Hy-Tec Industries Pty Limited

ABN: 90 070 100 702

Austen Quarry
Stage 2 Extension Project

Air Quality Assessment

Prepared by

Benbow Environmental

September 2014

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Air Quality Assessment

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CONTENTS

Page

CONTENTS

Page

ATTACHMENTS

FIGURES

CONTENTS

Page

TABLES

EQUATIONS

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EXECUTIVE SUMMARY

Benbow Environmental has been engaged by RW Corkery & Co Pty Ltd on behalf of Hy-Tec Industries Pty Limited to conduct an Air Quality and Greenhouse Gas Assessment for the Stage 2 Extension of the Austen Quarry ("the Proposal"). An assessment of environmental constraints was undertaken previous to this assessment. This report has been prepared to provide details of the environmental impact assessment.

Austen Quarry ("the quarry") is located approximately 3.5km south-southwest of Hartley village and 10km south of Lithgow. At the quarry, Rhyolite, an extrusive volcanic rock which is blasted, crushed and screened to produce high quality aggregates and crushed rock, for sale to regional and Sydney markets. The extension would increase the life of the quarry by an estimated 30 years when operating at the current maximum production rate of 1.1 Mtpa (production currently averages 700,000 tpa).

This Air Quality Assessment (including a Greenhouse Gas Assessment) has been conducted in accordance with the NSW Environment Protection Authority (NSW EPA) guidelines, with the criteria also sourced from these guidelines. These criteria are consistent with the National Environment Protection Measure ambient air quality goals published by the statutory body, the National Environment Protection Council (NEPC). In addition to the determination of appropriate meteorological data, selection of modelling techniques, the terrain, emission factors and rates, and building wake effects were also appropriately considered.

The assessment was conducted in accordance with the NSW EPA "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales"*, as well as the newly published "*Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia'"*.

The air emissions impacts at the nearest identified receptors within the vicinity of the quarry were determined using CALPUFF.

No exceedances have been predicted for any of the scenarios examined. Recommendations relating to management of blasting and other operational activities have been noted to ensure that compliance would be achieved at all times as a result of the Proposal.

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1. INTRODUCTION

Benbow Environmental has been engaged by RW Corkery & Co Pty Ltd on behalf of Hy-Tec Industries Pty Limited to conduct an Air Quality Assessment (including a Greenhouse Gas Assessment) for the Stage 2 Extension of the Austen Quarry ("the Proposal"). An assessment of environmental constraints was undertaken previous to this assessment. This report has been prepared to provide details of the environmental impact assessment.

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This report examines the air quality impacts, including greenhouse gases, from the Proposal to the surrounding privately-owned residences.

1.1 SCOPE OF WORKS

The scope of this assessment has been limited to the following:

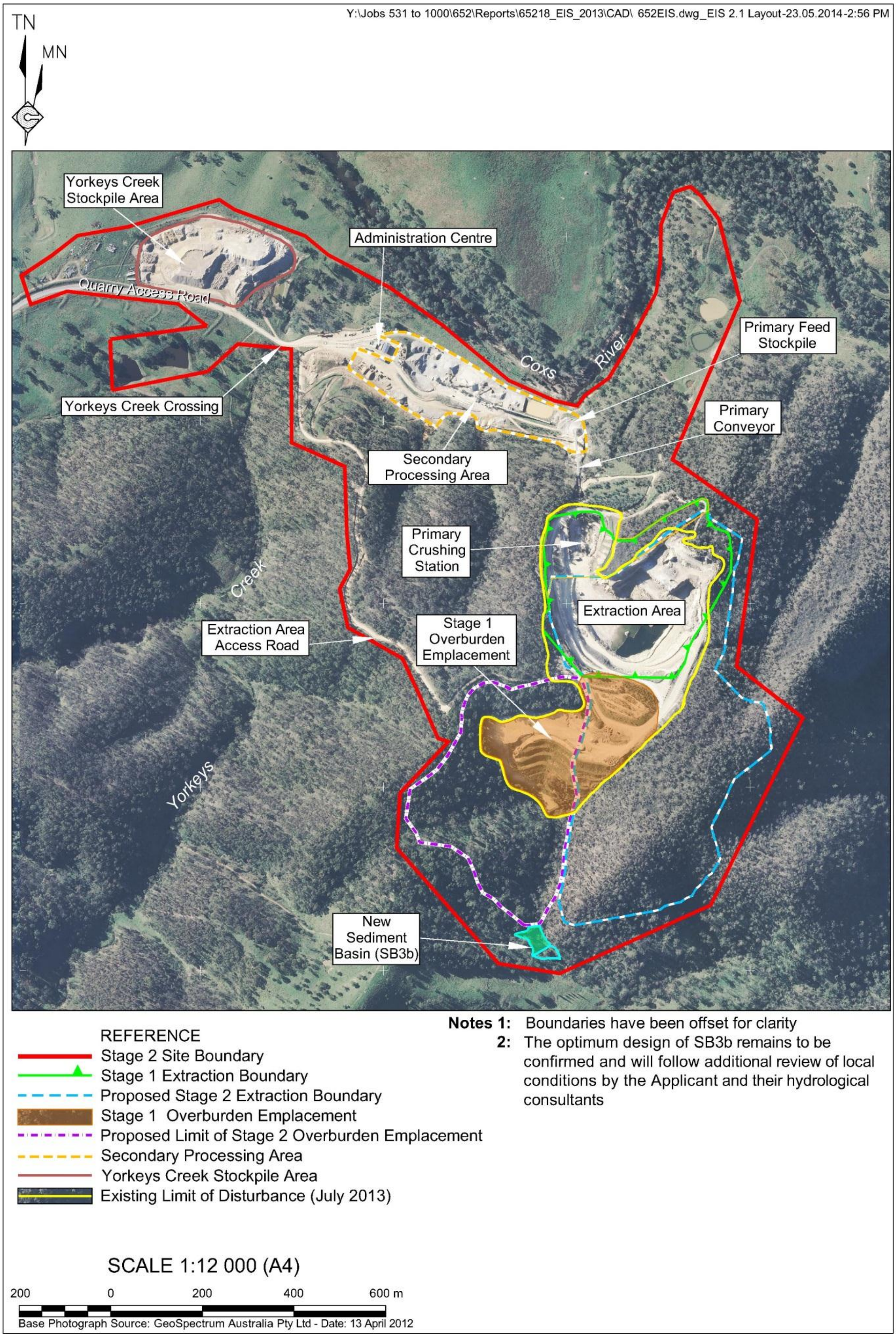
- Include a brief description of the Proposal;
- Undertake an assessment of predicted air quality impacts surrounding the Study Area, particularly at surrounding privately-owned residences, and relate it to appropriate criteria;
- Undertake a greenhouse gas assessment for the Proposal in accordance with relevant guidelines;
- Based on the initial air quality modelling, recommend operational safeguards/mitigation measures to alleviate potential impact and achieve compliance with nominated air quality criteria;
- Following a review of initial modelling results to predict residual air quality impacts, complete additional modelling as required;
- Ensure the requirements of the Director-General, EPA and other government agencies relating to air quality are addressed; and
- Identify the need for on-going monitoring and outline appropriate monitoring locations and parameters.

2. PROJECT DESCRIPTION

2.1 INTRODUCTION

The Austen Quarry ("see **Figure 2–1**") is located approximately 3.5km south-southwest of the village of Hartley and 10km south of Lithgow. The quarry is located on rural land, owned by the Hartley Pastoral Corporation Pty Ltd (HPC), and is currently operating under Development Consent No. 103/94 (DA 103/94), which approves the extraction, screening and despatch of up to 1.1 million tonnes of rhyolite products per year until March 2020. Hy-Tec Industries Pty Limited ("the Applicant") proposes to extend the extraction area and overburden emplacement of the quarry in order to extend the operational life of the quarry (until 2050).

Figure 2-1: Main Areas and Location of Interest for Stage 2



Source: Curtesy of R. W. Corkery & Co Pty Ltd 2014

For the purposes of this document, reference is made to existing approved components or activities as "Stage 1" and new or extended components or activities as "Stage 2". The locations of all components, which together are referred to as the Site (an area of approximately 144ha) are shown in **Figure 2–2**.

It is noted that should development consent be granted for the Proposal, the Stage 2 extraction area would incorporate the existing Stage 1 extraction area and likewise, the Stage 2 overburden emplacement would incorporate the Stage 1 overburden emplacement.

2.2 STAGING OF THE PROJECT

Figure 2–2 has been provided as the appropriate extraction sequence for the Stage 2 Extension. Out of the number of stages outlined in the sequence, it was deemed appropriate by the project team to use Stages A, C, and E to assess the impacts associated with the Proposal on air quality.

2.3 EXTRACTION OPERATIONS

Extraction operations would continue to be undertaken in a similar manner to existing operations i.e. using conventional drill and blast, load and haul methods. This would involve a sequence of activities commencing with vegetation clearing and topsoil/subsoil removal, and where necessary stockpiling this for future rehabilitation, followed by overburden removal (where present) and finally extraction of the rhyolite.

This subsection presents information relating to the proposed extended extraction operations including vegetation clearing, soil removal, overburden removal, extraction methods, extraction rates and the mobile equipment fleet.

The Stage 2 extraction area would incorporate a lateral extension of a deepening the existing (Stage 1) extraction area along an adjacent southwest-northwest trending ridge. The northern side of the ride within the existing Stage 1 extraction area would remain as a visual barrier to views from the north. The area of the extension covers approximately 16.1ha and lies immediately to the southeast and east of the Stage 1 extraction area. The combined area of the Stage 1 and Stage 2 extraction areas would be 28.2ha. Extraction is proposed to a depth of 685m AHD, approximately 60m deeper than the current extraction area floor (745m AHD) and 50m deeper than the footings of the primary crushing station (735m AHD).

Although subject to modifications based on localised geological conditions or the optimal locations of quarry ramps or sumps, the following general design criteria of the Stage 2 extraction area would be adopted:

- Operational Face Height: 15m;
- Operational Bench Width: 20-100m;
- Terminal Bench Width: 5m-10m; and
- Face Angle: 70^{o} (approximate).

The proposed maximum 70^{o} face angle would be subject to further geotechnical investigation throughout the life of the quarry to ensure a safe and stable landform is achieved within the extraction area.

Vegetation would continue to be cleared by bulldozer and/or hydraulic excavator on steeper slopes or more densely vegetated areas. The cleared vegetation would be stockpiled for future placement, mulched and/or immediately placed on prepared sections of the overburden emplacement. Selected material may be made available for use by the land owner or sold for the purposes of fencing materials or firewood. The extent of clearing would be typically between 1.1ha to 6.6ha during each stage with between 1.0 and 2.0ha cleared at one time.

While soil depths are limited due to the outcropping nature of the rhyolite, any recoverable resources would be stripped using a bulldozer and/or excavator loaded into trucks and either stockpiled within an interim area within the overburden emplacement for future placement, or immediately placed on prepared sections of the overburden emplacement. The area of land cleared at any one time would be confined to an area that can be shaped and profiled such that all runoff from the cleared area is directed back into the active extraction area.

Following the removal of recoverable soil, any rippable rock that is not suitable for processing would be ripped by bulldozer or hydraulically excavated and loaded into haul trucks and placed within the overburden emplacement. Overburden above the rhyolite too hard to be ripped would be drilled and blasted before the material is loaded and hauled to the overburden emplacement. These development blasts would generally be smaller than production blasts due to the proximity to surface and associated potential for noise and fly-rock impacts.

Current quarry planning indicates approximately 2,200,000m^3 (4.4Mt) of overburden and interburden (including dyke material and weathered rock) would be removed throughout the life of the proposal. It is anticipated that the quantity of overburden removed each year would vary depending on the development activities undertaken during that year. It would generally be between 100,000t and 400,000t annually, although negligible quantities could be extracted during some years.

The exposed rhyolite would be drilled and blasted with the fractured rock loaded into haul trucks and tipped into the hopper at the primary crushing station. On average, each production blast would remove approximately 60,000t, although larger blasts of up to 100,000t or more may be planned whilst maintaining compliance with noise and vibration criteria. A blast yielding 60,000t would cover a surface area of approximately 1,600m^2, i.e. based upon a 15m high bench.

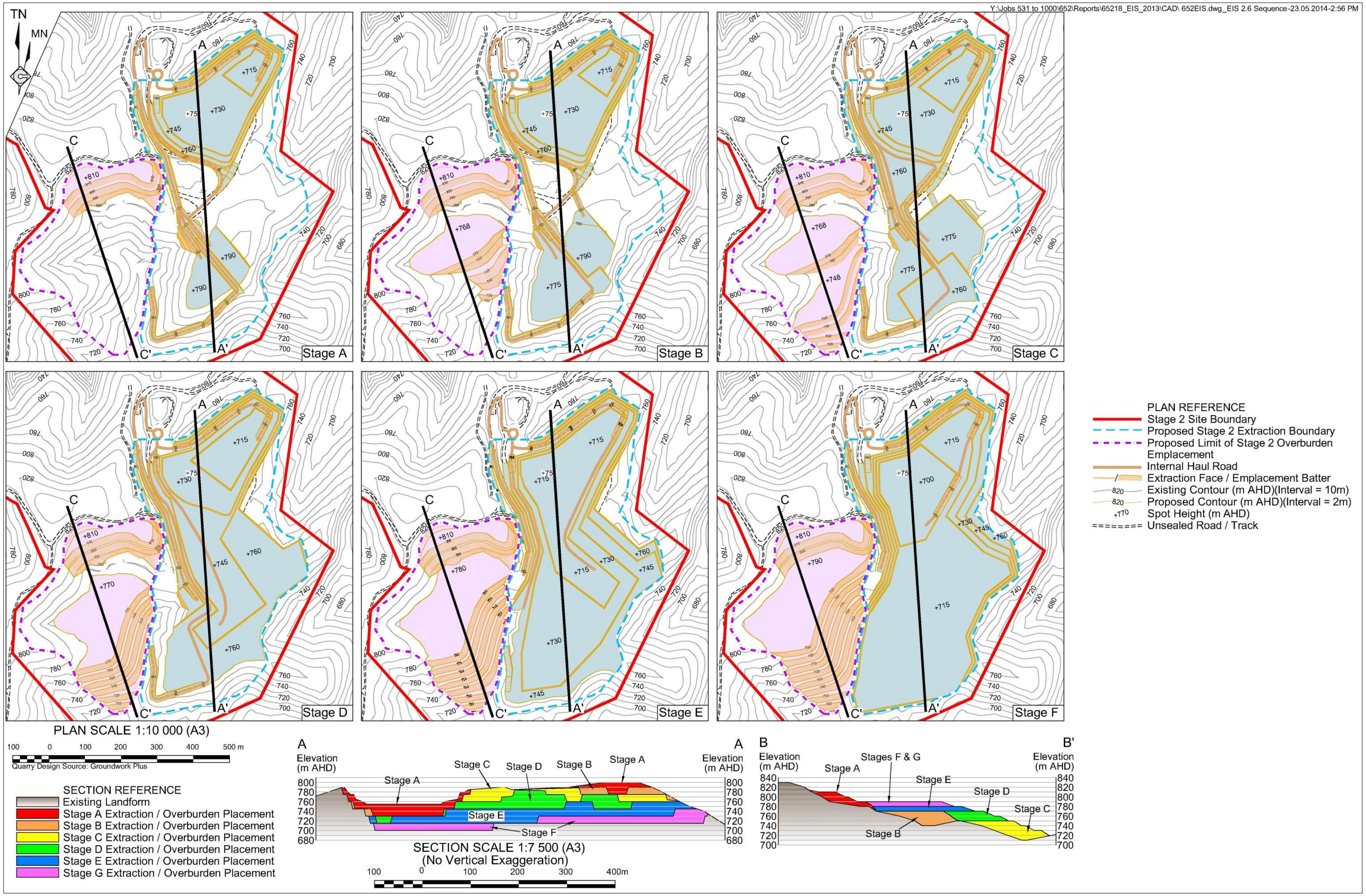
With the addition of one further haul truck and the increased capacity of the haul trucks from 40t to 60t to account for the increased overburden movement and production up to the maximum approved limit, the Applicant would continue to operate the same or equivalent mobile equipment throughout the life of the Proposal. The Applicant would also continue to operate one water truck between the Stage 2 extraction area and the secondary processing area and a fleet of light and maintenance vehicles. A drill rig would continue to be brought in on a contract basis for drilling blast holes. The number of items of mobile equipment is based upon the extraction of 1.1Mtpa of rhyolite and a maximum quantity of overburden of 0.4Mtpa.

Figure 2–4 to **Figure 2–6** outline the location of the equipment utilised for the extraction activities. Further details are provided in **Attachment 1**.

2.4 CRUSHING, SCREENING AND STOCKPILING OPERATIONS

The processing operations involve the use of a series of crushers and screens to crush and separate the rhyolite into various size aggregates and to blend some products to produce customised road pavement products.

Figure 2-2: Proposed Extraction Sequence for the Stage 2 Extension Project



Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

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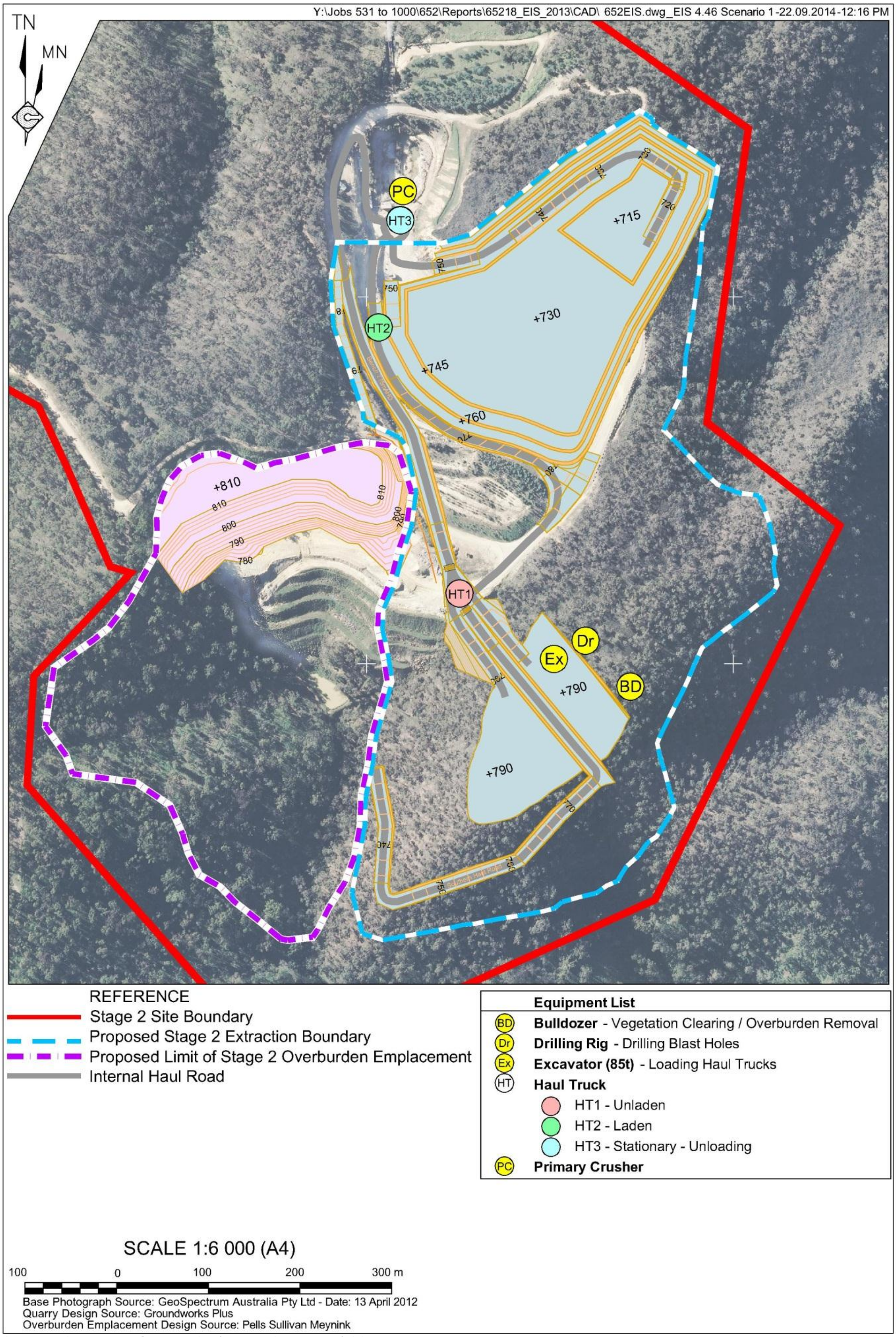
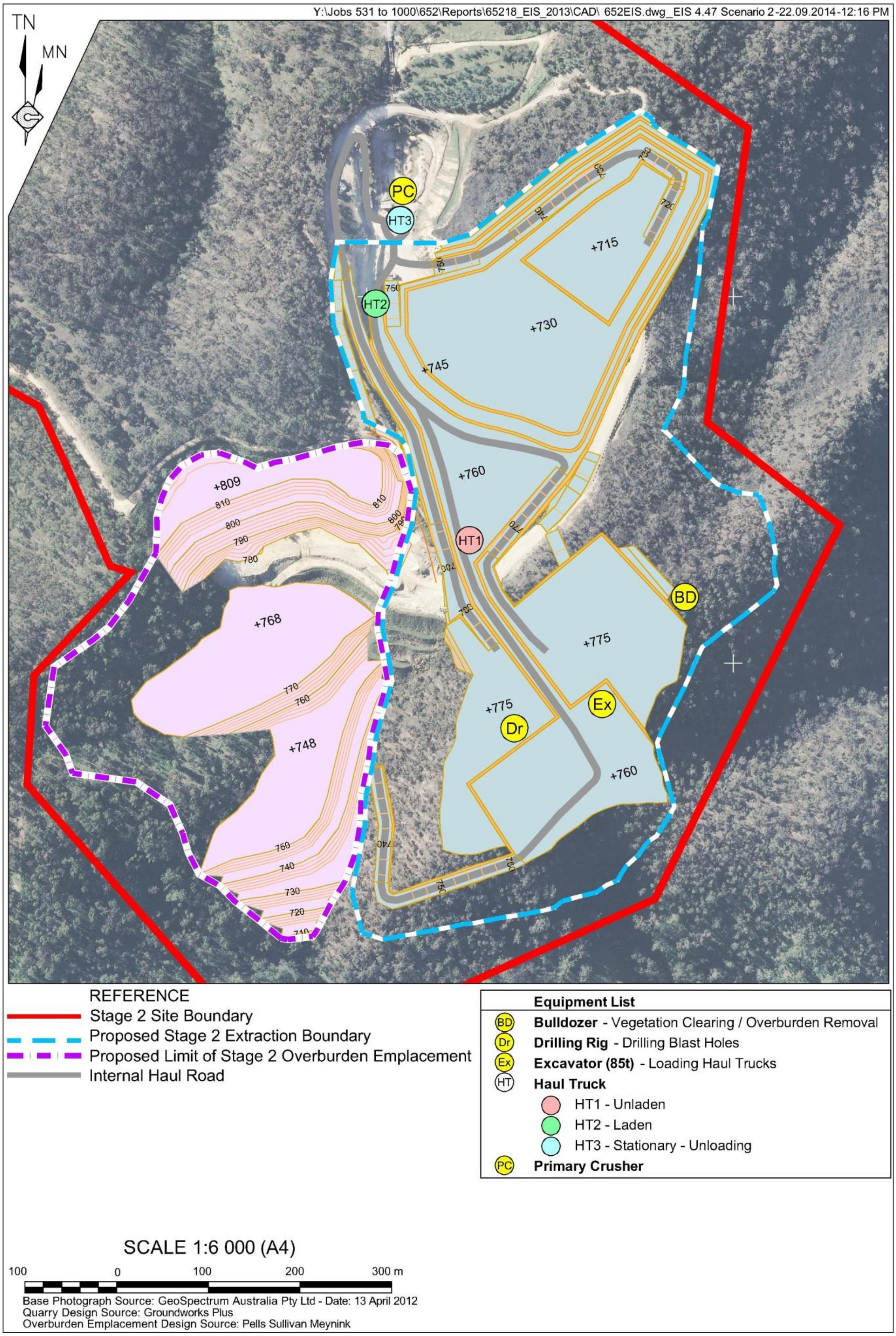
Figure 2-3: Scenario 1 - Location of Equipment at the Quarry Area



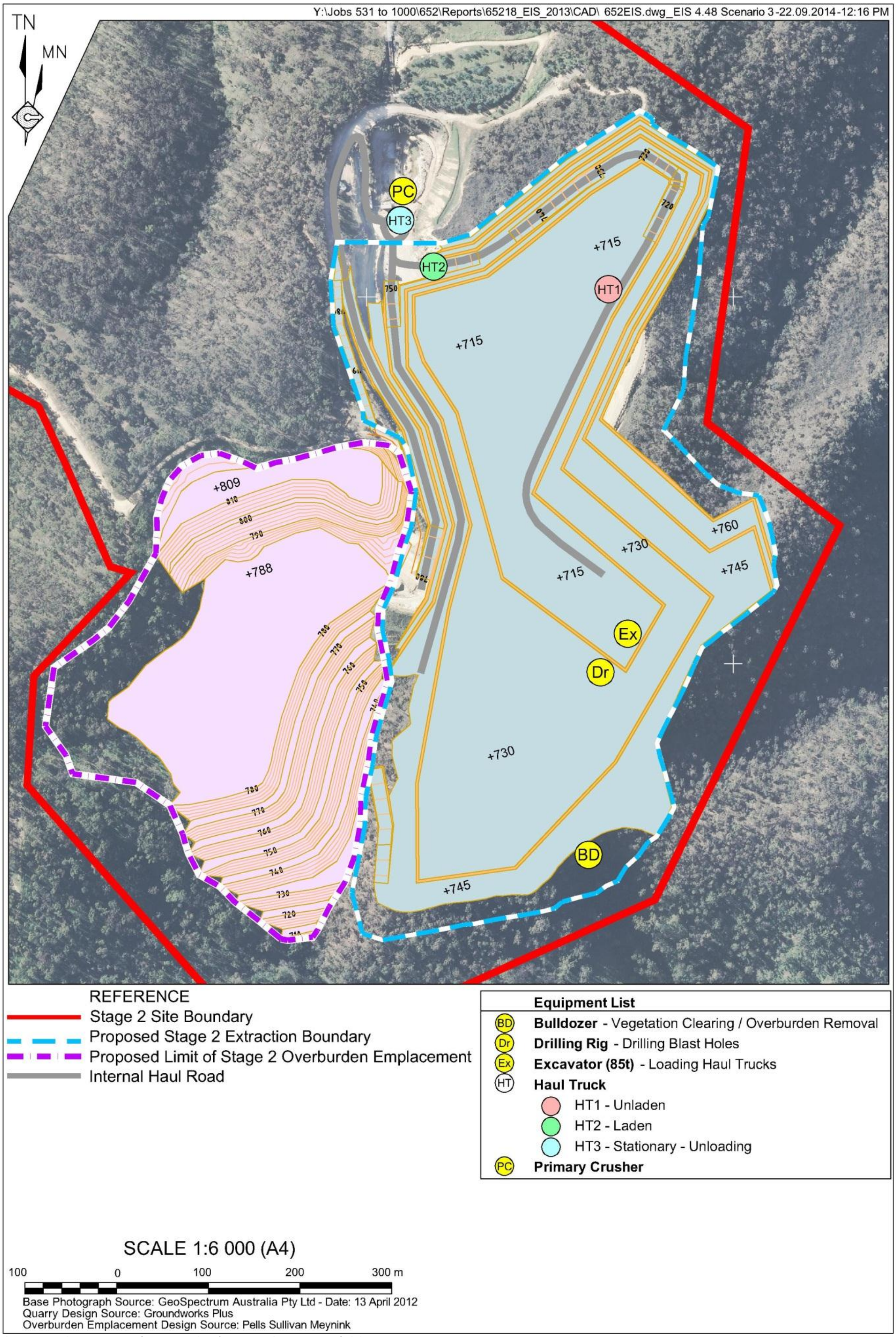
Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

Figure 2-4: Scenario 2 – Location of Equipment at the Quarry Area



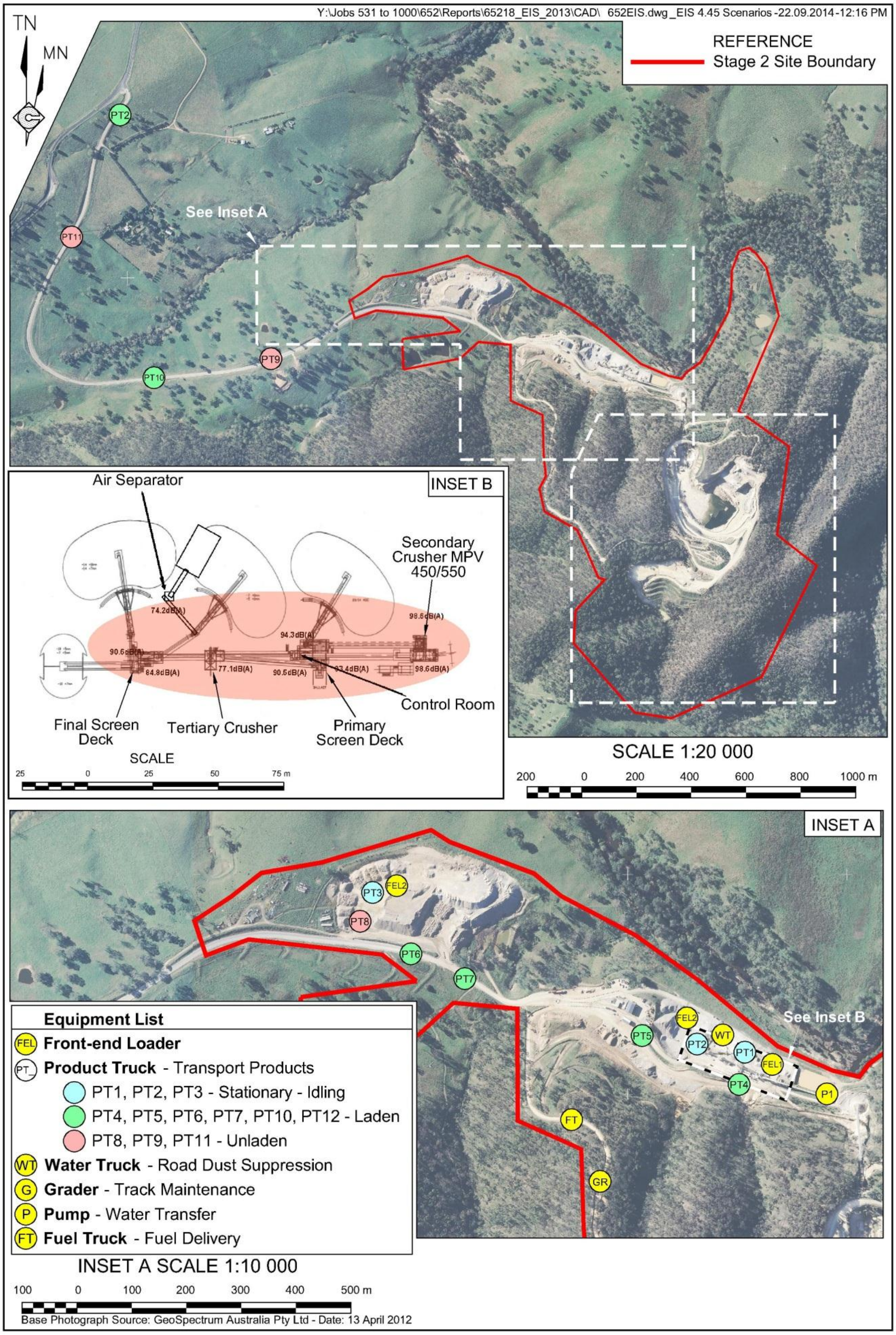
Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

Figure 2-5: Scenario 3 – Location of Equipment at the Quarry Area



Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

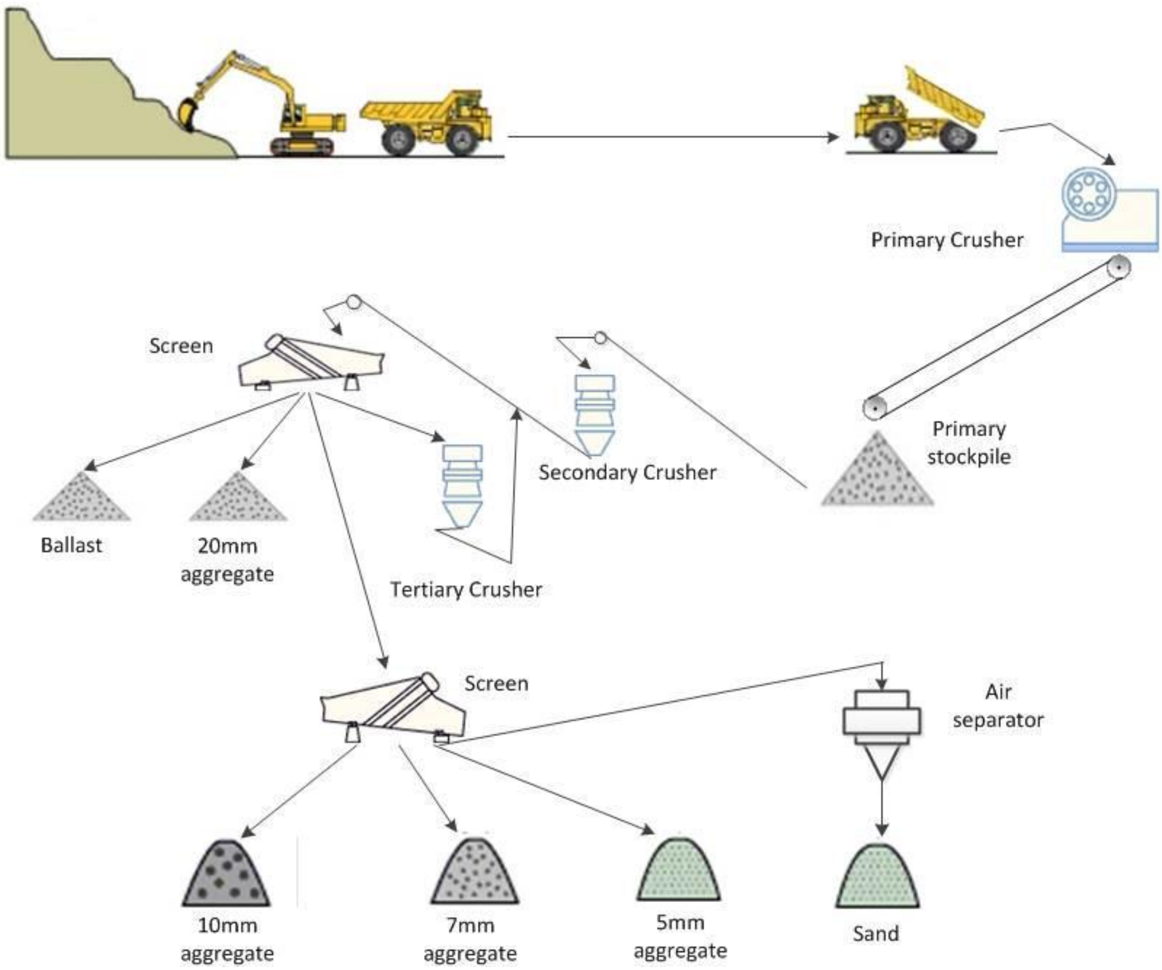
Figure 2-6: Locations of Secondary Processing Area and Yorkeys Creek Stockpile Area Air Emission Sources (All Three Scenarios)



Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

The blasted or fragmented rock is transported by haul truck to the primary crushing station located on the northern side of the Stage 1 extraction area at approximately 750m AHD. The crushed rhyolite (<250mm) is then conveyed to the primary feed stockpile within the secondary processing area. Scalps removed following primary crushing are conveyed to a temporary stockpile located to the west of Yorkeys Creek referred to as the Yorkeys Creek stockpile area. The primary crushed rhyolite is reclaimed from the base of the primary feed stockpile, and conveyed to secondary, tertiary and quaternary crushers to further reduce the size of the rock. **Figure 2–7** presents the process flow chart illustrating the movement of the extracted rock from the extraction area to the various product stockpiles.

Figure 2-7: Flow Chart Illustrating Rock Movement



Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

2.5 TRANSPORT OPERATIONS

All trucks would access the quarry via the existing entrance from Jenolan Caves Road. This entrance, the associated intersection with Jenolan Caves Road and the Quarry Access Road itself between Jenolan Caves Road and the Yorkeys Creek crossing immediately west of the secondary processing area is sealed.

All products would be loaded into road registered trucks (typically truck and dog trailer combinations or less commonly 19m B-Doubles) within either the secondary processing area or the Yorkeys Creek stockpile area. Trucks would exit the quarry via the departure weighbridge and Quarry Access Road. The Applicant requires all loads to be covered.

At maximum production level (1.1 million tpa), daily truck movements would approximate the following depending on the likely destination of products.

Scenario 1:	**Predominantly Sydney Customers**	
	Average:	125 loads / 250 trips or movements
	Maximum:	180 loads / 360 trips or movements
Scenario 2:	**Sydney Customers and Local Road Works**	
	Average:	150 loads / 300 trips or movements
	Maximum:	250 loads / 500 trips or movements

It is most likely that Scenario 1 would be the most common occurrence, except for those days when local projects are supplied, e.g. to supply RMS road works between Lithgow and Mount Victoria.

3. DISPERSION METEOROLOGY AND LOCAL AIR QUALITY

3.1 SITE-REPRESENTATIVE METEOROLOGICAL DATA

After having carried out the assessment of environmental constraints, it was deemed appropriate to utilise the computer simulation program TAPM (The Air Pollution Model) to generate a synthetic meteorological data file specific for the subject area as per the NSW EPA Approved Methods guidelines. NSW EPA recommends the use of prognostic meteorological models for generating meteorological data for areas where neither site-specific nor site-representative meteorological data are sufficient enough for use in the dispersion model selected. Further details are provided in Section 4.2.1.

TAPM is a three dimensional meteorological and air pollution model developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Atmospheric Research. TAPM uses databases of terrain, vegetation, soil type, sea surface temperature and synoptic-scale meteorological analyses for Australia.

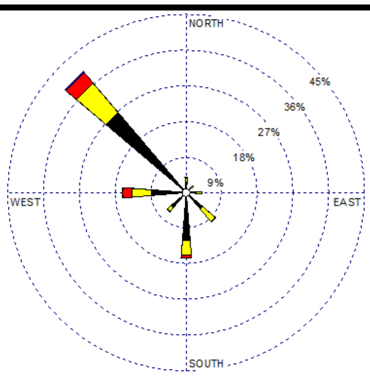
A site-representative meteorological data file was generated for Hartley NSW (encompassing the area of Austen Quarry) for the year 2012 with TAPM. The TAPM file contained values for temperature, wind speed, wind direction, mixing height, stability class and the sigma theta parameters.

Seasonal wind rose plots for the site-representative meteorological file have been included in the following section. **Figure 3–1** provides the site-specific wind rose plot for the subject area, based on TAPM.

Worst case dispersion conditions would be best associated with F-class stability conditions – generally associated with still/light winds and clear skies during the night time or early morning period (stable conditions). Analysis of the site-specific meteorological data indicates the F-class dispersion conditions **Table 3–1** and **Table 3–2** suggest these are present for approximately 26.13% of the time, indicating a slightly high-risk of enhanced impacts from the operations due to this weather condition.

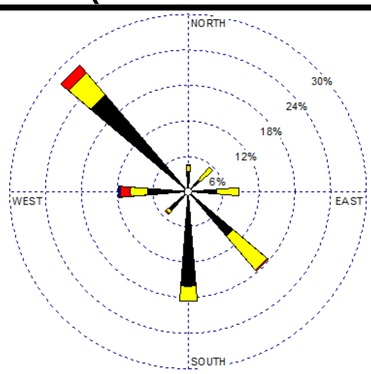
Figure 3-1: Wind Rose Plots for the Meteorological Station at Hartley Quarry (TAPM)

All Seasons



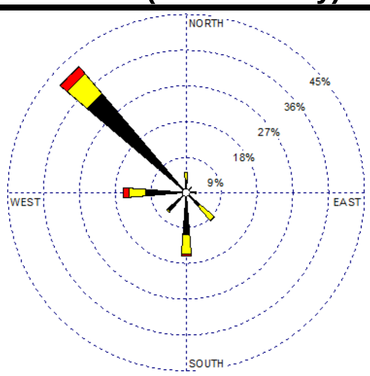
Average Wind Speed: 1.92 m/s
Calms Frequency: 5.75 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Summer (December – February)



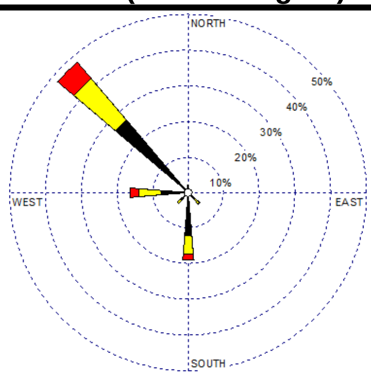
Average Wind Speed: 1.76 m/s
Calms Frequency: 6.62 %
Axis Frequencies: 6%, 12%, 18%, 24%, 30%

Autumn (March – May)



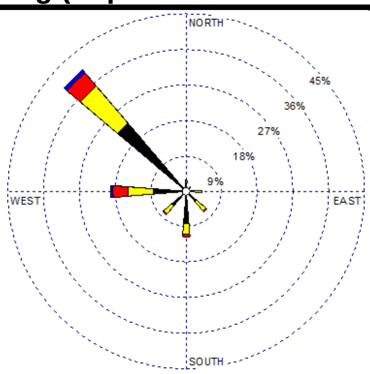
Average Wind Speed: 1.73 m/s
Calms Frequency: 6.30 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Winter (June – August)



Average Wind Speed: 2.08 m/s
Calms Frequency: 4.66 %
Axis Frequencies: 10%, 20%, 30%, 40%, 50%

Spring (September – November)



Average Wind Speed: 2.09 m/s
Calms Frequency: 5.45 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Legend

WIND SPEED
(m/s)

>= 11.1
8.8 - 11.1
5.7 - 8.8
3.6 - 5.7
2.1 - 3.6
0.5 - 2.1

In **Table 3–2** it can be deduced that stability class frequencies in the meteorological file have not been biased by TAPM towards giving enhanced dispersive conditions. Stability class D is the most frequent, with an occurrence of 37.13%. Stability classes A, B, C, which offer the best dispersion conditions, occur at frequencies of 5.35%, 15.61%, and 10.51%, respectively. This analysis suggests that poor mixing of air contaminants are anticipated within the local area.

Table 3-1: Wind Direction/Stability Class Frequency Distribution (Count) for Referenced Meteorological Data Input File – Hartley 2012 (by TAPM)

Frequency Distribution (Count)							
Direction (Blowing From)	**Stability Class**						
	A	**B**	**C**	**D**	**E**	**F**	**Total**
N	23	86	53	113	8	68	351
NE	37	63	30	81	2	8	221
E	84	92	56	116	7	6	361
SE	95	167	102	359	33	115	871
S	72	188	118	594	198	290	1460
SW	32	74	31	345	13	76	571
W	64	363	158	562	30	249	1426
NW	63	338	375	1093	171	1483	3523
Total	470	1371	923	3263	462	2295	**8784**

Table 3-2: Wind Direction/Stability Class Frequency Distribution (Percentage) for Referenced Meteorological Data Input File – Hartley 2012 (by TAPM)

Frequency Distribution (Percentage %)							
Direction (Blowing From)	**Stability Class**						
	A	**B**	**C**	**D**	**E**	**F**	**Total**
N	0.26	0.98	0.60	1.29	0.09	0.77	4.00
NE	0.42	0.72	0.34	0.92	0.02	0.09	2.52
E	0.96	1.05	0.64	1.32	0.08	0.07	4.11
SE	1.08	1.90	1.16	4.09	0.38	1.31	9.92
S	0.82	2.14	1.34	6.76	2.25	3.30	16.62
SW	0.36	0.84	0.35	3.93	0.15	0.87	6.50
W	0.73	4.13	1.80	6.40	0.34	2.83	16.23
NW	0.72	3.85	4.27	12.44	1.95	16.88	40.11
Total	5.35	15.61	10.51	37.15	5.26	26.13	**100.00**

Wind rose plots show the direction that the wind is coming from, with triangles known as "petals". The petals of the plots in the figures summarise wind direction data into 8 compass directions i.e. north, north-east, east, south-east, etc. The length of the triangles, or "petals", indicates the frequency that the wind blows from the direction presented. Longer petals for a given direction indicate a higher frequency of wind from that direction. Each petal is divided into segments, with each segment representing one of the six wind speed classes. Thus, the segments of a petal show what proportion of wind for a given direction falls into each class. The proportion of time, for which wind speed is less than speeds in the first class (i.e. 0.5m/s), when speed is negligible, is referred to as calm hours or "calms". Calms are not shown on a wind rose as they have no direction, but the proportion of time that made up for the period under consideration is noted under each wind rose.

The concentric circles in each wind rose are the axis, which denote frequencies. In comparing the plots it should be noted that the axis varies between wind roses, although all wind roses are similar in size. The frequencies denoted on the axes are indicated beneath each wind rose.

Local Wind Trends

A synthetic site representative meteorological data for the year 2012 was generated by TAPM (The Air Pollution Model) software (developed by the CSIRO) in accordance with the NSW EPA guidelines "Approved Method of Modelling and Analysis in New South Wales". Seasonal wind rose plots for this site-representative meteorological data have been included as **Figure 3–1**.

For the TAPM-generated meteorological data, it can be seen that medium strength winds from the north-west dominated the region for approximately 41% of the time through the year with average wind speeds of 1.92 m/s and a calms frequency of 5.75%. Medium strength winds from the west and south directions occur around 18% of the time. Winds from other directions are minor contributors.

The average wind speed recorded for the summer season was 1.76 m/s, with calms frequency of 6.62%. Dominant north-westerly, southerly, south-easterly, and westerly winds occurred at frequencies of around 28%, 18%, 18%, and 12% respectively. The rest of the wind directions make up the minority.

The autumn season data shows a slightly different wind pattern to the summer season. The autumn period shows the dominance of stronger winds from the north-east (44%), with westerly and southerly winds occurring at 17% of the time. The average wind speed for autumn is 1.73 m/s with a calms frequency of 6.30%. The autumn wind characteristics resembled the annual average the most.

Strong north-westerly winds were dominant in winter, detected at a frequency of 43%. Westerly and southerly winds had a frequency of around 17%, and 19% respectively. The rest of the winds made up the season with a frequency of less than 10%. The average winter wind speed was 2.08 m/s with a calms frequency of 4.66%.

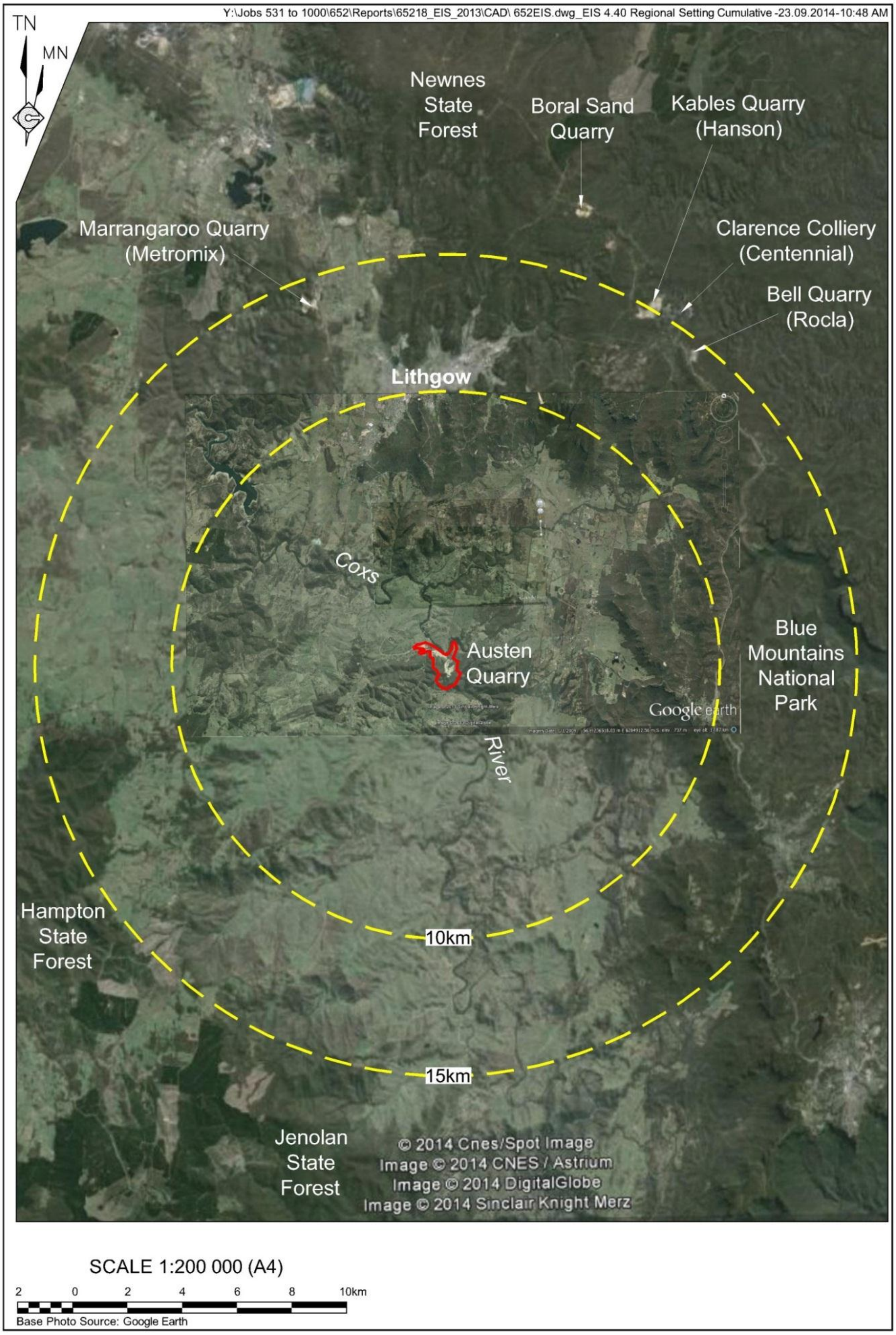
In the spring time, average wind speeds of 2.09 m/s with a calms frequency of 5.45% were recorded. Dominant winds occur from the north-west (43%), west (18%) and south (12%). The winds from the other directions were very similar to the autumn and winter seasons.

3.2 BACKGROUND AIR QUALITY

The Austen Quarry is the only extractive industry within the region with the potential to contribute dust to the local air shed. Local roads are asphalted and there were no public roads unsealed. Surrounding the Austen Quarry, farming land is located on the moderately to shallow sloped lands in between very steep terrain which retained a grassy woodland / forest cover. No horticulture is present due to the prevalence of steep terrain and farmlands remain grassed and undisturbed. Limited residential construction is ongoing within the Little Hartley area, primarily off Baaners Lane and John Grant Drive. **Figure 3-2** illustrates the regional setting with the Austen Quarry the only significant area of disturbance, i.e. dust generation within a 15km radius.

Considering the regional setting of the Austen Quarry noted above and presented on **Figure 3-2**, the quarry operations are considered to be the only source of dust and particulate emissions within the immediate regional area. It is noted that there will be some minor dust and particulate emissions from vehicle traffic and other residential-based activities, however, these are short-lived and localised emissions that do not travel to other areas. As a result, these emissions are unlikely to make any contribution to the overall (background) dust levels.

Figure 3-2: Regional Setting of the Austen Quarry



Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

Observations carried out during site visits by Benbow Environmental confirm the assessment regarding external sources of dust and particulate emissions within the area that could influence the cumulative impact from the quarry. Compared to most of the rural areas visited, the area within proximity to the quarry is considered to show no visible plumes of dust emanating from the quarry or from other sources or activities in the area, nor could large amounts of particulate deposits be observed beyond the entrance of the quarry which could be attributable to Austen Quarry.

Local agricultural activities such as cattle grazing and other similar activities would generate very little dust and airborne particulate impacts and would have none to minimal contribution to the overall cumulative impacts. Some of these activities are envisaged to have short-lived impacts and would only impact a few metres away from the source, whereas dust and particulate impacts from the quarry are predicted to reach up to hundreds of metres. Therefore, the magnitude of impact from the quarry and it being the only major source of dust/particulates in the local area is anticipated to define the overall background dust and particulate concentration at the nearest residences for all areas, to which this assessment will be quantifying based on site-specific details of the Proposal. As discussed throughout this report, three scenarios have been selected to illustrate the varying conditions that could be observed throughout the proposed operational lifetime (refer to **Figure 2–3** to **Figure 2–6**).

The conservative nature of the air quality assessment undertaken ensures that the predicted impacts would be sufficiently conservative to include the predicted impacts from these minor sources of dust and particulate emissions. Hence, no background air quality data was deemed to be appropriate for use to account for the contribution of emissions from sources extraneous to Austen Quarry.

4. AIR QUALITY IMPACTS

4.1 ADOPTED CRITERIA AND GUIDELINES

The following document from the NSW Environment Protection Authority (NSW EPA) was referenced for the assessment methodology and guidelines used in this study:

- "Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales" (August 2005).

The above listed guidelines are often referred to as the NSW EPA modelling guidelines. **Table 4–1** provides the applicable criteria from these NSW EPA modelling guidelines.

These criteria are consistent with the National Environment Protection Measure (NEPM) Ambient Air Quality criteria set by the National Environment Protection Council (NEPC), which is a statutory body with law making powers established under the *National Environment Protection Council Act 1994 (Commonwealth)* and corresponding legislation in other jurisdictions. NEPM Ambient Air Quality criteria consist of six key air pollutants: carbon monoxide, ozone, sulphur dioxide, nitrogen dioxide, lead and particulates as PM_{10}. Under the NEPM criteria set, PM_{10} is set to 50µg/m^3 under 24 hour averaging period, which is identical to the criteria outlined in the NSW EPA modelling guidelines.

Table 4-1: Applicable Dust and Particulate Criteria at Sensitive Receptors from the NSW EPA Modelling Guidelines

Pollutant	Averaging Period	Concentration		Source
		–	µg/m^3	
PM_{10}	24 hours	–	50	NEPC (1998)
	Annual	–	30	EPA (1998)
Total Suspended Particulates (TSP)	Annual	–	90	NHMRC (1996)
		g/m^2/month[a]	g/m^2/month[b]	
Deposited Dust	Annual	2	4	NERDDC (1988)

Notes: [a] – 2 is the maximum increase in deposited dust level.
[b] – 4 is the maximum total deposited dust level.

NEPC has recently published a NEPM criteria for $PM_{2.5}$, which has been utilised in this assessment as the applicable air quality criteria for particulates less than or equal to 2.5 microns.

- 24 hour average limit: 25 µg/m^3
- Annual average limit: 8 µg/m^3

4.2 AIR IMPACT MODELLING

4.2.1 Dispersion Model

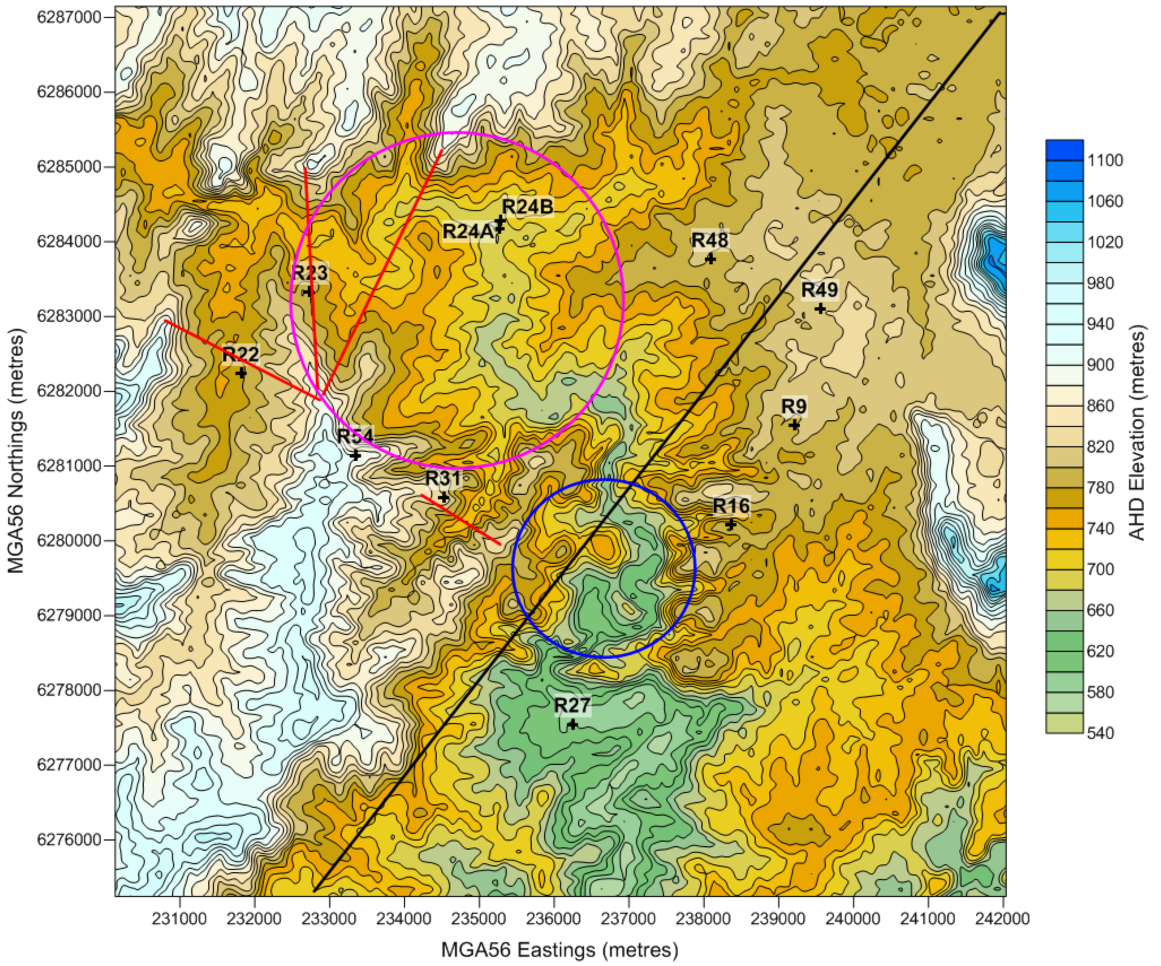
The NSW EPA-approved air dispersion model, CALPUFF PRO (version 7.3 plus), has been used for the quantification of air impacts from the Proposal.

The CALPUFF PRO Gaussian plume dispersion model was used for the prediction of potential off-site odour impacts. A year of meteorological data was generated and obtained as input into the CALPUFF dispersion modelling program. The data is considered representative of the wind climate at the subject site and study region in general and has been utilised as appropriate input into the model. A total number of 8784 individual temperature, wind speed and wind direction events were entered into the meteorological input file. This ensured that sufficient meteorological data was available so as to guarantee that worst-case conditions were adequately represented in the model predictions.

Meteorological input data were used in accordance with the NSW EPA modelling guidelines. Contribution due to the effects associated with the presence of buildings on and within proximity to the subject site was accounted for in the modelling by using the Prime downwash option. Emission rates were estimated using the emission factor databases and were used conservatively using reasonable and/or practical assumptions.

The optimal settings for CALMET as outlined in the document "*Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia'*" has been used. The selection of parameters for use into the simulation is demonstrated in **Figure 4–1**, which shows the lines to estimate the values for TERRAD (red line), R1MAX and R2 MAX (black line), R1 (blue circle) and R2 (pink circle).

Figure 4-1: Selection of CALMET Parameters as Outlined in the NSW EPA CALPUFF Guidance Document



4.2.2 Terrain Effects on Air Impacts through Katabatic Air Drainage

The meteorological condition known as katabatic flow (or katabatic drift) is simply the movement of cold air down a slope, generally under stable atmospheric conditions. Under such circumstances, dispersion of airborne pollutants is generally slow and the associated impacts can potentially reach peak concentration.

Given the undulating nature of the terrain elevation surrounding the site, some local katabatic air drainage effects are anticipated but would not be expected to significantly affect the air impact results at the surrounding residences.

4.2.3 Air Emission Sources

The following core activities would be included as part of the Proposal:

- Removal and emplacement of vegetation, topsoil and overburden;
- Drilling and blasting of hard rock;
- Transfer of hauled hard rocks by trucks;
- Crushing of raw feed in shielded pit;

- Transfer of crushed rock by conveyors;
- Secondary and tertiary crushing, screening and stockpiling; and
- Conveying/transport and distribution.

Considering the nature of the Proposal and the consideration of the air quality impact assessments prepared for similar proposals, dust and particulates have been found to be the assessable pollutants of concern for the assessment. These contaminants, which are referred to as either ‘dust’ or ‘dust and particulate’ emissions or contaminants throughout the remainder of this report, are as follows:

- $PM_{2.5}$ – particulate matter of size less than or equal to 2.5 microns
- PM_{10} – particulate matter of size less than or equal to 10 microns
- TSP – total suspended particulates
- Deposited Dust – dust deposition or deposited dust

Given the above, the following main sources of dust emissions have been identified:

- Drilling and blasting of hard rock within the currently active and proposed extraction areas;
- Vehicle travels on unsealed internal access roads;
- Crushing (primary, secondary and tertiary);
- Screening of rock within the processing plant;
- Loading and unloading of materials to hopper, crushers, stockpiles, trucks; and
- Wind erosion from stockpiles, emplacement areas and other exposed areas.

4.2.4 Assumptions Utilised

Table 4–2 provides a preliminary list of assumptions that would be utilised for the purpose of assessing dust impacts. These are based on a production rate of 1.1 million tonnes per year for the life of the Proposal.

Three activities that were considered in the Noise Impact Assessment but not in the Air Quality Assessment are the following:

- water truck;
- diesel pump; and
- air separator.

The water truck is a negligible source of dust due to its low speed and that on its second pass over an area it travels over already dampened road surfaces. Including it as a dust source would show no contribution to the predicted noise levels.

The diesel pump emits no dust and no particulate emissions of any consequence.

The air separator is part of the manufactured sand process. It has a rotor within an enclosed housing and its function is to apply speed to the particulates within the material to be converted to manufactured sand so that centrifugal force will size separate the particles. The air separator is an enclosed process and therefore has no uncontrolled dust emissions requiring inclusion in air emission modelling. There is no dust released from the air separator. Its operation has no dust emission factor attributed to it in the US-AP42 document.

Table 4-2: Preliminary List of Assumptions for the Purposes of Estimating Dust Impacts

Activity	Assumptions
Drilling rock	Holes spaced 2 m apart
Blasting rock	One blast per 2 weeks. Blast area of approximately 1,600m^2. Blasting is conducted at the area where drilling is conducted. Temperature of plumes assumed to be 50ºC.
Loading overburden to trucks	73,000 m^3/year 2.0 tonnes/m^3
Overburden in emplacement area	2% overburden moisture content
Dozer shaping overburden stockpile	Approximately 24 hours per week devoted to shaping
Loading rock to trucks	Total rock = 1.1 million tonnes/year
Hauling rock to hopper / primary crusher	All rock hauled to crusher 50 tonne trucks for transportation 2% moisture content
Primary crushing and screening	90% reduction of emission by use of shielding
Secondary crushing and screening	90% reduction of emission by use of shielding
Tertiary crushing and screening	90% reduction of emission by use of shielding
Product stockpiles	2% moisture content
Grading roads	Assumed to operate for 12 hours per day, for 2 days per month at a speed of 10 km/hr

The distribution of particles derived from the State Pollution Control Commission of NSW (now EPA) in 1986 (SPCC 1986) have been used to describe the fraction of $PM_{2.5}$ in the total suspended particulates, as outlined below:

- *$PM_{2.5}$ is 4.7% of the TSP*

As part of the assumptions for inputting the spatial coordinates of the sources in the dispersion model, the locations of the equipment as shown in **Figure 2–3** to **Figure 2–6** for each scenario have been used as the basis of the location of the dust/particulate emission sources.

4.2.5 Dust Emission Factors

Emission factors utilised for this assessment were obtained from the following list of sources:

- National Pollutant Inventory (NPI) Emission Estimation Technique Manuals;
- "Particle size distributions in dust from open cut coal mines in the Hunter Valley", Report No 10636-002-71, Prepared for the State Pollution Control Commission of NSW (now NSW EPA) by Dames & Moore, 41 McLaren Street, North Sydney, NSW 2060;
- "Dust Emissions – A Review", Prepared by F.W. Parrett, Applied Environmetrics 1992; and
- U.S. Environmental Protection Agency (USEPA) AP 42, Compilation of Air Pollutant Emission Factors.

References to air quality studies from other hard rock quarries in NSW have been made to ensure that appropriate emission factors are utilised in the assessment.

4.2.6 Calculation of Dust Emission Rates

4.2.6.1 Introduction

The Emission Estimation Technique Manual (EETM) for Mining and Processing of Non-Metallic Minerals (Version 2.0) sourced from the National Pollutant Inventory (NPI 2000) has been predominantly utilised for the estimation of emission rates for most of the identified emission sources on site. The text "Dust Emissions" published by F.W. Parrett (Parrett 1992) was utilised for the estimation of wheel-generated dust from unpaved roads, due to its ability to relate silt content and the number of rainy days to the potential for release of dust and particulate emissions. The U.S. Environmental Protection Agency AP 42 Compilation of Air Pollutant Emission Factors for Crushed Stone Processing and Pulverized Mineral Processing (USEPA 2004) were utilised for the estimation of Screening, Secondary and Tertiary Crushing dust emissions from the process, due to the data source having more detailed information in terms of estimating site-specific emission rates.

The following sections provide further details of the emission factors and other relevant information referred to from the manual.

4.2.6.2 Front End Loaders and Excavators

The following equation was provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000) for the estimation of dust and particulate emissions from front end loaders and excavators:

Equation 1:

$$EF = k * 0.0016 * (U / 2.2)^{1.3} * (M / 2)^{-1.4}$$

Where:

k = 1.56 for TSP
= 0.75 for PM_{10}
U = mean wind speed, in m/s
M = moisture content, in %
$EF_{PM2.5} = 0.047 * EF_{TSP}$

4.2.6.3 Drilling Operations

The following emission factors were provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000) for the estimation of dust and particulate emissions from drilling operations:

$EF_{PM10} = 0.0043$ kg/t
$EF_{TSP} = 0.012$ kg/t
$EF_{PM2.5} = 0.047 * EF_{TSP}$

4.2.6.4 Blasting Operations

The following equation was provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000) for the estimation of dust and particulate emissions from blasting operations.

Equation 2:

$$EF = k * 344 * A^{0.8} * M^{-1.9} * D^{-1.8}$$

Where:

k = 1 for TSP
= 0.52 for PM_{10}
M = moisture content, in %
D = depth of blast hole, in m
$EF_{PM2.5} = 0.047 * EF_{TSP}$

4.2.6.5 Wheel Generated Emissions from Unpaved Roads

The text "*Dust Emissions*" published by F.W. Parrett (Parrett 1992) contains a methodology of calculating dust and particulate emission rates based on the parameters of silt content, wind speed, average number of tyres in vehicles used, and number of rainy days throughout the year. Compared to generic emission factors, the referenced equation focuses on developing a site-specific emission factor based on site-specific conditions and properties.

Equation 3:

$$EF = 0.81 * P * S (V / 30) * (365 – R / 365) * (T / 4)$$

Where:

EF = TSP emission factor, in lb/mile (multiplied by the corresponding PM_{10}-TSP ratio for PM_{10} equivalent)
P = 0.62 for dirt roads, 0.32 for gravel roads
S = silt content, in %
V = average vehicle speed, in mph
R = number of days per year with rainfall of more than 0.01 inches
T = average number of tyres in vehicles travelling
$EF_{PM2.5} = 0.047 * EF_{TSP}$

4.2.6.6 Graders

The following equation was provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000) for the estimation of dust and particulate emissions from blasting operations.

Equation 4:

$$EF = 0.0034 * S^{k}$$

Where:

EF = estimated emission factor, in g/km
S = 2.5 for TSP
= 2.0 for PM_{10}
$EF_{PM2.5} = 0.047 * EF_{TSP}$

4.2.6.7 Wind Erosion

The following emission factors were provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000) for the estimation of wind erosion from any surfaces, including stockpiles:

EF_{PM10} = 0.2 kg/ha/hr
EF_{TSP} = 0.4 kg/ha/hr
$EF_{PM2.5}$ = 0.047 * 0.4 kg/t

4.2.6.8 Primary Crushing

The following emission factors were provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000) for the estimation of dust and particulate emissions from primary crushing operations:

EF_{PM10} = *0.02 kg/t*
EF_{TSP} = *0.2 kg/t*
$EF_{PM2.5}$ = 0.047 * 0.02 kg/t

4.2.6.9 Secondary & Tertiary Crushing, and Screening Operations

The following emission factors were provided within the US EPA AP42 Compilation of Air Pollutant Emission Factors for Crushed Stone Processing and Pulverized Mineral Processing for the estimation of dust and particulate emissions from secondary and tertiary crushing, as well as screening operations.

Secondary Crushing

EF_{PM10} = 0.0012 kg/t
EF_{TSP} = 0.0027 kg/t
$EF_{PM2.5}$ = 0.047 * 0.0027 kg/t

Tertiary Crushing

EF_{PM10} = 0.0012 kg/t
EF_{TSP} = 0.0027 kg/t
$EF_{PM2.5}$ = 0.047 * 0.0027 kg/t

Screening

EF_{PM10} = 0.0043 kg/t
EF_{TSP} = 0.0125 kg/t
$EF_{PM2.5}$ = 0.047 * 0.0125 kg/t

4.2.6.10 Bulldozer Operations

The following equation was provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000) for the estimation of dust and particulate emissions from bulldozing operations using a bulldozer.

Equation 5:

$$EF_{PM10} = 2.6 * s^{1.2} * M^{-1.3}$$
$$EF_{TSP} = 0.34 * s^{1.5} * M^{-1.4}$$

Where:

EF = estimated emission factor, in kg/t
s= silt content, in %
M = moisture content, in %

4.2.6.11 Emission Control Factors

Emission control factors were provided within the NPI EETM for Mining and Processing of Non-Metallic Minerals (NPI 2000), for use in conjunction with emission factors to estimate realistic figures of emission rates from identified dust and particulate emission sources. These factors are provided in **Table 4–3**.

Table 4-3: Referenced Control Factors from NPI Emission Estimation Technique Manuals

Control Type	Control Factor
Water Sprays (> 2L/m^2/hr)	75%
Wind Breaks	30%
Re-Vegetation (Overburden)	99%
Total Enclosure	99%
Soil is Naturally / Artificially Moist	50%

In addition to the control factors above, a study established by the University of Delaware has examined the effectiveness of vegetation to dust and particulate emissions from a dust/particulate emitting source (Malone et al, 2006). In this study, vegetation was set up and grown consisting of the following: three-row planting of a 16ft (4.9m) tall bald cypress at 30ft (9m) downwind of the source, 14ft (4.3m) tall Leyland cypress at 40ft (12.2m) downwind of the source, and 8ft (2.4m) tall Eastern red cedar at 48ft (14.6m) from the source. Results from this 'installation' showed a reduction of approximately 49% ± 27% for dust, with the ±27% due to the effects of varying wind directions caused during the sampling events. This result from the University of Delaware study relates well with the NPI control factor for re-vegetation, wherein close to 99% reduction would be achieved with overburden.

The control factors discussed above were used for the estimation of emission rates for use in the dispersion model, to accurately simulate the dust and particulate emissions from the proposal.

Table 4–4 provides a summary of the list of sources and the corresponding control factors that were applied to each source.

4.2.7 Building-Wake Effects

Building-wake effects occur when emissions from a source are hindered as they move from winds “washing” the emissions down to the nearest building structure. This phenomenon can enhance off-site dust impacts (depending on the location of the building structure, wind direction and the source).

Building-wake effects would be considered in the air dispersion modelling phase of the assessment by representing all buildings and structures on site as rectangular structures in the model.

4.2.8 Modelling Techniques Adopted

Some emission sources have been traditionally modelled as volume sources. One drawback to this approach is that it does not allow for the thermal buoyancy of the emissions to be considered and building downwash effects to be accurately simulated.

Table 4-4: Emission Reduction Control Factors Utilised

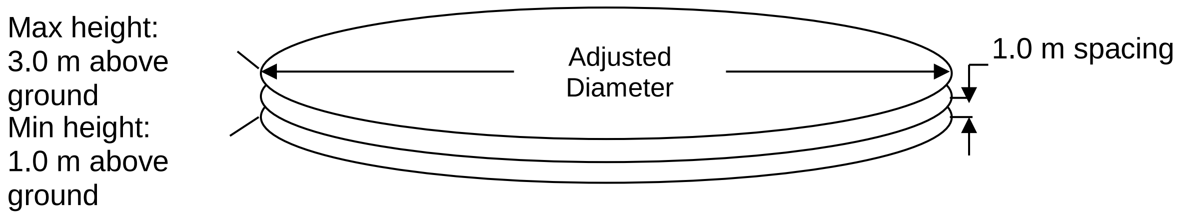
Source	Emission Control Factors Utilised
Front End Loader Operations	Vegetation; Watersprays; Windbreaks.
Vehicle Travel at the Processing and Product Despatch Area	Vegetation; Watercarts; Windbreaks.
Grader Operations	Vegetation; Watercarts; Windbreaks.
Wind Eroded Areas at the Processing and Product Despatch Area	Vegetation; Watercarts; Windbreaks.
Primary Crushing Operations	Vegetation; Total Enclosure; Windbreaks.
Secondary & Tertiary Crushing Operations	Vegetation; Enclosure; Windbreaks.
Screening Operations	Vegetation; Windbreaks.
Vehicle Travel within Quarry	Vegetation; Naturally / Artificially Moist Soil; Windbreaks.
Excavators, Drill Rig, and Bulldozer	Vegetation; Naturally / Artificially Moist Soil; Windbreaks.
Wind Eroded Areas of the Quarry	Vegetation; Naturally / Artificially Moist Soil; Windbreaks.
Blasting Areas	None

In recent times, it has subsequently become more common to model emission sources as “point (or stack) sources”. This method introduces a problem that stacks vent vertically and so can represent an unrealistic vertical component to the emissions.

To account for this, the diameter of the stacks is then made wide enough to produce a negligible vertical exit velocity. This creates an additional problem, as a wider source places emissions closer to receptors and unrealistically distributes the sources of emissions. To counter this problem, multiple stacks are positioned co-linearly (i.e. their centre-points are aligned) and placed above each other, so to adequately represent the volume source-nature of the source.

In conducting dust modelling for the emissions from (say, for example) blasting operations on site, this method was used where each source was modelled as three vertical pseudo stacks. The diameter of the stacks was assumed to be the size of the blast (diameter from the assumed blast area of 1,600m^2 equates to 44m of diameter) with an exit velocity of 0.1m/s. Three co-linear stacks, equally spaced between 1 to 3 metres above the ground, were used to represent the unloading and sorting activities. **Figure 4–2** is an example to illustrate this method.

Figure 4-2: Modelling of Emission Source as Three Vertical Pseudo-Stacks



4.2.9 Scenarios

Scenarios have been prepared to accommodate changes in source locations as shown in the projected extension areas of the quarry. Three scenarios have been considered to show the differences in air quality impacts from the sequential stages of the Stage 2 Extension (see **Figure 2–3** to **Figure 2–6**). With reference to **Figure 2–2**, these are:

- Scenario 1: Stage A;
- Scenario 2: Stage C; and
- Scenario 3: Stage E.

Attachment 1 provides additional detail on the location and elevations of each emission source.

4.2.10 Dust Emissions Inventory

Due to the long exhaustive list of dust and particulate emission sources being used in this assessment, the dust emissions inventory has been provided in **Attachment 2**.

4.3 DUST IMPACT MODELLING RESULTS

Using the output from the CALPUFF modelling predictions, the estimated impact results for representative receptors surrounding the quarry at each of the 3 scenarios have been provided (in tabulated form) in **Table 4–5, Table 4–6** and **Table 4–7.**

An extract of a sample CALPUFF output file has been provided in **Attachment 3**.

4.3.1 Discussion of Modelling Results

The predicted impact results from CALPUFF show that the highest impact is observed for the PM_{10} 24-hour average results. This was observed at Receptor R31 (781 Jenolan Caves Road, "Good Forest"), with a concentration of 35.4 $\mu g/m^3$ for Scenario 1, 48.4 $\mu g/m^3$ for Scenario 2, and 39.9 $\mu g/m^3$ for Scenario 3. These results provide a reflection of the impacts from the locations of the equipment as shown in **Figure 2–4**, **Figure 2–5** and **Figure 2–6** respectively. The result for Scenario 2 at Receptor R31 has been identified to be a potential concern given that the predicted ground level concentration is close to the assessment criteria threshold.

Similar patterns are observed for the PM_{10} annual average, the TSP annual average, and the deposited dust results, except for Receptor R16 (196B Baaners Lane, Little Hartley) which reported higher impacts than Receptor R31 by approximately 10%. This suggests that the blasting activities have more effect (given that it is conducted only once a day) on the 24 hour averaging period as opposed to the annual average results.

Most of the impact contribution is from the blasting operation, which has been assumed in the model to be carried out every day throughout the year. Although not assumed to be practical, these results indicate the worst-case impact that could occur from the Proposal.

An additional scenario was run in CALPUFF to provide a more realistic assessment as to the contribution of effects from blasting by selecting 26 random days throughout the year on which blasting emissions are included in the dispersion model output. The 26 days were selected by random using Microsoft Excel's RANDBETWEEN function to select 26 days throughout the year between the hours of 9am to 5pm every day to which blasting would be conducted. **Table 4-8** presents these randomly selected values.

Table 4-5: Estimated Impact Results for PM_{10}, TSP and Deposited Dust – Scenario 1

Substances	Averaging Time & Impact	Predicted Concentration / Deposition at Receptor ($\mu g/m^3$)											Units	Criteria	Pass
		R31	R54	R22	R23	R24A	R24B	R48	R49	R9	R16	R27			
Fine Particulates $\leq$2.5 microns ($PM_{2.5}$)	24 hour Incremental Impacts	1.58	1.33	0.44	0.68	0.77	0.77	0.65	0.37	0.73	1.48	0.46	$\mu g/m^3$	25 $\mu g/m^3$	Yes
	24 hour Cumulative Impacts	1.58	1.33	0.44	0.68	0.77	0.77	0.65	0.37	0.73	1.48	0.46	$\mu g/m^3$		Yes
	Annual Incremental Impacts	0.90	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.41	0.77	0.20	$\mu g/m^3$	8 $\mu g/m^3$	Yes
	Annual Cumulative Impacts	0.90	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.41	0.77	0.20	$\mu g/m^3$		Yes
Fine Particulates (PM_{10})	24 hour Incremental Impacts	35.4	23.3	11.4	13.9	12.4	12.9	12.1	6.6	13.3	28.3	7.3	$\mu g/m^3$	50 $\mu g/m^3$	Yes
	24 hour Cumulative Impacts	35.4	23.3	11.4	13.9	12.4	12.9	12.1	6.6	13.3	28.3	7.3	$\mu g/m^3$		Yes
	Annual Incremental Impacts	8.6	11.0	3.6	5.1	4.0	4.0	4.7	2.6	4.2	9.0	3.1	$\mu g/m^3$	30 $\mu g/m^3$	Yes
	Annual Cumulative Impacts	8.6	11.0	3.6	5.1	4.0	4.0	4.7	2.6	4.2	9.0	3.1	$\mu g/m^3$		Yes
Total Suspended Particulates (TSP)	Annual Incremental Impacts	8.64	11.01	3.61	5.11	4.08	4.1	4.71	2.61	4.21	9.01	3.11	$\mu g/m^3$	90 $\mu g/m^3$	Yes
	Annual Cumulative Impacts	8.64	11.01	3.61	5.11	4.08	4.1	4.71	2.61	4.21	9.01	3.11	$\mu g/m^3$		Yes
Deposited Dust	Annual Incremental Impacts	0.02	0.01	<0.01	<0.01	0.04	0.05	<0.01	<0.01	<0.01	0.01	<0.01	g/m^2/month	2 g/m^2/month	Yes
	Annual Cumulative Impacts	0.02	0.01	<0.01	<0.01	0.04	0.05	<0.01	<0.01	<0.01	0.01	<0.01	g/m^2/month	4 g/m^2/month	Yes

Note: Emission control factors discussed in Section 4.2.6.10 were utilised for each corresponding source.

Table 4-6: Estimated Impact Results for PM_{10}, TSP and Deposited Dust – Scenario 2

Substances	Averaging Time & Impact	Predicted Concentration at Receptor (µg/m³)											Units	Criteria	Pass
		R31	R54	R22	R23	R24A	R24B	R48	R49	R9	R16	R27			
Fine Particulates ≤2.5 microns ($PM_{2.5}$)	24 hour Incremental Impacts	1.63	1.33	0.46	0.72	0.76	0.76	0.64	0.36	0.73	1.56	0.46	µg/m³	25 µg/m³	
	24 hour Cumulative Impacts	1.63	1.33	0.46	0.72	0.76	0.76	0.64	0.36	0.73	1.56	0.46	µg/m³		
	Annual Incremental Impacts	0.91	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.43	0.85	0.22	µg/m³	8 µg/m³	
	Annual Cumulative Impacts	0.91	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.43	0.85	0.22	µg/m³		
Fine Particulates (PM_{10})	24 hour Incremental Impacts	48.4	24.4	9.3	13.1	11.8	11.7	12.9	8.5	12.8	25.5	7.5	µg/m³	50 µg/m³	Yes
	24 hour Cumulative Impacts	48.4	24.4	9.3	13.1	11.8	11.7	12.9	8.5	12.8	25.5	7.5	µg/m³		Yes
	Annual Incremental Impacts	1.1	0.5	0.2	0.4	0.6	0.6	0.3	0.2	0.6	1.2	0.3	µg/m³	30 µg/m³	Yes
	Annual Cumulative Impacts	1.1	0.5	0.2	0.4	0.6	0.6	0.3	0.2	0.6	1.2	0.3	µg/m³		Yes
Total Suspended Particulates (TSP)	Annual Incremental Impacts	1.2	1	0.4	0.8	1.2	1.2	0.6	0.4	1.2	2.4	0.6	µg/m³	90 µg/m³	Yes
	Annual Cumulative Impacts	1.2	1	0.4	0.8	1.2	1.2	0.6	0.4	1.2	2.4	0.6	µg/m³		Yes
Deposited Dust	Annual Incremental Impacts	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	g/m²/month	2 g/m²/month	Yes
	Annual Cumulative Impacts	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	g/m²/month	4 g/m²/month	Yes

Note: Emission control factors discussed in Section 4.2.6.10 were utilised for each corresponding source.
Values highlighted in **orange** are identified to be a potential concern, given that it is approaching towards the criteria value.

Table 4-7: Estimated Impact Results for PM_{10}, TSP and Deposited Dust – Scenario 3

Substances	Averaging Time & Impact	Predicted Concentration at Receptor ($\mu g/m^3$)											Units	Criteria	Pass
		R31	R54	R22	R23	R24A	R24B	R48	R49	R9	R16	R27			
Fine Particulates ≤2.5 microns ($PM_{2.5}$)	24 hour Incremental Impacts	1.68	1.32	0.46	0.70	0.79	0.79	0.66	0.38	0.78	1.62	0.48	$\mu g/m^3$	25 $\mu g/m^3$	
	24 hour Cumulative Impacts[1]	1.68	1.32	0.46	0.70	0.79	0.79	0.66	0.38	0.78	1.62	0.48	$\mu g/m^3$		
	Annual Incremental Impacts	0.91	0.39	0.14	0.25	0.49	0.49	0.26	0.17	0.45	0.88	0.21	$\mu g/m^3$	8 $\mu g/m^3$	
	Annual Cumulative Impacts[1]	0.91	0.39	0.14	0.25	0.49	0.49	0.26	0.17	0.45	0.88	0.21	$\mu g/m^3$		
Fine Particulates (PM_{10})	24 hour Incremental Impacts	39.9	18.2	6.0	8.3	8.5	8.8	7.2	4.2	6.6	10.9	4.0	$\mu g/m^3$	50 $\mu g/m^3$	Yes
	24 hour Cumulative Impacts[1]	39.9	18.2	6.0	8.3	8.5	8.8	7.2	4.2	6.6	10.9	4.0	$\mu g/m^3$		Yes
	Annual Incremental Impacts	1.1	0.4	0.2	0.3	0.5	0.4	0.2	0.2	0.3	0.6	0.2	$\mu g/m^3$	30 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[1]	1.1	0.4	0.2	0.3	0.5	0.4	0.2	0.2	0.3	0.6	0.2	$\mu g/m^3$		Yes
Total Suspended Particulates (TSP)	Annual Incremental Impacts	1.11	0.41	0.21	0.31	0.51	0.41	0.21	0.21	0.31	0.61	0.21	$\mu g/m^3$	90 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[2]	1.11	0.41	0.21	0.31	0.51	0.41	0.21	0.21	0.31	0.61	0.21	$\mu g/m^3$		Yes
Deposited Dust	Annual Incremental Impacts	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$g/m^2/month$	2 $g/m^2/month$	Yes
	Annual Cumulative Impacts[3]	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$g/m^2/month$	4 $g/m^2/month$	Yes

Note: Emission control factors discussed in Section 4.2.6.10 were utilised for each corresponding source.

Table 4-8: Randomly Selected 26 Days Throughout The Year Using Microsoft Excel's RANDBETWEEN Function

Julian Day (1-365)	Hour of the Day (9:00-17:00)
62	13:00
70	13:00
112	17:00
121	10:00
122	10:00
128	9:00
156	16:00
180	15:00
186	16:00
199	17:00
215	11:00
223	14:00
229	10:00
234	10:00
243	9:00
257	14:00
266	11:00
268	17:00
282	13:00
290	11:00
293	17:00
295	11:00
304	11:00
308	13:00
351	17:00
357	11:00

The respective dust emissions inventory for this additional scenario has been provided as **Attachment 4**.

Using the output from the CALPUFF modelling predictions for the 26 random day model run, **Table 4–9, Table 4–10** and **Table 4–11** present the estimated emissions received at representative receptors surrounding the quarry for each of the 3 scenarios**.**

Results from the additional modelling shows that the highest impact observed remains to be for the PM_{10} 24-hour average results. This was still observed at Receptor R31 (781 Jenolan Caves Road, Good Forest), with a concentration of 34.0 $\mu g/m^3$ for Scenario 1, 42.8 $\mu g/m^3$ for Scenario 2, and 20.4 $\mu g/m^3$ for Scenario 3.

Table 4-9: Estimated Impact Results for PM_{10}, TSP and Deposited Dust – Scenario 1 (with 26 Random Days of Blasting)

Substances	Averaging Time & Impact	Predicted Concentration / Deposition at Receptor ($\mu g/m^3$)											Units	Criteria	Pass
		R31	R54	R22	R23	R24A	R24B	R48	R49	R9	R16	R27			
Fine Particulates ≤2.5 microns ($PM_{2.5}$)	24 hour Incremental Impacts	1.99	1.16	0.90	1.24	0.01	0.01	0.16	0.08	1.66	1.62	0.06	$\mu g/m^3$	25 $\mu g/m^3$	
	24 hour Cumulative Impacts[1]	1.99	1.16	0.90	1.24	0.01	0.01	0.16	0.08	1.66	1.62	0.06	$\mu g/m^3$		
	Annual Incremental Impacts	0.16	0.06	0.05	0.05	<0.01	<0.01	0.02	0.01	0.11	0.16	<0.01	$\mu g/m^3$	8 $\mu g/m^3$	
	Annual Cumulative Impacts[1]	0.16	0.06	0.05	0.05	<0.01	<0.01	0.02	0.01	0.11	0.16	<0.01	$\mu g/m^3$		
Fine Particulates (PM_{10})	24 hour Incremental Impacts	34.0	12.7	8.0	20.9	9.1	9.6	9.5	20.5	18.1	32.4	10.7	$\mu g/m^3$	50 $\mu g/m^3$	Yes
	24 hour Cumulative Impacts[1]	34.0	12.7	8.0	20.9	9.1	9.6	9.5	20.5	18.1	32.4	10.7	$\mu g/m^3$		Yes
	Annual Incremental Impacts	0.90	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.41	0.77	0.20	$\mu g/m^3$	30 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[1]	0.90	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.41	0.77	0.20	$\mu g/m^3$		Yes
Total Suspended Particulates (TSP)	Annual Incremental Impacts	0.90	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.41	0.77	0.20	$\mu g/m^3$	90 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[2]	0.90	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.41	0.77	0.20	$\mu g/m^3$		Yes
Deposited Dust	Annual Incremental Impacts	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$g/m^2/month$	2 $g/m^2/month$	Yes
	Annual Cumulative Impacts[3]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$g/m^2/month$	4 $g/m^2/month$	Yes

Note: Emission control factors discussed in Section 4.2.6.10 were utilised for each corresponding source.

Table 4-10: Estimated Impact Results for PM_{10}, TSP and Deposited Dust – Scenario 2 (with 26 Random Days of Blasting)

Substances	Averaging Time & Impact	Predicted Concentration at Receptor ($\mu g/m^3$)											Units	Criteria	Pass
		R31	R54	R22	R23	R24A	R24B	R48	R49	R9	R16	R27			
Fine Particulates ≤2.5 microns ($PM_{2.5}$)	24 hour Incremental Impacts	1.51	1.20	0.66	1.77	0.06	0.06	0.12	0.11	1.75	2.50	0.09	$\mu g/m^3$	25 $\mu g/m^3$	
	24 hour Cumulative Impacts[1]	1.51	1.20	0.66	1.77	0.06	0.06	0.12	0.11	1.75	2.50	0.09	$\mu g/m^3$		
	Annual Incremental Impacts	0.10	0.06	0.04	0.07	<0.01	<0.01	0.02	0.01	0.11	0.17	0.01	$\mu g/m^3$	8 $\mu g/m^3$	
	Annual Cumulative Impacts[1]	0.10	0.06	0.04	0.07	<0.01	<0.01	0.02	0.01	0.11	0.17	0.01	$\mu g/m^3$		
Fine Particulates (PM_{10})	24 hour Incremental Impacts	42.8	13.9	5.6	23.1	8.5	8.4	9.7	18.1	16.2	25.5	15.1	$\mu g/m^3$	50 $\mu g/m^3$	Yes
	24 hour Cumulative Impacts[1]	42.8	13.9	5.6	23.1	8.5	8.4	9.7	18.1	16.2	25.5	15.1	$\mu g/m^3$		Yes
	Annual Incremental Impacts	0.91	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.43	0.85	0.22	$\mu g/m^3$	30 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[1]	0.91	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.43	0.85	0.22	$\mu g/m^3$		Yes
Total Suspended Particulates (TSP)	Annual Incremental Impacts	0.91	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.43	0.85	0.22	$\mu g/m^3$	90 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[2]	0.91	0.38	0.14	0.25	0.47	0.47	0.25	0.16	0.43	0.85	0.22	$\mu g/m^3$		Yes
Deposited Dust	Annual Incremental Impacts	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	g/m^2/month	2 g/m^2/month	Yes
	Annual Cumulative Impacts[3]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	g/m^2/month	4 g/m^2/month	Yes

Note: Emission control factors discussed in Section 4.2.6.10 were utilised for each corresponding source.

Table 4-11: Estimated Impact Results for PM_{10}, TSP and Deposited Dust – Scenario 3 (with 26 Random Days of Blasting)

Substances	Averaging Time & Impact	Predicted Concentration at Receptor ($\mu g/m^3$)											Units	Criteria	Pass
		R31	**R54**	**R22**	**R23**	**R24A**	**R24B**	**R48**	**R49**	**R9**	**R16**	**R27**			
Fine Particulates ≤2.5 microns ($PM_{2.5}$)	24 hour Incremental Impacts	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$\mu g/m^3$	25 $\mu g/m^3$	
	24 hour Cumulative Impacts[1]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$\mu g/m^3$		
	Annual Incremental Impacts	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$\mu g/m^3$	8 $\mu g/m^3$	
	Annual Cumulative Impacts[1]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$\mu g/m^3$		
Fine Particulates (PM_{10})	24 hour Incremental Impacts	20.4	5.8	2.8	16.3	5.1	5.4	7.6	15.5	11.9	15.5	7.0	$\mu g/m^3$	50 $\mu g/m^3$	Yes
	24 hour Cumulative Impacts[1]	20.4	5.8	2.8	16.3	5.1	5.4	7.6	15.5	11.9	15.5	7.0	$\mu g/m^3$		Yes
	Annual Incremental Impacts	0.56	0.22	0.09	0.16	0.29	0.29	0.14	0.09	0.19	0.40	0.10	$\mu g/m^3$	30 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[1]	0.56	0.22	0.09	0.16	0.29	0.29	0.14	0.09	0.19	0.40	0.10	$\mu g/m^3$		Yes
Total Suspended Particulates (TSP)	Annual Incremental Impacts	0.56	0.22	0.09	0.16	0.29	0.29	0.14	0.09	0.19	0.40	0.10	$\mu g/m^3$	90 $\mu g/m^3$	Yes
	Annual Cumulative Impacts[2]	0.56	0.22	0.09	0.16	0.29	0.29	0.14	0.09	0.19	0.40	0.10	$\mu g/m^3$		Yes
Deposited Dust	Annual Incremental Impacts	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	g/m^2/month	2 g/m^2/month	Yes
	Annual Cumulative Impacts[3]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	g/m^2/month	4 g/m^2/month	Yes

Note: Emission control factors discussed in Section 4.2.6.10 were utilised for each corresponding source.

The results observed for $PM_{2.5}$ and PM_{10} shows that predicted impact results from the "26 random days of blasting scenario" provide elevated results for some receptors, with lower results being predicted from the daily blasting scenario. These results are due to the agglomeration/fragmentation effects incorporated by CALPUFF in accounting for the effects of turbulence on the particle size distribution of the pollutant (which in CALPUFF's case is driven by the geometric mass mean diameter and the geometric standard deviation of the pollutant). Certain references such as those provided by Murillo et al 2013 indicate that these agglomeration and fragmentation effects are dominant in smaller sized particles such as dust nanoparticles and is seen to be more dominant in the $PM_{2.5}$ results than in PM_{10} results. These results are considered typical and provide a reflection of the 'realistic' predictive nature of such a complex air dispersion modelling program.

Overall, no exceedances to the NSW EPA-derived assessment criteria for ground level concentration and deposition impacts at the nearest potentially affected receptors were observed.

Recommendations have been provided in the following section, which have been partly considered by the Applicant given the infrastructure currently present in the approved Stage 1 quarry.

4.3.2 Further Discussion and Recommendations

4.3.2.1 Blasting Emissions

Blasting is considered to be a major source of dust and particulate emissions, considering the difference in results predicted for the 24 hour average and the annual average results from CALPUFF. However, as shown by the difference in results between the "26 random days of blasting" scenario and the "daily blasting" scenario (a difference of up to 19.5 $\mu g/m^3$), the effect of blasting emissions at surrounding receivers would be highly variable.

Fundamentally, the impact of dust/particulate plumes from blasting or any activities that release a significant amount of these particles into the atmosphere would be defined by the wind direction. The wind rose plots obtained from TAPM (as seen in **Figure 3–1**) indicates that having winds predominantly blow from the north-west results in elevated concentrations of PM_{10} under the 24-hour averaging period for receptors that are located south of the site (Receptor R31 to the south-west, and Receptor R16 to the south-east).

Examining **Figure 3–1** further, it shows that the second most dominant winds present throughout the year are from the south, at a frequency of approximately 17%. This frequency equates to 1,489 hours. Blasting is currently and proposed to be established at a frequency of one event every 2 weeks, which equates to a total 26 hours of events throughout the year. However, it has been determined (given common practices by most quarries) that blasting activities could be scheduled to minimise the potential for coincidence with emission enhancing winds, meaning possibly that blasting may be conducted up to once per week or twice per week depending on demand.

Results provided by the "daily blasting scenario" shows that, although the maximum result approaches the criteria of 50 $\mu g/m^3$, a concentration of less than this is much more likely as the maximum result assumes blasting occurs on every day, and therefore assumes coincidence with worst-case wind conditions, whereas in actual fact blasting is projected to only occur on (average) 26 days a year. The "26 random days of blasting" scenario provides a more realistic result, and while by randomly selecting the days and hours for each scenario it is difficult to predict whether this is considered to be at the lower end of the spectrum of results, the comparison of the two sets of results provide sufficient predictive information to indicate that the overall air quality impacts to the nearest potentially affected receptors would be well below the NSW EPA criteria. Importantly, the method of analysis does not exclude adverse weather conditions in the analysis, however, provides for a more realistic prediction of likely particulate matter concentrations. Recommendations addressing this aspect are provided below.

It is also noted that the landform around the quarry is complex and heavily vegetated (refer to Section 3.2). This would reduce the direct transport of a dust cloud generated by blasting past the quarry boundaries towards potential receivers and suggests the dispersion model is likely to overestimate particulate matter dispersion and received concentration.

It is also of note that there is no history of complaints from blasting which suggests the risk of an exceedance occurring is very low.

The discussion with respect to the potential for exceedances provided above notwithstanding, and acknowledging the assumptions utilised in the assessment, the following recommendations are provided:

- If possible, schedule blasting operations to avoid strong winds from the north-west. Results demonstrated by CALPUFF at worst-case still show compliance with the NSW EPA criteria and therefore due diligence actions to avoid winds blowing towards the south-east would reduce the impact as predicted in CALPUFF. This does not mean that these winds would have to be avoided at all times; flexibility to avoid blasting during these conditions is encouraged; and as discussed, the results from CALPUFF still show compliance even with the contribution effects from the north-western winds;
- Watercarts should continue to be used to ensure that the soil and other exposed unpaved areas are kept moist at all times to reduce the release of dust and particulates;
- Watersprays (or other means of providing additional moisture to overburden and earth materials) are to be appropriately used for front end loaders and excavators, which would reduce the impacts;
- Ensure that primary, secondary and tertiary crushing operations, are protected by enclosures, windbreaks and vegetation as much as possible; and
- Maintain use of the current Environmental Management Plan (EMP) throughout the operational life of the Proposal. This plan would ensure that all administrative and corrective action procedures would be established to identify, correct or mitigate any issues on site that could lead to excessive air quality impacts.

Consideration should be given to the review of the EMP to ensure that it reflects the proposed activities and subsequently the additional mitigation measures if required.

4.3.2.2 Vacant Lands

The potential for dust emissions to affect 25% of the area of adjoining properties given the complex terrain around the quarry is highly unlikely and was therefore not considered further.

4.3.2.3 Diesel Emissions

Diesel emissions were considered. Due to the location of the quarry and as noted previously, the complex terrain surrounding the quarry, these emissions were not considered to have the potential to have an impact on the quality of the ambient environment.

The mobile equipment and diesel powered generators operated by the quarry are fully maintained.

During inspections of the quarry for this assessment, there were no emissions of unburnt or partially burnt fuel emitted by the diesel engines. There was no odour evident of diesel emissions. Further assessment was not deemed necessary.

5. GREENHOUSE GAS ASSESSMENT

5.1 STANDARDS AND GUIDELINES

The following standards, sources and guidelines have been used as part of this greenhouse gas (GHG) assessment:

- Australian Standard AS ISO 14064.1: 2006 – "Greenhouse gases" – "Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals";
- Department of Climate Change and Energy Efficiency, July 2013. *Australian National Greenhouse Accounts – National Greenhouse Accounts Factors*;
- Department of Climate Change and Energy Efficiency, July 2013. *National Greenhouse and Energy Reporting System Measurement – Technical Guidelines*;
- Department of Climate Change and Energy Efficiency, 2013. *Australian National Greenhouse Accounts, Quarterly Update of Australia's National Greenhouse Gas Inventory, December Quarter 2012;*
- Greenhouse Gas Protocol, revised edition March 2004. *Corporate Accounting and Reporting Standard*; and
- Mining Association of Canada, 2000. *Inventorying, Measuring and Reporting on Climate Change Actions*, Pembina Institute and Stratos Inc.

Hy-Tec Industries Pty Limited is not required to report GHG emissions under the *National Greenhouse and Energy Reporting Act 2007*, since total emissions from the site are below the 25,000 tonne threshold for mandatory reporting.

The calculations used throughout this section are based on the *GHG Protocol Corporate Standard* and the *National Greenhouse Accounts (NGA) Factors*. The NGA factors are default emission factors provided by the Department of Climate Change and Energy Efficiency for use in calculating an organisation's greenhouse gas emissions, and are used here.

5.2 DIRECT AND INDIRECT EMISSIONS

Emissions are commonly classified as direct or indirect emissions, which are defined by the GHG Protocol as:

- *Direct GHG emissions are emissions from sources that are owned or controlled by the reporting entity;*

- *Indirect GHG emissions are emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity.*

Direct and indirect emissions are further categorized into three broad scopes:

- *Scope 1: All direct GHG emissions;*
- *Scope 2: Indirect emissions from consumption of purchased electricity, heat or steam;*
- *Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g. T&D losses) not covered in Scope 2, outsourced activities, waste disposal, etc.*

This assessment will examine all Scope 1 and 2 GHG emissions, and also some Scope 3 emissions.

5.3 ESTIMATION OF GREENHOUSE GAS EMISSIONS

5.3.1 Introduction

Site operations involve activities that require energy and fuel consumption; hence there would be greenhouse gas emissions. Direct GHG emissions (Scope 1) are generated from the use of explosives (ANFO) for blasting, and the use of diesel in generators and mobile plant including level trucks, excavator, loaders, water cart and stockpile road trucks. There are no indirect greenhouse gas emissions (Scope 2) since no electricity is purchased from the grid. Other indirect emissions (Scope 3) calculated here are from the upstream extraction and processing of raw materials required for producing the diesel only.

Management of the site activities would be undertaken to ensure all impacts, including GHG emissions, are mitigated and minimised. Apart from physical controls, procedural controls to be implemented would include a site environmental management system which would ensure ongoing compliance and identify opportunities for continual improvement.

5.3.2 Scope 1 GHG Emissions

Scope 1 greenhouse gas emissions are produced as a result of operating generators and mobile plant on site which are run on diesel fuel.

The National Greenhouse Accounts (NGA) Factors, July 2013 was used to estimate the Scope 1 GHG emissions. The following formula was adopted:

$$E = \frac{Q \ x \ EC \ x \ EF}{1{,}000}$$

Where:

E = the amount of estimated greenhouse gas emissions in tonnes $CO_{2\text{-}e}$ (carbon dioxide equivalent)
Q = the volume of fuel combusted in kL
EC = the heat content of specific fuel type in GJ/kL
EF = the greenhouse gas emission factor specific to fuel type in kg $CO_{2\text{-}e}$/GJ

The operation of generators and also mobile plant (including dump trucks, excavator, loaders, water cart and stockpile road trucks) produces GHGs as a result of combustion of diesel fuel.

Calculation of these emissions is estimated based on the following assumptions:

- The heat content (EC) for diesel is 38.6 GJ/kL (NGA, 2013); and
- Maximum diesel consumption of approximately 130 kL/month, divided into 70 kL/month for generators and 60 kL/month for mobile plant (as supplied by proponent). Assuming full production for 12 months, this equates to 1560 kL/year (840 kL and 720 kL for generators and mobile plant respectively);

Applying the formula above, the annual GHG emissions from diesel use is 4209.10 tCO_{2-e}.

Scope 1 GHG emissions are also produced from the combustion of ANFO (ammonium nitrate/fuel oil) for blasting. The Mining Association of Canada provides an emission factor of 0.189 tonnes CO_2 per tonne of ANFO (based on ANFO containing of 6% diesel). As provided by the Applicant, an estimated 7.2 tonnes of ANFO would be used annually. This yields a value of 1.36 tCO_{2-}.produced from blasting.

Table 5–1 summarises the annual Scope 1 GHG emissions

Table 5-1: Estimated Scope 1 (Direct) Greenhouse Gas Emissions

Activity	Annual Consumption	Emission Factor (kg CO_{2-e}/GJ)			Annual GHG Emissions (tonnes CO_{2-e})
		CO_2	CH_4	N_2O	
Diesel use by generators	840 kL	69.2	0.2	0.5	2266.44
Diesel use by mobile plant	720 kL	69.2	0.2	0.5	1942.66
ANFO (explosive) use	7.2 tonnes	0.189 (/ tonne ANFO)	-	-	1.36
Total Annual Scope 1 GHG Emissions					4210.46

5.3.3 Scope 2 GHG Emissions

Due to the fact that the quarry uses diesel generators to produce electricity on site, this scope provides zero GHG emissions.

5.3.4 Scope 3 GHG Emissions

Scope 3 emissions encompass an almost infinite range of potential sources. Only the scope 3 emissions from the extraction/processing of the diesel to be used at the quarry have been examined for this facility. No information is available for scope 3 emissions associated with the manufacture of ANFO explosive.

The extraction, processing and transport of diesel fuel to site have associated GHG emissions. A scope 3 emissions factor of 5.3 kg CO_{2-e}/GJ is provided in the NGA Factors (2013). Using the same methodology as used for Scope 1, with diesel heat content of 38.6 GJ/kL, we find that diesel scope 3 emissions total 319.14 tCO_{2-e}. Refer to **Table 5–2**.

5.3.5 Summary of GHG Emissions

As per information provided by the client, the facility will generate up to 1,100,000 tonnes of product per annum. A summary of the above-calculated GHG emissions is shown in **Table 5-3**.

Table 5-2: Total Estimated Scope 3 (Other Indirect) Greenhouse Gas Emissions

Activity	Annual Consumption	Emission Factor (kg CO_{2-e}/GJ)	Annual GHG Emissions (Tonne CO_{2-e})
Diesel use by generators	840 kL	5.3	171.85
Diesel use by mobile plant	720 kL	5.3	147.30
Total Annual Scope 3 GHG Emissions			319.14

Table 5-3: Estimated Total Annual GHG Emissions

Emission Type	Annual GHG Emissions (Tonne CO_{2-e})	Annual GHG Emissions Intensity (Tonne CO_{2-e} / Tonne rock product)	% of Total
Scope 1	4209.10	0.00383	100%
Scope 2	–	–	–
Scope 3	319.14	0.00029	N/A
Total (Scope 1 + 2)	**4,528.24**	**0.00412**	**100%**

The total amount of greenhouse gas emissions from the proposal is approximately 4,528.24 tonnes of CO_{2-e} per annum, or alternatively, 0.00412 tonnes CO_{2-e} per tonne of rock product sales.

The estimation of scope 1 and 3 emissions has been conducted based on primary activities only, which includes the use of fossil fuels in generators and mobile plant. The calculations have been made based on the 2013 NGA factors, stated assumptions and also figures provided by the proponent.

Scope 1 emissions account for all of the GHG emissions directly attributable to site operations. This results solely from the use of diesel fuels in generators (51.76%) and mobile plant (48.24%). Scope 3 emissions are much less than Scope 1; however, not all potential Scope 3 sources have been included (which are considered to be accounted for in the Scope 1 and 3 emissions of other organisations related to the project).

Year to December 2012 annual estimated greenhouse emissions for Australia were 551.9 Mt CO_{2-e} (DCCEE, 2013). In comparison, the estimated annual greenhouse emission for the Project is 0.0042091 Mt CO_{2-e} (Scopes 1 and 3). Therefore, the annual contribution of greenhouse emissions from the project in comparison to the Australian greenhouse emissions in 2012 is approximately 0.0008%.

5.4 MEASURES TO REDUCE GREENHOUSE EMISSIONS

Opportunities to reduce greenhouse gas emissions need to be considered as an ongoing objective within the site's Environmental Management Plan. Understanding where the greenhouse gas emissions are generated is the first step in determining ways to reduce emission per unit of material processed.

Since the largest source of greenhouse gas emissions is Scope 1 from the consumption of diesel, reduction measures have been recommended for this activity. Scope 3 emissions included in this report are related to diesel use, and so the following recommendations will also help reduce these Scope 3 emissions. Other GHG reduction options have also been suggested.

A summary of options to reduce the total greenhouse emissions from the site is listed below:

- Improve process monitoring and management systems to ensure equipment is well-maintained and operating efficiently and only when necessary, in order to minimise diesel and electricity (via the generators) requirements;
- Consider using biodiesel if compatible. Unlike traditional diesel which is produced from crude oil, biodiesel is produced from clean or renewable sources, which is less GHG-intensive (i.e. biodiesel involves less Scope 3 emissions);
- Implementing an energy management program and/or undertaking regular energy audits of the site; and,
- Consider switching to alternative, clean energy sources such as a solar. A solar electric (photovoltaic) system will reduce the amount of diesel fuel needed to be used in generators.

6. STATEMENT OF POTENTIAL AIR IMPACTS

The NSW EPA "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales"* was followed in the preparation of this air assessment. The impact criteria for the pollutants considered were used to determine whether the potential impacts from the Proposal were within reasonable limits or would exceed the guidelines.

The impacts on residential areas within the vicinity of the quarry were determined. The emissions from the operation of the Proposal were assessed using CALPUFF.

No exceedances have been predicted for any of the scenarios examined. Recommendations relating to management of blasting and other operational activities have been noted to reduce the potential for exceedances of the air quality criteria (i.e. PM_{10} criteria under the 24-hour averaging period) as a result of the Proposal.

The greenhouse gas assessment has estimated an annual greenhouse gas emissions total of 4,528.24 tonnes of CO_2-equivalent from the proposal, with an annual greenhouse gas emissions intensity of 0.00412 tonnes of $CO_{2\text{-e}}$ / tonne of rock product produced. Recommendations made as part of this assessment is the continued consideration for opportunities to reduce greenhouse gas emissions within the site's Environmental Management Plan. A summary of options have been provided in this document.

It is strongly recommended the Applicant fully adhere to the mitigation measures already implemented and any additional mitigation measures included in this document.

Prepared by:

Louise Temple Sustainability Engineer	Duke Ismael Senior Environmental Engineer	R T Benbow Principal Consultant

7. REFERENCES

1. NSW EPA 2005
NSW Environment Protection Authority, "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*", August 2005

2. NSW EPA 2011
NSW Environment Protection Authority, *"Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'"*, March 2011

3. Ormerod et al, 2003
Ormerod R.J., D'Abreton P.C., Holmes G., "Buoyancy Effects Associated With Non-Point Odour Sources: Modelling Issues and Implications", 2003

4. SPCC 1986
State Pollution Control Commission of NSW (now EPA), "Particle size distributions in dust from open cut coal mines in the Hunter Valley", Report Number 10636-002-71, Prepared for SPCC by Dames & Moore, 41 McLaren Street, North Sydney, NSW 2060

5. Murillo et al 2013
Murillo C., Dufaud O., Lopez O., Perrin L., Alexis V., Munoz F., "CFD Modelling of Nanoparticles Dispersion in a Dust Explosion Apparatus", Chemical Engineering Transactions, Volume 31 2013, A publication of AIDIC The Italian Association of Chemical Engineering Online, www.aidic.it/cet

8. LIMITATIONS

Our services for this project are carried out in accordance with our current professional standards for site assessment investigations. No guarantees are either expressed or implied.

This report has been prepared solely for the use of Hy-Tec Industries Pty Ltd, as per our agreement for providing environmental services. Only Hy-Tec Industries Pty Ltd is entitled to rely upon the findings in the report within the scope of work described in this report. Otherwise, no responsibility is accepted for the use of any part of the report by another in any other context or for any other purpose.

Although all due care has been taken in the preparation of this study, no warranty is given, nor liability accepted (except that otherwise required by law) in relation to any of the information contained within this document. We accept no responsibility for the accuracy of any data or information provided to us by Hy-Tec Industries Pty Ltd for the purposes of preparing this report.

Any opinions and judgements expressed herein, which are based on our understanding and interpretation of current regulatory standards, should not be construed as legal advice.

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ATTACHMENTS

Note: Attachments 3 and 4 are only available on the Project CD

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Attachment 1: Location of Equipment utilised for Extraction Activities

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Hy-Tec Industries Pty Limited

ABN: 90 070 100 702

Figure A	Processing and Product Despatch – relevant to all stages
Figure B	Scenario 1 –Stage A
Figure C	Scenario 2 –Stage C
Figure D	Scenario 3 –Stage E

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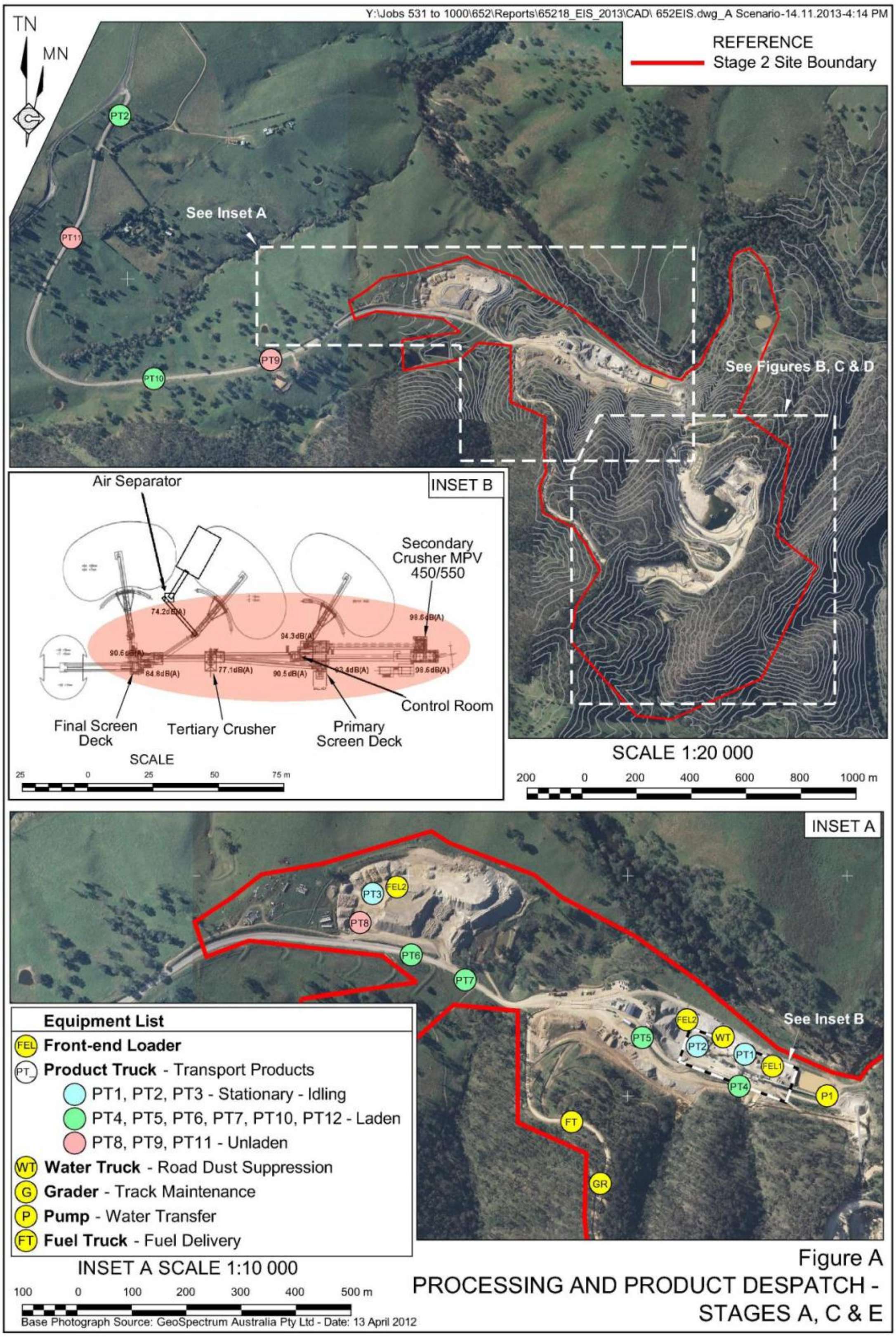


Figure A
PROCESSING AND PRODUCT DESPATCH - STAGES A, C & E

OPERATIONAL SCENARIO 1

PROCESSING AND PRODUCT DESPATCH – FIGURE A

Processing Plant

Various Crushers, Screens and Conveyors @ 665m AHD

Product Loading

Front-end loaders

FEL1 @ 664m AHD	FEL2 @ 666m AHD	FEL3 @ 709m AHD

Product Despatch

Stationary Trucks – Idling

PT1 @ 665m AHD	PT2 @ 667m AHD	PT3 @ 709m AHD

Laden Trucks – In motion

PT4 @ 666m AHD	PT5 @ 679m AHD	PT6 @ 701m AHD
PT7 @ 690m AHD	PT10 @ 745m AHD	PT12 @ 765m AHD

Unladen Trucks – In motion

PT8 @ 710m AHD	PT9 @ 745m AHD	PT11 @ 770m AHD

Other Activities

Water Truck	WT @ 666m AHD
Fuel Truck	FT @ 731m AHD
Grader	GR @ 752m AHD

EXTRACTION OPERATIONS – STAGE A – FIGURE B

Primary Crusher @ 738m AHD

Bulldozer – Vegetation Clearing/Overburden Removal @ 796m AHD

Drilling Rig – Drilling Blast Holes @ 800m AHD

Excavator – Loading Haul Trucks @ 795m AHD

Haul Truck – Transporting Blasted Rock

HT1 @ 780m AHD	HT2 @ 758m AHD	HT3 @ 750m AHD

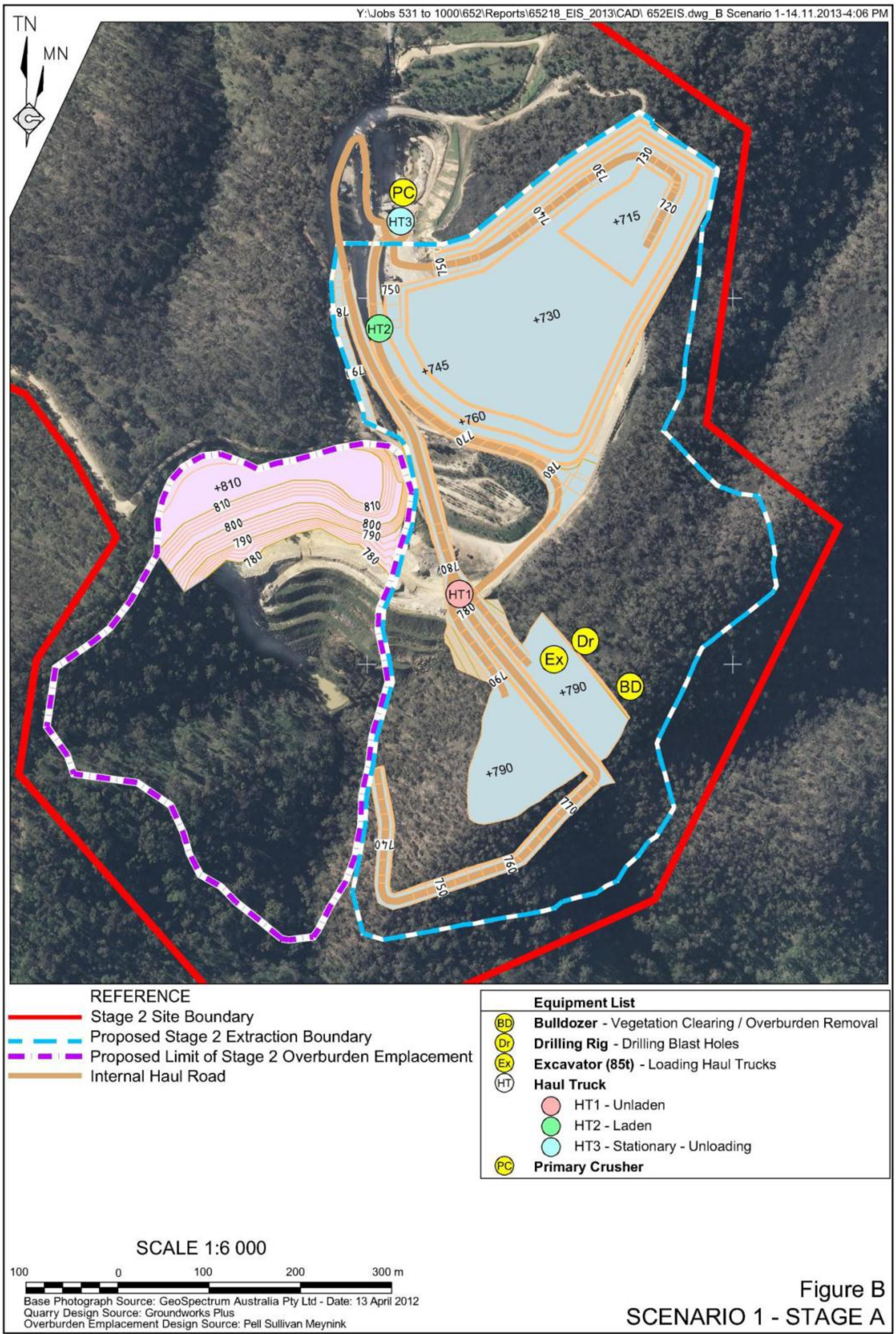


Figure B
SCENARIO 1 - STAGE A

OPERATIONAL SCENARIO 2

PROCESSING AND PRODUCT DESPATCH – FIGURE A

Processing Plant

Various Crushers, Screens and Conveyors @ 665m AHD

Product Loading

Front-end loaders

FEL1 @ 664m AHD	FEL2 @ 666m AHD	FEL3 @ 709m AHD

Product Despatch

Stationary Trucks – Idling

PT1 @ 665m AHD	PT2 @ 667m AHD	PT3 @ 709m AHD

Laden Trucks – In motion

PT4 @ 666m AHD	PT5 @ 679m AHD	PT6 @ 701m AHD
PT7 @ 690m AHD	PT10 @ 745m AHD	PT12 @ 765m AHD

Unladen Trucks – In motion

PT8 @ 710m AHD	PT9 @ 745m AHD	PT11 @ 770m AHD

Other Activities

Water Truck	WT @ 666m AHD
Fuel Truck	FT @ 731m AHD
Grader	GR @ 752m AHD

EXTRACTION OPERATIONS – STAGE C – FIGURE C

Primary Crusher @ 738m AHD

Bulldozer – Vegetation Clearing/Overburden Removal @ 786m AHD

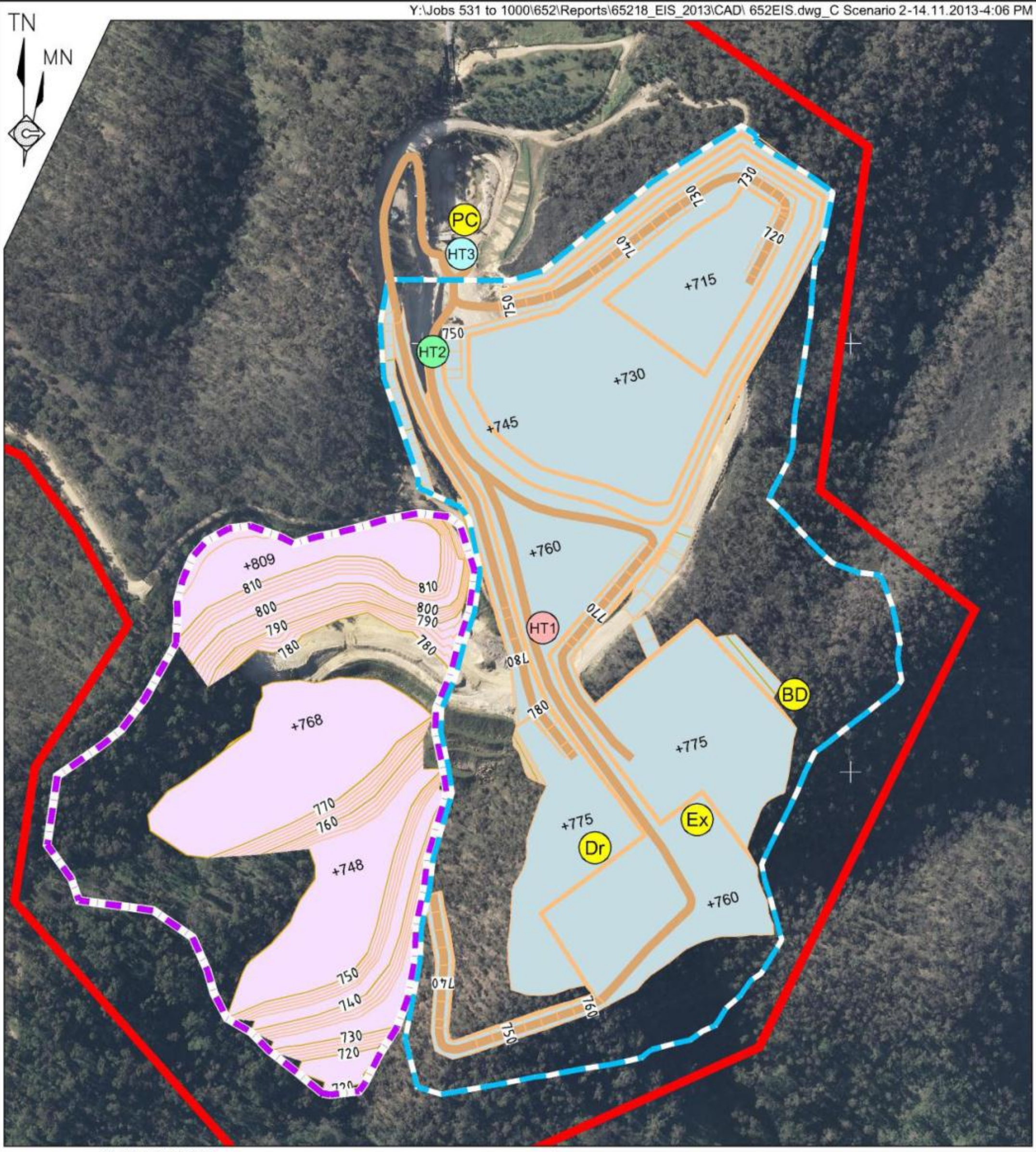
Drilling Rig – Drilling Blast Holes @ 775m AHD

Excavator – Loading Haul Trucks @ 765m AHD

Haul Truck – Transporting Blasted Rock

HT1 @ 760m AHD	HT2 @ 758m AHD	HT3 @ 750m AHD

Y:\Jobs 531 to 1000\652\Reports\65218_EIS_2013\CAD\ 652EIS.dwg_C Scenario 2-14.11.2013-4:06 PM



REFERENCE
- Stage 2 Site Boundary
- Proposed Stage 2 Extraction Boundary
- Proposed Limit of Stage 2 Overburden Emplacement
- Internal Haul Road

Equipment List
- BD **Bulldozer** - Vegetation Clearing / Overburden Removal
- Dr **Drilling Rig** - Drilling Blast Holes
- Ex **Excavator (85t)** - Loading Haul Trucks
- HT **Haul Truck**
  - HT1 - Unladen
  - HT2 - Laden
  - HT3 - Stationary - Unloading
- PC **Primary Crusher**

SCALE 1:6 000

100 0 100 200 300 m

Base Photograph Source: GeoSpectrum Australia Pty Ltd - Date: 13 April 2012
Quarry Design Source: Groundworks Plus
Overburden Emplacement Design Source: Pell Sullivan Meynink

Figure C
SCENARIO 2 - STAGE C

OPERATIONAL SCENARIO 3

PROCESSING AND PRODUCT DESPATCH – FIGURE A

Processing Plant

Various Crushers, Screens and Conveyors @ 665m AHD

Product Loading

Front-end loaders

FEL1 @ 664m AHD	FEL2 @ 666m AHD	FEL3 @ 709m AHD

Product Despatch

Stationary Trucks – Idling

PT1 @ 665m AHD	PT2 @ 667m AHD	PT3 @ 709m AHD

Laden Trucks – In motion

PT4 @ 666m AHD	PT5 @ 679m AHD	PT6 @ 701m AHD
PT7 @ 690m AHD	PT10 @ 745m AHD	PT12 @ 765m AHD

Unladen Trucks – In motion

PT8 @ 710m AHD	PT9 @ 745m AHD	PT11 @ 770m AHD

Other Activities

Water Truck	WT @ 666m AHD
Fuel Truck	FT @ 731m AHD
Grader	GR @ 752m AHD

EXTRACTION OPERATIONS – STAGE E – FIGURE D

Primary Crusher @ 738m AHD

Bulldozer – Vegetation Clearing/Overburden Removal @ 742m AHD

Drilling Rig – Drilling Blast Holes @ 730m AHD

Excavator – Loading Haul Trucks @ 720m AHD

Haul Truck – Transporting Blasted Rock

HT1 @ 715m AHD	HT2 @ 751m AHD	HT3 @ 750m AHD

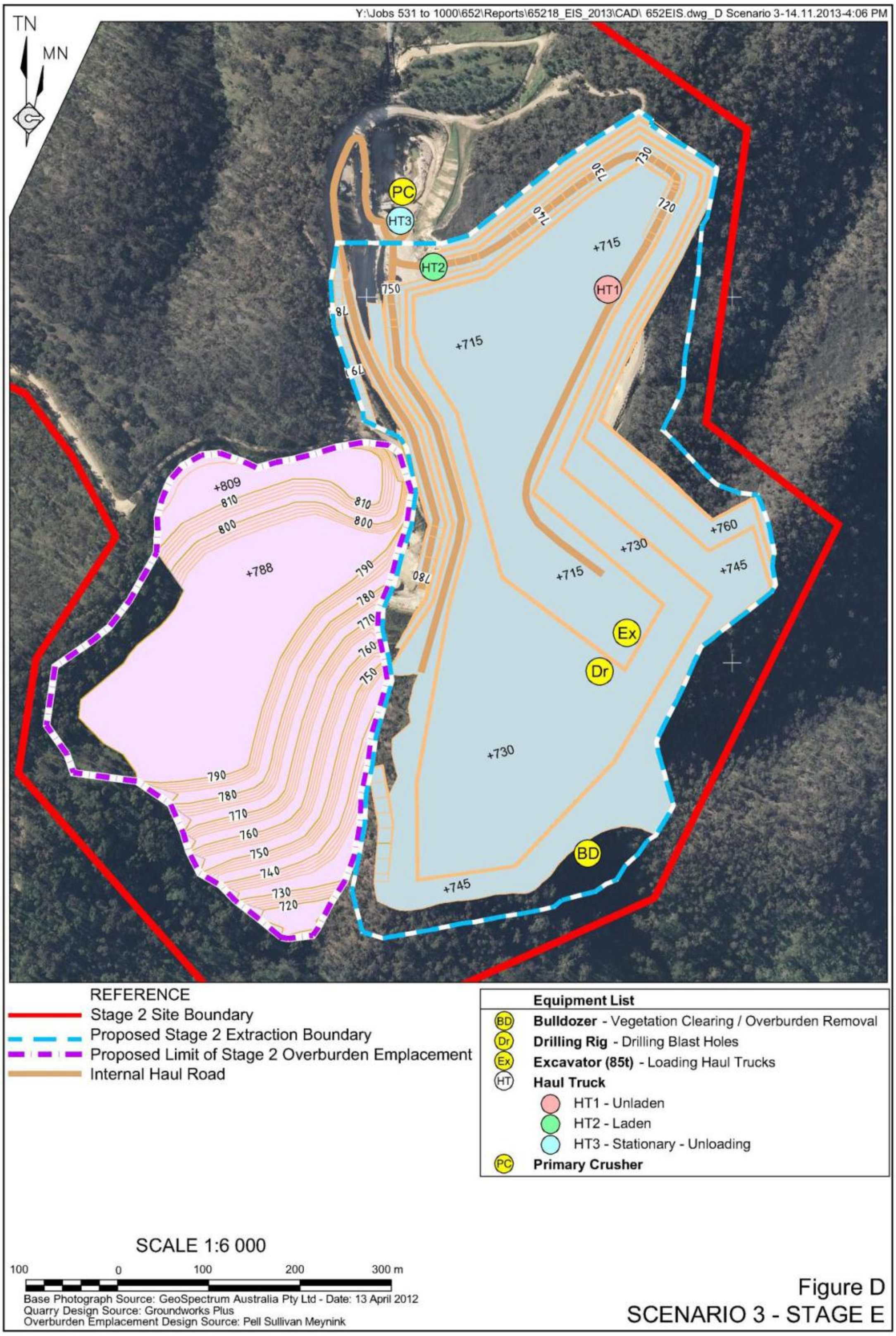


Figure D
SCENARIO 3 - STAGE E

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Attachment 2: Dust Emissions Inventory

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Source ID	Source Description	MGA56 X Coordinates (m)	MGA56 Y Coordinates (m)	Source Height (m)	Diameter / Area (m or m^2)	Exit Temp (^oC)	Hours Active in Model	Scenario 1 PM_{10} Emission Rate (g/s or $g/m^2.s$)	Scenario 1 TSP Emission Rate (g/s or $g/m^2.s$)	Scenario 2 PM_{10} Emission Rate (g/s or $g/m^2.s$)	Scenario 2 TSP Emission Rate (g/s or $g/m^2.s$)	Scenario 3 PM_{10} Emission Rate (g/s or $g/m^2.s$)	Scenario 3 TSP Emission Rate (g/s or $g/m^2.s$)
Emission Sources Present in All Scenarios													
FEL1	Front end loader	235862	6281657	0.1	5m	25	6am-10pm	1.02E+01	2.13E+01	1.02E+01	2.13E+01	1.02E+01	2.13E+01
FEL2	Front end loader	235704	6281742	0.1	5m	25	6am-10pm	1.02E+01	2.13E+01	1.02E+01	2.13E+01	1.02E+01	2.13E+01
FEL3	Front end loader	235171	6281984	0.1	5m	25	6am-10pm	1.02E+01	2.13E+01	1.02E+01	2.13E+01	1.02E+01	2.13E+01
TT01	Vehicle Travel	235124 235071 235404 235426	6282005 6281896 6281749 6281787	0.1	31127m^2	25	6am-10pm	8.51E-08	3.40E-07	8.51E-08	3.40E-07	8.51E-08	3.40E-07
TT02	Vehicle Travel	235426 235402 235559 235602	6281785 6281751 6281380 6281394	0.1	17906m^2	25	6am-10pm	1.48E-07	3.40E-07	8.51E-08	3.40E-07	8.51E-08	3.40E-07
TT03	Vehicle Travel	235434 235604 235882 235781	6281787 6281650 6281585 6281725	0.1	34578m^2	25	6am-10pm	7.66E-08	3.40E-07	7.66E-08	3.40E-07	8.51E-08	3.40E-07
G	Grader	235426 235402 235559 235602	6281785 6281751 6281380 6281394	0.1	17906m^2	25	6am-6pm	7.87E-05	2.49E-04	7.87E-05	2.49E-04	7.87E-05	2.49E-04
WE01	Wind Eroded Area	235181 235089 235256 235373	6282048 6281924 6281860 6281992	0.1	29580m^2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05
WE02	Wind Eroded Area	235637 235602 235822 235975	6281780 6281688 6281596 6281611	0.1	27525m^2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05
STSC	Secondary & Tertiary Crushing and Screening	235826	6281645	0.1	5m	25	6am-10pm	1.18E-01	1.18E-01	1.18E-01	1.18E-01	1.18E-01	1.18E-01
Scenario 1 Sources													
PC	Primary Crushing	236041	6281318	0.1	5m	25	6am-10pm	9.51E-02	9.51E-01	9.51E-02	9.51E-01	9.51E-02	9.51E-01
TT11	Vehicle Travel	236017 235997 236046 236064	6281297 6281123 6281115 6281297	0.1	8811m^2	25	6am-10pm	3.01E-07	1.20E-06	3.01E-07	1.20E-06	3.01E-07	1.20E-06

Source ID	Source Description	MGA56 X Coordinates (m)	MGA56 Y Coordinates (m)	Source Height (m)	Diameter / Area (m or m^2)	Exit Temp (^{o}C)	Hours Active in Model	Scenario 1 PM_{10} Emission Rate (g/s or g/m^2.s)	Scenario 1 TSP Emission Rate (g/s or g/m^2.s)	Scenario 2 PM_{10} Emission Rate (g/s or g/m^2.s)	Scenario 2 TSP Emission Rate (g/s or g/m^2.s)	Scenario 3 PM_{10} Emission Rate (g/s or g/m^2.s)	Scenario 3 TSP Emission Rate (g/s or g/m^2.s)
TT12	Vehicle Travel	235997 236126 236163 236040	6281123 6280792 6280819 6281111	0.1	14070m^2	25	6am-10pm	1.20E-06	2.65E-03	1.20E-06	2.65E-03	1.20E-06	2.65E-03
EX	Excavator	236207	6280808	0.1	5m	25	6am-10pm	1.02E+01	2.13E+01	1.02E+01	2.13E+01	1.02E+01	2.13E+01
DR	Drill Rig	236241	6280827	0.1	5m	25	6am-10pm	2.00E-01	4.76E-01	2.00E-01	4.76E-01	2.00E-01	4.76E-01
BD	Bulldozer	236290	6280776	0.1	5m	25	6am-10pm	1.56E-04	3.11E-03	1.56E-04	3.11E-03	1.56E-04	3.11E-03
WE11	Wind Eroded Area	235827 235762 235999 236021	6281021 6280883 6280852 6281027	0.1	35268m^2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05
WE12	Wind Eroded Area	236014 236221 236379 236299	6281211 6281007 6281327 6281395	0.1	66633m^2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05
BL11	Blasting	236241	6280827	1	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
BL12	Blasting	236241	6280827	2	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
BL13	Blasting	236241	6280827	3	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
Scenario 2 Sources													
PC	Primary Crushing	236039	6281318	0.1	5m	25	6am-10pm	9.51E-02	9.51E-01	9.51E-02	9.51E-01	9.51E-02	9.51E-01
TT21	Vehicle Travel	236025 235989 236032 236064	6281299 6281158 6281150 6281289	0.1	6191m^2	25	6am-10pm	4.85E-11	9.51E-01	4.85E-11	9.51E-01	4.85E-11	9.51E-01
TT22	Vehicle Travel	235989 236147 236185 236036	6281156 6280807 6280825 6281146	0.1	14374m^2	25	6am-10pm	1.84E-07	7.37E-07	1.84E-07	7.37E-07	1.84E-07	7.37E-07
EX	Excavator	236257	6280756	0.1	5m	25	6am-10pm	1.02E+01	2.13E+01	1.02E+01	2.13E+01	1.02E+01	2.13E+01
DR	Drill Rig	236162	6280729	0.1	5m	25	6am-10pm	2.00E-01	4.76E-01	2.00E-01	4.76E-01	2.00E-01	4.76E-01
BD	Bulldozer	236348	6280874	0.1	5m	25	6am-10pm	1.56E-04	3.11E-03	1.56E-04	3.11E-03	1.56E-04	3.11E-03
WE21	Wind Eroded Area	235795 235830 235939 236029	6280999 6280581 6280505 6281012	0.1	80441m^2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05

Source ID	Source Description	MGA56 X Coordinates (m)	MGA56 Y Coordinates (m)	Source Height (m)	Diameter / Area (m or m^2)	Exit Temp (^oC)	Hours Active in Model	Scenario 1 PM_{10} Emission Rate (g/s or $g/m^2.s$)	Scenario 1 TSP Emission Rate (g/s or $g/m^2.s$)	Scenario 2 PM_{10} Emission Rate (g/s or $g/m^2.s$)	Scenario 2 TSP Emission Rate (g/s or $g/m^2.s$)	Scenario 3 PM_{10} Emission Rate (g/s or $g/m^2.s$)	Scenario 3 TSP Emission Rate (g/s or $g/m^2.s$)
WE22	Wind Eroded Area	236050 236104 236343 236352	6281223 6280644 6280820 6281353	0.1	153722m2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05
BL21	Blasting	236162	6280729	1	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
BL22	Blasting	236162	6280729	2	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
BL23	Blasting	236162	6280729	3	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
Scenario 3 Sources													
PC	Primary Crushing	236043	6281318	0.1	5m	25	6am-10pm	9.51E-02	9.51E-01	9.51E-02	9.51E-01	9.51E-02	9.51E-01
TT31	Vehicle Travel	236013 236074 236128 236060	6281287 6281184 6281228 6281307	0.1	6531m^2	25	6am-10pm	4.05E-07	1.62E-06	4.05E-07	1.62E-06	4.05E-07	1.62E-06
TT32	Vehicle Travel	236122 236078 236308 236308	6281228 6281184 6281180 6281244	0.1	11668m^2	25	6am-10pm	4.05E-07	1.62E-06	4.05E-07	1.62E-06	4.05E-07	1.62E-06
EX	Excavator	236286	6280836	0.1	5m	25	6am-10pm	1.02E+01	2.13E+01	1.02E+01	2.13E+01	1.02E+01	2.13E+01
DR	Drill Rig	236258	6280791	0.1	5m	25	6am-10pm	2.00E-01	4.76E-01	2.00E-01	4.76E-01	2.00E-01	4.76E-01
BD	Bulldozer	236243	6280592	0.1	5m	25	6am-10pm	1.56E-04	3.11E-03	1.56E-04	3.11E-03	1.56E-04	3.11E-03
WE31	Wind Eroded Area	235805 235713 235935 236031	6281009 6280712 6280500 6281011	0.1	102107m^2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05
WE32	Wind Eroded Area	236058 236058 236349 236377	6281229 6280544 6280641 6281350	0.1	213577m^2	25	All hours	5.56E-06	1.11E-05	5.56E-06	1.11E-05	5.56E-06	1.11E-05
BL31	Blasting	236258	6280791	1	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
BL32	Blasting	236258	6280791	2	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04
BL33	Blasting	236258	6280791	3	40m	50	1pm everyday	5.57E+03	1.07E+04	5.57E+03	1.07E+04	5.57E+03	1.07E+04

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Attachment 3: Extract of a Sample CALPUFF output*

*Note: A copy of this Attachment is only available on the Project CD.

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```
                    CALPUFF     Version: 6.267      Level: 090710

*****************************************************************************************************************
***********


 Clock time: 08:58:06
       Date: 12-14-2013


 Internal Coordinate Transformations by  ---  COORDLIB   Version: 1.99   Level: 070921


 Run Title:
   131044




 -------------
 Subgroup (0a)
 -------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

 Default Name  Type          File Name
 ------------  ----          ---------
  none         input    * METDAT=     *   *END*


 --------------------------------------------------------------------------------

 INPUT GROUP: 1 -- General run control parameters
 --------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   1  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   ! IBYR  =  2012  !
                       Month  (IBMO)  --    No default   ! IBMO  =  0  !
                       Day    (IBDY)  --    No default   ! IBDY  =  0  !
     Starting time:    Hour   (IBHR)  --    No default   ! IBHR  =  0  !
                       Minute (IBMIN) --    No default   ! IBMIN =  0  !
                       Second (IBSEC) --    No default   ! IBSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  0  !
                       Month  (IEMO)  --    No default   ! IEMO  =  0  !
                       Day    (IEDY)  --    No default   ! IEDY  =  0  !
     Ending time:      Hour   (IEHR)  --    No default   ! IEHR  =  0  !
                       Minute (IEMIN) --    No default   ! IEMIN =  0  !
                       Second (IESEC) --    No default   ! IESEC =  0  !

     (These are only used if METRUN = 0)
```

```
Base time zone        (XBTZ) -- No default       ! XBTZ= -10.0  !
The zone is the number of hours that must be
ADDED to the time to obtain UTC (or GMT)
Examples: PST = 8., MST = 7.
        CST = 6., EST = 5.

Length of modelling time-step (seconds)
Equal to update period in the primary
meteorological data files, or an
integer fraction of it (1/2, 1/3 ...)
Must be no larger than 1 hour
(NSECDT)                    Default:3600     ! NSECDT =  3600  !
                          Units: seconds

Number of chemical species (NSPEC)
                          Default: 5       ! NSPEC =  1   !

Number of chemical species
to be emitted  (NSE)           Default: 3       ! NSE =  1   !

Flag to stop run after
SETUP phase (ITEST)            Default: 2       ! ITEST =  2   !
(Used to allow checking
of the model inputs, files, etc.)
     ITEST = 1 - STOPS program after SETUP phase
     ITEST = 2 - Continues with execution of program
               after SETUP

Restart Configuration:

  Control flag (MRESTART)      Default: 0       ! MRESTART =  0   !

     0 = Do not read or write a restart file
     1 = Read a restart file at the beginning of
         the run
     2 = Write a restart file during run
     3 = Read a restart file at beginning of run
         and write a restart file during run

  Number of periods in Restart
  output cycle (NRESPD)       Default: 0       ! NRESPD =  0   !

     0 = File written only at last period
    >0 = File updated every NRESPD periods

Meteorological Data Format (METFM)
                          Default: 1       ! METFM =  1   !

     METFM = 1 - CALMET binary file (CALMET.MET)
     METFM = 2 - ISC ASCII file (ISCMET.MET)
     METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
     METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
               surface parameters file (SURFACE.DAT)
     METFM = 5 - AERMET tower file (PROFILE.DAT) and
               surface parameters file (SURFACE.DAT)

Meteorological Profile Data Format (MPRFFM)
      (used only for METFM = 1, 2, 3)
                          Default: 1       ! MPRFFM =  1   !
```

```
        MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
        MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                         Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                         Default: 60.0    ! PGTIME = 60. !


!END!

-------------------------------------------------
NOTICE: Starting year in control file sets the
       expected century for the simulation.  All
       YY years are converted to YYYY years in
       the range:  1962 2061
-------------------------------------------------



--------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)              Default: 1     ! MGAUSS =  1   !
       0 = uniform
       1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                    Default: 3     ! MCTADJ =  3   !
       0 = no adjustment
       1 = ISC-type of terrain adjustment
       2 = simple, CALPUFF-type of terrain
           adjustment
       3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                 Default: 0     ! MCTSG =  0   !
       0 = not modelled
       1 = modelled

     Near-field puffs modelled as
     elongated slugs? (MSLUG)           Default: 0     ! MSLUG =  0   !
       0 = no
       1 = yes (slug model used)

     Transitional plume rise modelled?
     (MTRANS)                     Default: 1     ! MTRANS =  1   !
       0 = no  (i.e., final rise only)
       1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)          Default: 1     ! MTIP =  1  !
       0 = no  (i.e., no stack tip downwash)
       1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
```

```
point sources not subject to building
downwash? (MRISE)              Default: 1     ! MRISE =  1  !
   1 = Briggs plume rise
   2 = Numerical plume rise

Method used to simulate building
downwash? (MBDW)               Default: 1     ! MBDW =   1  !
   1 = ISC method
   2 = PRIME method

Vertical wind shear modelled above
stack top (modified Briggs plume rise)?
(MSHEAR)                       Default: 0     ! MSHEAR =  0  !
   0 = no  (i.e., vertical wind shear not modelled)
   1 = yes (i.e., vertical wind shear modelled)

Puff splitting allowed? (MSPLIT)      Default: 0     ! MSPLIT =  0  !
   0 = no (i.e., puffs not split)
   1 = yes (i.e., puffs are split)

Chemical mechanism flag (MCHEM)       Default: 1     ! MCHEM =  0   !
   0 = chemical transformation not
       modelled
   1 = transformation rates computed
       internally (MESOPUFF II scheme)
   2 = user-specified transformation
       rates used
   3 = transformation rates computed
       internally (RIVAD/ARM3 scheme)
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)
   5 = user-specified half-life with or
       without transfer to child species

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM =  0   !
   0 = aqueous phase transformation
       not modelled
   1 = transformation rates adjusted
       for aqueous phase reactions

Wet removal modelled ? (MWET)         Default: 1     ! MWET =  0   !
   0 = no
   1 = yes

Dry deposition modelled ? (MDRY)      Default: 1     ! MDRY =  0   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modelled ? (MTILT)             Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
```

```
   - MDRY  = 1
   - NSPEC = 1  (must be particle species as well)
   - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
              set to zero for a single particle diameter

 Method used to compute dispersion
 coefficients (MDISP)             Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

 Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
 (Used only if MDISP = 1 or 5)       Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

 Back-up method used to compute dispersion
 when measured turbulence data are
 missing (MDISP2)                 Default: 3     ! MDISP2 =  3  !
 (used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

 [DIAGNOSTIC FEATURE]
 Method used for Lagrangian timescale for Sigma-y
 (used only if MDISP=1,2 or MDISP2=1,2)
 (MTAULY)                         Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)            -- e.g., 306.9
```

[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV) Default: 0 ! MTAUADV = 0 !
0 = No turbulence advection
1 = Computed (OPTION NOT IMPLEMENTED)
10 < Direct user input (s) -- e.g., 800

Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB) Default: 1 ! MCTURB = 1 !
1 = Standard CALPUFF subroutines
2 = AERMOD subroutines

PG sigma-y,z adj. for roughness? Default: 0 ! MROUGH = 0 !
(MROUGH)
0 = no
1 = yes

Partial plume penetration of Default: 1 ! MPARTL = 1 !
elevated inversion modelled for
point sources?
(MPARTL)
0 = no
1 = yes

Partial plume penetration of Default: 1 ! MPARTLBA = 1 !
elevated inversion modelled for
buoyant area sources?
(MPARTLBA)
0 = no
1 = yes

Strength of temperature inversion Default: 0 ! MTINV = 0 !
provided in PROFILE.DAT extended records?
(MTINV)
0 = no (computed from measured/default gradients)
1 = yes

PDF used for dispersion under convective conditions?
Default: 0 ! MPDF = 0 !
(MPDF)
0 = no
1 = yes

Sub-Grid TIBL module used for shore line?
Default: 0 ! MSGTIBL = 0 !
(MSGTIBL)
0 = no
1 = yes

Boundary conditions (concentration) modelled?
Default: 0 ! MBCON = 0 !
(MBCON)
0 = no
1 = yes, using formatted BCON.DAT file
2 = yes, using unformatted CONC.DAT file

```
Note:  MBCON > 0 requires that the last species modelled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modelling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                              Default: 0     ! MSOURCE = 0  !
(MSOURCE)
  0 = no
  1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapour and temperature from each cooling tower
```

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Attachment 4: Dust Emissions Inventory (26 Random Days Scenario)*

*Note: A copy of this Attachment is only available on the Project CD.

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Dust Emissions Inventory for Blasting Assumed to Occur 26 Random Days Per Year

Source ID	Source Description	MGA56 X Coordinates (m)	MGA56 Y Coordinates (m)	Source Height (m)	Diameter / Area (m or m2)	Exit Temp (ºC)	Hours Active in Model	Scenario 1 PM2.5 Emission Rate (g/s or g/m².s)	Scenario 1 PM10 Emission Rate (g/s or g/m².s)	Scenario 1 TSP Emission Rate (g/s or g/m².s)	Scenario 2 PM2.5 Emission Rate (g/s or g/m².s)	Scenario 2 PM10 Emission Rate (g/s or g/m².s)	Scenario 2 TSP Emission Rate (g/s or g/m².s)	Scenario 3 PM2.5 Emission Rate (g/s or g/m².s)	Scenario 3 PM10 Emission Rate (g/s or g/m².s)	Scenario 3 TSP Emission Rate (g/s or g/m².s)
Emission Sources Present in All Scenarios																
FEL1	Front end loader	235862	6281657	0.1	5m	25	6am-10pm	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01
FEL2	Front end loader	235704	6281742	0.1	5m	25	6am-10pm	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01
FEL3	Front end loader	235171	6281984	0.1	5m	25	6am-10pm	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01
TT01	Vehicle Travel	235124 235071 235404 235426	6282005 6281896 6281749 6281787	0.1	31,127m²	25	6am-10pm	1.60E-08	8.51E-08	3.40E-07	1.60E-08	8.51E-08	3.40E-07	1.60E-08	8.51E-08	3.40E-07
TT02	Vehicle Travel	235426 235402 235559 235602	6281785 6281751 6281380 6281394	0.1	17,906m²	25	6am-10pm	1.60E-08	1.48E-07	3.40E-07	1.60E-08	8.51E-08	3.40E-07	1.60E-08	8.51E-08	3.40E-07
TT03	Vehicle Travel	235434 235604 235882 235781	6281787 6281650 6281585 6281725	0.1	34,578m²	25	6am-10pm	1.60E-08	7.66E-08	3.40E-07	1.60E-08	7.66E-08	3.40E-07	1.60E-08	8.51E-08	3.40E-07
G	Grader	235426 235402 235559 235602	6281785 6281751 6281380 6281394	0.1	17,906m²	25	6am-6pm	1.17E-05	7.87E-05	2.49E-04	1.17E-05	7.87E-05	2.49E-04	1.17E-05	7.87E-05	2.49E-04
WE01	Wind Eroded Area	235181 235089 235256 235373	6282048 6281924 6281860 6281992	0.1	29,580m²	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
WE02	Wind Eroded Area	235637 235602 235822 235975	6281780 6281688 6281596 6281611	0.1	27,525m²	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
STSC	Secondary & Tertiary Crushing and Screening	235826	6281645	0.1	5m	25	6am-10pm	5.57E-03	1.18E-01	1.18E-01	5.57E-03	1.18E-01	1.18E-01	5.57E-03	1.18E-01	1.18E-01
Scenario 1 Sources																
PC	Primary Crushing	236041	6281318	0.1	5m	25	6am-10pm	4.47E-02	9.51E-02	9.51E-01	4.47E-02	9.51E-02	9.51E-01	4.47E-02	9.51E-02	9.51E-01
TT11	Vehicle Travel	236017 235997 236046 236064	6281297 6281123 6281115 6281297	0.1	8,811m²	25	6am-10pm	5.65E-08	3.01E-07	1.20E-06	5.65E-08	3.01E-07	1.20E-06	5.65E-08	3.01E-07	1.20E-06
TT12	Vehicle Travel	235997	6281123	0.1	14,070m²	25	6am-10pm	1.24E-04	1.20E-06	2.65E-03	1.24E-04	1.20E-06	2.65E-03	1.24E-04	1.20E-06	2.65E-03

		236126 236163 236040	6280792 6280819 6281111													
EX	Excavator	236207	6280808	0.1	5m	25	6am-10pm	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01
DR	Drill Rig	236241	6280827	0.1	5m	25	6am-10pm	2.24E-02	2.00E-01	4.76E-01	2.24E-02	2.00E-01	4.76E-01	2.24E-02	2.00E-01	4.76E-01
BD	Bulldozer	236290	6280776	0.1	5m	25	6am-10pm	1.46E-04	1.56E-04	3.11E-03	1.46E-04	1.56E-04	3.11E-03	1.46E-04	1.56E-04	3.11E-03
WE11	Wind Eroded Area	235827 235762 235999 236021	6281021 6280883 6280852 6281027	0.1	35268 m^2	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
WE12	Wind Eroded Area	236014 236221 236379 236299	6281211 6281007 6281327 6281395	0.1	66,633 m^2	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
BL11	Blasting	236241	6280827	1	40m	50	See table below	503.8343308	5.57E+03	1.07E+04	503.8343308	5.57E+03	1.07E+04	503.8343308	5.57E+03	1.07E+04
BL12	Blasting	236241	6280827	2	40m	50	See table below	503.8343308	5.57E+03	1.07E+04	503.8343308	5.57E+03	1.07E+04	503.8343308	5.57E+03	1.07E+04
BL13	Blasting	236241	6280827	3	40m	50	See table below	503.8343308	5.57E+03	1.07E+04	503.8343308	5.57E+03	1.07E+04	503.8343308	5.57E+03	1.07E+04
Scenario 2 Sources																
PC	Primary Crushing	236039	6281318	0.1	5m	25	6am-10pm	4.47E-02	9.51E-02	9.51E-01	4.47E-02	9.51E-02	9.51E-01	4.47E-02	9.51E-02	9.51E-01
TT21	Vehicle Travel	236025 235989 236032 236064	6281299 6281158 6281150 6281289	0.1	6,191 m^2	25	6am-10pm	4.47E-02	4.85E-11	9.51E-01	4.47E-02	4.85E-11	9.51E-01	4.47E-02	4.85E-11	9.51E-01
TT22	Vehicle Travel	235989 236147 236185 236036	6281156 6280807 6280825 6281146	0.1	14,374 m^2	25	6am-10pm	3.46E-08	1.84E-07	7.37E-07	3.46E-08	1.84E-07	7.37E-07	3.46E-08	1.84E-07	7.37E-07
EX	Excavator	236257	6280756	0.1	5m	25	6am-10pm	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01
DR	Drill Rig	236162	6280729	0.1	5m	25	6am-10pm	2.24E-02	2.00E-01	4.76E-01	2.24E-02	2.00E-01	4.76E-01	2.24E-02	2.00E-01	4.76E-01
BD	Bulldozer	236348	6280874	0.1	5m	25	6am-10pm	1.46E-04	1.56E-04	3.11E-03	1.46E-04	1.56E-04	3.11E-03	1.46E-04	1.56E-04	3.11E-03
WE21	Wind Eroded Area	235795 235830 235939 236029	6280999 6280581 6280505 6281012	0.1	80,441 m^2	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
WE22	Wind Eroded Area	236050 236104 236343 236352	6281223 6280644 6280820 6281353	0.1	153,722 m^2	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
BL21	Blasting	236162	6280729	1	40m	50	See table below	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04
BL22	Blasting	236162	6280729	2	40m	50	See table below	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04
BL23	Blasting	236162	6280729	3	40m	50	See table below	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04

Scenario 3 Sources

PC	Primary Crushing	236043	6281318	0.1	5m	25	6am-10pm	4.47E-02	9.51E-02	9.51E-01	4.47E-02	9.51E-02	9.51E-01	4.47E-02	9.51E-02	9.51E-01
TT31	Vehicle Travel	236013 236074 236128 236060	6281287 6281184 6281228 6281307	0.1	65,31m^2	25	6am-10pm	7.62E-08	4.05E-07	1.62E-06	7.62E-08	4.05E-07	1.62E-06	7.62E-08	4.05E-07	1.62E-06
TT32	Vehicle Travel	236122 236078 236308 236308	6281228 6281184 6281180 6281244	0.1	11,668m^2	25	6am-10pm	7.62E-08	4.05E-07	1.62E-06	7.62E-08	4.05E-07	1.62E-06	7.62E-08	4.05E-07	1.62E-06
EX	Excavator	236286	6280836	0.1	5m	25	6am-10pm	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01	1.00E+00	1.02E+01	2.13E+01
DR	Drill Rig	236258	6280791	0.1	5m	25	6am-10pm	2.24E-02	2.00E-01	4.76E-01	2.24E-02	2.00E-01	4.76E-01	2.24E-02	2.00E-01	4.76E-01
BD	Bulldozer	236243	6280592	0.1	5m	25	6am-10pm	1.46E-04	1.56E-04	3.11E-03	1.46E-04	1.56E-04	3.11E-03	1.46E-04	1.56E-04	3.11E-03
WE31	Wind Eroded Area	235805 235713 235935 236031	6281009 6280712 6280500 6281011	0.1	102,107m^2	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
WE32	Wind Eroded Area	236058 236058 236349 236377	6281229 6280544 6280641 6281350	0.1	213,577m^2	25	All hours	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05	5.22E-07	5.56E-06	1.11E-05
BL31	Blasting	236258	6280791	1	40m	50	See table below	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04
BL32	Blasting	236258	6280791	2	40m	50	See table below	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04
BL33	Blasting	236258	6280791	3	40m	50	See table below	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04	5.04E+02	5.57E+03	1.07E+04

The 26 days were selected by random using Microsoft Excel's RANDBETWEEN function to select 26 days throughout the year between the hours of 9am to 5pm every day to which blasting would be conducted. These randomly selected values are as follows:

Julian Day (1-365)	Hour of the Day (9:00-17:00)
62	13:00
70	13:00
112	17:00
121	10:00
122	10:00
128	9:00
156	16:00
180	15:00
186	16:00
199	17:00
215	11:00
223	14:00
229	10:00
234	10:00
243	9:00

Julian Day (1-365)	Hour of the Day (9:00-17:00)
257	14:00
266	11:00
268	17:00
282	13:00
290	11:00
293	17:00
295	11:00
304	11:00
308	13:00
351	17:00
357	11:00