APPENDIX 11

Dust Survey

JANDRA QUARRY EXTENSION

Air Quality Assessment

For:
CSR CONSTRUCTION MATERIALS

October 1999

38070AIRRP2

Report No. 38070AIRRP2

This report was prepared in accordance with the scope of services set out in the contract between ERM Mitchell McCotter Pty Ltd ACN 002 773 248 (ERMMM) and CSR Construction Materials. To the best of our knowledge, the proposal presented herein accurately reflects the CSR's intentions when the report was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In preparing the report, ERMMM used data, surveys, analyses, designs, plans and other information provided by the individuals and organisations referenced herein. While checks were undertaken to ensure that such materials were the correct and current versions of the materials provided, except as otherwise stated, ERMMM did not independently verify the accuracy or completeness of these information sources.

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Chapter 1

INTRODUCTION

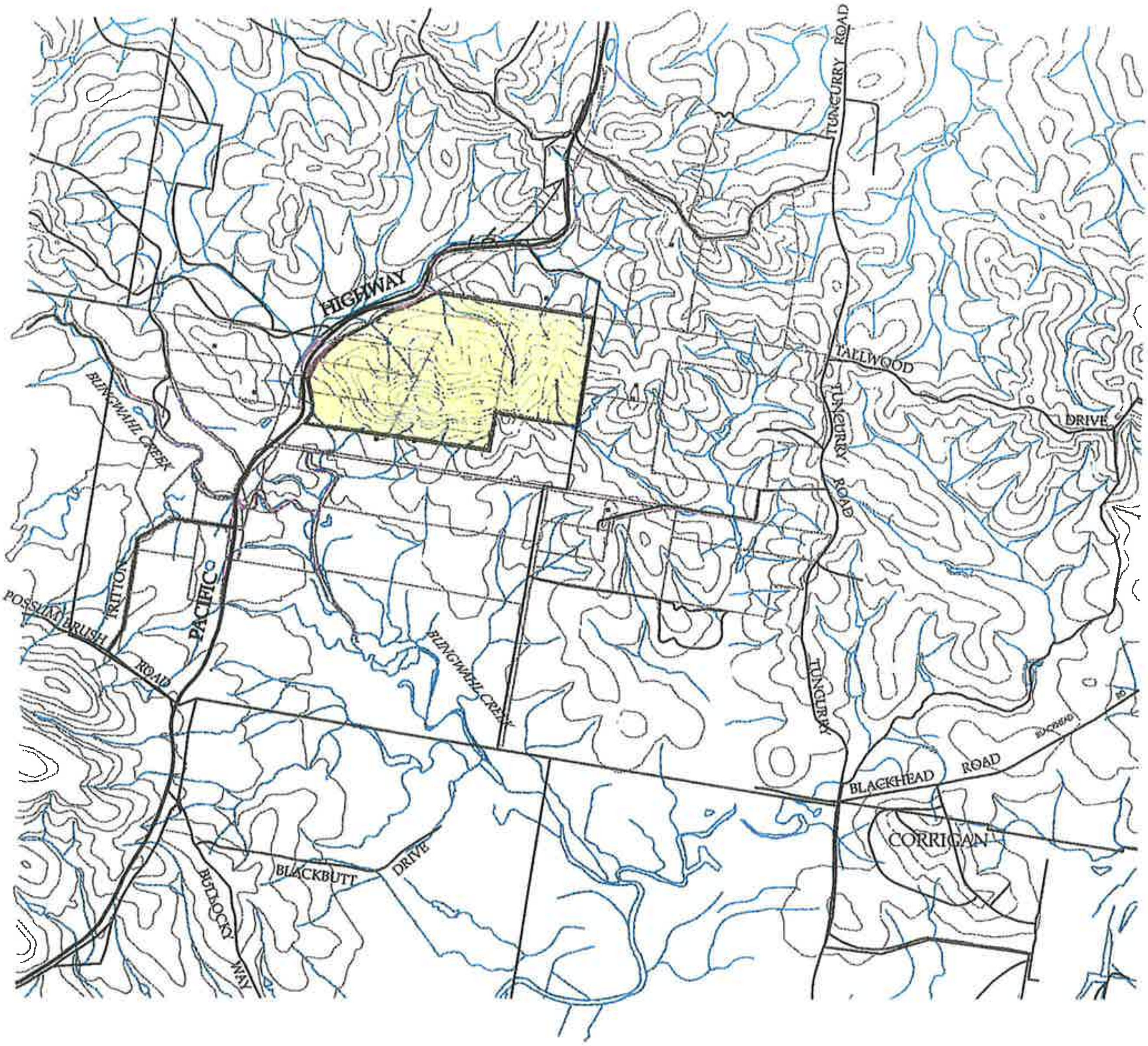
1.1 AN OVERVIEW

CSR Construction Materials (CSR) owns and operates a quarry situated on 118 ha of freehold land located adjacent to the Pacific Highway approximately 18 km south of Taree (see *Figure 1.1*). Current approvals allow for an extraction rate of 150,000 tonnes per annum (tpa), place some stringent controls on operating hours and blasting, and give reserves of around 560,000 tonnes. This equates to about four year's life. The present operation crushes and screens the material and provides a pre-coating facility for sealing aggregates.

CSR is seeking to gain approval to:

- expand operating hours from 6.00 am to 6.00 pm Monday to Friday and 6.00 am to 3.00 pm Saturdays. Ancillary operations such as refuelling, servicing and maintaining plant will be undertaken between 6.00 am and 9.00 pm Monday to Saturday;
- expand the existing site facilities area;
- lift approved production levels from 150,000 tpa to an average 250,000 tpa;
- significantly expand reserves to allow planning for the companies future. This includes extraction down to Relative Level (RL) 20 and will provide 16 million tonnes of fresh rock;
- remove the restrictions on blasting to enable the adoption of normal commercial blasting practices;
- locate on site, from time to time on an as needs basis, a mobile pugmill and/or a mobile asphalt plant; and
- construct a new weighbridge and office complex west of the current weighbridge.

Quarry practices will remain essentially the same, including the continuation of current dust mitigation procedures. The quarry processing plant will not be changed, the extra capacity required will be accommodated by the extension of the operating hours.



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CSR PROPERTY BOUNDARY

RESIDENCES

CADASTRAL BOUNDARIES

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Figure 1.1 SITE LOCALITY

1.2 QUARRY DEVELOPMENT

The main haul roads to the upper benches have been established on the eastern side of the existing quarry. To avoid disruption to the main haul roads it is proposed to initially quarry to the west.

Existing benches have been developed at 12 m heights and it is proposed to continue with 12 m separation down to RL 50. From this level it is proposed to develop two 15 m high benches. The quarry plan includes:

- terminal bench width of half the face height;
- final face angle of 75°;
- haul roads 15 m wide and at 1:10 grade;
- rock density of 2.65 t/m^3;
- topsoil 1 m thick; and
- weathered rock 10 m thick.

Four stages of development have been proposed as described below.

1.2.1 Stage 1.

This stage involves expanding the quarry to the west.

Where possible, the first action will be to develop an excavated slot along the southern rim of the quarry through the topsoil and weathered rock, leaving the final south face at a stable angle suitable for plant growth, and replanting. When the active quarry face extends south to meet this revegetated slot, much of the final visual impact will be mitigated. Where the development of the slot is not possible due to the location of the existing southern quarry face, revegetation will be commenced as soon as possible following completion of the final southern face. At the same time a sump will be put down into the floor of the quarry to trap all the water from disturbed areas. This will be enlarged from time to time.

Benches will be developed at RL 50, 62, 74, 84 and 96. It has been calculated that this development will generate 61,900 m^3 of overburden, 619,300 m^3 (1.64 million tonnes) of weathered rock and 1,685,800 m^3 (4.47 million tonnes) of fresh rock. It is expected that most of the weathered rock will be processed and sold as road base type product.

As terminal faces are developed on the southern and western limits overburden and topsoil will be placed on the benches and rehabilitated. This method has been used successfully at the Ferntree Gully Quarry (Melbourne) by CSR.

The prior rehabilitation of the top 10 m of overburden and the weathered rock along the southern slot and the ridge on the northern rim of the quarry, will assist to significantly reduce any further visual impact when the site is viewed from the north.

1.2.2 Stage 2

This stage involves the easterly development of the RL 50, 62, 74, 86 and 98 faces half way to the proposed eastern limit of the quarry and developing a new floor at RL 35 in the latter part.

Again, a preliminary slot will be cut along the southern rim, to enable rehabilitation of the top bench in weathered rock before it is exposed to view from the north. Terminal faces on the southern rim, not needed for access or the haul road, will be rehabilitated.

This stage will yield some 442,000 m^3 of overburden, 489,100 m^3 of weathered rock (1.29 million tonnes) and 1,640,800 m^3 of fresh rock (4.35 million tonnes).

Visual impact of this stage be diminished by prior rehabilitation of the weathered rock face.

Early in Stage 2 the existing haul roads will need to be relocated, and it is proposed that access from the RL 50 bench to the higher benches will be via a ramp developed along the northern and eastern faces. The higher sections of this ramp will be live and will have to be relocated from time to time.

All runoff from the disturbed area will be gathered either on the RL 35 level, or in a sump below RL 35. After settling, all water will be pumped out into the existing water management system.

Towards the end of this stage operations will come within 20 m of the south-east corner of the CSR property. A formal legal agreement between CSR and the owners of the adjoining property (YALA) restricting activities on the adjoining land during blasting is currently being negotiated.

1.2.3 *Stage 3*

This stage is the continued development east of the RL 35, 50, 62, 74 and 98 benches to their most eastern limit. At no stage will the eastern ridge be breached. Towards the end of this stage a drop cut to a new floor level at RL 20 will be developed.

Again the weathered rock profile along the southern rim will be rehabilitated, and after development all visible terminal faces will be rehabilitated.

During this stage the operation will extract 34,500 m^3 of overburden, 300,700 m^3 of weathered rock (751,700 tonnes) and 1,371,600 m^3 of fresh rock (3.6 million tonnes).

Completion of this stage will represent the end of any disturbance of the site, the quarry having practically reached its final rim position.

1.2.4 *Stage 4*

In this stage effort is concentrated on removing the bottom RL 20 bench, and some peripheral clean up. It will release 4,500 m^3 of overburden, 45,000 m^3 of weathered rock (112,700 tonnes) and 1,537,600 m^3 of fresh rock (4.1 million tonnes).

Other than maintenance of existing rehabilitation there will be little additional areas requiring rehabilitation.

At the end of this stage the floor will be approximately 750 metres long and 100 metres wide. This stage has the potential to yield in excess of 2.5 million tonnes of fresh rock. Approval for extraction of this additional resource is not part of this application.

Chapter 2

AIR QUALITY CRITERIA

2.1 AIR QUALITY CRITERIA

The effects of dust on health and amenity were assessed by comparing dust deposition rates and dust concentrations with recognised air quality criteria. These criteria were established from research in both New South Wales, Victoria and overseas. To include the full range of potential impacts, reference was made to criteria for long-term (annual average) and short-term (24 hour) periods, and to different particle sizes. The following sections detail appropriate criteria.

2.2 NATIONAL ENVIRONMENT PROTECTION MEASURE (NEPM)

Ambient air quality throughout Australia is the subject of *The National Environment Protection Council (Ambient Air Quality) Measure 1998* (NEPM). This is a Commonwealth initiative to achieve nominated standards of air quality within ten years. All states and territories have adopted the ten-year air quality goals for pollutants specified in Schedule 2 of NEPM.

In adopting the NEPM air quality goals, the State Government undertakes to conduct measurements of air quality at performance monitoring stations located in regions where greater than 25,000 people may be affected. Monitoring station locations are selected to represent exposure of a large proportion of the population rather than exposure of individual people. It is also important to note that the NEPM criteria are not to be compared solely to the emissions from one source, they are meant as regional air quality goals. NEPM criteria are therefore not considered in this assessment.

2.3 DUST DEPOSITION

Dust deposition criteria developed by the NSW Environment Protection Authority (NSW EPA) are given in *Table 2.1*. These set maximum increases above existing levels. For example, in residential areas with existing annual average deposition of between zero and two g/m^2/month, an increase of up to two g/m^2/month would be permitted.

Table 2.1 ASSESSMENT CRITERIA FOR DUST DEPOSITION

Existing Deposition (g/m^2/month)	Maximum Acceptable Increase (g/m^2/month annual average)	
	Residential Suburban Land Use	Rural, Semi-Rural Urban, Commercial & Industrial Land Uses
2	2	2
3	1	2
4	0	1

Based on these criteria the permissible increase at properties around the quarry will be as shown in *Table 2.2*.

Table 2.2 GUIDELINES FOR INCREASES IN DUST DEPOSITION

Site	Annual Average Deposition for 1996 - 1997[1] (g/m^2/month)	Permissible increase in deposition (g/m^2/month)
1	1.90	2.0
2	1.76	2.0
3	2.62	2.0

Note: *1. Details provided in Section 3.6.*

2.4 DUST CONCENTRATION

Concentration criteria for long-term annual averages and short-term 24 hour periods were considered. Two size ranges were also addressed: total solid particulate matter (TSP) or particles less than 50 microns (one millionth of a metre) and particles smaller than 10 microns (PM_{10}).

PM_{10} particle concentrations are of interest because they can reach the lower parts of the respiratory system and may have health as well as amenity impacts. Most PM_{10} particles are caused by combustion from motor vehicles, bushfires and industrial processes. Some PM_{10} particles are generated by evaporation of sea spray and from vegetation. Most quarrying dust consists of coarser particles which have amenity rather than health effects.

The assessment criteria are as follows.

2.4.1 *Short-term Criteria*

Based on United States Environmental Protection Agency (USEPA) standards, the NSW EPA adopts a 24 hour concentration criterion of 150 $\mu g/m^3$ for PM_{10} which should not be exceeded more than once per year.

2.4.2 *Long-term Criteria*

The National Health and Medical Research Council of Australia (NHMRC) recommends a maximum annual concentration of 90 $\mu g/m^3$ total suspended particulate in a residential environment, which is compared to in the absence of a more suitable standard. For particles smaller than 10 microns, the NSW EPA adopts the USEPA PM_{10} standard of 50 $\mu g/m^3$ annual average.

Chapter 3

DUST DISPERSION MODELLING

3.1 INTRODUCTION

The ISC dispersion model was chosen to predict dust deposition rates and airborne concentrations of respirable (PM_{10}) and inhalable (TSP) dust resulting from dust emissions. Calculated dust deposition rates were compared against available monitored data in the locality to validate the model's result. No measured values were available for TSP and PM_{10} concentrations in the locality.

3.2 ISC MODEL

The Industrial Source Complex (ISC) dispersion model is a gaussian plume dispersion model used to evaluate the air quality impact of emissions from industrial source complexes. It has been approved by most regulatory authorities nationally and internationally. The ISC model consists of two programs for short and long term analyses. The short-term model uses sequential hourly meteorological data to estimate deposition or concentration patterns from one hour to one year. The long-term model uses statistical wind data summaries to estimate seasonal and annual concentration and deposition patterns. For the purpose of this investigation only the short-term model has been used. It has been used to account for the short-term variability of the emissions from the quarry.

3.3 SELECTION OF MODEL OPTIONS

For modelling atmospheric dispersion of emissions from the quarry, the following options were selected:

- Unless otherwise stated, regulatory and/or default options were used as based on previous studies.

- Ground level concentrations are predicted at 14 discrete receptors corresponding to locations of sensitivity. A Cartesian receptor grid was also used with local grid coordinates and a resolution of 200 meters.

- As a conservative assumption, only dry deposition was considered. The effects of wet deposition would reduce the total dust impact of the quarry. Additionally an appropriate scavenging coefficient (for wet deposition) could not be determined with any confidence.

- Plume mass depletion was not included for deposition calculations.

The ISC plume dispersion model was used to determine the 24 hour and annual average ground level concentration of PM_{10} and the annual average ground level concentration of TSP. Monthly averages for dust deposition were also predicted.

3.4 METHODOLOGY

CSR proposes to extend their quarry operations at Jandra from 150,000 tonnes per annum to an average 250,000 tonnes per annum. Dust emissions from each quarrying activity were estimated and used in a short-term dust dispersion model. The model calculated average 24 hour concentrations for PM_{10} and TSP around the quarry based on emission rates and meteorological data.

There has been a wide and significant body of data that has been collected to demonstrate the accuracy of the ISC modelling process. For this assessment, 12 months of dust deposition monitoring data recorded at the quarry site boundary were available to verify modelling assumptions. This was performed to confirm that all assumptions in the model under current conditions are valid. The dust deposition monitoring results verified the assumptions of the model for the current stage.

Based on the verified model, levels of dust deposition and dust concentrations were predicted. Air quality impacts due to proposed quarry operations were determined by comparing the predicted levels with relevant criteria.

3.4.1 Existing Environment

Dispersion modelling requires good quality weather data, including wind speed, wind direction and atmospheric stability. This is incorporated into the model as a frequency distribution of wind speed and wind direction by stability class.

The ISC model requires specific meteorological (MET) data. Hourly information for a complete year is required for wind direction, winds speed, temperature, stability class, rural and urban mixing heights to complete calculations.

The Bureau of Meteorology installed an automatic weather station at the Taree airport. The information is a compilation of meteorological data at 9.00 am to 3.00 pm. The data includes rainfall, wind speed and wind frequency for the area. The information is insufficient for complete modelling of dust emission from the quarry and instead a compilation of statistical data, "Metsamp" was used. This meteorological file is used to calculate a worst case scenario and as such only the highest concentration value can be considered, as opposed to the NSW EPA regulations which allow for one exceedence of the short-term value.

Appendix A details the windrose summaries for wind speed and direction for the Taree region for each of the seasons. The roses are similar for each season and, wind direction and speed vary slightly with more than 50% of wind prevailing from the east in the mornings and from the north-west in the afternoon.

Calm conditions (less than 3 m/s) are experienced for approximately 30% of the mornings and the afternoon breeze creating less stable conditions later in the day.

Daily average temperatures from 28°C in the summer, 21°C in the autumn, 18°C in the winter and 23°C in the spring.

The number of rain days per year average 130 with approximately 1,184 mm of rain falling during an average year.

3.4.2 Wind Data

Wind speed influences the dust emitted from disturbed areas. Wind erosion of such areas mainly occurs at velocities of more than 5.4 metres per second, which were recorded approximately 15 per cent of the time in the Jandra area. For the meteorological file used, wind direction is allocated in 30 degree increments for the full 360 degrees. Wind speed ranged from 0.5 m/s to 20 m/s for all of the wind directions calculated.

3.4.3 Stability Class

Stability class is used to determine the rate at which a dust plume disperses by turbulent mixing. Each stability class is associated with a dispersion curve, which is used by the dispersion model to calculate plume dimensions and dust concentrations downwind of the source.

Stability classes are categorised from 1 to 6 or, A to F. Stability Class 1 applies under sunny conditions with light winds when dispersion of the plume is most rapid. Stability Class 4 applies under windy and/or overcast conditions when dispersion is moderately rapid, and stability Class 6 occurs at night when winds are light and the sky is clear. Classes 2, 3 and 5 are intermediate conditions between those described above.

The meteorological data used covered all 6 stability classes.

3.4.4 Mixing Heights

Mixing Height refers to the height that fine dust particles will be ultimately mixed in the atmosphere. In this instance where most of the sources are non-buoyant ground level emissions, the predictions from the ISC model are not particularly sensitive to the mixing heights. Theoretical mixing height values have been used to cover both urban and rural mixing heights ranging from 1,000 to 2,250 metres.

3.5 DUST DEPOSITION MONITORING RESULTS

CSR has a network of dust gauges located around the quarry as shown on *Figure 3.1*. *Table 3.1* shows monthly dust deposition monitored at specific sites around the quarry.

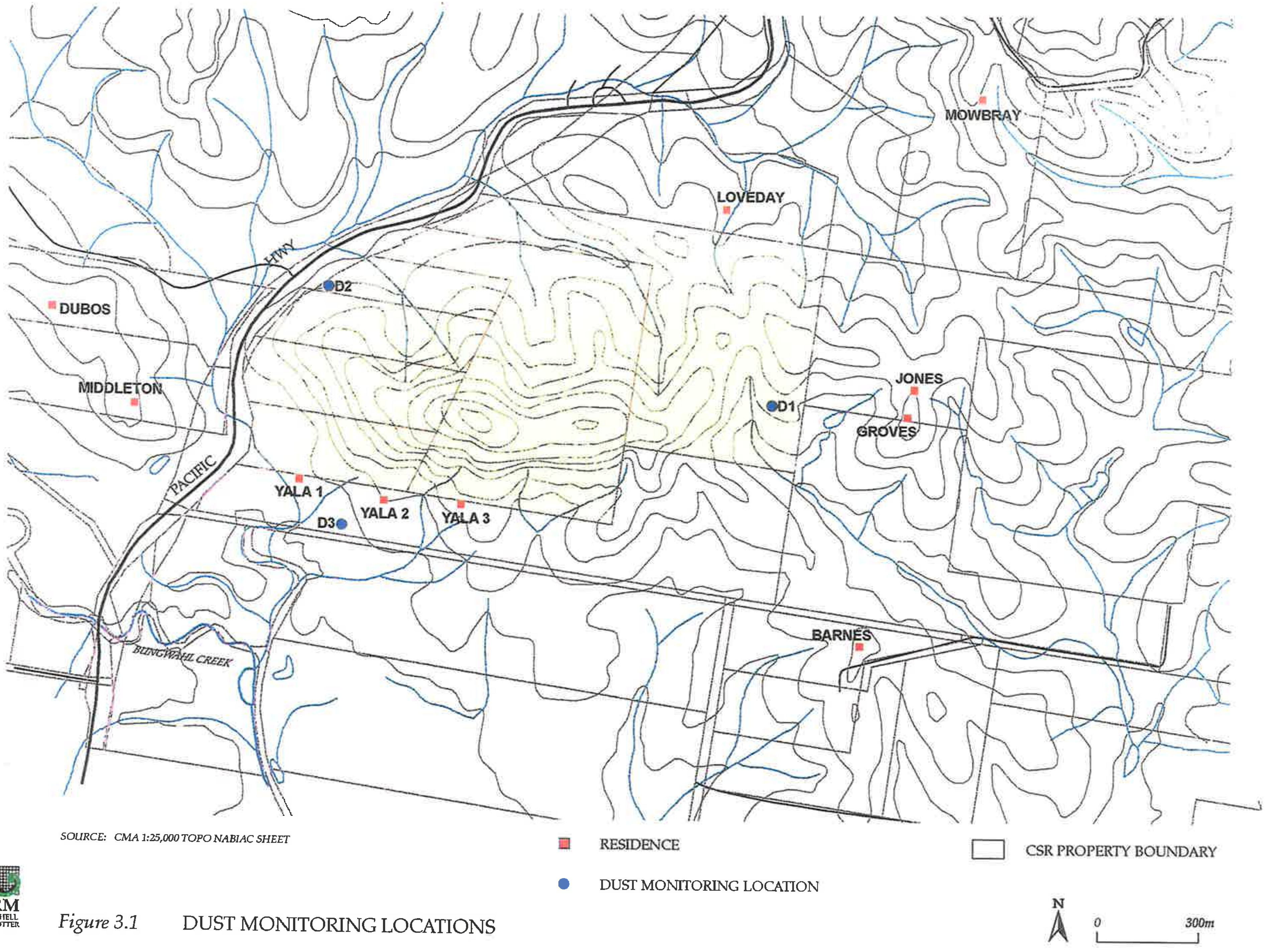

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Figure 3.1 DUST MONITORING LOCATIONS

Table 3.1 DUST MONITORING RESULTS

Site	Date	Dust Deposition[1]
1	02/01/96	2.37
2		2.55
3		2.54
1	02/11/96	0.116
2		0.445
3		0.189
1	02/12/96	5.53
2		4.44
3		4.62
1	30/01/97	3.62
2		2.38
3		2.31
1	04/03/97	1.74
2		13.38 *
3		2.40
1	01/04/97	1.39
2		1.81
3		3.45
1	29/04/97	1.15
2		1.69
3		2.46
1	02/06/97	1.56
2		1.73
3		4.04
1	30/07/97	2.06
2		1.09
3		3.68
1	02/08/97	0.67
2		0.74
3		2.11
1	02/09/97	0.69
2		0.74
3		1.06

Note *1 g/m^2/month - grams per square metre per month (1996 to 1997).*
** Suspect result.*

To predict dust dry deposition concentrations, the ISC model requires additional information in the MET data file. In addition to hourly data for a complete year on wind direction, speed, temperature, stability class, rural and urban mixing height, three other factors are required. These are friction velocity, Monin-obhikov length and surface roughness. It is difficult to accurately input statistical data for these variables. To obtain dry dust deposition predictions these variables have been input from an existing MET file.

The deposition values predicted from the current quarrying operations can be compared against the measured results, *Table* 3.2.

Table 3.2 COMPARISON OF DUST MONITORING SITES MEASUREMENTS VERSUS PREDICTED CONCENTRATIONS

Dust Monitoring Site	Measured Range (g/m^2/month)	Average (g/m^2/month)	Predicted Concentration (g/m^2/month)
1	0.116 - 5.53	1.90	0.94
2	0.445 - 4.44 (13.38) *	1.76	2.47
3	0.189 - 4.62	2.62	0.65

Note: * *Suspect result, averages calculated excluding 13.38 value.*

The predicted concentrations fall within the measured range of monitored dust levels. Drilling and blasting have not been included as sources in the modelling of dust deposition due to their episodic impacts. However even without these episodic impacts the predicted concentrations correlate to an acceptable level.

Chapter 4

DUST EMISSIONS

4.1 INTRODUCTION

Quarry operations generate dust from many sources. Initially sediment controls are implemented and then the area is cleared of vegetation. Next drilling and blasting takes place. This involves the drilling of a series of holes in a grid format to a depth dependant on the planned quarry face, in this instance either 13 or 16 m. Explosives are then placed down the holes. The holes are then capped with stemming, which at the time of the blast, results in the soil being ruptured and up-lifted minimising the dust emission significantly.

Drilling and in particular blasting has the greatest potential for dust emissions. A number of mitigation measures such as capping, not blasting during adverse wind speed and wind direction need to be considered during each blasting episode. Although the potential dust emissions from blasting are significant, appropriate measures can significantly reduce the impact. In addition drilling and blasting is an episodic emission which occurs approximately monthly at the quarry. The object of blasting is to open seams which are suitable for front-end loaders and excavators to access. As a dust control measure the shot rock is well watered down prior to loading and CSR guidelines for blasting are followed. The shot rock is loaded into dump trucks and transported to the processing plant.

The material is transported by dump truck to the crushing and screening plant where it is crushed and sorted according to size. After crushing and screening the product is stockpiled using front-end loaders, or dependant on the market, goes to the pre-coating or asphalt batching plants.

Dust sources include dust from construction of access roads, land clearing, drilling, blasting, loading and unloading, transport, crushing and screening, wind erosion from stockpiles and dumps. Each operation can produce dust in varying amounts projecting it into the air at different heights and falling at different distances from the source. For example truck movement generates small amounts of dust at low levels while uncontrolled blasting can project dust high into the atmosphere and dust particle size can vary depending on the blast size.

4.2 DUST EMISSIONS RATES

The amount of dust generated has been calculated by applying emission factors for the various processes. Emission factors have been obtained from published data by the former State Pollution Control Commission of New South Wales (SPCC), now the NSW EPA.

Emission factors for activities not listed in the SPCC report were taken from United States Environment Protection Agency (USEPA) studies. A list of individual quarrying activities, emission factors and data sources used in assessments are presented in *Table 4.1*.

Table 4.1 EMISSION RATES

Activity	Emission Rate	Reference
Overburden removal		
Excavator/Shovel	0.025 kg/t	SPCC et al (1988)
Dozer	5.1 kg/hr	USEPA (1988)
Drilling	0.6 kg/hole	SPCC (1983)
Blasting	550-4,334 kg/blast	SPCC (1983) modified
Quarrying		
Excavator/FEL	0.025 kg/t	SPCC et al (1988)
Dozers/Rubber tyred Dozers	3.1 kg/hr	USEPA (1988)
Rehabilitation		
Dumping	0.012 kg/t	SPCC et al(1988)
Dozer	5.1 kg/hr	USEPA (1988)
Haulage		
Overburden	2 kg/vkt	SPCC et al(1988)
Extraction	2 kg/vkt	SPCC et al(1988)
Wind Erosion		
Extraction	0.4 kg/ha/hr	SPCC (1983)
Overburden	0.4 kg/ha/hr	SPCC (1983)
Pre-Strip	0.4 kg/ha/hr	SPCC (1983)

Notes:

kg	*kilogram*	*vkt*	*vehicle kilometre travelled*
hr	*hour*	*km*	*kilometre*
ha	*hectares*	*t*	*tonne*
m3	*cubic metre*	*FEL*	*Front End Loaders*

4.3 DUST PARTICLE SIZE

PM_{10} emissions were estimated by adding the fine particles (FP) and a percentage of the inhalable particles (IP) fraction based on distributions provided by the USEPA.

A list of individual quarrying activities and the associated particle size distribution are presented in *Table 4.2.*

Table 4.2 PARTICLE SIZE DISTRIBUTION

Plant/Activity	FP (%)	IP (%)	CP (%)	Reference
Excavator/Shovel/FEL	7.0	50.0	43.0	Dames & Moore (1986)
Dozer/Rubber tyred	19.6	54.0	26.4	USEPA (1981)
Dumping	4.0	44.0	52.0	Dames & Moore (1986)
Conveyor	4.0	44.0	52.0	Dames & Moore (1986)
Dozer	19.6	54.0	26.4	USEPA (1981)
Haulage	6.0	53.0	41.0	Dames & Moore (1986)
Overburden - Wind Erosion	3.5	67.0	29.5	Dames & Moore (1986)

Notes:

FP *fine particles (0 to 2.5 microns)*

IP *Inhalable particles (2.5 to 15.0 microns)*

CP *Coarse particles (15 to 30.0 microns)*

Emissions were entered into the model as open pit and area sources. These sources were located at worst case locations as well as being representative of current quarrying operations. Consideration was also given to sources located on the pit floor and at elevations below the normal ground level.

Activities in the quarry that generate dust include:

- wind erosion;
- stockpile wind erosion;
- drilling;
- blasting;
- excavator during truck loading;
- haulage;

- dumping;
- crushing and screening;
- exhaust from vehicles;
- conveyor transfer points; and
- product stockpiling and loading with front-end loaders.

4.4 DUST EMISSION ESTIMATES

4.4.1 Wind Erosion

The annual average dust emission for exposed areas is 0.4 kg/ha/hr (SPCC 1983). Application of this annual average for all wind-speeds would overestimate emissions depending on the number of days when wind-speed was less than 5m/s. Examination of the wind roses concluded that in fact only 15% of wind speeds were above 5.4m/s.

Good quarry practice ensures that once exposed faces are no longer needed they are to be rehabilitated as quickly as possible, therefore the area within the quarry which has been cleared and exposed, but not rehabilitated, will be kept to a minimum.

Currently the maximum output of the quarry is 150,000 tonnes per annum. Based upon the maximum area exposed of 1.5 ha (Wilkinson-Murray 1986) for production of 50,000 tonnes per annum it has been calculated that the required face exposed to achieve the current output would be 4.5 ha. For the proposed increase in output to 250,000 tonnes per annum (Stages 1 - 4) the exposed face has been calculated at 7.5 ha.

The emissions for wind erosion have been modelled as an open-pit source. Based on this information we estimate that the current facility emissions for wind erosion is 15,768 kg/yr and emissions for each of the proposed Stages 1-4 are 26,280 kg/yr.

4.4.2 Stockpile Wind Erosion

The emission factor for stockpile erosion is the same as that for wind erosion (0.4 kg/ha/hr (SPCC 1983). It has been estimated that the current operations maximum required stockpile area is 0.648 ha (approximately 30m by 70m by 3m high). For Stages 1-4 this value has been calculated to be 1.08 ha (a ratio of 150,000:250,000 calculated from output (tpa)). It is proposed that the stockpiles will be sprayed with water from the water cart. This dust management procedure has not been included in calculating the emission factor so as to remain a conservative (overestimation) assessment.

The emissions for stockpile wind erosion have been modelled as an area source located 3m above ground level. Based on this information it is estimated that the current facility emissions for wind erosion is 2,700 kg/yr and emissions for each of the proposed Stages 1-4 are 3784 kg/yr.

4.4.3 Dump Truck Loading

Loading of trucks by excavator and front-end loader generates 0.025 kg dust per tonne (SPCC et al 1988). The following have been based on 150,000 tpa for current operations and 250,000 tpa for each proposed stage operations. The emissions resulting from excavation have been modelled as an open-pit source. Based on this information we estimate that the current facility emission for excavation is 3,750 kg/yr and emissions for each of the proposed Stages 1-4 are 6,250 kg/yr.

4.4.4 Haulage

Off-highway dump trucks raise dust at the rate of 2 kg per vehicle kilometre travelled (vkt) on roads with normal dust control measures (SPCC et al 1988). For roads watered frequently the emission rate can be reduced to 1 kg/vkt (Shearer, Dougherty and Easterbrook, 1981). For modelling of haulage emissions the value of 2 kg /vkt was used. Haulage has been modelled as two distinct components.

The first is the haul road, which winds its way from the base of the pit to the top. This distance was calculated using the haul road gradient, 1 in 10, and has been modelled as an open-pit source. The second component consisted of the haul road from the top of the pit to the dumping area near the crushing and screening plant and has been modelled as an area source. It was estimated that this distance, including a return trip and manoeuvring of the vehicle to be in the correct dumping position, would be no further than 300 m.

The haulage during this operation is performed by the Caterpillar articulated dump truck D30D (30 tonne capacity). The current output of 150,000 tpa equates to 5,000 trips per year. The proposed output of 250,000 tpa equates to 8,334 trips per year. Based on this information we estimate that the current facility emission for haulage (ie including the haul road from within the pit as well as from the top of the pit to the crushing and screening plant) is 11,400 kg/yr. Total emission for Stage 1 is 19,000 kg/yr, for Stage 3 is 24,000 kg/yr and Stage 4 is 29,000 kg/yr.

4.4.5 *Dumping*

The process of dumping generates dust at the rate of 0.012 kg/t (SPCC et al 1988). The current facility has been calculated based on 150,000 tpa while the proposed Stages 1 - 4 have been based on 250,000 tpa. This emission source has been modelled as an area source with release height of 1.5m. Based on this information we estimate that the current facility emissions for dumping are 1,800 kg/yr and emissions for each of the proposed Stages 1-4 are 3,000 kg/yr.

4.4.6 *Crushing*

Dust generated from crushing depends on the extent of crushing (primary, secondary or tertiary), the moisture content and the dust mitigation measures applied to the process. The crushing and screening plant is equipped with two (2) DCE Vokes dust extraction units in addition to the Hosokawa Mikropul dust extraction unit. The plant also has misting sprays at the primary boot and product discharge points. All screens have dust covers and are sealed. As long as the mist sprays, in particular, are maintained to good working order the emissions from the crushing and screening plant are spasmodic and are typically low concentration in nature. Due to the mitigation equipment installed it is considered that the dust generated by the crushing and screening plant is insignificant under normal conditions, and therefore these emissions were incorporated into the conveyor emissions for the model.

4.4.7 *Exhaust From Vehicles*

Off-highway diesel trucks generate particulate emissions at a rate of 0.12 kg/hr (US EPA, 1995). The current operation runs for ten (10) hours a day five (5) days a week, and uses a sole Caterpillar articulated dump truck (D30D) to transport wastes. For the proposed Stages 1 -4 it is assumed two Caterpillar articulated dump trucks (D30D) will be operating and the operation hours are five (5) twelve (12) hour days a week and one (1) seven (7) hour day (Saturday 6.00 am - 1.00 pm) for fifty-two (52) weeks in a year.

These sources were modelled as both an open-pit and area source, by splitting the emissions and adding these to the haulage and haul road emissions. Based on this information the current facilities dust emissions from exhausts are 312 kg/yr, while emissions for each of the proposed Stages 1-4 are 418 kg/yr.

4.4.8 *Conveyor Transfer Points*

The emission rate for conveyor transfer points is 0.006 kg/t (NSW EPA). It has been assumed that all of the 150,000 tonnes (for the current operation), and all 250,000 tonnes (proposed operation) travels via the conveyor to transfer points. This emission has been modelled as an area source, released at a height of 1.5m. Based on this information the current facilities emissions are 900 kg/yr, while emissions for each of the proposed Stages 1-4 are 1,500 kg/yr.

4.4.9 *Product Handling*

Product handling is undertaken using front-end loaders and includes stockpiling and loading sales trucks. Dust generated from the action of front-end loaders is at a rate of 0.025 kg/hr (SPCC et al 1988). For the current operation it has been assumed that two front-end loaders are active for ten (10) hours per day, five (5) days a week. For the proposed operation it has been assumed that two front-end loaders are active for twelve (12) hours per day, five (5) days a week, with seven (7) hours of operation on a Saturday. These emissions are being modelled as an area source. Based on this information the current facilities emissions are 7,500 kg/yr, while emissions for each of the proposed Stages 1-4 are 12,500 kg/yr.

4.5 EPISODIC IMPACTS; DRILLING AND BLASTING

Drilling and blasting have the potential to cause significant impacts on the neighbouring areas. Their episodic nature allows this impact to be avoided. Drilling usually occurs over a period of two to five days, as a precursor to blasting. Three different blast designs have been proposed based on different geology (eg. solid or weathered rock) as well as for different bench heights, either 12 or 15 metres (Brodbeck, 1999). In terms of the different blast designs they differ in number of blast holes (41 - 54), blast hole depth (13 m - 16 m) and spacing between blast holes (3.7 - 4.1m). These figures are based on an approximate blast size of 20,000 tonnes and a calculated with a rock density of 2.6 g/cc. These blast designs are typical only and the particular blast design will be determined to achieve the optimum result based upon local geology and achievement of blast overpressure and ground vibration EPA criteria.

Based on 20,000 tonnes per blast, there would be an average twelve (12) drilling episodes per year (ie. monthly), each of which last for two to five days. The current blast design typically involves drilling 900 holes per year (75 per episode), while the highest number of holes that all proposed stages (1-4) will drill are, 648 per year (54 per episode).

In accordance with the proposed drilling design, blasting will occur on average monthly, however blasting occurs on one day per episode. For each blasting episode capping (stemming) is placed over blast holes to minimise dust and to maximise blast success. The capping is used to ensure that the pressure generated from the blast will be forced down the hole, opening seams for extraction.

The holes drilled for the blast are often drilled in rows of three or four, roughly the width of the desired bench. Drill rigs are fitted with dust extractors. During blasting these rows are detonated separately, but in rapid succession. The main emissions generated from these activities are emitted during this 1 - 3 second interval. Dust emanates from the entire area of the blast, averaging 400 m^2.

Due to the episodic nature of these impacts, their short, infrequent nature and the standard implementation of dust mitigation measures such as adequate stemming and not drilling and blasting in adverse weather conditions, dust generated during drilling and blasting is assumed to be insignificant for dispersion modelling which is run for a minimum period of 365 days. Therefore, drilling and blasting has not been included as a source in the model.

4.5.1 Asphalt Plant

It is proposed that a mobile asphalt plant capable of producing around 100 tonnes an hour will be located on-site on an as needed basis. An area 100 m by 50 m will be allocated south-west of the existing weighbridge and site office to accommodate this plant.

In the asphalt making process the aggregates are fed into the plant. After screening they pass through the drier to reduce moisture. Individual sized aggregates, together with filler are mixed with hot bitumen to form asphalt, which is then transported by truck to the required site.

The loading of aggregates will be undertaken by the front-end loaders used for product stockpiling and whose dust emissions are accounted for in Section 4.4.9. The asphalt plant has one stack fitted with a wet scrubber to reduce odour and dust emissions. It is expected that emissions will be minimal and stack height release high enough to reduce ground level effects.

4.5.2 Pugmill

It is proposed that a mobile pugmill be added to the facility to mix lime or cement (stored in filler silos) and aggregate together which is then loaded into trucks for delivery. Loading for this process will be undertaken using the product stockpile front-end loaders. Usage of the pugmill will be based on market demand. It is anticipated that the market volume required will be minor. As such, there are no expected additional dust or odour emissions of considerable consequence and the pugmill has not been considered in the model.

4.5.3 Summary

A summary of dust emissions for area and open-pit sources to be used in the ISC model is given in *Table 4.3* and *Table 4.4* respectively.

Table 4.3 SUMMARY OF INPUT EMISSIONS (AREA SOURCES)

Source /Quarry Stage	Emission (kg/yr)	Emission (g/s/m^2) TSP	Emission (g/s/m^2) PM_{10}
Dumping			
Current	1,800	0.002	0.001
Stages 1 -4	3,000	0.001	0.0005
Haul road			
Current	3,081	0.0003	0.0002
Stages 1 - 4	5,109	0.0004	0.0002
Conveyor			
Current	900	0.002	0.001
Stages 1 -4	1,500	0.002	0.001
Product handling			
Current	7,500	0.0003	0.0002
Stages 1 -4	12,500	0.0002	0.0001
Stockpiles			
Current	2,700	3.4E-5	2.4E-5
Stages 1 - 4	3784.3	2.9E-5	2.0E-5

Table 4.4 SUMMARY OF INPUT EMISSIONS (OPEN-PIT SOURCES)

Source /Quarry Stage	Emission (kg/yr)	Emission (g/s/m²) TSP	Emission (g/s/m²) PM_{10}
Wind erosion			
Current	15,768	9.4E-7	6.6E-7
Stage 1	26,280	2.9E-7	2.0E-7
Stage 3	26,280	1.2E-7	8.5E-8
Stage 4	26,280	1.0E-7	7.1E-7
Loading			
Current	3,750	7.5E-7	4.2E-7
Stage 1	6,250	1.7E-7	1.0E-7
Stage 3	6,250	7.3E-8	4.2E-8
Stage 4	6,250	6.0E-8	3.4E-8
Haulage			
Current	8,631	1.7E-6	1.0E-6
Stage 1	14,310	3.9E-7	2.3E-7
Stage 3	19,311	2.3E-7	1.4E-7
Stage 4	24,311	2.3E-7	1.4E-7