Appendix D
Air Quality Impact Assessment

Jandra Quarry Intensification Project

Air Quality Impact Assessment

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Jandra Quarry Intensification Project

Air Quality Impact Assessment

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1 INTRODUCTION

Element Environment commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct an air quality impact assessment for a proposed increase in production at Jandra Quarry, operated by Holcim (Australia) Pty Ltd (Holcim).

Jandra Quarry is currently operating under development consent (DA231-10-99) with an approved extraction rate of 250,000 tonnes per calendar year. Holcim is seeking to modify the development consent to provide for an increase in production and transportation of finished products to a maximum limit of 475,000 tonnes per calendar year.

This report presents the methodology, input data, assumptions and findings of an air quality impact assessment performed for the proposed intensification in production.

2 PROJECT BACKGROUND

Over the past 14 years since the current development approval of Jandra Quarry was granted, extraction has been focused in the western part of the quarry pit, to avoid disturbing the main haul roads to the upper benches, which were established on the eastern side of the quarry during early pit development.

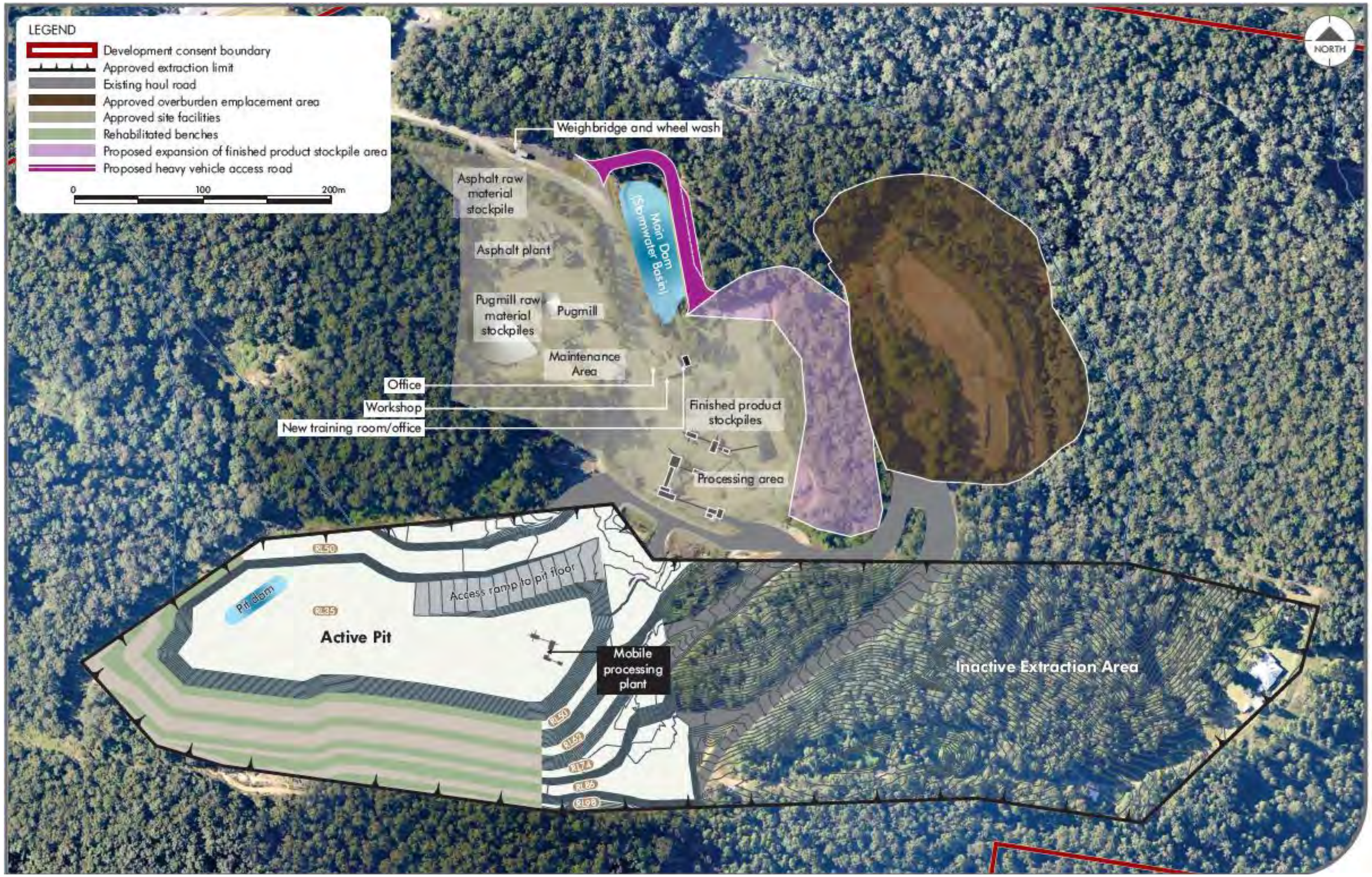
Overburden and topsoil has been placed on benches RL 98 and RL 86, where terminal faces were developed on the southern limits of the pit. Bench RL 98 has been revegetated with a mixture of grasses, shrubs and trees as part of the staged rehabilitation process, while Bench RL 86 has been planted with grasses, to be followed with woody vegetation. Additional overburden and topsoil that is stripped from the western part of the approved extraction area, that is not required for rehabilitation of terminal benches, is hauled primarily along the northern RL 62 bench to the overburden emplacement area.

The existing approved quarry pit design, as detailed in the 1999 EIS, has a depth limit of RL20 and (at the time) contained 16.5 million tonnes (Mt) of fresh rock. To date, Holcim has extracted and processed in the order of 3 Mt of this resource.

The proposed modification is being sought for the production and transportation of a maximum of 475,000 tonnes of finished quarry products per calendar year, with an approval period of 30 years. Note it is not proposed to increase extraction of the overall resource and therefore no modification to the approved quarry pit disturbance area is proposed or considered necessary. However, minor modifications are proposed to the approved site facilities to support the proposed intensification in production (refer to the Environmental Assessment for a detailed description of the proposed modification).

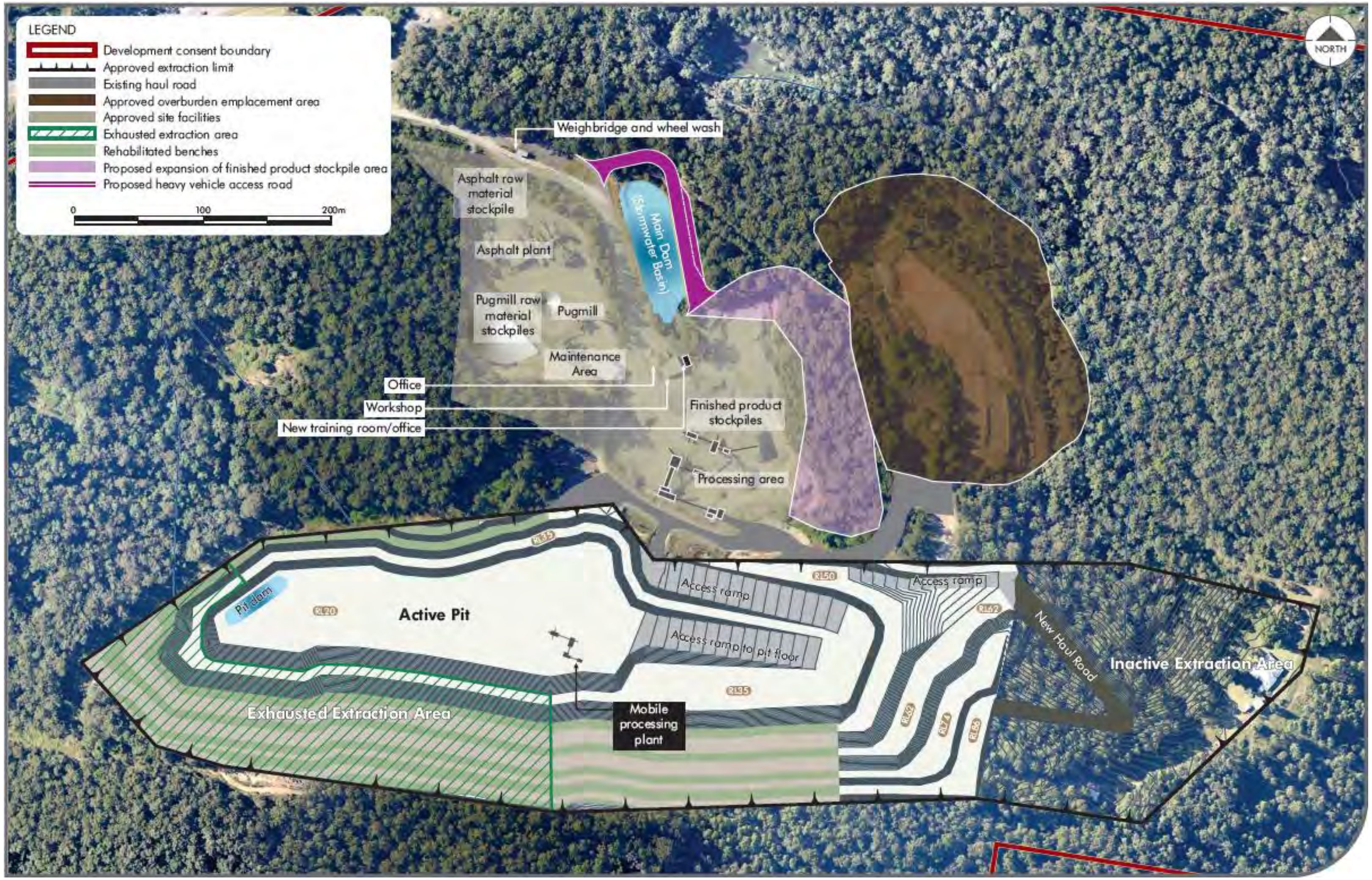
Holcim has revisited the four stage quarry development schedule presented in the EIS (ERM 1999) and have developed revised staging plans for extraction of the remaining resource over the next 30 years. Stage 1 involves expanding the quarry to the western extent of the approved extraction area and developing a new 15 metre high bench to increase the quarry depth to RL35. Stage 2 involves developing a final 15 metre high bench in the western section of the quarry to increase the quarry depth to the approval limit of RL20. This stage also includes the extension of the pit eastwards to a depth of RL35. Stage 3 involves expanding the quarry to the eastern extent of the approved extraction area and increasing the quarry depth to the approval limit of RL20. The site layouts for each stage are presented in **Figure 1**, **Figure 2** and **Figure 3**, respectively.

Figure 1 Site Layout – Stage 1



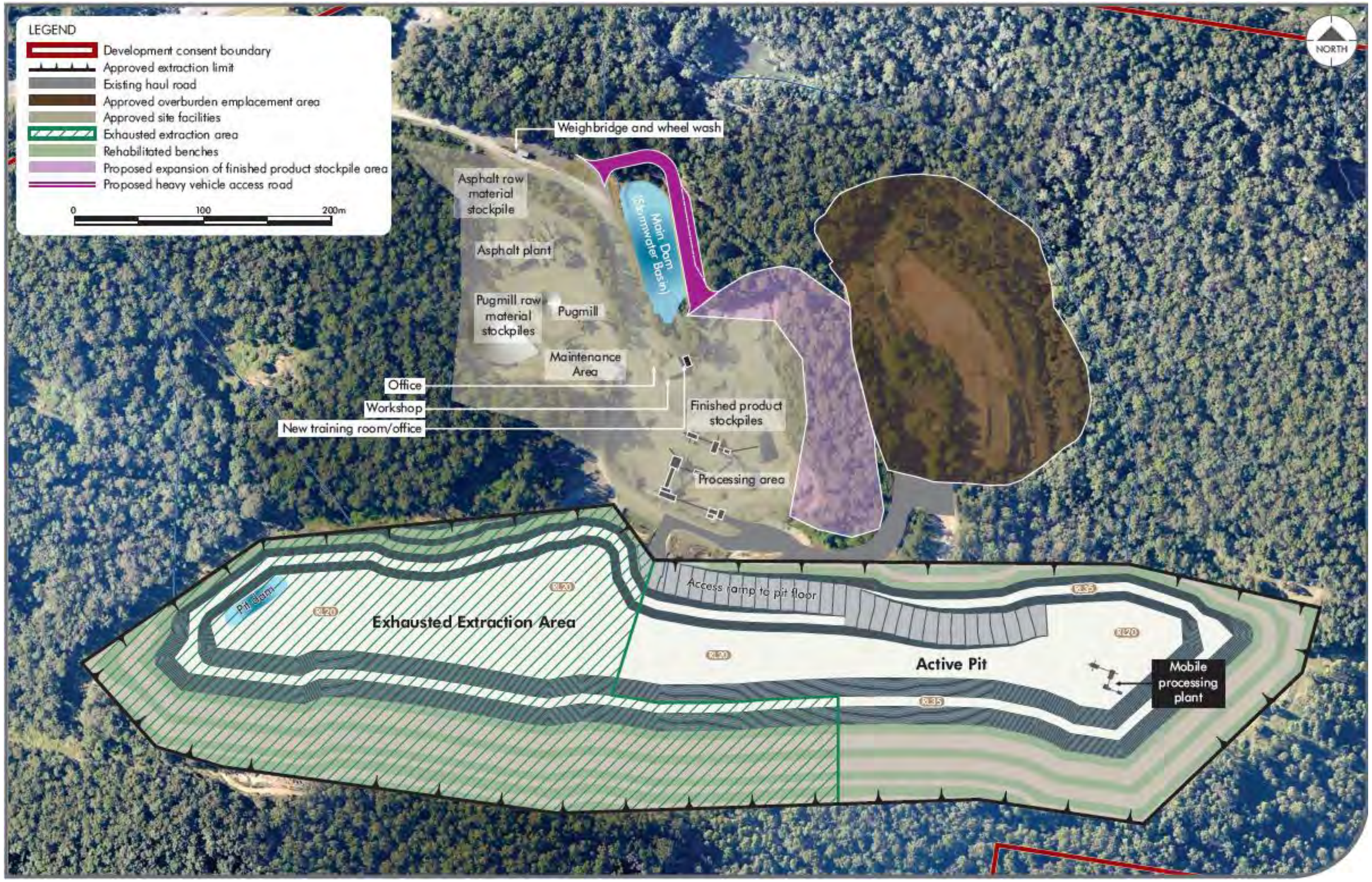
Source: 100171 F6 Proposed Stage 1 Extraction.pdf

Figure 2 Site Layout – Stage 2



Source: 100171 F7 Proposed Stage 2 Extraction.pdf

Figure 3 Site Layout – Stage 3



Source: 100171 F8 Proposed Stage 3 Extraction.pdf

3 LOCAL AND REGIONAL SETTING

Jandra Quarry is a hard rock quarry located approximately 17 kilometres (km) south of Taree in the Greater Taree Local Government Area (LGA). The regional location of the Project is shown in **Figure 4**.

3.1 Topography and Land Use

The site is located on the Pacific Highway at Possum Brush, NSW. The closest town to the site is Nabiac, located approximately 10 km to the southwest of the site.

Scattered residences are located to the northeast, east, southeast and southwest of the operational area of the site. The surrounding areas comprise predominantly cleared agricultural land on the lower slopes and moderate to heavy vegetated land on steeper areas. The lower slopes to the south and east of the site have been extensively cleared and are primarily used for cattle grazing.

3.2 Sensitive Receptors

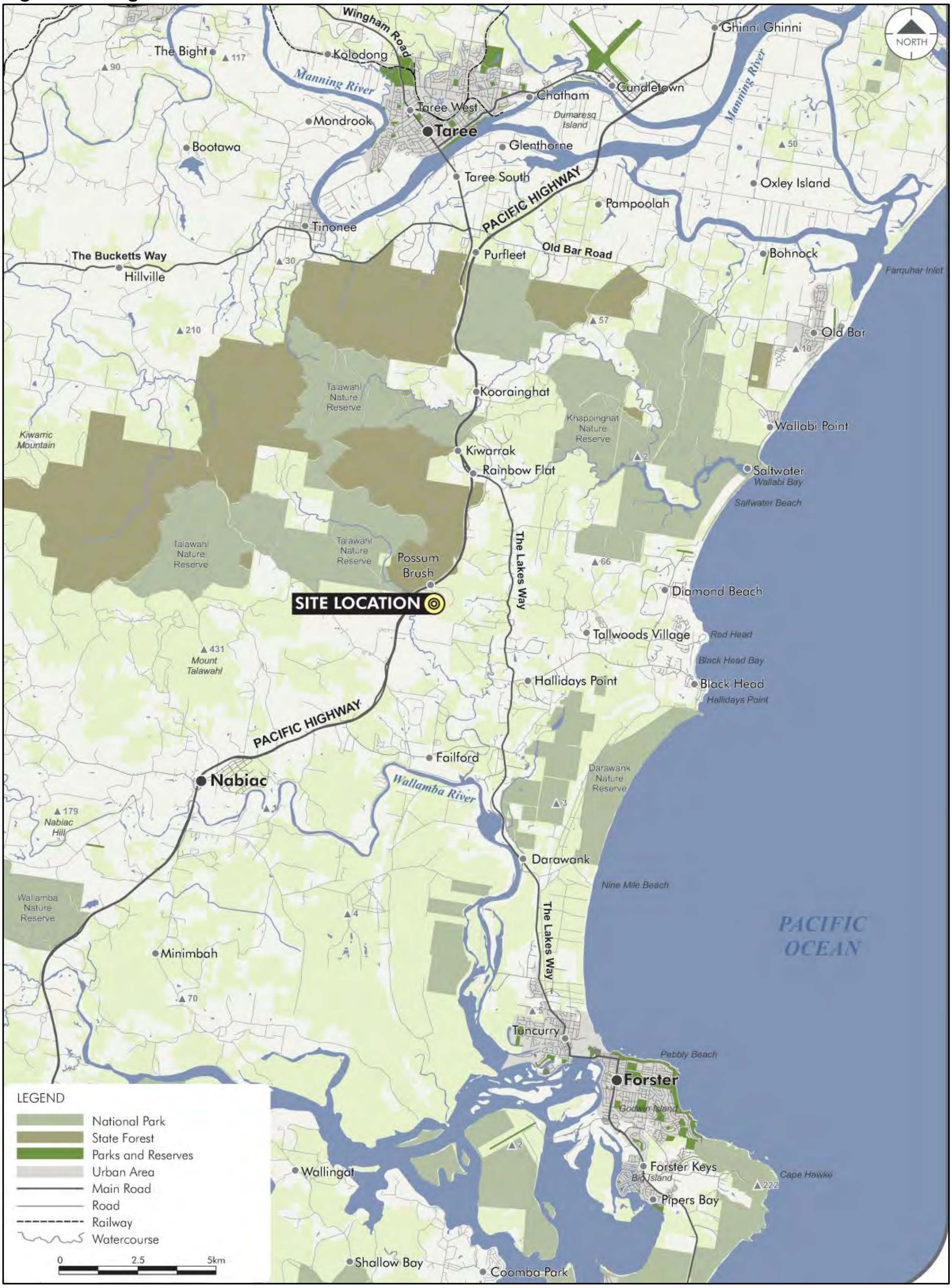
A number of sensitive receptors are located southeast and southwest of the site. The nearest privately-owned sensitive receptor is located to the northeast of the site. Two residences owned by Holcim (one occupied and one vacant) are located immediately south of the development consent boundary, on Holcim owned land. A further residence owned by Holcim is located within the development consent boundary, at the eastern extent of the approved extraction area (quarry pit). The locations of the identified sensitive receptors surrounding the site are presented in **Figure 5**. All receptors identified in **Figure 5** were assessed and are considered as worst-case representatives of all other receptors in the surrounding area.

3.3 Neighbouring Pollutant Sources

The site is surrounded by agricultural land and moderate to heavy vegetated land. No major mining or any other significant industrial activities were found in the desktop survey of the local area conducted for this study. Two relatively small scale quarries are currently operating approximately 4 km to the northwest of the site. Possum Brush Quarry is located approximately 2 km west of the Pacific Highway at Possum Brush with an approval limit of extracting 200,000 tonnes of hard rock per annum. Failford Quarry is located approximately 500 m east of the Pacific Highway at Failford. No detailed information on this operation is publicly available.

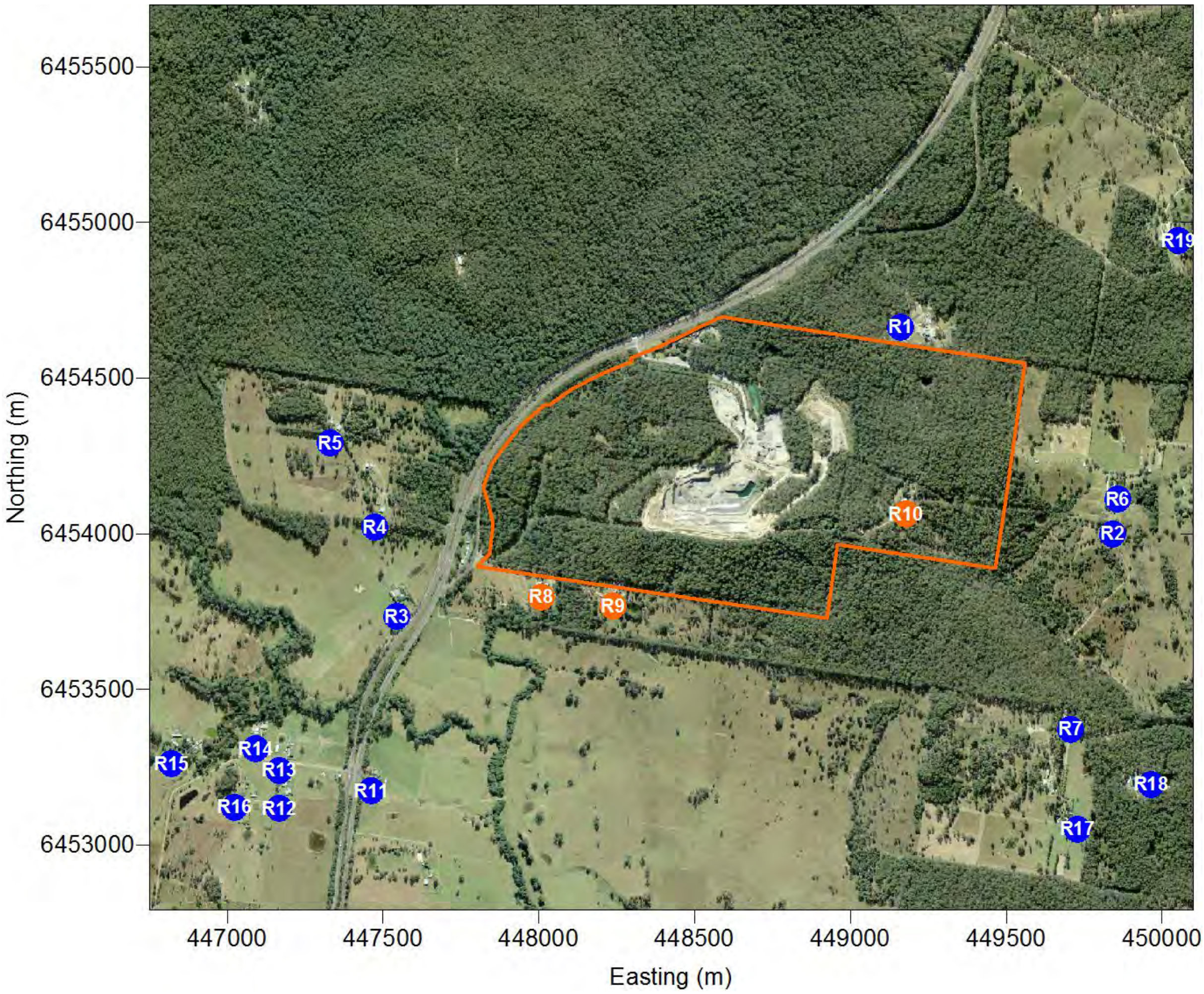
Considering the relative distance and vegetative cover between these quarries and sensitive receptors identified for this study, it is unlikely that potential emissions from these quarry operations will significantly elevate the ambient pollutant concentration at the surrounding areas of the Jandra Quarry site. Potential impacts associated with these operations have therefore not been considered further in predicting the cumulative impact of relevant pollutants for this study.

Figure 4 Regional Context



Source: 100171 F1 Regional Context

Figure 5 Sensitive Receptors



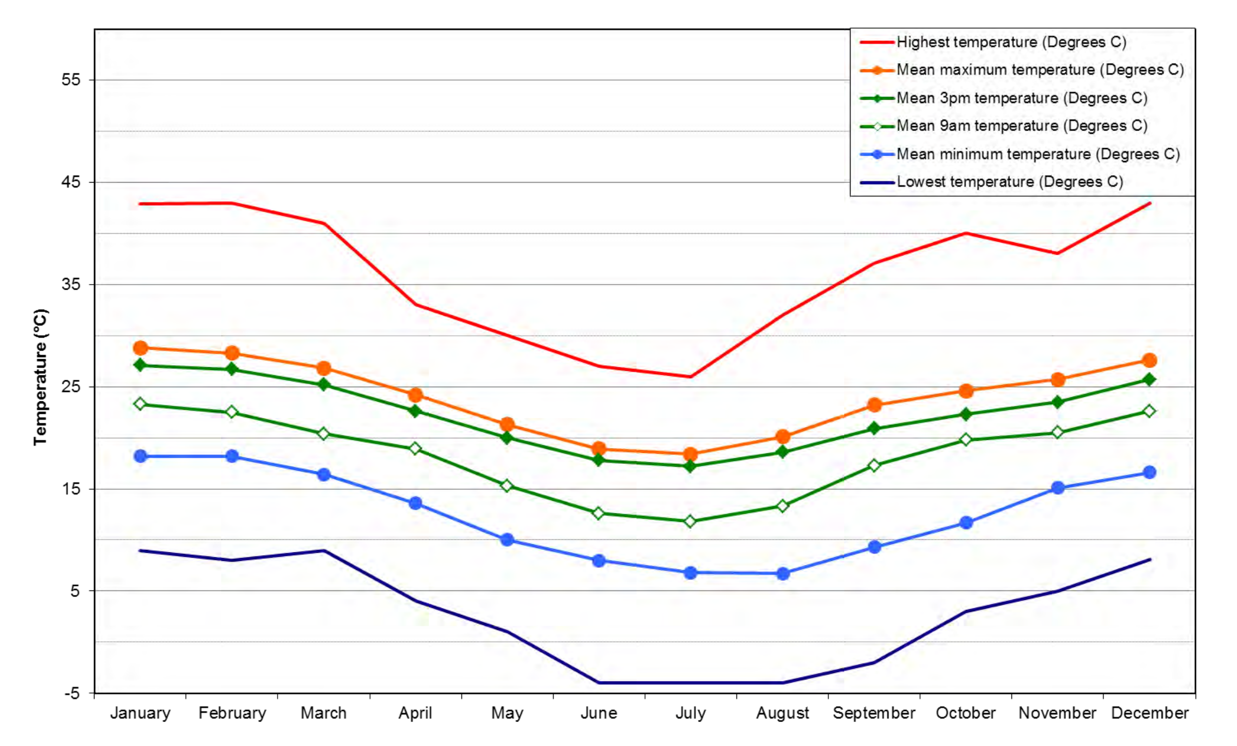
3.4 Local Meteorology

The nearest available meteorological monitoring station operated by the Bureau of Meteorology (BOM) collecting data suitable for use in a quantitative air dispersion modelling study is located at Taree Airport (Station 060141) which commenced operation in 1997 and is located approximately 18 km north of the site. The long-term climate data summary for the area presented in the following sections is based on historical data from the Taree Airport BOM station.

3.4.1 Temperature

Monthly mean maximum and minimum temperatures recorded at Taree Airport are presented in **Figure 6**. The data show that average maximum temperatures in the region often exceed 25°C. During the winter months the average maximum temperature falls to about 18°C. Average minimum temperatures range from 18°C in summer to 7°C in winter.

Figure 6 Monthly Average Minimum and Maximum Temperatures (1997-2014)



3.4.2 Rainfall

Long-term rainfall statistics for Taree Airport are summarised in **Figure 7**. Rainfall is relatively high in late summer and early autumn and tends to be lowest during late winter and early spring with an average of approximately 50 mm recorded during August and September. Peak rainfall events occur early autumn, with the maximum daily rainfall in March. The highest monthly rainfall recorded over the time period examined was 504 mm recorded in April 2008.

3.4.3 Relative Humidity

Monthly average 9:00 AM and 3:00 PM relative humidity data for Taree Airport are presented in **Figure 8**. The humidity levels are higher in the morning compared to the afternoon. Levels are relatively higher in summer and autumn and relatively low in winter and spring.

3.4.4 Wind Speed and Wind Direction

Annual average 9:00 AM and 3:00 PM wind data for Taree Airport are presented as windroses in **Figure 9**. The windroses show the frequent occurrence of land and sea breeze conditions in the area with predominant westerly winds in the morning while easterly winds dominate in the afternoon.

Figure 7 Monthly Average Rainfall Data - Clermont (1870-2013)

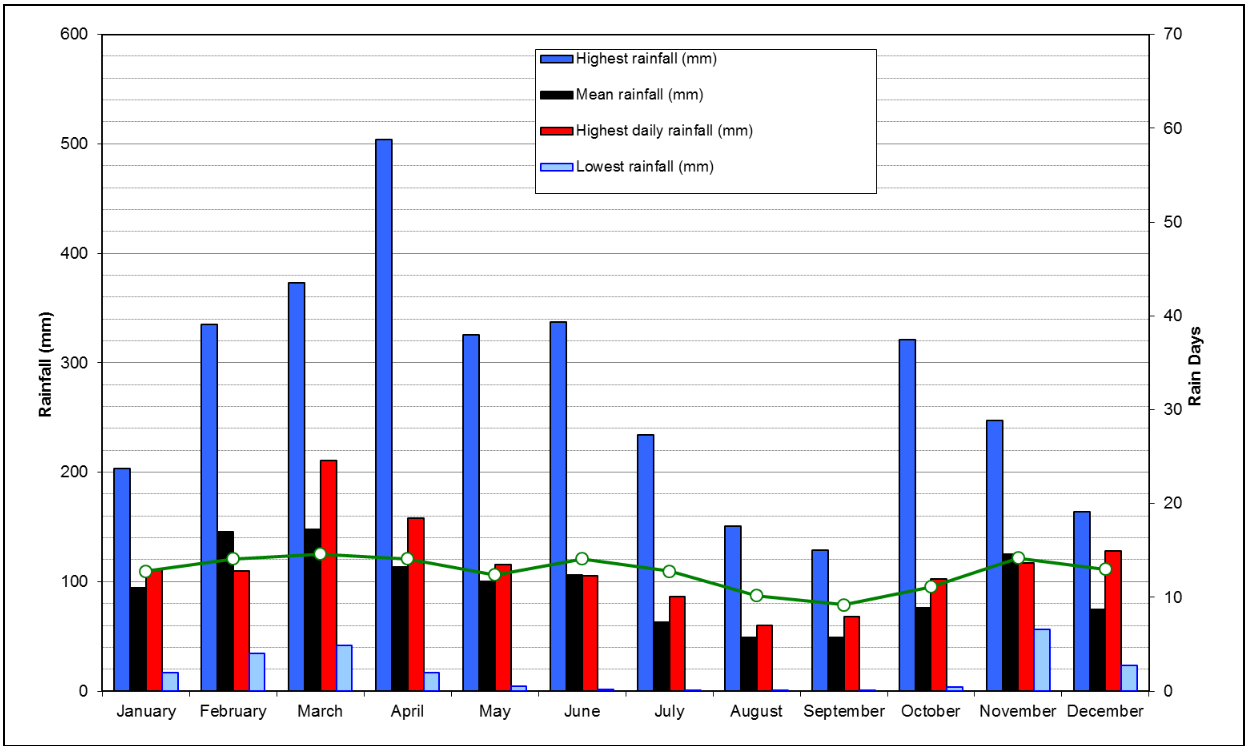


Figure 8 Monthly Average 9:00 AM and 3:00 PM Relative Humidity Data - Clermont

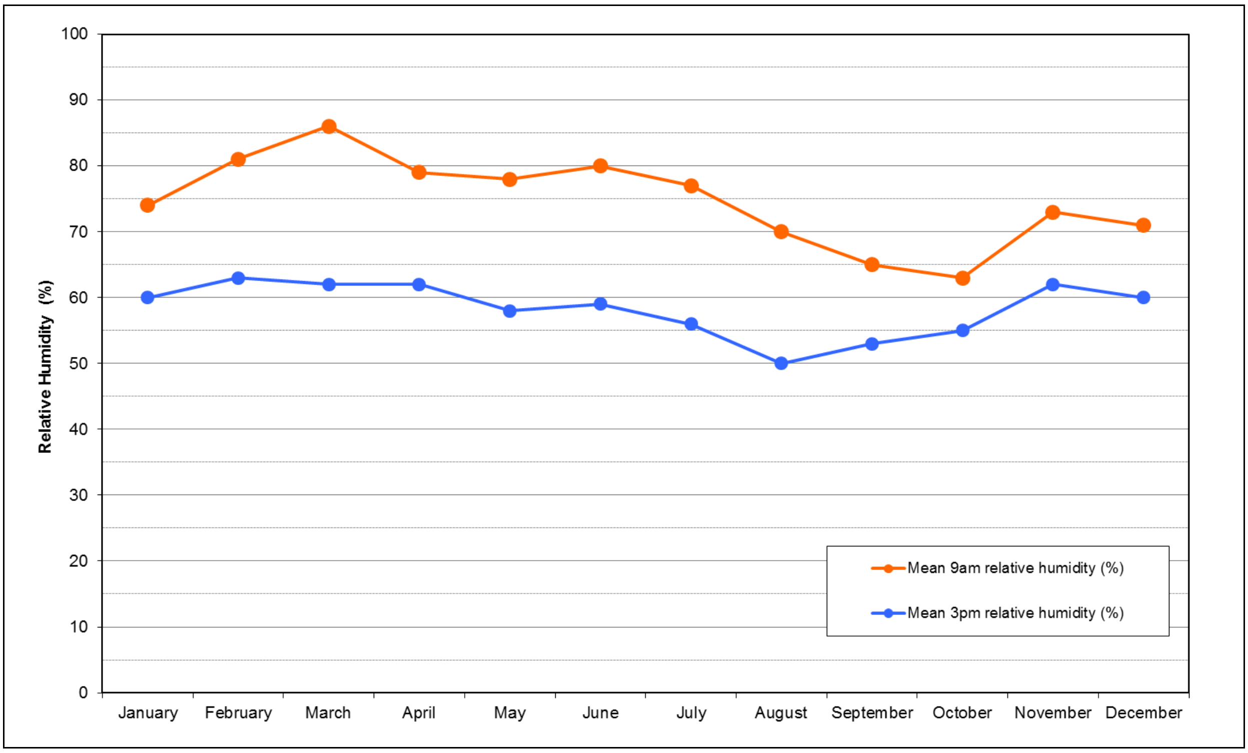
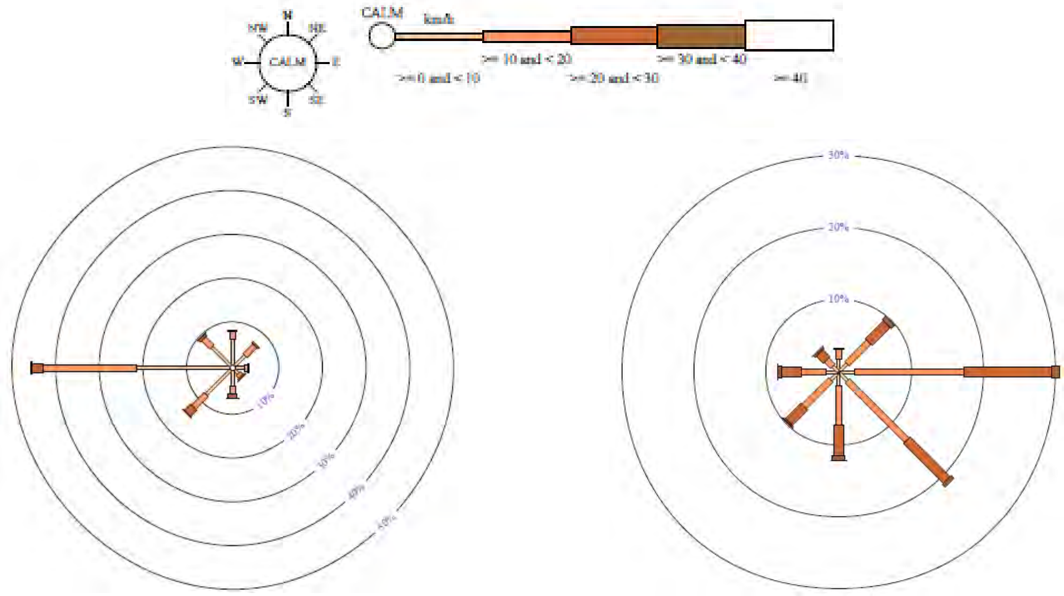


Figure 9 Annual Average 9:00 AM and 3:00 PM Wind Data (1997 – 2010)



9 AM **3 PM**

4 AIR QUALITY CRITERIA

4.1 Pollutants of Interest

The main emissions from the Project will be emissions of particulate matter which will be generated from a range of quarry activities, including drilling and blasting, as well as the handling and transport of overburden/topsoil materials, shot rock and finished product. Wind erosion of disturbed areas and stockpiles/processing areas also has the potential to generate dust emissions under dry windy conditions.

From a health and nuisance impact perspective, particles are classified primarily by size, as TSP (total suspended particulates), PM_{10} (particulate matter with an aerodynamic diameter up to 10 µm) and $PM_{2.5}$ (particulate matter with an aerodynamic diameter up to 2.5 µm).

Human health effects of dust tend to be associated with particles with an aerodynamic diameter of 10 µm or less (≤ PM_{10}). These smaller particles tend to remain suspended in the air for longer periods and can penetrate into the lungs. The PM10-2.5 fraction (coarse fraction) is termed “thoracic particles”. These particles are inhaled into the upper part of the airways and lung. $PM_{2.5}$ particles are fine particles that are inhaled more deeply and lodge in the gas exchange region (alveolar region) of the human lung and are termed “respirable dust”. Emissions of TSP have the potential to result in nuisance impacts due to increased rates of dust deposition in the surrounding area.

Other potential pollutants that will be emitted as a result of the Project include products of fuel combustion from the on-site vehicles and mobile/fixed equipment; namely:

- oxides of nitrogen (NO_x),
- sulphur oxides (SO_x),
- carbon monoxide (CO); and
- volatile organic compounds (VOCs).

Given the small scale of these emissions and the relative distances between the Project and nearby sensitive receptors, the proposed operation would not be expected to result in a significant increase in ambient concentrations of these pollutants at surrounding sensitive receptors and therefore have not been quantitatively assessed in this study.

The only potential source of odour identified for the Project is the proposed mobile asphalt plant. The asphalt plant is proposed to operate 24 hours per day on a campaign basis primarily to cater for night road works. Impact associated with the potential odour emissions from the proposed asphalt plant at the surrounding sensitive receptor locations are presented in **Section 9**.

Based on the discussion above, this assessment focusses on the following key pollutants of interest:

- $PM_{2.5}$;
- PM_{10};
- TSP;
- Dust deposition; and
- Odour.

4.2 Criteria Adopted for this Assessment

The air quality criteria adopted for use in the assessment of fugitive particulate emissions from the operational activities are summarised in **Table 1**. These criteria are applicable to cumulative impacts, i.e. the total exposure level including background.

Table 1 Criteria Adopted for this Assessment – Particulate Matter

Pollutant	Averaging Period	Criteria	Source
Particulate Matter as PM_{10}	24-Hours	50 µg/m^3	NSW OEH
	Annual	30 µg/m^3	NSW OEH
Particulate Matter as $PM_{2.5}$	24-Hours	25 µg/m^3	NEPM
	Annual	8 µg/m^3	NEPM
Total Suspended Particulate Matter (TSP)	Annual	90 µg/m^3	NSW OEH
Dust Deposition[1,2]	Annual	2 g/m^2/month	NSW OEH
Odour[3]	Nose response	2 OU	NSW OEH

(1) Dust is assessed as insoluble solids as defined by AS 3580.10.1-1991.
(2) Note that 2 g/m^2/month relates to the incremental contribution to dust deposition from the development. Cumulative levels are not to exceed 4 g/m^2/month.
(3) The odour criteria of 2 OU is the most stringent applicable in NSW and would ensure minimal impact on the most sensitive of populations.

5 EXISTING AIR QUALITY

The existing air quality in the area immediately surrounding the site is influenced by a number of factors including traffic and agricultural activities. Holcim monitor the dust deposition rate at a number of locations surrounding the site. The locations of the monitoring sites are presented in **Figure 10**.

Ambient monitoring data for particulate matter ($PM_{2.5}$, PM_{10} and TSP) were not available at the time of this study. Review of available dust deposition data shows that dust deposition in the local area is well below the relevant OEH guideline. However, analysis of the data collected by Holcim reveals inconsistency in the monitoring period. The monitoring period varies from 20 days to 87 days and due to this inconsistency with the Australian Standard (30 days ±2 days), the recorded data was considered as non-compliant and therefore has not been used in this assessment.

In absence of any reliable site representative ambient monitoring and dust deposition data, available ambient monitoring data recorded within a similar area with no significant mining/industrial activities were analysed to establish the regional background level for this study. **Figure 11** presents 24-hour average ambient PM_{10} monitoring data recorded at Wybong, Aberdeen and Merriwa monitoring sites operated by NSW OEH, approximately 140 km to the west of the site. Data recorded in Newcastle (approximately 100 km to the south of the site) was not selected for analysis given the influence of industry and heavy vehicle traffic which is not representative of the Project site. Data recorded at the Wybong, Aberdeen and Merriwa stations show a relatively similar trend in the ambient PM_{10} concentration. The Merriwa monitoring site recorded one exceedence (6 October 2013) and Wybong monitoring site recorded three exceedences (6, 18 and 19 October 2013) of the 24 hour PM_{10} criterion. On 6 October 2013, all three monitoring sites recorded relatively high ambient PM_{10} concentrations, indicating a regional event was the cause of the exceedances. However on 18 October and 19 October 2013, the Wybong monitoring site recorded extremely high PM_{10} concentrations compared to the Merriwa and Aberdeen monitoring sites indicating a local event in the vicinity of the Wybong monitoring site was the cause of this exceedance. Based on the analysis of the available monitoring data, data recorded at the Aberdeen monitoring site was considered to be most suitable for this study.

It is noted that the ambient PM_{10} concentrations in the vicinity of the Jandra Quarry are likely to be lower than that measured at Aberdeen site, as the monitoring data is highly likely to be influenced to some degree by the following activities

- Use of wood heaters in the Aberdeen area;
- Intense agricultural activities in the vicinity of the monitoring site; and
- Mining activities within the Upper Hunter region.

Therefore, use of monitoring data recorded at Aberdeen monitoring site is likely to overestimate the background particulate environment when compared with areas surrounding the Jandra Quarry operations.

Figure 10 Location of Monitoring Sites

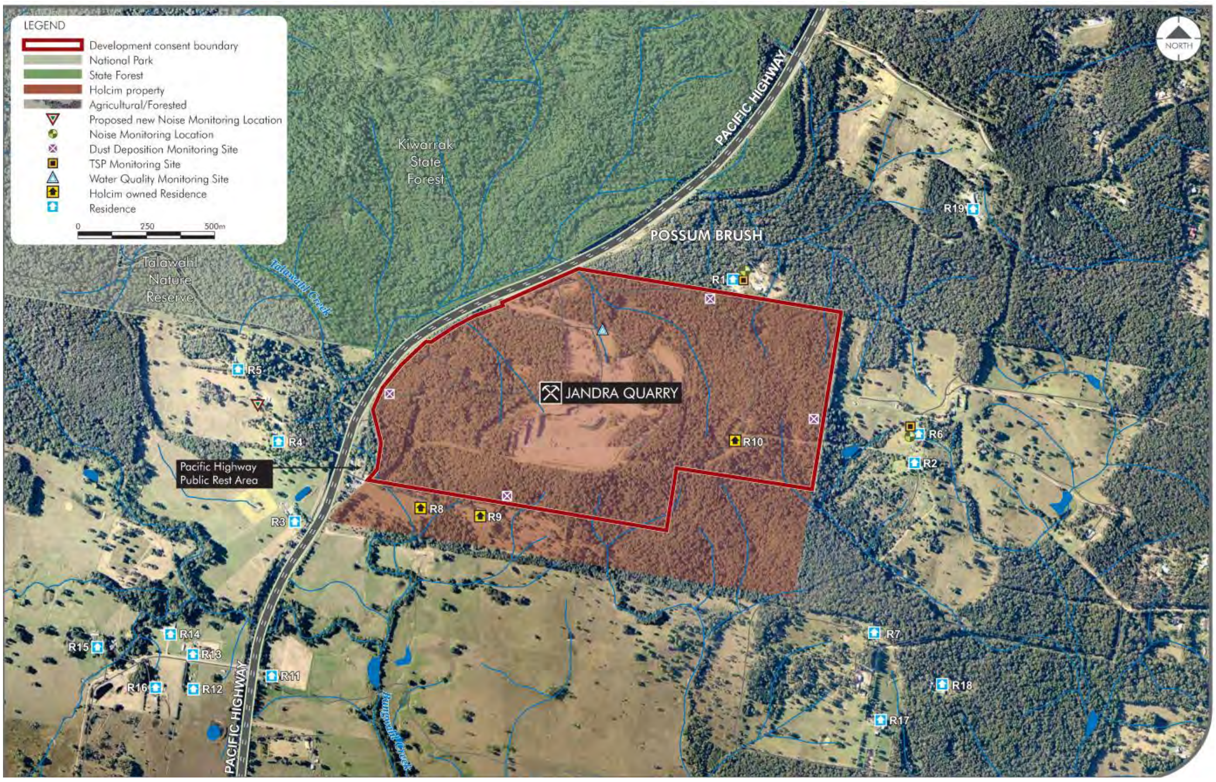
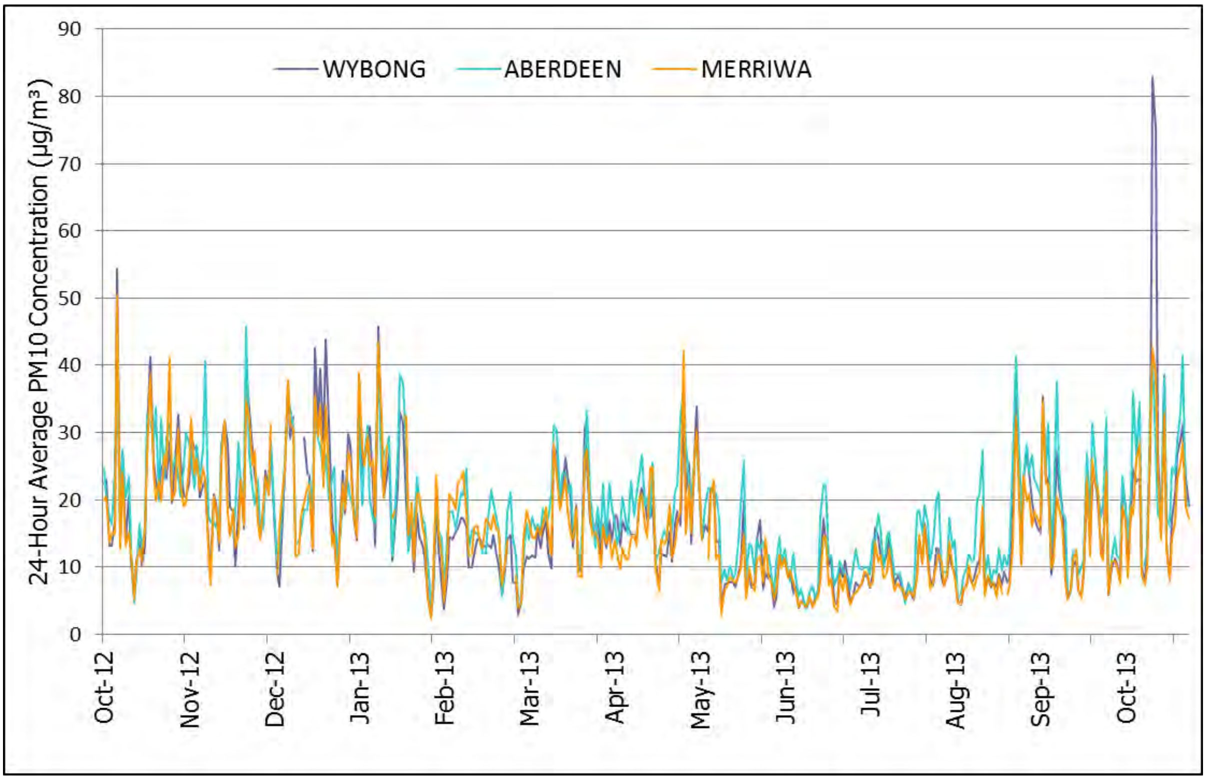


Figure 11 24-Hour Average Ambient PM_{10} Concentrations



5.1 Estimated Background Level

Ambient monitoring data for $PM_{2.5}$ and TSP are not available at any of the above monitoring sites. Background $PM_{2.5}$ and TSP concentrations were therefore estimated using the $PM_{2.5}/PM_{10}$ and PM_{10}/TSP ratio based on the data collected in the vicinity of coal mines and presented in the Australian Coal Review (Richardson 2000). The data showed that an average of 40% of TSP was found to consist of particles in the size range of PM_{10} and only 4% of TSP (or equivalently 10% of PM_{10}) was found to consist of particles in the size range of $PM_{2.5}$. Estimated background particulate concentrations used to assess the cumulative impact are presented in **Table 2**.

It is noted that the ratios are related to coal mining operations but in the absence of ratios related to hard rock quarry operations, the approach is considered to be appropriate.

Table 2 Estimated Background Particulate Level

Pollutant	Averaging Period	Data (µg/m³)
$PM_{2.5}$[1]	24-hour	Daily varying
	Annual	1.8
PM_{10}	24-hour	Daily varying
	Annual	18.3
TSP[2]	Annual	46

[1]Estimated assuming a $PM_{2.5}/PM_{10}$ ratio of 0.1
[2]Estimated assuming a PM10/TSP ratio of 0.4

No reliable dust deposition data is available to estimate the background level for the local area. Therefore, assessment of the cumulative dust deposition rate has not been included in this assessment. The predicted incremental dust deposition rate is compared with the relevant OEH guideline for incremental (project only) dust deposition rate of 2 mg/m²/month to assess compliance of this project.

6 EMISSION ESTIMATION

6.1 Emission Factors

Potential particulate emissions from the Stage 1, Stage 2 and Stage 3 operations were estimated based on the emission factors presented in the latest *Emission Estimation Technique Manual for Mining* (hereafter, "EETMM"), *Version 3.1* (Environment Australia, 2012) and USEPA AP42 documents. Details of the emission factor/equations used in estimating the potential emissions are provided below. The proposed particulate matter control measures to be employed at the site, and those used to estimate particulate emissions are presented in **Table 3**.

Bulldozer

$$EF = k \times \frac{s^{1.2}}{M^{1.3}} \text{ kg/h}$$

where k=2.6 for TSP and 0.34 for PM_{10}, s = silt content and M = moisture content.
Source: EETMM and AP42

Miscellaneous Handling (Excavators, loading/unloading of material)

$$EF = k \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2}\right)^{-1.4} \text{ kg/t}$$

where k=0.74 for TSP and 0.35 for PM_{10}, U = mean wind speed and M = moisture content.
Source: EETMM and AP42

Grader Operation

$$EF = 0.0034 \times S^{2.5} \text{ kg/VKT}$$

$$EF = 0.00336 \times S^{2.0} \text{ kg/VKT}$$

where S = average vehicle speed
Note: VKT = Vehicle Kilometres Travelled
Source: AP42

Blasting

$$EF = 0.00022 \times A^{1.5} \text{ kg/blast}$$

where A = Blast area (m²),PM_{10} is 52% of TSP.
Source: EETMM

Wind Erosion

EF = 0.4 kg/ha/hr for TSP

EF = 0.2 kg/ha/hr for TSP
Source: EETMM

Haul Truck Wheel Dust

$$EF = k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{W}{3}\right)^{0.45} \times \left(\frac{0.4536}{1.6093}\right) \text{kg/VKT}$$

where k=4.9 for TSP and 1.5 for PM_{10}, a=0.7 for TSP and 0.9 for PM_{10}, s = silt content and W = vehicle gross mass
Note: VKT = Vehicle Kilometres Travelled.
Source: USEPA AP-42

Crushing (Controlled)

0.0006 kg/t for TSP, 0.00027 kg/t for PM_{10} and 0.00005 kg/t for $PM_{2.5}$

Screening (Controlled)

0.0011 kg/t for TSP, 0.00037 kg/t for PM_{10} and 0.000025 kg/t for $PM_{2.5}$

6.2 Activity Data and Assumptions

The activity data used to estimate potential particulate emissions from the proposed activities for each stage are summarised in **Table 4**. The existing/proposed mitigation measures were considered in estimating the potential particulate emissions from the proposed operation (refer **Table 3**).

Table 3 Mitigation Measures

Activity	Description	Control Efficiency
Hauling on unpaved roads	Level 1 watering (<2 l/m^2/hr) with water cart	50%
Grading unpaved haul roads	Level 1 watering with water cart	50%
Processing area and stockpiles	Level 2 watering (>2 l/m^2/hr) with sprinklers	75%
Wind erosion	Keep the active pit and overburden dump area to a minimum level	Up to 0.5 ha of overburden area and 1 ha of pit area will be active at any time
Crushing and Screening	Enclosed and use water sprays	USEPA emission factor for controlled crushing and screening operation were used
Activities located within the pit	Pit retention	50% for TSP 5% for PM_{10}
Hauling of finished product	Sealed road	Particulate emission potential is very low and has not been considered for this assessment
Handling and transport of shot rock and overburden	Holcim is proposing to stop extraction of shot rock materials during the overburden stripping/hauling/emplacement periods	

6.3 Estimated Particulate Emissions

Emissions from the proposed operation for each stage were estimated based on the activity and assumptions data presented in **Table 4** and emission factors presented in **Section 6.1**. The resulting estimated emissions for each stage are presented in **Table 5**, **Table 6** and **Table 7**.

It is noted that a number of activities including bulldozer, grader, overburden transport and handling would occur on a campaign basis for a relatively short period of time (<3% of the year). These activities are unlikely to make any significant contribution in the predicted long term (annual) average impact, however may contribute significantly in elevating the short term (24-hour) average impact. To account for the contribution from these activities, potential daily maximum emission rates were also estimated and used for predicting the short term impact from this project on surrounding sensitive receptors.

Table 4 Summary of Activity Data and Assumptions used to Estimate Particulate Emissions (Stages 1, 2 and 3)

Activity	Daily Maximum	Unit	Annual	Unit
Drilling and Blasting				
Drilling	11	holes/day	1,320	holes/annum
Blasting	1	blast/day	24	blast/annum
Area of each blast	750	m^2	750	m^2
Overburden (OB)				
Overburden amount	4,000	t/day	40,000	t/annum
Moisture content	6	%	6	%
Silt content	10	%	10	%
Dozers on overburden	12	hrs/day	120	hr/annum
Haul truck average empty weight	30	t	30	t
Haul truck gross weight	65	t	65	t
Haul truck loading capacity	35	t	35	t/load
Hauling distance (return) - Stage 1	1.3	km	1.3	km
Hauling distance (return) - Stage 2	0.6	km	0.6	km
Hauling distance (return) - Stage 3	0.8	km	0.8	km
Haul road silt content	5	%	5	%
Number of return trips	120	return trip/day	1200	return trip/annum
Rock				
Rock amount	3,200	t/day	475,000	t/annum
Crushed rock - processing plant	2,358	t/day	350,000	t/annum
Crushed rock - in pit mobile plant	842	t/day	125,000	t/annum
Moisture content	1.0	%	1.0	%
Haul truck empty weight	32	t	32	t
Haul truck gross weight	72	t	72	t
Hauling distance (return) - Stage 1	0.8	km	0.8	km
Hauling distance (return) - Stage 2	0.8	km	0.8	km
Hauling distance (return) - Stage 3	1.0	km	1.0	km
Haul truck loading capacity	40	t/load	40	t/load
Haul road silt content	5	%	5	%
Number of return trips	80	return trip/day	11875	return trip/annum
Processing plant				
Crushing	2,358	t/annum	350,000	t/annum
Screening	2,358	t/annum	350,000	t/annum
Grader				
Speed of grader	8	km/hr	8	km/hr
Hour of operation	10	hrs/day	60	hr/annum
Wind Erosion				
Active overburden dump	0.5	ha	0.5	ha
Active pit	1	ha	1	ha
Processing area	5.4	ha	5.4	ha
Proposed new stockpile extension	1	ha	0.8	ha

Table 5 Estimated Emissions – Stage 1

Activity	Maximum Daily Emission Rate (kg/day)			Annual Emission Rate (kg/annum)			Intensity		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	Daily Maximum	Annual	Unit
Dozer operation	48.1	10.4	5.1	481	104	51	12	120	hours
Drilling	6.5	3.4	0.3	779	405	36	11	1,320	holes
Blasting	4.5	2.3	0.1	108	56	3	1	24	blasts
Loading overburden to trucks	0.7	0.3	0.0	7	3	0	4,000	40,000	tonnes
Emplacing overburden at dump	0.7	0.3	0.0	7	3	0	4,000	40,000	tonnes
Hauling overburden on unpaved roads	211.3	54.3	5.4	2,113	543	54	156	1,560	VKT
Loading shot rock to trucks	Concurrent handling of in-pit overburden and shot rock will not be conducted			527	473	29	3,200	475,000	tonnes
Unloading shot rock at stockpile				776	367	21	2,358	350,000	tonnes
Loading shot rock to hopper - in pit mobile crusher				139	125	8	842	125,000	tonnes
Crushing shot rock at pit				38	32	6	842	125,000	tonnes
Screening shot rock at pit				69	44	3	842	125,000	tonnes
Hauling shot rock to stockpile				13,360	3,433	343	64	9,500	VKT
Loading shot rock to hopper-processing plant	5.2	2.5	0.1	776	367	21	2,358	350,000	tonnes
Crushing at processing plant	1.4	0.6	0.1	210	95	18	2,358	350,000	tonnes
Screening at processing plant	2.6	0.9	0.1	385	130	9	2,358	350,000	tonnes
Unloading crushed rock to product stockpile	7.1	3.4	0.2	1,054	498	29	3,200	475,000	tonnes
Loading product to trucks	7.1	3.4	0.2	1,054	498	29	3,200	475,000	tonnes
Grading roads	24.6	8.6	0.8	295	103	9	100	600	VKT
WE - Active Pit	4.8	4.6	0.4	1,752	1,664	164	1.0	1.0	ha
WE - Dump Area	4.8	2.4	0.2	1,752	876	82	0.5	0.5	ha
WE - processing area	13.0	6.5	0.6	4,730	2,365	221	5.4	5.4	ha
WE - new extension of product stockpile	1.9	1.0	0.1	701	350	33	0.8	0.8	ha
Total TSP emissions (kg/annum)	**344.4**	**104.8**	**13.8**	**31,114**	**12,537**	**1,169**			

Table 6 Estimated Emissions – Stage 2

Activity	Maximum Daily Emission Rate (kg/day)			Annual Emission Rate (kg/annum)			Intensity		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	Daily Maximum	Annual	Unit
Dozer operation	48.1	10.4	5.1	481	104	51	12	120	hours
Drilling	6.5	3.4	0.3	779	405	36	11	1,320	holes
Blasting	4.5	2.3	0.1	108	56	3	1	24	blasts
Loading overburden to trucks	0.7	0.3	0.0	7	3	0.2	4,000	40,000	tonnes
Emplacing overburden at dump	0.7	0.3	0.0	7	3	0.2	4,000	40,000	tonnes
Hauling overburden on unpaved roads	97.5	25.1	2.5	975	251	25	72	1,560	VKT
Loading shot rock to trucks				527	473	29	3,200	475,000	tonnes
Unloading shot rock at stockpile				776	367	21	2,358	350,000	tonnes
Loading shot rock to hopper - in pit mobile crusher	Concurrent handling of in-pit overburden and shot rock will not be conducted			139	125	8	842	125,000	tonnes
Crushing shot rock at pit				38	32	6	842	125,000	tonnes
Screening shot rock at pit				69	44	3	842	125,000	tonnes
Hauling shot rock to stockpile				13,360	3,433	343	64	9,500	VKT
Loading shot rock to hopper-processing plant	5.2	2.5	0.1	776	367	21	2,358	350,000	tonnes
Crushing at processing plant	1.4	0.6	0.1	210	95	18	2,358	350,000	tonnes
Screening at processing plant	2.6	0.9	0.1	385	130	9	2,358	350,000	tonnes
Unloading crushed rock to product stockpile	7.1	3.4	0.2	1,054	498	29	3,200	475,000	tonnes
Loading product to trucks	7.1	3.4	0.2	1,054	498	29	3,200	475,000	tonnes
Grading roads	24.6	8.6	0.8	295	103	9	100	600	VKT
WE - Active Pit	4.8	4.6	0.4	1,752	1,664	164	1.0	1.0	ha
WE - Dump Area	4.8	2.4	0.2	1,752	876	82	0.5	0.5	ha
WE - processing area	13.0	6.5	0.6	4,730	2,365	221	5.4	5.4	ha
WE - new extension of product stockpile	1.9	1.0	0.1	701	350	33	0.8	0.8	ha
Total TSP emissions (kg/annum)	**230.7**	**75.6**	**10.9**	**29,976**	**12,244**	**1,139**			

Table 7 Estimated Emissions – Stage 3

Activity	Maximum Daily Emission Rate (kg/day)			Annual Emission Rate (kg/annum)			Intensity		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	Daily Maximum	Annual	Unit
Dozer operation	48.1	10.4	5.1	481	104	51	12	120	hours
Drilling	6.5	3.4	0.3	779	405	36	11	1,320	holes
Blasting	4.5	2.3	0.1	108	56	3	1	24	blasts
Loading overburden to trucks	0.7	0.3	0.0	7	3	0	4,000	40,000	tonnes
Emplacing overburden at dump	0.7	0.3	0.0	7	3	0	4,000	40,000	tonnes
Hauling overburden on unpaved roads	130.0	33.4	3.3	1,300	334	33	156	1,560	VKT
Loading shot rock to trucks	Concurrent handling of in-pit overburden and shot rock will not be conducted			527	473	29	3,200	475,000	tonnes
Unloading shot rock at stockpile				776	367	21	2,358	350,000	tonnes
Loading shot rock to hopper - in pit mobile crusher				139	125	8	842	125,000	tonnes
Crushing shot rock at pit				38	32	6	842	125,000	tonnes
Screening shot rock at pit				69	44	3	842	125,000	tonnes
Hauling shot rock to stockpile				16,700	4,291	429	80	11,875	VKT
Loading shot rock to hopper-processing plant	5.2	2.5	0.1	776	367	21	2,358	350,000	tonnes
Crushing at processing plant	1.4	0.6	0.1	210	95	18	2,358	350,000	tonnes
Screening at processing plant	2.6	0.9	0.1	385	130	9	2,358	350,000	tonnes
Unloading crushed rock to product stockpile	7.1	3.4	0.2	1,054	498	29	3,200	475,000	tonnes
Loading product to trucks	7.1	3.4	0.2	1,054	498	29	3,200	475,000	tonnes
Grading roads	24.6	8.6	0.8	148	52	5	100	600	VKT
WE - Active Pit	4.8	4.6	0.4	1,752	1,664	164	1.0	1.0	ha
WE - Dump Area	4.8	2.4	0.2	1,752	876	82	0.5	0.5	ha
WE - processing area	13.0	6.5	0.6	4,730	2,365	221	5.4	5.4	ha
WE - new extension of product stockpile	1.9	1.0	0.1	701	350	33	0.8	0.8	ha
Total TSP emissions (kg/annum)	**263.2**	**83.9**	**11.7**	**33,493**	**13,135**	**1,229**			

7 ATMOSPHERIC DISPERSION MODELLING METHODOLOGY

7.1 Modelling Methodology

Emissions from the Project have been modelled using a combination of the TAPM, CALMET and CALPUFF models. CALPUFF is a transport and dispersion model that ejects “puffs” of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

Steady-state models like AUSPLUME assume that meteorology is unchanged by topography over the modelling domain and may result in significant over or under estimation of air quality impacts. The CALPUFF dispersion model has the ability to handle three dimensional meteorology as well as calm wind speeds (<0.5 m/s) and therefore was considered to be appropriate for this assessment.

More advanced dispersion models (such as CALPUFF) are approved for use by many regulatory authorities in situations where these models may be more appropriate than use of steady-state models and assumptions.

7.1.1 TAPM

The TAPM prognostic model, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was used to generate the upper air data required for CALMET modelling.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate one full year of hourly meteorological observations at user-defined levels within the atmosphere.

Additionally, TAPM may assimilate actual local wind observations to optimise the model solution. The wind speed and direction observations are used to realign the predicted solution towards the observation values. Available observed meteorological data from nearby Bureau of Meteorology (BOM) stations located at Taree Airport were incorporated into TAPM. **Table 8** details the parameters used in the TAPM meteorological modelling for this assessment.

Table 8 Meteorological Parameters used for this Study - TAPM

TAPM (v 4.0.4)	
Number of grids (spacing)	4 (30 km, 10 km, 3 km and 1 km)
Number of grid points	25 x 25 x 35
Year of analysis	06/10/2012-06/10/2013
Centre of analysis	448,860 m E 6454,818 m S
Data assimilation	Taree Airport BOM Station

7.1.2 CALMET

In the simplest terms, CALMET is a meteorological model that develops hourly wind and other meteorological fields on a three-dimensional gridded modelling domain that are required as inputs to the CALPUFF dispersion model. Associated two dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, sea breeze, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final hourly varying wind field thus reflects the influences of local topography and land uses.

CALMET modelling was conducted using the nested CALMET approach, where the final results from a coarse-grid run were used as the initial guess of a fine-grid run. This has the advantage that off-domain terrain features including slope flows, blocking effect can be allowed to take effect and the larger –scale wind flow provides a better start in the fine-grid run.

The outer domain (30 km × 30 km) was modelled with a resolution of 0.6 km. TAPM-generated three dimensional meteorological data was used as the initial guess wind field and the local topography and available surface weather observations in the area were used to refine the wind field predetermined by TAPM data. Hourly surface meteorological data from Bureau of Meteorology (BOM) stations located at Taree Airport were incorporated in the outer domain modelling.

The output from the outer domain CALMET modelling was then used as the initial guess field for the inner domain CALMET modelling. The inner domain encompasses an area of 10 km × 10 km. A horizontal grid spacing of 0.1 km was used to adequately represent the important local terrain features and land use. The fine scale local topography and land use information were used in this run to refine the wind field parameter predetermined by the coarse CALMET run.

Table 9 details the parameters used in the meteorological modelling.

Table 9 Meteorological Parameters used for this Study – CALMET (v 6.42)

Outer Domain	
Meteorological grid	30 km × 30 km
Meteorological grid resolution	0.6 km
Surface station data	Taree Airport BoM Station
Initial guess filed	3D output from TAPM modelling
Inner Domain	
Meteorological grid	10 km × 10 km
Meteorological grid resolution	0.1 km
Initial guess field	3D output from outer domain model run

7.2 Meteorological Data Used in Modelling

7.2.1 Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET for the site is presented in **Figure 12**.

Figure 12 indicates that over the 1-year period used in the modelling, the site experienced predominantly light to moderate winds (<5 m/s), with the prevailing wind direction from the western quadrant. Calm wind conditions (wind speeds less than 0.5 m/s) were predicted to occur approximately 5% throughout the year.

The seasonal wind roses indicate that:

- In spring, light winds from the western quadrant are predominant.
- In summer, light winds from the east and northeast are predominant.
- In autumn and winter winds from the west are predominant.

7.2.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability (see **Table 10**). These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models.

The frequency of each stability class predicted by CALMET is presented in **Figure 13**. The results indicate a high frequency of F Stability Class condition, which is typical for inland areas. Stability Class F is indicative of very stable night time conditions, conducive to a low level of pollutant dispersion due to mechanical mixing.

Table 10 Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category Description
A	Very unstable - Low wind, clear skies, hot daytime conditions
B	Unstable - Clear skies, daytime conditions
C	Moderately unstable - Moderate wind, slightly overcast daytime conditions
D	Neutral - High winds or cloudy days and nights
E	Stable - Moderate wind, slightly overcast night-time conditions
F	Very stable - Low winds, clear skies, cold night-time conditions

7.2.3 Mixing Heights

Diurnal variations in maximum and average mixing depths predicted by CALMET at the Project Site are illustrated in **Figure 14**. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

Figure 12 Wind Roses for the Project Site, as Predicted by CALMET

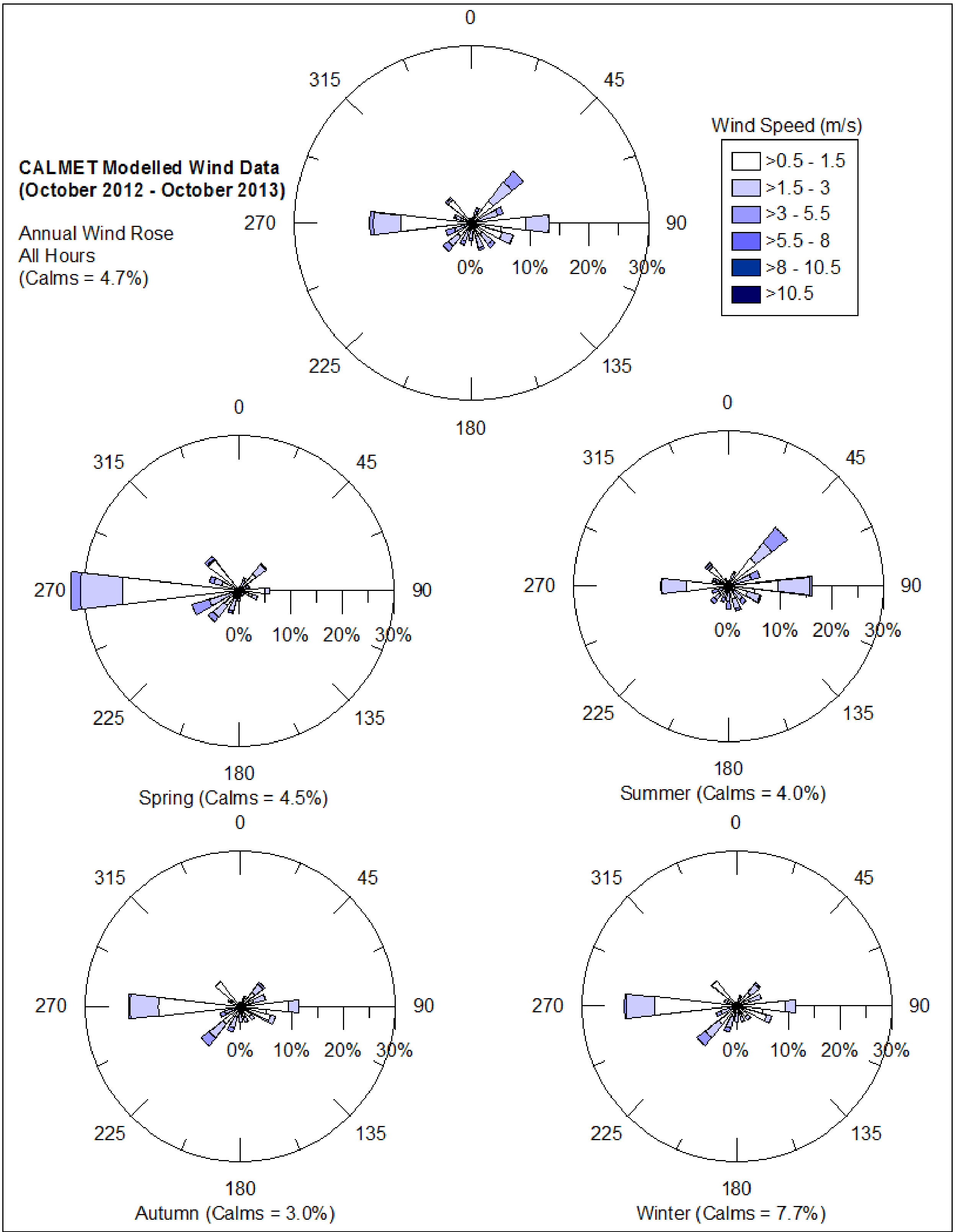


Figure 13 Stability Class Distribution Predicted by CALMET for the Project Site

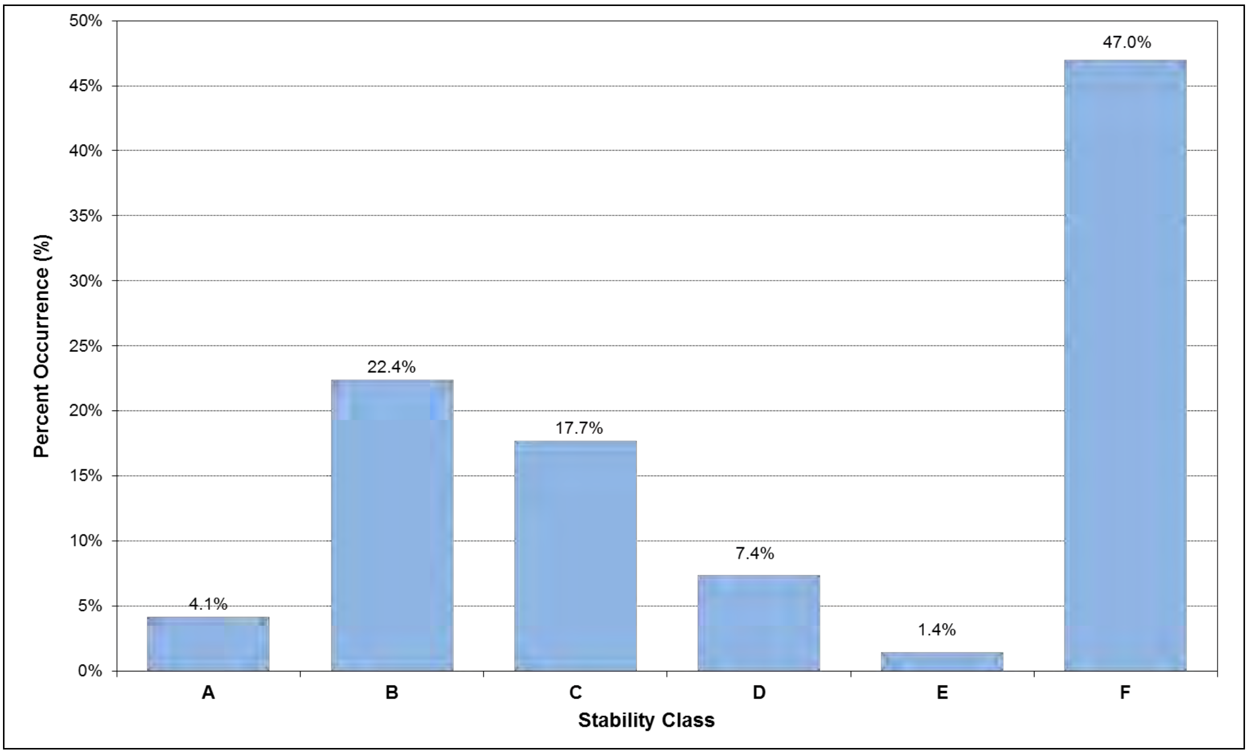
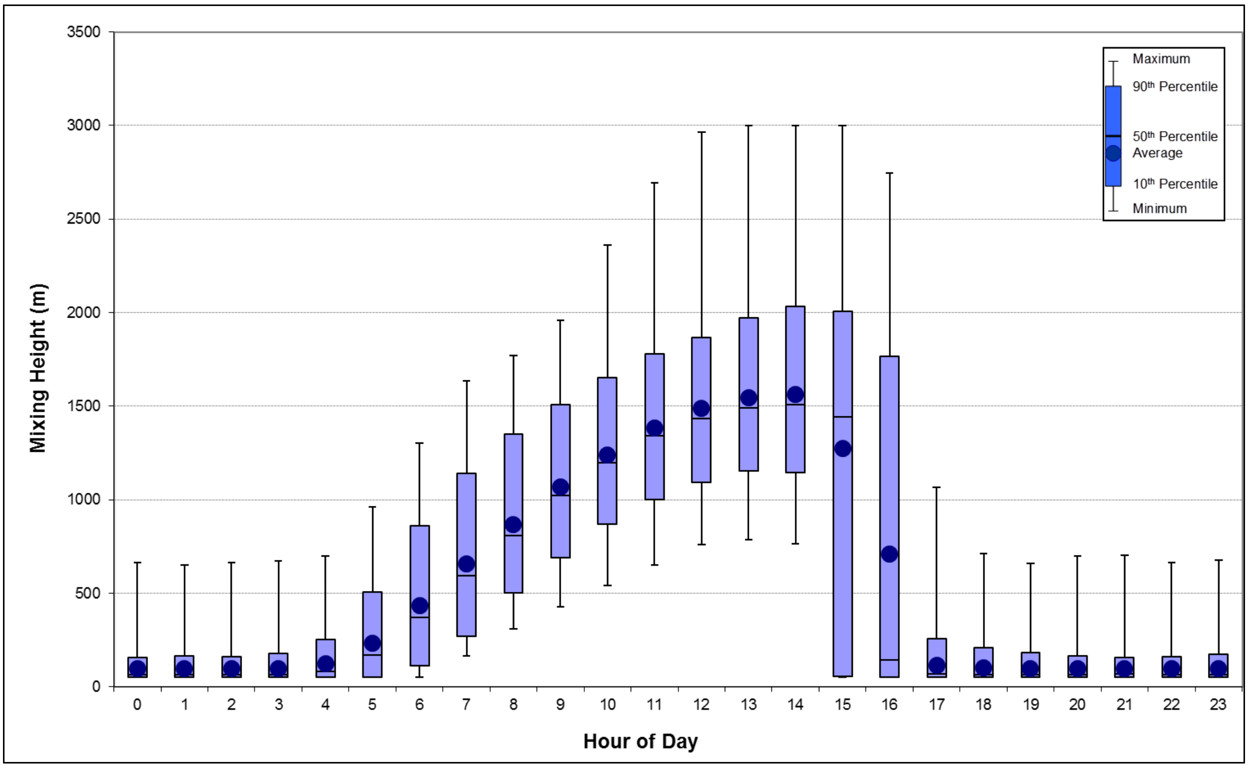


Figure 14 Mixing Heights Predicted by CALMET for the Project Site



8 PREDICTED IMPACTS

The predicted concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition rates at the nearest sensitive receptors and pollutant contour plots are presented and discussed below for each stage modelled in this study.

8.1 $PM_{2.5}$ Concentrations

The 24-hour and annual average incremental and cumulative $PM_{2.5}$ concentrations predicted by the modelling at the sensitive receptors for each stage modelled in this study are presented in **Table 11**. The estimated background $PM_{2.5}$ concentrations presented in **Section 5.1** have been used to calculate the cumulative impacts at each sensitive receptor.

The predicted maximum 24-hour and annual average cumulative $PM_{2.5}$ concentrations at each surrounding sensitive receptor for each stage are below the relevant ambient air quality criteria presented in **Section 4.2**.

Contour plots of the incremental (Project only) maximum 24-hour and annual average $PM_{2.5}$ concentrations are presented in **Appendix A** for each stage modelled in this study.

8.2 PM_{10} Concentrations

The maximum 24-hour average incremental and cumulative PM_{10} concentrations predicted by the modelling at the sensitive receptors for each operational year modelled in this study are presented in **Table 12**. The estimated background PM_{10} concentrations presented in **Section 5.1** have been used to calculate the cumulative impacts at each sensitive receptor.

The maximum 24-hour average cumulative PM_{10} concentrations predicted at the surrounding privately owned sensitive receptors comply with the relevant ambient air quality criterion for each stage modelled. Following the guidance provided in the "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (DEC 2005) a contemporaneous analysis, presenting the cumulative impact for the five days with highest background PM_{10} concentration and the five days with the highest predicted PM_{10} increment for each stage of the project at the worst impacted privately owned receptor (R1) is presented in **Table 13**. The analysis showed that the predicted increment from the proposed operation is minimal on the days with relatively high background concentration and therefore the potential PM10 emissions from the project are unlikely to significantly elevate the PM10 concentration in the local area on these days.

A maximum of one day of exceedence was predicted at quarry owned receptors R9 (currently unoccupied) in Stage 1. A maximum of four days of exceedences was predicted at quarry owned receptor R10 for Stage 3 of the project.

The predicted annual average PM_{10} concentrations are below the relevant ambient air quality criterion presented in **Section 4.2** at all surrounding privately owned sensitive receptors identified for this study.

Contour plots of the incremental (Project only) maximum 24-hour average PM_{10} concentrations are presented in **Appendix A** for each stage modelled in this study.

Table 11 Predicted Incremental and Cumulative $PM_{2.5}$ Concentrations at Surrounding Sensitive Receptors (µg/m³)

Receptor ID	Increment						Cumulative					
	Maximum 24-Hour Average			Annual Average			Maximum 24-Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
Guideline							**25**	**25**	**25**	**8**	**8**	**8**
Privately Owned Receptors												
R1	4.3	3.4	3.9	0.1	0.1	0.1	5.8	4.8	5.5	1.9	1.9	1.9
R2	0.9	0.6	0.9	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R3	0.9	0.7	0.6	<0.1	<0.1	<0.1	4.7	4.6	4.6	<1.9	<1.9	<1.9
R4	1.1	0.9	0.8	<0.1	<0.1	<0.1	5.0	4.8	4.7	<1.9	<1.9	<1.9
R5	0.9	0.7	0.6	<0.1	<0.1	<0.1	4.7	4.7	4.7	<1.9	<1.9	<1.9
R6	0.9	0.7	0.9	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R7	0.5	0.4	0.6	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R11	0.5	0.4	0.4	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R12	0.5	0.4	0.3	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R13	0.5	0.4	0.3	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R14	0.5	0.4	0.3	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R15	0.3	0.3	0.3	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R16	0.4	0.3	0.3	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R17	0.4	0.3	0.5	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R18	0.4	0.3	0.4	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R19	0.8	0.6	0.8	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
Quarry Owned Receptors												
R8	1.1	0.9	0.9	<0.1	<0.1	<0.1	4.6	4.6	4.6	<1.9	<1.9	<1.9
R9	1.9	1.7	1.4	<0.1	<0.1	<0.1	5.4	4.7	4.6	<1.9	<1.9	<1.9
R10	4.1	3.4	9.8	<0.1	<0.1	0.2	5.3	4.6	11.3	<1.9	<1.9	2.0
Criteria								**25**			**8**	

Table 12 Predicted Incremental and Cumulative PM_{10} Concentrations at Surrounding Sensitive Receptors ($\mu g/m^3$)

Receptor ID	Increment						Cumulative					
	Maximum 24-Hour Average			Annual Average			Maximum 24-Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
Guideline							**50**	**50**	**50**	**30**	**30**	**30**
Privately Owned Receptors												
R1	34.3	28.3	33.0	1.2	1.3	1.4	49.5	46.1	48.2	19.5	19.6	19.7
R2	6.3	5.1	6.0	0.2	0.2	0.2	45.8	45.8	45.8	18.5	18.5	18.5
R3	6.3	4.7	4.2	0.4	0.3	0.3	45.9	45.8	45.8	18.7	18.6	18.6
R4	7.6	5.0	4.8	0.4	0.4	0.4	47.6	46.0	46.0	18.7	18.7	18.7
R5	5.7	4.1	4.1	0.3	0.3	0.3	46.8	46.3	46.3	18.6	18.6	18.6
R6	7.0	5.6	6.4	0.2	0.2	0.3	45.8	45.8	45.8	18.5	18.5	18.6
R7	4.0	2.8	4.1	<0.1	<0.1	<0.1	45.8	45.8	45.8	<18.4	<18.4	<18.4
R11	3.6	2.5	2.4	0.2	0.2	0.2	45.8	45.8	45.8	18.5	18.5	18.5
R12	3.2	2.1	2.1	0.2	0.2	0.1	45.8	45.8	45.8	18.5	18.5	18.4
R13	3.4	2.3	2.2	0.2	0.2	0.1	45.8	45.8	45.8	18.5	18.5	18.4
R14	3.3	2.1	2.1	0.2	0.2	0.1	45.8	45.8	45.8	18.5	18.5	18.4
R15	2.5	1.8	1.7	0.1	0.1	0.1	45.8	45.8	45.8	18.4	18.4	18.4
R16	2.9	1.9	1.9	0.1	0.1	0.1	45.8	45.8	45.8	18.4	18.4	18.4
R17	3.4	2.5	3.5	<0.1	<0.1	<0.1	45.8	45.8	45.8	<18.4	<18.4	<18.4
R18	2.6	1.9	2.4	<0.1	<0.1	<0.1	45.8	45.8	45.8	<18.4	<18.4	<18.4
R19	5.4	4.5	6.1	0.2	0.2	0.3	45.8	45.8	45.8	18.5	18.5	18.6
Quarry Owned Receptors												
R8	8.2	6.1	6.2	0.6	0.6	0.5	45.9	45.8	45.9	18.9	18.9	18.8
R9	14.8	10.9	9.7	0.9	0.9	0.8	51.2	45.9	45.9	19.2	19.2	19.1
R10	29.0	22.1	53.2	0.8	0.8	2.0	47.4	45.9	67.2	19.1	19.1	20.3
Criteria								**50**			**30**	

Table 13 Summary of Contemporaneous Impact and Background – R1

Date	Highest Background (µg/m³)	Predicted Increment (µg/m³)	Total (µg/m³)	Date	Background (µg/m³)	Highest Increment (µg/m³)	Total (µg/m³)
				Stage 1			
22-11-2012	45.8	0.6	46.4	03-06-2013	10.8	34.3	45.1
09-01-2013	42.7	0.0	42.7	22-06-2013	11.6	30.2	41.8
29-08-2013	41.3	0.3	41.6	30-07-2013	13.7	25.0	38.7
07-11-2012	40.7	0.0	40.7	08-07-2013	14.2	24.9	39.1
06-10-2012	40.6	0.3	40.9	07-06-2013	9.2	22.9	32.1
				Stage 2			
22-11-2012	45.8	0.3	46.1	03-06-2013	10.8	28.3	39.1
09-01-2013	42.7	0.0	42.7	22-06-2013	11.6	20.7	32.3
29-08-2013	41.3	0.3	41.6	17-05-2013	10.2	19.0	29.2
07-11-2012	40.7	0.0	40.7	30-07-2013	13.7	18.9	32.6
06-10-2012	40.6	0.1	40.7	08-07-2013	14.2	16.3	30.5
				Stage 2			
06-10-2012	40.6	0.2	40.8	03-06-2013	10.8	33.0	43.8
07-11-2012	40.7	0.0	40.7	22-06-2013	11.6	25.3	36.9
22-11-2012	45.8	0.9	46.7	25-06-2013	8.7	21.1	29.8
09-01-2013	42.7	0.0	42.7	08-07-2013	14.2	22.8	37.0
29-08-2013	41.3	0.3	41.6	30-07-2013	13.7	22.9	36.6
Criteria			**50**				**50**

Note: Top 5 shown for each Stage of operation

8.3 TSP Concentrations

The annual average incremental and cumulative TSP concentrations predicted by the modelling at the surrounding sensitive receptors for each stage modelled in this study are presented **Table 14**. An estimated annual average background TSP concentration of 46 µg/m³ has been used to calculate the cumulative impacts at each sensitive receptor.

As shown in **Table 14**, the predicted cumulative annual average TSP concentration at each identified sensitive receptor complies with the relevant ambient air quality criterion for each stage modelled in this study. Contour plots for the incremental (Project only) annual average TSP concentrations are presented in **Appendix A** for each stage.

8.4 Dust Deposition

The annual average incremental dust deposition rates predicted by the modelling at the sensitive receptors for each operational year modelled in this study are presented in **Table 15**.

As shown in **Table 15**, the predicted incremental annual average dust deposition rate at each identified sensitive receptor is minimal and complies with the relevant ambient air quality criteria for each operational year modelled. Considering that the predicted incremental dust deposition rate at any surrounding sensitive receptor is below 0.1 mg/m²/month, the proposed operation is unlikely to elevate the dust deposition level significantly in the local area to cause any exceedence of the NSW OEH criterion for cumulative dust deposition rate of 4 mg/m²/month. Contour plots of the incremental (Project only) annual average dust deposition rates are presented in **Appendix A** for each stage.

Table 14 Predicted Incremental and Cumulative Annual Average TSP Concentrations (µg/m³)

Receptor ID	Increment			Cumulative		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
Privately Owned Receptors						
R1	2.5	2.6	2.8	48.5	48.6	48.8
R2	0.3	0.3	0.4	46.3	46.3	46.4
R3	0.8	0.7	0.6	46.8	46.7	46.6
R4	0.9	0.8	0.7	46.9	46.8	46.7
R5	0.6	0.5	0.5	46.6	46.5	46.5
R6	0.4	0.4	0.5	46.4	46.4	46.5
R7	0.1	0.1	0.2	46.1	46.1	46.2
R11	0.4	0.4	0.3	46.4	46.4	46.3
R12	0.3	0.3	0.3	46.3	46.3	46.3
R13	0.3	0.3	0.3	46.3	46.3	46.3
R14	0.3	0.3	0.3	46.3	46.3	46.3
R15	0.2	0.2	0.2	46.2	46.2	46.2
R16	0.3	0.2	0.2	46.3	46.2	46.2
R17	<0.1	<0.1	0.1	<46.1	<46.1	46.1
R18	<0.1	<0.1	<0.1	<46.1	<46.1	<46.1
R19	0.4	0.4	0.5	46.4	46.4	46.5
Quarry Owned Receptors						
R8	1.3	1.1	1.0	47.3	47.1	47.0
R9	1.7	1.7	1.7	47.7	47.7	47.7
R10	1.5	1.5	4.6	47.5	47.5	50.6
Criteria					**90**	

Table 15 Predicted Incremental Annual Average Dust Deposition Rate (g/m²/month)

Receptor ID	Stage 1	Stage 2	Stage 3
Privately Owned Receptors			
R1	<0.1	<0.1	<0.1
R2	<0.1	<0.1	<0.1
R3	<0.1	<0.1	<0.1
R4	<0.1	<0.1	<0.1
R5	<0.1	<0.1	<0.1
R6	<0.1	<0.1	<0.1
R7	<0.1	<0.1	<0.1
R11	<0.1	<0.1	<0.1
R12	<0.1	<0.1	<0.1
R13	<0.1	<0.1	<0.1
R14	<0.1	<0.1	<0.1
R15	<0.1	<0.1	<0.1
R16	<0.1	<0.1	<0.1
R17	<0.1	<0.1	<0.1
R18	<0.1	<0.1	<0.1
R19	<0.1	<0.1	<0.1
Quarry Owned Receptors			
R8	<0.1	<0.1	<0.1
R9	<0.1	<0.1	<0.1
R10	<0.1	<0.1	0.1
Criteria		**2**	

9 ODOUR IMPACT ASSESSMENT

As discussed in **Section 4.1**, operation of an asphalt plant within the approved site facilities area was identified as the only potential odour source at the site. Holcim is proposing to operate the asphalt plant for 24 hours a day on a campaign basis primarily to cater for night road works.

Potential odour emission and stack parameters for the proposed asphalt plant operation was estimated based on stack testing data from a similar site at Gympie in QLD. It is noted that no information was available on the stack height of the proposed plant at the time of modelling. The manufacturer indicated that the height may vary from between 5 meters and 16.5 meters. Therefore modelling was performed for two scenarios based on minimum (5 meters) and maximum (16.5 meters) stack height. The stack parameters and odour emission rate representative of the proposed asphalt plant is presented in **Table 16**.

Table 16 Stack Parameters and Odour Emission Rate – Proposed Asphalt Plant

Parameter	Data
Stack cross sectional area	1.33 m^2
Stack diameter (equivalent)	1.3 m
Exit temperature	118°C
Exit velocity	13.1 m/s
Stack height	5 m (Scenario 1) 16.5 m (Scenario 2)
Odour emission rate	15,200 OU m^3/s
Operating hours	24 hours

Dispersion modelling to assess the potential odour impact at surrounding receptors was conducted using a similar modelling methodology outlined in **Section 7**. The predicted 99^{th} percentile odour concentrations at surrounding sensitive receptors are presented in **Table 17**. The modelling results showed that the predicted odour impacts at surrounding sensitive receptors are well below the most stringent NSW OEH odour criterion of 2 OU.

Based on the modelling results, it is concluded that the proposed asphalt plant operation is unlikely to cause any odour nuisance at any surrounding sensitive receptors.

Table 17 Predicted 99th Percentile Odour Concentrations at Surrounding Sensitive Receptors

Receptor ID	Predicted Nose Response Odour Concentration (OU)	
	5 m Stack	**16.5 m Stack**
	Privately Owned Receptors	
R1	0.1	<0.1
R2	<0.1	<0.1
R3	<0.1	<0.1
R4	<0.1	<0.1
R5	<0.1	<0.1
R6	<0.1	<0.1
R7	<0.1	<0.1
R11	<0.1	<0.1
R12	<0.1	<0.1
R13	<0.1	<0.1
R14	<0.1	<0.1
R15	<0.1	<0.1
R16	<0.1	<0.1
R17	<0.1	<0.1
R18	<0.1	<0.1
R19	<0.1	<0.1
	Quarry Owned Receptors	
R8	<0.1	<0.1
R9	0.2	<0.1
R10	0.1	<0.1
Criteria	**2**	

10 CONCLUSION

To predict the potential worst case impact at each surrounding sensitive receptor for the proposed quarry operation, potential particulate emissions for each stage of quarry operation were quantified, modelled and assessed against the relevant NSW OEH guidelines.

The fugitive particulate emissions from the proposed operation for each operating stage were estimated using emission estimation techniques outlined in USEPA AP42 documents (USEPA 2006) and *NPI EET Manual for Mining*, v 3.1, (DEH, 2012). Appropriate mitigation measures adopted for this assessment (presented in **Table 3**) were also considered in estimating the potential dust emissions from the proposed operation. Air quality modelling was conducted for TSP, PM_{10}, $PM_{2.5}$ and deposited dust, and the ground level concentrations and deposition rates were predicted at 20 identified sensitive receptors.

Based on examination of the modelling results the following conclusions have been drawn:

- **Maximum 24-hour average cumulative $PM_{2.5}$ concentrations** predicted at surrounding sensitive receptors for each modelled stage of operation are below the relevant ambient air quality criterion of 25 µg/m³. The incremental impacts predicted due to emissions from the Project are less than 10 µg/m³ (<40% of the standard) at any surrounding sensitive receptor locations.
- **Annual average cumulative $PM_{2.5}$ concentrations** predicted as a result of the proposed project are very low and well below the relevant ambient air quality criterion of 8 µg/m³ at each surrounding sensitive receptor. The incremental impacts predicted due to emissions from the Project are less than 0.3 µg/m³ (<4% of the standard) at any surrounding sensitive receptor locations.
- **Maximum 24-hour average cumulative PM_{10} concentrations** predicted at the surrounding privately owned sensitive receptors for each stage modelled in this study are below the relevant standard of 50 µg/m³. The incremental impacts predicted due to emissions from the Project are less than 35 µg/m³ (less than 70% of the standard) at any privately owned sensitive receptor locations.
- **Annual average cumulative PM_{10} concentrations** at all sensitive receptors surrounding the Project are predicted to be below the relevant guidelines for all operational years presented in this study. The incremental impacts predicted due to emissions from the Project are less than 2.1 µg/m³ (<7% of the standard) at any surrounding sensitive receptor locations.
- **Annual average cumulative TSP concentrations and dust deposition rates** at all sensitive receptors surrounding the Project are predicted to be below the relevant guidelines for all operational years presented in this study. Any adverse impacts at these locations are therefore considered to be unlikely.

Other potential pollutants including combustion emissions from the onsite vehicles, namely nitrogen oxides (NO_x), sulphur oxides (SO_x), volatile organic compounds (VOC's) are likely to be minimal.

Modelling results also showed that potential odour emissions from the proposed asphalt plant operation are also unlikely to cause any odour nuisance at any surrounding sensitive receptors.

11 REFERENCES

DEH 2012 *National Pollutant Inventory Emission Estimation Technique Manual for Mining Version 3.1*, Australian Government Department of Environment and Heritage, January 2012.

DEC 2005 *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*

Richardson 2000 *Fine Dust: Implications for the Coal Industry, the Australian Coal Review.*

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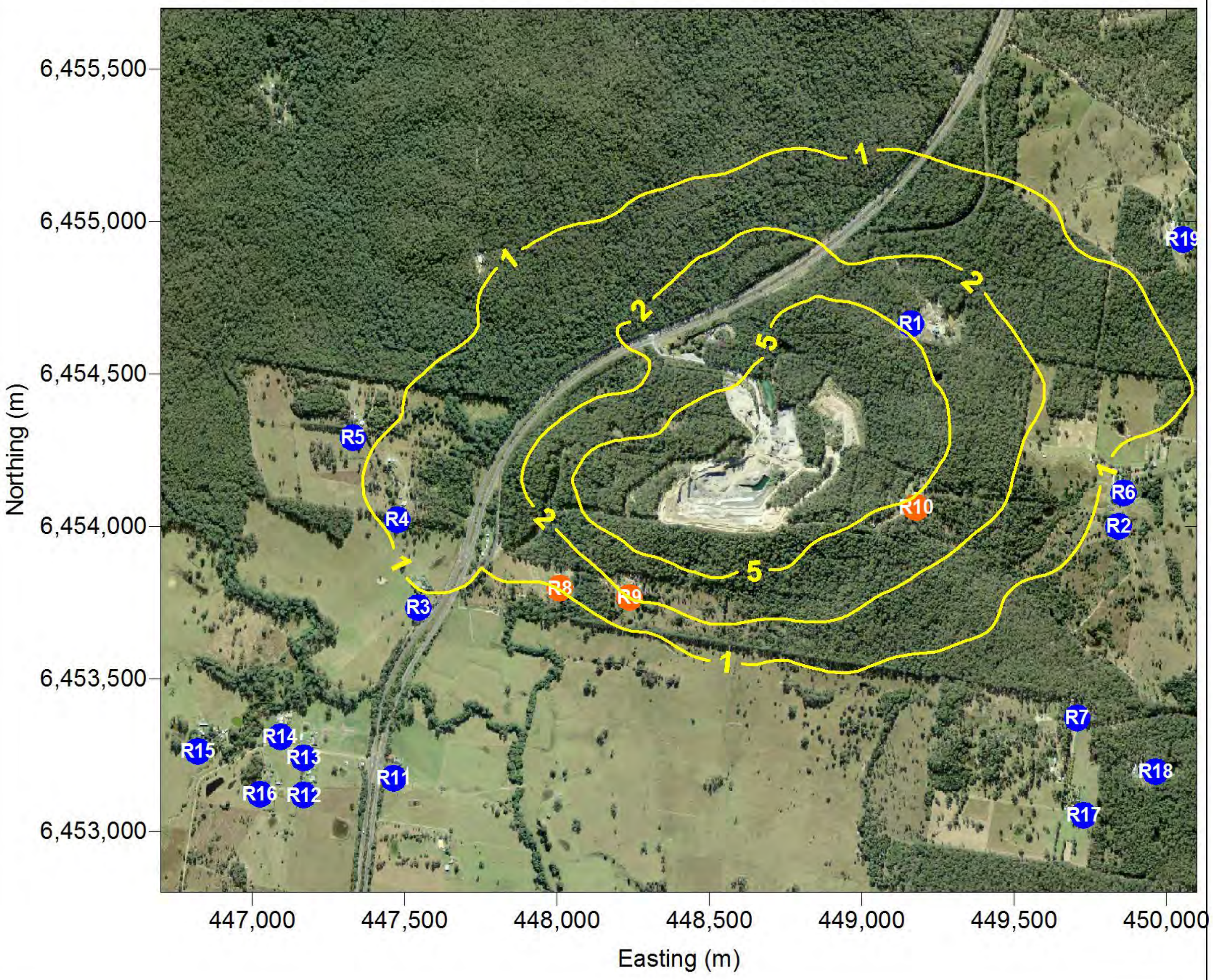

Maximum Predicted 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

Dispersion Model: Calpuff V6.267
Modelling Period: Oct 2012 - Oct 2013
Modeller: FR

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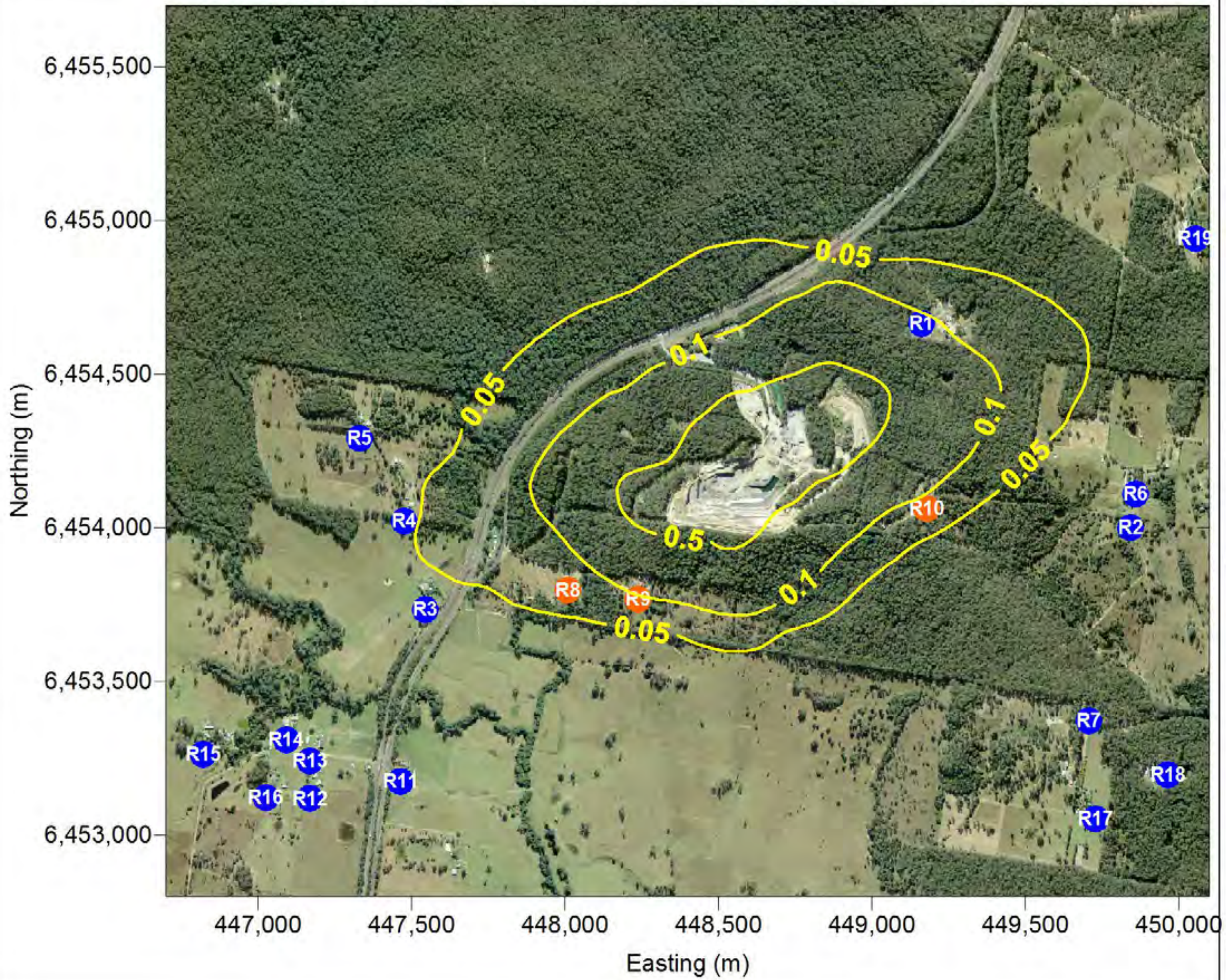
AIR DISPERSION MODELLING STUDY

Incremental Impact - Stage 1

Project No. 610.13023 Date 03/06/2014



Predicted Annual Average $PM_{2.5}$ Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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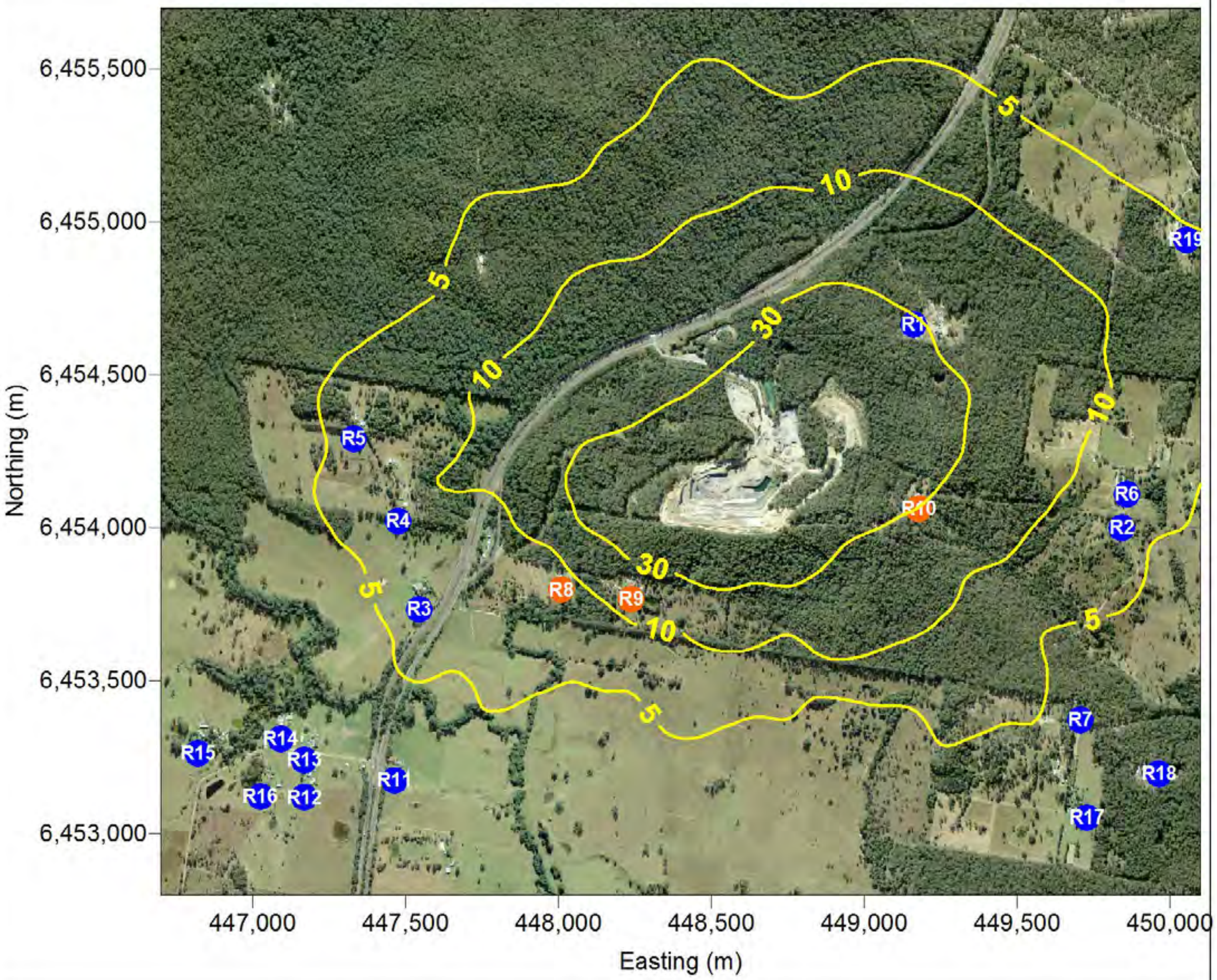

Maximum Predicted 24-Hour Average PM_{10} Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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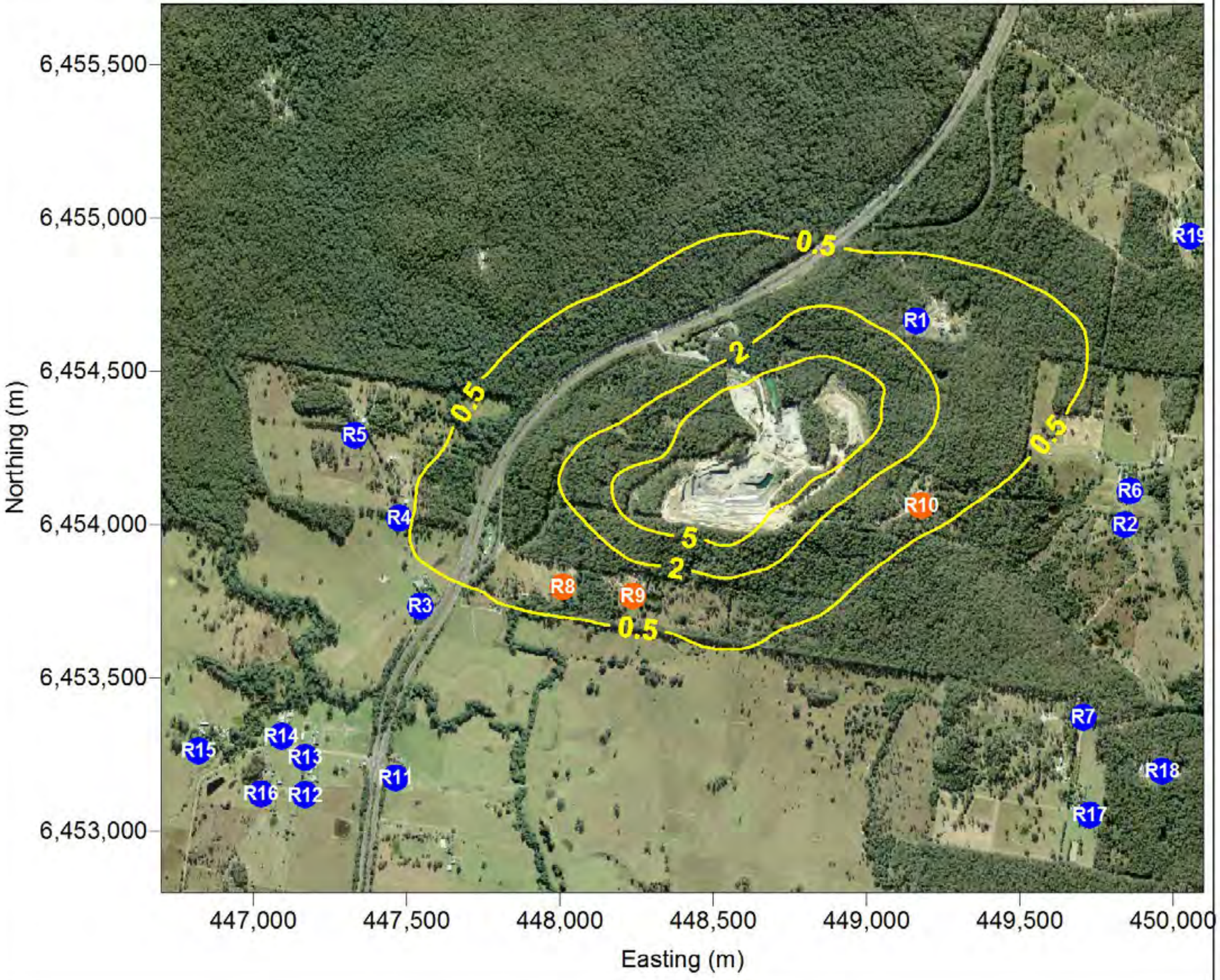

Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$)

LEGEND

Privately Owned Receptors
Quarry Owned Receptors

NOTES

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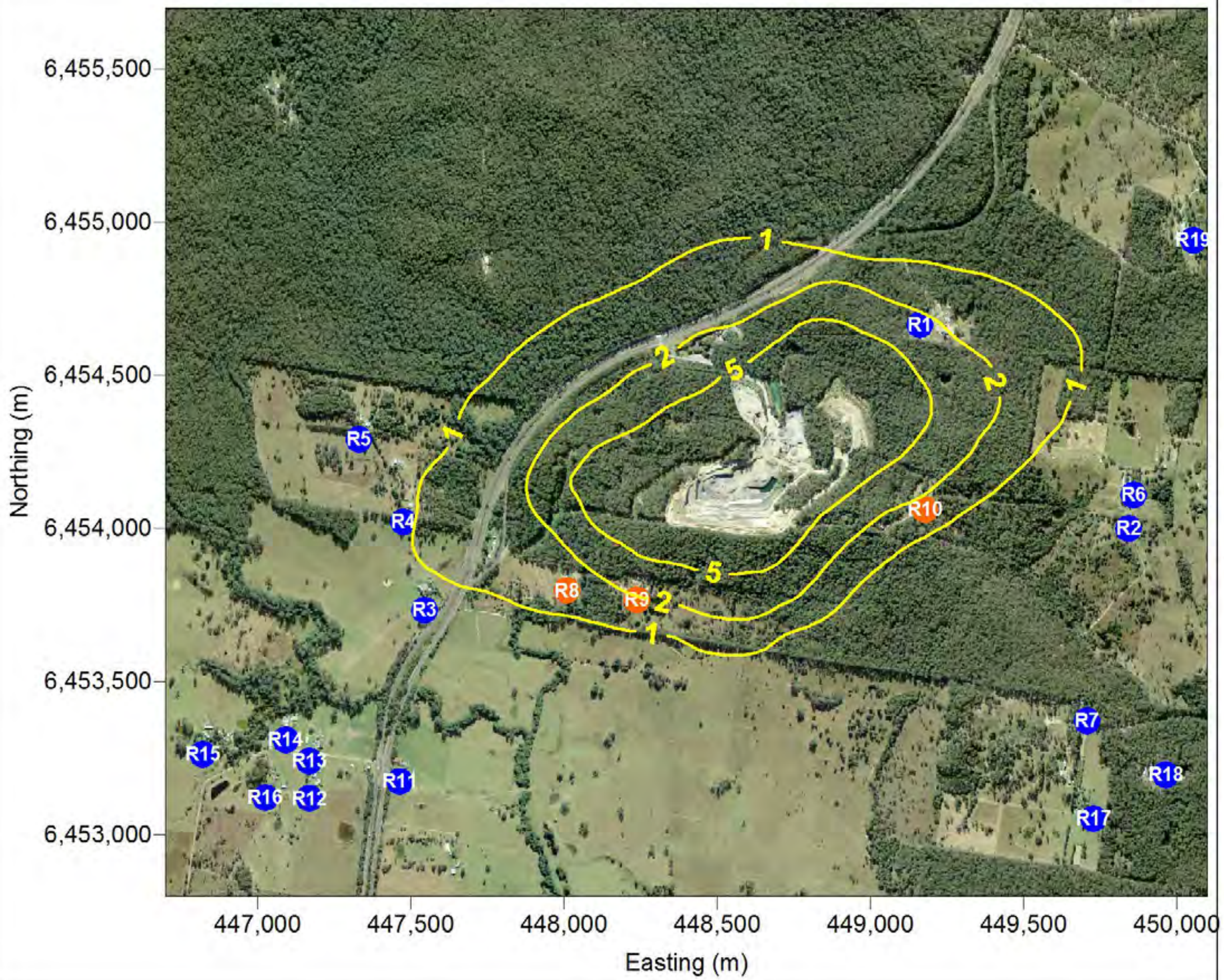
Contour Plots



Predicted Annual Average TSP Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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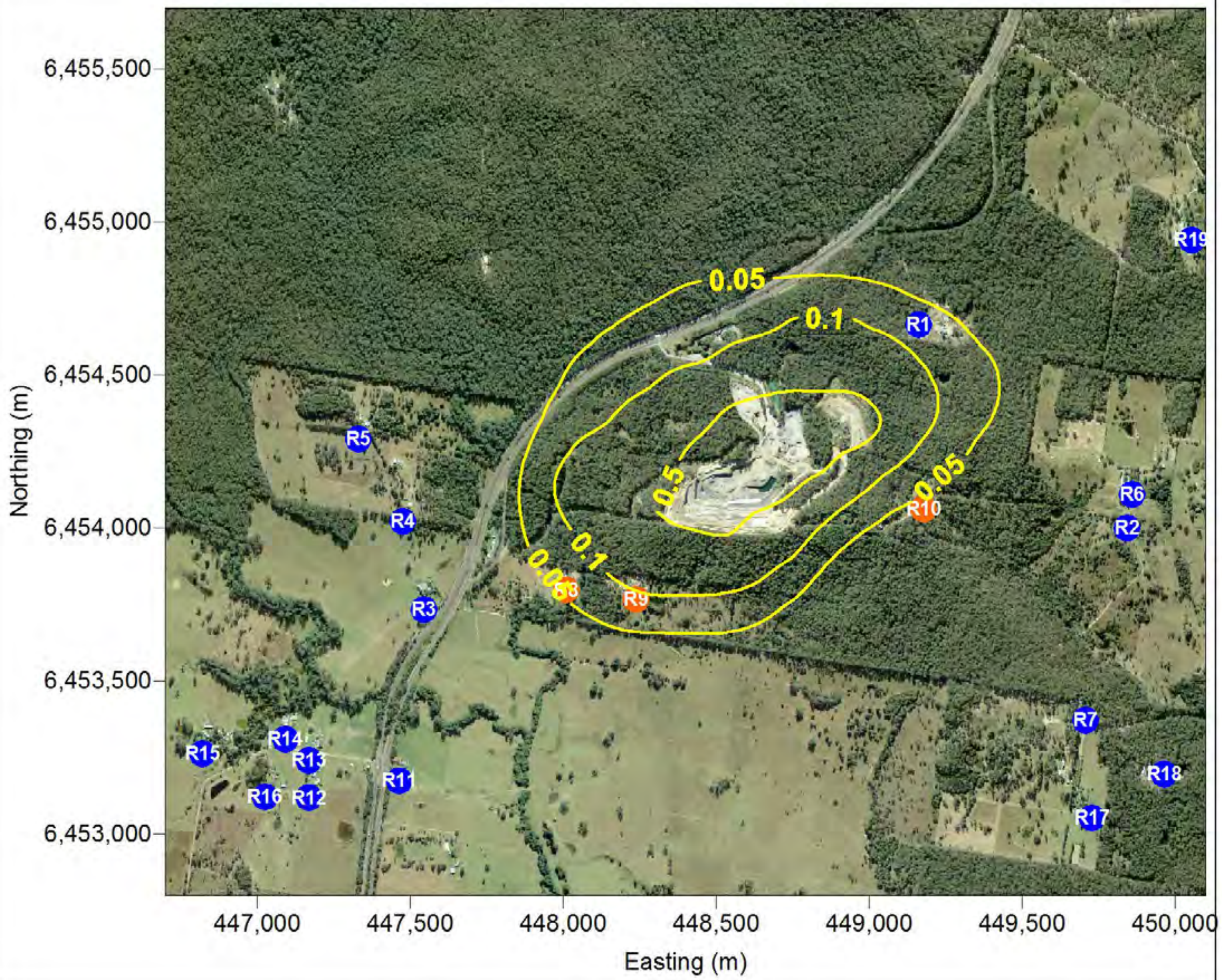

Predicted Annual Average Dust Deposition (g/m²/month)

LEGEND

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- Quarry Owned Receptors

NOTES

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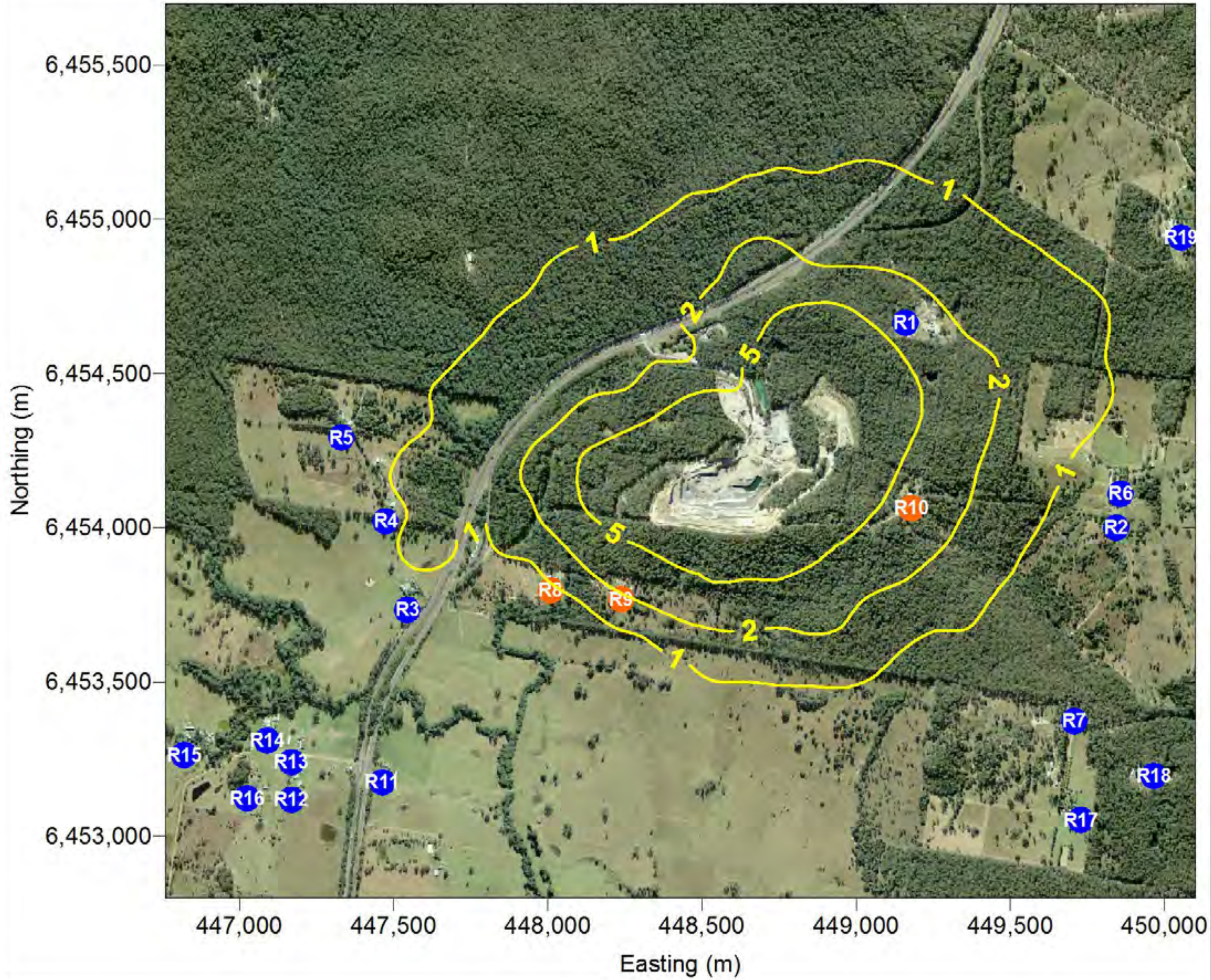

Maximum Predicted 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

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Incremental Impact - Stage 2

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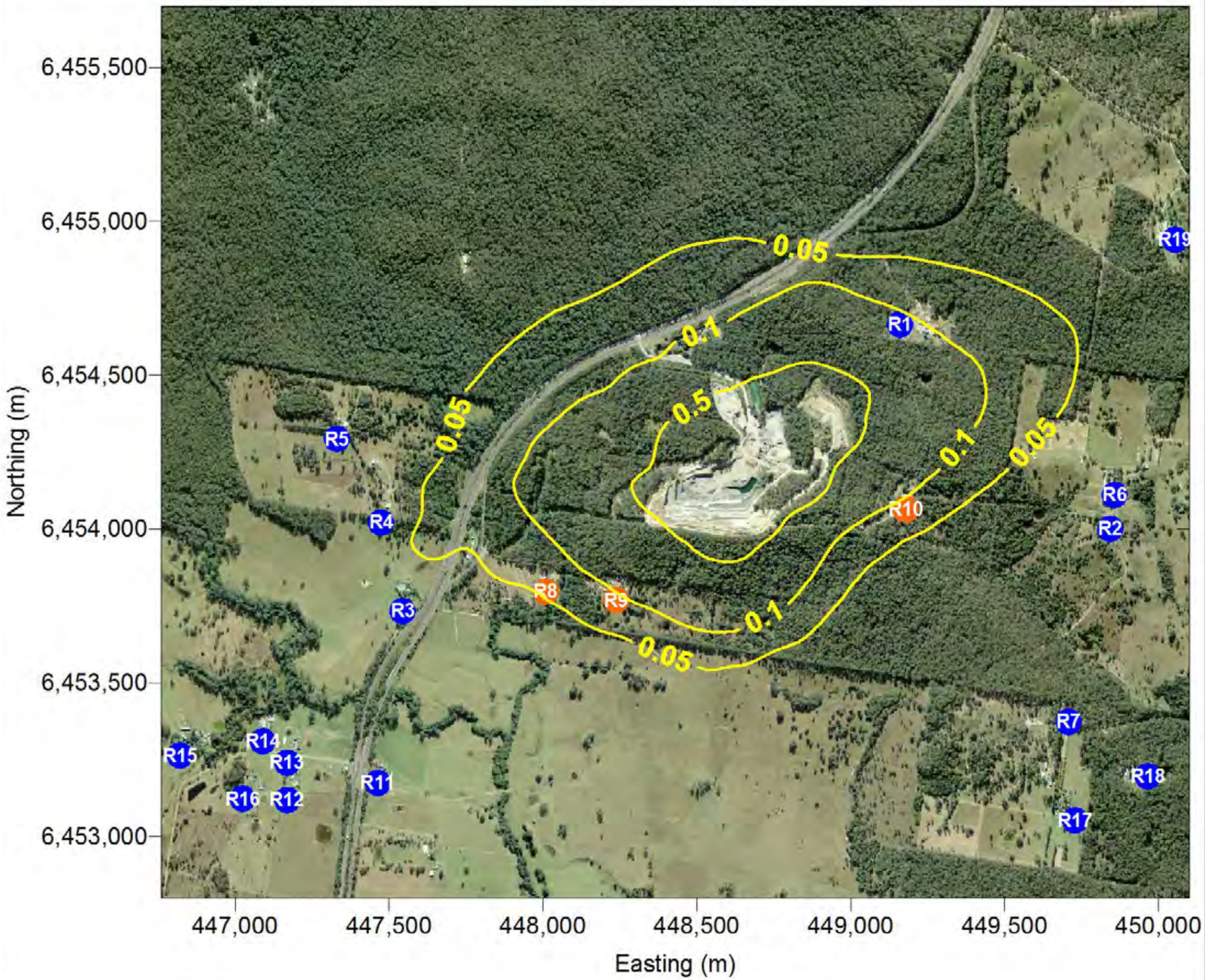

Predicted Annual Average $PM_{2.5}$ Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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Incremental Impact - Stage 2

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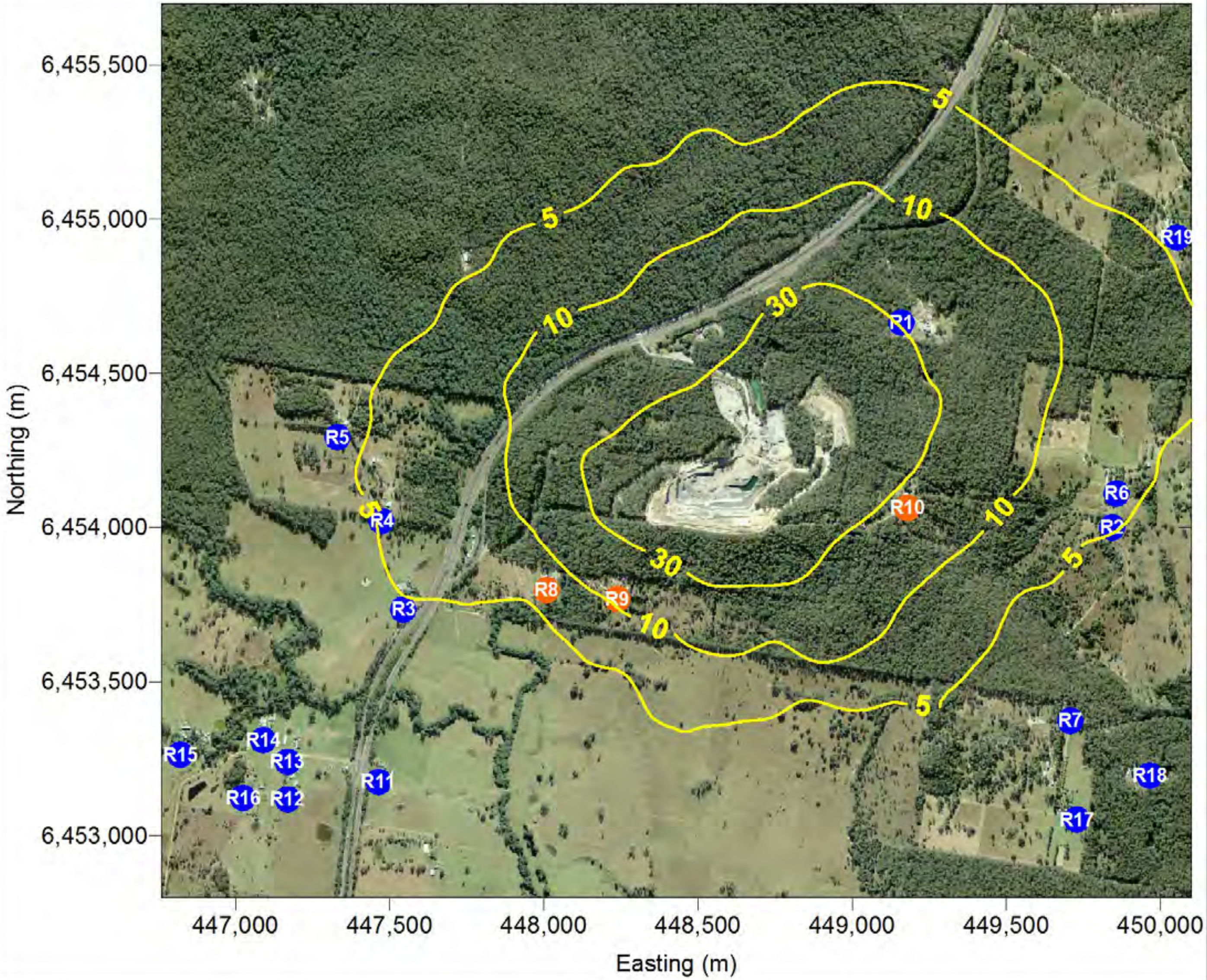

Maximum Predicted 24-Hour Average PM_{10} Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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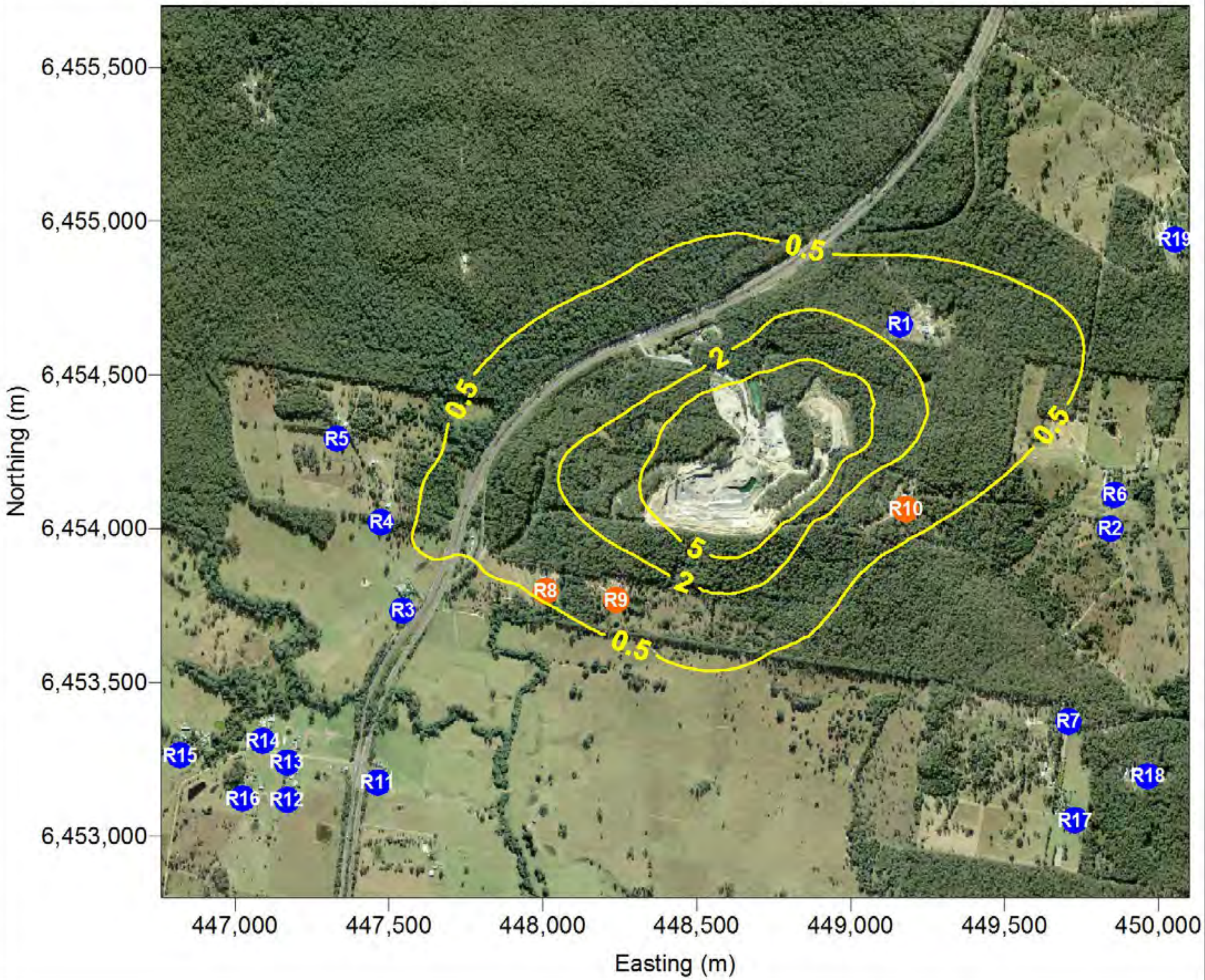

Predicted Annual Average PM_{10} Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

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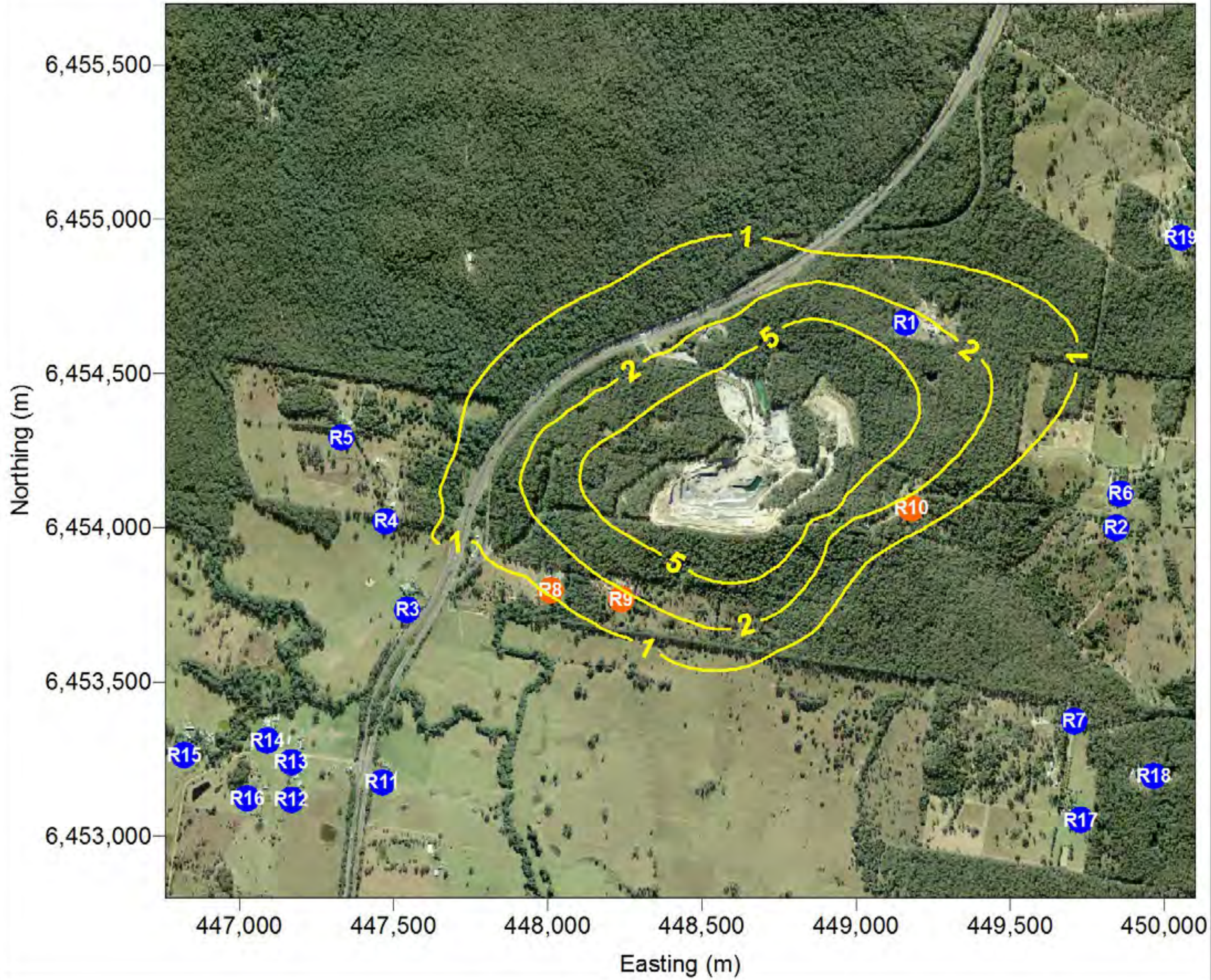

Predicted Annual Average TSP Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

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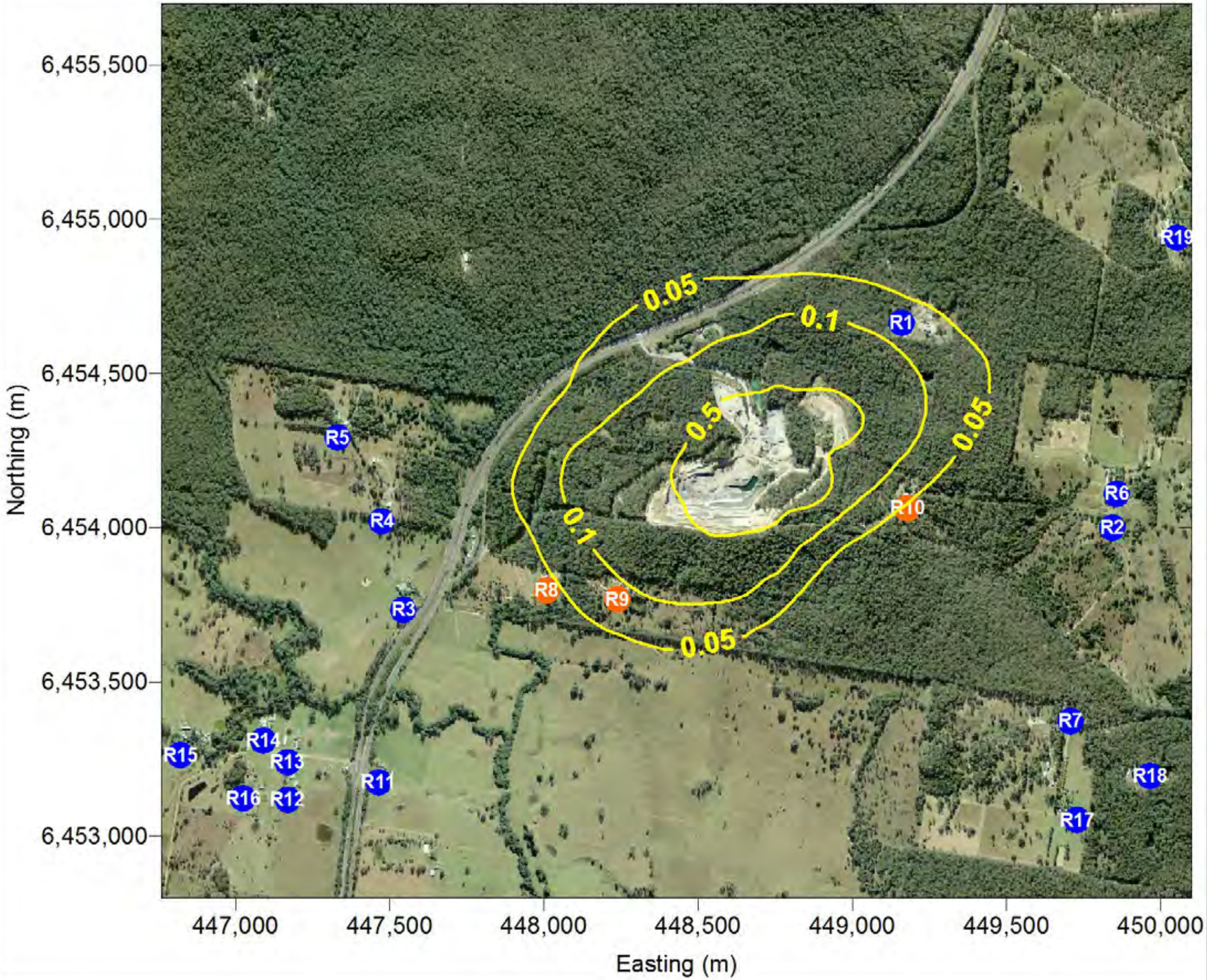

Predicted Annual Average Dust Deposition (g/m²/month)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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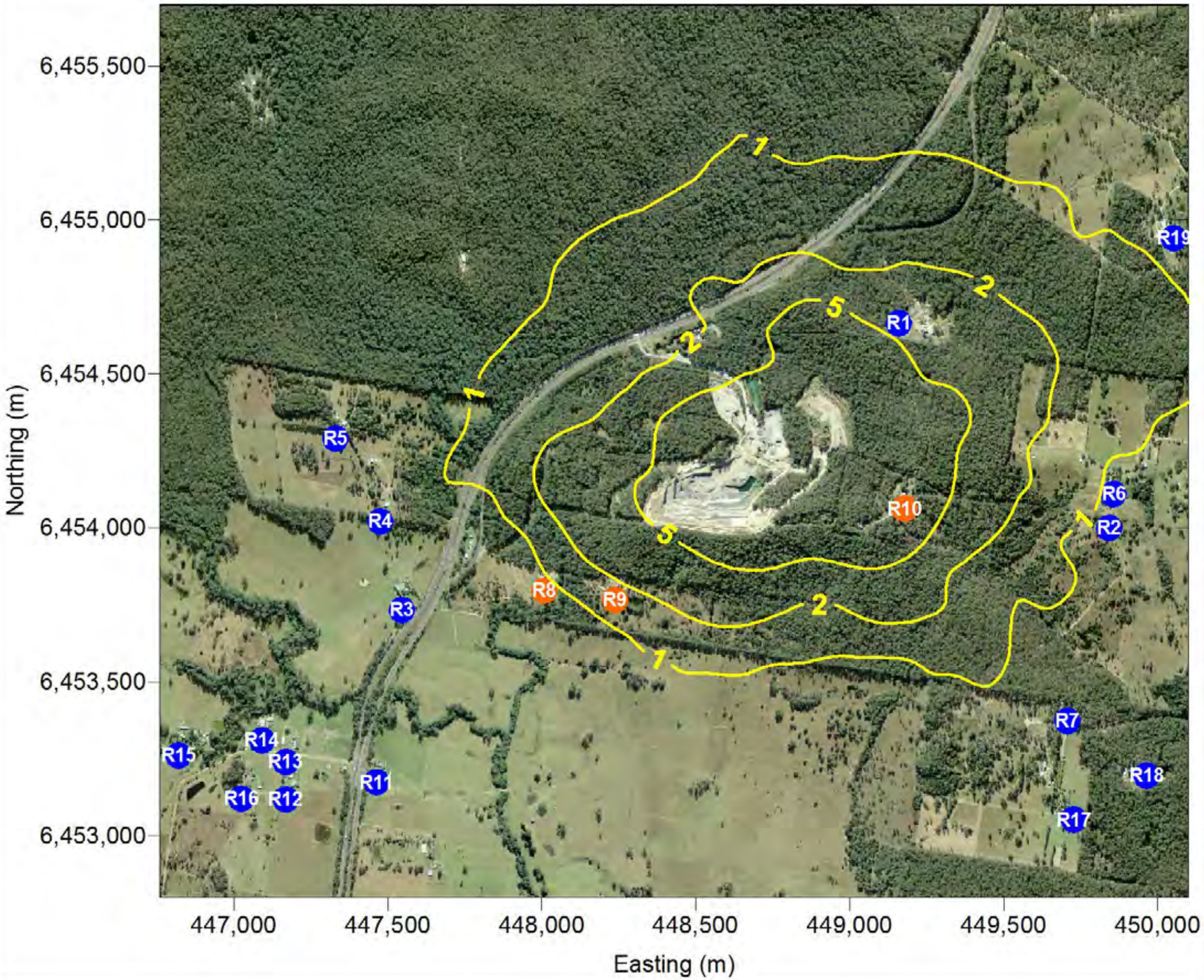

Maximum Predicted 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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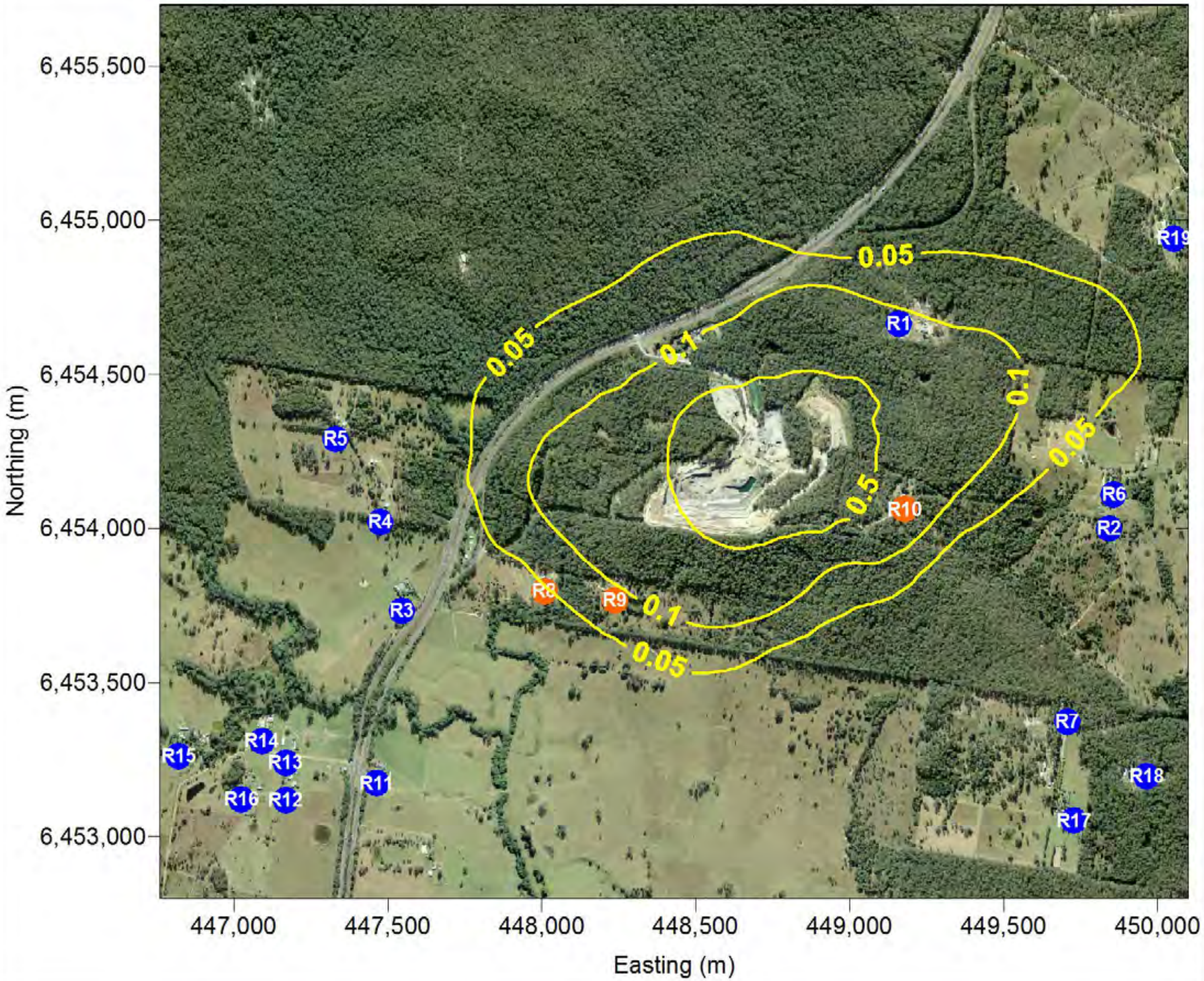
Incremental Impact - Stage 3

Project No	610.13023	Date	03/06/2014



Predicted Annual Average $PM_{2.5}$ Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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Incremental Impact - Stage 3

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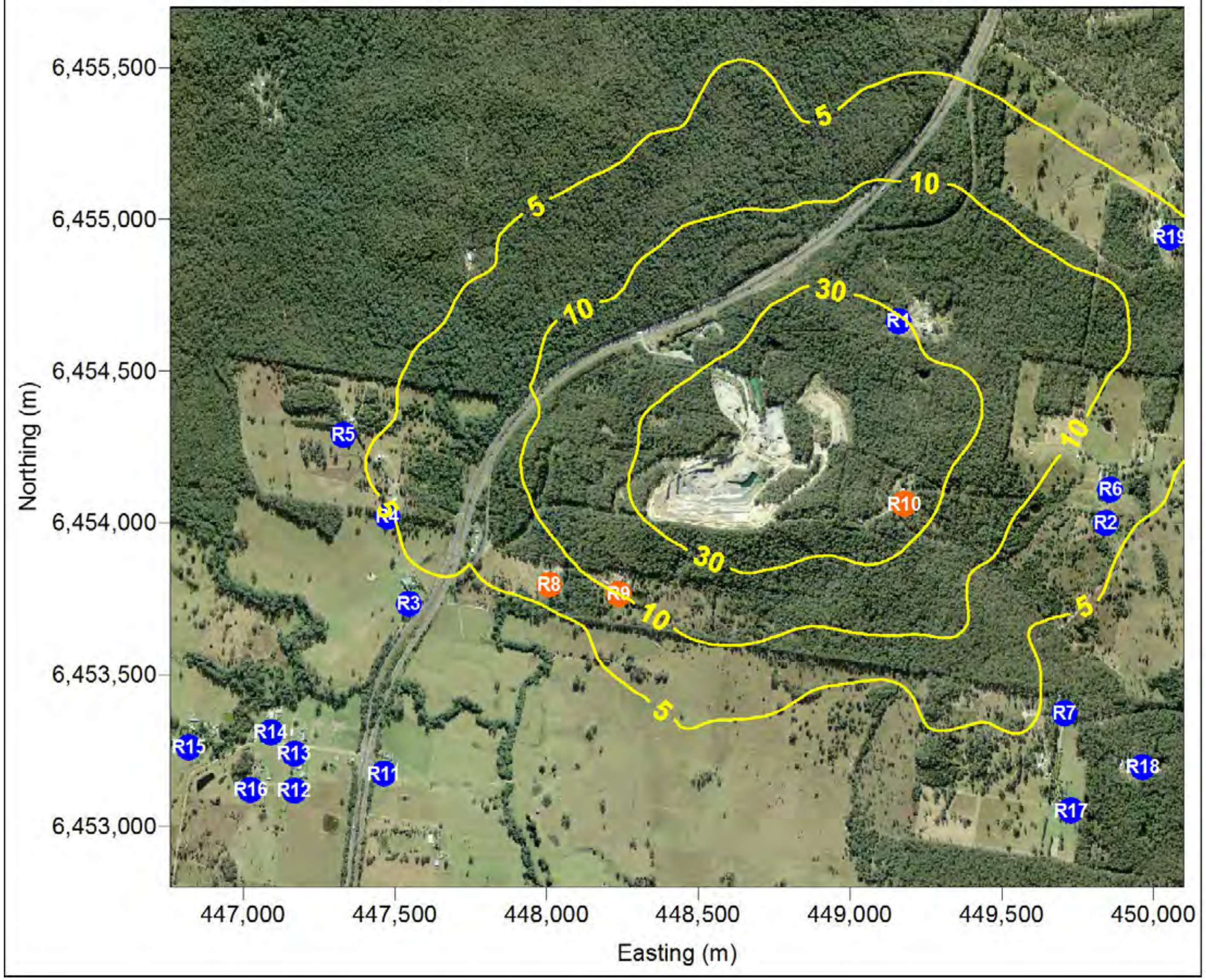

Maximum Predicted 24-Hour Average PM_{10} Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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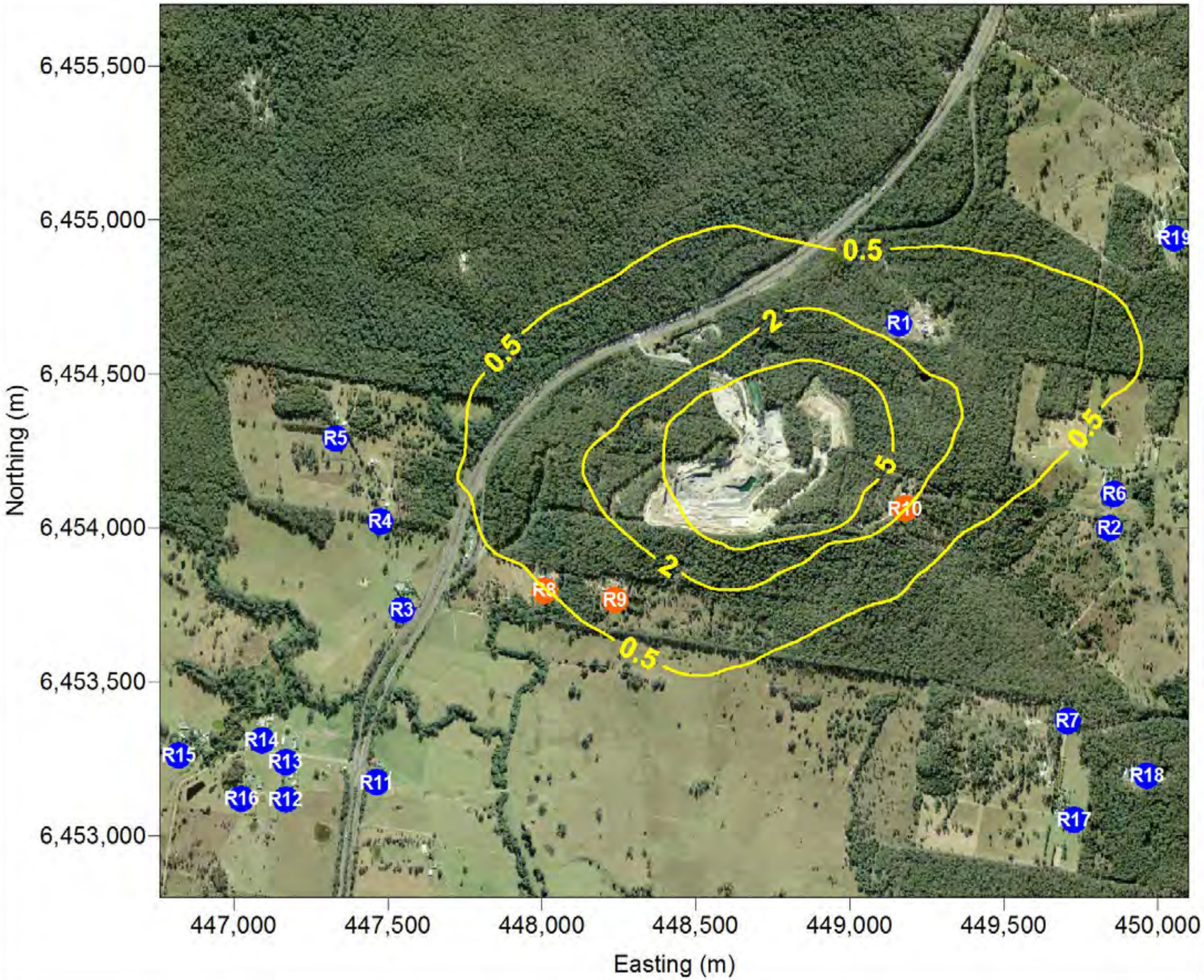
Incremental Impact - Stage 3

Project No	610.13023	Date	03/06/2014



Predicted Annual Average PM_{10} Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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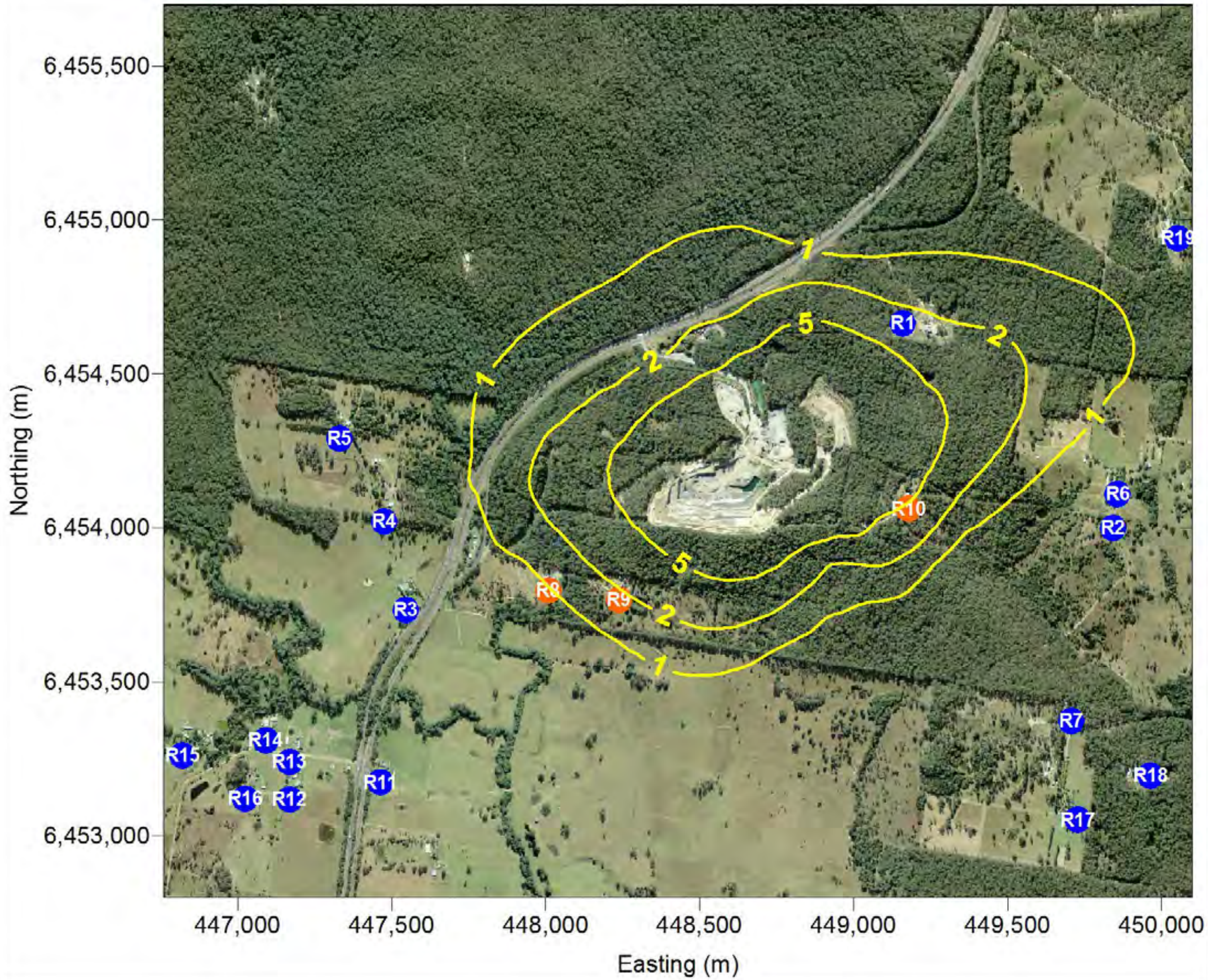
AIR DISPERSION MODELLING STUDY

Incremental Impact - Stage 3

Project No. 610.13023 Date 03/06/2014



Predicted Annual Average TSP Concentrations (µg/m³)

LEGEND

- Privately Owned Receptors
- Quarry Owned Receptors

NOTES

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Modelling Period: Oct 2012 - Oct 2013
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AIR DISPERSION MODELLING STUDY

Incremental Impact - Stage 3

Project No 610.13023 Date 03/06/2014

Contour Plots