Hanson

ABN: 90 009 679 734

Environmental Assessment

for the

Installation and Operation of a Crushing System at the Calga Sand Quarry

Prepared by:

R.W. CORKERY & CO. PTY. LIMITED

August 2016

This page has intentionally been left blank

Hanson

ABN: 90 009 679 734

Environmental Assessment

for the

Installation and Operation of a Crushing System at the Calga Sand Quarry

Prepared for:

Hanson Australia Pty Ltd
ABN: 90 009 679 734
Level 18, 2-12 Macquarie Street
PARRAMATTA NSW 2150

Telephone: (02) 9354 2600
Fax: (02) 9354 2695
Email: andrew.driver@hanson.com.au

Prepared by:

R.W. Corkery & Co. Pty. Limited
Geological & Environmental Consultants
ABN: 31 002 033 712

Brooklyn Office:
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Telephone: (02) 9985 8511
Facsimile: (02) 6361 3622
Email: brooklyn@rwcorkery.com

Orange Office:
62 Hill Street
ORANGE NSW 2800

Telephone: (02) 6362 5411
Facsimile: (02) 6361 3622
Email: orange@rwcorkery.com

Brisbane Office:
Suite 5, Building 3
Pine Rivers Office Park
205 Leitchs Road
BRENDALE QLD 4500

Telephone: (07) 3205 5400
Facsimile: (02) 6361 3622
Email: brisbane@rwcorkery.com

Ref No. 264/48

August 2016

R.W. CORKERY & CO. PTY. LIMITED

This Copyright is included for the protection of this document

CONTENTS

Page

APPENDICES

CONTENTS

Page

FIGURES

TABLES

PLATES

1. INTRODUCTION

1.1 SCOPE

This document has been prepared by R.W. Corkery & Co. Pty. Limited to accompany an application by Hanson Construction Materials Pty Ltd, a division of Hanson Australia Pty Ltd, ("Hanson") under Section 75W of the *Environmental Planning and Assessment Act* (see **Appendix 1**) to install and operate a crushing system within the existing approved processing operations at the Calga Sand Quarry ("the Quarry").

The installation and operation of a crushing system is necessary to maximise the recovery of extractable friable sandstone from the remainder of Stage 3 of the Quarry.

For the purposes of this document, the area of the existing approved quarry operation is referred to as the "Quarry Site" (see **Figure 1.1**). This area covers the existing extraction Stages 1, 2 and 3 within the Calga Sand Quarry on Lot 2, DP229889, a property owned by Hanson. This lot lies within the Parish of Narara, County of Northumberland and the local government area of Gosford City. The Quarry Site, illustrated on **Figure 1.1**, is located approximately 1.7km northwest of the Calga Interchange on the M1 Freeway.

1.2 THE PROPONENT AND THE QUARRY SITE

1.2.1 The Proponent

Calga Sand Quarry is owned and operated by Hanson, which is part of the, HeidelbergCement Group. Hanson is a major supplier of aggregates, sands and premixed concrete to the civil, industrial, residential, and commercial construction industries. Hanson and its subsidiaries operate over 55 quarries and more than 225 concrete plants throughout Australia, employing over 3000 people nationwide. Hanson operates to ISO/AS 14001 to reduce the impact its operations have on the environment. Calga Sand Quarry has an Environmental Management System in place and strives for continual improvement in all aspects of its environmental performance.

It is noted that Calga Quarry was owned and operated by Rocla Materials Pty Ltd (Rocla) from October 2002 until 30 January 2016 when the quarry was acquired by Hanson.

1.2.2 The Quarry Site

Figure 1.2 displays the existing layout of the Quarry Site and identifies the six extraction sub-stages within Stage 3, namely Stages 3/1 to 3/6.

Figure 1.2 also displays the location of the recently relocated processing plant and administration building on the quarry floor.

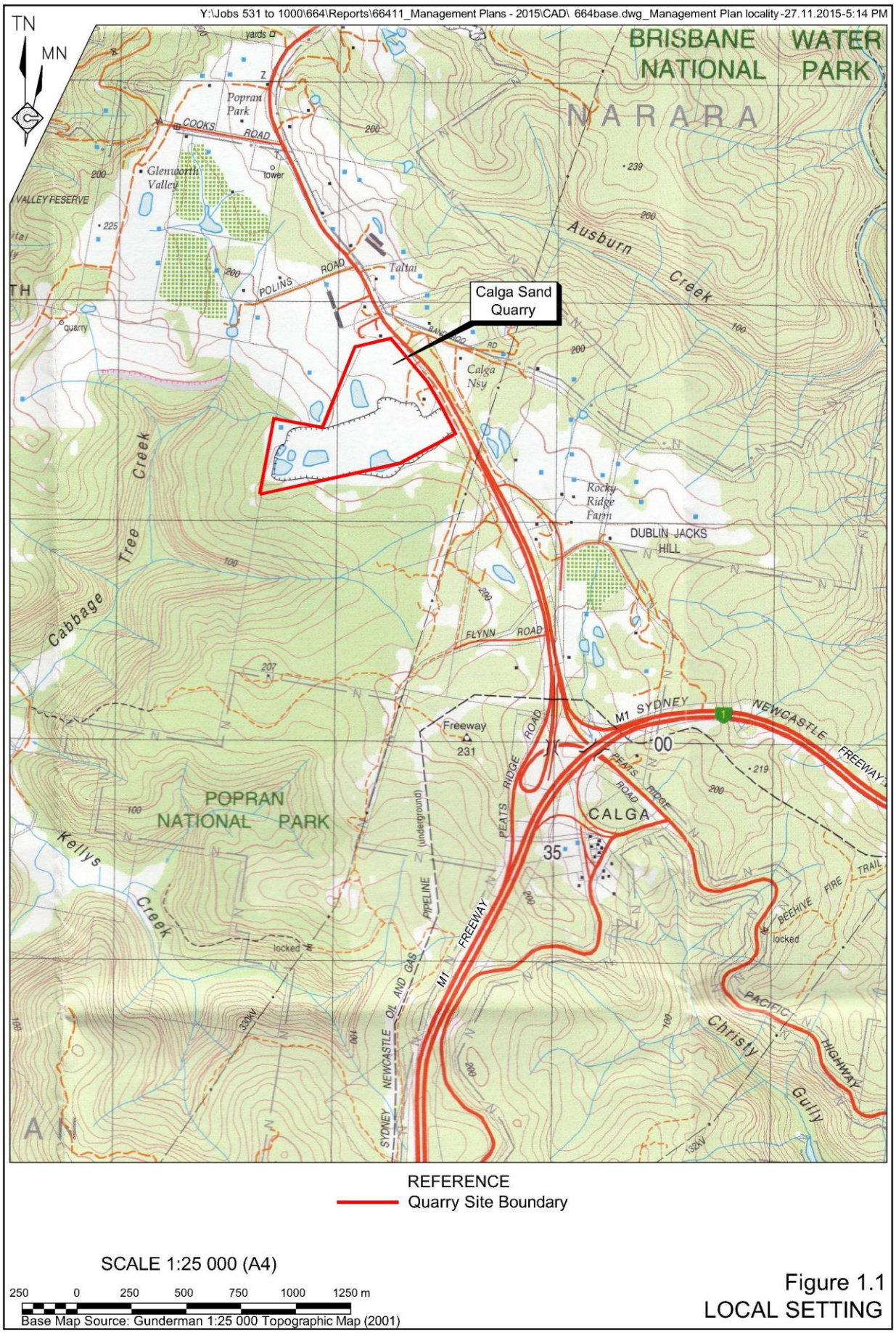


Figure 1.1
LOCAL SETTING

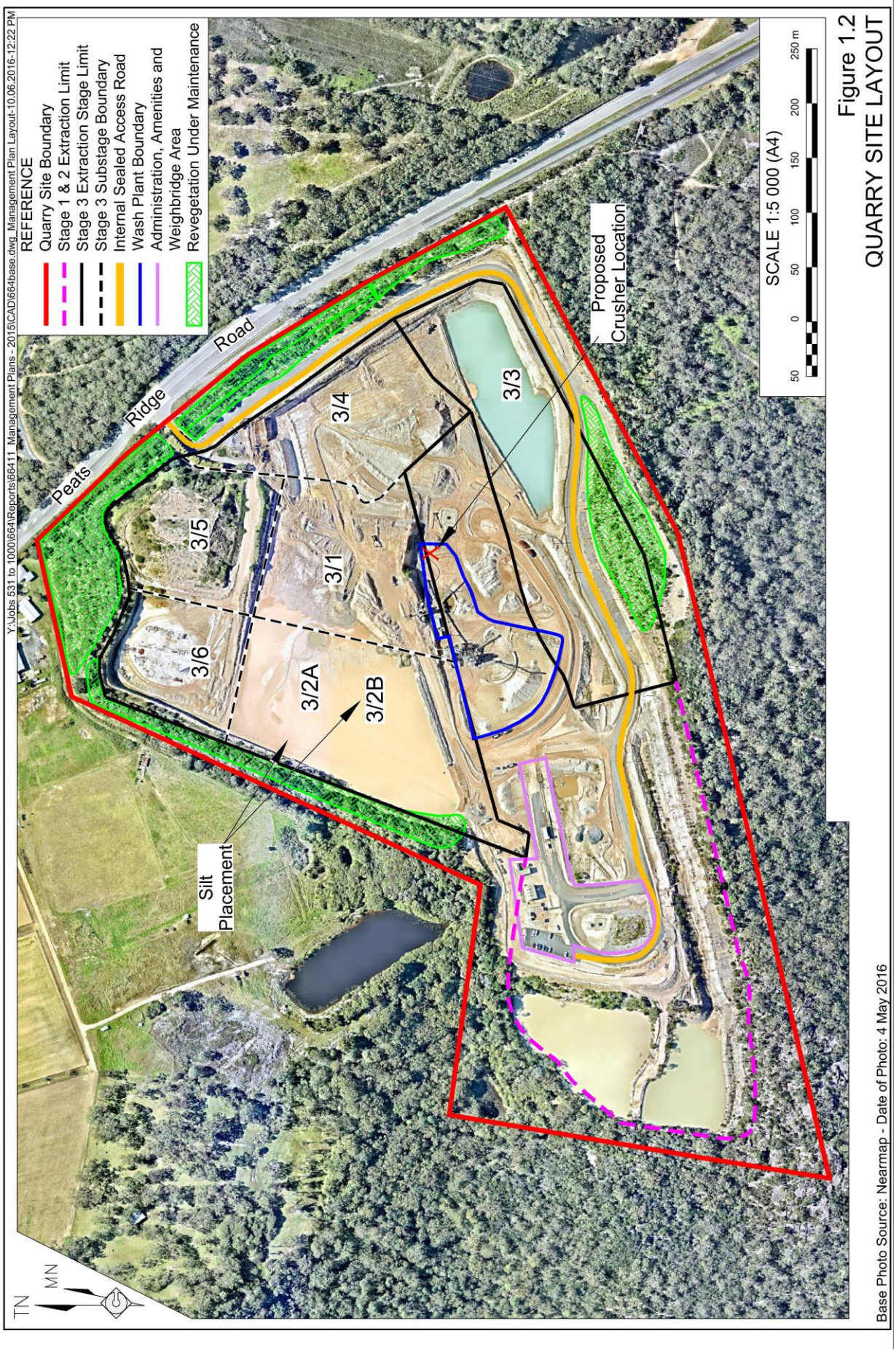


Figure 1.2
QUARRY SITE LAYOUT

1.3 BACKGROUND TO THE PROPOSAL

The initial development application submitted in 1990 for the Calga Sand Quarry was considered and determined by the NSW Land and Environment Court with a development consent granted in July 1991 (Development Consent No. 10604). The Court approved extraction Stages 1 and 2. Extraction continued under the Development Consent No. 10604 until December 2004 when the sand resources within Stages 1 and 2 were exhausted and the development consent expired. At that time, operations at the Calga Sand Quarry were suspended whilst an application to extend operations northwards onto Stage 3 was determined. Following the granting of Development Consent DA 94-4-2004 on 28 October 2005, sand extraction commenced within Stage 3 of the Quarry Site and processing and product despatch resumed. The development consent for the existing Calga Sand Quarry expires on 1 July 2030.

The previous quarry operator, Rocla, sought approval to extend its existing sand extraction and processing operations to the south onto Lots 1 and 2, DP 805358 ("the Southern Extension"). The *Environmental Assessment* for the proposed Southern Extension was submitted in November 2009. A response to submissions document and Preferred Project Report were submitted to the Department of Planning and Infrastructure on 12 November 2012. This application was initially approved by the Planning Assessment Commission on 23 December 2013 but refused by the NSW Land and Environment (L&E) Court on 17 November 2015.

Hanson is now seeking to modify operations at the Quarry through installation and operation of a crushing system.

Crushing System

A crushing system, to reduce the quantity of oversized raw material unable to be processed to yield sand within the existing processing plant, is proposed to be included as part of the processing operations. Given the judgment of the L&E Court, Hanson now wishes to amend Development Consent DA 94-4-2004 to install and operate a crushing system as part of its processing operations.

Operational noise criteria nominated for the Quarry Site, as set by *Condition 3(2)* of DA 94-4-2004, are listed in **Table 1.1**. Project-specific noise levels have previously been established for three residences with remaining residences nominated at the default level of 35dB(A) L_{Aeq} despite the dominant noise received at these residences being from traffic on Peats Ridge Road and the M1 Freeway.

Table 1.1
Operational Noise Criteria Nominated by DA 94-4-2004*

Residential Location	Noise Limit ($L_{Aeq\ (15\ minute)}$)			Noise Limit ($L_{A1,1\ minute}$)
	Day (7:00am-6:00pm)	**Evening** (6:00pm-10:00pm)	**Night** (10:00pm-7:00am)	**Night** (10:00pm-7:00am)
CN-1: Power	41	35	35	45
CN-2: King	40	35	35	45
CN-3: Kashouli	39	35	35	45
All Other Residences	35	35	35	45
** Condition 3(2)*				

1.4 PRODUCT INFORMATION AND PROJECT LIFE

1.4.1 Product Information

The processing of the raw friable sandstone extracted within Calga Sand Quarry results in the production of two principal products, namely, concrete sand (a washed sand product) and mortar sand (a dry-screened and blended product). Within these two broad classifications, products are also sold according to colour and with specified size gradings. All blended products may include blends incorporating imported materials and washed sand.

Table 1.2 records the monthly/annual sales of the various products produced at the Quarry during 2015.

Table 1.2
Calga Sand Quarry – 2015 Monthly Sales (tonnes)

	Monthly Sand Sales
January	12 667
February	19 564
March	24 504
April	15 155
May	25 175
June	28 325
July	25 459
August	22 734
September	22 429
October	22 265
November	18 486
December	14 330
Total	**251 093**

Source: Hanson (2016)

1.4.2 Project Life

It has been estimated that approximately 1.8 million tonnes of suitable material remains within Stage 3. Based on projected annual sales of up to 400 000 tonnes, the remaining resource within the Quarry Site would result in a Quarry life of approximately 4 to 5 years.

1.5 PROCESSING OPERATIONS

The existing processing operations involve the use of two plants, namely a wash plant and mortar sand plant involving the following equipment and activities.

Wash Plant

- Feed bin/hopper
- Vibrating screen
- Cyclones
- Dewatering screen
- Silt pump
- Radial stacking conveyor
- Product stockpiles

Mortar Sand Plant

- Vibrating screen
- Mobile conveyor
- Product stockpiles

The wash plant is designed to initially separate the oversize material, after which the remaining sand passes through a washing stage to remove the bulk of the clay and silt i.e. the <75μm fraction. The final stage involves the sand being screened and the bulk of the water removed via a cyclone. The washed sand is stacked via a radial stacker which allows the segregation of different final products (such as single and double washed sand) into separate stockpiles. The final product is either relocated to product stockpiles awaiting sale and transport or loaded directly onto product trucks.

The mortar sand plant simply separates the sand from oversize material and retains the fine silts and clay required to achieve the workability of the sand in mortar. The raw sand is blended with washed sand initially in the stockpile area and then through the plant itself to produce the mortar sand products. The oversize material is collected and used in conjunction with the overburden in the rehabilitation of silt cells.

The combined capacity of both the existing wash plant and mortar sand plant is estimated to be in the order of 400 000tpa i.e. consistent with the production limit imposed by DA 94-4-2004.

1.6 CONSULTATION

Representatives of Hanson conducted a door knocking campaign of all residences and local businesses in the vicinity of the Quarry over the course of two days on 4-5 August 2016 as well as visiting the Peats Ridge Public School. Community members were provided with a letter and fact sheet directly and asked if they had questions or feedback on the documents. Where residents were not available on the day, a letter and fact sheet were left in the letterbox. A brief report describing the consultation program is included as **Appendix 2** including the letter and fact sheet.

Those members of the public who were available for consultation expressed their appreciation for the efforts made by Hanson to consult directly with them. No negative feedback was received during the consultation or in response to the letter and fact sheet.

2. PROJECT DESCRIPTION

2.1 INTRODUCTION

The design of the Calga Sand Quarry reflects Hanson's intention to maximise the recovery of the friable sandstone resource whilst developing it in such a manner that reflects the environmental and community constraints. Hanson proposes to incorporate a crushing system to its processing operations to maximise the quantity of material available for processing, and decrease the quantity of material classified as "oversize". Importantly, sufficient oversize would be retained for rehabilitation of the silt cells within Stage 3.

2.2 APPROVALS REQUIRED

Based upon the current project design and understanding of environmental issues, the installation and operation of a crushing system would require the following approvals to proceed.

- Modification of Development Consent 94-4-2004, under section 75W of the *Environmental Planning and Assessment Act 1979,* from the Minister for Planning – as the Quarry was originally approved by the Minister for Planning in 2005.
- Modification of Environment Protection Licence 11295 from the NSW Environment Protection Authority.

2.3 PROPOSED CRUSHING SYSTEM

2.3.1 Crushing System Components

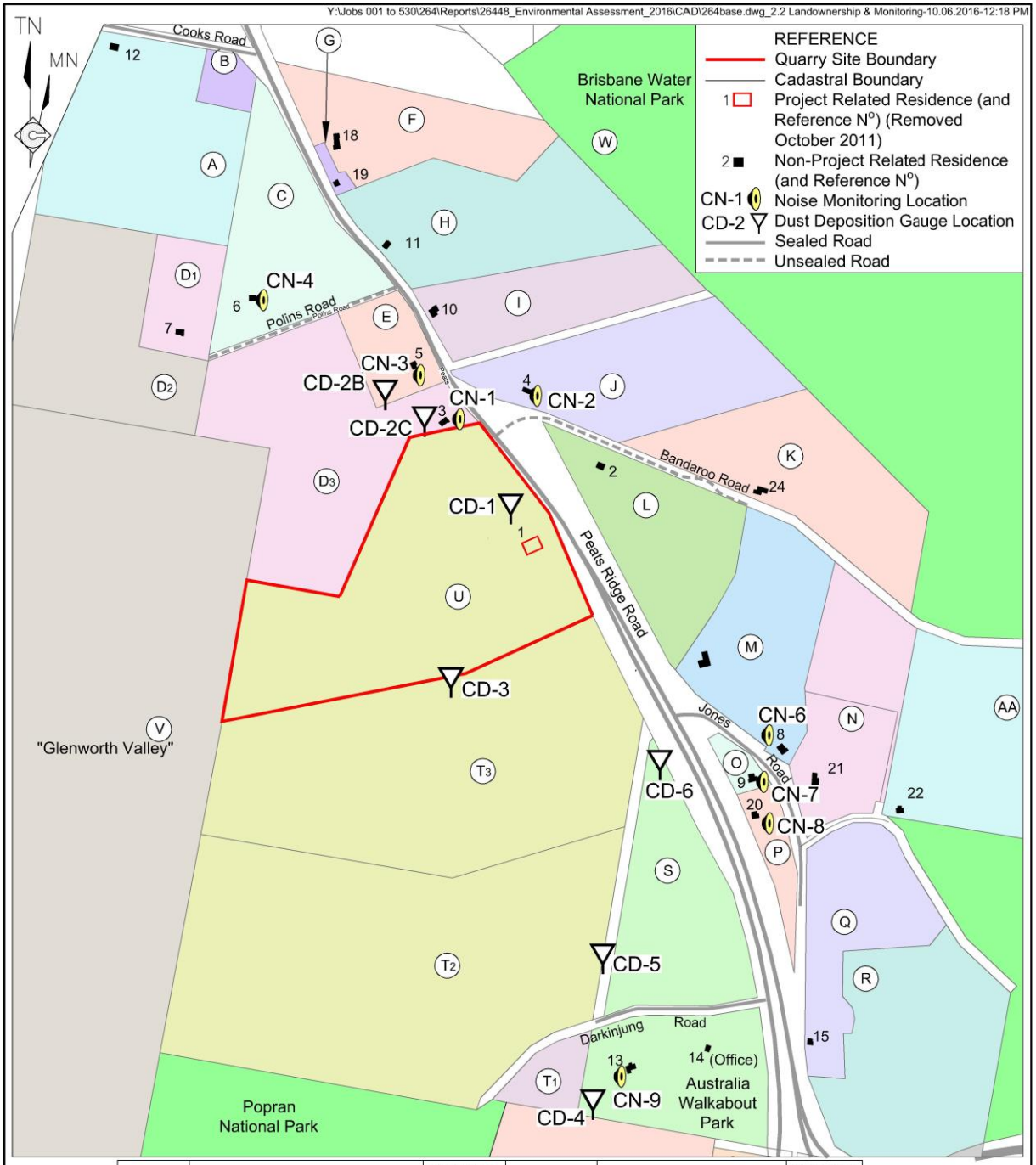
Whilst it is friable in nature, the extracted sandstone at the Quarry benefits from some crushing to prepare the raw feed for the wash plant. The proposed crushing system would include a crushing system capable of reducing the extracted sandstone to less than 50mm. A diesel-powered mobile crusher (**Plate 2.1**) has been used in trials at the Quarry to determine its suitability in terms of production and noise emissions and has proven effective in both senses. It is anticipated that the crushing system would eventually become a permanent component of the fixed wash plant. The introduction of a crushing system would improve the yield of quarry products from the raw feed by up to 20 per cent and as such reduce bulldozer ripping time at the Quarry as well as extending the quarry life.

Plate 2.1: Diesel powered mobile jaw crushing system. (Ref: E664-H007)

2.3.2 Crushing System Location

An indicative location for the proposed crushing system is identified in **Figure 2.1.** The proposed crushing system would be located within the area currently designated for processing and stockpiling activities. This will ensure that the crushing system will also benefit from the abatement measures such as high walls, bund screens and lower profile terrains which have been engineered into the existing plant and stockpile area. An indicative location with an elevation of approximately 195m AHD and location approximately 18m south of an existing 6m to 8m high extraction face previously developed within extraction Stage 2/5 and adjacent to the boundary of extraction Stage 3/1 or the purposes of assessing the potential noise levels (see **Figure 2.1**). **Figure 2.2** shows the locations of the residences surrounding the Quarry.

Figure 2.1
CRUSHER LOCATION
AND RECEIVERS



Property	Owner(s)	Residence Reference	Property	Owner(s)	Residence Reference
A	*G.D. & D.A. Marler	12	P	D. O'Bryan	20
B	Airservices Australia	-	Q	N. Soulis	15
C	A.M. & R.A. Townsend	6	R	J.H. Hunt	-
D1	Power Pastoral Holdings Pty Ltd	7	S	C.J. Barnard	13, 14#
D2	Glenworth Valley Pastoral Company	-	T1	Hanson Australia Pty Ltd	-
D3	Power Pastoral Holdings Pty Ltd	3	T2	Hanson Australia Pty Ltd	-
E	B. Kashouli	5	T3	Hanson Australia Pty Ltd	-
F	J.& A.V. Serou	18	U	Hanson Australia Pty Ltd	1
G	G.L Gratton-Wilson	19	V	B.A. & B.J. Lawler	-
H	J. Hajje	11	W	Brisbane Water National Park	-
I	W P White & K M Eaton	10	X	Popran National Park	-
J	R.D. King	4	Y	C.J. Barnard	-
K	G.B. & L.P. Miles	24	Z	C.J. Barnard	-
L	F. & G. Rozmanec	2	AA	Tokoloshe Pty Ltd	22
M	S & N.E. Cauchi	8	AB	J.R. & S.Y. Glover	23
N	GF & J Gilbertson	21	AC	M.J. Lambert	-
O	W. White	9			

SCALE 1:15 000 (A4)

250 0 250 500 750 m

Cadastral Information Source: Digitised from LPI DCDB

Figure 2.2
LAND OWNERSHIP, RESIDENCES AND MONITORING LOCATIONS

3. ENVIRONMENTAL FEATURES, SAFEGUARDS AND IMPACTS

3.1 INTRODUCTION

Figure 1.1 displays the local setting of the Calga Sand Quarry. The Quarry Site lies on an elevated region commonly referred to as the Hunter Plateau which forms part of the dissected Hornsby Plateau locally. The Quarry Site is located near the southern end of the Somersby Plateau. The topography of the Quarry Site is significantly modified by the extraction that has been underway on site for over 20 years although the overall slope remains to the southwest. A small rocky ridge forms the southwestern boundary of the Quarry Site with gently sloping to steeply sloping gradients (1° to 18°) and elevations of approximately 170m AHD to 195m AHD. The remainder of the topography within the Quarry Site has been altered by extraction and related activities including the extraction area, water storage dams, silt cells and stockpiles. The elongated east-west orientated quarry void currently is located on the southern half of the Quarry Site with steep (60° to 70°) walls and a quarry floor between 190m and 200m AHD.

Dense native bushland is currently present along the southern and western boundaries of the Quarry Site and on surrounding properties to the west and south. **Figure 1.1** displays the considerable areas of native bushland in the Calga area, including the Brisbane Water and Popran National Parks.

Figure 2.2 displays the land ownership and residences around the Calga Sand Quarry. Most of the neighbouring properties are life-style blocks, some with varying degrees of agriculture. The property which borders the Quarry Site to the west is operated as the Glenworth Valley Horse Riding Facility. The owners of the "Glenworth Valley" property, B.A. & B.J. Lawler, also own two residences on the property near Polins Road. The two closest non-project related residences to the proposed crushing system are approximately 600m to the northeast of the proposed crusher location i.e. on properties D3 and J (see **Figure 2.2**). In both cases, the residences are shielded from quarry-related activities by perimeter bund walls and extraction faces. The introduction of a crushing system to the processing plant would not influence a number of environmental components of the surrounding environment. The only components where changes could occur relate to noise, visibility, air quality and the approach to rehabilitation. Each of these issues are addressed in the remainder of this section.

3.2 NOISE

3.2.1 Crushing System

An assessment of the noise impacts of the proposed crushing system was undertaken by Wilkinson Murray Pty Limited (Wilkinson Murray) in December 2015 and is reproduced in full as **Appendix 3**. The assessment determined the potential impacts of the crushing system based upon the measured background noise levels at residences in the vicinity of the Quarry.

A series of on-site noise level measurements was undertaken during a trial of a diesel-powered mobile crushing system at the Quarry on 4 March 2013. Noise predictions associated with the crushing system were made using a sound power level of 109dB(A). 10th percentile predicted noise levels due to the operation of the crusher alone at the nearest receivers (CN-1 and CN-2 - see **Figure 2.1**) were calculated as 29dB(A) and 31dB(A) respectively (Wilkinson Murray, 2015). $L_{Aeq15min}$ noise levels generated by all activities within the Quarry Site, excluding the crushing system, were measured at 40dB(A) at both locations CN-1 and CN-2. These levels did not change when the crusher was operated for the trial period, which suggests noise levels from the crushing system alone at CN-1 and CN-2 may be conservatively estimated to be approximately 30dB(A). That is, the crushing system is not perceptibly audible amongst the rest of operations.

Noise predictions during daytime (7:00am to 6:00pm) operation of the combined existing development and crushing system were made using the ENM environmental noise model updated from previous assessments of noise levels at the Quarry (Wilkinson Murray, 2015). **Table 3.1** displays the noise limits provided in DA 94-4-2004 and EPL 11295, the Project Specific Noise Levels (PSNLs) established for these locations and the results of the assessment.

Table 3.1
Predicted Operational (Daytime) Noise Levels (dB(A))

Noise Monitoring Location (Figure 2.2)	Current Noise Limits[1] ($L_{Aeq,15min}$)	Rating Background Levels ($L_{Aeq,15min}$)	Project Specific Noise Levels ($L_{Aeq,15min}$)	Predicted Noise Level ($L_{Aeq15min}$) Attributable to the Quarry Operations
Residence 3 (CN-1) – Power	41	36[2]	41[5]	41
Residence 4 (CN-2) – King	40	35[2]	40[5]	40
Residence 5 (CN-3) – Kashouli	39	36[2]	39[5]	39
Residence 6 (CN-4) – Townsend	35	35[2]	35[5]	35
Residence 8 (CN-6) – Cauchi	35	38[3]	43	36
Residence 9 (CN-7) – White	35	38[3]	43	35
Residence 20 (CN-8) – O'Bryan	35	43[3]	48	<35
Residence 13 (CN-9) – Barnard	35	38[4]	43	<35

Notes

1 – Established in DA 94-4-2004 and EPL 11295.

2 – Rating background levels at these locations were established in Wilkinson Murray (2004).

3 – Rating background levels at these locations were recorded in Wilkinson Murray (2009).

4 – The rating background level at Residence 13 was established by Wilkinson Murray (2010) and Renzo Tonin (2013). The Renzo Tonin (2013) estimate is used for this assessment as it is the more conservative estimate at this location.

5 – PSNL based on DA 94-4-2004 and EPL 11295.

Source: Predicted noise levels from Table 1 of Wilkinson Murray (2015)

Rating background levels (or background noise levels) for Residence 8, Residence 9, Residence 20 and Residence 13 have been established in assessments undertaken at the Quarry including a noise assessment (Wilkinson Murray, 2009) and targeted noise monitoring activities undertaken at Residence 13 (Wilkinson Murray, 2010 and Renzo Tonin, 2013). PSNLs for these residences were established as the recorded rating background noise levels plus 5dB(A), which is the method applied in the *Industrial Noise Policy* (EPA, 2000) for determining the intrusiveness noise criteria levels for assessment of noise-related impacts.

The results of the noise assessment undertaken by Wilkinson Murray (2015) are also included in **Table 3.1**. These are based on predictions of the noise level exceeded during 10% of 15-minute periods during worst case meteorological conditions. Predicted noise levels are those attributable to the Quarry and do not take into account background noise (which is higher than noise associated with the Quarry in some locations).

The noise level predicted at Residence 8 is 1dB(A) above the existing criteria at this location. A change in the level of a sound of 1dB(A) to 2dB(A) is considered to be inaudible to the human ear. In addition, the assessment undertaken by Wilkinson Murray (2015) considered worst case scenario meteorological conditions. Therefore the predicted exceedance at Residence 8 of 1dB(A) is considered to be negligible.

In conclusion, noise levels generated by the approved operations combined with the additional mobile crushing system are predicted to remain compliant with the daytime noise limits during all Stage 3 operations. Notwithstanding the noise levels predicted in **Table 3.1**, there may be times when operations at the Quarry would be audible at surrounding residences as the criteria used for assessment and compliance are based on intrusive noise levels and not audibility.

3.3 VISIBILITY

Condition 3(32) in Development Consent 94-4-2004 requires Hanson to *"implement all practicable measures to minimise the visual impacts of the development:*

- *establish, re-vegetate and subsequently maintain the acoustic barrier to minimise the visual impacts of development, in accordance with the concept final landform in the Amendment Report;*
- *include a progress report on the re-vegetation and maintenance of the acoustic barrier in the AEMR, and*
- *to the satisfaction of the Director General.*

The Proponent shall take all practicable measures to prevent and/or minimise any off-site lighting impacts from the development.

All external lighting associated with the development shall comply with Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting."

The indicative location for the proposed crushing system is identified in **Figure 2.1.** The proposed crushing system would be located within the area currently designated for processing and stockpiling activities. This will ensure that the crushing system will also benefit from the abatement measures such as high walls, bund screens and lower profile terrains which have been engineered into the existing plant and stockpile area.

Due to the nature of the topography between the floor of the rehabilitated extraction area and the surrounding land to the north and east of the Quarry Site, the lack of public access to the surrounding land and the elevation of the extraction floor, there would be no long or short distance vantage points toward the proposed location for the crushing system. Hence, the crushing system would not be visible from either the north or east (the location of nearby residences) and therefore would not cause any visual impacts.

3.4 AIR QUALITY

Air quality is managed within the Quarry through a series of standard design and operational controls that reduce the potential impact of dust produced during regular operations. The proposed crushing system would comprise only a minor component of processing operations and potential dust sources within the Quarry Site. The majority of the crushing system is enclosed to reduce dust emissions from the system. The system would be located on the floor of the existing processing area which is screened by bunds and existing high walls. Regular deposited dust monitoring is undertaken to ensure that dust levels do not exceed the limits provided in DA 94-4-2004. Existing dust monitoring locations for the Quarry are displayed on **Figure 2.2**.

Condition 3(8) of DA 94-4-2004 provides air quality criteria for the Quarry and Section 4 of the approved *Air Quality Monitoring Program* (AQMP) describes the monitoring program implemented at the Quarry. In accordance with Section 4.3 of the AQMP, deposited dust is measured at each of the monitoring locations displayed in **Figure 2.2**. Given the low predictions of air quality impacts at the Quarry, monitoring of PM_{10} is only necessary should deposited dust impacts exceed 3.7g/m^2/month (i.e. an incremental increase greater than 2.0g/m^2/month above the background level of 1.7g/m^2/month). As PM_{10} monitoring is not undertaken at the Quarry, existing compliance is considered against the criteria for deposited dust, which is 3.7g/m^2/month. **Table 3.2** displays the annual average levels of deposited dust at each of the dust monitoring locations recorded since 2007. These levels demonstrate that the Quarry is currently operating in full compliance with the applicable air quality criterion.

Table 3.2
Average Annual Deposited Dust Monitoring Results 2007 – 2015 (g/m^2/month)

	CD-1	CD-2C	CD-3	CD-4	CD-5	CD-6
2007 Average	1.2	1.7	0.9	1.2	0.9	1.2
2008 Average	0.7	1.1	0.4	0.8	0.4	0.8
2009 Average	2.0	2.6	1.5	1.2	1.2	1.9
2010 Average	1.3	1.1	0.5	0.5	0.5	0.7
2011 Average	2.1	0.8	0.7	0.4	0.3	0.5
2012 Average	1.8	1.3	1.3	0.5	0.3	0.5
2013 Average	1.4	1.1	2.2	0.5	0.4	0.6
2014 Average	1.1	1.7	1.5	0.7	0.5	0.8
2015 Average	1.2	1.3	0.8	0.6	0.6	0.6
Source: Hanson (2016)						

An assessment of potential impacts relating to deposited dust and particulate matter was undertaken by PAE Holmes in 2009 for the operation of the Southern Extension (reproduced as **Appendix 4**). The results of this assessment are considered to give an appropriate and much more conservative indication of potential impacts associated with the proposed installation of a crushing system for the following reasons.

- Production at the Quarry during Stage 3 operations would not exceed 400 000 tonnes per annum and the PAE Holmes assessment considered an annual production rate of one million tonnes per annum. This is 2.5 times the production proposed for the modification.

- The PAE Holmes assessment considered placement of the crushing system in the same location as the proposed crushing system.
- The PAE Holmes assessment also considered the potential impact associated with replicating the crushing system at a second location, increasing potential cumulative impacts of two crushing systems compared to the single crushing system proposed under the modification.
- The PAE Holmes assessment assessed the coincident extraction in Stage 4 (proposed at that time) and Stage 3, increasing the source of emissions in each of the assessed scenarios. Cumulative impacts in these scenarios would have been greater than operations proposed under the modification which only propose extraction within the approved Stage 3 extraction area.

PAE Holmes modelled impacts in accordance with the guideline document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) using dispersion models created using the US EPA ISCST3 computer model. **Table 3.3** provides a summary of the parameters assessed, criteria levels and maximum predicted impacts during a worst case scenario. These results are considered to be a very conservative estimate of potential particulate matter impacts under the proposed modification.

Table 3.3
Deposited Dust and Particulate Matter Assessment Results and Criteria

Parameter	Criteria (Maximum total or cumulative levels)*	Predicted Maximum Cumulative Levels
Annual average PM_{10}	30$\mu g/m^3$	2.9$\mu g/m^3$
Maximum 24hr Average PM_{10}	50$\mu g/m^3$	22$\mu g/m^3$
Annual Average Total Suspended Particulates	90$\mu g/m^3$	4$\mu g/m^3$
Dust Deposition	4.0g/m^2/month or an incremental increase of 2.0g/m^2/month	<1.0g/m^2/month
* Criteria sourced from DEC (2005)		
Source: PAEHolmes (2009)		

This conservative prediction of deposited dust and particulate matter impacts indicates that air quality impacts would remain below existing criteria levels with the inclusion of the crushing system.

In addition, the sandstone being fed into the crushing system would typically have a moisture content of approximately 10 per cent. This moisture content would provide additional dust suppression for the crushing system.

Assuming the continued implementation of the Project design features, operational safeguards and mitigation measures, the impacts upon air quality at surrounding residences would continue to comply with the Quarry's air quality conditional requirements.

3.5 REHABILITATION OF THE QUARRY SITE

In accordance with *Condition 3(22)* of DA 94-4-2004, a Rehabilitation and Landscape Management Plan (RLMP) was prepared within 6 months of the date of consent. Rehabilitation of the Quarry Site is required to be generally consistent with the RLMP.

The silt cells on the quarry floor within Stages 1 and 2 have been capped using oversize materials and a number of perimeter slopes have been revegetated. None of the revegetated areas would be disturbed by the proposed crushing system.

The introduction of a crushing system would result in a reduction of the quantity of oversize material available for use in the rehabilitation of the Quarry Site, where the material is currently used to cap completed silt cells. Hanson proposes to continue to cap the completed silt cells with overburden material together with a quantity of oversize friable sandstone that will either not be crushed or remains as oversize (>50mm) from the crushing system. Hanson would ensure that there is sufficient material generated through extraction to be available for rehabilitation of the silt cells. The adoption of this approach would ensure that rehabilitation of the Quarry Site is not compromised by the introduction of a crushing system.

4. EVALUATION AND JUSTIFICATION OF THE PROPOSAL

4.1 CRUSHING SYSTEM

This *Environmental Assessment* has been prepared to present an assessment of the likely environmental impacts associated with the incorporation of a crushing system into the processing operations at the Calga Sand Quarry.

The incorporation of a crushing system would allow for a greater recovery of the extracted resource in quarry production. The potential for adverse impacts associated with the crushing system would be mitigated through its location on the quarry floor near a 6m to 8m high near vertical rock face and through the implementation of a range of appropriate safeguards and management measures.

In light of these conclusions, it is assessed that the crushing system, as presented in this *Environmental Assessment,* could be incorporated in a manner that would satisfy all relevant statutory goals and criteria and environmental objectives.

The new crushing system would meet best practice design to comply with all relevant health and safety objectives.

5. REFERENCES

Environmental Protection Authority (2000). *Industrial Noise Policy.*

Hanson Australia Pty Ltd (2016) – *Annual Environmental Management Report for 2015*.

PAEHolmes (2009). *Calga Sand Quarry Southern Extension Air Quality Assessment, Part 6* of the *Specialist Consultant Studies Compendium*. Prepared by PAEHolmes Pty Ltd on behalf of Rocla Materials Pty Ltd.

Renzo Tonin (2013). *Rocla Calga Sand Quarry – Operational Noise Assessment – 6 June 2013.*

Wilkinson Murray (2004). *Calga Sand Quarry Extension – Noise Assessment – May 2004.*

Wilkinson Murray (2009). *Calga Sand Quarry Southern Extension Noise Assessment, Part 5* of the *Specialist Consultant Studies Compendium*. Prepared by Wilkinson Murray Pty Ltd on behalf of Rocla Pty Ltd.

Wilkinson Murray (2010) – Investigation of Noise Complaint from Australia Walkabout Wildlife Park - Noise Monitoring 26 Feb - 5 Mar 2010.

Wilkinson Murray (2015). *Calga Sand Quarry - Stage 3 Noise Assessment with Wash Plant Crushing System – 2015*.

Appendices

(Total No. of pages including blank pages = 122)

Appendix 1 Application to Modify a Development Consent (6 pages)

Appendix 2 Consultation Report (8 pages)

Appendix 3 2015 Crusher Noise Assessment – Wilkinson Murray (8 pages)

Appendix 4* 2009 Air Quality Assessment – PAE Holmes (98 pages)

* This Appendix is only available on the digital version of this document

This page has intentionally been left blank

Appendix 1

Application to Modify a Development Consent

(Total No. of pages including blank pages = 6)

This page has intentionally been left blank

NSW GOVERNMENT Planning & Environment

Application to Modify a Development Consent

DA Modification Number: _DA-94-4-2004_____

1. Before you lodge

You can use this form to apply to modify a development consent given by the Minister for Planning. If the changes you propose mean the development will not be substantially the same as that originally approved, please do not use this form. You will need to submit a new development application.

Disclosure statement

Persons lodging applications are required to declare reportable political donations (including donations of or more than $1,000) made in the previous two years. For more details, including a disclosure form, go to **www.planning.nsw.gov.au/donations**

Lodgement

To minimise delay in receiving a decision about your application, please ensure you submit all relevant information to us. When your application has been assessed, you will receive a notice of determination.

To complete this form, please place a cross in the appropriate boxes ☐ and complete all sections.

2. Details of the applicant

NAME

Mr ☒ Ms ☐ Mrs ☐ Dr ☐ Other ☐

First name	Family name
Andrew	Driver

Company/organisation	ABN
Hanson Construction Materials Pty Ltd	900009679734

STREET ADDRESS

Unit/street no.	Street name
L18, 2-12	Macquarie St

Suburb or town	State	Postcode
Parramatta	NSW	2150

POSTAL ADDRESS (or mark 'as above')

Suburb or town	State	Postcode
As above		

CONTACT DETAILS

Daytime telephone	Fax	Mobile
029354 2600		

Email: andrew.driver@hanson.com.au

How would you prefer to be contacted? email

3. Identify the land

Unit/street no. (or lot no. for Kosciuszko ski resorts): 1215

Street or property name: Peats Ridge Rd

Suburb, town or locality: Calga

Postcode: 2250

Lot/DP or Lot/Section/DP or Lot/Strata no.
Please ensure that you put a slash (/) between lot, section, DP and strata numbers. If you have more than one piece of land, you will need to separate them with a comma eg 123/579, 162/2.

Lot 2 DP229889

(1) (Note: You can find the lot, section, DP or strata number on a map of the land or on the title documents for the land, if title was provided after 30 October 1983. If you have documents older than this, you will need to contact Land & Property Information (LPI), a division of the Department of Finance, Service and Innovation, for updated details.

(2) Note: If the subject land is located within the Kosciuszko ski resorts area, DP and strata numbers may not always apply.

4. Details of the original development consent

Describe what the original consent allows

Sand extraction, processing and ancillary activities. Modification 1 determined 29 June 2012.

What is the development application no.?: DA 94-4-2004

What is the date of consent?: 28/10/2005

What was the original estimated cost of development (including GST)?:

5. Describe the modification you propose to make

Please indicate the type of modification you propose to make by placing a cross in the appropriate box ☐ below.

You need to submit with your application form a full description of the expected impacts of the modifications proposed, including relevant plans, drawings and compliance with relevant controls.

☐ A modification to correct a minor error, misdescription or miscalculation

Describe the error, misdescription or miscalculation
(Refer to section 96(1) of the *Environmental Planning and Assessment 1979* (EP&A) Act)

☒ A modification that will have minimal environmental impact

Describe the modification and its expected impact
(Refer to section 96(1A) of the EP&A Act)

Refer to attached environmental assessment report.

☐ Any other modification

Describe the modification and its expected impact
(Refer to section 96(2) of the EP&A Act)

Will the modified development be substantially the same as the development that was originally approved?

No ☐➢ Please submit a new development application.

Yes ☒➢ Please provide evidence that the development will remain substantially the same.
(If you need to attach additional pages, please list below the material attached).

Refer to attached environmental assessment report.

6. Number of jobs to be created

Please indicate the number of jobs this will create. This should be expressed as a proportion of full time jobs over a full year. (e.g. a person employed full-time for 6 months would equal 0.5 of a full-time equivalent job; six contractors working on and off over 2 weeks equate to 2 people working full-time for 2 weeks, which equals approximately 0.08 of an FTE job.)

Construction jobs (full-time equivalent)	-
Operation jobs (full-time equivalent)	-

7. Application fee

For development that involves a building or other work, the fee for your application is based on the estimated cost of the development.

Clause 258 of the Environmental Planning and Assessment Regulation 2000 and the table attached to that clause set out how to calculate the fee for an application for modification of a consent.

If your development needs to be advertised to the public you may also need to include an advertising fee. Clause 258 of the regulations includes details on these fees.

Note: Contact us if you need help to calculate the fee for your application.

Estimated cost of the development	Total fees lodged
$650,000	

8. Political donation disclosure statement

Persons lodging a development application are required to declare reportable political donations (including donations of or more than $1000) made in the previous two years. Disclosure statements are to be submitted with your application.

Have you or any person with a financial interest in the application or any persons associated with the application made a political donation?

No ☒
Yes ☐

Have you attached a disclosure statement to this application?

No ☒
Yes ☐

Note: for more details about political donation disclosure requirements, including a disclosure form, go to **www.planning.nsw.gov.au/donations**.

9. Signatures

The lessee(s) of the land this application relates to must sign the application.

As the lessee(s) of the above property, I/we consent to this application:

Signature

Name

Andrew Driver

Date

1 July 2016

Capacity in which you are signing

NSW Development Manager
Hanson Construction Materials

Signature

Name

Date

Capacity in which you are signing

10. Applicant's Signature

The applicant must sign the application.

Signature

Name

Andrew Driver

Date

1 July 2016

11. Privacy policy

The information you provide in this application will enable us, and any relevant state agency, to assess your application under the *Environmental Planning and Assessment Act 1979* and other applicable state legislation. If the information is not provided, your application may not be accepted. If your application is for designated development or advertised development, it will be available for public inspection and copying during a submission period. Written notification of the application will also be provided to the neighbourhood. You have the right to access and have corrected information provided in your application. Please ensure that the information is accurate and advise us of any changes.

12. Contact details

Alpine Resorts Team
Shop 5A, 19 Snowy River Avenue
PO Box 36, JINDABYNE NSW 2627
Telephone: 02 6456 1733
Facsimile : 02 6456 1736
Email: alpineresorts@planning.nsw.gov.au

Head Office
23-33 Bridge Street, SYDNEY 2000
GPO Box 39, SYDNEY NSW 2001
Telephone: 02 9228 6333 or 1300 305 695
Facsimile: 02 9228 6555
Email: information@planning.nsw.gov.au

Note: for contact details of other Sydney Metropolitan and Regional Offices, go to **www.planning.nsw.gov.au**

Appendix 2

Consultation Report

prepared by

Hanson Construction Materials Pty Ltd

(Total No. of pages including blank pages = 8)

This page has intentionally been left blank

Report of Community Engagement – contact with Calga stakeholders

August 2016

1. Objectives

Representatives of Hanson conducted a door knocking campaign of all residents and local businesses surrounding the Calga sand quarry, off Peats Ridge Road, over the course of two days on 4-5 August, 2016.

The objective was to personally meet community stakeholders to offer a fact sheet about the quarry's operations, its current development approval and its preparation, via submission for approval to the Department of Planning and Environment, to install and operate an updated crushing system. The fact sheet outlined that this modification will include amendment to noise criteria for the quarry to ensure appropriate acoustic levels on site and the quarry is committed to mitigating impacts on the Calga community.

The fact sheet also provides information for the community to seek more information about the quarry and its plans by directly contacting key Hanson management, through Hanson's enquiry line or by visiting Hanson's national website.

The fact sheet also provided information about Hanson's national operations and commitment to safety and sustainability, in keeping with the company's fact sheet template, as background information.

A covering letter accompanied the fact sheet to further provide information about the quarry manager's role, long-term experience at Calga and his contact details for any enquiries.

2. Methodology

The quarry team identified a number of local residential roads and neighbouring businesses surrounding the quarry as high priority stakeholders for sharing updates about quarry operations. Over several hours during a weekday and business hours, team members visited each home and business identified to make personal contact, introduce themselves as representatives of Hanson and offer the covering letter and fact sheet as a proactive tool for current information and also a means for interacting with the quarry and the company.

Any residents or businesses that were unoccupied at the time of this visit were left the information either in a letterbox, mail slot, or under their business door. Many homes were either unattended or the door was not answered during this visit.

Of all of the residents at home during this time, only one person was not interested in any discussion, he did not express any concerns about Hanson nor the Calga quarry and he accepted the material but did not wish to speak with us. Several residents expressed their surprise and/or thanks for the visit and the information. One resident said he was not at all concerned by the quarry's operations and asked not to be further updated. No stakeholders met during this visit provided any negative feedback they wished Hanson or Calga quarry to note or follow up.

Two businesses, one being the local public school, requested that the information also be emailed to them for their records and this was completed within the same day.

All contact and any specific comments as feedback are recorded within the stakeholder matrix.

3. Summary

In general stakeholders met in person were receptive to the engagement effort by Hanson and Calga quarry and most expressed some level of satisfaction with the direct contact.

No negative feedback was provided during this visit.

Stakeholders were advised that Calga quarry would continue to provide updates about its operations over time and that feedback and future contact for any enquiries is invited, at any time, via several communication methods provided in the fact sheet and covering letter.

Hanson Construction Materials Pty Ltd
ABN 90 009 679 734
Level 18, 2-12 Macquarie Street
Parramatta NSW 2150
Locked Bag 5260
Parramatta NSW 2124

28 July 2016

Dear neighbours,

I would like to take this opportunity to introduce myself and tell you a little about us at the nearby Calga Sand Quarry, which is now owned by Hanson but has been operating off Peats Ridge Road, for the past 25 years.

I have been the Quarry Manager for the past 13 years and reside on the Central Coast with my family.

The Calga Quarry has proudly provided local job opportunities for highly trained staff and drivers and Hanson have actively supported many community groups in our local region, as well as schools and several businesses.

We produce a range of fine washed sand typically used in concrete and construction, for house slabs, in the laying of pipes and in between pavers, for bricklaying, and in sand-pits, horse ménage and golf bunkers amongst other purposes.

For the past few years we have also hosted many visitors and researchers conducting inspections of Aboriginal heritage sites, environmental management, flora and fauna protection on site and our long-term rehabilitation projects. Our 130 hectare site is recognised for its leadership in best practice and environmental responsibility. You can read a little more about us online: http://www.hanson.com.au/About/Regulatory-Information/Projects/Calga

Hanson is reaching out to our community in many ways and our Community Engagement Officer, Rebecca Grisman, is available to help answer any questions you may have about our quarry or our company. If you have any enquiries about our facility, sponsorship opportunities or would like to take a tour of our site, please contact Rebecca at Rebecca.Grisman@hanson.com.au.

I enclose a fact sheet that outlines what we do here at the Calga Quarry and a project update. Thank you for your time and we look forward to seeing you in the community.

Kind regards

Paul Slough

Manager, Calga Sand Quarry

Calga Sand Quarry Project

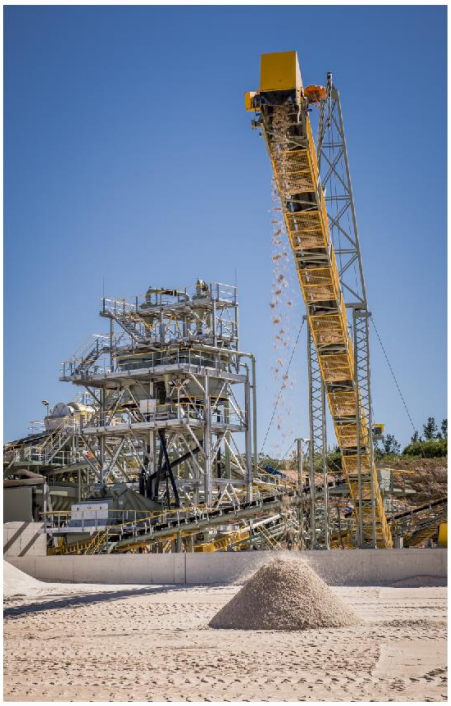
Who is Hanson

Hanson is part of the HeidelbergCement group, which employs 57,000 people across five continents. In Australia Hanson has about 70 quarries, 200 concrete plants, two precast concrete product sites and one asphalt plant located around the country. Hanson acquired Calga Sand Quarry from Rocla Materials Pty Ltd in February 2016.

What we do at Calga Sand Quarry

Calga Sand Quarry covers an area of 130 ha, located off Peats Ridge Road within the Gosford Local Government Area. The quarry contains substantial resources of friable sandstone which is processed into construction grade sand. Specifically;

- Our sand products include specified sands for concrete, mortar, plaster, fill and specialised dried sands for glass manufacture, used in foundries, sports surfaces and many other manufacturing uses.
- Calga Sand Quarry employs around 12 full time staff members from the local area. The quarry reinvests into the surrounding community by employing local contractors and supporting local jobs.
- Calga Quarry practices progressive rehabilitation on the site.
- Calga Quarry regularly conducts environmental monitoring of noise emissions, air quality, water quality and also conducts ecological surveys and hosts heritage visits - Visit: http://www.hanson.com.au/About/Regulatory-Information/Projects/Calga for more information.



Current Development Approval

Calga Sand Quarry has been operating since initial project approval was granted in 1991, and currently operates under Development Consent DA 94-4-2004 which was approved under the *Department of Planning and Assessment Act 1979* in 2005.

Safety—High Performance—Innovation—Respect—Integrity

Hanson
HEIDELBERGCEMENTGroup

Our professional drivers are world class

- Our fleet is certified through the National Heavy Vehicle Accreditation Scheme (NHVAS), which is recognised for industry best-practice.
- The company has a zero tolerance policy for unsafe driving and requires all our drivers to be responsible, professional and highly trained, in keeping with Hanson's Driver's Code.
- All trucks are numbered to ensure any complaints are followed up fast.
- We complete road worthiness, driver fatigue and other checks of vehicles every day.
- Hanson is continually seeking sustainable solutions for transporting products across Australia.

Project Update

Modification to the Crushing System and Noise Criteria Amendment

Hanson is in the process of finalising a submission to the Department of Planning and Environment to modify existing Development Consent DA 94-4-2004 under section 75W of the *Environmental Planning and Assessment Act 1979* to include the installation and operation of a crushing system to maximise the recovery of extractible friable sandstone on site. The modification will include amendment to noise criteria for the quarry to ensure appropriate acoustic levels are applied to the site. Hanson have employed expert consultants to ensure the modification is consistent with industry standards, thereby minimising impacts on the Calga community.

Further Information

Further information will be presented in the Environmental Assessment which will be placed on the Department's website for public exhibition in the coming weeks. Hanson welcomes any feedback and urges you to contact:

- Calga Quarry Manager: Paul Slough on (02) 4375 1151; or
- NSW Operations Manager Aggregates: Chris Dolden on 0457 738 811

should you have any further queries regarding the progress of the Environmental Assessment. Alternatively you can ring Hanson's enquiry number 1800 882 478, or visit http://www.hanson.com.au/Contact.

Did you know

- Building a typical house requires about 100 tonnes of aggregate?
- Constructing just 1 km of highway requires approximately 25,000 tonnes of crushed rock?
- Just 1 km of suburban road requires 5000 tonnes of crushed rock?
- It takes hundreds of tonnes of concrete and asphalt to create footpaths, kerbs and gutters in your community?
- One high rise building can use up to 1000 tonnes of aggregate for every floor?
- Calga Sand Quarry is open for visitor tours, on request.
- We know you need us – and we need you too – as customers, employees and neighbours.

Contact us to take a tour of Calga Sand Quarry, we look forward to meeting you.

Visit www.hanson.com.au or call Hanson's Enquiry Line
PH: 1800 882 478

Safety—High Performance—Innovation—Respect—Integrity

Calga Stakeholder Matrix

Stakeholder	Contact name	Address	Phone	Email	Comments
Local residents					
R.D. King		5 Bandaroo Rd			4/8 - Letterbox drop fact sheet and project update.
F. & G. Rozmanec	Frank & Gina Rozmanec	30 Bandaroo Rd	4375 1161		4/8 - Frank was home waiting for a visit from Paul. Left information with Frank and advised Paul.
G.B. & L.P. Miles		51 Bandaroo Rd			4/8 - Letterbox drop fact sheet and project update.
		32 Polins Rd			4/8 - Letterbox drop fact sheet and project update.
Power Pastoral Holdings	Walter Power	48 Polins Rd	0413 091 639		4/8 - Letterbox drop fact sheet and project update.
Glenworth Valley Pastoral Company	Barton Lawler	51 Polins Rd		Barton@glenworth.com.au	4/8 - Letterbox drop fact sheet and project update.
W. White	Winston White	24 Jones Rd	0414 900 555		4/8 - Letterbox drop fact sheet and project update.
D. O'Bryan	Dave O'Bryan	30 Jones Rd	4375 1194		4/8 - Letterbox drop fact sheet and project update.
GF & J Gilbertson		31 Jones Rd			4/8 - Letterbox drop fact sheet and project update.
Tokoloshe Pty Ltd		49 Jones Rd			4/8 - Letterbox drop fact sheet and project update.
		59 Jones Rd			4/8 - Letterbox drop fact sheet and project update.
		69 Jones Rd			4/8 - Letterbox drop fact sheet and project update.
J.Hunt & T. Thomson	John Hunt & Terri Thomson	104 Jones Rd			4/8 - Letterbox drop fact sheet and project update.
		1410 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
		1445 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
		1449 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
		1450 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
		1461 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
		1650 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
		1703 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
		1782 Peats Ridge Road			4/8 - Spoke with the gentleman on site, he said he is not concerned with Hanson's operations and didn't feel the need to see further updates.
		1815 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
J. Hajje		2197 Peats Ridge Road	0418 277 355		4/8 - Letterbox drop fact sheet and project update.
		2002 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
B. Kashouli		2218 Peats Ridge Road	4375 1118		4/8 - Letterbox drop fact sheet and project update.
J & A.V. Serou		2235 Peats Ridge Road			4/8 - Letterbox drop fact sheet and project update.
Business within 10km					
Power Pastoral Holdings	Walter Power	2236 Peats Ridge Road	0413 091 639		4/8 - Drove in but no one seemed to be onsite, information letterbox dropped.
Australia Walkabout Wildlife Park	General Manager - Tassin Barnard	1 Darkinjung Road Cnr Peats Ridge Road Calga, NSW 2250 Australia	02 4375 1100	info@walkaboutpark.com.au	20 May, 24 May & 31 May, Rebecca called and emailed the park to offer contact details; advised Tassin was not available to speak but had got messages, no response to emails. 15/6/16 - Bianca visited reception and spoke with lady on front desk, Tassin was out. Gave her Rebecca's card as Hanson point of contact. 4/8 - Tassin was not onsite. Factsheet and letter was left at reception for her; Rebecca also offered to email a pdf version as per previous contact. Rebecca sent it same day.
Glenworth Valley Outdoor Adventures		69 Cooks Road, Glenworth Valley	02 4375 1222	Barton@glenworth.com.au	4/8 - Spoke with Shannon, went over project update. Left fact sheet and letter with her. Happy to receive further info via email to pass onto owners.
Mangrove Mountain Springs		522 Peats Ridge Road Calga	02 4375 1101		4/8 - Letterbox drop fact sheet and project update.
Mangrove Mountain Golf Course	Gwen	18 Hallards Road Central Mangrove	02 4373 1129	mmmclub@bigpond.com.au	
Royale Orchids		70 Brieses Rd, Peats Ridge NSW 2250	02 4375 1199		4/8 - No one on site fact sheet and project update to be emailed.
Boral Sand Quarry		Bushells Rd, Peats Ridge NSW 2250	1300 723 999		
Express Annexures	Winston White	2207 Peats Ridge Road, Calga NSW 2250	0414 900 555		4/8 - No one on site fact sheet and letter left in mailbox.
Sires on Ice		3 Jones Road Calga NSW 2250	0243 751 001 0413 702 107	info@siresonice.com	4/8 - Explained project update to receptionist who took the fact sheet and letter for the owners.
Ozsea Aquaculture Systems		760 Peats Ridge Rd, Peats Ridge NSW 2250	02 4373 1142		4/8 - Letterbox drop fact sheet and project update.
Peats Ridge Market		1231 Peats Ridge Rd, Peats Ridge NSW 2250	0419 601 232		4/8 - Held at Peats Ridge Primary school every few weeks, visited school.
Specimen Tree Nursery/Wildwood		1700 Peats Ridge Rd, Peats Ridge NSW 2250	02 4375 1200		4/8 - Letterbox drop fact sheet and project update left with lady in office. She said she wasn't concerned and didn't need further updates.
Henderson Park	Suzanne	2133 Peats Ridge Road Calga NSW 2250	0416 046 589	suzanne@hendersonpark.net.au	4/8 - Letterbox drop fact sheet and project update.
Caffee D'italia		522 Peats Ridge Rd, Peats Ridge NSW 2250	02 4375 1122		4/8 - Letterbox drop fact sheet and project update.
Schools					
Peats Ridge Public School	Principal – Mr Carter	1231 Peats Ridge Road Peats Ridge 2250	02 4373 1149	john.carters@det.nsw.edu.au	4/8 -Spoke to the Principal he was interested in some sponsorship opportunities, mentioned he did get in touch with Hanson last year with no response. Requested a pdf copy of the fact sheet via email and Rebecca sent it same day.
Media					
Central Coast Express Advocate	Editor - Mark Nolan	GPO Box 7002 Sydney NSW 2001	02 4323 5009	editor@expressadvocate.com.au	4/8 - Rebecca called and offered to send pdf of fact sheet to editor. Completed.
Coast Community News	Editor - Cec Bucello	PO Box 1056 Gosford 2250	02 4325 7369	editorial@centralcoastnews.net	4/8 - Rebecca called and offered to send pdf of fact sheet to editor. Completed.
NBN News Central Coast		312 The Entrance Road, Erina, 2250	02 4367 5211		4/8 - Rebecca called and offered to send pdf of fact sheet to editor. Completed.

Appendix 3

Crushing System Noise Assessment

prepared by

Wilkinson Murray Pty Limited

(Total No. of pages including blank pages = 8)

This page has intentionally been left blank

WILKINSON MURRAY

1 December 2015

WM Project Number: 01127-AC
Our Ref: RWC011215 RH

Mr Angus Richmond
Rocla Material Pty Ltd
PO BOX 36
GUILDFORD NSW 2161

Dear Angus

Re: Calga Sand Quarry - Stage 3 Noise Assessment with Wash Plant Crushing System

Introduction

Rocla Materials Pty Ltd (Rocla) proposes to install and operate a crushing system within the existing approved processing operations at the Calga Sand Quarry ("the Quarry"). **Figure 1** displays the proposed location of the crusher and the monitoring locations that have been used for noise monitoring to establish compliance with noise limits in Environment Protection Licence (EPL) 11295 and for assessments undertaken for the previously proposed Southern Extension to the Quarry, which has been refused development approval.

The crushing system is proposed to operate only between 7.00am and 6.00pm, in conjunction with the wash plant.

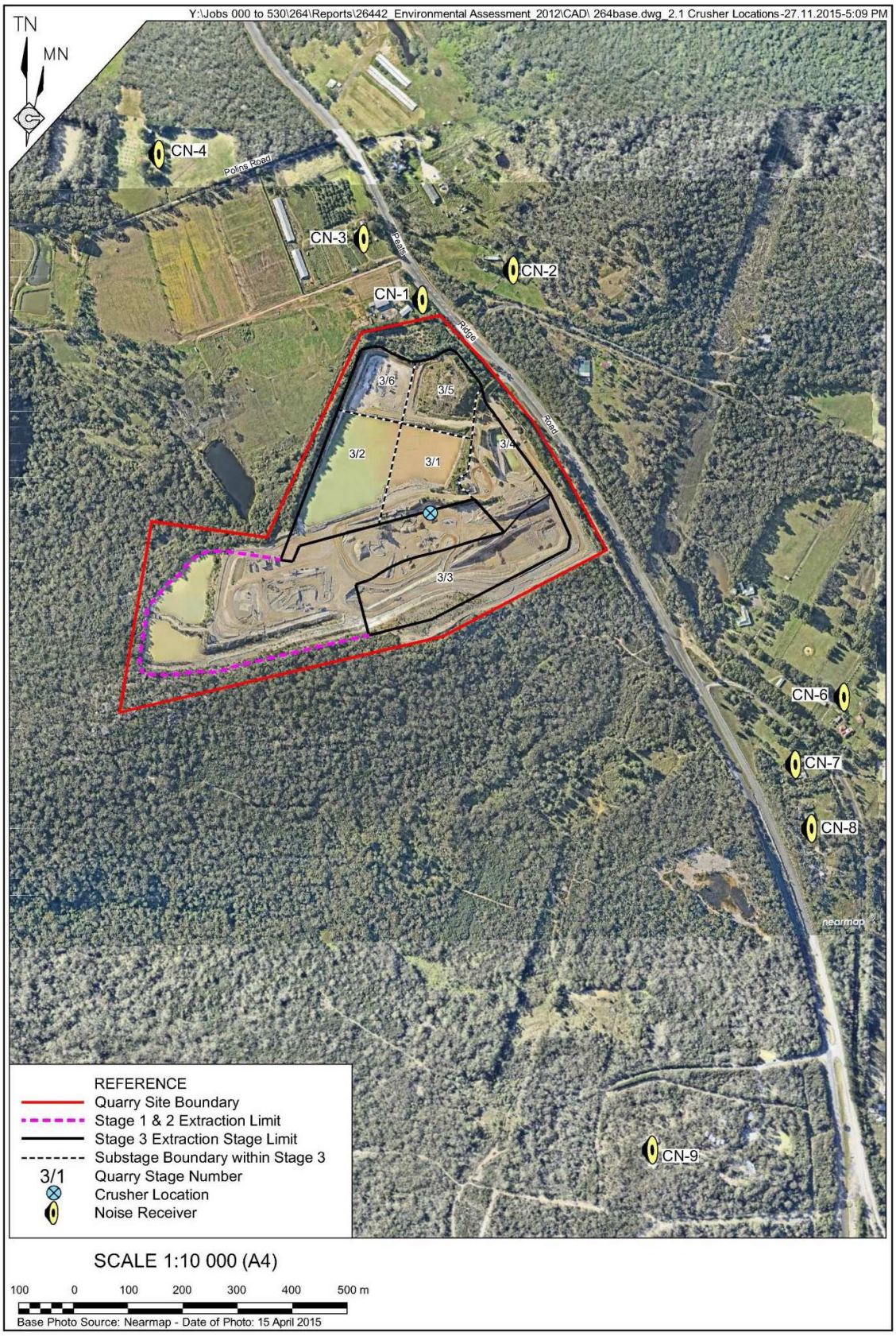
The receivers addressed in this assessment are also shown in **Figure 1** and listed below:

- Residence 3 (CN-1) – Power
- Residence 4 (CN-2 – King
- Residence 5 (CN-3) – Kashouli
- Residence 6 (CN-4) – Townsend
- Residence 8 (CN-6) – Cauchi
- Residence 9 (CN-7) – White
- Residence 20 (CN-8) – O'Bryan
- Residence 13 (CN-9) – Barnard

A more detailed site plan and land ownership plan are appended to this letter.

Wilkinson Murray Pty Limited · ABN 39 139 833 060
Level 4, 272 Pacific Highway, Crows Nest NSW 2065, Australia • Offices in Orange, Qld & Hong Kong
t +61 2 9437 4611 • f +61 2 9437 4393 • e acoustics@wilkinsonmurray.com.au • w www.wilkinsonmurray.com.au
ACOUSTICS AND AIR

Figure 1 Crushing System Location & Noise Receivers



Noise Predictions Associated with Approved Operations with Wash Plant Crushing System

Noise predictions associated with the crushing system were made using the existing ENM environmental noise model that was used as part of the 2009 noise assessment for the Southern Extension, and using a sound power level of 109dBA (based on on-site measurements).

For daytime calculations, 41 separate meteorological conditions were considered – wind speeds of 1-5 knots in each of eight directions, and zero wind speed (representing both zero wind and wind speeds above 5 knots). Noise levels were calculated under each of these conditions, and the probability of occurrence of each condition for the day periods in each season was then used to calculate the L_{Aeq} noise level which would be exceeded for 10% of 15-minute periods.

Table 1 shows the calculated noise level exceeded for 10% of 15-minute periods during the worst-case season during the daytime period 7.00am-6.00pm in relation to Stage 3 activities when levels are predicted to be higher than 35dBA. **Table 1** also includes the noise limits provided in EPL 11295 and the more recently recorded background noise levels, plus 5dB(A), which is the standard method for determining suitable operational intrusiveness noise criteria for an operation. It is anticipated that following approval, a modification to EPL 11295 would be required to establish more appropriate noise limits at residences that are reflective of recorded background levels plus 5dB(A).

Table 1 Predicted Daytime Noise Levels – Approved Operations with Crushing System

Location	EPL 11295 Noise Limits ($L_{Aeq,15min}$)	Noise Criteria Background + 5dB(A) ($L_{Aeq,15min}$)	Predicted Level ($L_{Aeq,15min}$)
Residence 3 (CN-1) – Power	41	41	41
Residence 4 (CN-2) – King	40	40	40
Residence 5 (CN-3) – Kashouli	39	39	39
Residence 6 (CN-4) – Townsend	35	-	35
Residence 8 (CN-6) – 3 Jones Road	35	43 *	36
Residence 9 (CN-7) – 24 Jones Road	35	43 *	35
Residence 20 (CN-8) – 30 Jones Road	35	48 *	<35
Residence 13 (CN-9) – Walkabout Park	35	46 *	<35

* Note: Criterion based on recommended intrusiveness noise criteria recommended as part of the Calga Sand Quarry Southern Extension EA Noise Assessment (Wilkinson Murray, 2009)

The predicted noise levels comply with the relevant criteria at all the identified receivers, excluding Residence 8, where noise levels would exceed the EPL 11295 criteria by 1dB(A). A change in noise level of 1dB(A) is not discernible to the human ear, and therefore not considered to be an exceedance of noise criteria for the purposes of establishing compliance.

In addition, a daytime Rating Background Level (RBL) of 38dB(A) has been recorded at Residence 8 in February 2007 indicating that the calculated noise levels would not exceed background levels, nor the industry standard intrusiveness noise criterion of 43dB(A) (ie. background plus 5dB(A)).

Confirmation of Crushing System Noise Levels

Table 2 presents the 10th percentile calculated noise levels due to the crushing System alone at two of the receiver locations where compliance monitoring is undertaken.

Table 2 Predicted Noise Levels – Mobile Crushing System Alone

Crushing System Location	Calculated $L_{Aeq,15min}$ Noise Level (dB(A))	
	CN1	CN2
At wash plant	31	29

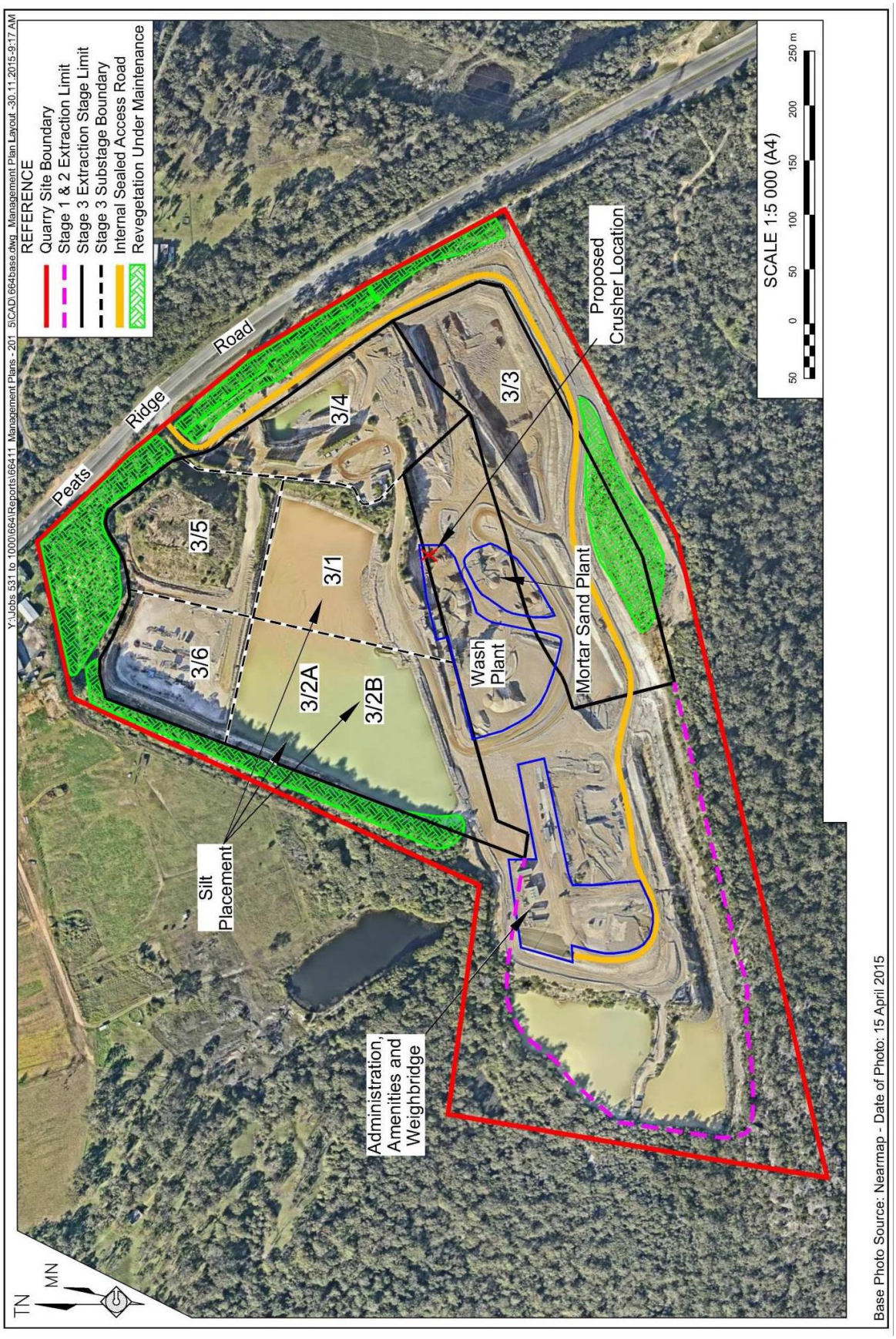
Noise measurements were conducted on Monday, 4 March 2013 at CN1 and CN2 to establish whether noise generated during a trial of the crushing system would be audible amongst the rest of the operations. Noise levels generated by all noise sources within the whole site did not change with and without the crusher operating, which confirms noise levels from the crusher alone are estimated to be approximately 30dBA at CN1 and CN2. These attended monitoring results are consistent with the 10th percentile noise predictions presented in **Table 2**.

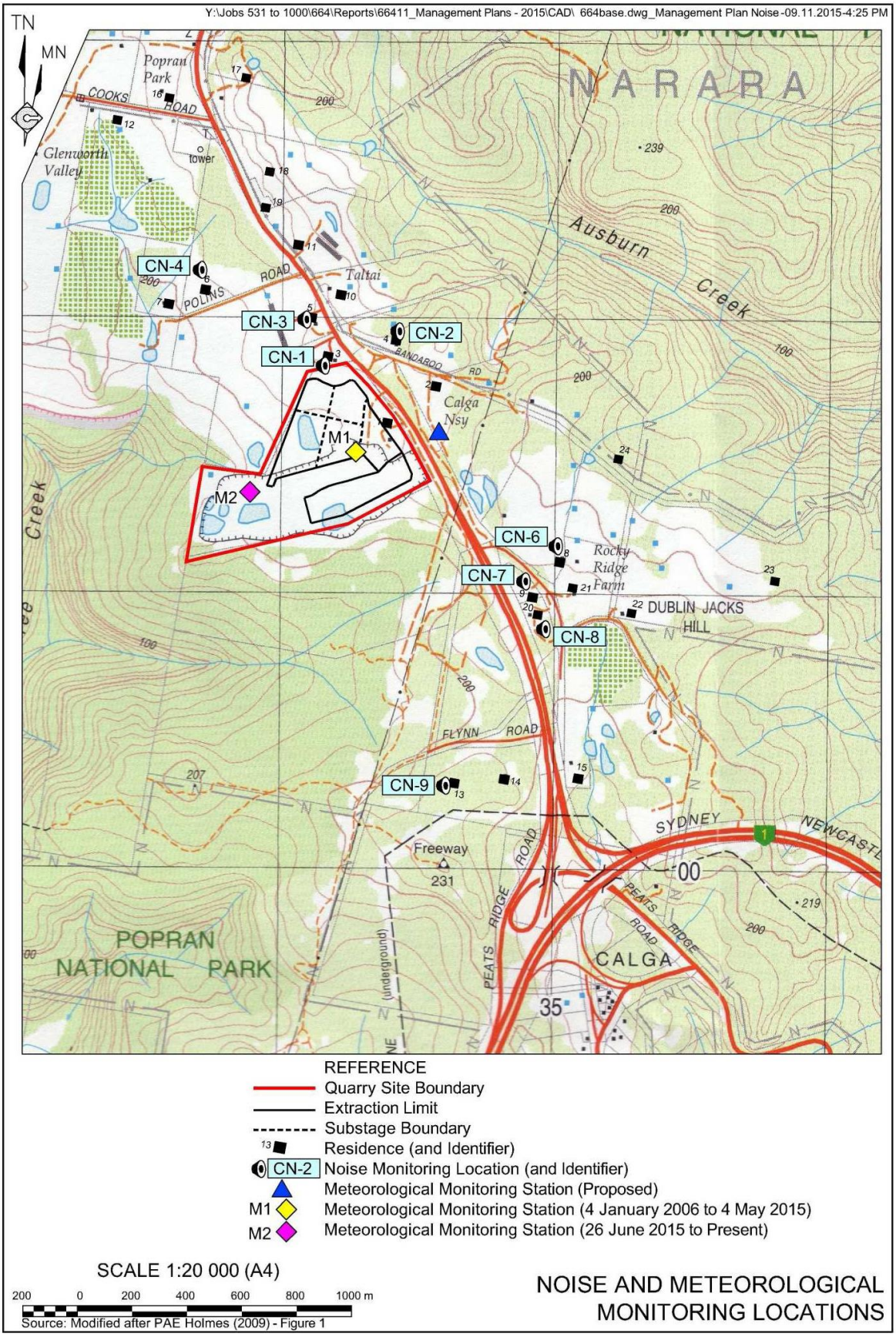
Based upon the above, it is concluded that the incorporation of a crushing system in the wash plant would not contribute to any non-compliance of the noise limits nominated in EPL 11295.

I trust this information is sufficient. Please contact us if you have any further queries.

Yours faithfully
WILKINSON MURRAY

Roman Haverkamp
Senior Engineer


Y:\Jobs 531 to 1000\664\Reports\66411 Management Plans - 201 5\CAD\ 664base.dwg Management Plan Layout -30.11.2015-9:17 AM
REFERENCE
Quarry Site Boundary
Stage 1 & 2 Extraction Limit
Stage 3 Extraction Stage Limit
Stage 3 Substage Boundary
Internal Sealed Access Road
Revegetation Under Maintenance
SCALE 1:5 000 (A4)
50 0 50 100 150 200 250 m
Ridge
Road
Peats
3/1
3/2A
3/2B
3/3
3/4
3/5
3/6
Proposed Crusher Location
Wash Plant
Mortar Sand Plant
Silt Placement
Administration, Amenities and Weighbridge
TN
MN
Base Photo Source: Nearmap - Date of Photo: 15 April 2015



Source: Modified after PAE Holmes (2009) - Figure 1

Appendix 4

Air Quality Assessment

prepared by

PAE Holmes September 2009

(Total No. of pages including blank pages = 98)

This Appendix is only available on the digital version of this document

This page has intentionally been left blank

Rocla®
Materials Pty Ltd
ABN: 30 083 169 091

Calga Sand Quarry

Southern Extension

Air Quality Assessment

Prepared by:
PAEHolmes

September, 2009

Specialist Consultant Studies Compendium
Part 6

This page has intentionally been left blank

Rocla®
Materials Pty Ltd
ABN: 30 083 169 091

Calga Sand Quarry

Southern Extension

Air Quality Assessment

Prepared for:
R.W. Corkery & Co. Pty. Limited
Level 1, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

On behalf of:
Rocla Materials Pty Ltd
PO Box 36
GUILDFORD NSW 2161

Prepared by:
PAEHolmes
Suite 2B, 14 Glen Street
EASTWOOD NSW 2122

Tel: 02 9874 8644
Fax: 02 9874 8904
Email: judith.cox@paeholmes.com

September, 2009

CONTENTS

Page

CONTENTS

Page

APPENDICES

LIST OF TABLES

CONTENTS

Page

LIST OF FIGURES (all figures at the end of the report)

CONTENTS

Page

GLOSSARY OF TERMS

BoM	Bureau of Meteorology
NSW DECC	New South Wales Department of Environment and Climate Change
g/m^2/month	grams per square metre per month
$\mu g/m^3$	micrograms per cubic metre
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measures
NHMRC	National Health and Medical Research Council
$PM_{2.5}$	particulate matter less than 2.5 μm in diameter
PM_{10}	particulate matter less than 10 μm in diameter
TSP	Total suspended particulates
US EPA	United States Environment Protection Agency

EXECUTIVE SUMMARY

Rocla Materials Pty Limited (Rocla) is proposing to extend its existing sand extraction and processing operations on Lot 2, DP 229889 at Calga ("the Calga Sand Quarry") to the south onto Lots 1 and 2, DP 805358 ("the Southern Extension"). This report provides an assessment of the existing environment, both in terms of the current climatic conditions and the existing air quality with respect to background dust deposition rates, and quantitatively assesses the dust impacts that may be associated with combined operation of the approved Calga Sand Quarry and the proposed Southern Extension (the "Project").

Predictions of dust concentration and deposition levels have been made using a modified version of the US EPA's short-term industrial source complex dispersion model ISCST3 (**US EPA, 1995a**) which is referred to in this report as ISCMOD. The dispersion model predictions have been compared to relevant air quality goals. Dispersion modelling procedures follow NSW Department of Environment and Climate Change (DECC) guidelines (**NSW DEC, 2005**).

Four scenarios were modelled to represent the progressive development and operation of the existing approved and proposed Southern Extension of the Calga Sand Quarry. Predictions were made at the nearby residences of the concentrations of PM_{10} (24-hour and annual average), TSP (annual average), and dust deposition (annual average).

The annual average concentrations of PM_{10}, TSP and deposition rates from emissions associated with the Project are shown to comply with the NSW DECC's assessment criteria.

There is a possibility that maximum 24-hour average PM_{10} concentrations could exceed the assessment criterion under unusual conditions, for example, when the background level is already high due to the presence of bushfire smoke. However, these events would be rare and the contribution that the Project would make to 24-hour PM_{10} concentrations would be very small.

This page has intentionally been left blank

1 INTRODUCTION

This report has been prepared by PAEHolmes for R.W. Corkery & Co. Pty Limited who are in turn acting for Rocla Materials Pty Ltd (Rocla). Rocla is proposing to extend its existing sand extraction and processing operations on Lot 2, DP 229889 at Calga ("the Calga Sand Quarry") to the south onto Lots 1 and 2, DP 805358 ("the Southern Extension"). The purpose of this report is to provide an assessment of the existing environment, both in terms of the current climatic conditions and the existing air quality with respect to background dust deposition rates, and quantitatively assess dust impacts that may be associated with the combined operation of the approved Calga Sand Quarry and proposed Southern Extension.

The assessment uses a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the existing Calga Sand Quarry and proposed Southern Extension. To assess the effect that the dust emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality goals. Dispersion modelling procedures follow NSW Department of Environment and Climate Change (DECC) guidelines (**NSW DEC, 2005**).

Predictions of dust concentration and deposition levels have been made using a modified version of the US EPA's short-term industrial source complex dispersion model ISCST3 (**US EPA, 1995a**) which will be referred to in this report as ISCMOD.

2 PROJECT DESCRIPTION

Rocla currently operates the Calga Sand Quarry, located adjacent to Peats Ridge Road, approximately 1.0km north-northwest of the Calga Interchange of the F3 Freeway (see **Figure 1**[1]). The quarry is operated under Development Consent DA 94-4-2004 issued by the Minister for Planning on 28 October 2005. In accordance with DA 94-4-2004, Rocla is currently extracting and processing sand from Stage 3 of the Calga Sand Quarry on Lot 2, DP 229889. Stages 1 and 2 of the Calga Sand Quarry were completed under Development Consent No. 10604.

The proposed Southern Extension of the Calga Sand Quarry would involve the progressive development of sand extraction and processing on to Lots 1 and 2, DP 805358 and a progressive increase in sand production from the Calga Sand Quarry up to a maximum of 1Mtpa. The combined existing (Stage 3) and proposed Southern Extension (Stages 4 and 5) quarry operations are collectively referred to as "the Project", which has been designed to optimise the recovery of sand whilst satisfying both site and surrounding environmental constraints and progressively creating a final landform suited to the proposed end uses. The area of land on which the Project is located, namely Lot 2, DP 229889 and Lots 1 and 2, DP 805358, is referred to throughout this report as "the Project Site".

Figure 2 displays the following principal components of the Project.

- The Stage 3 extraction areas: where sand extraction will proceed generally in a manner consistent with the current approved operation.

[1] Please note all figures are provided of the rear of the report.

- Two new extraction stages: namely Stages 4 and 5. Stage 4 would be a direct southerly extension of the existing Calga Sand Quarry and Stage 5 would be developed as a separate area. It is envisaged that extraction within Stage 5 would only commence following the validation of various predictions relating to noise and air quality levels received at the residence to the southeast of Stage 5.
- Four proposed sand processing areas: comprising the two sequential locations for the existing 400,000 tpa plant (Sites A and B) and two sequential locations for the proposed 600,000 tpa plant (Site C and D). The existing 400,000 tpa sand processing plant (Site A) will be retained in its current location until the completion of extraction stage 3/2, at which time it would be re-located to the completed floor of the Stage 1 quarry area (Site B). Early in the development of Stage 4, a second processing plant would be established on Site C. Both processing plants would ultimately be combined or replaced by a single processing plant capable of producing 1 000 000tpa at a long-term location on the floor of a completed section of stage 4(site D). No processing is proposed within Stage 5 as all raw sand materials would be transported to the plant(s) in Stage 4.
- Site access roads to the Project Site. Access to the Project Site would be initially via the existing site entrance (referred to as the “northern entrance”) and site access road off Peats Ridge Road. During the early stages of extraction within Stage 4, a new site entrance (the “southern entrance”) and access road would be constructed from Peats Ridge Road to create a specific access point and road for activities within Stages 4 and 5. Whilst operations are underway within both Stages 3 and 4, it is proposed to use the southern entrance for incoming vehicles only and the northern entrance for departing vehicles only. Following the completion of activities within Stage 3 and / or the commissioning of the 1Mtpa capacity processing area, the southern entrance may become the sole entrance / exit for vehicles entering and leaving the Southern Extension, with the existing entrance retained for access to Lot 2, DP 229889 only.
- The Project Site administration area (including workshops and fuel storage) would initially be retained in its current location before being relocated adjacent to the wash plant on the floor of Stage 1 to accommodate extraction from Stages 3/3 and 3/4. In the long-term, the administration area would be relocated to Stage 4/1, coinciding with the consolidation of processing operations within the Southern Extension.

Rocla intends to continue the current method of extraction and processing for the life of the Project. This involves the clearing of surface vegetation, removal of any topsoil and overburden and ripping of the exposed friable sandstone. The ripped sandstone would be transferred to either a washing plant, where finer clays and silts are removed from the sand, or to a dry mortar sand plant, where the sand is simply screened and finer clays and silts retained.

Extraction would continue in a staged manner, with Stages 3 and 4 (and Stages 4 and 5) undertaken concurrently to maintain the higher production rate. Once extraction is completed within an extraction stage, the quarry floor would be used for deposition and containment of the silt from the washing plant in a series of silt cells, a method currently employed at the Calga Sand Quarry.

After deposition and consolidation, the silt cells would be capped with the previously removed overburden and screened oversize material and then re-profiled to form part of the final landform. Once profiled, topsoil would be spread and the area revegetated either by sowing of pasture grasses or planting of native tree and shrub species. The Project Site would be progressively rehabilitated in this way, with Stage 4 incorporated into the final landform of the existing Calga Sand Quarry. It is proposed that Stage 5 would be rehabilitated to provide long-term nature conservation, and possibly a water storage for neighbouring property owners.

3 AIR QUALITY GOALS

3.1 Dust

In its modelling and assessment guidelines, the New South Wales Department of Environment and Climate Change (NSW DECC) 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 Ambient Air-NEPMs (see **NEPC, 1998**)). However, the NSW DECC'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 1 summarises the air quality goals for dust that are relevant to the Project.

Table 1
Air Quality Impact Assessment Criteria for Particulate Matter Concentrations

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	NHMRC
Particulate matter <10μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	NSW DECC
	30 $\mu g/m^3$	Annual mean	NSW DECC long-term reporting goal
	50 $\mu g/m^3$	(24-hour average, 5 exceedances permitted per year)	NEPM

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 2 (NEPC, 2003)**. It is noted that these goals have not been adopted in NSW for assessment of projects.

Table 2
Advisory Reporting Standards for PM2.5 Concentrations

Particulate matter < 2.5 μm ($PM_{2.5}$)	8 $\mu g/m^3$	Annual mean	NEPM*
	25 $\mu g/m^3$	24-hour maximum	NEPM*
**Not applicable to projects in NSW*			

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces and possibly on vegetation/crops. **Table 3** shows the dust deposition criteria set out in the DECC procedures for modelling air pollutants from sources (**NSW DEC, 2005**).

Table 3
NSW DEC Criteria for Dust (Insoluble Solids) Fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

3.2 Diesel and Other Vehicle Emissions

The sulphur content of Australian diesel is too low to cause sulphur dioxide (SO_2) goals to be exceeded even in quarrying operations that use large quantities of diesel. For this reason, no detailed study is required to demonstrate that emissions of SO_2 from the quarry will not significantly affect ambient SO_2 concentrations. Similarly, NO_x and CO emissions are too small to require a detailed modelling assessment.

3.3 Crystalline Silica

3.3.1 Introduction

Silica (SiO_2) is a naturally occurring mineral composed of silicon and oxygen. It exists in crystalline and amorphous forms depending on the structural arrangement of the oxygen and silicon atoms. Only the crystalline forms are known to be fibrogenic[2] and only the respirable particles (those which are capable of reaching the gas exchange region of the lungs) are considered in determining health effects of crystalline silica.

There are a number of size-based descriptors used in describing particulate matter and it is useful to define these for the following discussion. The descriptors are:

- PM_{10} - particles with an equivalent aerodynamic diameter of less than approximately 10μm – the largest of these are inhalable;
- PM_7 - particles with an equivalent aerodynamic diameter of less than approximately 7μm – the largest of these can reach the thoracic region of the respiratory system;
- PM_4 - particles with an equivalent aerodynamic diameter of less than approximately 4μm – the largest of these can reach the alveoli; and
- $PM_{2.5}$ - particles with an equivalent aerodynamic diameter of less than approximately 2.5μm – fine particle fraction.

Particles described as PM_7 are a sub-component of PM_{10}, PM_4 particles are a sub-component of PM_7 and PM_{10}, and $PM_{2.5}$ particles are a sub-component of PM_4, PM_7 and PM_{10}.

[2] Fibrogenic dust is a dust which causes an increase of fibrotic (scar) tissue after deposition in the gas exchange region of the lung.

The three most common types of crystalline silica are quartz, tridymite and cristobalite. Human exposure to crystalline silica occurs most often during occupational activities that involve the working of materials containing crystalline silica products (e.g. masonry, concrete, sandstone) or use or manufacture of crystalline silica-containing products. Activities that involve cutting, grinding or breaking of these materials can result in the liberation of particles in PM_{10}, PM_7, PM_4 and $PM_{2.5}$ size ranges. Ambient crystalline silica dust can occur due to natural, industrial and agricultural activities.

Repeated and prolonged exposure to relatively high concentrations of crystalline silica can cause the disease known as silicosis. This respiratory disease is characterised by scarring and hardening of the lung tissue and it reduces the ability of the lungs to extract oxygen from the air. Occurrences of silicosis are highly correlated to occupations where particles of crystalline silica are released to the atmosphere (e.g. mining, quarrying, foundries, sandblasting). Silicosis is becoming less common in industrialised nations due to the stringent controls on airborne dust and the use of protective devices.

General community (non-occupational) exposure to respirable crystalline silica is typically well below the national exposure standards and consequently is unlikely to present significant risks to public health. The World Health Organization's Concise International Chemical Assessment Document on Crystalline Silica, Quartz (**CICAD, 2000**) states that "*there are no known adverse health effects associated with the non-occupational exposure to quartz*".

3.3.2 Assessment Criteria

Occupational Goals

In Australia, the occupational exposure standards for respirable crystalline silica are defined by the National Occupational Health and Safety Commission (NOHSC). The national exposure standard for respirable crystalline silica is 100$\mu g/m^3$ (Time Weighted Average (TWA))[3]. Although the occupational standard is not applicable to the assessment of the ambient air quality, the risk of silicosis among people living in areas surrounding activities such as quarrying would generally be very small provided the concentration of respirable particles at the source was acceptable in terms of occupational safety.

Ambient Goals

NSW has not set any impact assessment criteria for crystalline silica. The Victorian EPA has adopted an ambient assessment criterion for mining and extractive industries of 3$\mu g/m^3$ (annual average as $PM_{2.5}$) (**VEPA, 2007**). This has been derived from the Reference Exposure Level (REL)[4] set by the California EPA Office of Environmental Health Hazard Assessment of 3 $\mu g/m^3$ (annual average as PM_4) (**OEHHA, 2005**).

[3] TWA - the average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week.

[4] RELs are used by the California Environmental Protection Agency as indicators of potential adverse health effects. A REL is a concentration level (g/m^3) or dose (mg/kg/day) at (or below) which no adverse health effects are anticipated for a specified time period. RELs are generally based on the most sensitive adverse health effect reported in the medical and toxicological literature. RELs are designed to protect the most sensitive individuals in the population by the inclusion of margins of safety.

US EPA Silicosis Potency Estimates

The **US EPA (1996)** examined the non-cancer epidemiological literature on crystalline silica induced diseases. From the extensive data available, which examined the medical histories of thousands of miners, they concluded that the cumulative risk of developing silicosis is zero for cumulative exposures of less than 1000$\mu g/m^3$.years.

Cumulative exposure is the average respirable crystalline silica concentration a person is exposed to over a period of time, multiplied by the number of years exposed. For example, an exposure of 1000$\mu g/m^3$.years, would be experienced by an individual exposed to 14.3 $\mu g/m^3$ per year for 70 years. For cumulative exposures less than 1000$\mu g/m^3$.years, the US EPA concludes that the risk of developing silicosis is zero.

The methodology defined by the US EPA has been applied to the predicted impacts at the nearby residences to determine the cumulative risk (see **Section 7.3**).

4 EXISTING ENVIRONMENT

This section describes the local setting of the Project Site including dispersion meteorology, local climatic conditions and existing dust levels in the area.

4.1 Topography

The Project Site lies within an elevated region, commonly referred to as the Somersby Plateau, which forms part of the dissected Hornsby Plateau. The landscape surrounding the Project Site is relatively flat to the east and north with elevations generally ranging between 200m AHD and 215m AHD. The landscape to the south and west of the Project Site consists of relatively steep sloping ridges and valleys falling to elevations of 10m AHD adjacent to Cabbage Tree Creek (see **Figure 3**).

On the Project Site, the topography of the existing Calga Sand Quarry has been altered by quarrying and related activities forming an east-west orientated valley with steep quarry walls and a quarry floor between 185m and 190m AHD.

The topography of the Southern Extension area of the Project Site is gently to moderately sloping to the southwest, with two gullies joining to form a valley through the centre of the area (roughly between Stages 4 and 5) which falls to 80m AHD on the western boundary. The northeastern corner of the Southern Extension area is generally flat to gently sloping with elevations from approximately 215m AHD to 250m AHD. A small rocky ridge forms the southwestern boundary of the Project Site. **Figure 3** shows a pseudo 3-dimensional plot of the Project Site and local topography.

4.2 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCMOD, requires information about the dispersion characteristics of the area. In particular, data are required on topography, wind speed, wind direction, atmospheric stability class[5] and mixing height[6].

[5] A 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.

Although wind speed and wind direction data are collected on-site, (see **Figure 1** for the location of the meteorological station), no parameters are collected to enable derivation of stability class and mixing height. Therefore, a set of site-specific, synthetic meteorological data for the Project Site was created using The Air Pollution Model (TAPM) developed by CSIRO. The local wind speed and wind direction were used in TAPM as an observation file.

TAPM is a prognostic model which includes synoptic information determined from the six hourly Limited Area Prediction System (LAPS) (**Puri et al., 1997**). The model is discussed further in the user manual which accompanies the model (see **Hurley, 2002**).

A summary of the data and parameters used as part of the meteorological component of this study are shown in **Table 4**.

Seasonal wind roses created from the Calga meteorology data and the TAPM data are presented in **Figure 4** and **Figure 5**, respectively. While there are some minor differences between the two sets of data, the TAPM data are considered to be representative of the wind patterns in the area.

Table 4
Meteorological Parameters used for this Study

TAPM (v 3.0)	
Number of grids (spacing)	4 (30km, 10km, 3km, 1km)
Number of grids point	25 x 25 x 25
Year of analysis	1st April 2006 to 31st March 2007
Centre of analysis	Calga Sand Quarry (33°24.5' S, 151°13' E)
Local observation file	Calga Sand Quarry meteorological station

On an annual basis, the most common winds for the area are from the west-southwest. This is also the predominant wind direction in winter and autumn. During summer, the predominant wind direction is from the east-northeast and in spring from the northwest. The mean annual wind speed at 10m above local ground level is 3.3m/s.

4.3 Atmospheric Stability

Table 5 presents a frequency of atmospheric stability classes at the site.

Table 5
Frequency of Atmospheric Stability Classes

Pasquill Gifford stability class	Frequency (%)
A	1.2
B	10.9
C	13.6
D	32.2
E	24.2
F	17.9
TOTAL	**100.0**

[6] 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.

Class A (which occur 1.2% of the time) relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions the dust plumes will spread rapidly. Class F (which occur 17.9% of the time) relates to stable conditions, such as occur at night-time 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.

Joint wind speed, wind direction and stability class frequency tables for Calga are presented in **Appendix A**.

4.4 Local Climatic Conditions

The closest Bureau of Meteorology site that collects climatic information is at Peats Ridge, approximately 10km northeast of the Project Site. The data are summarised in **Table 6**, which presents information on temperature, relative humidity, and rainfall (**Bureau of Meteorology, 2007**).

4.4.1 Temperature

On average, January is the warmest month with a mean daily maximum temperature of 26.9 ^{o}C and July the coolest with a mean daily maximum of 15.9 ^{o}C.

Table 6
Temperature, humidity and rainfall data for Peats Ridge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9:00am Mean Temperature (^{o}C) and Relative Humidity (%)													
Dry-bulb	21.0	20.5	19.0	17.3	14.2	11.3	10.5	12.1	15.2	17.8	18.4	20.2	16.5
Humidity	78	82	82	78	79	77	75	69	65	65	71	73	75
3:00pm Mean Temperature (^{o}C) and Relative Humidity (%)													
Dry-bulb	25.2	24.9	23.0	20.4	17.5	15.0	14.5	16.2	18.6	20.7	22.0	24.1	20.2
Humidity	64	66	67	66	67	66	60	56	54	58	61	63	62
Daily Maximum Temperature (^{o}C)													
Mean	26.9	26.5	24.5	22.2	19.1	16.4	15.9	17.6	20.4	22.9	24.0	26.0	21.9
Daily Minimum Temperature (^{o}C)													
Mean	14.7	14.8	13.0	10.0	7.5	4.8	3.5	3.8	6.0	8.6	11.1	13.2	9.2
Rainfall (mm) (22.7 years of record)													
Mean monthly rainfall - mm	118.3	156.2	145.2	123.9	101.9	96.0	66.6	85.5	72.1	94.0	105.8	90.6	1257.4
Raindays (Number)													
Mean no. of raindays	14.2	14.3	15.0	11.5	12.8	10.6	10.2	9.2	9.2	10.9	13.3	12.7	143.9
(Station number: 061351; Elevation: 280 m; Latitude: 33 deg 19 min; Longitude: 151 deg 15 min) Source: Bureau of Meteorology (2007).													

4.4.2 Relative Humidity

Relative humidity observed at 9:00am is lowest in September and October (65%) and highest in February and March (82%). For the 3:00pm observations, the lowest relative humidity occurs in September (54%) and the highest occurs in March and May (67%).

4.4.3 Rainfall

Mean annual rainfall is 1257.4 mm with the wettest month, on average, being February (monthly average 156.2 mm over an average of 14.3 days) and the driest is September (monthly average 72.1 mm over an average of 9.2 days).

4.5 Existing Air Quality

Air quality standards and goals refer to pollutant levels which include the quarry-related and existing sources. To fully assess impacts against all the relevant air quality standards and goals (detailed in **Section 3)** it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the Project is likely to contribute to these levels.

4.5.1 Dust Deposition

Since 2001, three dust deposition gauges (CD-1, CD-2a/2b, and CD-3), located in and around Stage 3 of the Calga Sand Quarry, have been monitoring deposited dust levels attributable to the Calga Sand Quarry and other local sources. An additional gauge (CD-4) was installed in October 2006, and a further two gauges (CD-5 and CD-6) were installed in December 2006. **Figure 1** shows the location of each of these gauges.

Monitoring data from these sites is presented in **Table 7**, for the period April 2001 to May 2007. No extraction or processing activities were taking place at the quarry for the period 31 December 2004 to January 2006.

Table 7
Summary of Dust Monitoring Results (g/m^2/month)

Page 1 of 3

Monitoring period[(a)]	Total Insoluble Solids						
	CD-1	CD-2a	CD-2b	CD-3	CD-4	CD-5	CD-6
01/04/01 to 04/05/01	0.4	0.2		0.7			
04/05/01 to 01/06/01	0.4	0.5		0.4			
01/06/01 to 24/06/01	1.4	0.3		0.6			
30/06/01 to 01/08/01	0.4	0.3		0.2			
01/08/01 to 11/09/01	0.9	0.3		0.6			
12/09/01 to 03/10/01	1.2	1.3		0.7			
04/10/01 to 06/11/01	1.2	0.4		0.5			
07/11/01 to 10/12/01	19.1*	0.7		0.4			
2001 average	**0.9**	**0.6**		**0.5**			

Table 7 (Cont'd)
Summary of Dust Monitoring Results (g/m^2/month)

Monitoring period[a]	Total Insoluble Solids						
	CD-1	CD-2a	CD-2b	CD-3	CD-4	CD-5	CD-6
11/12/01 to 09/01/02	1.3	1.8		0.5			
10/01/02 to 08/04/02	0.7	2.3		0.2			
08/04/02 to 01/05/02	0.7	0.5		1.6			
01/05/02 to 14/06/02	0.3	0.5		0.5			
14/06/02 to 01/08/02	0.3	0.7		0.3			
01/08/02 to 04/09/02	0.7	0.4		0.4			
04/09/02 to 01/10/02	1.1	2.0		1.7			
01/10/02 to 07/11/02	1.6	2.6		2.4			
07/11/02 to 03/12/02	0.5	4.1		1.6			
03/12/02 to 17/12/02	2.5	1.8		1.1			
2002 average	**0.9**	**1.7**		**1.1**			
17/12/02 to 11/02/03	1.5	1.4		1.4			
11/02/03 to 04/03/03	0.5	2.5		0.4			
04/03/03 to 08/04/03	0.5	5.5		0.6			
08/04/03 to 13/05/03	0.8	1.6		0.4			
13/05/03 to 03/06/03	0.3	1.6		0.1			
03/06/03 to 08/07/03	0.6	0.4		0.1			
08/07/03 to 08/08/03	0.4	0.4		0.2			
08/08/03 to 08/09/03	0.7	0.6		0.3			
08/09/03 to 16/10/03	0.6	0.4		4.4			
16/10/03 to 18/11/03	0.8	0.4		0.8			
2003 average	**0.7**	**1.5**		**0.9**			
18/11/03 to 12/01/04	0.9	1.0		2.5			
12/01/04 to 10/02/04	1.0	1.1		0.8			
10/02/04 to 16/03/04	0.9	0.8		0.4			
16/03/04 to 08/04/04	0.5	2.4		0.3			
08/04/04 to 01/06/04	1.2	1.2		0.5			
01/06/04 to 14/07/04	0.3	0.4		0.2			
14/07/04 to 31/07/04	1.5	1.1		0.3			
31/07/04 to 31/08/04	1.0	0.5		0.3			
31/08/04 to 30/09/04	1.4	0.8		0.4			
30/09/04 to 31/10/04	1.0	0.2		0.5			
31/10/04 to 30/11/04	1.5	0.7		0.5			
30/11/04 to 31/12/04	1.3	1.1		1.0			
2004 average	**1.0**	**0.9**		**0.6**			
31/12/05 to 02/02/05	1.3	1.1		0.8			
02/02/05 to 01/03/05	[b]	1.9		2.3			
01/03/05 to 08/02/06**	[b]	0.8		0.5			
2005 average	**1.3**	**1.3**		**1.2**			
09/02/06 to 02/03/06	[b]	1.6		0.5			
03/03/06 to 04/04/06	[b]	4.0		0.4			
04/04/06 to 1/05/06	[b]	4.3		0.5			
01/05/06 to 02/06/06	1.2[c]	6.9*		0.4			
02/06/06 to 03/07/06	1.2	5.0*		0.2			
03/07/06 to 02/08/06	0.7	*		1.1			
02/08/06 to 04/09/06	1.6		1.0	0.5			
04/09/06 to 03/10/06	0.9		0.3	0.9			
03/10/06 to 01/11/06	2.3		1.2	0.8	0.7		
01/11/06 to 01/12/06	3.3		1.1	1.7	1.6		
2006 average	**1.6**	**3.3**	**0.9**	**0.7**	**1.2**		

Table 7 (Cont'd)
Summary of Dust Monitoring Results (g/m^2/month)

Monitoring period[(a)]	Total Insoluble Solids						
	CD-1	**CD-2a**	**CD-2b**	**CD-3**	**CD-4**	**CD-5**	**CD-6**
03/01/07 to 02/02/07	0.8		0.9	0.6	519*	126*	9.3*
02/02/07 to 01/03/07	1.9		1.3	1.2	1.2	0.8	0.4
01/03/07 to 02/05/07	0.5		1.1	0.4	0.7	0.6	20.8*
02/05/07 to 01/06/07	0.9		0.6	0.4	0.8	1.6	3.0
01/06/07 to 02/07/07	1.0		1.6	0.4	0.2	0.2	0.1
02/07/07 to 02/08/07	1.0		1.5	0.6	0.8	0.5	1.0
02/08/07 to 04/09/07	1.3		1.8	0.9	0.9	0.6	0.9
04/09/07 to 03/10/07	0.6		0.9	0.5	3.3	1.0	0.9
03/10/07 to 01/11/07	2.1		4.8	1.3	1.6	1.4	1.4
01/11/07 to 03/12/07	2.6		2.5	1.1	0.9	0.9	1.2
3/12/07 to 02/01/08	0.4		1.2	1.4	1.1	1.0	1.4
2007 average	**1.4**		**1.6**	**0.9**	**1.2**	**1.0**	**1.3**
January 2008	1.4		0.4	0.5	0.6	2.9	0.4
February 2008	0.9		1	1.2	0.7	0.5	0.8
March 2008	0.9		2	0.5	0.4	0.3	0.4
April 2008	0.6		1.8	0.4	0.3	0.4	0.3
May 2008	0.6		0.5	0.3	1.2	0.2	0.5
June 2008	1.4		1.2	0.4	1.7	23.9*	1.1
July 2008	0.8		0.9	0.2	1.1	0.5	1.4
August 2008	0.7		2.2	0.3	0.4	0.2	3
September 2008	0.5		16.6*	0.6	0.5	0.4	2.3
2008 average (to September 2008)	**0.9**		**1.3**	**0.5**	**0.8**	**0.7**	**1.1**

Notes:
(a) Not all data complies with period of exposure specified in Australian Standard AS 3580.10.1 (1991)
* Sample contaminated. Levels are not included in annual average calculation

The data presented in **Table 7** shows that, on an annual average basis, dust deposition levels are generally very low with annual averages of 0.5g/m^2/month to 1.6g/m^2/month. There have been occasions when elevated levels have been measured, however, these samples have been demonstrated to be contaminated due to a variety of sources. Contamination can include bird droppings, vegetation (such as plant matter, algae, pollen or seeds), insects or some other interference to the gauges. The elevated levels recorded at CD-4, CD-5 and CD-6 in January 2007 are consistent with material being added to the gauges, ie. the levels are not due to normal dust deposition processes.

4.5.2 PM_{10} and Inferred TSP Concentrations

No PM_{10} or TSP data are collected on a continuous basis close to the Calga Sand Quarry. However, PM_{10} data were collected over a 2-week period from 16th May 2007 to 1st June 2007 by Carbon Based Environmental Pty Ltd at the residence inside the Australia Walkabout Park facility. The location of the DustTrak monitor used is shown on **Figure 1**. Due to the high density of trees within the park and around the residence it was not possible to meet the requirements of Australian Standard AS 2922 Ambient Air – Guide for Siting of Sampling Units. The monitoring location chosen was the best available with the highest probable impact from the quarry.

Data was collected every five minutes and averaged into daily 24-hour average concentrations for comparison against the NEPM PM_{10} goal. **Table 8** presents a summary of the monitoring results. The data collected show low levels of PM_{10} except on 17th May when the 24-hour average concentration measured was 64μg/m^3. This exceeds the NEPM goal of 50μg/m^3. It should be noted that the PM_{10} levels are from all sources, not just the Calga Sand Quarry. In addition, the NEPM standard for PM_{10} states that the goal should not be exceeded on more than five occasions over the period of a year.

Carbon Based Environmental Pty Ltd investigated the correlation of the wind data collected at the Calga Sand Quarry on the day of the exceedance and while there were a fair proportion of winds blowing from the Project site towards the Walkabout Park, the highest PM_{10} levels occurred when the wind was blowing from the southwest. The wind direction that would bring particulate matter from the quarry to the Walkabout Park is from the north and northwest. There were consistent 5-minute average levels above 30μg/m^3 from the north/northeast. Subsequent assessment of site activities on that day showed no unusual activity at the quarry site.

The dust deposition data collected at CD-4 (the closest to the Walkabout Park) for the period 2nd May to 1st June was measured to be 0.8g/m^2/month which is below the goal of 4g/m^2/month.

In February 2007, a High Volume Air Sampler (HVAS) was installed at a similar location to CD-1 and set to collect samples for a 24-hour period every three days, this is twice as often as the 6-day protocol defined by the DECC. The sampling program was designed to collect additional data over a short timeframe.

Table 8
DustTrak PM_{10} concentrations at Australia Walkabout Park (μg/m^3)

Date	PM_{10} 24-hour average concentration (μg/m^3)
16/5/07	24
17/05/07	64
18/05/07	10
19/05/07	1
20/05/07	3
21/05/07	3
22/05/07	4
23/05/07	2
24/05/07	3
25/05/07	7
26/05/07	19
27/05/07	21
28/05/07	15
29/05/07	12
30/05/07	5
31/05/07	10
01/06/07	9
Average	**12.5**

A HVAS was also installed at the Walkabout Park for a period of a month in August 2007. The data collected in August were collected according to the 6-day DECC protocol.

Table 9 presents a summary of the data collected. Notably, all the measured concentrations are below the NEPM goal of 50μg/m^3.

The closest continuous monitoring station that could be considered representative of the area is a DECC site located at Richmond. This site is located approximately 50km southwest of the Project Site.

Table 10 presents a summary of the maximum 24-hour average concentrations measured each month for the period April 2006 to March 2007. This monitoring period corresponds with the meteorological data collected at Calga.

Except for November and December 2006, all the data are below the DECC assessment criteria of 50μg/m^3. These exceedances are both attributable to bush fires in the Blue Mountains (**NSW DECC, 2007**).

Table 9
HVAS PM_{10} concentrations (μg/m^3)

Date	PM_{10} 24-hour average concentration (μg/m^3)
February 2007 – Location CD-1	
04/02/07	14
07/0207	15
10/02/07	12
13/02/07	10
16/02/07	13
19/02/07	20
22/02/07	17
25/02/07	12
28/02/07	13
Average	**14**
August 2007 – Walkabout Park	
03/08/07	1
09/08/07	1
15/08/07	4
21/08/07	5
27/08/07	8
Average	**3.8**

Table 10
PM_{10} concentrations at Richmond April 2006 to March 2007 (μg/m^3)

Month	Monthly maximum 24-hour average	Monthly average 24-hour average
Apr-06	26.3	18.4
May-06	31.8	16.0
Jun-06	23.3	12.6
Jul-06	18.8	10.4
Aug-06	23.7	15.7
Sep-06	38.5	16.2
Oct-06	31.7	20.9
Nov-06	63.1	25.0
Dec-06	60.7	23.4
Jan-07	43.0	22.3
Feb-07	29.5	15.8
Mar-07	22.3	15.4
	Annual average	**17.7**

When detailed local monitoring data are not available, it becomes difficult to quantify the existing air quality and to undertake a robust air quality assessment. In this study, only local dust deposition data are available. However, taking account of existing land use and consideration of the nearest monitoring sites where other data are collected, it has been assumed that the following background concentrations apply at the nearest residences.

- Annual average dust deposition is less than 2g/m^2/month.
- Annual average TSP of 20 to 30 μg/m^3.
- Annual average PM_{10} of 10 to 15 μg/m^3.

In addition, the DECC guideline requires an assessment against 24-hour PM_{10} concentrations. This assessment adopts the approach that the predicted 24-hour average PM_{10} concentration (background and increment attributable to the Project) should not exceed 50μg/m^3 at the nearest residences. **Section 7.4** presents an analysis of the probability that the 24-hour assessment criteria will be exceeded due to the Project.

5 ESTIMATED DUST EMISSIONS

Detailed emissions inventories have been prepared for four operating scenarios which are considered representative of the progressive development and operation of Stages 3, 4 and 5. The four scenarios considered are:

- Scenario 1: Stage 3/2 and W1 of Stage 4/1;
- Scenario 2: Part Stage 3/2, Stage 3/3 and Stage 4/3;
- Scenario 3: Stage 3/6, Stage 3/5, W4 of Stage 4/5 and S5 of Stage 4/5; and
- Scenario 4: Stage 5/3.

Emissions have been estimated using emission factor equations published in AP-42 (**US EPA, 1995b** and updates from the US EPA website) and from studies undertaken by the coal industry in the Hunter Valley and published in a report prepared for the National Energy Research and Development and Demonstration Council (**NERDDC, 1988**).

A summary of the activities and estimated dust emissions resultant from the Project are presented below in **Table 11**. These estimates assume an appropriate level of control of dust emissions is achievable through the use of watering carts on all unsealed areas of the active extraction area. Details of the calculations of the dust emissions are presented in **Appendix B**.

6 APPROACH TO ASSESSMENT

In August 2005, the DECC published guidelines for the assessment of air pollution sources using dispersion models (**NSW DEC, 2005**). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the Project. The approach taken in this assessment follows, as closely as possible, the approaches suggested by the guidelines.

Table 11
Estimated Dust Emissions from Four Scenarios of the Proposed Activities

ACTIVITY	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Stripping topsoil	1,120	1,120	1,120	560
Excavation of overburden	54	33	52	18
Loading overburden to trucks for haulage emplacement area	54	33	52	18
Hauling overburden to emplacement area	1,686	1,428	3,076	476
Emplacing overburden at emplacement area	54	29	52	18
Dozer ripping sand	23,646	23,646	23,646	11,823
Excavation of sand	94	264	378	378
Dumping sand to stockpiles	94	264	378	378
Loading sand to trucks for haulage to processor plants	94	264	378	378
Hauling sand to processing plants	6,657	17,600	27,143	91,429
Dumping sand to crushing plants	94	264	378	378
Dumping sand to dry processing plants	19	53	76	76
Dumping sand to wet processing plants	76	211	302	302
Crushing sand	964	2,700	3,857	3,857
Dry Screening	893	2,500	3,571	3,571
Wet Screening	-	-	-	-
Product stacking from conveyor	117	326	466	466
Loading product to road trucks	117	326	466	466
FEL working on stockpiles	923	923	923	923
Transporting product off-site by road	1,333	9,053	10,667	10,667
Wind erosion from exposed areas (extraction and overburden areas)	18,922	37,493	55,714	14,016
Wind erosion from product stockpiles - all	1,752	10,162	15,067	15,067
Total	**58,762**	**108,693**	**147,760**	**155,262**

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

The model used was the US EPA ISCST3 model. The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995a**). The modelling has been based on the use of three particle-size categories (0μm to 2.5μm - referred to as FP, 2.5μm to 10μm - referred to as CM (coarse matter) and 10μm to 30μm - referred to as the Rest). Emission rates of TSP have been calculated using emission factors developed both within NSW and by the US EPA (see **Appendix B**).

The distribution of particles has been derived from measurements published by the SPCC **(SPCC, 1986)**. The distribution of particles in each particle size range is as follows.

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

Modelling was done 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. The predicted concentration 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 or quarrying 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 quarry 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 then the model has the potential to significantly overstate impacts.

Extraction operations were represented by a series of volume sources positioned according to the location of activities for each of the modelled scenarios. **Figure 6** to **Figure 9** show the numbered locations that represent dust sources assumed in the modelling.

All activities have been modelled only during the hours 6:00am to 9:00pm, except for wind erosion type activities which have been modelled for 24 hours per day. **Appendix B** provides a summary of dust emissions, hours of emission and allocation of sources for each activity.

The ISC model has a tendency to overestimate short-term (24-hour) PM_{10} concentrations (see for example **Holmes Air Sciences, 2002 and 2006**). To overcome this difficulty, the ISC model 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 minute)$^{0.2}$. The modification improves the performance of the model in predicting 24-hour concentrations and makes 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 0.3m compared with 0.03m for the original curves. The adjustment leads to an increase in the horizontal and vertical curves by a factor of (0.3m/0.03m)$^{0.2}$, namely 1.6.

7 ASSESSMENT OF IMPACTS

7.1 Introduction

Dispersion model simulations were completed for Scenarios 1 to 4, identified in Section 5 and illustrated on **Figures 6** to **9**. This section provides an interpretation of the predicted dust concentrations and deposition levels produced by these simulations. The model runs were undertaken using the meteorological data described in **Section 4.2** and the emissions data described in **Section 5**. Receptors were positioned across a grid 3.6km by 4.5km in size with the Project Site in the approximate centre. Additional receptors were positioned at the closest residences as shown in **Figure 1**. It should be noted that Residence 1 is owned by the landowner of Lot 2, DP 229889 (on which Stage 3 of the Calga Sand Quarry is located), is project-related and will be removed as Stage 3 of the Project progresses. Therefore, the assessment of the impacts is based on the non-Project related residences (Residences 2 to 23).

Dust concentrations and deposition rates due to the Project have been presented as isopleth diagrams showing the following.

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

The maximum 24-hour average contour plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that occurred at each location over the year regardless of when it occurs. The maxima are used to show concentrations which can possibly be reached under the modelled conditions.

7.2 Assessment of Predicted Dust Impacts Attributable to the Project

Table 12 to **Table 15** summarise the model predictions at each of the residential receptors for the four scenarios modelled.

Table 12
Predicted PM_{10} and TSP concentrations and deposition levels for Scenario 1

Page 1 of 2

	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust deposition (g/m^2/month)
	24-hour average	Annual average	Annual average	Annual average
	Impact assessment criteria			
Residence ID	***50***	***30***	***90***	***2***
1	6	1	2	0.3
2	4	0	1	0.2
3	4	0	1	0.1
4	3	0	1	0.1
5	3	0	1	0.1
6	3	0	0	0.1
7	2	0	0	0.1
8	3	1	1	0.1
9	3	1	1	0.1

Table 12 (Cont'd)
Predicted PM_{10} and TSP concentrations and deposition levels for Scenario 1

	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust deposition (g/m^2/month)
	24-hour average	Annual average	Annual average	Annual average
	Impact assessment criteria			
Residence ID	***50***	***30***	***90***	***2***
10	3	0	1	0.1
11	3	0	0	0.1
12	2	0	0	0.0
13	3	0	0	0.1
14	3	0	0	0.1
15	2	0	0	0.0
16	2	0	0	0.0
17	2	0	0	0.0
18	3	0	0	0.0
19	3	0	0	0.0
20	3	1	1	0.1
21	3	0	1	0.1
22	3	0	0	0.1
23	2	0	0	0.0

Table 13
Predicted PM_{10} and TSP concentrations and deposition levels for Scenario 2

	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust deposition (g/m^2/month)
	24-hour average	Annual average	Annual average	Annual average
	Impact assessment criteria			
Residence ID	***50***	***30***	***90***	***2***
1	7	1	2	0.4
2	7	1	1	0.2
3	6	1	1	0.2
4	5	0	1	0.1
5	6	0	1	0.1
6	4	0	1	0.1
7	3	0	0	0.1
8	9	1	2	0.4
9	9	1	2	0.5
10	5	0	1	0.1
11	5	0	1	0.1
12	3	0	0	0.0
13	5	0	1	0.1
14	6	0	1	0.1
15	5	0	1	0.1
16	3	0	0	0.0
17	4	0	0	0.0
18	5	0	0	0.1
19	5	0	0	0.1
20	10	1	2	0.4
21	8	1	2	0.3
22	6	1	1	0.2
23	4	0	1	0.1

Table 14
Predicted PM_{10} and TSP concentrations and deposition levels for Scenario 3

	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust deposition (g/m^2/month)
	24-hour average	Annual average	Annual average	Annual average
	Impact assessment criteria			
Residence ID	***50***	***30***	***90***	***2***
1	11	2	3	0.5
2	9	1	2	0.3
3	7	1	1	0.2
4	6	1	1	0.2
5	8	1	1	0.2
6	5	0	1	0.1
7	4	0	1	0.1
8	9	2	3	0.5
9	10	2	3	0.6
10	6	1	1	0.2
11	8	1	1	0.1
12	4	0	0	0.1
13	9	1	1	0.2
14	8	1	1	0.2
15	7	1	1	0.2
16	5	0	0	0.1
17	6	0	0	0.0
18	7	0	1	0.1
19	7	1	1	0.1
20	9	2	3	0.5
21	8	1	2	0.4
22	6	1	1	0.3
23	5	1	1	0.1

Table 15
Predicted PM_{10} and TSP concentrations and deposition levels for Scenario 4

	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust deposition (g/m^2/month)
	24-hour average	Annual average	Annual average	Annual average
	Impact assessment criteria			
Residence ID	***50***	***30***	***90***	***2***
1	11	1	2	0.3
2	9	1	1	0.2
3	10	1	1	0.1
4	6	1	1	0.1
5	9	1	1	0.1
6	6	0	1	0.1
7	5	0	1	0.1
8	15	2	3	0.5
9	17	3	4	0.7
10	8	1	1	0.1
11	8	0	1	0.1
12	5	0	0	0.0
13	22	2.9	4	0.7
14	15	2	3	0.5
15	11	1	2	0.3
16	5	0	0	0.0
17	5	0	0	0.0
18	6	0	0	0.0
19	7	0	1	0.1
20	17	3	4	0.7
21	15	2	3	0.5
22	13	2	2	0.3
23	10	1	1	0.1

24-hour Average PM_{10}

Figure 10 (Scenario 1), **Figure 11** (Scenario 2), **Figure 12** (Scenario 3) and **Figure 13** (Scenario 4) show the maximum predicted 24-hour average PM_{10} concentrations. It can be seen that predicted maximum 24-hour PM_{10} concentrations at the most affected non-project related residence (Residence 13) is 22$\mu g/m^3$ due to the operations during Scenario 4. This is below the NSW DECC goal of 50$\mu g/m^3$ for 24-hour average PM_{10} concentrations.

Annual Average PM_{10}

Annual average PM_{10} concentrations are shown in **Figure 14** (Scenario 1), **Figure 15** (Scenario 2) **Figure 16** (Scenario 3) and **Figure 17** (Scenario 4). The most affected non-project related residence (Residence 13) is predicted to experience annual average PM_{10} concentrations of 2.9$\mu g/m^3$ due to the operations during Scenario 4. Assuming that the existing annual average PM_{10} concentration for the area is 15$\mu g/m^3$ (see **Section 4.5**) the maximum resultant annual average PM_{10} concentration is 17.9$\mu g/m^3$. This is below the NSW DECC goal of 30$\mu g/m^3$.

Annual Average TSP

Annual average TSP concentrations at the nearest residences are shown in **Figure 18** (Scenario 1), **Figure 19** (Scenario 2), **Figure 20** (Scenario 3) and **Figure 21** (Scenario 4). The maximum predicted concentration at the non-project related residences is 4$\mu g/m^3$ (Residence 13, Scenario 4). It is unlikely that the 90 $\mu g/m^3$ NHMRC goal would be exceeded due to the existing operations even with existing annual average TSP concentrations.

Dust Deposition

Figure 22 (Scenario 1), **Figure 23** (Scenario 2), **Figure 24** (Scenario 3) and **Figure 25** (Scenario 4) show the predicted dust deposition levels. Dust deposition levels at the nearest residences are predicted to be less than 1.0g/m^2/month. Compliance with the NSW DECC goal of 4g/m^2/month would be anticipated with the existing dust deposition of 2g/m^2/month.

7.3 Assessment of Predicted Crystalline Silica Impacts Attributable to the Project

7.3.1 Silica Generation of the Calga Sand Quarry Operations

In order to compare the predicted concentrations of crystalline silica in the ambient air due to the project with the relevant assessment criteria, it was necessary to know the crystalline silica content of the dust emissions from the Calga Sand Quarry operations.

Getex were commissioned to take dust samples at the Calga Sand Quarry in April 2008 to determine both the maximum crystalline silica content (from ripping of the sandstone) and the crystalline silica content of the dust emissions from activities that do not involve ripping.

Ripping of the sandstone (using dozers) from its in-situ position is likely to produce dust emissions with the highest percentage of crystalline silica in the relevant size range. Samples of dust were taken at three locations outside a dozer while ripping competent sandstone in the lower parts of the quarry. The average crystalline silica content of the PM_{10} dust sampled was 90%.

Dust generated by the hauling of material is considered representative of the crystalline silica content of all sand on the haul roads and sand not subject to ripping. Samples of dust were taken at three locations outside a haul truck as it travelled along a haul route. The average crystalline silica content of this dust was 6%.

7.3.2 Comparison with California REL

The measurements taken at the Calga Sand Quarry were made in accordance with Australian Standard AS 2985-2004: Workplace atmospheres – Method for sampling and gravimetric determination of respirable dust. This standard measures PM_7 while the dispersion model predictions are for concentrations of PM_{10}. The California EPA REL applies to PM_4 and therefore the predicted impacts of PM_{10} concentrations need to be adjusted to PM_4 concentrations before they can be compared with the standard. In our analysis we have assumed that the crystalline silica fraction of PM_7 is the same for PM_{10} and PM_4.

Therefore, it has been assumed that 90% of PM_{10} emissions from sand ripping is crystalline silica and that 6% of PM_{10} emissions from the remainder of the dust generating activities is crystalline silica.

Based on data published by the SPCC (**SPCC, 1986**), the PM_{10}/TSP ratio is 0.391. Using this proportion and the predicted total dust emissions of **Table 11**, the predicted PM_{10} emissions for each scenario have been calculated and are as presented in **Table 16**.

Table 16
Summary of predicted PM_{10} emissions from excavation and all other sources (kg/y)

Source	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Ripping	9246	9246	9246	4623
All other sources	13730	33253	48528	56085
Total	22976	42499	57774	60708

The average crystalline silica in the dust emissions from the project will be given by:

$$\text{Average crystalline silica in } PM_{10} \text{ emissions} = \frac{(PM_{10\ \text{excavation}} * 0.9) + (PM_{10\ \text{all other activities}} * 0.06)}{\text{Total } PM_{10} \text{ emissions}} = 0.24$$

As noted above, in order to compare the predicted impacts with the Californian EPA REL it is necessary to estimate the PM_4 concentrations of crystalline silica arising from the Project.

The ratio of PM_4/PM_{10} is 0.3 (**SPCC, 1986**), therefore, the predicted annual average PM_{10} concentrations have been converted to annual average PM_4 concentrations by multiplying by the ratio of PM_4/PM_{10}, ie. 0.3. The crystalline silica content has then been estimated by multiplying by the average crystalline silica in the PM_{10} emissions ie. 0.24).

At the most affected residence the predicted annual average PM_{10} concentration was 2.9μg/m^3. Therefore, the estimated annual average respirable (PM_4) concentration of crystalline silica was 0.21μg/m^3 [2.9μg/m^3 * 0.3 * 0.24]. This is approximately 14 times lower than the Californian REL of 3μg/m^3.

7.3.3 Consideration of the US EPA Risk Estimate

As exposure to crystalline silica is primarily an occupational health hazard, very little monitoring has been conducted to measure ambient concentrations.

Data collected in Victoria estimated the background concentration to be 0.7μg/m^3 (**Toxikos, 2005**). This is comparable to the ambient level in a Californian rural area of 0.6μg/m^3 (**OEHHA, 2005**). In the absence of any local data, it has been assumed the background level of 0.7μg/m^3 as measured in Victoria applies to the Project Site. The cumulative risk related to the exposure of crystalline silica is therefore as presented below.

Existing background respirable crystalline silica	=	0.7μg/m^3
Increase in respirable crystalline silica at most affected receptor	=	0.21μg/m^3
Total annual respirable crystalline silica	=	0.91μg/m^3

Based on the assumption that the project has a proposed life of 30 years, the respirable crystalline silica exposure during the operation of the quarry is 0.91μg/m^3 x 30 years = 27.3μg/m^3.years.

If an individual were to live for the remaining 40 years of their assumed 70 year lifetime in the same area, the exposure to respirable crystalline silica would be 0.7μg/m^3 x 40 years = 28.0μg/m^3.years.

The total lifetime exposure from background concentrations and the proposed Project would be 27.3μg/m^3.years + 28.0μg/m^3.years = 55.3.μg/m^3.years.

As discussed above, the US EPA concluded that the cumulative risk of developing silicosis is zero for cumulative exposures of less than 1000μg/m^3.years. The estimated total lifetime cumulative exposure for the proposed Project is approximately 18 times lower than this.

7.4 Assessment of Cumulative 24-hour Average PM_{10} Impact

7.4.1 Introduction

In assessing air quality impacts, it is necessary to add the contribution attributable to the Project to the existing background. For 24-hour PM_{10} concentrations, the likely existing concentrations are determined from monitoring data. In this case the existing background data has been assumed to be equivalent to the data collected at the DECC Richmond site. This is the closest site with representative air quality data.

The approach taken in this assessment has been to calculate for each of the scenarios modelled, the probability that a given background concentration might occur with the maximum predicted 24-hour average concentration at the worst-affected residential receptor and cause an exceedance or add to an existing exceedance.

7.4.2 Scenario 1 (Stage 3/2 and W1 of Stage 4/1)

For Scenario 1 (based on the proposed operation of Stage 3/2 and W1 of Stage 4/1), the highest predicted 24-hour PM_{10} concentration at the residential receptors is 4.1 $\mu g/m^3$ at Residence 3.

Firstly, it should be noted that the background data set provides two (out of 365) 24-hour monitored PM_{10} concentrations that exceed the 50$\mu g/m^3$ criterion. Thus, the probability that the criterion is exceeded without the presence of emissions from the Project is 0.55% (2 in 365).

Next, it is useful to examine the monitored concentrations and estimate the probability that a day with a given background might occur with particular contribution from the Project that would cause an exceedance or add to an exceedance. The analysis is shown in **Table 17**.

Table 17
Scenario 1 - Calculation of Probability that Quarry Emissions will cause Exceedances of 24-hour PM_{10} Assessment Criterion (at Residence 3)

Rank of prediction	Predicted concentration at most affected residence ($\mu g/m^3$)	50$\mu g/m^3$ minus value of prediction ($\mu g/m^3$)	Probability of predicted value occurring (ie. 1/365)	Probability of background exceeding 50$\mu g/m^3$ minus value of prediction	Probability of exceeding 50$\mu g/m^3$ 24-hour average (product of columns 4 and 5)
1	4.0	46.0	0.00274	0.00822	0.000023
2	3.9	46.1	0.00274	0.00822	0.000023
3	3.2	46.8	0.00274	0.00822	0.000023
4	3.1	46.9	0.00274	0.00822	0.000023
5	3.0	47.0	0.00274	0.00822	0.000023
6	2.9	47.1	0.00274	0.00822	0.000023
7	2.9	47.1	0.00274	0.00822	0.000023
8	2.7	47.3	0.00274	0.00822	0.000023
9	2.7	47.3	0.00274	0.00822	0.000023
10	2.7	47.3	0.00274	0.00822	0.000023
11	2.4	47.6	0.00274	0.00822	0.000023
12	2.4	47.6	0.00274	0.00822	0.000023
13	2.3	47.7	0.00274	0.00822	0.000023
14	2.3	47.7	0.00274	0.00822	0.000023
15	2.3	47.7	0.00274	0.00822	0.000023
16	2.3	47.7	0.00274	0.00822	0.000023
17	2.3	47.7	0.00274	0.00822	0.000023
18-368	<2.3	>47.7	0.95342	0.00822	0.007836
				Total	**0.008219**

Table 17 examines the 365 predicted 24-hour average concentrations at the most affected residential receptor (Residence 3) and determines the probability that the background level could be such that the predicted concentration plus the background would cause an exceedance.

Assuming that the background concentration is the same as it was in the monitoring year, the table shows that considering the operation of Scenario 1 over a year, there is a 0.82% chance that there will be an exceedance of the 24-hour PM_{10} assessment criterion of 50$\mu g/m^3$ on any given day.

However, there already is a 0.55% (2/365) chance that on any given day a 24-hour PM_{10} concentration above 50$\mu g/m^3$ would be experienced, even without the contribution of the Project, so the increase in probability of an exceedance due to the quarry emissions is 0.27%. That is, we could expect approximately one extra day of exceedance per year at the most affected residential receptor. This is considered an insignificant change in air quality.

7.4.3 Scenario 2 (part Stage 3/2, Stage 3/3 and Stage 4/3)

For Scenario 2 (based on the proposed operations of part Stage 3/2, Stage 3/3 and Stage 4/3), the highest predicted 24-hour PM_{10} concentration at the residential receptors is 9.4$\mu g/m^3$ at Receptor 20.

Table 18 shows the results for Scenario 2, following the same analysis used in **Section 7.4.2**.

Table 18 examines the 365 predicted 24-hour average concentrations at the most affected residential receptor (Residence 3) and determines the probability that the background level could be such that the predicted concentration plus the background would cause an exceedance.

The table shows that considering the operation of Scenario 2 over a year, there is a 0.83% chance that there will be an exceedance of the 24-hour PM_{10} assessment criterion of 50$\mu g/m^3$ on any given day. However, there already is a 0.55% (2/365) chance that on any given day a 24-hour PM_{10} concentration above 50$\mu g/m^3$ would be experienced even without the contribution of the Project, so the increase in probability of an exceedance due to the quarry emissions is 0.28%. That is, we could expect 1.05 extra days of exceedance per year at the most affected residential receptor. As before, this is considered an insignificant change in air quality.

7.4.4 Scenario 3 (Stage 3/6, Stage 3/5, W4 of Stage 4/5 and S5 of Stage 4/5)

For Scenario 3 (based on the proposed operations of Stage 4/7 and Stage 5/1), the highest predicted 24-hour PM_{10} concentration at the residential receptors is 9.3$\mu g/m^3$ at Residence 9.

Table 19 shows the results for Scenario 3, following the same analysis used in **Section 7.4.2**

Table 19 examines the 365 predicted 24-hour average concentrations at the most affected residential receptor (Residence 9) and determines the probability that the background level could be such that the predicted concentration plus the background would cause an exceedance.

Table 18
Scenario 2 - Calculation of Probability that Quarry Emissions will cause Exceedances of 24-hour PM_{10} Assessment Criterion (at Residence 3)

Rank of prediction	Predicted concentration at most affected residence ($\mu g/m^3$)	$50\mu g/m^3$ minus value of prediction ($\mu g/m^3$)	Probability of predicted value occurring (ie. 1/365)	Probability of background exceeding $50\mu g/m^3$ minus value of prediction	Probability of exceeding $50\mu g/m^3$ 24-hour average (product of columns 4 and 5)
1	9.4	40.6	0.00274	0.01644	0.000045
2	7.8	42.2	0.00274	0.01370	0.000038
3	7.2	42.8	0.00274	0.01370	0.000038
4	7.0	43.0	0.00274	0.01096	0.000030
5-6	6.7	43.3	0.00548	0.01096	0.000060
7	6.5	43.5	0.00274	0.01096	0.000030
8-9	6.0	44.0	0.00548	0.01096	0.000060
10	5.9	44.1	0.00274	0.01096	0.000030
11-12	5.7	44.3	0.00548	0.01096	0.000060
13	5.6	44.4	0.00274	0.01096	0.000030
14-15	5.5	44.5	0.00548	0.00822	0.000045
16	5.4	44.6	0.00274	0.00822	0.000023
17-18	5.1	44.9	0.00548	0.00822	0.000045
19-20	5.0	45.0	0.00548	0.00822	0.000045
21	4.9	45.1	0.00274	0.00822	0.000023
22	4.8	45.2	0.00274	0.00822	0.000023
23-24	4.7	45.3	0.00548	0.00822	0.000045
25	4.6	45.4	0.00274	0.00822	0.000023
26-28	4.4	45.6	0.00822	0.00822	0.000068
29-31	4.3	45.7	0.00822	0.00822	0.000068
32	4.2	45.8	0.00274	0.00822	0.000023
33-35	4.1	45.9	0.00822	0.00822	0.000068
36-38	4.0	46.0	0.00822	0.00822	0.000068
39	3.9	46.1	0.00274	0.00822	0.000023
40-41	3.8	46.2	0.00548	0.00822	0.000045
42	3.7	46.3	0.00274	0.00822	0.000023
43	3.6	46.4	0.00274	0.00822	0.000023
44-47	3.5	46.5	0.01096	0.00822	0.000090
48	3.4	46.6	0.00274	0.00822	0.000023
49-51	3.3	46.7	0.00822	0.00822	0.000068
52-56	3.2	46.8	0.01370	0.00822	0.000113
57	3.1	46.9	0.00274	0.00822	0.000023
58-60	3.0	47.0	0.00822	0.00822	0.000068
61-64	2.9	47.1	0.01096	0.00822	0.000090
65-69	2.8	47.2	0.01370	0.00822	0.000113
70-76	2.7	47.3	0.01918	0.00822	0.000158
77-82	2.6	47.4	0.01644	0.00822	0.000135
83-86	2.5	47.5	0.01096	0.00822	0.000090
87-88	2.4	47.6	0.00548	0.00822	0.000045
89-92	2.3	47.7	0.01096	0.00822	0.000090
93-365	<2.3	>47.7	0.74795	0.00822	0.006147
				Total	**0.008347**

Table 19
Scenario 3 - Calculation of Probability that Quarry Emissions will cause Exceedances of 24-hour PM_{10} Assessment Criterion (at Residence 9)

Rank of prediction	Predicted concentration at most affected residence ($\mu g/m^3$)	$50\mu g/m^3$ minus value of prediction ($\mu g/m^3$)	Probability of predicted value occurring (ie. 1/365)	Probability of background exceeding $50\mu g/m^3$ minus value of prediction	Probability of exceeding $50\mu g/m^3$ 24-hour average (product of columns 4 and 5)
1	9.3	40.7	0.00274	0.01644	0.000045
2	9.1	40.9	0.00274	0.01644	0.000045
3	9.0	41.0	0.00274	0.01644	0.000045
4	8.8	41.2	0.00274	0.01644	0.000045
5	8.7	41.3	0.00274	0.01644	0.000045
6	8.5	41.5	0.00274	0.01644	0.000045
7	7.6	42.4	0.00274	0.01370	0.000038
8	7.2	42.8	0.00274	0.01370	0.000038
9-10	6.9	43.1	0.00548	0.01096	0.000060
11-12	6.7	43.3	0.00548	0.01096	0.000060
13-15	6.1	43.9	0.00822	0.01096	0.000090
16	6.0	44.0	0.00274	0.01096	0.000030
17-18	5.9	44.1	0.00548	0.01096	0.000060
19	5.8	44.2	0.00274	0.01096	0.000030
20	5.7	44.3	0.00274	0.01096	0.000030
21-24	5.6	44.4	0.01096	0.01096	0.000120
25	5.4	44.6	0.00274	0.00822	0.000023
26-27	5.3	44.7	0.00548	0.00822	0.000045
28	5.2	44.8	0.00274	0.00822	0.000023
29-30	5.1	44.9	0.00548	0.00822	0.000045
31-33	5.0	45.0	0.00822	0.00822	0.000068
34	4.7	45.3	0.00274	0.00822	0.000023
35-37	4.6	45.4	0.00822	0.00822	0.000068
38-41	4.5	45.5	0.01096	0.00822	0.000090
42-45	4.4	45.6	0.01096	0.00822	0.000090
46	4.3	45.7	0.00274	0.00822	0.000023
47-49	4.2	45.8	0.00822	0.00822	0.000068
50-54	4.1	45.9	0.01370	0.00822	0.000113
55-56	4.0	46.0	0.00548	0.00822	0.000045
57-60	3.9	46.1	0.01096	0.00822	0.000090
61-64	3.8	46.2	0.01096	0.00822	0.000090
65-71	3.7	46.3	0.01918	0.00822	0.000158
72-76	3.6	46.4	0.01370	0.00822	0.000113
77-80	3.5	46.5	0.01096	0.00822	0.000090
81-86	3.4	46.6	0.01644	0.00822	0.000135
87	3.3	46.7	0.00274	0.00822	0.000023
88-93	3.2	46.8	0.01644	0.00822	0.000135
94-98	3.1	46.9	0.01370	0.00822	0.000113
99-101	3.0	47.0	0.00822	0.00822	0.000068
102-106	2.9	47.1	0.01370	0.00822	0.000113
107-110	2.8	47.2	0.01096	0.00822	0.000090
111-116	2.7	47.3	0.01644	0.00822	0.000135
117-118	2.6	47.4	0.00548	0.00822	0.000045
119-122	2.5	47.5	0.01096	0.00822	0.000090
123-130	2.4	47.6	0.02192	0.00822	0.000180
131-132	2.3	47.7	0.00548	0.00822	0.000045
133-365	<2.3	>47.7	0.63836	0.00822	0.005247
				Total	**0.008504**

The table shows that considering the operation of Scenario 3 over a year, there is a 0.85% chance that there will be an exceedance of the 24-hour PM_{10} assessment criterion of 50μg/m^3 on any given day. However, there already is a 0.55% (2/365) chance that on any given day a 24-hour PM_{10} concentration above 50μg/m^3 would be experienced, even without the contribution of the Project, so the increase in probability of an exceedance due to the quarry emissions is 0.30%. That is, we could expect 1.1 extra days of exceedance per year at the most affected residential receptor. As before, this is considered an insignificant change in air quality.

7.4.5 Scenario 4 (Stage 5/3)

For Scenario 4 (based on the proposed operations of Stage 5/3), the highest predicted 24-hour PM_{10} concentration at the residential receptors is 9.3μg/m^3 at Residence 3.

Table 20 shows the results for Scenario 4, following the same analysis used in **Section 7.4.2**.

Table 20 examines the 365 predicted 24-hour average concentrations at the most affected residential receptor (Residence 3) and determines the probability that the background level could be such that the predicted concentration plus the background would cause an exceedance.

The table shows that considering the operation of Stage 5 over a year, there is a 0.86% chance that there will be an exceedance of the 24-hour PM_{10} assessment criterion of 50μg/m^3 on any given day. However, there already is a 0.55% (2/365) chance that on any given day a 24-hour PM_{10} concentration above 50μg/m^3 would be experienced, even without the contribution of the Project, so the increase in probability of an exceedance due to the quarry emissions is 0.31%. That is, we could expect 1.1 extra days of exceedance per year at the most affected residential receptor. This is considered an insignificant change in air quality.

8 MITIGATION AND MONITORING

8.1 Introduction

The modelling results presented above are based on the assumption that the Proponent applies the control measures discussed in Section 8.2 to minimise dust emissions. This section outlines procedures proposed for the management and control of dust emissions.

8.2 Proposed dust management and control procedures

The following procedures are proposed for the management of dust emissions from the project. The aim of these procedures is to minimise the emission of dust and the effects of these are included in the model simulations. Dust can be generated from two primary sources, these being:

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

Table 20
Scenario 4 - Calculation of Probability that Quarry Emissions will cause Exceedances of 24-hour PM_{10} Assessment Criterion (at Residence 13)

Rank of prediction	Predicted concentration at most affected residence ($\mu g/m^3$)	$50\mu g/m^3$ minus value of prediction ($\mu g/m^3$)	Probability of predicted value occurring (ie. 1/365)	Probability of background exceeding $50\mu g/m^3$ minus value of prediction	Probability of exceeding $50\mu g/m^3$ 24-hour average (product of columns 4 and 5)
1	9.3	40.7	0.00274	0.01644	0.000045
2	9.1	40.9	0.00274	0.01644	0.000045
3	9.0	41.0	0.00274	0.01644	0.000045
4	8.8	41.2	0.00274	0.01644	0.000045
5	8.7	41.3	0.00274	0.01644	0.000045
6	8.5	41.5	0.00274	0.01644	0.000045
7	7.6	42.4	0.00274	0.01370	0.000038
8	7.2	42.8	0.00274	0.01370	0.000038
9-10	6.9	43.1	0.00548	0.01370	0.000075
11-12	6.7	43.3	0.00548	0.01370	0.000075
13-15	6.1	43.9	0.00822	0.01370	0.000113
16	6.0	44.0	0.00274	0.01370	0.000038
17-18	5.9	44.1	0.00548	0.01370	0.000075
19	5.8	44.2	0.00274	0.01370	0.000038
20	5.7	44.3	0.00274	0.01370	0.000038
21-24	5.6	44.4	0.01096	0.01370	0.000150
25	5.4	44.6	0.00274	0.00822	0.000023
26-27	5.3	44.7	0.00548	0.00822	0.000045
28	5.2	44.8	0.00274	0.00822	0.000023
29-30	5.1	44.9	0.00548	0.00822	0.000045
31-33	5.0	45.0	0.00822	0.00822	0.000068
34	4.7	45.3	0.00274	0.00822	0.000023
35-37	4.6	45.4	0.00822	0.00822	0.000068
38-41	4.5	45.5	0.01096	0.00822	0.000090
42-45	4.4	45.6	0.01096	0.00822	0.000090
46	4.3	45.7	0.00274	0.00822	0.000023
47-49	4.2	45.8	0.00822	0.00822	0.000068
50-54	4.1	45.9	0.01370	0.00822	0.000113
55-56	4.0	46.0	0.00548	0.00822	0.000045
57-60	3.9	46.1	0.01096	0.00822	0.000090
61-64	3.8	46.2	0.01096	0.00822	0.000090
65-71	3.7	46.3	0.01918	0.00822	0.000158
72-76	3.6	46.4	0.01370	0.00822	0.000113
77-80	3.5	46.5	0.01096	0.00822	0.000090
81-86	3.4	46.6	0.01644	0.00822	0.000135
87	3.3	46.7	0.00274	0.00822	0.000023
88-93	3.2	46.8	0.01644	0.00822	0.000135
94-98	3.1	46.9	0.01370	0.00822	0.000113
99-101	3.0	47.0	0.00822	0.00822	0.000068
102-106	2.9	47.1	0.01370	0.00822	0.000113
107-110	2.8	47.2	0.01096	0.00822	0.000090
111-116	2.7	47.3	0.01644	0.00822	0.000135
117-118	2.6	47.4	0.00548	0.00822	0.000045
119-122	2.5	47.5	0.01096	0.00822	0.000090
123-130	2.4	47.6	0.02192	0.00822	0.000180
131-132	2.3	47.7	0.00548	0.00822	0.000045
133-365	<2.3	>47.7	0.63836	0.00822	0.005247
				Total	**0.008625**

Table 21 and **Table 22** list the different sources of wind-blown and quarry-generated dust respectively, and the proposed controls.

Table 21
Control Procedures for Wind-blown Dust

Source	Control Procedures
Areas disturbed by quarrying	Disturb only the minimum area necessary for quarrying. Reshape, topsoil and rehabilitate completed overburden emplacement areas as soon as practicable after the completion of overburden tipping.
Stockpiles	Maintain stockpiles in a moist condition using water carts to minimise wind-blown and traffic-generated dust.

Table 22
Quarry-generated Dust and Controls

Source	Control procedures
Haul Road Dust	All roads and trafficked areas will be watered as required using water trucks to minimise the generation of dust. All haul roads will have edges clearly defined with marker posts or equivalent to control their locations. Obsolete roads will be ripped and re-vegetated.
Topsoil Stripping	Access tracks used by topsoil stripping equipment during their loading and unloading cycle will be watered.
Topsoil Stockpiling	Long term topsoil stockpiles, not used for over 3 months will be re-vegetated.

8.3 Monitoring

It is envisaged that the monitoring program necessary to verify environmental performance will incorporate the following.

- One meteorological station.
- The current network of deposition gauges, or as otherwise approved by the DECC, would be used to monitor dust fallout.

9 CONCLUSIONS

The Project has been assessed to identify potential impacts due to emissions of dust as a result of the proposed Calga Sand Quarry Southern Extension.

Four scenarios were modelled to represent the progressive development and operation of the existing approved and proposed stages of the Calga Sand Quarry. Predictions were made at the nearby residences of the concentrations of PM_{10} (24-hour and annual average), TSP (annual average), and dust deposition (annual average).

The annual average concentrations of PM_{10}, TSP and deposition rates from emissions associated with the quarry are shown to comply with the NSW DECC's assessment criteria.

There is a possibility that maximum 24-hour average PM_{10} concentrations could exceed the assessment criterion under unusual conditions, for example, when the background level is already high due to the presence of bushfire smoke. However, these events would be rare and the contribution that the Project would make to 24-hour PM_{10} concentrations would be very small.

An assessment of the crystalline silica impacts has shown that all predicted impacts are below the assessment criteria.

10 REFERENCES

Arya S P (1999)
"Air Pollution Meteorology and Dispersion" Published by Oxford University Press (Page 202 and 208)

Bureau of Meteorology (2007)
Climatic Averages Australia, Bureau of Meteorology website
http://www.bom.gov.au/climate/averages/

CICAD (2000)
"Concise International Chemical Assessment Document 24. Crystalline Silica, Quartz" Published by the World Health Organization, Geneva, 2000.

Hanna S. R., Briggs G. A., Deardorff J. C., Egan B. A., Gifford F. A. and Pasquill F. (1977)
"AMS Workshop on Stability Classification Schemes and Sigma Curves - Summary of Recommendations" concerning the adjustment of sigma-curves" Bulletin American Meteorological Society, Volume 58, Number 12, 1305-1309.

Holmes Air Sciences (2002)
"Air Quality Assessment: Warkworth Mine", Prepared by Holmes Air Sciences, Suite 2B, 14 Glen Street, Eastwood, NSW 2122.

Holmes Air Sciences (2006)
"Meteorological and Dust Data Summary and Analysis: Mt Arthur Coal Monitoring Data for 2005". Prepared for Mt Arthur Coal Pty Ltd, April 2006.

Hurley, P J (2002)
"The Air Pollution Model (TAPM) Version 2 : User Manual", CSIRO Research Internal Paper No. 25, April 2002

NEPC (1998)
"National Environmental Protection Measure and Impact Statement for Ambient Air Quality". National Environment Protection Council Service Corporation, Level 5, 81 Flinders Street, Adelaide SA 5000.

NEPC (2003)
"Variation to the National Environment Protection (Ambient Quality) Measure for Particles as $PM_{2.5}$", May 2003.

NERDDC (1988)
"Air pollution from surface coal mining: Volume 2 Emission factors and model refinement", National Energy Research and Demonstration Council, Project 921.

NSW DEC, 2005
"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW", August 2005

NSW DECC (2007)
"National Environmental Protection Measure; New South Wales Annual Compliance Report", Prepared July 2007, Department of Environment Climate Change, NSW

OEHHA (2005)

"Adoption of Chronic Reference Exposure Levels for Silica", prepared by the Office of Environmental Health Hazard Assessment. Website address: http://www.oehha.org/air/chronic_rels/silica_final.html

Puri, K., Dietachmayer, G. S., Mills, G. A., Davidson, N. E., Bowen, R. A., and Logan, L. W. (1997)

"The BMRC Limited Area Prediction System, LAPS". Aust. Met. Mag., 47, 203-223.

SPCC (1983)

"Air Pollution from Coal Mining and Related Developments", Published by NSW State Pollution Control Commission (now EPA)

SPCC (1986)

"Particle size distributions in dust from open cut coal mines in the Hunter Valley", Report Number 10636-002-71, Prepared for the State Pollution Control by Dames & Moore, 41 Mclaren Street, North Sydney, NSW 2060.

Toxicos (2005)

"Health Risk Assessment of Crystalline Silica from Alex Fraser's proposed Recycling/Transfer Station of Construction Waste, Clarinda", Prepared by Toxicos Pty Ltd, February 2005, TR080105-RF.

US EPA (1985 and updates)

'Compilation of Air Pollutant Emission Factors', AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711. Note this reference is now a web-based document.

US EPA (1995a)

"User's Guide for the Industrial Source Complex (ISC3) Dispersion Models - Volume 1 User's Instructions" US Environmental Protection Agency, Office of Air Quality Planning and Standards Emissions, Monitoring and Analysis Division, Research Triangle Park, North Carolina 27711.

US EPA (1995b)

"Compilation of Air Pollutant Emission Factors", AP-42, Fifth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

US EPA (1996)

"Ambient Levels and Noncancer Health Effects of Inhaled Crysalline and Amorphous Silica", Prepared by the United States Environmental Protection Agency, Office of Research and Development, Washington, DC 20460, EPA/600/R-95/115, November 1996.

VEPA (2007)

"Protocol for Environmental Management: Mining and Extractive Industries", Prepared by the Victorian EPA, December 2007.

This page has intentionally been left blank

FIGURES

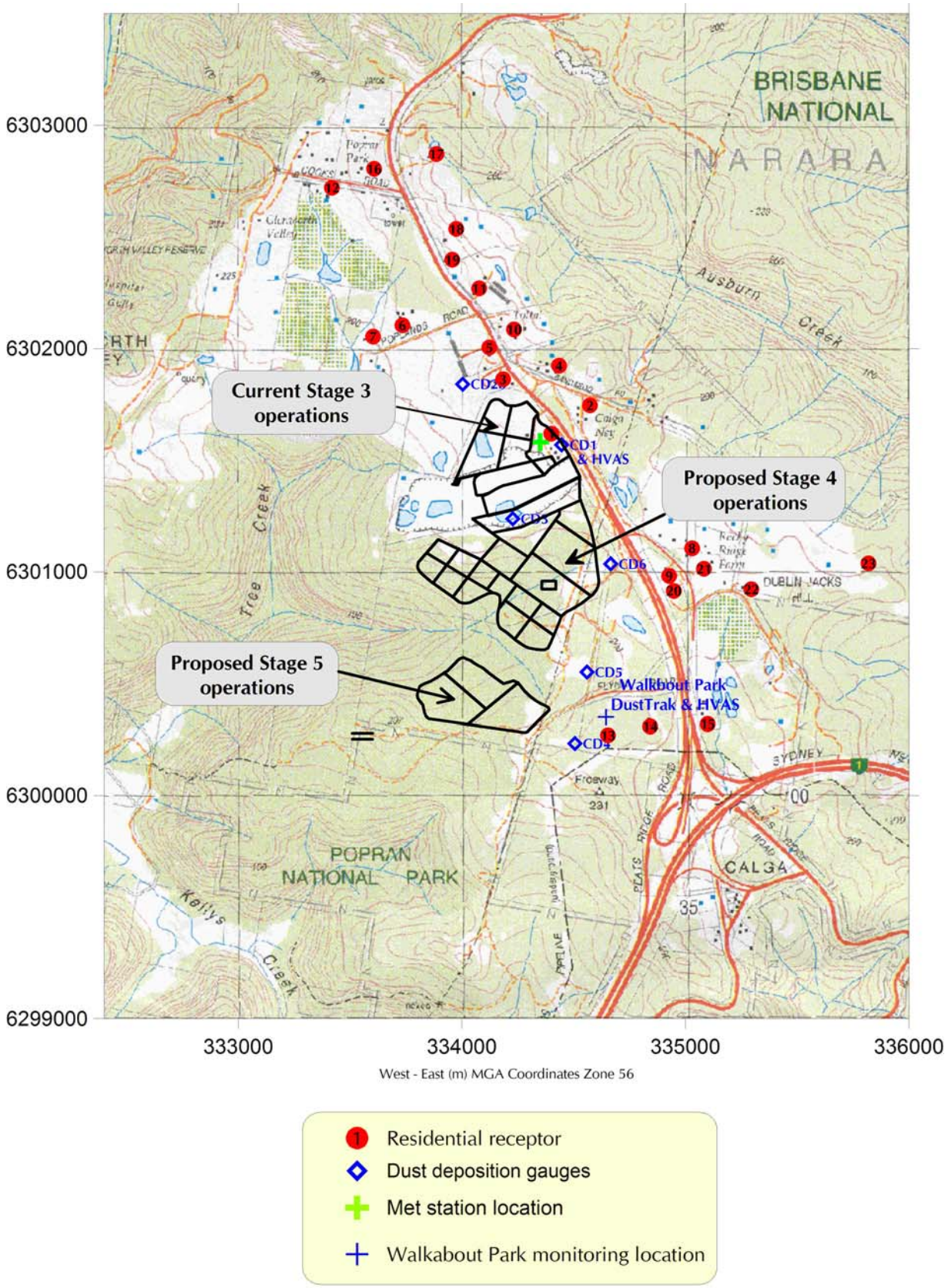


Figure 1: Site location and location of meteorological station, dust monitors and residential receptors

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

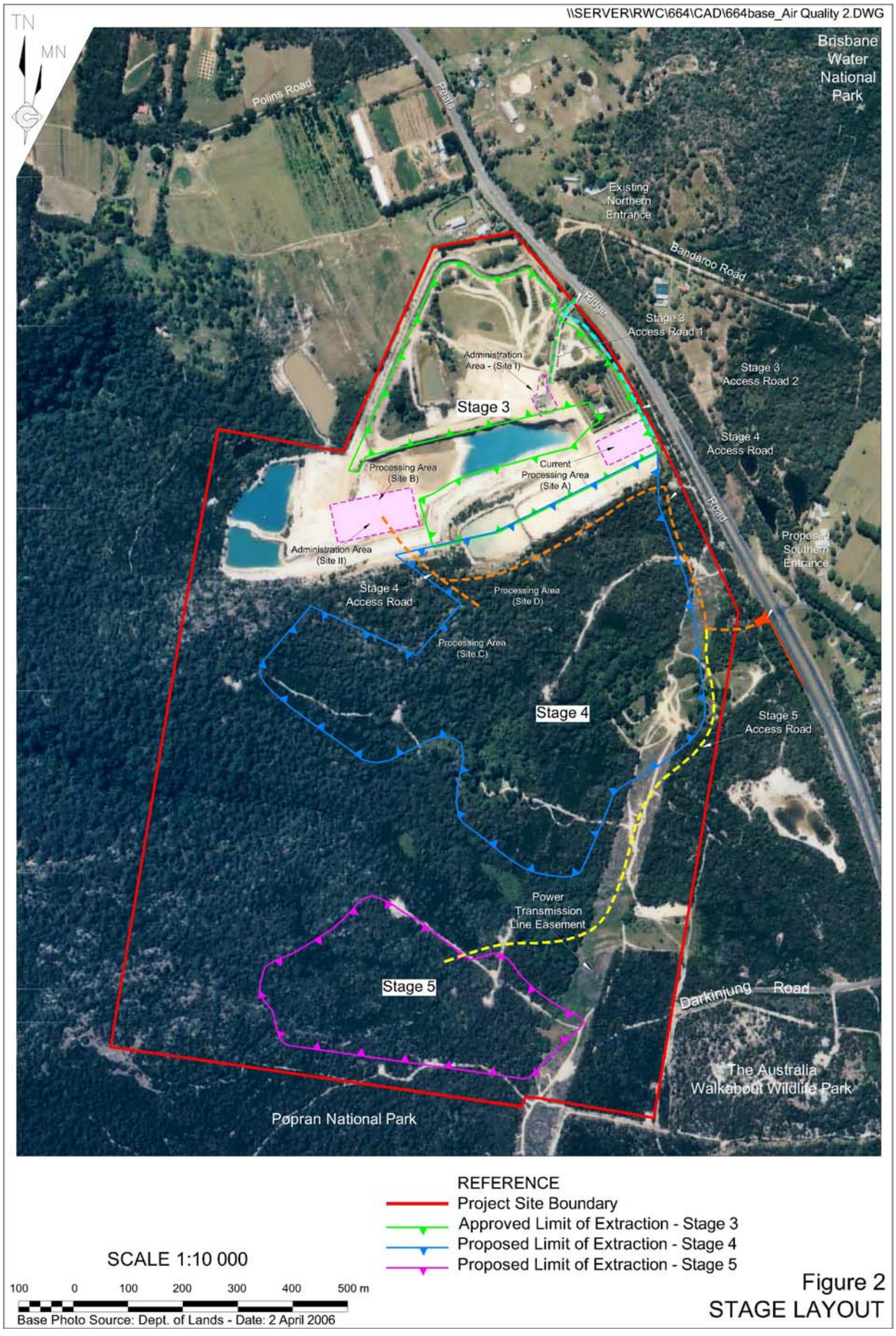


Figure 2
STAGE LAYOUT

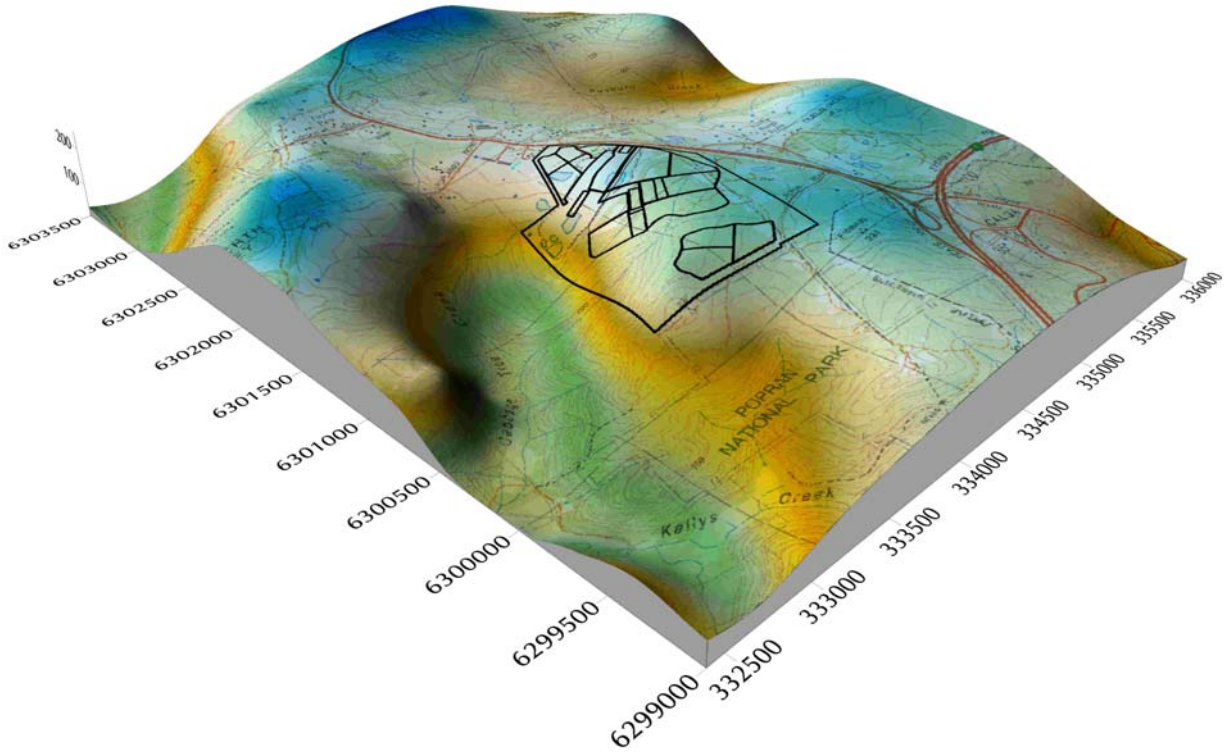


Figure 3: Pseudo 3D-plot of area with Project site boundary and proposed southern extension

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

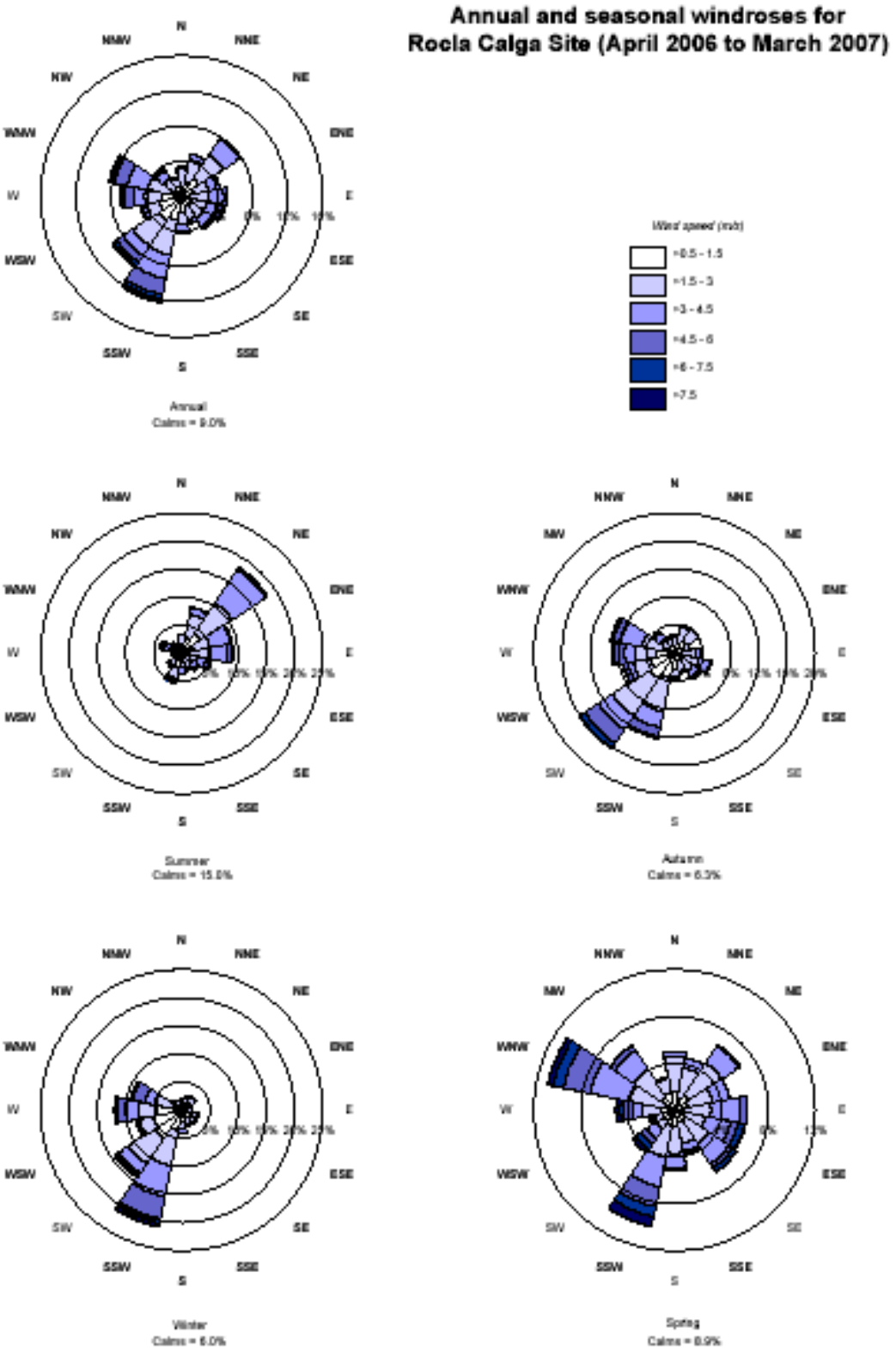


Figure 4: Annual and seasonal windroses for Calga – April 2006 to March 2007

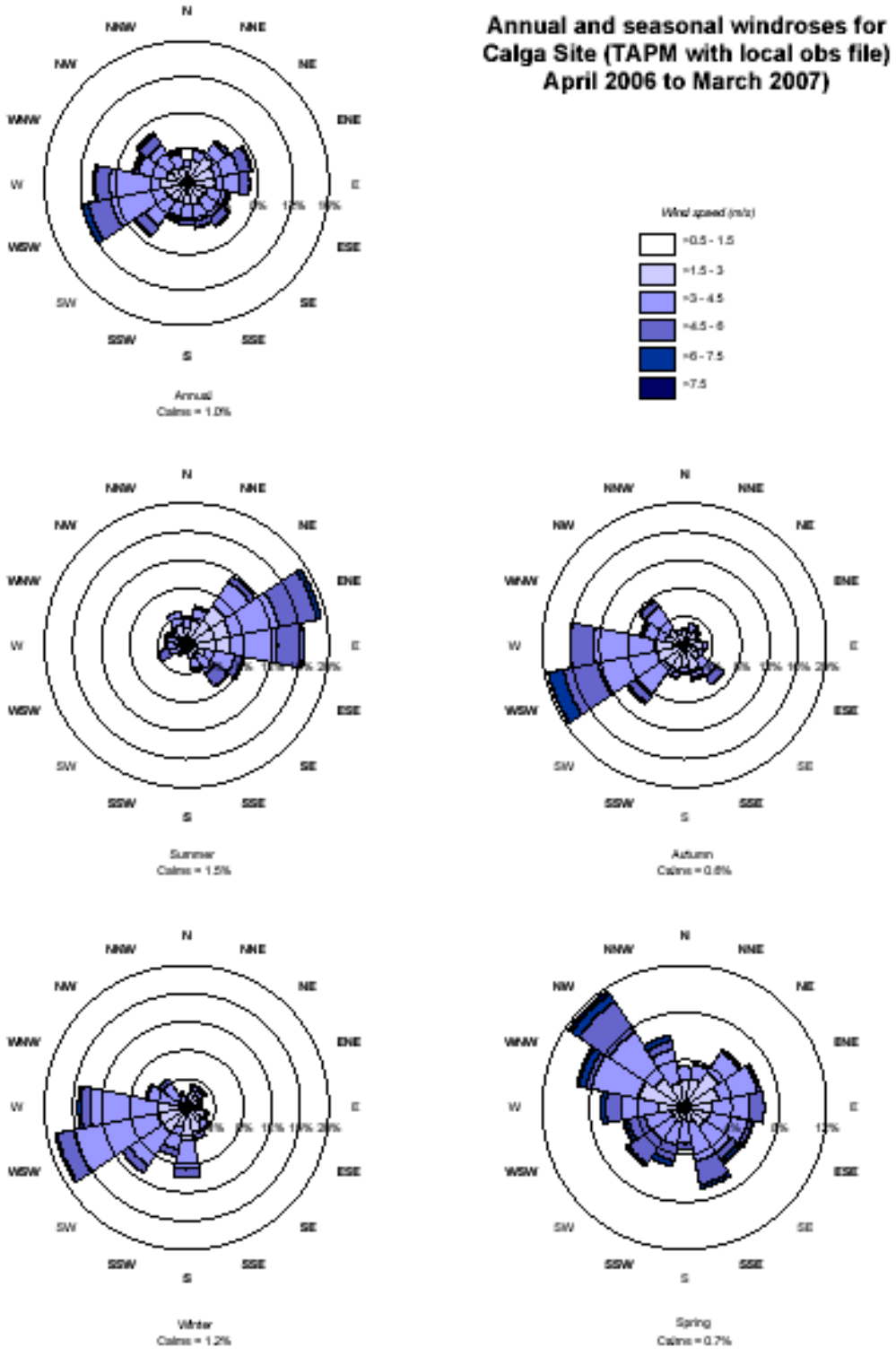


Figure 5: Annual and seasonal windroses for Calga (TAPM with local obs file) – April 2006 to March 2007

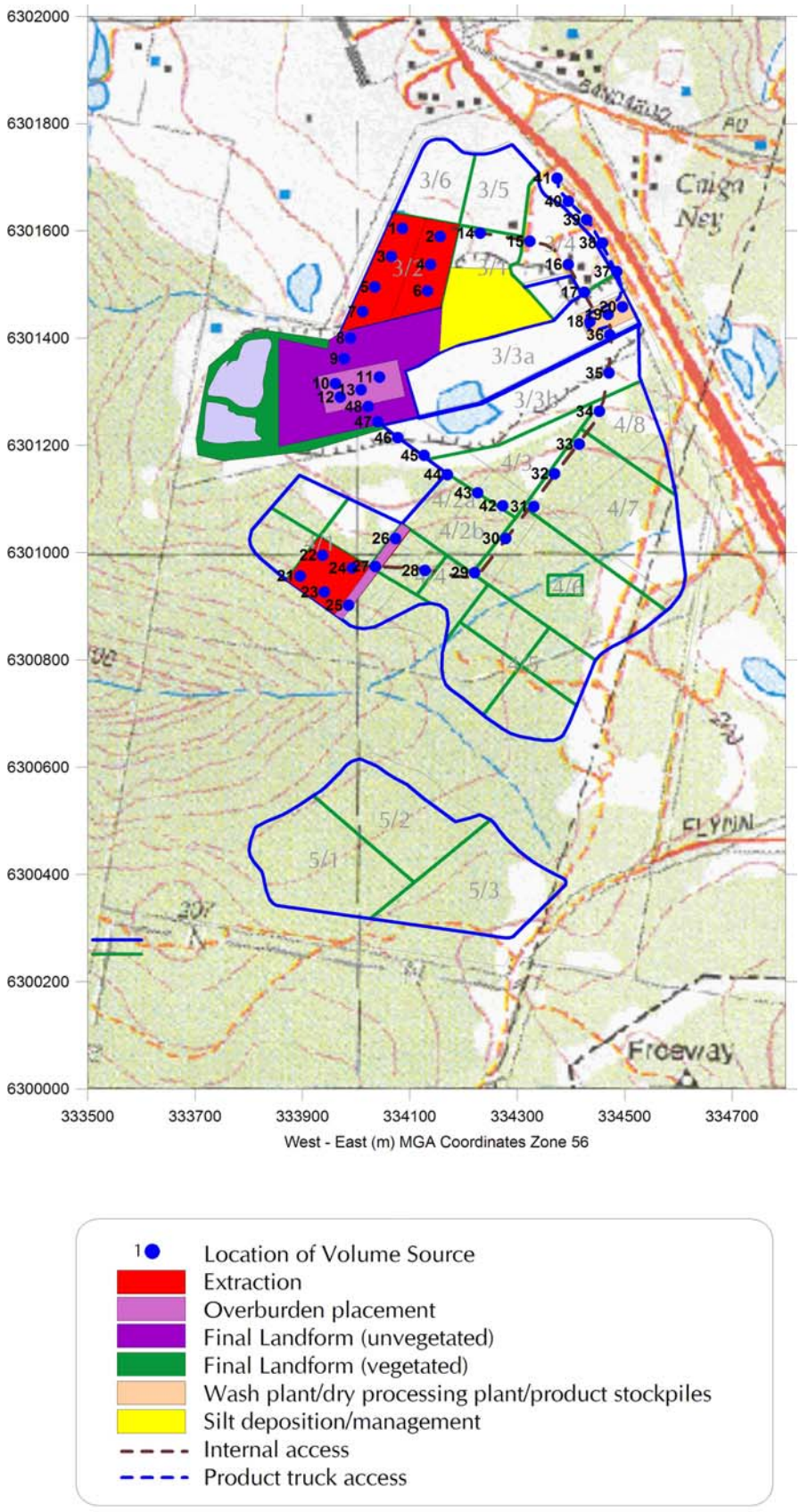


Figure 6: Location of volume sources for Scenario 1

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

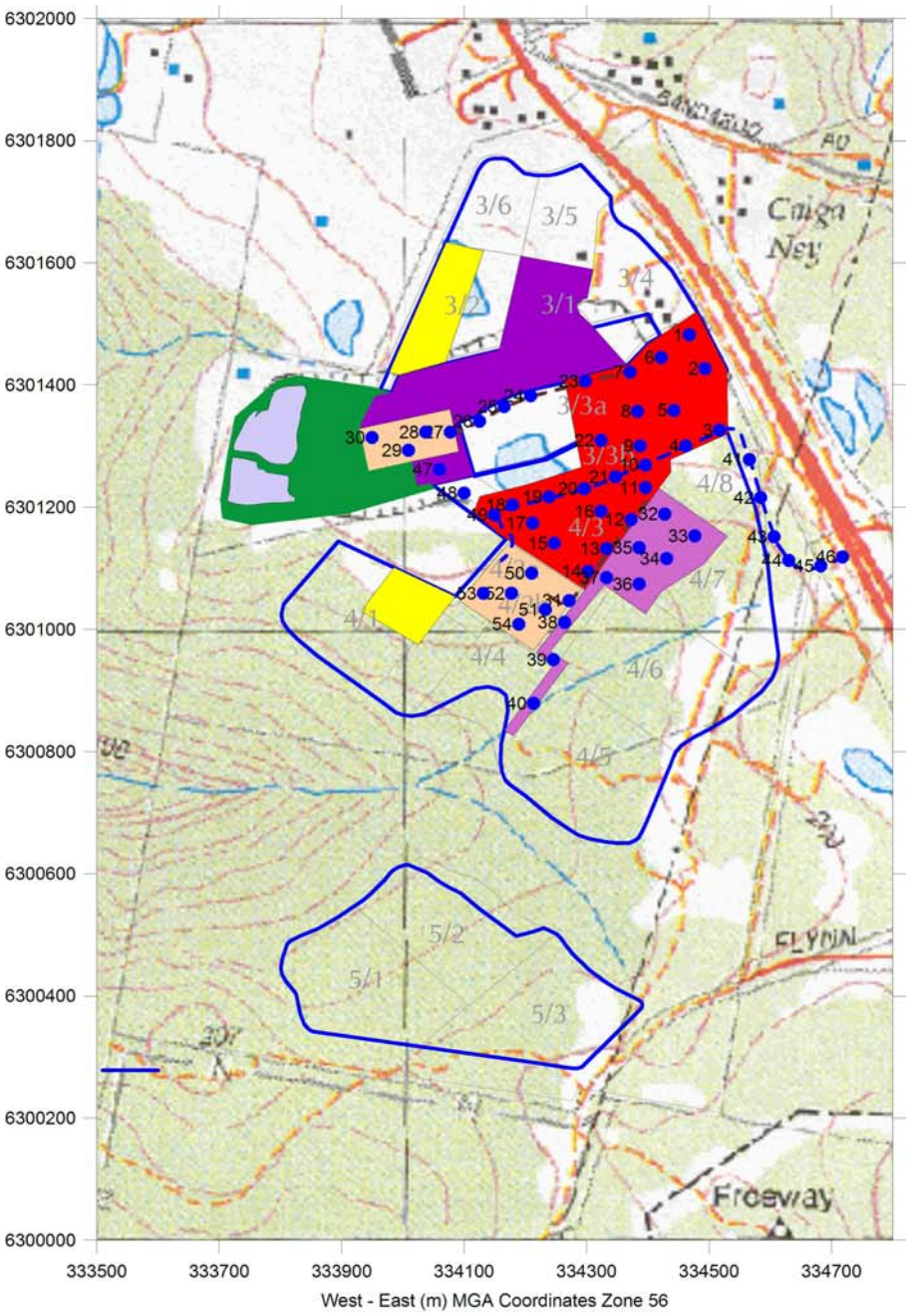


Figure 7: Location of volume sources for Scenario 2

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

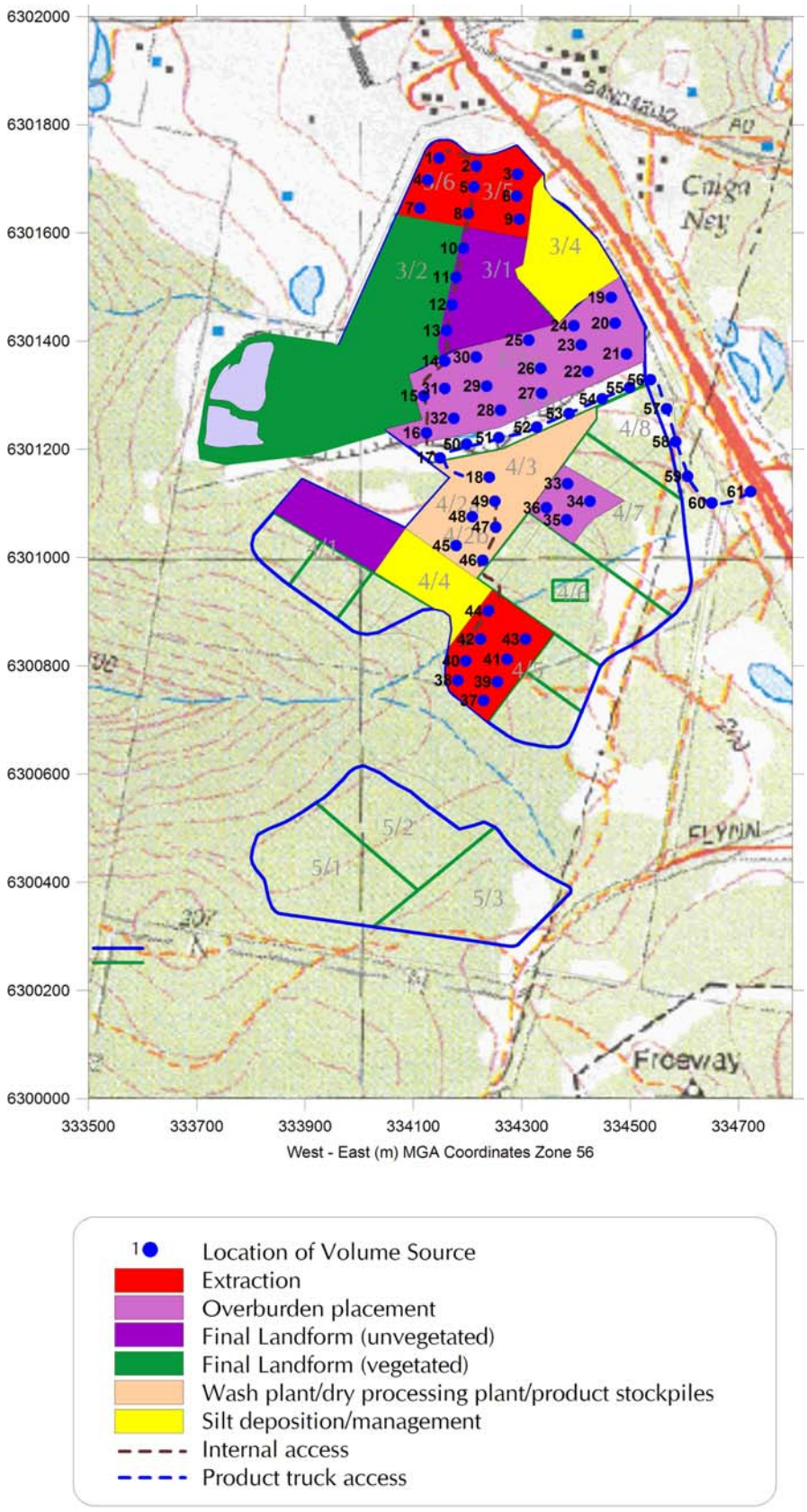


Figure 8: Location of volume sources for Scenario 3

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

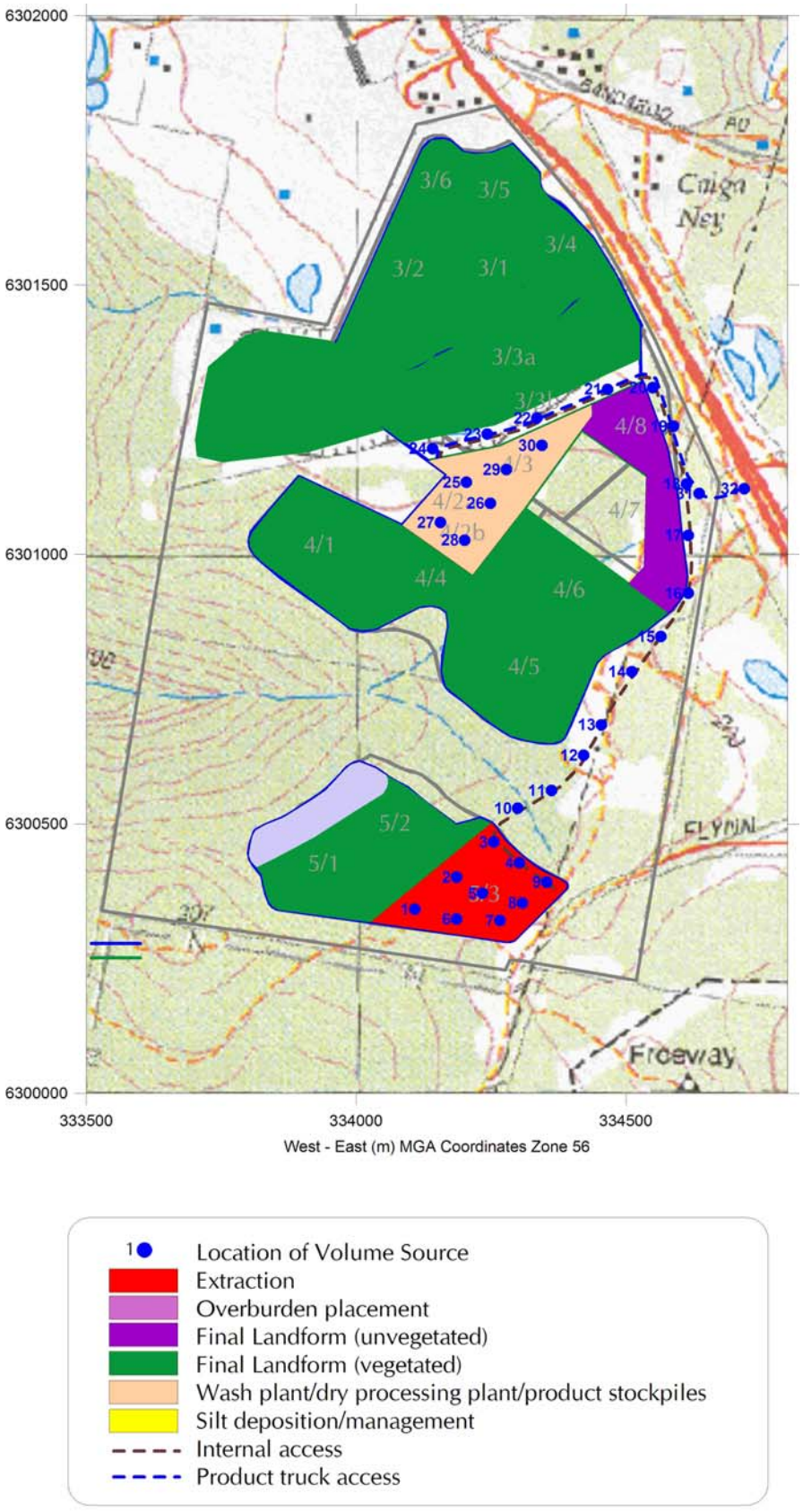


Figure 9: Location of volume sources for Scenario 4

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

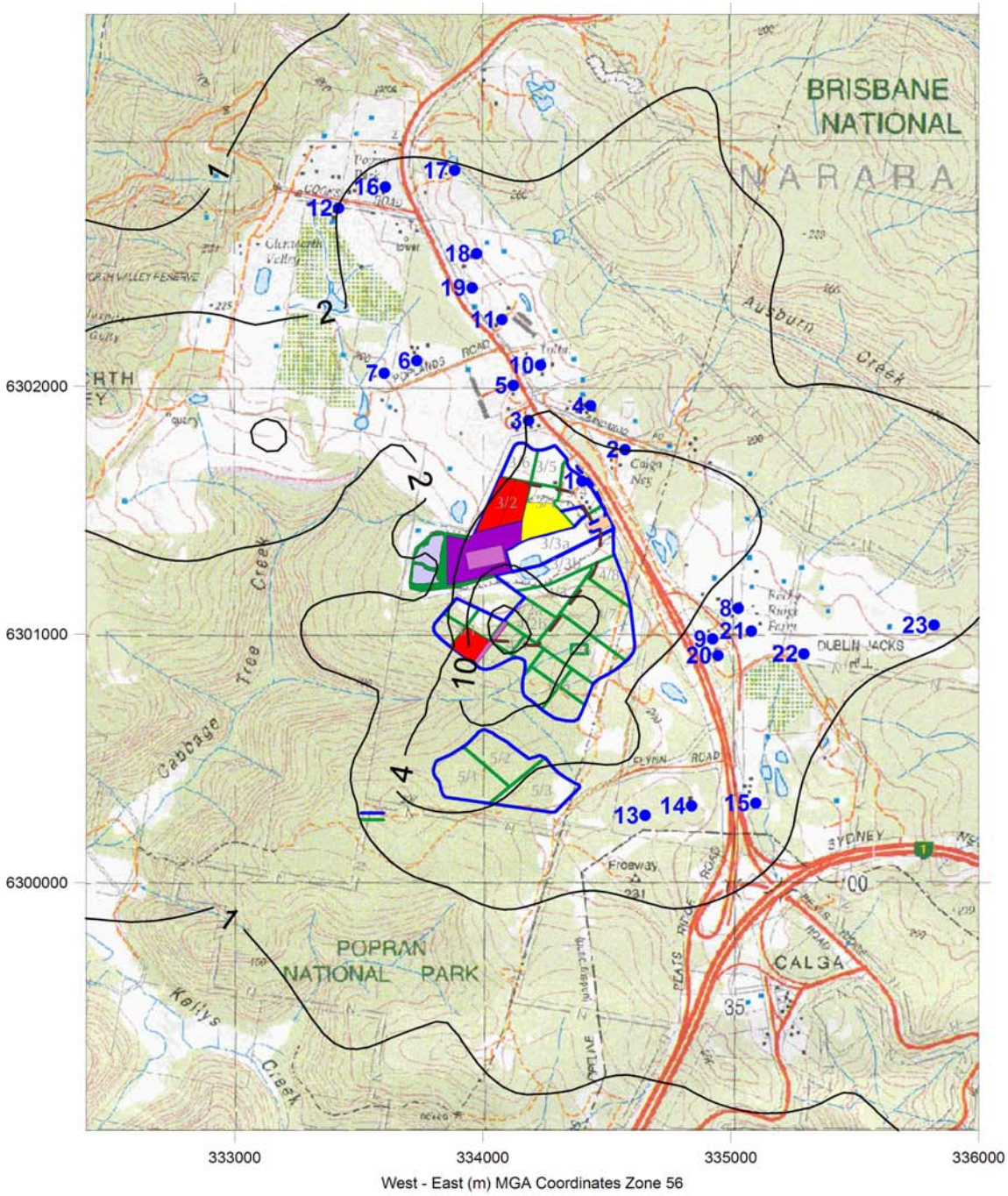


Figure 10: Predicted maximum 24-hour average PM_{10} concentrations due to operations from Scenario 1 (Stage 3/2 and W1 of 4/1)

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

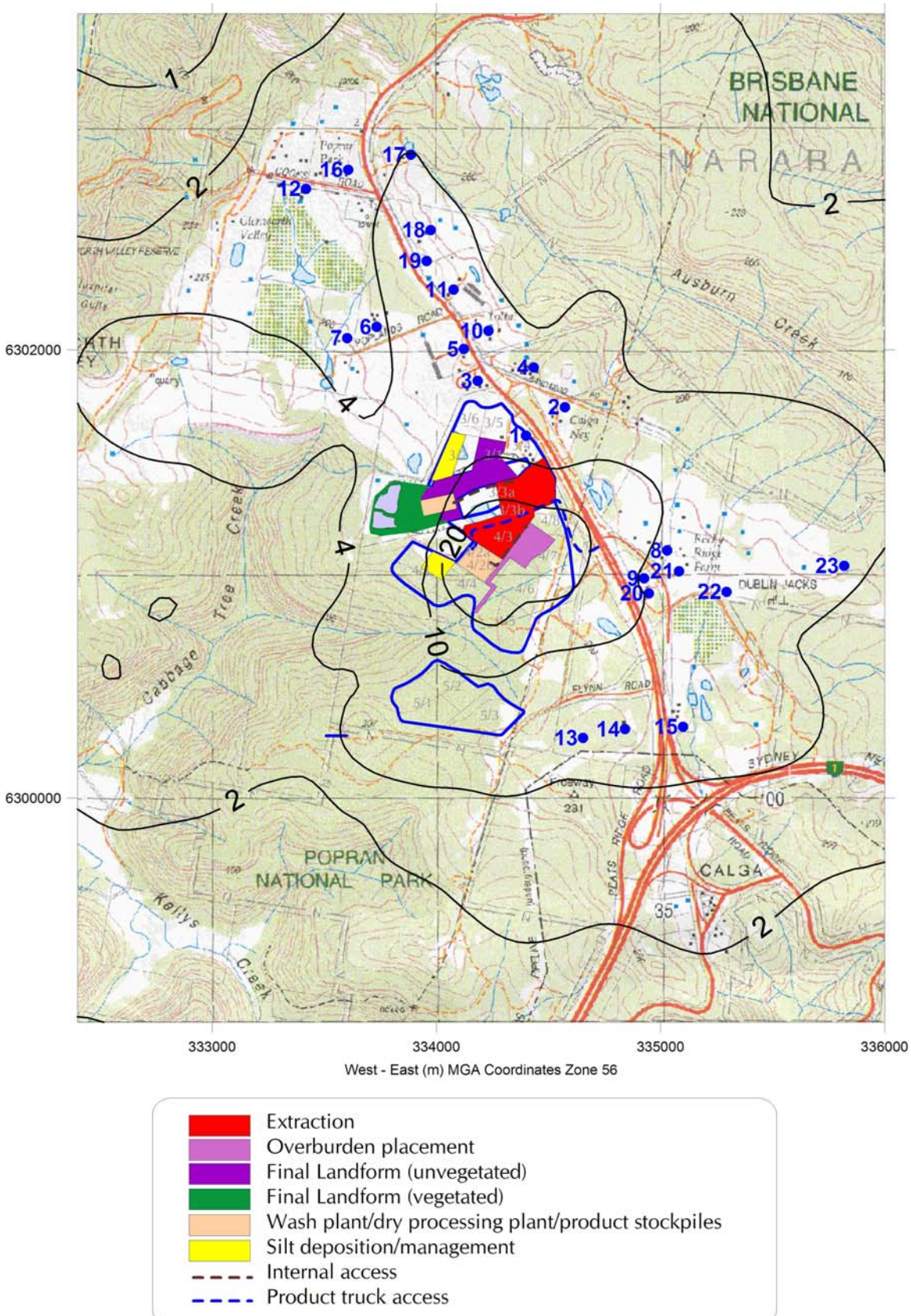


Figure 11: Predicted maximum 24-hour average PM_{10} concentrations due to operations from Scenario 2 (Part Stage 3/2, Stage 3/3 and Stage 4/3)

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

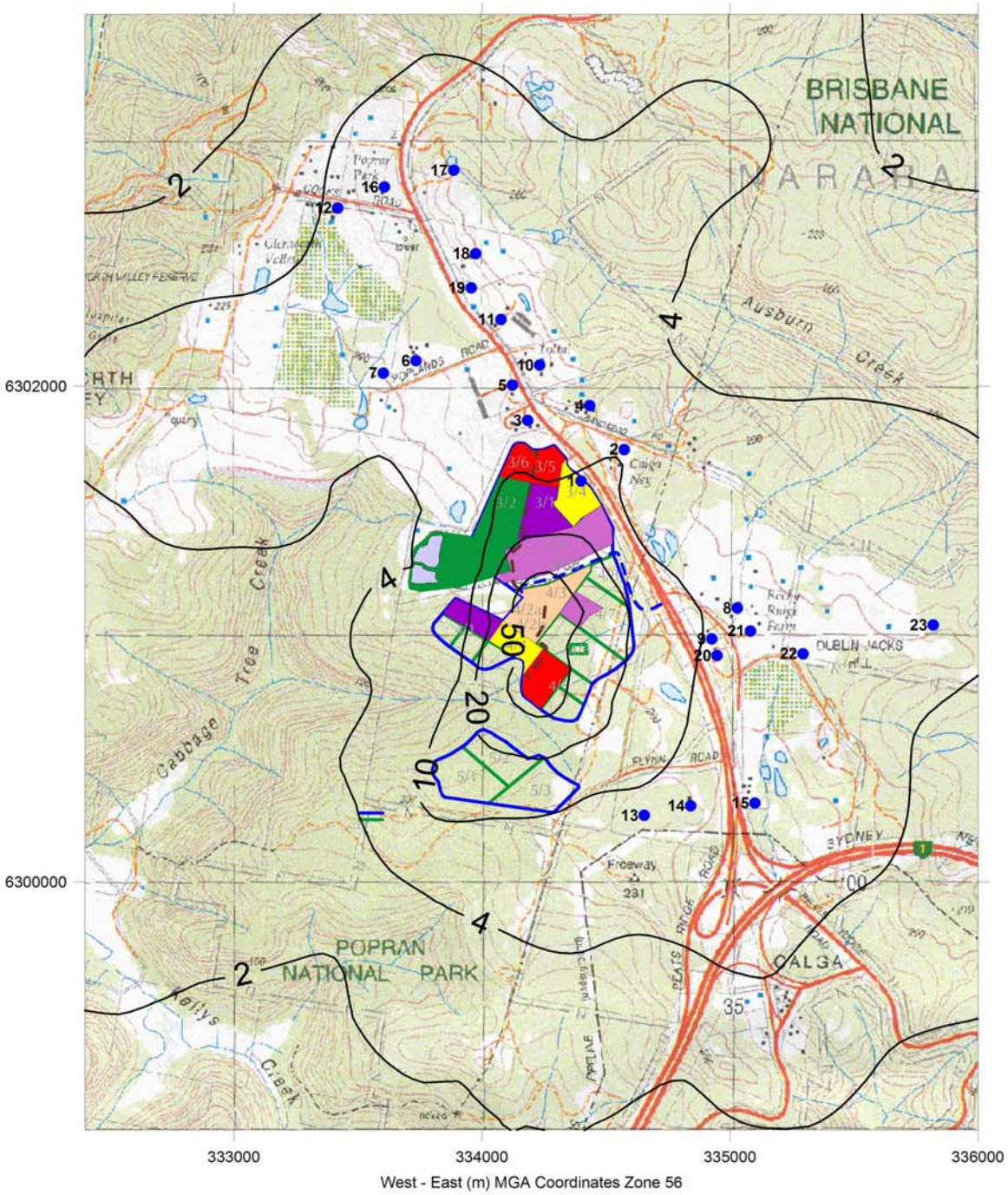


Figure 12: Predicted maximum 24-hour average PM_{10} concentrations due to operations from Scenario 3 (Stage 3/6, Stage 3/5, W4 of Stage 4/5 and S5 of Stage 4/5)

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

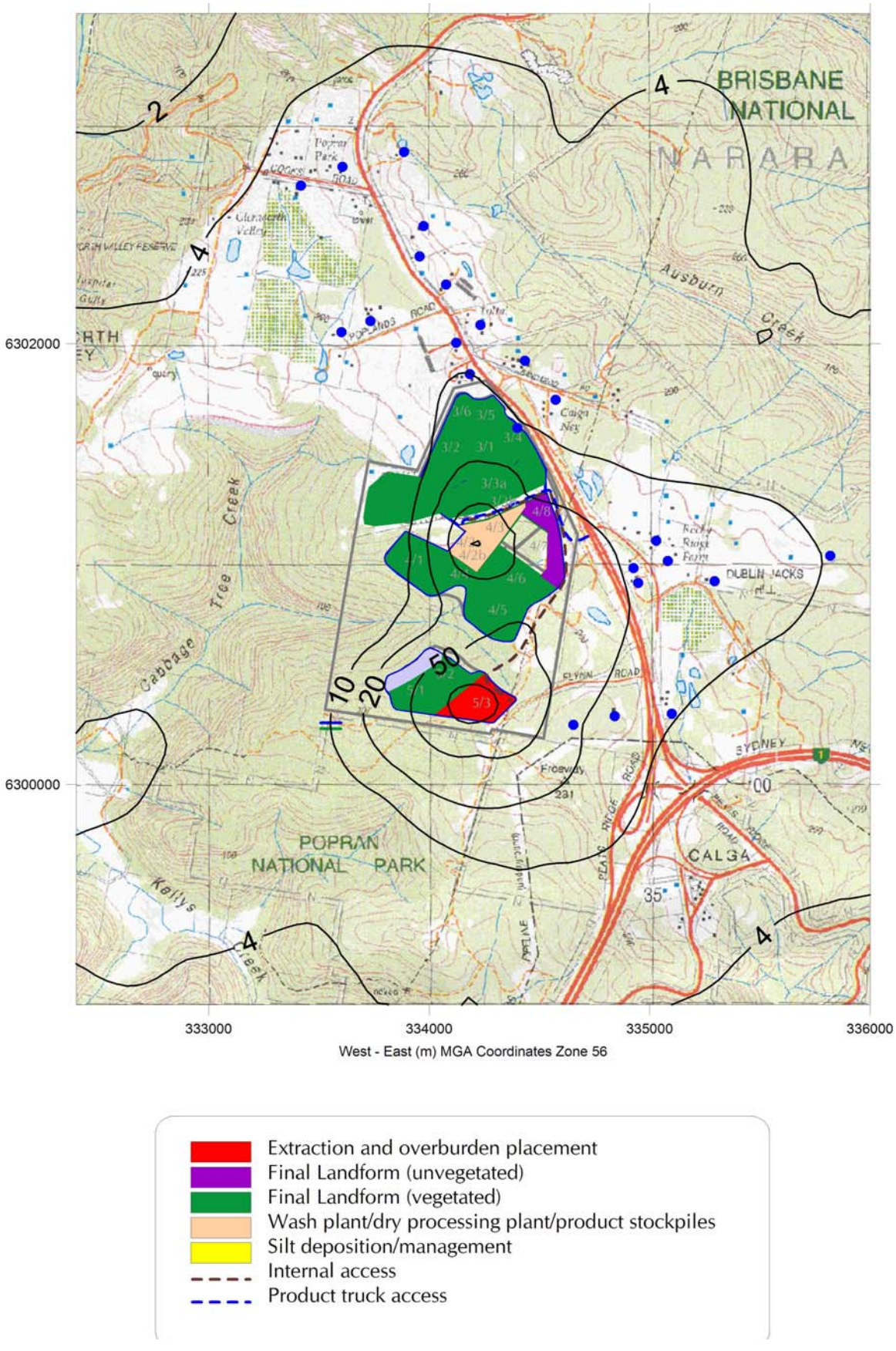


Figure 13: Predicted maximum 24-hour average PM_{10} concentrations due to operations from Scenario 4 (Stage 5/3)

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

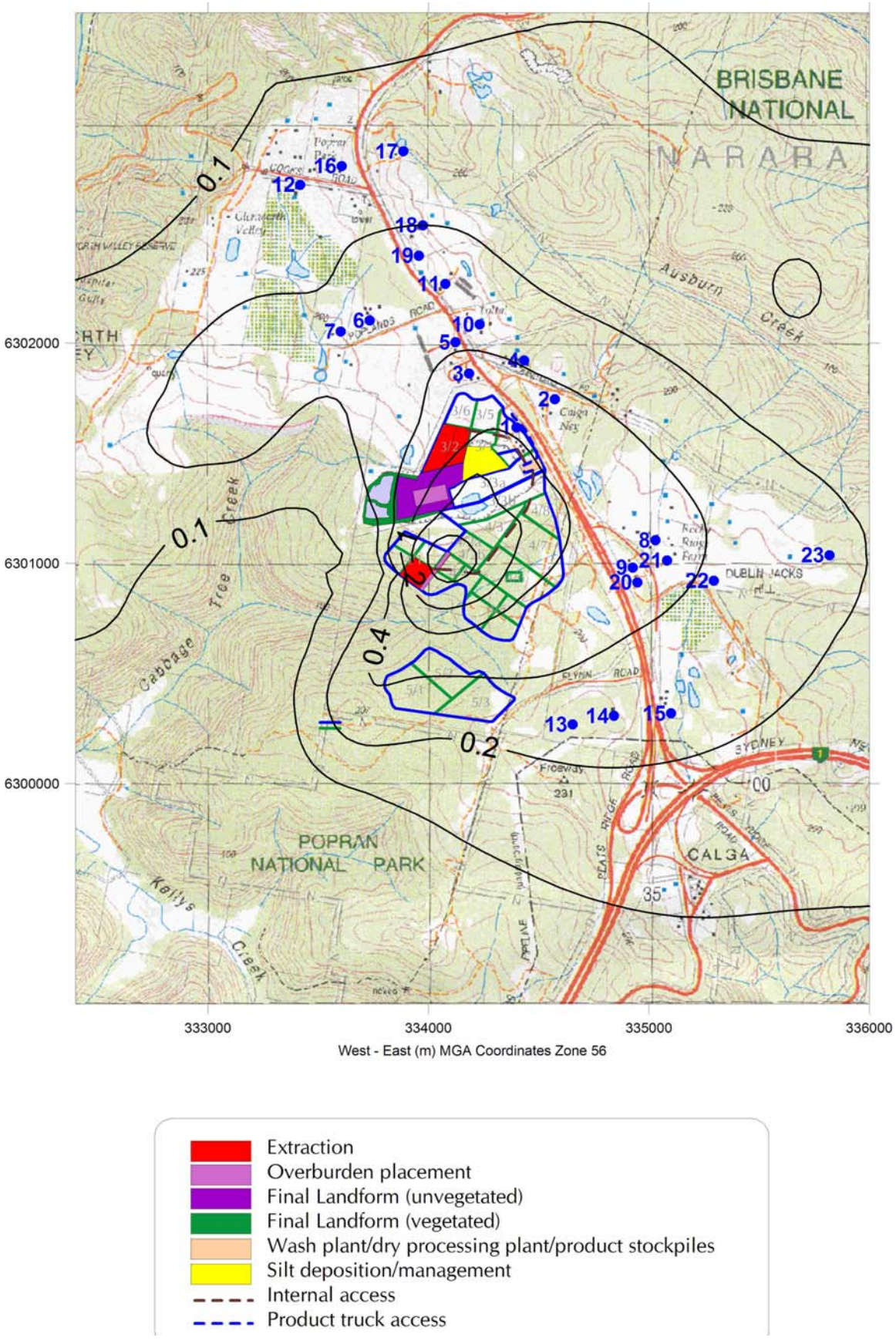


Figure 14: Predicted annual average PM_{10} concentrations due to operations from Scenario 1 (Stage 3/2 and W1 of 4/1)

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

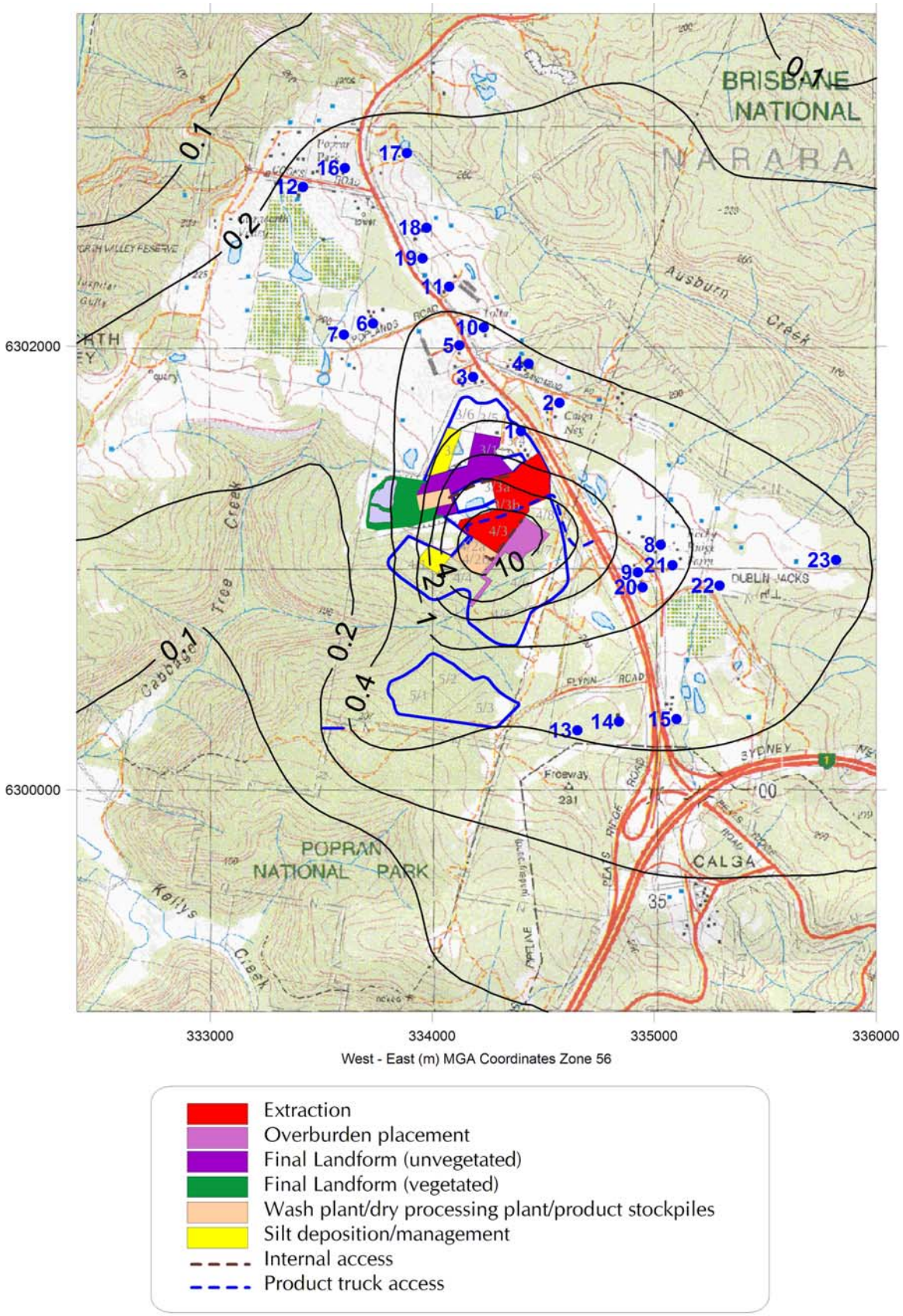


Figure 15: Predicted annual average PM_{10} concentrations due to from Scenario 2 (Part Stage 3/2, Stage 3/3 and Stage 4/3)

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

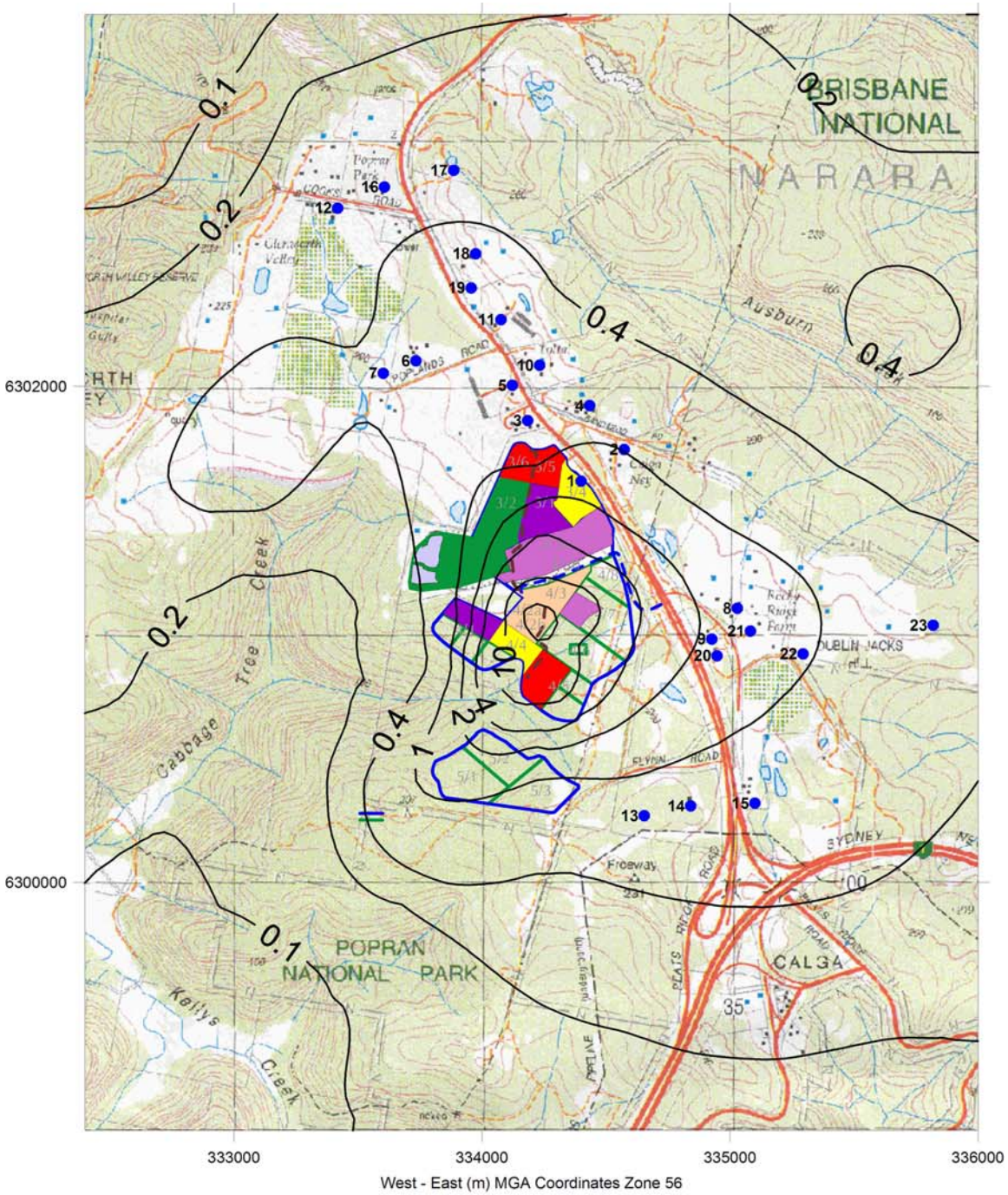


Figure 16: Predicted annual average PM_{10} concentrations due to operations from Scenario 3 (Stage 3/6, Stage 3/5, W4 of Stage 4/5 and S5 of Stage 4/5)

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

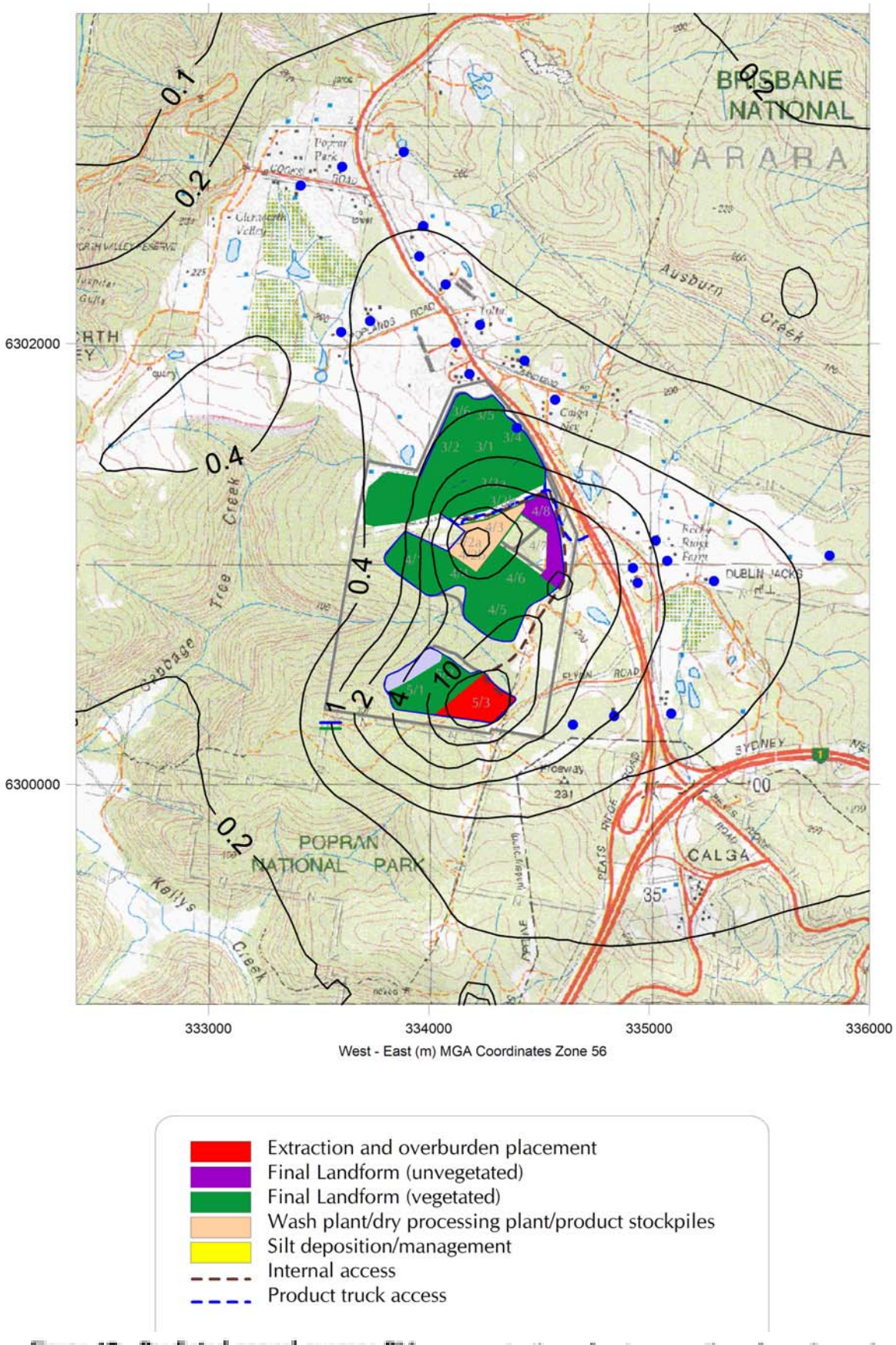


Figure 17: Predicted annual average PM_{10} concentrations due to operations from Scenario 4 (Stage 5/3)

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

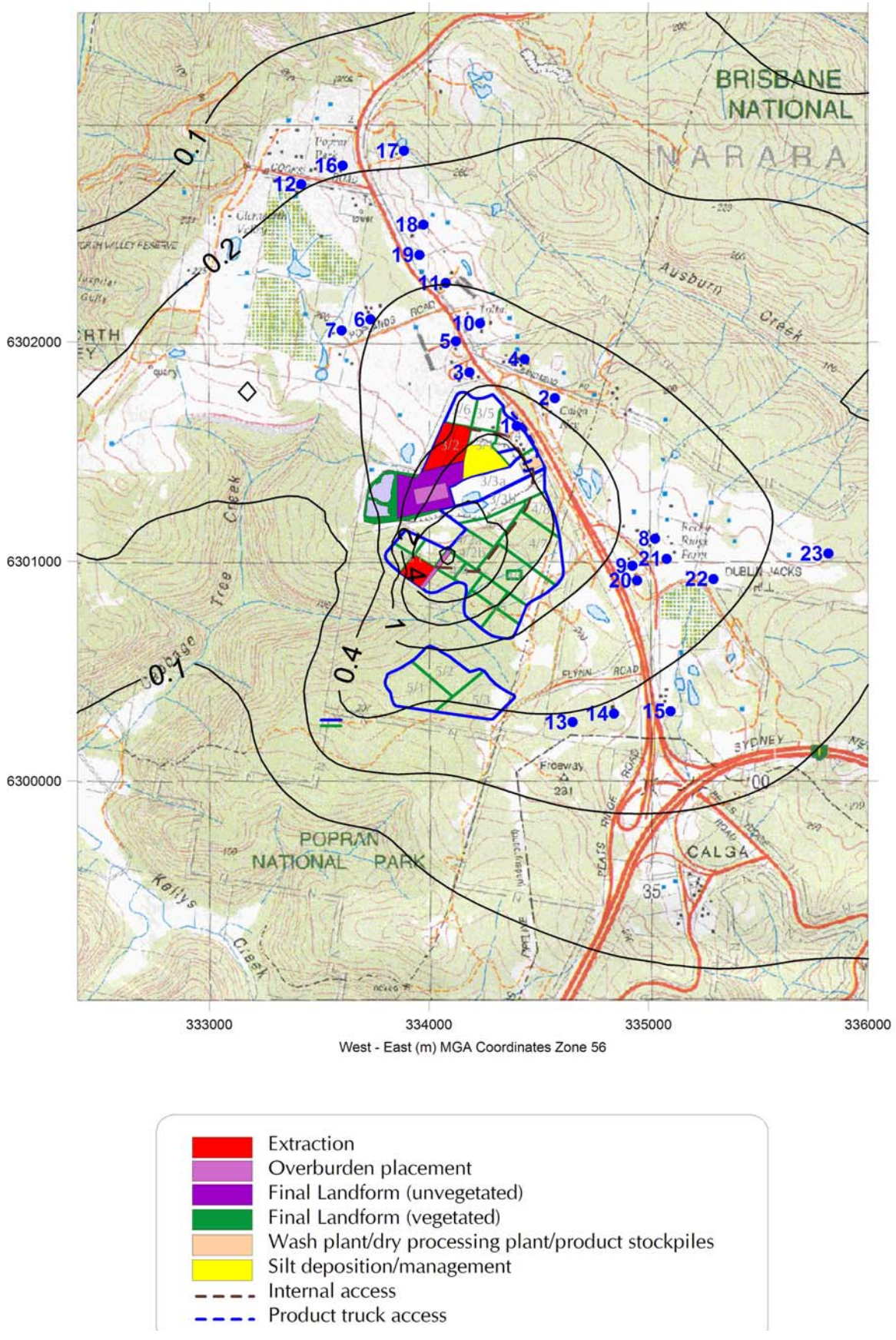


Figure 18: Predicted annual average TSP concentrations due to operations from Scenario 1 (Stage 3/2 and Stage 4/2)

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

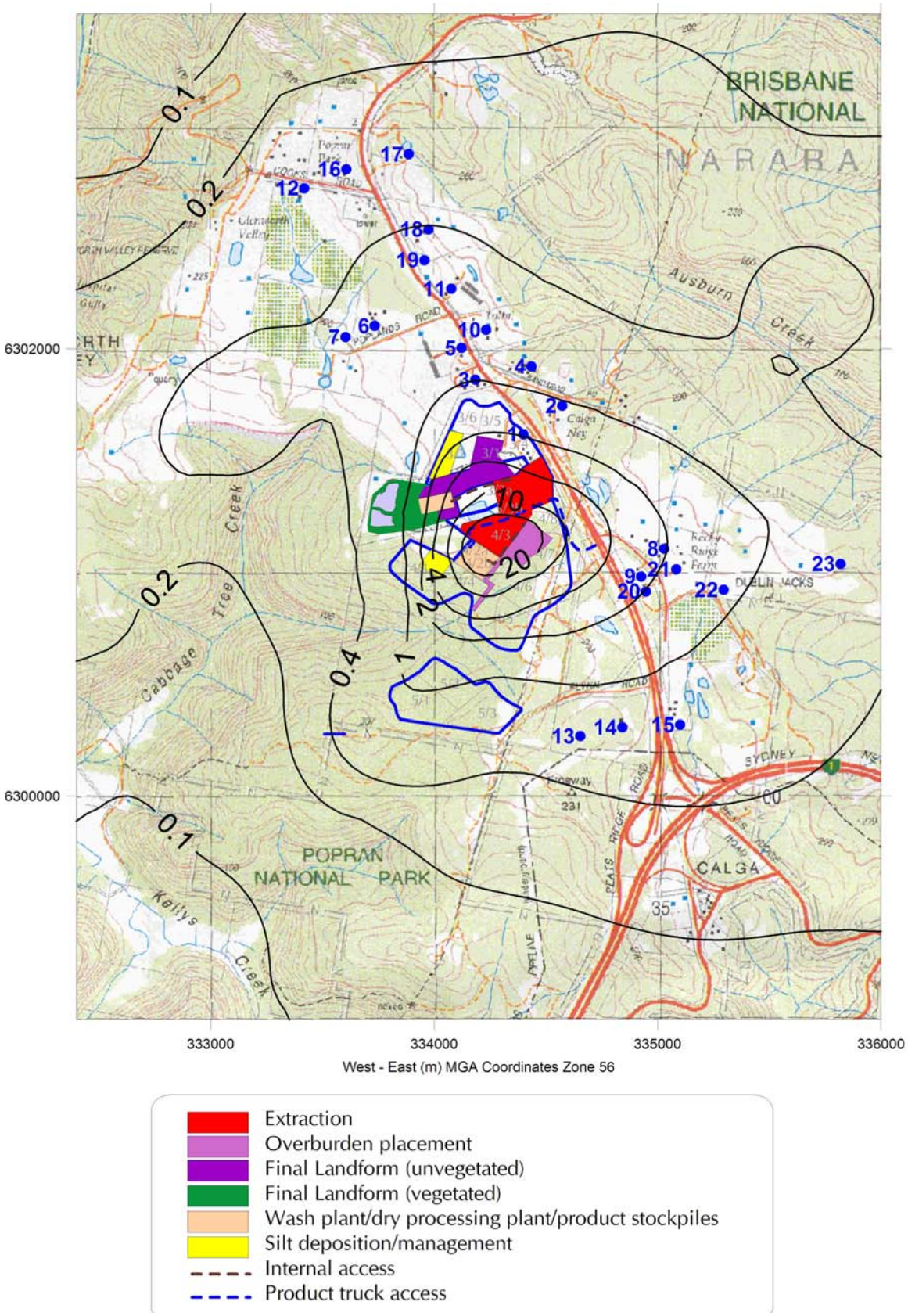


Figure 19: Predicted annual average TSP concentrations due to operations from Scenario 2 (Stage 3/6 and Stage 4/5)

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

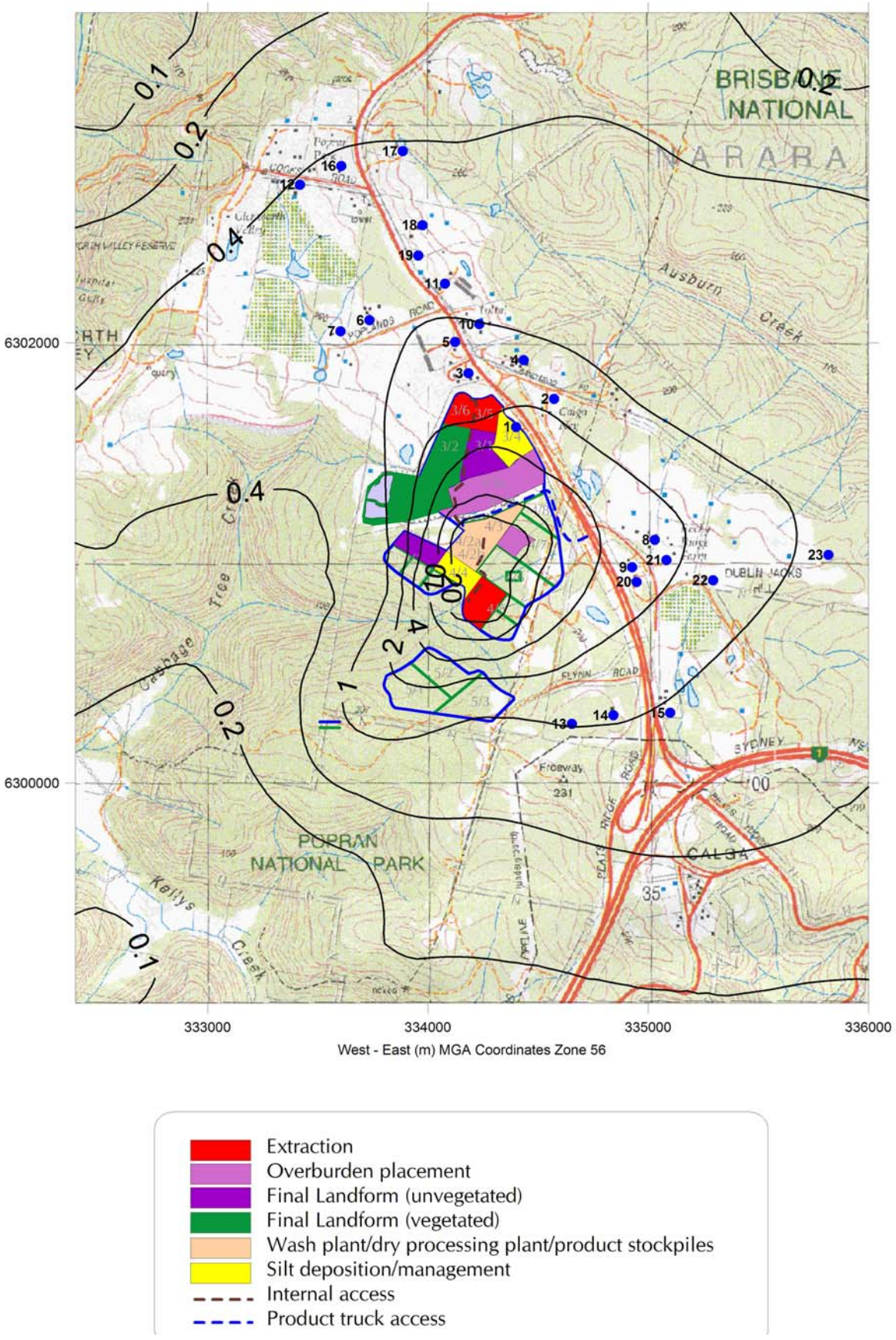


Figure 20: Predicted annual average TSP concentrations due to operations from Scenario 3 (Stage 4/7 and Stage 5/1)

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

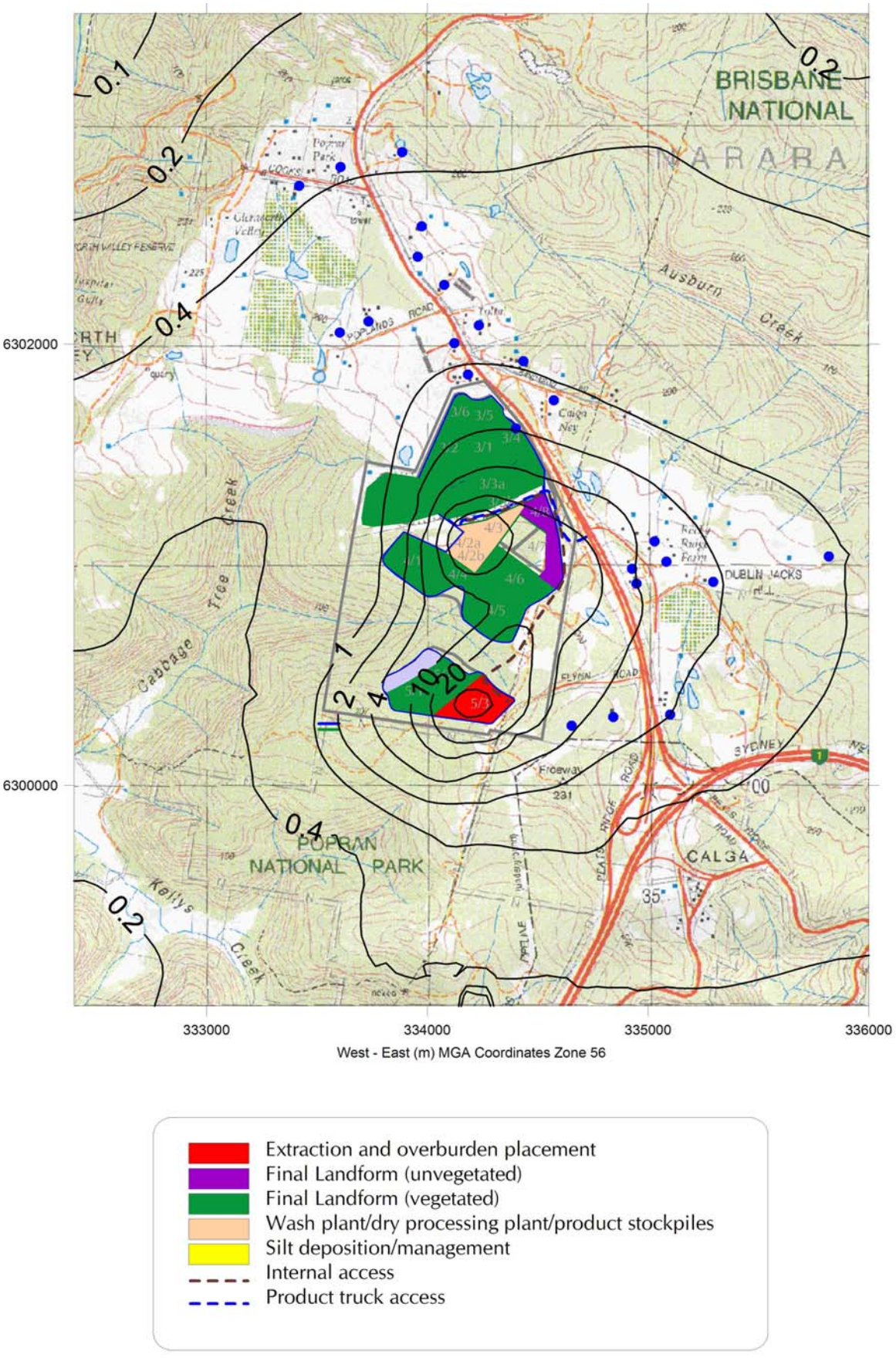


Figure 21: Predicted annual average TSP concentrations due to operations from Scenario 4 (Stage 5/3)

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

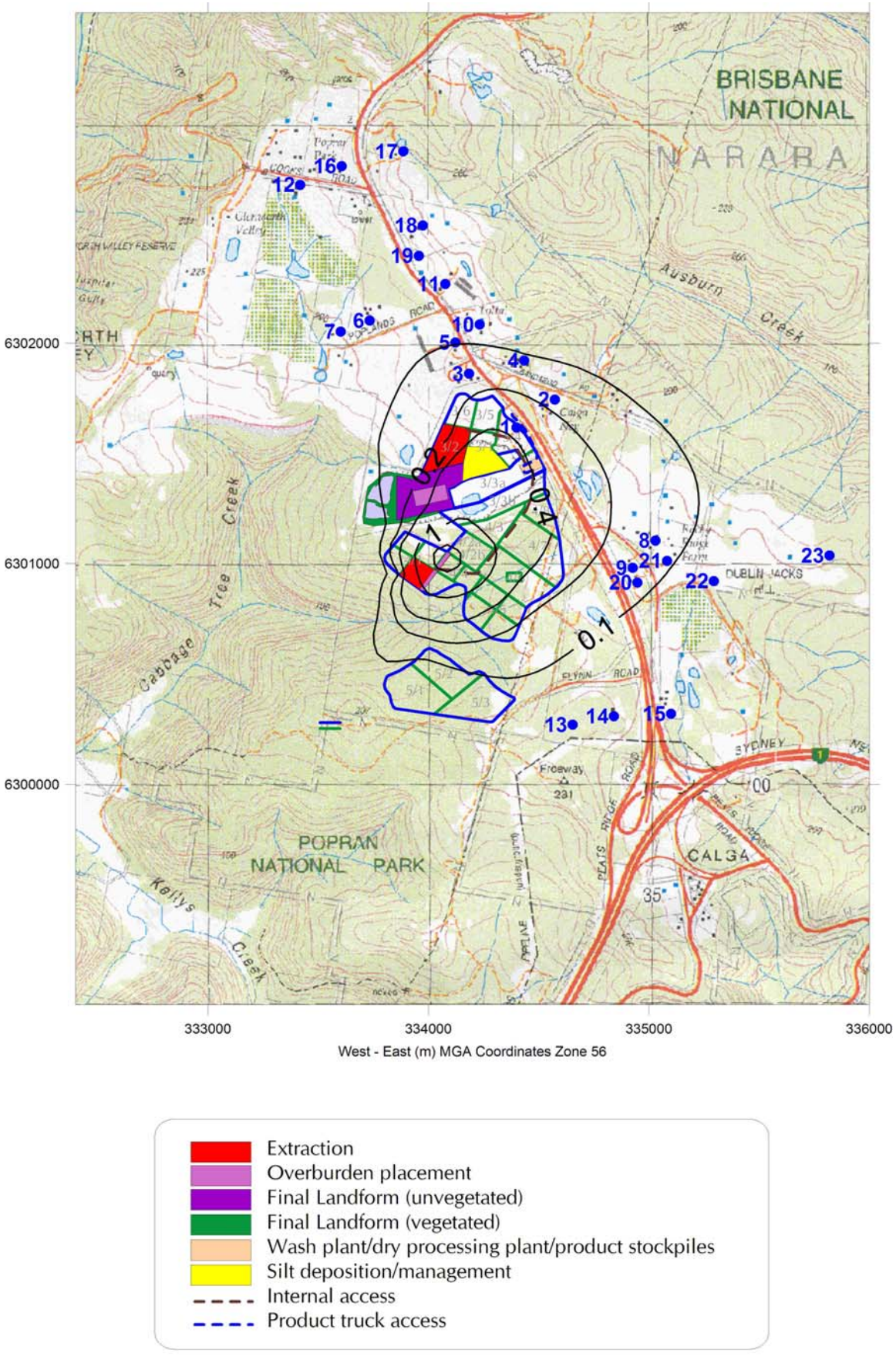


Figure 22: Predicted annual average dust deposition due to operations from Scenario 1 (Stage 3/2 and Stage 4/2)

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

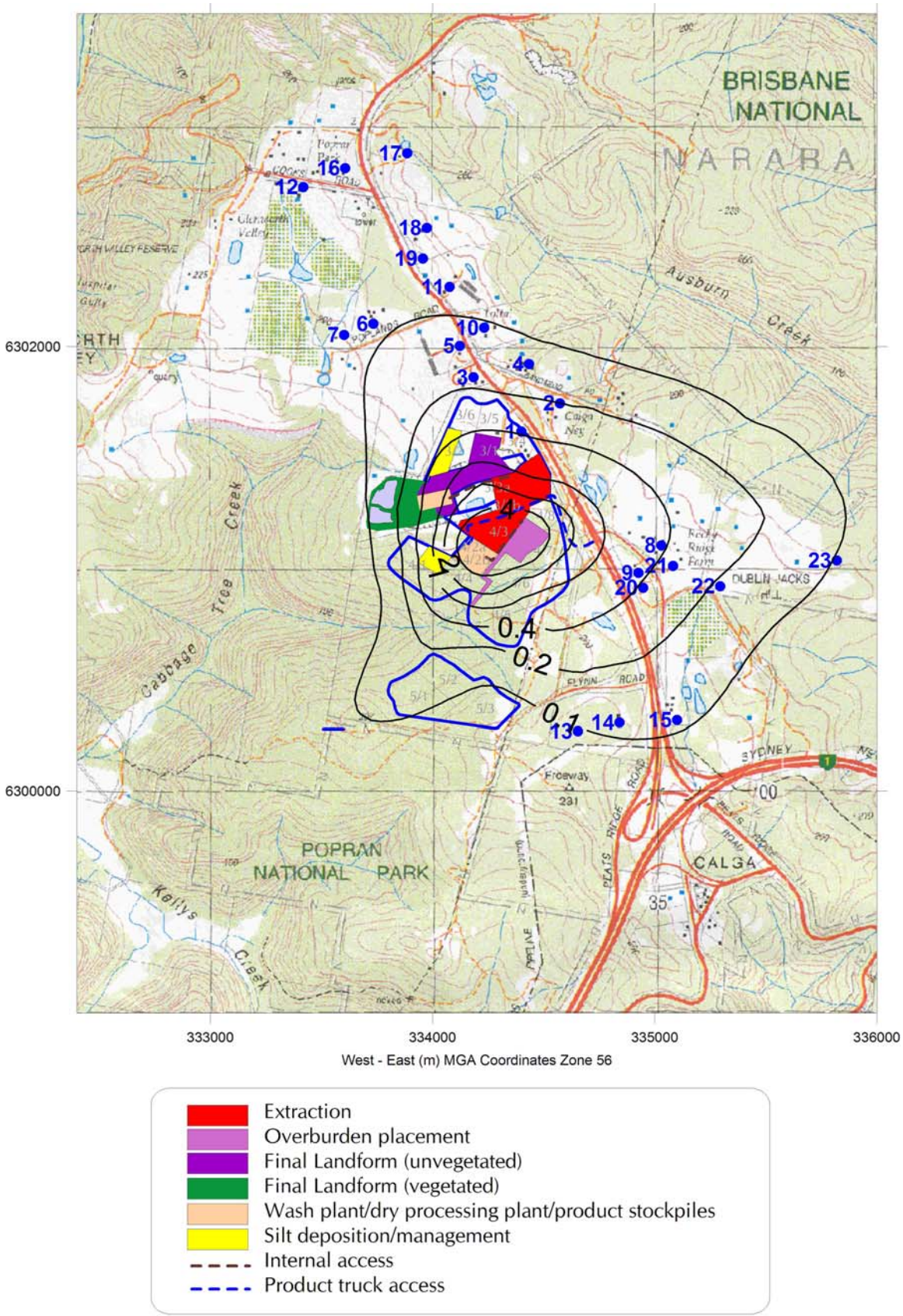


Figure 23: Predicted annual average dust deposition due to operations from Scenario 2 (Stage 3/6 and Stage 4/5)

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

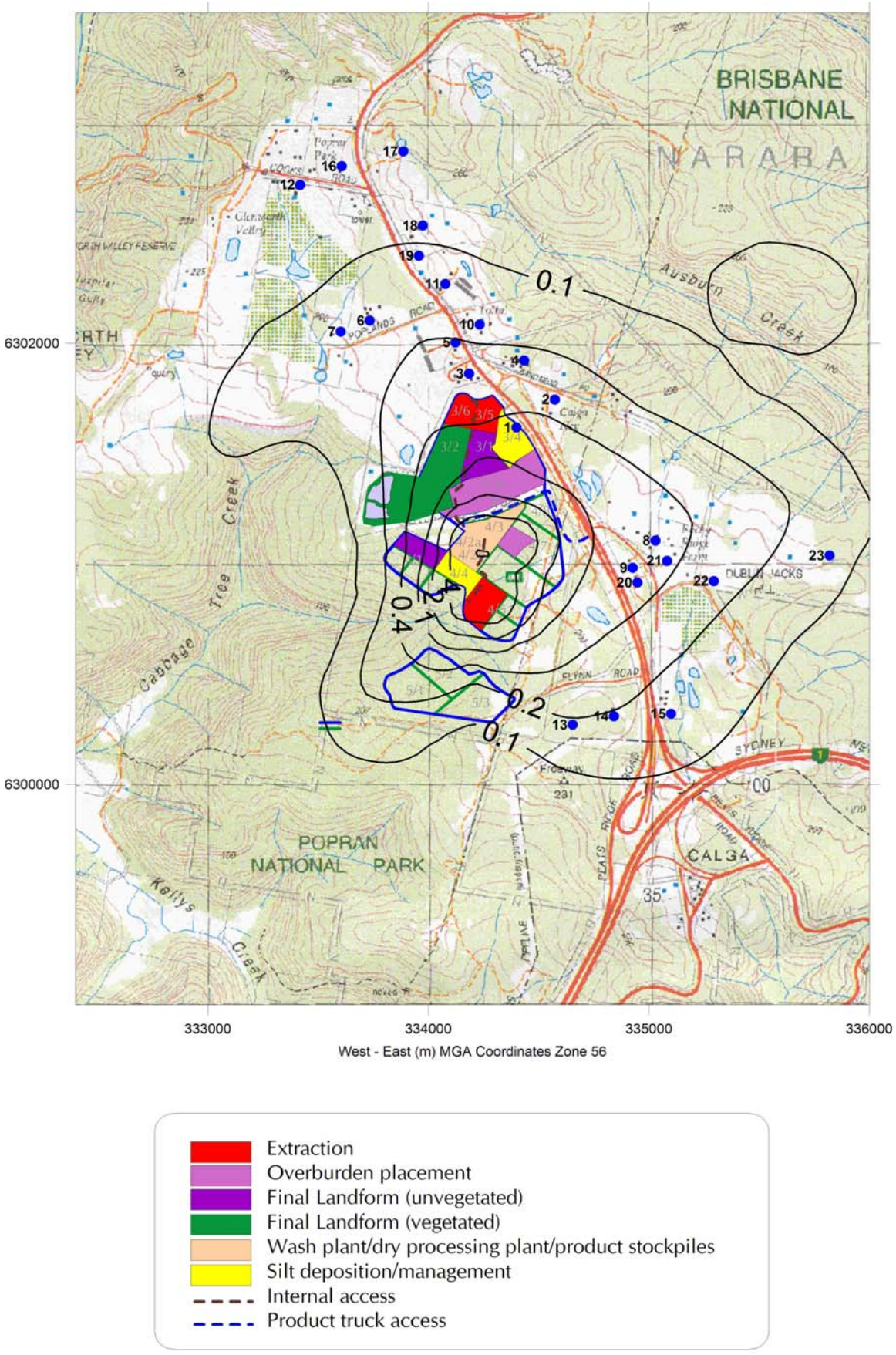


Figure 24: Predicted annual average dust deposition due to operations from Scenario 3 (Stage 4/7 and Stage 5/1)

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

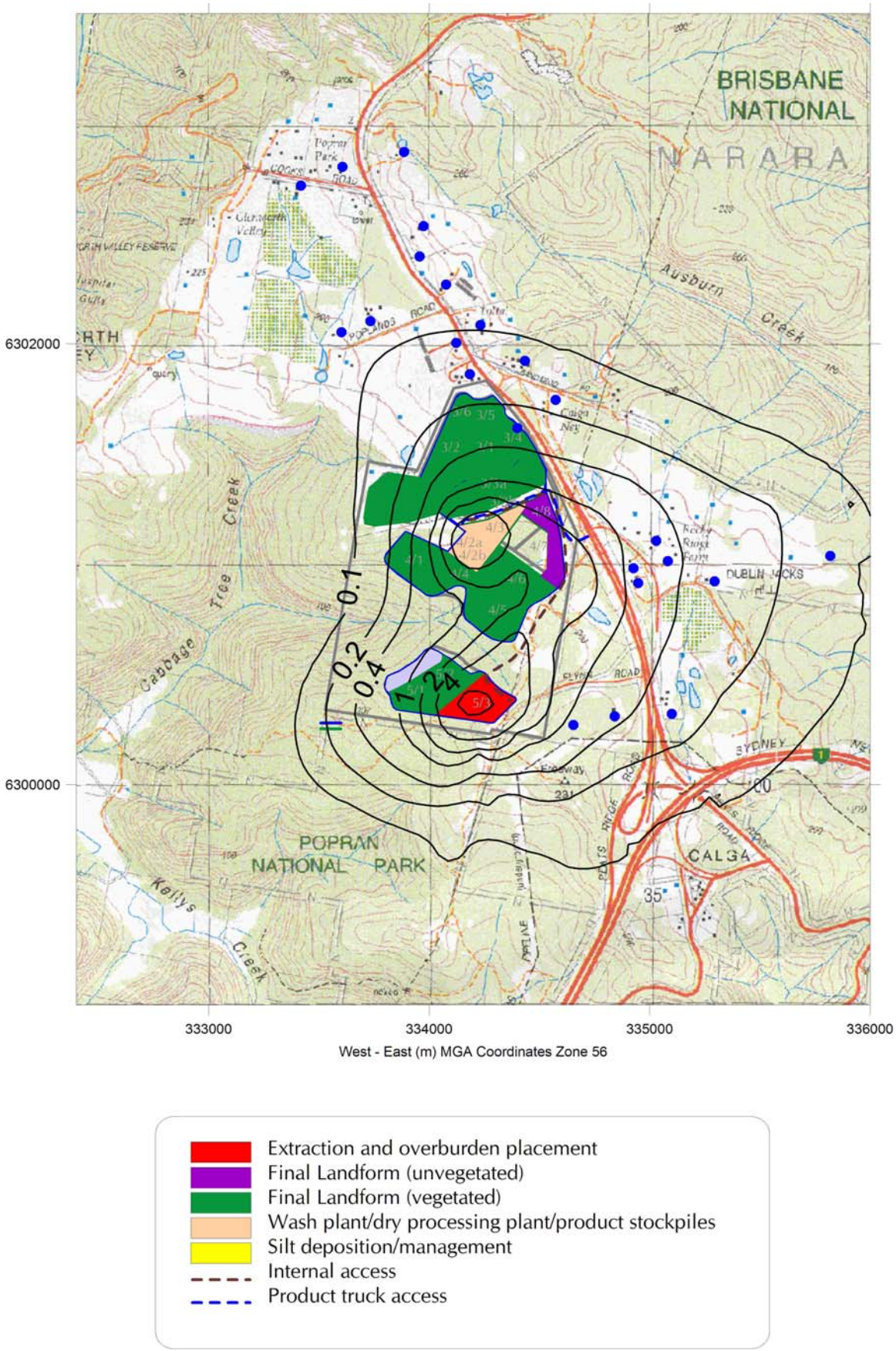


Figure 25: Predicted annual average dust deposition due to operations from Scenario 4 (Stage 5/3)

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

APPENDICES

Appendix A: Joint Wind Speed, Wind Direction and Stability Class Frequency Tables

Appendix B: Dust Emissions Inventory

(No. of pages excluding this page = 26)

This page has intentionally been left blank

Appendix A

Joint Wind Speed, Wind Direction and Stability Class Frequency Tables

(No. of pages excluding this page = 5)

Note: This Appendix is presented in full on the Project CD

STATISTICS FOR FILE: C:\Jobs\Calga07\Met\TAPM\Calga_0607_TAPM.aus
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	0.000228	0.000457	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000799
NE	0.000114	0.001027	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.001484
ENE	0.000228	0.001027	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.001712
E	0.000000	0.000342	0.000799	0.000000	0.000000	0.000000	0.000000	0.000000	0.001142
ESE	0.000000	0.000114	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
SE	0.000000	0.000571	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
SSE	0.000114	0.000457	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
S	0.000114	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000571
SSW	0.000000	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
SW	0.000342	0.000457	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
WSW	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000114
W	0.000114	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000228
WNW	0.000114	0.000114	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
NW	0.000342	0.000342	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000799
NNW	0.000228	0.000342	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000799
N	0.000000	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000571
CALM									0.000000
TOTAL	0.002055	0.006735	0.003196	0.000000	0.000000	0.000000	0.000000	0.000000	0.011986

MEAN WIND SPEED (m/s) = 2.34
NUMBER OF OBSERVATIONS = 105

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	0.001712	0.004452	0.001712	0.000000	0.000000	0.000000	0.000000	0.000000	0.007877
NE	0.001027	0.005251	0.002740	0.000228	0.000000	0.000000	0.000000	0.000000	0.009247
ENE	0.000457	0.006279	0.006393	0.001598	0.000000	0.000000	0.000000	0.000000	0.014726
E	0.000913	0.002854	0.008447	0.003881	0.000000	0.000000	0.000000	0.000000	0.016096
ESE	0.000571	0.001484	0.004566	0.000571	0.000000	0.000000	0.000000	0.000000	0.007192
SE	0.000913	0.001941	0.001256	0.000000	0.000000	0.000000	0.000000	0.000000	0.004110
SSE	0.000571	0.001027	0.000799	0.000000	0.000000	0.000000	0.000000	0.000000	0.002397
S	0.000342	0.001598	0.001256	0.000342	0.000000	0.000000	0.000000	0.000000	0.003539
SSW	0.001027	0.002626	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.005137
SW	0.000913	0.003425	0.002854	0.000913	0.000000	0.000000	0.000000	0.000000	0.008105
WSW	0.001256	0.002968	0.001484	0.000228	0.000000	0.000000	0.000000	0.000000	0.005936
W	0.001142	0.001712	0.001826	0.000342	0.000000	0.000000	0.000000	0.000000	0.005023
WNW	0.000571	0.001598	0.001027	0.000000	0.000000	0.000000	0.000000	0.000000	0.003196
NW	0.000913	0.002397	0.001256	0.000114	0.000000	0.000000	0.000000	0.000000	0.004680
NNW	0.000799	0.002511	0.001027	0.000114	0.000000	0.000000	0.000000	0.000000	0.004452
N	0.001370	0.002854	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.005708
CALM									0.001941
TOTAL	0.014498	0.044977	0.039612	0.008333	0.000000	0.000000	0.000000	0.000000	0.109361

MEAN WIND SPEED (m/s) = 2.82
NUMBER OF OBSERVATIONS = 958

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	0.000685	0.001142	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.002968
NE	0.000457	0.001826	0.001027	0.000685	0.000000	0.000000	0.000000	0.000000	0.003995
ENE	0.000913	0.001598	0.005251	0.007877	0.001598	0.000000	0.000000	0.000000	0.017237
E	0.000571	0.001598	0.004909	0.006164	0.000228	0.000000	0.000000	0.000000	0.013470
ESE	0.000228	0.001256	0.003539	0.001370	0.001027	0.000114	0.000000	0.000000	0.007534
SE	0.000457	0.000799	0.001484	0.000799	0.000228	0.000114	0.000000	0.000000	0.003881
SSE	0.000228	0.001256	0.001370	0.000342	0.000000	0.000000	0.000000	0.000000	0.003196
S	0.000799	0.001142	0.003311	0.000913	0.000000	0.000000	0.000000	0.000000	0.006164
SSW	0.000457	0.001256	0.002968	0.000913	0.000000	0.000000	0.000000	0.000000	0.005594
SW	0.000913	0.001826	0.008790	0.001826	0.001826	0.000000	0.000000	0.000000	0.015183
WSW	0.000799	0.002511	0.008105	0.002854	0.002283	0.000228	0.000000	0.000000	0.016781
W	0.001712	0.003311	0.003425	0.002169	0.000799	0.000000	0.000000	0.000000	0.011416
WNW	0.001826	0.002283	0.002169	0.001712	0.001142	0.000114	0.000000	0.000000	0.009247
NW	0.000913	0.003539	0.002740	0.001826	0.000571	0.000114	0.000000	0.000000	0.009703
NNW	0.000799	0.002055	0.001598	0.000571	0.000228	0.000000	0.000000	0.000000	0.005251
N	0.000913	0.001370	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.002854
CALM									0.001142
TOTAL	0.012671	0.028767	0.052397	0.030023	0.009932	0.000685	0.000000	0.000000	0.135616

MEAN WIND SPEED (m/s) = 3.75
NUMBER OF OBSERVATIONS = 1188

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	0.001712	0.002968	0.001027	0.000228	0.000000	0.000000	0.000000	0.000000	0.005936
NE	0.000913	0.005479	0.005365	0.002740	0.000000	0.000000	0.000000	0.000000	0.014498
ENE	0.001484	0.005708	0.008219	0.003653	0.000114	0.000000	0.000000	0.000000	0.019178
E	0.002854	0.006164	0.008562	0.002283	0.000000	0.000000	0.000000	0.000000	0.019863
ESE	0.002740	0.009132	0.007648	0.001142	0.000000	0.000000	0.000000	0.000000	0.020662
SE	0.002055	0.008676	0.012100	0.006621	0.000685	0.000000	0.000000	0.000000	0.030137
SSE	0.001256	0.010388	0.009932	0.005708	0.001256	0.000114	0.000000	0.000000	0.028653
S	0.001484	0.007877	0.007648	0.003539	0.000114	0.000000	0.000000	0.000000	0.020662
SSW	0.001370	0.004224	0.004566	0.003881	0.001256	0.000000	0.000000	0.000000	0.015297
SW	0.001142	0.005594	0.008219	0.006735	0.000114	0.000000	0.000000	0.000000	0.021804
WSW	0.001484	0.005023	0.012215	0.013014	0.004909	0.000342	0.000000	0.000000	0.036986
W	0.001484	0.006621	0.011073	0.007877	0.001826	0.000000	0.000000	0.000000	0.028881
WNW	0.000799	0.006393	0.007534	0.001712	0.001142	0.000342	0.000000	0.000000	0.017922
NW	0.001484	0.003881	0.006735	0.007877	0.002055	0.000571	0.000114	0.000000	0.022717
NNW	0.001370	0.002055	0.003311	0.001256	0.001256	0.000000	0.000000	0.000000	0.009247
N	0.001027	0.001484	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.003082
CALM									0.006621
TOTAL	0.024658	0.091667	0.114726	0.068265	0.014726	0.001370	0.000114	0.000000	0.322146

MEAN WIND SPEED (m/s) = 3.56
NUMBER OF OBSERVATIONS = 2822

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	0.002397	0.001484	0.005594	0.001142	0.000000	0.000000	0.000000	0.000000	0.010616
NE	0.002626	0.003767	0.004452	0.000342	0.000000	0.000000	0.000000	0.000000	0.011187
ENE	0.003539	0.002854	0.003425	0.000913	0.000000	0.000000	0.000000	0.000000	0.010731
E	0.003196	0.005479	0.001598	0.000000	0.000000	0.000000	0.000000	0.000000	0.010274
ESE	0.000457	0.003539	0.003425	0.000457	0.000000	0.000000	0.000000	0.000000	0.007877
SE	0.000228	0.003425	0.006507	0.003653	0.000000	0.000000	0.000000	0.000000	0.013813
SSE	0.000342	0.004224	0.002854	0.000913	0.000000	0.000000	0.000000	0.000000	0.008333
S	0.000457	0.005708	0.002854	0.000799	0.000000	0.000000	0.000000	0.000000	0.009817
SSW	0.000799	0.003653	0.004338	0.001712	0.000000	0.000000	0.000000	0.000000	0.010502
SW	0.000457	0.003196	0.007763	0.003425	0.000000	0.000000	0.000000	0.000000	0.014840
WSW	0.000571	0.002968	0.030936	0.009589	0.000000	0.000000	0.000000	0.000000	0.044064
W	0.001027	0.003539	0.027511	0.005137	0.000000	0.000000	0.000000	0.000000	0.037215
WNW	0.000685	0.001826	0.015297	0.000000	0.000000	0.000000	0.000000	0.000000	0.017808
NW	0.001712	0.001712	0.012100	0.003311	0.000000	0.000000	0.000000	0.000000	0.018836
NNW	0.001941	0.001256	0.005594	0.001142	0.000000	0.000000	0.000000	0.000000	0.009932
N	0.001712	0.001484	0.002397	0.000000	0.000000	0.000000	0.000000	0.000000	0.005594
CALM									0.000457
TOTAL	0.022146	0.050114	0.136644	0.032534	0.000000	0.000000	0.000000	0.000000	0.241895

MEAN WIND SPEED (m/s) = 3.45
NUMBER OF OBSERVATIONS = 2119

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	0.000342	0.009018	0.002055	0.000000	0.000000	0.000000	0.000000	0.000000	0.011416
NE	0.000228	0.013470	0.004338	0.000000	0.000000	0.000000	0.000000	0.000000	0.018037
ENE	0.000114	0.007078	0.004224	0.000000	0.000000	0.000000	0.000000	0.000000	0.011416
E	0.000114	0.007420	0.002511	0.000000	0.000000	0.000000	0.000000	0.000000	0.010046
ESE	0.000000	0.004338	0.002397	0.000000	0.000000	0.000000	0.000000	0.000000	0.006735
SE	0.000114	0.003311	0.001941	0.000000	0.000000	0.000000	0.000000	0.000000	0.005365
SSE	0.000228	0.005708	0.002169	0.000000	0.000000	0.000000	0.000000	0.000000	0.008105
S	0.000000	0.003311	0.002968	0.000000	0.000000	0.000000	0.000000	0.000000	0.006279
SSW	0.000342	0.005023	0.002854	0.000000	0.000000	0.000000	0.000000	0.000000	0.008219
SW	0.000114	0.005023	0.006050	0.000000	0.000000	0.000000	0.000000	0.000000	0.011187
WSW	0.000000	0.007534	0.009132	0.000000	0.000000	0.000000	0.000000	0.000000	0.016667
W	0.000000	0.009589	0.012671	0.000000	0.000000	0.000000	0.000000	0.000000	0.022260
WNW	0.000114	0.006621	0.006849	0.000000	0.000000	0.000000	0.000000	0.000000	0.013584
NW	0.000114	0.004338	0.007192	0.000000	0.000000	0.000000	0.000000	0.000000	0.011644
NNW	0.000342	0.005137	0.003767	0.000000	0.000000	0.000000	0.000000	0.000000	0.009247
N	0.000114	0.006849	0.001826	0.000000	0.000000	0.000000	0.000000	0.000000	0.008790
CALM									0.000000
TOTAL	0.002283	0.103767	0.072945	0.000000	0.000000	0.000000	0.000000	0.000000	0.178995

MEAN WIND SPEED (m/s) = 2.86
NUMBER OF OBSERVATIONS = 1568

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	0.007078	0.019521	0.011644	0.001370	0.000000	0.000000	0.000000	0.000000	0.039612
NE	0.005365	0.030822	0.018265	0.003995	0.000000	0.000000	0.000000	0.000000	0.058447
ENE	0.006735	0.024543	0.027968	0.014041	0.001712	0.000000	0.000000	0.000000	0.075000
E	0.007648	0.023858	0.026826	0.012329	0.000228	0.000000	0.000000	0.000000	0.070890
ESE	0.003995	0.019863	0.021804	0.003539	0.001027	0.000114	0.000000	0.000000	0.050342
SE	0.003767	0.018721	0.023630	0.011073	0.000913	0.000114	0.000000	0.000000	0.058219
SSE	0.002740	0.023059	0.017466	0.006963	0.001256	0.000114	0.000000	0.000000	0.051598
S	0.003196	0.020091	0.018037	0.005594	0.000114	0.000000	0.000000	0.000000	0.047032
SSW	0.003995	0.017123	0.016210	0.006507	0.001256	0.000000	0.000000	0.000000	0.045091
SW	0.003881	0.019521	0.033790	0.012900	0.001941	0.000000	0.000000	0.000000	0.072032
WSW	0.004224	0.021005	0.061872	0.025685	0.007192	0.000571	0.000000	0.000000	0.120548
W	0.005479	0.024886	0.056507	0.015525	0.002626	0.000000	0.000000	0.000000	0.105023
WNW	0.004110	0.018836	0.032991	0.003425	0.002283	0.000457	0.000000	0.000000	0.062100
NW	0.005479	0.016210	0.030137	0.013128	0.002626	0.000685	0.000114	0.000000	0.068379
NNW	0.005479	0.013356	0.015525	0.003082	0.001484	0.000000	0.000000	0.000000	0.038927
N	0.005137	0.014612	0.006849	0.000000	0.000000	0.000000	0.000000	0.000000	0.026598
CALM									0.010160
TOTAL	0.078311	0.326027	0.419521	0.139155	0.024658	0.002055	0.000114	0.000000	1.000000

MEAN WIND SPEED (m/s) = 3.34
NUMBER OF OBSERVATIONS = 8760

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 1.2%
B : 10.9%
C : 13.6%
D : 32.2%
E : 24.2%
F : 17.9%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0041	0199	0125
02	0000	0000	0000	0043	0210	0112
03	0000	0000	0000	0055	0207	0103
04	0000	0000	0000	0068	0202	0095
05	0000	0000	0000	0090	0190	0085
06	0000	0000	0000	0202	0116	0047
07	0000	0000	0023	0285	0041	0016
08	0000	0004	0108	0253	0000	0000
09	0000	0062	0128	0175	0000	0000
10	0004	0117	0146	0098	0000	0000
11	0006	0164	0101	0094	0000	0000
12	0024	0163	0087	0091	0000	0000
13	0029	0148	0089	0099	0000	0000
14	0026	0130	0106	0103	0000	0000
15	0015	0100	0132	0118	0000	0000
16	0001	0060	0137	0167	0000	0000
17	0000	0010	0103	0252	0000	0000
18	0000	0000	0028	0263	0034	0040
19	0000	0000	0000	0173	0079	0113
20	0000	0000	0000	0018	0163	0184
21	0000	0000	0000	0028	0164	0173
22	0000	0000	0000	0033	0168	0164
23	0000	0000	0000	0037	0166	0162
24	0000	0000	0000	0036	0180	0149

```
--------------------------------
STABILITY CLASS BY MIXING HEIGHT
--------------------------------
Mixing height    A    B    C    D    E    F
    <=500 m    0016 0494 0737 2236 2083 1560
   <=1000 m    0049 0378 0312 0438 0029 0008
   <=1500 m    0029 0066 0081 0108 0007 0000
   <=2000 m    0006 0014 0045 0028 0000 0000
   <=3000 m    0005 0006 0011 0010 0000 0000
    >3000 m    0000 0000 0002 0002 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   0146  0134  0066  0018  0001  0000  0000
  02   0148  0138  0063  0014  0002  0000  0000
  03   0146  0137  0070  0010  0002  0000  0000
  04   0157  0131  0063  0011  0003  0000  0000
  05   0149  0137  0061  0018  0000  0000  0000
  06   0140  0148  0062  0015  0000  0000  0000
  07   0174  0138  0039  0012  0002  0000  0000
  08   0153  0120  0071  0016  0005  0000  0000
  09   0167  0077  0076  0043  0002  0000  0000
  10   0078  0101  0101  0074  0011  0000  0000
  11   0012  0061  0143  0125  0024  0000  0000
  12   0007  0016  0091  0209  0040  0002  0000
  13   0006  0011  0050  0197  0089  0012  0000
  14   0012  0012  0040  0153  0127  0020  0001
  15   0011  0019  0048  0147  0112  0027  0001
  16   0013  0026  0082  0135  0082  0026  0001
  17   0016  0057  0117  0119  0043  0013  0000
  18   0087  0087  0110  0058  0017  0006  0000
  19   0173  0100  0068  0021  0003  0000  0000
  20   0182  0130  0045  0008  0000  0000  0000
  21   0167  0149  0038  0011  0000  0000  0000
  22   0153  0151  0055  0005  0001  0000  0000
  23   0148  0136  0071  0008  0002  0000  0000
  24   0143  0136  0077  0007  0002  0000  0000
```

Appendix B

Dust Emissions Inventory

(No. of pages excluding this page = 18)

This page has intentionally been left blank

Calga Sand Quarry

Introduction

The dust emission inventory has been formulated from the description of the sand extraction and processing operations provided on behalf of Rocla and emission factors developed using emission factor equations provided in **NERDDC, 1988** and **US EPA (1985)** (and subsequent updates) publication referred to as AP-42.

Estimated emissions are presented for all significant dust generating activities associated with the extraction and processing operations.

It has been assumed that activities occur 14 hours a day, 300 days per year. Dust from wind erosion is assumed to occur over 24 hours per day, but wind erosion is also assumed to be proportional to the third power of wind speed. Generally, this will mean that most wind erosion occurs in the day when wind speeds are highest.

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.

Stripping topsoil

An emission rate of 14 kg/h has been used for stripping topsoil (**SPCC, 1983**).

Excavating material, dumping to stockpiles, loading material, dumping at processing plants

Each tonne of material excavated, dumped to stockpiles and loaded to trucks for haulage to the processing plants will generate a quantity of TSP that will depend on the wind speed and the moisture content. Equation 1 shows the relationship between these variables.

Equation 1

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

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 2006-2007 meteorological dataset and has been adjusted to take account of the 6:00am to 10:00pm operation. The moisture content was assumed to be 4.8%. It has been assumed that 80% of the material excavated will be transferred directly to trucks. This results in an emission rate of 0.00064 kg/t.

Hauling material / product on unsealed surfaces

After the application of water, the emission factor used for trucks hauling waste rock on unsealed surfaces is 1 kg per vehicle kilometre travelled (kg/VKT). It should be noted that higher control efficiencies can be achieved via use of agglomeration agents if necessary.

The return trip for each year was measured from the location of the haul routes and it was assumed haul trucks with an average capacity of 50 t were used.

Dry screening
As per the AP-42 emission factor for crushed stone processing (AP-42 Section 11.19.2), it was assumed that the dry screening of material results in an emission rate of 0.0125 kg/t.

Wet screening
It was assumed that the wet screening of material results in zero emissions.

FEL working on stockpiles and loading product to trucks
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in Equation 2.

Equation 2

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

where,

$E_{TSP} = TSP \ \ emissions$

$s = \text{silt content } (\%), \text{ and}$

$M = \text{moisture } (\%)$

The silt content in the product was assumed to be 10%, and the moisture content 4.8%. This results in an emission rate of 5.4 kg/h.

Equation 1 could have been used for the assessment of FEL working on stockpiles and loading to product trucks. However, as the stockpile activity involves some pushing of material and not just loading, Equation 2 was used as it gives a more conservative estimate of the impacts.

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

ESTIMATED DUST EMISSIONS: CALGA SAND QUARRY

SCENARIO 1 – STAGE 3/2 AND W1 OF STAGE 4/1

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 3	Units
Stage 3/2a and 3/2b													
Stripping topsoil - Stage 3/2	560	40	h/y	14.0	kg/h								
Excavation of overburden- Stage 3/2	49	131,376	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Loading overburden to trucks for haulage emplacement area- Stage 3/2	49	131,376	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Hauling overburden to emplacement area- Stage 3/2	1,314	131,376	t/y	0.04000	kg/t	50	t/truck load	0.5	km/return trip	4.0	kg/VKT	75	% control
Emplacing overburden at emplacement area- Stage 3/2	49	131,376	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Dozer ripping sand - Stage 3/2	11,823	4,992	h/y	2.4	kg/h	10	silt content in %	9	moisture content in %				
Excavation of sand - Stage 3/2	63	238,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to stockpiles - Stage 3/2	63	238,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Loading sand to trucks for haulage to processor plants - Stage 3/2	63	238,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Hauling sand to processing plant (Site A) - Stage 3/2	2,863	238,571	t/y	0.04800	kg/t	50	t/truck load	0.6	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site A - Stage 3/2	63	238,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site A - Stage 3/2	13	47,714	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site A - Stage 3/2	50	190,857	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand- Stage 3/2	644	238,571		0.00270	kg/t								
Dry Screening - Stage 3/2	596	47,714	t/y	0.0125	kg/t								
Wet Screening - Stage 3/2	-	190,857	t/y	0.000	kg/t								
Product stacking from conveyor - Stage 3/2	78	167,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks - Stage 3/2	78	167,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Stage 4-1-W1a													
Stripping topsoil - Stage 4/1-W1a	560	40	h/y	14.0	kg/h								
Excavation of overburden- Stage 4/1-W1a	4	11,620	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Loading overburden to trucks for haulage emplacement area- Stage 4/1-W1a	4	11,620	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Hauling overburden to emplacement area- Stage 4/1-W1a	372	11,620	t/y	0.12800	kg/t	50	t/truck load	1.6	km/return trip	4.0	kg/VKT	75	% control
Emplacing overburden at emplacement area- Stage 4/1-W1a	4	11,620	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Dozer ripping sand - Stage 4/1-W1a	11,823	4,992	h/y	2.4	kg/h	10	silt content in %	9	moisture content in %				
Excavation of sand - Stage 4/1-W1a	31	118,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to stockpiles - Stage 4/1-W1a	31	118,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Loading sand to trucks for haulage to processor plants - Stage 4/1-W1a	31	118,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Hauling sand to processing plant (Site A) - Stage 4/1-W1a	3,794	118,571	t/y	0.12800	kg/t	50	t/truck load	1.6	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site A - Stage 4/1-W1a	31	118,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site A - Stage 4/1-W1a	6	23,714	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site A - Stage 4/1-W1a	25	94,857	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand- Stage 4/1-W1a	320	118,571		0.00270	kg/t								
Dry Screening - Stage 4/1-W1a	296	23,714	t/y	0.0125	kg/t								
Wet Screening - Stage 4/1-W1a	-	94,857	t/y	0.000	kg/t								
Product stacking from conveyor - Stage 4/1-W1a	39	83,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks - Stage 4/1-W1a	39	83,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Common													
FEL working on stockpiles	923	230	h/y	4.0	kg/h	10	silt content in %	6	moisture content (%)				
Transporting product off-site by road from Site A	1,333	250,000	t/y	0.00533	kg/t	30	t/truck load	0.8	km/return trip	0.2	kg/VKT		
Wind erosion from exposed areas (extraction and overburden areas)	18,922	5.4	ha	0.4	kg/ha/h	8,760	h						
Wind erosion from product stockpiles - all	1,752	0.5	ha	0.4	kg/ha/h	8,760	h						

```
------------------------------
  DUST EMISSION CALCULATIONS V2
 ------------------------------

 Output emissions file  :
C:\Jobs\Calga07\ISC\Y2\y2_emiss.dat
 Meteorological file    :
C:\Jobs\Calga07\Met\calga_2.isc
 Number of dust sources : 48
 Number of activities   : 40
 No-blast conditions    : None
 Wind sensitive factor  : 1.772 (1.832
adjusted for activity hours)
 Wind erosion factor    : 54.879

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil - Stage
3/2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 7
1 2 3 4 5 6 7
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Excavation of overburden-
Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 49 kg/y
 FROM SOURCES  : 7
1 2 3 4 5 6 7
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Loading overburden to
trucks for haulage emplacement area- Stage
3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 49 kg/y
 FROM SOURCES  : 7
1 2 3 4 5 6 7
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Hauling overburden to
emplacement area- Stage 3/2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1314 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Emplacing overburden at
emplacement area- Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 49 kg/y
 FROM SOURCES  : 4
10 11 12 13
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dozer ripping sand - Stage
3/2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11823 kg/y
 FROM SOURCES  : 7
1 2 3 4 5 6 7
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Excavation of sand  - Stage
3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 63 kg/y
 FROM SOURCES  : 7
1 2 3 4 5 6 7
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to stockpiles
- Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 63 kg/y
 FROM SOURCES  : 7
1 2 3 4 5 6 7
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Loading sand to trucks for
haulage to processor plants  - Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 63 kg/y
 FROM SOURCES  : 7
1 2 3 4 5 6 7
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Hauling sand to processing
plant (Site A)  - Stage 3/2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2863 kg/y
 FROM SOURCES  : 11
1 2 3 4 5 6 14 15 16 17 18
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site A - Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 63 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site A - Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 13 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0
```

```
 ACTIVITY NAME : Dumping sand to wet
processing plant at Site A - Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 50 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Crushing sand- Stage 3/2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 644 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dry Screening  - Stage 3/2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 596 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Wet Screening  - Stage 3/2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Product stacking from
conveyor  - Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 78 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Loading product to road
trucks  - Stage 3/2
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 78 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Stripping topsoil - Stage
4/1-W1a
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Excavation of overburden-
Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 4 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Loading overburden to
trucks for haulage emplacement area- Stage
4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 4 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Hauling overburden to
emplacement area- Stage 4/1-W1a
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 372 kg/y
 FROM SOURCES  : 17
21 22 23 24 25 26 27 28 29 30 42 43 44 45 46
47 48
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Emplacing overburden at
emplacement area- Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 4 kg/y
 FROM SOURCES  : 7
10 11 12 13 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dozer ripping sand - Stage
4/1-W1a
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11823 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Excavation of sand  - Stage
4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 31 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to stockpiles
- Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 31 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Loading sand to trucks for
haulage to processor plants  - Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 31 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0
```

```
 ACTIVITY NAME : Hauling sand to processing
plant (Site A)  - Stage 4/1-W1a
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3794 kg/y
 FROM SOURCES  : 16
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
36
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site A - Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 31 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site A - Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 6 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to wet
processing plant at Site A - Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 25 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Crushing sand- Stage 4/1-
W1a
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 320 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dry Screening  - Stage 4/1-
W1a
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 296 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Wet Screening  - Stage 4/1-
W1a
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Product stacking from
conveyor  - Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 39 kg/y
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Loading product to road
trucks  - Stage 4/1-W1a
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 39 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : FEL working on stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 923 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Transporting product off-
site by road from Site A
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1333 kg/y
 FROM SOURCES  : 8
19 20 21 37 38 39 40 41
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Wind erosion from exposed
areas (extraction and overburden areas)
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 18922 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 6 7 10 11 12 13 21 22 23 24 25 26
27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1

 ACTIVITY NAME : Wind erosion from product
stockpiles - all
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1752 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1
```

SCENARIO 2 – PART STAGE 3/2, STAGE 3/3 AND STAGE 4/3

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 3	Units
Stage 3/3													
Stripping topsoil - Stage 3/3	560	40	h/y	14.0	kg/h								
Excavation of overburden- Stage 3/3	21	55,674	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Loading overburden to trucks for haulage emplacement area- Stage 3/3	21	55,674	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Hauling overburden to emplacement area- Stage 3/3	1,113	55,674	t/y	0.08000	kg/t	50	t/truck load	1	km/return trip	4.0	kg/VKT	75	% control
Emplacing overburden at emplacement area- Stage 3/3	21	55,674	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Dozer ripping sand - Stage 3/3	11,823	4,992	h/y	2.4	kg/h	10	silt content in %	9	moisture content in %				
Excavation of sand - Stage 3/3	132	500,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to stockpiles - Stage 3/3	132	500,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Loading sand to trucks for haulage to processor plants - Stage 3/3	132	500,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Hauling sand to processing plant (Site B) - Stage 3/3	8,000	400,000	t/y	0.08000	kg/t	50	t/truck load	1	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site B - Stage 3/3	106	400,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site B - Stage 3/3	21	80,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site B - Stage 3/3	85	320,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand at Site B- Stage 3/3	1,080	400,000		0.00270	kg/t								
Dry Screening at Site B - Stage 3/3	1,000	80,000	t/y	0.0125	kg/t								
Wet Screening Site B - Stage 3/3	-	320,000	t/y	0.000	kg/t								
Product stacking from conveyor Site B - Stage 3/3	131	280,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks Site B - Stage 3/3	131	280,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Hauling sand to processing plant (Site C) - Stage 3/3	3,600	100,000	t/y	0.14400	kg/t	50	t/truck load	1.8	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site C - Stage 3/3	26	100,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site C - Stage 3/3	5	20,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site C - Stage 3/3	21	80,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand at Site C- Stage 3/3	270	100,000		0.00270	kg/t								
Dry Screening at Site C - Stage 3/3	250	20,000	t/y	0.0125	kg/t								
Wet Screening Site C - Stage 3/3	-	80,000	t/y	0.000	kg/t								
Product stacking from conveyor Site C - Stage 3/3	33	70,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks Site C - Stage 3/3	33	70,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Stage 4-3													
Stripping topsoil - Stage 4/3	560	40	h/y	14.0	kg/h								
Excavation of overburden- Stage 4/3	12	31,444	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Loading overburden to trucks for haulage emplacement area- Stage 4/3	12	31,444	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Hauling overburden to emplacement area- Stage 4/3	314	31,444	t/y	0.04000	kg/t	50	t/truck load	0.5	km/return trip	4.0	kg/VKT	75	% control
Emplacing overburden at emplacement area- Stage 4/3	8	31,444	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dozer ripping sand - Stage 4/3	11,823	4,992	h/y	2.4	kg/h	10	silt content in %	9	moisture content in %				
Excavation of sand - Stage 4/3	132	500,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to stockpiles - Stage 4/3	132	500,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Loading sand to trucks for haulage to processor plants - Stage 4/3	132	500,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Hauling sand to processing plant (Site C) - Stage 4/3	6,000	500,000	t/y	0.04800	kg/t	50	t/truck load	0.6	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site C - Stage 4/3	132	500,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site C - Stage 4/3	26	100,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site C - Stage 4/3	106	400,000	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand Site C - Stage 4/3	1,350	500,000		0.00270	kg/t								
Dry Screening Site C - Stage 4/3	1,250	100,000	t/y	0.0125	kg/t								
Wet Screening Site C - Stage 4/3	-	400,000	t/y	0.000	kg/t								
Product stacking from conveyor Site C - Stage 4/3	163	350,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks Site C - Stage 4/3	163	350,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Common													
FEL working on stockpiles	923	230	h/y	4.0	kg/h	10	silt content in %	6	moisture content (%)				
Transporting product off-site by road from Site B	3,733	280,000	t/y	0.01333	kg/t	30	t/truck load	2	km/return trip	0.2	kg/VKT		
Transporting product off-site by road from Site C	5,320	420,000	t/y	0.01267	kg/t	30	t/truck load	1.9	km/return trip	0.2	kg/VKT		
Wind erosion from exposed areas (extraction and overburden areas)	37,493	10.7	ha	0.4	kg/ha/h	8,760	h						
Wind erosion from product stockpiles - all	10,162	2.9	ha	0.4	kg/ha/h	8,760	h						

```
------------------------------
  DUST EMISSION CALCULATIONS V2
 ------------------------------

 Output emissions file  :
C:\Jobs\Calga07\ISC\Y5\y5_emiss.dat
 Meteorological file    :
C:\Jobs\Calga07\Met\calga_2.isc
 Number of dust sources : 54
 Number of activities   : 50
 No-blast conditions    : None
 Wind sensitive factor  : 1.772 (1.833
adjusted for activity hours)
 Wind erosion factor    : 54.879

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil - Stage
3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 12
1 2 3 4 5 6 7 8 9 10 22 23
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of overburden-
Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21 kg/y
 FROM SOURCES  : 12
1 2 3 4 5 6 7 8 9 10 22 23
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading overburden to
trucks for haulage emplacement area- Stage
3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21 kg/y
 FROM SOURCES  : 12
1 2 3 4 5 6 7 8 9 10 22 23
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling overburden to
emplacement area- Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1113 kg/y
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 22 23 32 33
34 35 36 37 38 39 40
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Emplacing overburden at
emplacement area- Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21 kg/y
 FROM SOURCES  : 9
32 33 34 35 36 37 38 39 40
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dozer ripping sand - Stage
3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11823 kg/y
 FROM SOURCES  : 12
1 2 3 4 5 6 7 8 9 10 22 23
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of sand  - Stage
3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 132 kg/y
 FROM SOURCES  : 12
1 2 3 4 5 6 7 8 9 10 22 23
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to stockpiles
- Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 132 kg/y
 FROM SOURCES  : 12
1 2 3 4 5 6 7 8 9 10 22 23
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading sand to trucks for
haulage to processor plants  - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 132 kg/y
 FROM SOURCES  : 12
1 2 3 4 5 6 7 8 9 10 22 23
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling sand to processing
plant (Site B)  - Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 8000 kg/y
 FROM SOURCES  : 16
1 2 3 4 5 6 7 8 9 10 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site B - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 106 kg/y
 FROM SOURCES  : 1
28
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site B - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21 kg/y
 FROM SOURCES  : 1
28
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0
```

```
 ACTIVITY NAME : Dumping sand to wet
processing plant at Site B - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 85 kg/y
 FROM SOURCES  : 1
28
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Crushing sand at Site B-
Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1080 kg/y
 FROM SOURCES  : 1
28
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dry Screening at Site B -
Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1000 kg/y
 FROM SOURCES  : 1
28
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wet Screening Site B -
Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
28
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Product stacking from
conveyor Site B  - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 131 kg/y
 FROM SOURCES  : 1
29
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading product to road
trucks  Site B - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 131 kg/y
 FROM SOURCES  : 2
29 30
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling sand to processing
plant (Site C)  - Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3600 kg/y
 FROM SOURCES  : 20
1 2 3 4 5 6 7 8 9 10 22 23 24 25 26 27 47 48
49 50
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site C - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 26 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site C - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 5 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to wet
processing plant at Site C - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Crushing sand at Site C-
Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 270 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dry Screening at Site C -
Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 250 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wet Screening Site C -
Stage 3/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Product stacking from
conveyor Site C  - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 33 kg/y
 FROM SOURCES  : 1
51
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0
```

```
 ACTIVITY NAME : Loading product to road
trucks  Site C - Stage 3/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 33 kg/y
 FROM SOURCES  : 2
51 52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Stripping topsoil - Stage
4/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of overburden-
Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 12 kg/y
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading overburden to
trucks for haulage emplacement area- Stage
4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 12 kg/y
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling overburden to
emplacement area- Stage 4/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 314 kg/y
 FROM SOURCES  : 19
11 12 13 14 15 16 17 18 19 20 32 33 34 35 36
37 38 39 40
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Emplacing overburden at
emplacement area- Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 8 kg/y
 FROM SOURCES  : 9
32 33 34 35 36 37 38 39 40
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dozer ripping sand - Stage
4/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11823 kg/y
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of sand  - Stage
4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 132 kg/y
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to stockpiles
- Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 132 kg/y
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading sand to trucks for
haulage to processor plants  - Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 132 kg/y
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling sand to processing
plant (Site C)  - Stage 4/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6000 kg/y
 FROM SOURCES  : 12
11 12 13 14 15 16 17 18 19 20 31 49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site C - Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 132 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site C - Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 26 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dumping sand to wet
processing plant at Site C - Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 106 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0
```

```
 ACTIVITY NAME : Crushing sand Site C -
Stage 4/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1350 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Dry Screening  Site C -
Stage 4/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1250 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Wet Screening  Site C -
Stage 4/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
52
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Product stacking from
conveyor Site C - Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 163 kg/y
 FROM SOURCES  : 1
51
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Loading product to road
trucks Site C - Stage 4/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 163 kg/y
 FROM SOURCES  : 2
51 52
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : FEL working on stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 923 kg/y
 FROM SOURCES  : 5
50 51 52 53 54
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Transporting product off-
site by road from Site B
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3733 kg/y
 FROM SOURCES  : 17
3 4 10 18 19 20 21 40 41 42 43 44 45 46 47
48 49
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Transporting product off-
site by road from Site C
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5320 kg/y
 FROM SOURCES  : 15
3 4 10 18 19 20 21 40 41 42 43 44 45 46 49
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 0

 ACTIVITY NAME : Wind erosion from exposed
areas (extraction and overburden areas)
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 37493 kg/y
 FROM SOURCES  : 30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
19 20 21 32 33 34 35 36 37 38 39 40
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1

 ACTIVITY NAME : Wind erosion from product
stockpiles - all
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 10162 kg/y
 FROM SOURCES  : 9
27 28 29 30 50 51 52 53 54
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1
```

SCENARIO 3 – STAGE 3/5, STAGE 3/6, W4 OF STAGE 4/5 AND S5 OF STAGE 4/5

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 3	Units
Stage 3/5 + Stage 3/6													
Stripping topsoil - Stage 3/5 and 3/6	560	40	h/y	14.0	kg/h								
Excavation of overburden- Stage 3/5 and 3/6	15	39,270	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Loading overburden to trucks for haulage emplacement area- Stage 3/5 and 3/6	15	39,270	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Hauling overburden to emplacement area- Stage 3/5 and 3/6	1,100	39,270	t/y	0.11200	kg/t	50	t/truck load	1.4	km/return trip	4.0	kg/VKT	75	% control
Emplacing overburden at emplacement area- Stage 3/5 and 3/6	15	39,270	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Dozer ripping sand - Stage 3/5 and 3/6	11,823	4,992	h/y	2.4	kg/h	10	silt content in %	9	moisture content in %				
Excavation of sand - Stage 3/5 and 3/6	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to stockpiles - Stage 3/5 and 3/6	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Loading sand to trucks for haulage to processor plants - Stage 3/5 and 3/6	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Hauling sand to processing plant (Ste D) - Stage 3/5 and 3/6	18,571	714,286	t/y	0.10400	kg/t	50	t/truck load	1.3	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site D - Stage 3/5 and 3/6	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site D - Stage 3/5 and 3/6	38	142,857	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site D - Stage 3/5 and 3/6	151	571,429	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand- Stage 3/5 and 3/6	1,929	714,286		0.00270	kg/t								
Dry Screening - Stage 3/5 and 3/6	1,786	142,857	t/y	0.0125	kg/t								
Wet Screening - Stage 3/5 and 3/6	-	571,429	t/y	0.000	kg/t								
Product stacking from conveyor - Stage 3/5 and 3/6	233	500,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks - Stage 3/5 and 3/6	233	500,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Stage 4/2b, Stage 4/5-W4 and Stage 4/5-S5													
Stripping topsoil - Stage 4/2b, 4/2b, 4/5-W4 and 4/5-S5	560	40	h/y	14.0	kg/h								
Excavation of overburden- Stage 4/2b, 4/2b, 4/5-W4 and 4/5-S5	37	98,840	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Loading overburden to trucks for haulage emplacement area- Stage 4/2b, 4/5-W4 and 4/5-S5	37	98,840	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Hauling overburden to emplacement area- Stage 4/2b, 4/5-W4 and 4/5-S5	1,977	98,840	t/y	0.08000	kg/t	50	t/truck load	1	km/return trip	4.0	kg/VKT	75	% control
Emplacing overburden at emplacement area- Stage 4/2b, 4/5-W4 and 4/5-S5	37	98,840	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Dozer ripping sand - Stage 4/2b, 4/5-W4 and 4/5-S5	11,823	4,992	h/y	2.4	kg/h	10	silt content in %	9	moisture content in %				
Excavation of sand - Stage 4/2b, 4/5-W4 and 4/5-S5	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to stockpiles - Stage 4/2b, 4/5-W4 and 4/5-S5	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Loading sand to trucks for haulage to processor plants - Stage 4/2b, 4/5-W4 and 4/5-S5	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Hauling sand to processing plant (Ste D) - Stage 4/2b, 4/5-W4 and 4/5-S5	8,571	714,286	t/y	0.04800	kg/t	50	t/truck load	0.6	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site D - Stage 4/2b, 4/5-W4 and 4/5-S5	189	714,286	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site D - Stage 4/2b, 4/5-W4 and 4/5-S5	38	142,857	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site D - Stage 4/2b, 4/5-W4 and 4/5-S5	151	571,429	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand- Stage 4/2b, 4/5-W4 and 4/5-S5	1,929	714,286		0.00270	kg/t								
Dry Screening - Stage 4/2b, 4/5-W4 and 4/5-S5	1,786	142,857	t/y	0.0125	kg/t								
Wet Screening - Stage 4/2b, 4/5-W4 and 4/5-S5	-	571,429	t/y	0.000	kg/t								
Product stacking from conveyor - Stage 4/2b, 4/5-W4 and 4/5-S5	233	500,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks - Stage 4/2b, 4/5-W4 and 4/5-S5	233	500,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Common													
FEL working on stockpiles	923	230	h/y	4.0	kg/h	10	silt content in %	6	moisture content (%)				
Transporting product off-site by road from Site D	10,667	1,000,000	t/y	0.01067	kg/t	30	t/truck load	1.6	km/return trip	0.2	kg/VKT		
Wind erosion from exposed areas (extraction and overburden areas)	55,714	15.9	ha	0.4	kg/ha/h	8,760	h						
Wind erosion from product stockpiles - all	15,067	4.3	ha	0.4	kg/ha/h	8,760	h						

```
  ------------------------------
  DUST EMISSION CALCULATIONS V2
 ------------------------------

 Output emissions file  :
C:\Jobs\Calga07\ISC\Y9\y9_emiss.dat
 Meteorological file    :
C:\Jobs\Calga07\Met\calga_2.isc
 Number of dust sources : 61
 Number of activities   : 40
 No-blast conditions    : None
 Wind sensitive factor  : 1.772 (1.833
adjusted for activity hours)
 Wind erosion factor    : 54.879

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil - Stage
3/5 and 3/6
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of overburden-
Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 15 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading overburden to
trucks for haulage emplacement area- Stage
3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 15 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling overburden to
emplacement area- Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1100 kg/y
 FROM SOURCES  : 30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 19 20
21 22 23 24 25 26 27 28 29 30 31 32
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Emplacing overburden at
emplacement area- Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 15 kg/y
 FROM SOURCES  : 14
19 20 21 22 23 24 25 26 27 28 29 30 31 32
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dozer ripping sand - Stage
3/5 and 3/6
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11823 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of sand  - Stage
3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to stockpiles
- Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading sand to trucks for
haulage to processor plants  - Stage 3/5 and
3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling sand to processing
plant (Site D)  - Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 18571 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site D - Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site D - Stage 3/5 and
3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 38 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0
```

```
 ACTIVITY NAME : Dumping sand to wet
processing plant at Site D - Stage 3/5 and
3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 151 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Crushing sand- Stage 3/5
and 3/6
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1929 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dry Screening  - Stage 3/5
and 3/6
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1786 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wet Screening  - Stage 3/5
and 3/6
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Product stacking from
conveyor  - Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 233 kg/y
 FROM SOURCES  : 1
48
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading product to road
trucks  - Stage 3/5 and 3/6
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 233 kg/y
 FROM SOURCES  : 1
48
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Stripping topsoil - Stage
4/2b, 4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 8
37 38 39 40 41 42 43 44
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of overburden-
Stage 4/2b, 4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 37 kg/y
 FROM SOURCES  : 8
37 38 39 40 41 42 43 44
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading overburden to
trucks for haulage emplacement area- Stage
4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 37 kg/y
 FROM SOURCES  : 8
37 38 39 40 41 42 43 44
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling overburden to
emplacement area- Stage 4/2b, 4/5-W4 and
4/5-S5
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1977 kg/y
 FROM SOURCES  : 14
33 34 35 36 37 38 39 40 41 42 43 44 46 47
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Emplacing overburden at
emplacement area- Stage 4/2b, 4/5-W4 and
4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 37 kg/y
 FROM SOURCES  : 4
33 34 35 36
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dozer ripping sand - Stage
4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11823 kg/y
 FROM SOURCES  : 9
36 37 38 39 40 41 42 43 44
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of sand  - Stage
4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 9
36 37 38 39 40 41 42 43 44
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to stockpiles
- Stage 4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 9
36 37 38 39 40 41 42 43 44
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0
```

```
 ACTIVITY NAME : Loading sand to trucks for
haulage to processor plants  - Stage 4/2b,
4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 9
36 37 38 39 40 41 42 43 44
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling sand to processing
plant (Site D)  - Stage 4/2b, 4/5-W4 and
4/5-S5
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 8571 kg/y
 FROM SOURCES  : 11
37 38 39 40 41 42 43 44 46 47 49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site D - Stage 4/2b, 4/5-W4 and
4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 189 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site D - Stage 4/2b,
4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 38 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to wet
processing plant at Site D - Stage 4/2b,
4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 151 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Crushing sand- Stage 4/2b,
4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1929 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dry Screening  - Stage
4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1786 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wet Screening  - Stage
4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
49
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Product stacking from
conveyor  - Stage 4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 233 kg/y
 FROM SOURCES  : 1
48
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading product to road
trucks  - Stage 4/2b, 4/5-W4 and 4/5-S5
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 233 kg/y
 FROM SOURCES  : 1
48
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : FEL working on stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 923 kg/y
 FROM SOURCES  : 3
45 46 47
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Transporting product off-
site by road from Site D
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 10667 kg/y
 FROM SOURCES  : 17
17 18 46 47 49 50 51 52 53 54 55 56 57 58 59
60 61
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wind erosion from exposed
areas (extraction and overburden areas)
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 55714 kg/y
 FROM SOURCES  : 37
1 2 3 4 5 6 7 8 9 15 16 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
41 42 43 44
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1

 ACTIVITY NAME : Wind erosion from product
stockpiles - all
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 15067 kg/y
 FROM SOURCES  : 3
45 46 47
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1
```

SCENARIO 4 –STAGE 5/3

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 3	Units
				Stage 5/3									
Stripping topsoil - Stage 5/3	560	40	h/y	14.0	kg/h								
Excavation of overburden- Stage 5/3	18	47,600	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Loading overburden to trucks for haulage emplacement area- Stage 5/3	18	47,600	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Hauling overburden to emplacement area- Stage 5/3	476	47,600	t/y	0.04000	kg/t	50	t/truck load	0.5	km/return trip	4.0	kg/VKT	75	% control
Emplacing overburden at emplacement area- Stage 5/3	18	47,600	t/y	0.00038	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	7	moisture content (%)				
Dozer ripping sand - Stage 5/3	11,823	4,992	h/y	2.4	kg/h	10	silt content in %	9	moisture content in %				
Excavation of sand - Stage 5/3	378	1,428,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to stockpiles - Stage 5/3	378	1,428,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Loading sand to trucks for haulage to processor plants - Stage 5/3	378	1,428,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Hauling sand to processing plant (Site D) - Stage 5/3	91,429	1,428,571	t/y	0.25600	kg/t	50	t/truck load	3.2	km/return trip	4.0	kg/VKT	75	% control
Dumping sand to crushing plant at Site D - Stage 5/3	378	1,428,571	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to dry processing plant at Site D - Stage 5/3	76	285,714	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Dumping sand to wet processing plant at Site D - Stage 5/3	302	1,142,857	t/y	0.00026	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)				
Crushing sand- Stage 5/3	3,857	1,428,571		0.00270	kg/t								
Dry Screening - Stage 5/3	3,571	285,714	t/y	0.0125	kg/t								
Wet Screening - Stage 5/3	-	1,142,857	t/y	0.000	kg/t								
Product stacking from conveyor - Stage 5/3	466	1,000,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
Loading product to road trucks - Stage 5/3	466	1,000,000	t/y	0.00047	kg/t	1.833	average of (wind speed/2.2)^1.3 in m/s	6	moisture content (%)				
FEL working on stockpiles	923	230	h/y	4.0	kg/h	10	silt content in %	6	moisture content (%)				
Transporting product off-site by road from Site D	10,667	1,000,000	t/y	0.01067	kg/t	30	t/truck load	1.6	km/return trip	0.2	kg/VKT		
Wind erosion from exposed areas (extraction and overburden areas)	14,016	4.0	ha	0.4	kg/ha/h	8,760	h						
Wind erosion from product stockpiles - all	15,067	4.3	ha	0.4	kg/ha/h	8,760	h						

```
------------------------------
  DUST EMISSION CALCULATIONS V2
 ------------------------------

 Output emissions file  :
C:\Jobs\Calga07\ISC\Y22\y22_emiss.dat
 Meteorological file    :
C:\Jobs\Calga07\Met\calga_2.isc
 Number of dust sources : 32
 Number of activities   : 22
 No-blast conditions    : None
 Wind sensitive factor  : 1.772 (1.833
adjusted for activity hours)
 Wind erosion factor    : 54.879

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil - Stage
5/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of overburden-
Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 18 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading overburden to
trucks for haulage emplacement area- Stage
5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 18 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling overburden to
emplacement area- Stage 5/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 476 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Emplacing overburden at
emplacement area- Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 18 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dozer ripping sand - Stage
5/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11823 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Excavation of sand  - Stage
5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 378 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to stockpiles
- Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 378 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading sand to trucks for
haulage to processor plants  - Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 378 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Hauling sand to processing
plant (Site D)  - Stage 5/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 91429 kg/y
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
19 20 21 22 23 24 25
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to crushing
plant at Site D - Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 378 kg/y
 FROM SOURCES  : 1
26
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to dry
processing plant at Site D - Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 76 kg/y
 FROM SOURCES  : 1
26
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dumping sand to wet
processing plant at Site D - Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 302 kg/y
 FROM SOURCES  : 1
26
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0
```

```
ACTIVITY NAME : Crushing sand- Stage 5/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3857 kg/y
 FROM SOURCES  : 1
26
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Dry Screening  - Stage 5/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3571 kg/y
 FROM SOURCES  : 1
26
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wet Screening  - Stage 5/3
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
26
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Product stacking from
conveyor  - Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 466 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Loading product to road
trucks  - Stage 5/3
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 466 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : FEL working on stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 923 kg/y
 FROM SOURCES  : 3
26 27 28
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Transporting product off-
site by road from Site D
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 10667 kg/y
 FROM SOURCES  : 9
18 19 20 21 22 23 24 31 32
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wind erosion from exposed
areas (extraction and overburden areas)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 14016 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0

 ACTIVITY NAME : Wind erosion from product
stockpiles - all
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 15067 kg/y
 FROM SOURCES  : 6
25 26 27 28 29 30
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0
```