emissions from the extraction and transport of diesel are presented in **Table 10.6**.

Table 10.6
Estimated (Scope 3) CO_2-e emissions from the extraction and transport of diesel

Operational year	Diesel CO_2-e emissions (t CO_2-e/y)
Construction - 4 months	-
Year 1	229
Year 2	301
Year 3	302
Year 4	196
Year 5	130
Total	**1,157**

10.4.5.2 Generation of purchased electricity

Based on information provided by the Proponent, **Table 10.4** presents a summary of purchased electricity consumption at the Project Site. These values are used to calculate the GHG emissions from electricity generated off-site before purchase by the proponent. Equation 2 in Section 10.4.4.1 was used to calculate emissions from electricity generation.

Electricity generation emission factors used are provided in **Table 10.1**.

The projected GHG emissions from the generation of purchased electricity usage are presented in **Table 10.7**.

Table 10.7
Estimated (Scope 3) CO_2-e emissions from the generation of purchased electricity use

Operational year	Electricity CO_2-e emissions (t CO_2-e/y)
Construction - 4 months	37
Year 1	6,523
Year 2	8,144
Year 3	8,382
Year 4	8,399
Year 5	6,267
Total	**37,752**

10.5 GREENHOUSE GAS EMISSIONS RESULTS

A summary of the total GHG emissions associated with the Project are presented in **Table 10.8**.

Table 10.8
Summary of estimated CO_2-e emissions (t CO_2-e/y)

Year	Scope 1	Scope 2	Scope 3	Total
Construction - 4 months	0	184	37	221
Year 1	2,997	32,252	6,751	42,000
Year 2	3,952	40,265	8,445	52,662
Year 3	3,959	41,445	8,684	54,088
Year 4	2,564	41,530	8,595	52,689
Year 5	1,705	30,989	6,397	39,091
Total	**15,178**	**186,665**	**38,910**	**240,752**

The annual greenhouse emissions in NSW for 2007 were 162.7Mt (DCC, 2009b). **Table 10.9** presents the CO_2-e emission percentage increase for each year of the Project's operations above the NSW 2007 greenhouse emission estimate. These estimates include all scope emissions.

Table 10.9
Summary of estimated percentage increase CO_2-e emissions (t CO_2-e/y)

Year	% Increase from NSW 2007 greenhouse emissions
Construction - 4 months	<0.001
Year 1	0.026
Year 2	0.032
Year 3	0.033
Year 4	0.032
Year 5	0.024

For the life of the Project, it has been estimated that the development would release approximately 0.24Mt/y CO_2-e. The maximum annual increase of emissions would be in Year 3 which would represent an approximate annual contribution of 0.03% to baseline 2007 NSW emissions.

11. CONCLUSIONS

This report has assessed the air quality associated with the proposed Dargues Reef Gold Project located in the Southern Tableland region of New South Wales.

One 'worst-case' operating scenario has been assessed to represent the potential air quality impacts that the Project would have on sensitive receptors (e.g. residences) in the proximity of the Project Site.

Dispersion modelling has been used to assess the impact that dust emissions from the Project would have on the local air quality. The emissions inventory developed for Year 3 (worst case) operations has been used with local meteorological data and a modified version of the US EPA's ISCST3 model to predict the maximum 24-hour PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition (insoluble solids). The modelling has been undertaken to show the effects of the Project alone and with background dust levels considered.

It is concluded that air quality impacts would not exceed the assessment criteria at any of the surrounding sensitive receptors or non-Project related residences.

A greenhouse gas assessment has been conducted using the National Greenhouse Accounts Factors. A project is required to report to the NGER system if it will emit greater than 25kt of greenhouse emissions. As such, the Project would be subject to the reporting under the system. For the life of the Project, it has been estimated that the Project would release approximately 0.24Mt/y CO_2-e. The maximum annual increase of emissions would be in Year 3, which would represent an approximate contribution of 0.03% (all scope emissions) to baseline 2007 NSW emissions.

12. REFERENCES

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FIGURES

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(Note: Colour versions of these figures are available on the Project CD)

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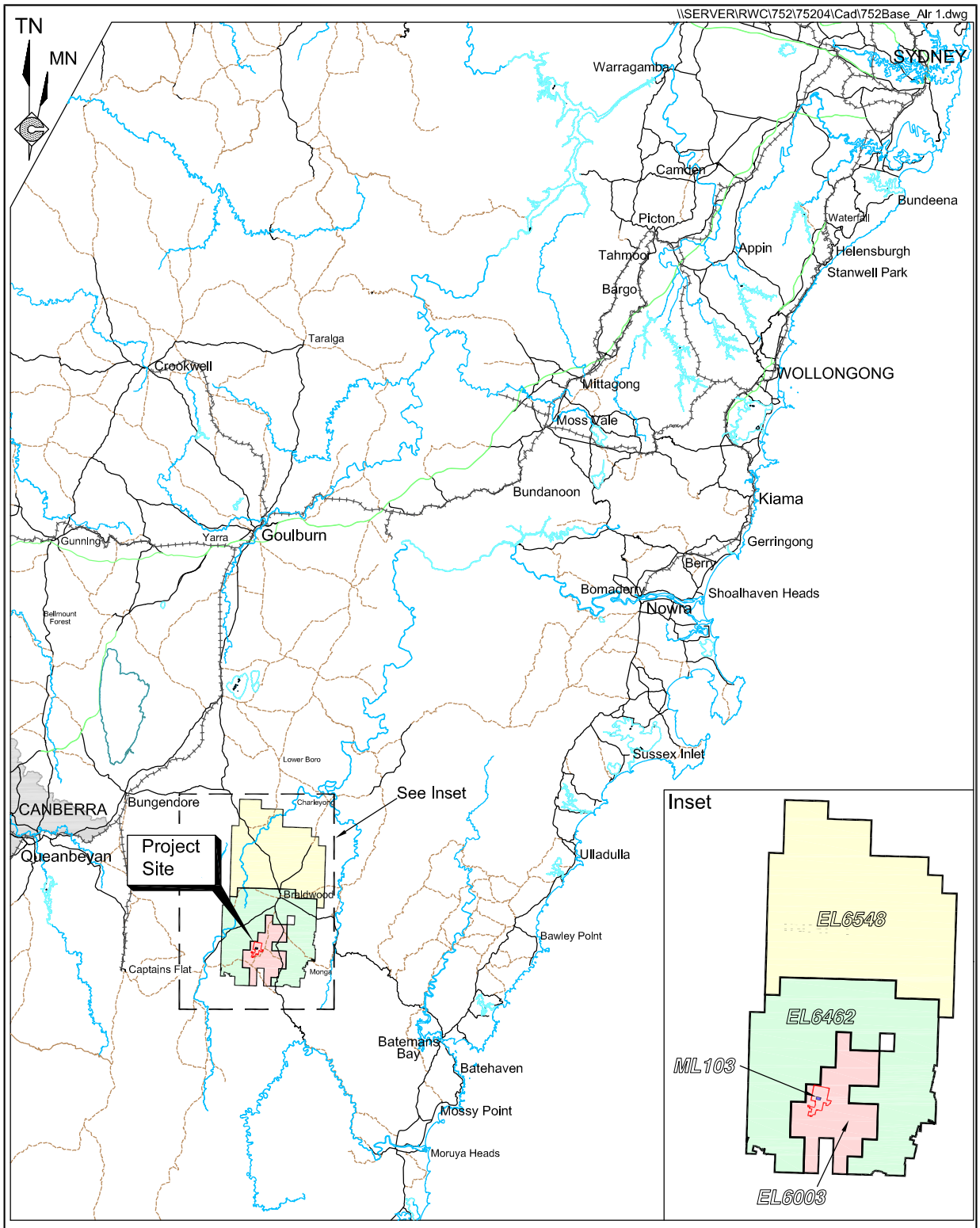

Figure 1
LOCALITY PLAN

Note: A colour version of this Figure is available on the Project CD

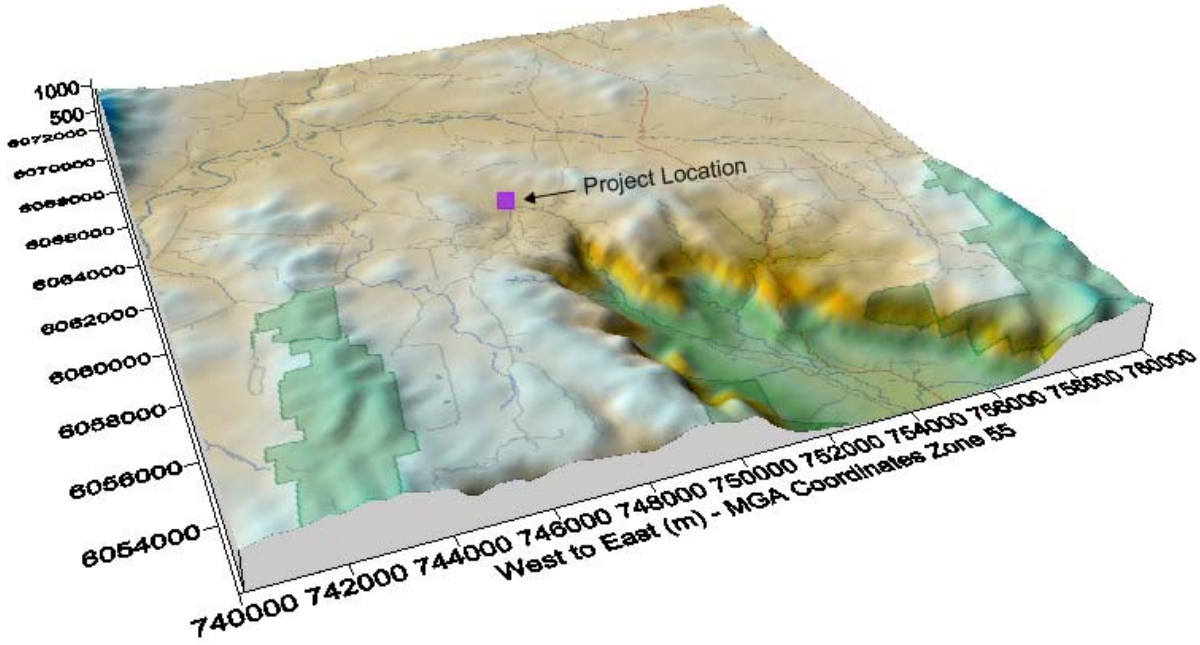

Figure 2 Pseudo 3D plot of local terrain

\\SERVER\RWC\752\75204\Cad\752EA_Air 3.DWG

TN
MN

See Detail Right

Site Access Road

Tailings Storage Facility

Tailings Storage Facility Access Road

Ventilation Rise

Spring Creek

Existing Site Access Track (to be decommissioned)

Majors Creek Road

Detail

Proponent & Mining Contractor Offices
Concentrate Storage
Gold Room
Floatation Tanks
Raw Water
Reagent & Other Storage
Concentrator
Crushing & Grinding Circuit
Processing Plant Office Area
+ 692
Water Supply Tanks
ROM Pad
+ 705
Sub-station
Settling Dam
Temporary Waste Rock Emplacement
Fuel Bay
Core Yard
Lay Down Yard
Workshop
Box Cut

SCALE 1:4 000

50 0 50 100 150 200 m

See Detail Left

REFERENCE

- Project Site Boundary
- 675 Contour (m AHD)(Interval = 5m)
- 675 Contour (m AHD)(Interval = 10m)
- + 692 Spot height (m AHD)
- Creek / Drainage Line
- Sealed Road
- Unsealed Road
- Existing Dam/Water Storage
- Proposed Settling Dam
- Proposed Harvestable Rights Dam (Indicative Location)
- Catchment Boundary
- P Existing Transmission Line
- P Proposed Transmission Line
- Proposed Pipeline (Indicative)
- Proposed Road/Track (Sealed/Unsealed)
- Fence (note: fences not co-incident with cadastral boundaries)

SCALE 1:8 000

100 0 100 200 300 400 m

Base Map Source: Geo-spectrum (Australia) Pty Ltd

Figure 3
PROJECT SITE LAYOUT

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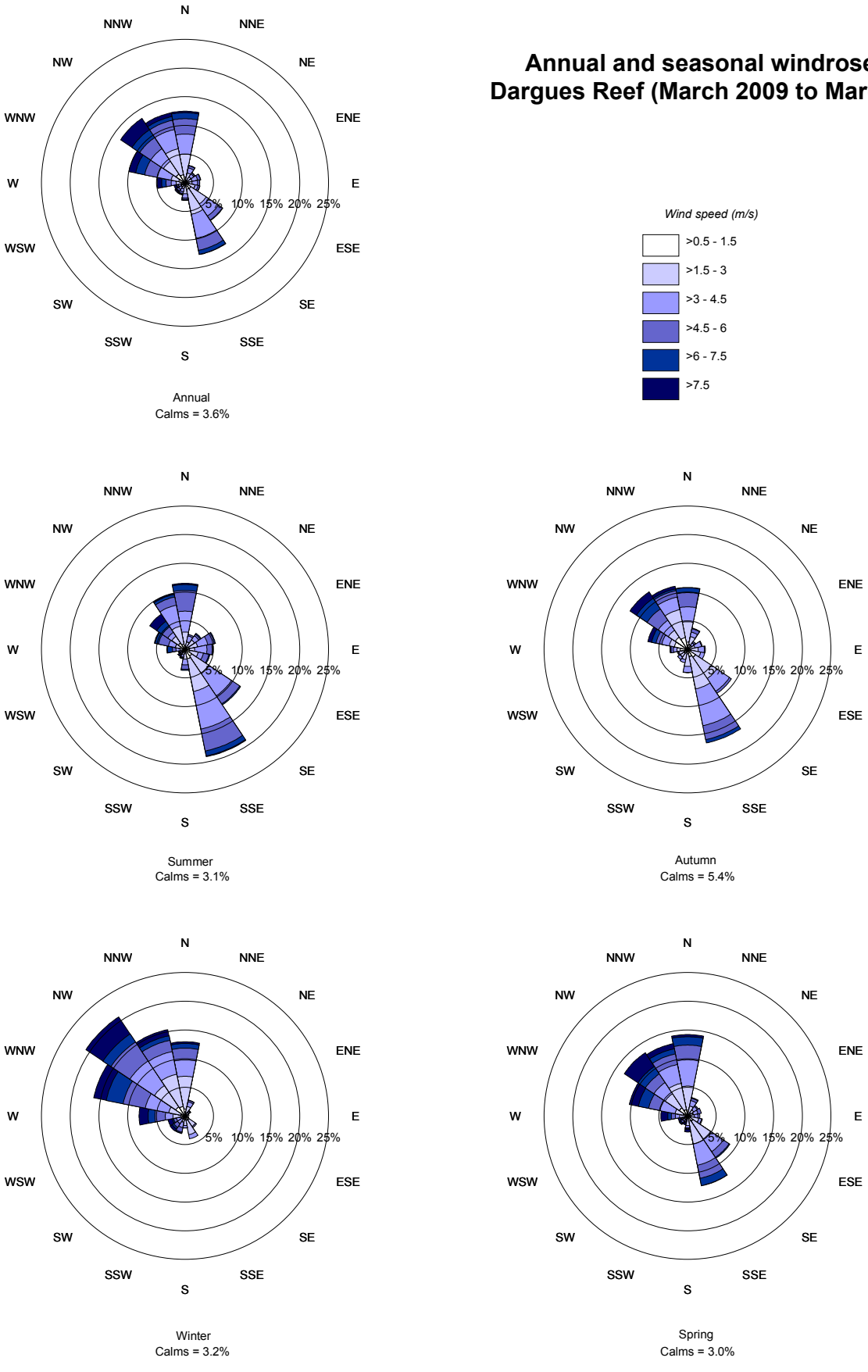

Figure 4 **Annual and seasonal windroses for Dargues Reef (March 2009 to March 2010)**

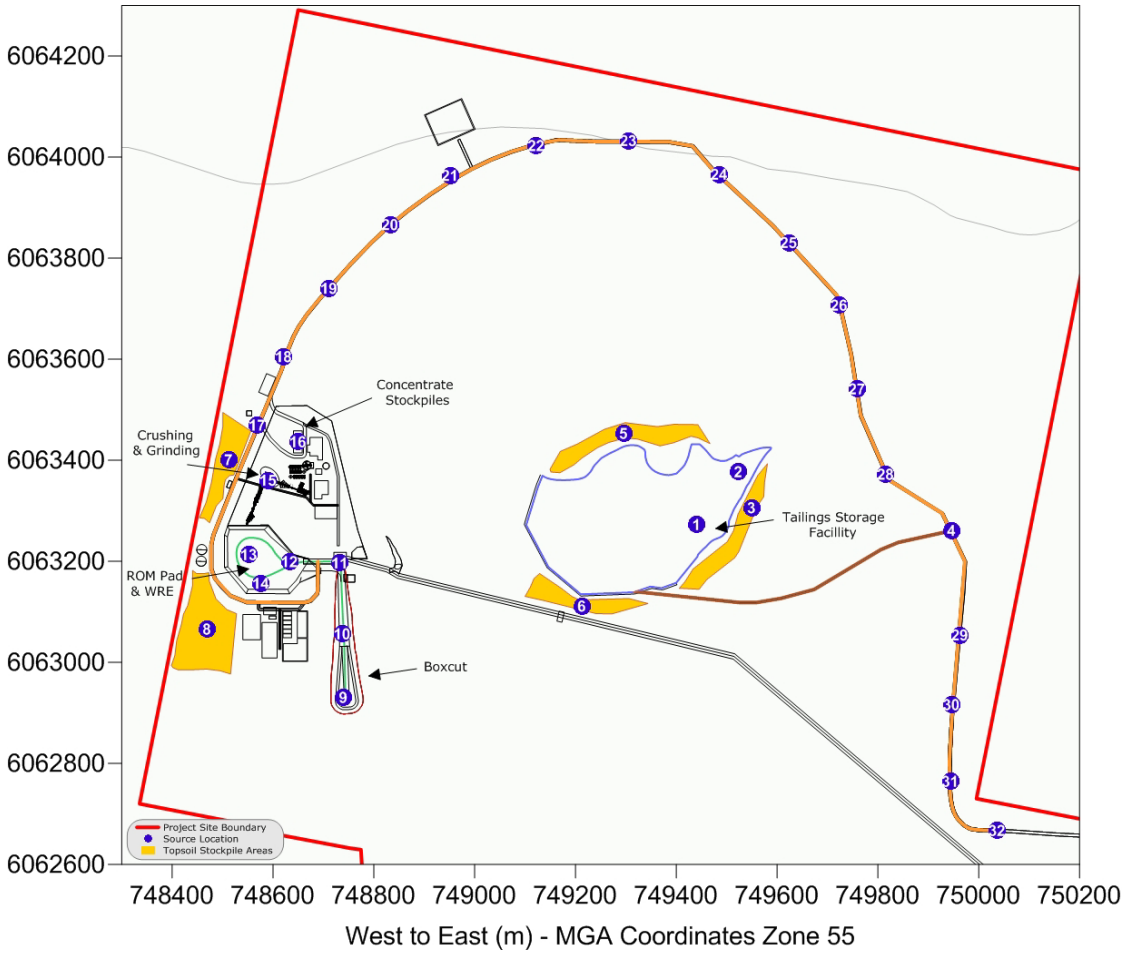

Figure 5 Modelling source locations

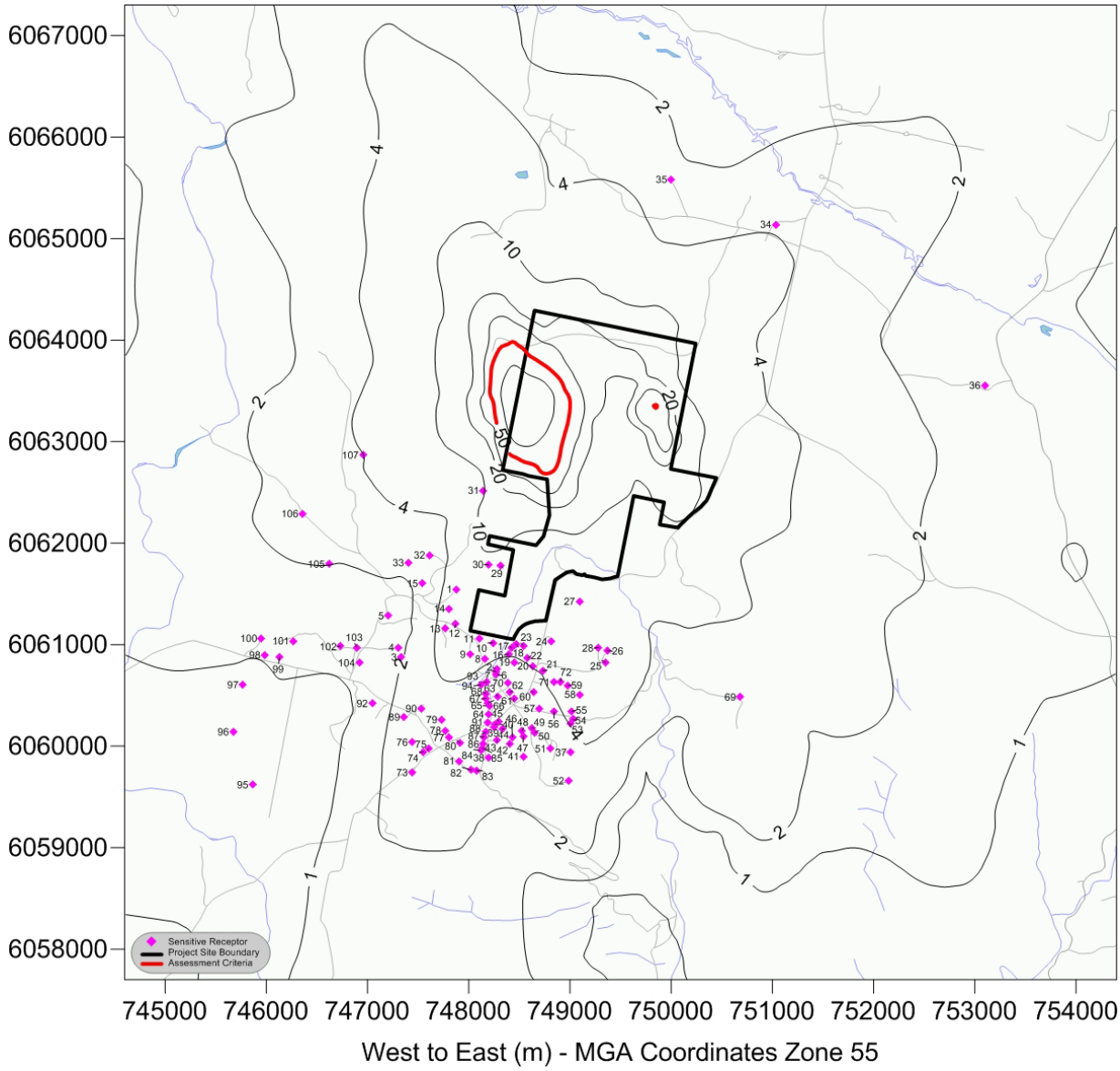

Figure 6 Year 3 - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project alone

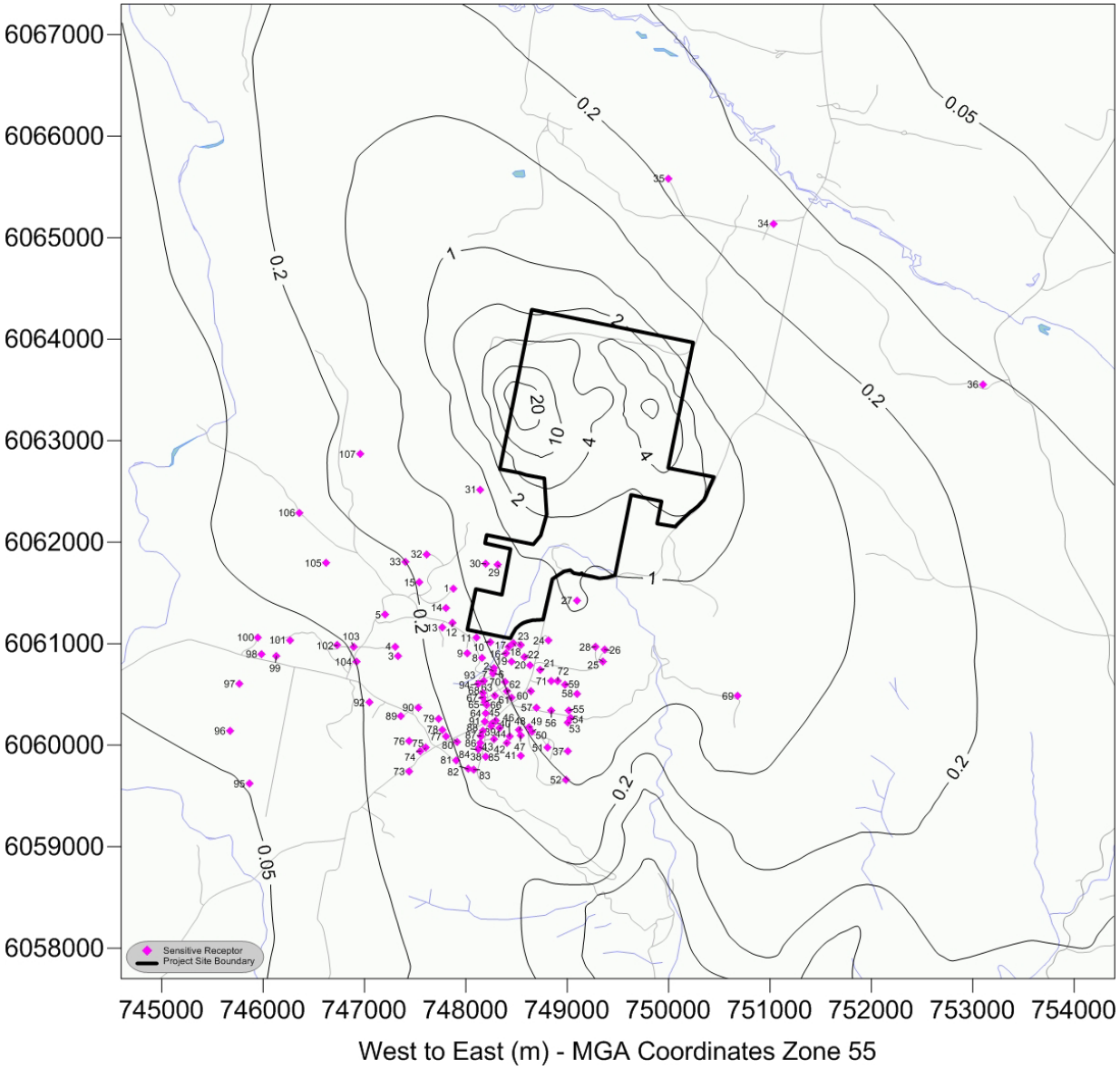

Figure 7 Year 3 - Predicted annual average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project alone

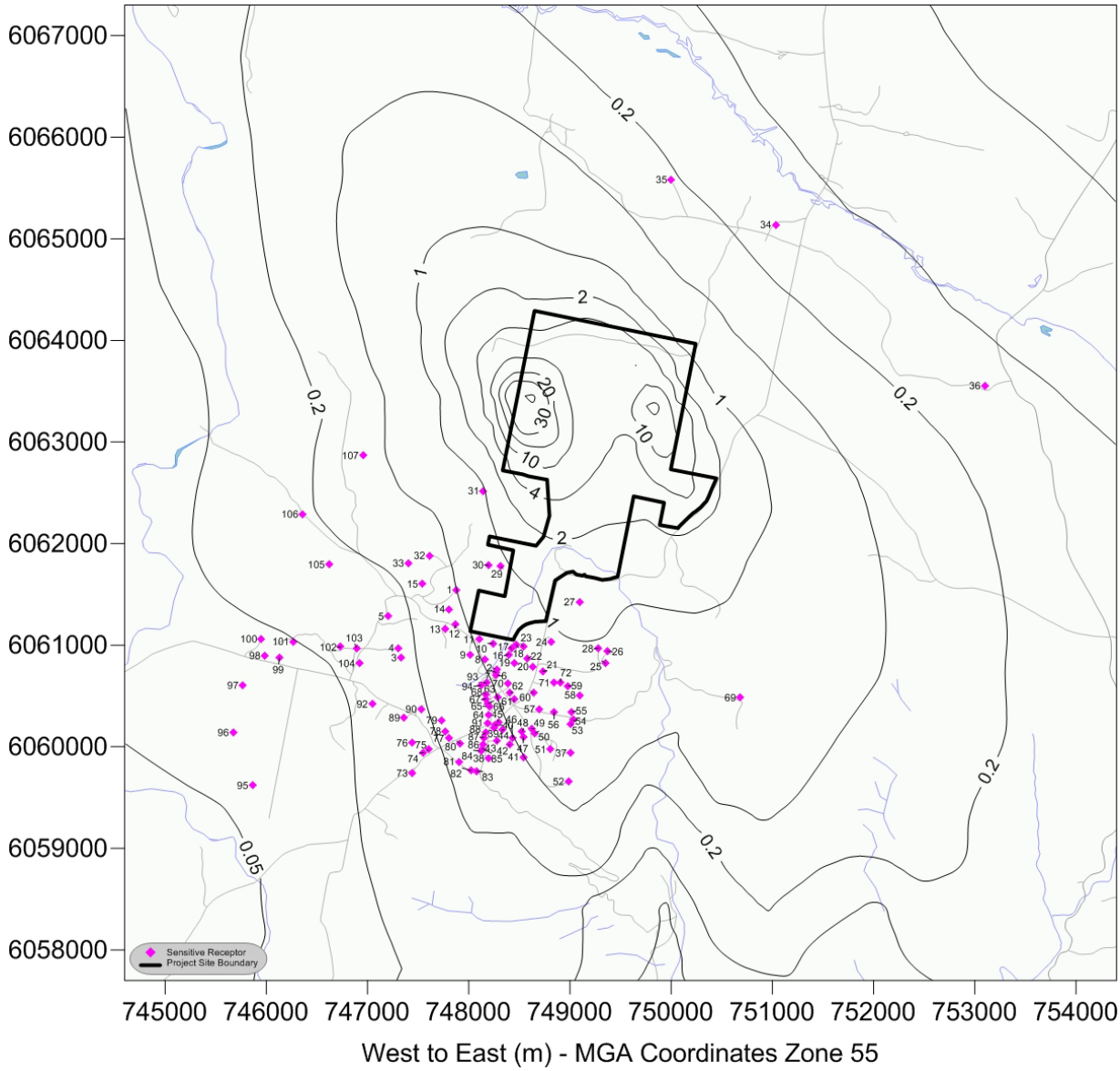

Figure 8 Year 3 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project alone

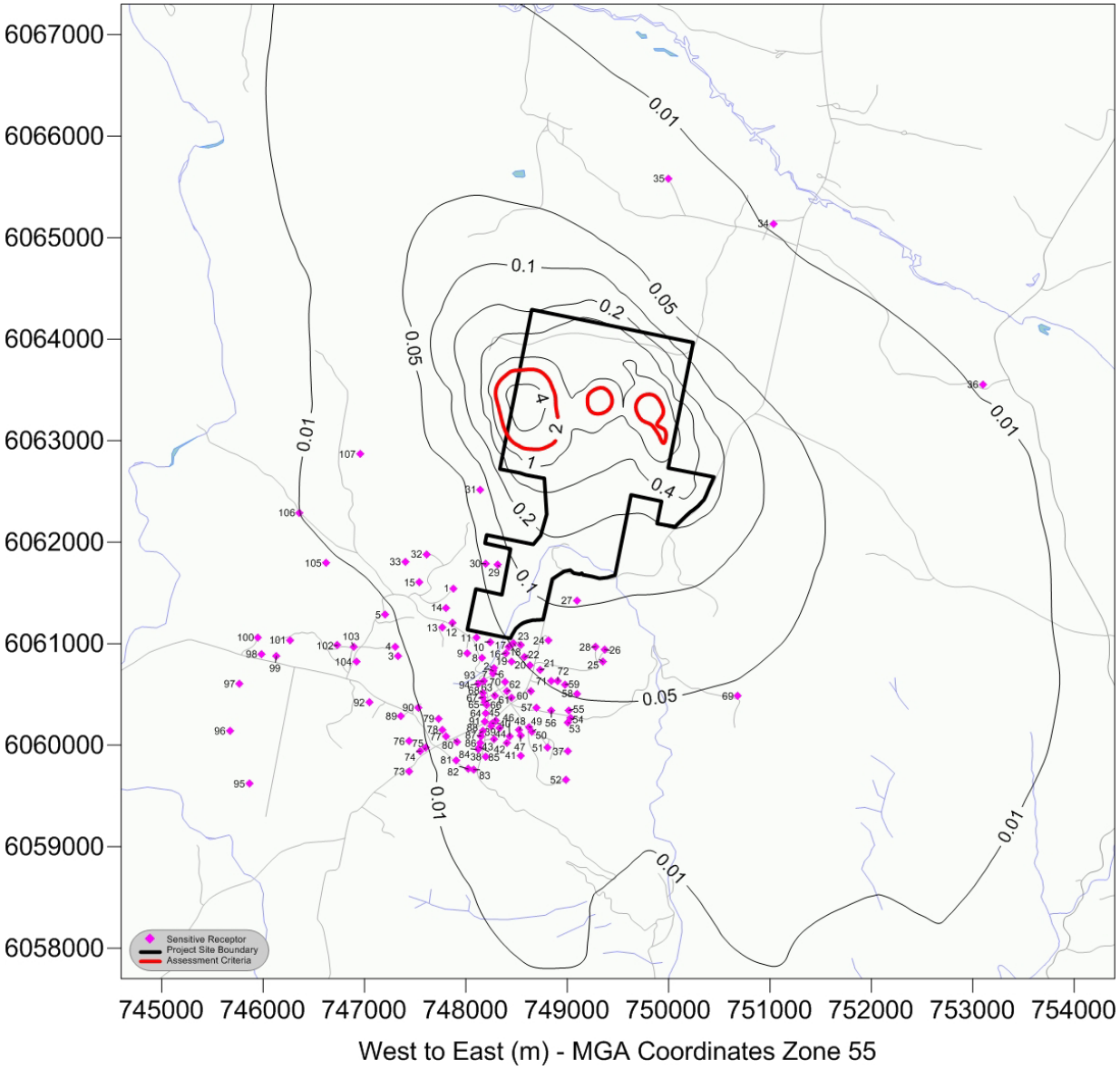

Figure 9 Year 3 - Predicted annual average dust deposition levels (g/m^2/month) due to emissions from the Project alone

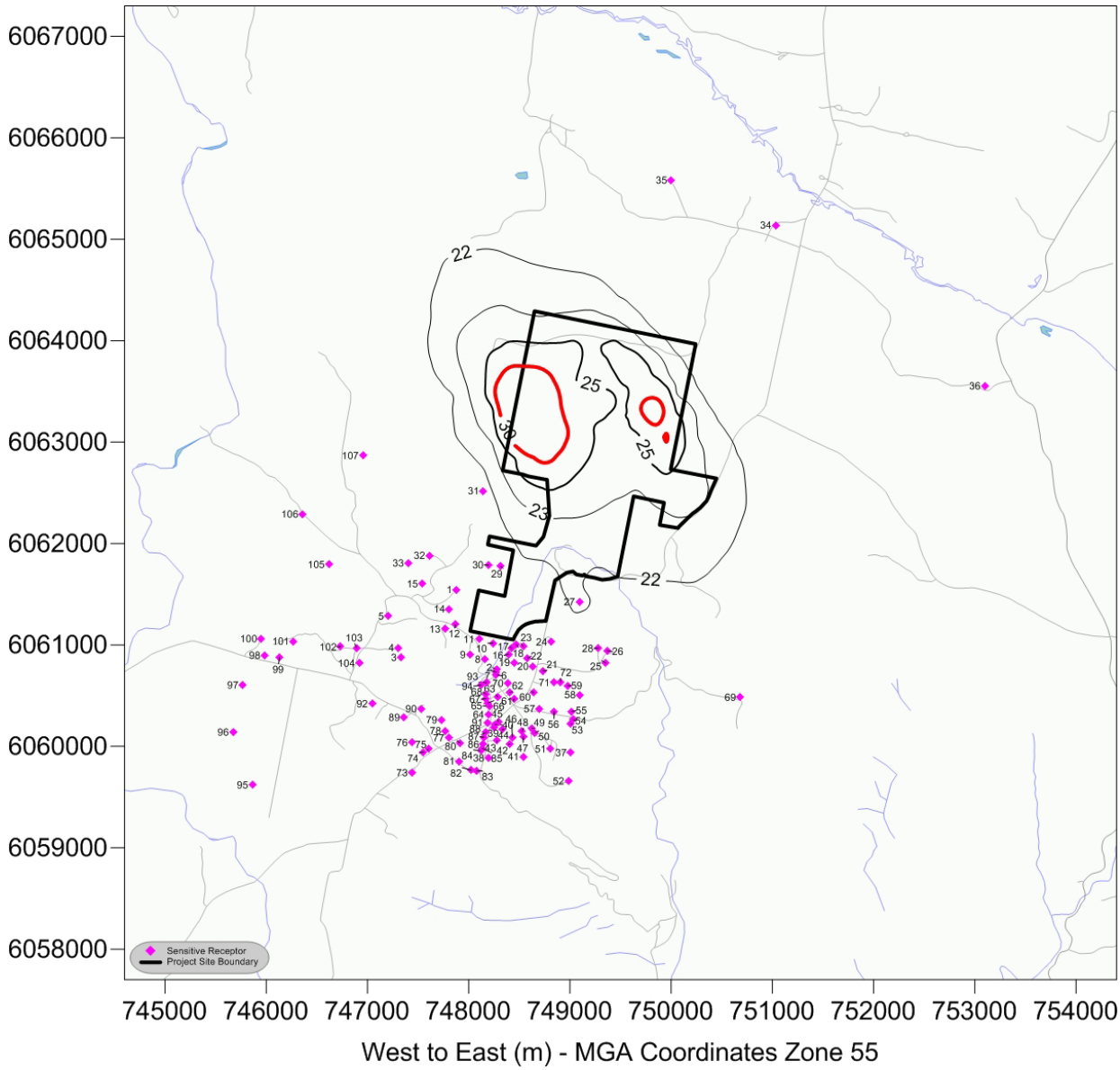

Figure 10 Year 3 - Predicted annual average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project and other sources

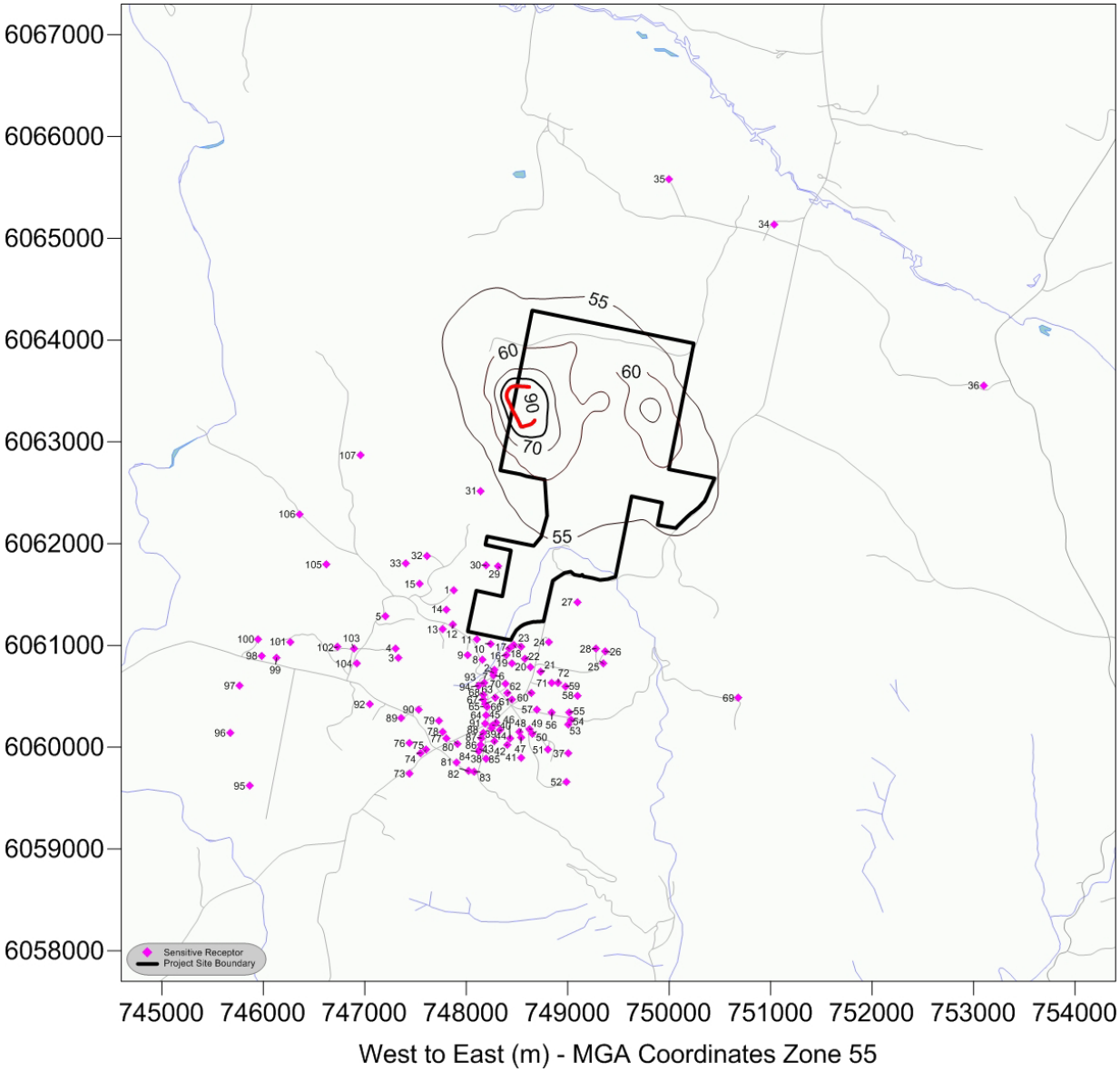

Figure 11 Year 3 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project and other sources

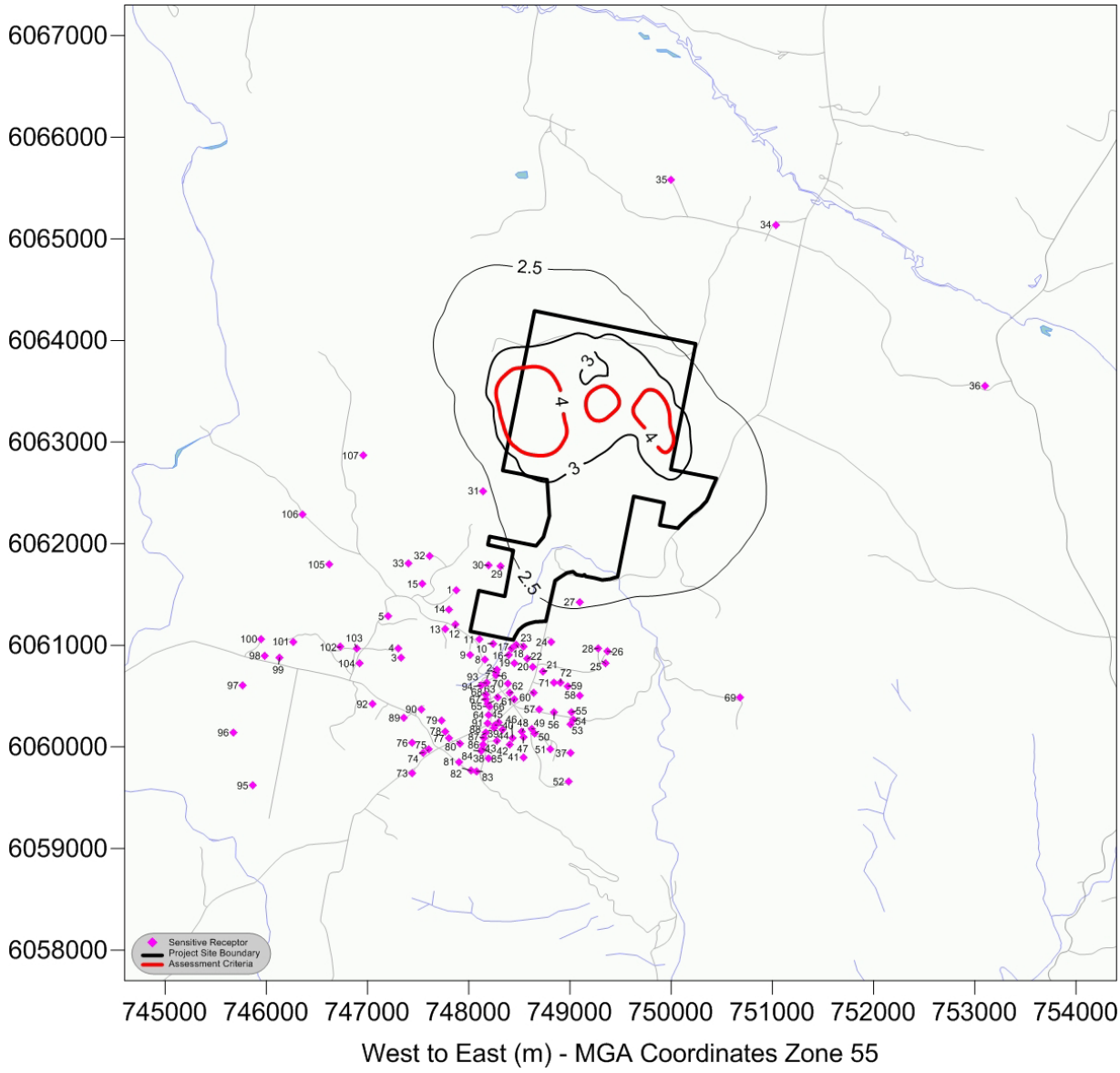

Figure 12 Year 3 - Predicted annual average dust deposition levels (g/m^2/month) due to emissions from the Project and other sources

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Appendices

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Appendix 1 Joint Wind Speed, Wind Direction and Stability Class Frequency Tables

Appendix 2 Estimated Dust Emissions

Appendix 3 Example ISCMOD Input File

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Appendix 1

Joint Wind Speed, Wind Direction and Stability Class Frequency Tables

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STATISTICS FOR FILE: C:\Jobs\Dargues_Reef\ISC\Dargues_0910_MODEL.isc
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000975	0.001827	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002802
NE	0.000731	0.001096	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001827
ENE	0.000122	0.000975	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001096
E	0.000122	0.001096	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001218
ESE	0.000365	0.001705	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002071
SE	0.000365	0.001096	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001462
SSE	0.000487	0.000975	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001462
S	0.000365	0.000365	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000731
SSW	0.000122	0.000122	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000244
SW	0.000000	0.000731	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000731
WSW	0.000000	0.000365	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000365
W	0.000365	0.000975	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001340
WNW	0.000000	0.000731	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000731
NW	0.000000	0.000975	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000975
NNW	0.000487	0.000487	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000975
N	0.000487	0.001096	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001584
CALM									0.000000
TOTAL	0.004995	0.014618	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.019613

MEAN WIND SPEED (m/s) = 2.02
NUMBER OF OBSERVATIONS = 161

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000365	0.001218	0.001462	0.000000	0.000000	0.000000	0.000000	0.000000	0.003045
NE	0.000000	0.000609	0.001340	0.000000	0.000000	0.000000	0.000000	0.000000	0.001949
ENE	0.000122	0.000244	0.000122	0.000000	0.000000	0.000000	0.000000	0.000000	0.000487
E	0.000122	0.000244	0.001218	0.000000	0.000000	0.000000	0.000000	0.000000	0.001584
ESE	0.000000	0.000244	0.001218	0.000000	0.000000	0.000000	0.000000	0.000000	0.001462
SE	0.000122	0.002315	0.002071	0.000000	0.000000	0.000000	0.000000	0.000000	0.004507
SSE	0.000000	0.001584	0.001584	0.000000	0.000000	0.000000	0.000000	0.000000	0.003167
S	0.000000	0.000365	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000365
SSW	0.000000	0.000000	0.000487	0.000000	0.000000	0.000000	0.000000	0.000000	0.000487
SW	0.000609	0.000244	0.000487	0.000000	0.000000	0.000000	0.000000	0.000000	0.001340
WSW	0.000000	0.000122	0.000609	0.000000	0.000000	0.000000	0.000000	0.000000	0.000731
W	0.000000	0.000609	0.001705	0.000000	0.000000	0.000000	0.000000	0.000000	0.002315
WNW	0.000122	0.001096	0.003289	0.000000	0.000000	0.000000	0.000000	0.000000	0.004507
NW	0.000000	0.001584	0.001340	0.000000	0.000000	0.000000	0.000000	0.000000	0.002924
NNW	0.000365	0.000975	0.001096	0.000000	0.000000	0.000000	0.000000	0.000000	0.002436
N	0.000365	0.001705	0.001218	0.000000	0.000000	0.000000	0.000000	0.000000	0.003289
CALM									0.000000
TOTAL	0.002193	0.013156	0.019247	0.000000	0.000000	0.000000	0.000000	0.000000	0.034596

MEAN WIND SPEED (m/s) = 2.87
NUMBER OF OBSERVATIONS = 284

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000365	0.001462	0.002071	0.000487	0.000000	0.000000	0.000000	0.000000	0.004385
NE	0.000000	0.001462	0.001462	0.000487	0.000000	0.000000	0.000000	0.000000	0.003411
ENE	0.000122	0.000975	0.002924	0.000731	0.000000	0.000000	0.000000	0.000000	0.004751
E	0.000122	0.001340	0.004142	0.002558	0.000000	0.000000	0.000000	0.000000	0.008162
ESE	0.000487	0.001218	0.002558	0.002680	0.000000	0.000000	0.000000	0.000000	0.006944
SE	0.000122	0.002558	0.005604	0.003411	0.000000	0.000000	0.000000	0.000000	0.011694
SSE	0.000609	0.003776	0.007309	0.003167	0.000000	0.000000	0.000000	0.000000	0.014862
S	0.000122	0.000365	0.000365	0.000487	0.000000	0.000000	0.000000	0.000000	0.001340
SSW	0.000244	0.000000	0.000365	0.000365	0.000000	0.000000	0.000000	0.000000	0.000975
SW	0.000244	0.000244	0.001096	0.000853	0.000000	0.000000	0.000000	0.000000	0.002436
WSW	0.000244	0.000000	0.000244	0.000487	0.000000	0.000000	0.000000	0.000000	0.000975
W	0.000122	0.000731	0.002193	0.003776	0.000000	0.000000	0.000000	0.000000	0.006822
WNW	0.000244	0.000853	0.009745	0.013278	0.000000	0.000000	0.000000	0.000000	0.024120
NW	0.000975	0.001827	0.005238	0.006578	0.000000	0.000000	0.000000	0.000000	0.014618
NNW	0.000609	0.001705	0.001949	0.001827	0.000000	0.000000	0.000000	0.000000	0.006091
N	0.000731	0.002071	0.002802	0.001705	0.000000	0.000000	0.000000	0.000000	0.007309
CALM									0.000000
TOTAL	0.005360	0.020587	0.050067	0.042880	0.000000	0.000000	0.000000	0.000000	0.118894

MEAN WIND SPEED (m/s) = 3.93
NUMBER OF OBSERVATIONS = 976

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001340	0.004142	0.004385	0.003289	0.000609	0.000365	0.000000	0.000000	0.014131
NE	0.001705	0.003533	0.002193	0.001949	0.000487	0.000000	0.000000	0.000000	0.009867
ENE	0.001827	0.004385	0.005482	0.004020	0.000487	0.000000	0.000000	0.000000	0.016202
E	0.002558	0.004142	0.004264	0.001096	0.000244	0.000000	0.000000	0.000000	0.012304
ESE	0.002436	0.004385	0.001827	0.000244	0.000609	0.000000	0.000000	0.000000	0.009502
SE	0.006822	0.020953	0.015836	0.004020	0.000853	0.000000	0.000000	0.000000	0.048483
SSE	0.005604	0.035327	0.035449	0.019125	0.007187	0.000487	0.000000	0.000000	0.103179
S	0.002071	0.006822	0.004507	0.001827	0.000853	0.000731	0.000365	0.000000	0.017176
SSW	0.001949	0.003167	0.002436	0.002558	0.001218	0.000853	0.000122	0.000000	0.012304
SW	0.001218	0.001705	0.002193	0.002558	0.001705	0.001584	0.000487	0.000122	0.011573
WSW	0.001096	0.001827	0.001827	0.001584	0.001340	0.002436	0.000487	0.000609	0.011207
W	0.003045	0.003898	0.003289	0.004995	0.007187	0.003289	0.002558	0.001949	0.030211
WNW	0.004751	0.006578	0.011573	0.009502	0.016080	0.008527	0.002680	0.000975	0.060665
NW	0.008649	0.010233	0.015836	0.015958	0.016202	0.012304	0.006578	0.004385	0.090145
NNW	0.005482	0.019978	0.019491	0.013034	0.006700	0.004142	0.002071	0.001218	0.072116
N	0.003776	0.018394	0.014618	0.020587	0.010233	0.002315	0.000487	0.000000	0.070411
CALM									0.007431
TOTAL	0.054331	0.149470	0.145206	0.106347	0.071994	0.037033	0.015836	0.009258	0.596906

MEAN WIND SPEED (m/s) = 4.26
NUMBER OF OBSERVATIONS = 4900

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001705	0.003776	0.001340	0.000365	0.000000	0.000000	0.000000	0.000000	0.007187
NE	0.000975	0.001340	0.001218	0.000000	0.000000	0.000000	0.000000	0.000000	0.003533
ENE	0.000975	0.001340	0.001340	0.000122	0.000000	0.000000	0.000000	0.000000	0.003776
E	0.000731	0.000975	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001705
ESE	0.001827	0.002924	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004751
SE	0.003167	0.002436	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005604
SSE	0.004385	0.004507	0.000244	0.000000	0.000000	0.000000	0.000000	0.000000	0.009136
S	0.002193	0.005238	0.002071	0.000487	0.000000	0.000000	0.000000	0.000000	0.009989
SSW	0.001705	0.002924	0.001949	0.000365	0.000000	0.000000	0.000000	0.000000	0.006944
SW	0.001462	0.001462	0.001827	0.000122	0.000000	0.000000	0.000000	0.000000	0.004873
WSW	0.001462	0.001584	0.001340	0.000609	0.000000	0.000000	0.000000	0.000000	0.004995
W	0.001827	0.001949	0.000853	0.000000	0.000000	0.000000	0.000000	0.000000	0.004629
WNW	0.004995	0.003289	0.000244	0.000000	0.000000	0.000000	0.000000	0.000000	0.008527
NW	0.006700	0.008893	0.002680	0.000365	0.000000	0.000000	0.000000	0.000000	0.018638
NNW	0.006456	0.020709	0.013278	0.002436	0.000000	0.000000	0.000000	0.000000	0.042880
N	0.003655	0.014740	0.015836	0.004020	0.000000	0.000000	0.000000	0.000000	0.038251
CALM									0.010842
TOTAL	0.044220	0.078085	0.044220	0.008893	0.000000	0.000000	0.000000	0.000000	0.186259

MEAN WIND SPEED (m/s) = 2.27
NUMBER OF OBSERVATIONS = 1529

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000244	0.000731	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000975
NE	0.000609	0.000487	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001096
ENE	0.000731	0.000244	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000975
E	0.000365	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000365
ESE	0.000731	0.000975	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001705
SE	0.000853	0.000731	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001584
SSE	0.000487	0.000609	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001096
S	0.000365	0.000487	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000853
SSW	0.000609	0.000487	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001096
SW	0.000244	0.000122	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000365
WSW	0.000975	0.000365	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001340
W	0.001340	0.000365	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001705
WNW	0.001096	0.001218	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002315
NW	0.001705	0.001949	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003655
NNW	0.001705	0.002436	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004142
N	0.000975	0.002193	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003167
CALM									0.017298
TOTAL	0.013034	0.013400	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.043732

MEAN WIND SPEED (m/s) = 1.12
NUMBER OF OBSERVATIONS = 359

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.004995	0.013156	0.009258	0.004142	0.000609	0.000365	0.000000	0.000000	0.032525
NE	0.004020	0.008527	0.006213	0.002436	0.000487	0.000000	0.000000	0.000000	0.021684
ENE	0.003898	0.008162	0.009867	0.004873	0.000487	0.000000	0.000000	0.000000	0.027287
E	0.004020	0.007796	0.009624	0.003655	0.000244	0.000000	0.000000	0.000000	0.025338
ESE	0.005847	0.011451	0.005604	0.002924	0.000609	0.000000	0.000000	0.000000	0.026434
SE	0.011451	0.030089	0.023511	0.007431	0.000853	0.000000	0.000000	0.000000	0.073334
SSE	0.011573	0.046778	0.044585	0.022293	0.007187	0.000487	0.000000	0.000000	0.132903
S	0.005116	0.013644	0.006944	0.002802	0.000853	0.000731	0.000365	0.000000	0.030454
SSW	0.004629	0.006700	0.005238	0.003289	0.001218	0.000853	0.000122	0.000000	0.022049
SW	0.003776	0.004507	0.005604	0.003533	0.001705	0.001584	0.000487	0.000122	0.021318
WSW	0.003776	0.004264	0.004020	0.002680	0.001340	0.002436	0.000487	0.000609	0.019613
W	0.006700	0.008527	0.008040	0.008771	0.007187	0.003289	0.002558	0.001949	0.047022
WNW	0.011207	0.013765	0.024851	0.022780	0.016080	0.008527	0.002680	0.000975	0.100865
NW	0.018029	0.025460	0.025094	0.022902	0.016202	0.012304	0.006578	0.004385	0.130954
NNW	0.015105	0.046291	0.035814	0.017298	0.006700	0.004142	0.002071	0.001218	0.128639
N	0.009989	0.040200	0.034474	0.026313	0.010233	0.002315	0.000487	0.000000	0.124010
CALM									0.035571
TOTAL	0.124132	0.289317	0.258740	0.158119	0.071994	0.037033	0.015836	0.009258	1.000000

MEAN WIND SPEED (m/s) = 3.62
NUMBER OF OBSERVATIONS = 8209

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 2.0%
B : 3.5%
C : 11.9%
D : 59.7%
E : 18.6%
F : 4.4%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0188	0132	0022
02	0000	0000	0000	0193	0125	0024
03	0000	0000	0000	0176	0137	0029
04	0000	0000	0000	0171	0136	0035
05	0000	0000	0000	0179	0127	0036
06	0000	0000	0006	0210	0101	0025
07	0001	0003	0020	0247	0061	0010
08	0006	0006	0047	0259	0019	0005
09	0009	0026	0073	0234	0000	0000
10	0020	0024	0083	0215	0000	0000
11	0021	0042	0100	0179	0000	0000
12	0024	0047	0110	0161	0000	0000
13	0028	0045	0117	0152	0000	0000
14	0029	0038	0120	0155	0000	0000
15	0012	0030	0120	0180	0000	0000
16	0006	0014	0104	0208	0008	0002
17	0005	0008	0053	0244	0029	0003
18	0000	0001	0023	0262	0047	0009
19	0000	0000	0000	0268	0066	0008
20	0000	0000	0000	0219	0101	0022
21	0000	0000	0000	0216	0102	0024
22	0000	0000	0000	0206	0100	0036
23	0000	0000	0000	0185	0119	0038
24	0000	0000	0000	0193	0119	0031

```
--------------------------------
STABILITY CLASS BY MIXING HEIGHT
--------------------------------
Mixing height    A    B    C    D    E    F
    <=500 m    0008 0017 0087 1086 1503 0350
   <=1000 m    0061 0102 0356 1660 0014 0002
   <=1500 m    0092 0165 0533 1454 0012 0007
   <=2000 m    0000 0000 0000 0388 0000 0000
   <=3000 m    0000 0000 0000 0257 0000 0000
    >3000 m    0000 0000 0000 0055 0000 0000

----------------------------
MIXING HEIGHT BY HOUR OF DAY
----------------------------
       0000  0100  0200  0400  0800  1600  Greater
        to    to    to    to    to    to   than
Hour   0100  0200  0400  0800  1600  3200  3200
  01   0038  0079  0057  0057  0057  0048  0006
  02   0037  0069  0071  0059  0059  0043  0004
  03   0037  0091  0063  0044  0053  0050  0004
  04   0039  0096  0059  0048  0052  0047  0001
  05   0097  0069  0044  0032  0054  0043  0003
  06   0061  0102  0096  0023  0033  0025  0002
  07   0081  0049  0103  0087  0014  0008  0000
  08   0000  0091  0088  0163  0000  0000  0000
  09   0000  0000  0117  0145  0080  0000  0000
  10   0000  0000  0000  0214  0128  0000  0000
  11   0000  0000  0000  0145  0197  0000  0000
  12   0000  0000  0000  0092  0250  0000  0000
  13   0000  0000  0000  0045  0297  0000  0000
  14   0000  0000  0000  0000  0342  0000  0000
  15   0000  0000  0000  0000  0342  0000  0000
  16   0000  0000  0000  0000  0342  0000  0000
  17   0001  0010  0013  0009  0298  0011  0000
  18   0005  0027  0027  0026  0227  0029  0001
  19   0010  0033  0038  0050  0168  0041  0002
  20   0031  0060  0043  0053  0105  0049  0001
  21   0039  0064  0050  0058  0081  0049  0001
  22   0046  0069  0044  0058  0069  0054  0002
  23   0048  0082  0046  0043  0068  0051  0004
  24   0047  0086  0038  0054  0068  0045  0005
```

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Appendix 2

Estimated Dust Emissions

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Dargues Reef Gold Project Emissions Inventory

Description of operations

The dust emission inventory has been prepared using the operational description of the proposed mining activities provided by R.W. Corkery & Co.

Topsoil would be removed using dozers and excavators then either loaded via a wheeled loader and pushed onto temporary stockpiles or loaded to trucks for emplacement at various waste emplacement areas. Waste rock removed from underground would not be brought to the surface but would be utilised in backfilling and stoping operations. A proportion of waste rock in the WRE area would be hauled underground and also used for stope backfilling purposes.

The underground ore would be hauled above ground to the ROM pad where it will go through various stages of crushing and screening before moving onto the processing plant. The ore will then be transported off-site via light and medium vehicles.

Emission estimates

Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

All activities have been modelled for 24 hours per day, with the exception of topsoil removal activities which have been assumed to occur between the hours of 7am and 6pm.

Dust from wind erosion is assumed to occur over 24 hours per day, however, wind erosion is also assumed to be proportional to the third power of wind speed. This will mean that most wind erosion occurs during the day when wind speeds are highest.

Dozers on topsoil

Emissions from dozers/excavators stripping topsoil have been calculated using the US EPA emission factor equation (US EPA, 1985 and updates). The equation is as follows:

Equation 1

$$E_{TSP} = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \quad \text{kg/hour}$$

where,

E_{TSP} = *TSP emissions*

s = silt content (%), and

M = moisture (%)

Based on information provided by the Proponent and assumptions based on previous studies, it was assumed the silt content of the topsoil is 2% and the moisture content is 6%. This gives an emission factor of 0.6 kg/h.

Loading material / dumping topsoil and waste rock using shovels/excavators/FELs

Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. **Equation 2** shows the relationship between these variables.

Equation 2

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \quad kg/t$$

where,
E_{TSP} = *TSP emissions*
$k = 0.74$
U = *wind speed(m/s)*
M = *moisture content (%)*
[where $0.25 \leq M \leq 4.8$*]*

The wind speed value was taken from the 2009/2010 meteorological dataset described in **Section 4.2.1**. The moisture content for waste rock was assumed to be 6% for topsoil and waste rock.

Hauling material / product on unsealed surfaces
After the application of water, the emission factor used for trucks hauling waste rock or ore on unsealed surfaces is 1 kg per vehicle kilometre travelled (kg/VKT).

The return trip for each year was measured from the location of the haul routes. As per information provided, haul trucks with a capacity of 50 t are used for the hauling of topsoil, waste rock and ore.

Wind erosion
The emission factor for wind erosion was assumed to be 0.4 kg/ha/h as per SPCC (1983).

Grading roads
Estimations of TSP emissions from grading roads have been made using the US EPA (1985 and updates) emission factor equation (**Equation 3**).

Equation 3

$$E_{TSP} = 0.0034 \times S^{2.5} \quad kg/VKT$$

where,
S = speed of the grader in km/h (taken to be 8 km/h)

Primary crushing of material
The emission factor used for primary crushing of material has been taken to be 0.2 kg/t (NPI Emission Estimation Technique Manual for Gold Ore Processing).

The emission factor used for secondary crushing of material has been taken to be 0.6 kg/t (NPI Emission Estimation Technique Manual for Gold Ore Processing). It has been assumed that there would be a reduction of TSP emissions due to it being an enclosed area. A 90% control has been applied.

Screening and ball milling of material
The emission factor used for screening of material has been taken to be 0.08 kg/t (NPI Emission Estimation Technique Manual for Gold Ore Processing).

The emission factor used for ball milling of material has been taken to be 0 kg/t (NPI Emission Estimation Technique Manual for Gold Ore Processing) as this will be a wet process with circuit water sprays in use as per information supplied by the Proponent.

Table A2.1
Detailed Emission Estimation

ACTIVITY	TSP emission for Year 3 in (kg/y)	Intensity	Units	Emission factor	units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Topsoil Removal - Dozers/Excavators stripping topsoil	179	308	h/y	0.6	kg/h	2	silt content in %	6	moisture content in %		
Topsoil removal - Wheeled loader loading topsoil from TSF	53	82,620	t/y	0.00064	kg/t	2.528	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Topsoil removal - Emplacing topsoil at stockpile at TSF	53	82,620	t/y	0.00064	kg/t	2.528	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Topsoil removal - Loading topsoil from stockpile near WRE to trucks	1.2	1,800	t/y	0.00064	kg/t	2.528	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
Topsoil removal - Hauling topsoil to WRE	10.8	1,800	t/y	0.01	kg/t	50	t/truck load	0.3	km/return trip	1.0	kg/VKT
Topsoil removal - Emplacing/respreading topsoil at WRE	1.2	1,800	t/y	0.00064	kg/t	2.528	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
WASTE (rock) - Loading rock from WRE to trucks	21	40,000	t/y	0.00052	kg/t	2.044	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %		
WASTE (rock) - Hauling from WRE to underground	696	40,000	t/y	0.0174	kg/t	50	t/truck load	0.9	km/return trip	1.0	kg/VKT
ORE - Hauling ROM ore to ROM pad	5,940	330,000	t/y	0.018	kg/t	50	t/load	0.9	km/return trip	1.0	kg/VKT
ORE - Unloading ROM to stockpile	453	330,000	t/y	0.0014	kg/t	2.044	average of (wind speed/2.2)^1.3 in m/s	3	moisture content in %		
ORE - Wheeled loader rehandle ore to ROM bin	453	330,000	t/y	0.0014	kg/t	2.044	average of (wind speed/2.2)^1.3 in m/s	3	moisture content in %		
ORE - Primary Crushing	66,000	330,000	t/y	0.2	kg/t						
ORE - Ball milling	-	265,000	t/y	-	kg/t					50%	control
ORE - Screening	26,400	330,000	t/y	0.08	kg/t						
ORE - Unloading of crushed / prcessed ore (concentrate) to stockpile	6	40,000	t/y	0.0003	kg/t	2.044	average of (wind speed/2.2)^1.3 in m/s	9	moisture content in %	50%	control
ORE - Wheeled loader loading from concentrate stockpile to vehicles	12	40,000	t/y	0.0003	kg/t	2.044	average of (wind speed/2.2)^1.3 in m/s	9	moisture content in %		
Ore - Hauling concentrate off-site	5,360	40,000	t/y	0.13400	kg/ha/h	50	t/truck load	6.7	km/return trip	1.0	kg/VKT
WE - Waste Rock Emplacement/ROM pad (incl. ROM stockpiles)	3,154	1.8	ha	0.4	kg/ha/h	8,760	h/y	50%	control		
WE - Soil Stockpile Areas	17,170	4.9	ha	0.4	kg/ha/h	8,760	h/y				
WE - Concentrate stockpile	876	0.5	ha	0.4	kg/ha/h	8,760	h/y	50%	control		
Grading roads	43,132	70,080	km	1	kg/VKT	8	speed of graders in km/h				

Table A2.2
Source allocation

ACTIVITY	Source ID				
Topsoil Removal - Dozers/Excavators stripping topsoil	1	2			
Topsoil removal - Wheeled loader loading topsoil from TSF	1	2			
Topsoil removal - Emplacing topsoil at stockpile at TSF	3				
Topsoil removal - Loading topsoil from stockpile near WRE to trucks	8				
Topsoil removal - Hauling topsoil to WRE	8	14			
Topsoil removal - Emplacing/respreading topsoil at WRE	14				
WASTE (rock) - Loading rock from WRE to trucks	14				
WASTE (rock) - Hauling from WRE to underground	9	10	11	12	14
ORE - Hauling ROM ore to ROM pad	9	10	11	12	13
ORE - Unloading ROM to stockpile	13				
ORE - Wheeled loader rehandle ore to ROM bin	13				
ORE - Primary Crushing	15				
ORE - Ball milling	15				
ORE - Screening	15				
ORE - Unloading of crushed / processed ore (concentrate) to stockpile	16				
ORE - Wheeled loader loading from concentrate stockpile to vehicles	16				
Ore - Hauling concentrate off-site	4	17-32			
WE - Waste Rock Emplacement/ROM pad (incl. ROM stockpiles)	12	13	14		
WE - Soil Stockpile Areas	3	5	6	7	8
WE - Concentrate stockpile	16				
Grading roads	4	17-32			
Refer to **Figure 5** for source locations.					

Appendix 3

Example ISCMOD Input File

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**  ISCST3 model input runstream : Dust - Dargues Reef 'worst-case' Y3
CO STARTING
   TITLEONE ISCST3 Dust Model Run
   MODELOPT RURAL CONC DDEP DRYDPLT HE>ZI
   AVERTIME 24 PERIOD
   POLLUTID TSP
   ERRORFIL C:\Jobs\Dargues_Reef\ISC\error.log
   TERRHGTS ELEV
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  POINT1  VOLUME  749441 6063272 706.6
   LOCATION  POINT2  VOLUME  749524 6063377 711.1
   LOCATION  POINT3  VOLUME  749550 6063305 712.7
   LOCATION  POINT4  VOLUME  749946 6063260 725.0
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   LOCATION  POINT96  VOLUME  750037 6062667 680.7
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   LOCATION  STACK2  POINT  749736 6063180 728.4679
   LOCATION  STACK3  POINT  749736 6063180 728.4679
** Point Source       QS   RH  IL   IV
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   SRCPARAM  STACK2  0.53 5.0 293 11.9 4.0
   SRCPARAM  STACK3  0.53 5.0 293 11.9 4.0
   PARTDIAM  STACK1 1.0
   PARTDIAM  STACK2 5.0
   PARTDIAM  STACK3 17.3
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   PARTDIAM  POINT33-POINT64  5.0
   PARTDIAM  POINT65-POINT96  17.3
   MASSFRAX  STACK1-STACK3 1.0
   MASSFRAX  POINT1-POINT96  1.0
   PARTDENS  STACK1-STACK3 2.5
   PARTDENS  POINT1-POINT96  2.5
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   SRCGROUP  CM  POINT33-POINT64 STACK2
   SRCGROUP  REST  POINT65-POINT96 STACK3
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Appendix 4

Director-General's Requirements

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Table A4.1
Director-General's Requirements
(Department of Planning – 23 April 2010)

Paraphrased Requirement	Relevant EA Section(s)
ENERGY	
Calculate the scope 1, 2 and 3 emissions of the mining operations and describe what measures would be implemented to ensure these operations are energy efficient;	0

Table A4.2
Coverage of Environmental Issues

Page 1 of 2

Government Agency	Paraphrased Requirement	Relevant EA Section(s)
	AIR QUALITY	
Department of Environment, Climate Change & Water (01/04/10)	The existing ambient air quality in the vicinity of the proposal should be characterised and discussed.	5
	The EA must identify all sources of air emissions from the project, including:	7
	• the quantities and physio-chemical parameters (eg concentration, moisture content, bulk density, particle sizes etc) of materials to be used, transported, produced or stored;	Appendix 2
	• an outline of procedures for handling, transport, production and storage; and	7
	• the management of solid, liquid and gaseous waste streams with potential for significant air impacts *Note: emissions can be classed as either:* *- point (eg emissions from stack or vent) or* *- fugitive (from wind erosion, leakages or spillages, associated with loading or unloading, conveyors, storage facilities, plant and yard operation, vehicle movements (dust from road, exhausts, loss from load), land clearing and construction works).*	9
	The EA must describe in detail the measures proposed to mitigate the impacts and the extent to which the mitigation measures are likely to be effective in achieving the relevant environmental outcomes. An analysis of different mitigation measures/technologies that have been investigated should also be included.	9
	GREENHOUSE EMISSIONS	
Department of Environment, Climate Change & Water (01/04/10)	A comprehensive assessment of and report on the project's predicted greenhouse gas emissions (tCO_2e). Emissions should be reported on a:	10
	a. Greenhouse intensity (emissions per unit of production) basis;	10
	b. Total annual emissions basis; and	10
	c. Total project lifetime basis, including construction, operation and decommissioning.	10

Table A4. 2
Coverage of Environmental Issues (cont'd)

Government Agency	Paraphrased Requirement	Relevant EA Section(s)
GREENHOUSE EMISSIONS (cont'd)		
	The assessment of project emissions should include direct emissions (ie, those occurring on the project site), indirect emissions (eg those offsite as a result of the project, such as through electricity use) and any significant upstream and/or downstream emissions associated with the project.	10
Department of Environment, Climate Change & Water (01/04/10)	The emissions should be estimated using an appropriate methodology, in accordance with the Department of Planning's Draft "Guidelines: Energy and Greenhouse in EIA" (2002) and the Australian Greenhouse Office's "Factors and Methods Workbook" (2006).	10
	Emissions should be compared in the EA against:	10
	a. Industry 'best practice' emissions intensity for the activity; and	10
	b. Total annual NSW emissions, so the impact of the proposal on NSW emission reduction targets can be evaluated.	10
	The proponent should evaluate and report on the feasibility of measures to further reduce greenhouse gas emissions associated with the project.	10