Boral Resources (NSW) Pty Limited

ABN: 51 000 756 507

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

(Accompanying the Environmental Impact Statement)

Compiled by:

R. W. CORKERY & CO. PTY. LIMITED

Boral Resources (NSW) Pty Limited

ABN: 51 000 756 507

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Specialist Consultant Studies Compendium

(Accompanying the Environmental Impact Statement)

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Part 3 **Traffic Assessment**
Transport and Urban Planning

Part 4 **Flora and Fauna Assessment**
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PART 1: NOISE ASSESSMENT

Prepared by

Richard Heggie Associates Pty Ltd

November, 2003

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PART 1: NOISE ASSESSMENT

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EXECUTIVE SUMMARY

This report presents the results and findings of a detailed noise and blasting assessment for the continued operation of Dunmore Quarry, near Kiama, NSW.

ANALYSIS OF POTENTIAL NOISE IMPACTS

E.1 OPERATIONAL NOISE ISSUES

In order to determine the noise impact of Dunmore Quarry on surrounding residential receivers the site was computer modelled. Quarrying noise emissions, within the proposed hours of operation, for the existing and proposed quarry production levels under calm weather conditions, are predicted to comply with all project specific noise levels at all residential locations for daytime, evening, night and morning shoulder periods.

Predicted noise levels for the operation of Dunmore Quarry during the evenings in autumn and winter, under adverse winds, will comply with the project specific noise levels at all locations with the exception of Location K (Stocker) where a minor exceedance of 1 dBA may occur for the proposed operating situation.

Measurements of noise levels during shutdown periods, associated with wind switch activation, have established that a reduction of 2 to 3 dB(A) is possible as a result of implementing this control measure. An increase in noise to a level of 46 dB(A) may occur at Location K (Stocker) for short periods prior to activation of the wind switch.

Predicted noise levels for the operation of Dunmore Quarry during the nights in autumn and winter, under adverse winds and temperature inversion conditions, will comply with the project specific noise levels at all locations.

Predicted noise levels for the operation of Dunmore Quarry during the morning shoulder period in autumn and winter, under adverse winds and temperature inversion conditions, will comply with the project specific noise levels at all locations for the existing and proposed quarry production rates.

The cumulative impact of the Dunmore Quarry operation, Dunmore Sand and Soil's Dunmore Lakes Stage 2 and Stage 3 proposal and Dunmore concrete batching plant will comply with the appropriate amenity noise goals.

E.2 SLEEP DISTURBANCE

The predicted sleep disturbance levels for the existing and proposed quarry production levels indicate that Dunmore Quarry will meet the sleep disturbance criterion at night.

During the morning shoulder period the operation of Dunmore Quarry generally complies with the proposed sleep disturbance goals. However, to reduce the likelihood of quarry operational noise causing awakening reactions in this period, it is recommended that a programme of noise reduction measures be implemented. A description of the proposed noise reduction measures are given in **Table E.2.1**.

TABLE E.2.1

Noise Reduction measures Sleep Disturbance

Description of Process	Noise Reduction Measure
Loading raw material by haul truck into empty boot bin	Ensure boot bin is left full prior to the morning start-up
Oversized rock in primary crusher	Avoid, where possible, oversized raw feed between 6.00 am and 7.00 am
Rock impact noise on chutes below No.1 screen	Redesign and provide noise damping on chutes on No.1 screen
Loading of finished product into empty rail wagons and truck bodies	Designate an early morning loading area close to the existing stockpile bunds to shield loading process

E.3 NOISE MITIGATION AND MANAGEMENT

In order to reduce the noise impact on residential receivers surrounding Dunmore Quarry, Best Environmental Practice together with Best Achievable Technology have been considered and incorporated into the noise mitigation strategy for the quarry. The mitigation strategy includes:

- Construction of a 4 m high acoustic bund adjacent to residence K (Stocker).
- Construction of an acoustic bund on the south-western corner of the Croome Farm development to shield Location A (McParland) from noise from quarrying activity. The construction of this bund is ongoing.
- The construction of an acoustic wall (at RL 7 m) adjacent to the stockpile area and rail loading area.
- The cladding of Screen 1. The cladding has been constructed on the southern and eastern side and includes a solid floor at screen level. Chutes below screen level have been shielded on the southern and eastern sides.
- Drilling would be conducted between 6.00am and 10.00pm, however, for the evening period, between 6.00pm and 10.00pm, drilling would be confined to the second bench level or lower.
- Boral has a negotiated agreement with the landholder of Location J (Creagan), Locations L and N (Dunmore Sand and Soil) acknowledging/accepting exceedances to EPA noise goals. Readymix has verbally advised it would be prepared to complete a similar negotiated agreement for Location M.

Noise Management Strategy for Evening Operation
In order to further reduce the impact of operation of Dunmore Quarry in periods of adverse weather conditions (wind from the west) in the evening period Best Management Practice strategies are currently being employed:

- Wind speed and direction is monitored using a weather station located at the quarry. The recently installed weather station has a sensor height of 10 m. The weather station is linked to the quarry primary feeder. When wind speeds between 2 m/s and 3 m/s are detected from the westerly sector the primary feeder is automatically shut down. The weather station monitors average winds speeds over a 30 minute period from the west ±45^{o} to determine the activation of an automatic shutdown.

This means that the primary jaw crusher, gyratory crusher, and primary screen ceases operation. This results in the ceasing of extraction operations including loading and transporting of primary feed to the plant. It should be noted that the secondary/tertiary section of the plant continues to operate from a surge pile of primary crushed material. Stockpiling and sales also operates as normal. Measurements of noise levels during shutdown periods, associated with wind switch activation, have established that a reduction of 2 to 3 dB(A) is possible as a result of implementing this control measure.

Noise Management Strategy for Night Period
In order to reduce the impact of operation of Dunmore Quarry night period it is recommended that the following management strategies be employed:

- All processing and extraction will cease at 10.00 pm.
- Sales activity, which includes hauling of finished product from processing plant bins to stockpile (10.00 pm to midnight) and loading delivery vehicles and trains, should continue from 10.00 pm to 7.00 am

During periods when temperature inversions are likely or westerly wind of between 2 m/s and 3 m/s are measured the quarry operation should:

- Employ one front end loader only to load materials for sale.

In addition to these strategies, the following specific safeguards would also be implemented.

- Ensure the primary crusher receival bin would be left full prior to the morning start-up.
- Avoid, where possible, oversized raw feed would be avoided between 6.00am and 7.00am.
- Redesign and provide noise damping would be installed on chutes on No. 1 screen.
- Designate an early morning loading area would be designated close to the existing stockpile bunds to shield the loading process.
- New silencers for haul trucks are being evaluated (one has been installed).

Boral also intends to investigate the following.

- Further cladding of plant components.
- Investigate the use of flashing lights connected to headlights of mobile equipment – to avoid the use of reversing alarms at night.
- The replacement of the single large start-up siren with a series of smaller localised sirens.

E.5 TRANSPORT NOISE ISSUES

Road Traffic Impact

Predictions of road traffic noise from the Princes Highway indicate that the proposed increase in heavy vehicle movements from Dunmore Quarry along the Princes Highway for the increase in production levels will be maintained within 2 dBA of the existing traffic noise levels during daytime and night-time periods.

The predicted noise levels indicate that the proposed Dunmore Quarry road traffic movements are estimated to increase the current Princess Highway contributed traffic noise level by up to 0.6 dBA. The LAmax noise level from existing heavy vehicle movements would remain unchanged.

Rail Traffic Impact

The noise from trains entering, leaving and being loaded at Dunmore Quarry has been considered in noise predictions for the current and proposed operation during the day, evening and night periods.

On leaving the project site and entering the rail corridor noise from Dunmore Quarry rail movements would need to comply with the Rail Infrastructure Corporation licence conditions for the rail network to Sydney. The noise licence conditions applicable to this situation state that *"the licensee is required to work towards the goal of 60 dB(A)Leq, (24hr) and 85 dB(A) max pass-by noise, (24hr) at one metre from the facade of the nearest affected residential property".*

Giving consideration to the fact that the proposed Dunmore Quarry train despatches will not result in any additional rail movements (just trains of greater length) it is envisaged that the change in noise level, when compared to that for the existing rail movements on the line, would be insignificant.

E.6 USE OF EXPLOSIVES

There will be no additional blasting impacts as a result of this proposal. However, the frequency of blasting will increase from an average of 36 times per annum to approximately 72 times per annum. Blasting will be carried out within the hours of 9.00 am to 5.00 pm Mondays to Saturdays as is current practice.

The blast predictions demonstrate that airblast and ground vibration levels will meet the EPA and ANZECC guidelines for proposed blasting at all residential locations surrounding the development with appropriate MIC limits in place.

1 INTRODUCTION

Richard Heggie Associates has been commissioned to conduct a noise and blasting impact assessment for the continued operation of Dunmore Quarry near Kiama NSW (see Figure 1, **Appendix A**). The quarry is owned and operated by Boral Resources (NSW) Pty Ltd (Boral).

Boral is seeking a single Development Consent that will provide for increased hours of operation and increased production. A single consent would also overcome some inconsistencies that are currently in place arising from the present consent conditions and existing use rights.

Broadly, the objectives of the noise and blasting assessment are to identify the potential impacts of noise from quarrying, processing and transportation at the Dunmore Quarry during the proposed extension to operating hours. The cumulative impacts of the operation of Dunmore Quarry in conjunction with other proposed extractive and associated operations are also addressed.

The noise impact assessment will form part of a Environmental Impact Statement (EIS) for Dunmore Quarry, which will seek approval to:

- increase the extraction rate from 1.2 million tonnes per annum in 2003 up to 2.5 million tonnes per annum by 2005; and
- consolidate and modify hours of operation for extraction, processing, maintenance and sales of finished product to meet demand quarry materials

The noise assessment has been prepared in accordance with Australian Standard AS 1055-1997 “Description and Measurement of Environmental Noise” Part 1, 2 and 3 and generally in accordance with the EPA’s Industrial Noise Policy and Environmental Noise Control Manual.

2 DESCRIPTION OF PROPOSED PROJECT

2.1 Existing Quarry Operation

Two major extensions of Dunmore Quarry took place in 1986 and 1994 for extraction within an area owned by the then NSW State Rail Authority and the Croome Farm area respectively. Both Development Applications, with accompanying EIS’s, were lodged with Shellharbour City Council and conditionally approved. The current proposal seeks only to increase the hours of operation and production level at the quarry and not to expand the area approved by Council in 1986 and 1994 for extraction of rock. Therefore, any general data of impact on the surrounding areas was addressed in the EIS accompanying the development application at the time.

2.1.1 Current Consent Conditions

Original Dunmore Quarry

Shellharbour City Council has acknowledged that the original Dunmore Quarry has existing use rights in which hours of operation, sales, maintenance and volumes are not limited.

RSA (Rail Infrastructure Corporation – RIC) Development Consent 86/161

Boral has consent to extract approximately 10 million tonnes of latite at a rate of 450,000 tonnes per annum. The hours of operation for activities undertaken in the RIC extraction area are as follows:

Extraction	6.00 am to 4.00 pm	Mondays to Fridays
	6.00 am to noon	Saturdays
Maintenance	2.30 pm to 10.30 pm	Mondays to Fridays
	noon to 4.00 pm	Saturdays

There are no restrictions for sales and processing hours and there are no limits on the amount of aggregates to be hauled by road.

Croome Farm – Development Consent 94/168

Boral has consent to extract 15 million tonnes at a rate of 750,000 tonnes per annum. The operation hours are as follows:

Extraction	6.00 am to 6.00 pm	Monday to Saturday
Processing	6.00 am to 6.00 pm	Monday to Saturday
Maintenance	4.00 pm to midnight	Monday to Friday
	6.00 am to 6.00 pm	Saturday
Sales	5.00 am to midnight	Monday to Saturday

(max 15 trucks per hour from 5.00 am to 6.00 am and from 6.00 pm to 10.00 pm)
(max 10 trucks per hour from 10.00 pm to midnight.

Screen House – Development Consent DA93/71

Operation hours (processing) 6.00 am to 6.00 pm

On 13 March 2003, Shellharbour City Council modified of the above Development Consents to allow Boral to uniformly increase the hours of operation at the quarry for a 9 month trial period. The approved hours of operation for the trial period area as follows:

Extraction	6.00 am to 10.00 pm	Monday to Saturday
Processing	6.00 am to 10.00 pm	Monday to Saturday
Sales	5.00 am to midnight	Monday to Saturday
Maintenance	Mondays to Fridays	4.00 pm to midnight
	Saturdays	6.00 am to 6.00 pm

2.2 Proposed Quarry Operation

Rate of Extraction
Boral proposes to increase the volumes of material extracted from Dunmore Quarry to meet the projected demands for quarry products. It is proposed that the new hours of operation of the project site will allow extraction to be carried out at the rates contained in **Table 2.2.1**.

TABLE 2.2.1

Proposed Extraction Rates

Year	Maximum Extraction Rate
2003 to 2004	2.2 million tonnes per annum
2004 to 2005	2.5 million tonnes per annum

Hours of Operation
In order to consolidate the existing hours of operation to create a single set of rules for the entire quarry area and meet the projected increase in demand for quarry products Boral proposes the following hours of operation:

Extraction	Monday to Saturday	6.00 am to 10.00 pm
Processing	Monday to Saturday	6.00 am to 10.00 pm
Maintenance	Monday to Sunday	24 hrs per day
Sales	Monday to Saturday	24 hrs per day
	Sunday	6.00 am to 10.00 pm

The above hours of operation for extraction and processing are the same as those that are currently adopted for the trial period.

2.3 Plant and Equipment

Acoustically significant items of plant and equipment were measured at Dunmore Quarry. The LAeq sound power levels of this plant and equipment were determined from these measurements and are given in **Table 2.4.1** for the existing operation and **Table 2.4.2** for the proposed operational increase to 2.5 million tonnes. Sound power levels of other plant and equipment, not able to be measured on-site, were obtained from an RHA database of similar equipment. The details of the octave band levels recorded are given in **Appendix B.**

The acoustically significant changes to the fixed plant and equipment are as follows.

- The Barmac crusher in the Primary/Secondary area will be upgraded.
- The 2 x HP400 secondary crushers will be replaced with 2 x HP500's.
- The HP500's will discharge onto two new screens. (1.8m x 4.8m x 22kw)

It is noted that the new crushers and screens will be fully enclosed in the enlarged tertiary crusher building.

TABLE 2.4.1

Equipment Sound Power Levels Existing Operation

Equipment		Sound Power Levels dB(A)
Existing Mobile Plant		
Front end loader Cat 992		118
Front end loader Cat 988		112
Front end loader WA600		110
Haul trucks Cat 773	3 off	118
Haul truck 775	1 off	119
Stockpiling Trucks Cat 773	1 off	118
Water Cart Cat 773	1 off	118
Hydraulic rock drill*		118
Excavator with hydraulic hammer*		126
Excavator*		111
Grader*		113
Dozer D8*		110
Delivery trucks as required		108
Train		105
Existing Fixed Plant		
Primary crusher		118
Primary gyratory crusher		117
Primary screen		129
Barmac		108
Secondary /tertiary crushers (2off)		119
Tertiary Screen house		108

* Items of equipment currently used intermittently are as follows.

Hydraulic rock drill 6.00 am to 6.00 pm 15 days per month
Excavator with hydraulic hammer 7.00 am to 6.00 pm 5 days per month
Excavator 6.00 am to 6.00 pm 1 day per month
Grader 6.00 am to 6.00 pm 3 days per month
Dozer 6.00 am to 6.00 pm 2 days per month

TABLE 2.4.2

Equipment Sound Power Levels Proposed Operation

Equipment		Sound Power Levels dB(A)
Proposed Mobile Plant		
Front end loader Cat 992		118
Front end loader Cat 988		112
Front end loader WA600		110
Haul trucks Cat 773	4 off	118
Haul truck 775	1 off	119
Stockpiling Trucks Cat 773	1 off	118
Water Cart Cat 773	1 off	118
Hydraulic rock drill*		118
Excavator with hydraulic hammer*		126
Excavator*		107
Grader*		113
Dozer D8*		110
Delivery trucks as required		108
Train		105
Proposed Fixed Plant		
Primary crusher		118
Primary gyratory crusher		117
Primary screen		129
Barmac		110
Secondary /tertiary crushers (2off)		119
Secondary screens (2off)		112
Tertiary Screen house		108

* Items of equipment that will be used intermittently as follows:
Hydraulic rock drill 6.00 am to 6.00 pm 25 days per month
Excavator with hydraulic hammer 7.00 am to 6.00 pm 8 days per month
Excavator 6.00 am to 6.00 pm 2 days per month
Grader 6.00 am to 6.00 pm 6 days per month
Dozer 6.00 am to 6.00 pm 2 days per month

3 SITE DETAILS

Dunmore Quarry is located approximately 7 kilometres north of Kiama, to the west of the Princes Highway. Boral's Development Application relates to the land described in **Table 3.1**. This land is collectively referred to as the Project Site.

TABLE 3.1

Project Site Property Details

Description	Details
Original Dunmore Quarry	Lot 3, DP 1030504; Lot 1, DP 213575; Lot 4, DP 1030504.
Rail Infrastructure Corporation (currently RIC)	Lot 1, DP 1002951.
Croome Farm	Lots 1 & 2, DP 224597.
Other Land	Lot 4, DP 227046.
Parish of Terragong; County of Camden; Municipality Shellharbour The land is zoned 4 (c) Extractive Industrial as outlined in Shellharbour LEP 2000	

The topography of the area surrounding Dunmore Quarry is generally undulating with residences located on rural land holdings. Several of the properties surrounding the Dunmore Quarry site are owned by Boral and other quarry related companies.

Figure 2, contained within **Appendix A,** gives the location of surrounding residences in the general area. **Table 3.2** contains a description of the closest surrounding residences.

TABLE 3.2

Surrounding Residential Locations

Assigned Residential Location	Proprietor/Tenant	Description
A	Privately owned	off Croome Lane
B	Privately owned	off Croome Lane
C	Privately owned	off Croome Lane
D	Privately owned	off Croome Road
E	Boral	off Croome Road
F	Privately owned	off Croome Road
G	Privately owned	off Croome Road
H	Boral	Rocklow Road
I	Boral	Rocklow Road
J	Privately owned	Swamp Road
K	Privately owned	Swamp Road
L	Dunmore Sand and Soil (Quarrying company owned)	off James Road
M	Readymix (Quarrying company owned)	off James Road
N	Dunmore Sand and Soil (Quarrying company owned)	James Road
O	Dunmore Lakes Estate	Fuller Drive

It is noted that Boral currently has a negotiated agreement with Mrs J Creagan (Location J), Dunmore Sand & Soil Pty Ltd (Locations L & N) which allows exceedances to the noise goals relevant to other residences. Readymix has verbally advised it would be prepared to complete a similar negotiated agreement for Location M.

4 IMPACT ASSESSMENT PROCEDURES

4.1 General Objectives For Noise Impact At Residential Receivers

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the EPA. The EPA released an Industrial Noise Policy (INP) in January 2000 that provides a framework and process for deriving noise criteria for consents and licences that will enable the EPA to regulate premises that are scheduled under the Protection of the Environment Operations Act, 1997.

The specific policy objectives are:

- to establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses;
- to use the criteria as the basis for deriving project specific noise levels;
- to promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;
- to outline a range of mitigation measures that could be used to minimise noise impacts;
- to provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and
- to carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the Act;

Assessing Intrusiveness
For assessing intrusiveness, the background noise needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (LAeq) of the source should not be more than 5 decibels above the measured background level (LA90).

Assessing Amenity
The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion. The cumulative effect of noise from industrial sources needs to be considered in assessing impact.

Sleep Disturbance
Sleep arousal has been assessed using the guidelines set out in the EPA's Environmental Noise Control Manual (1994) (ENCM) Section 19-3.

Road Traffic Noise
The Environment Protection Authority released the "Environmental Criteria for Road Traffic Noise" in May 1999.

The policy sets out noise criteria applicable to different road classifications for the purpose of defining traffic noise impacts.

5 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

5.1 Ambient Noise Survey

The objective of the ambient monitoring survey was to measure LA90(15minute) and LAeq(15minute) noise levels at the nearest potentially affected receptors during daytime, evening and night-time periods to enable the determination of the intrusiveness and amenity criteria for the development.

Ambient noise levels were monitored at four locations, given in **Table 5.1.1** adjacent to the Dunmore Quarry site, during October 2001 and July 1999. These background noise measurements have been supplemented with recent measurements conducted during a pre-trial and trial period from April to September 2003. **Figure 2** shows each noise monitoring location (**Appendix A)**. Operator-attended noise measurements were also taken in order to determine the character and contribution of noise sources to the total ambient noise level.

TABLE 5.1.1

Ambient Noise Monitoring Locations

Noise Monitoring Location	Description
A	McParland Residence
J	Cregan Residence, Swamp Road
K	Stocker Residence, Swamp Road
N	Dunmore Sand and Soil Residence, James Road (Quarrying company owned)

Unattended Continuous Monitoring

ARL Type EL215 environmental noise loggers were used to monitor the ambient noise levels at the residential locations given in **Table 5.1.1**. The noise loggers were programmed to record statistical noise level indices continuously in 15 minute intervals, including the LAmax, LA1, LA10, LA50, LA90, LA99, LAmin and the LAeq.

Weather data for the survey period was obtained from the weather station located at Dunmore Quarry. Noise data during periods of any rainfall and/or windspeeds in excess of 5 m/s (approximately 9 knots) were discarded in accordance with INP data exclusion rules. A summary of the results of the background surveys is given in **Table 5.1.2**. The ambient noise levels from each monitoring location are presented in graphical format in **Appendices C to F**.

TABLE 5.1.2

Summary of Existing Ambient Background Noise Levels

Location	Description		Background Noise Level L_{A90} dB(A) Rating Background Level	Estimated Contribution from Industrial Noise Sources L_{Aeq} dB(A)
Location A McParland Residence	**Daytime**	7 am to 6 pm	30	<44
	Evening	6 pm to 10 pm	30	<39
	Night	10 pm to 7 am	30	<34
	Shoulder	6 am to 7 am	30	<39
Location J Creagan Residence	**Daytime**	7 am to 6 pm	51	<44
	Evening	6 pm to 10 pm	47	<39
	Night	10 pm to 7 am	36	<34
	Shoulder	6 am to 7 am	49	<39
Location K Stocker Residence	**Daytime**	7 am to 6 pm	44	<44
	Evening	6 pm to 10 pm	39	<39
	Night	10 pm to 7 am	33	<34
	Shoulder	6 am to 7am	42	<39
Location N Dunmore Sand and Soil Residence (Quarrying Company owned)	**Daytime**	7 am to 6 pm	41	<44
	Evening	6 pm to 10 pm	38	<39
	Night	10 pm to 7 am	32	<34
	Shoulder	6 am to 7am	41	<39

Note: The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level.

L_{Aeq} - The equivalent continuous noise level is defined as the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

It should be noted that recent background noise levels recorded at Location K (Stocker) in the daytime and morning shoulder period are lower than those previously recorded at this residence. This is due to the location of the noise logger which was positioned (at the request of the landowner) to record quarry noise levels and is screened from other ambient sources (in particular traffic on the Princes Highway). To account for the shielding impact of the building 2 dBA has been added to the daytime and morning shoulder ambient results.

The early morning shoulder RBL levels have been calculated using actual measurements undertaken during the morning shoulder period. The EPA current preferred method to determine a morning shoulder RBL is to take the midpoint between the daytime and night-time period as it is claimed that the 10th percentile method does not give a statistically valid ABL level. In the Dunmore Quarry case, the current EPA approach under estimates the actual ambient noise level during this period. A conservative approach has been adopted in this report where the minimum LA90 level recorded in the morning shoulder period has been used as the ABL level instead of the 10 th percentile levels. An RBL using the modified ABL levels was then calculated.

Location A is the closest privately owned residence to the Croome Farm section of the Dunmore Quarry development. This location is remote from the Princes Highway and exhibits an ambient noise climate typical of a rural area. Locations J, K and N are more exposed to the

Princes Highway and the ambient noise is dominated by noise from traffic, with contributions from the Boral and Dunmore Lakes quarries. The acoustical environment (having through traffic with characteristic heavy and continuous traffic flows during peak periods) is best described by the urban category.

The estimated industrial contribution at each monitoring location was made in the absence of noise from the Boral Dunmore Quarry operation.

5.2 Effects of Meteorology on Predicted Noise Levels

Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the source of the noise. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration. When wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any period (day, evening, night) of any season, wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

Weather data was obtained, for the past 12 months, from a weather station located at the Albion Park Airport. The Albion Park weather station is located in the same topographical basin as, and in close proximity to, the subject site. This data was analysed to determine the frequency of occurrence of winds up to speeds of 3 m/s for daytime, evening and night in each season. The results of this analysis are contained within **Table 5.2.1**, **Table 5.2.2** and **Table 5.2.3**.

TABLE 5.2.1

Seasonal Frequency of Occurrence Wind Speed Intervals - Daytime

Period	Calm	Wind Direction	0.5 to 1.5 m/s	1.5 to 3 m/s	0.5 to 3 m/s
Summer	2.4%	WSW±45^{o}	0.3%	4.2%	4.5%
Autumn	3.8%	W±45^{o}	2.0%	5.6%	7.7%
Winter	4.2%	W±45^{o}	1.9%	5.3%	7.2%
Spring	1.6%	ENE±34^{o}	0.5%	4.1%	4.6%

TABLE 5.2.2

Seasonal Frequency of Occurrence Wind Speed Intervals - Evening

Period	Calm	Wind Direction	0.5 to 1.5 m/s	1.5 to 3 m/s	0.5 to 3 m/s
Summer	2.8%	SSE±45^{o}	0.8%	9.5%	10.3%
Autumn	7.4%	W±45^{o}	4.3%	28.7%	**33.0%**
Winter	3.5%	W±45^{o}	4.2%	24.2%	28.4%
Spring	4.5%	W±45^{o}	2.4%	14.4%	16.8%

TABLE 5.2.3

Seasonal Frequency of Occurrence Wind Speed Intervals - Night

Period	Calm	Wind Direction	0.5 to 1.5 m/s	1.5 to 3 m/s	0.5 to 3 m/s
Summer	18.0%	WSW±45°	6.5%	26.7%	**33.3%**
		W±45°	7.8%	26.5%	**34.2%**
Autumn	15.7%	WSW±45°	8.6%	26.0%	**34.6%**
		W±45°	8.1%	25.0%	**33.1%**
Winter	11.3%	WSW±45°	6.2%	17.8%	24.0%
		WSW±45°	7.1%	24.3%	31.5%
Spring	15.7%	W±45°	6.1%	23.6%	29.6%

Weather has been recorded at the Boral Dunmore Quarry weather station since 19 March 2003. To supplement the Albion Park data weather data from the Dunmore Quarry site has been analysed from March to August 2003 to determine the frequency occurrence of winds during day, evening and night periods. A summary of the results are given in **Table 5.2.4**, **Table 5.2.5** and **Table 5.2.6.**

TABLE 5.2.4

Seasonal Frequency of Occurrence Wind Speed Intervals - Daytime

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Autumn	12.4%	SSE ±45°	8.0%	5.0%	13.0%
		S ±45°	8.3%	5.5%	13.9%
		SSW ±45°	8.0%	6.1%	14.1%
		SW ±45°	7.4%	6.1%	13.5%
		WSW ±45°	7.0%	5.6%	12.5%
		W ±45°	6.5%	4.7%	11.3%
Winter	13.4%	W ±45°	7.4%	7.8%	15.2%
		WNW ±45°	8.1%	7.5%	15.6%
		NW ±45°	8.6%	7.3%	15.8%
		NNW ±45°	9.1%	7.1%	16.2%
		N ±45°	10.1%	7.2%	17.3%
		NNE ±45°	10.3%	6.8%	17.0%

TABLE 5.2.5

Seasonal Frequency of Occurrence Wind Speed Intervals - Evening

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Autumn	14.7%	W ±45°	13.6%	5.7%	19.4%
		WNW ±45°	15.1%	4.6%	19.7%
		NW ±45°	17.2%	3.8%	21.0%
		NNW ±45°	17.5%	3.7%	21.2%
		N ±45°	16.2%	4.2%	20.4%
		NNE ±45°	13.0%	3.9%	16.9%
Winter	27.3%	W ±45°	16.6%	5.1%	21.7%
		WNW ±45°	19.7%	6.7%	26.4%
		NW ±45°	21.3%	8.3%	**29.6%**
		NNW ±45°	20.2%	8.3%	28.5%
		N ±45°	17.8%	7.2%	25.0%
		NNE ±45°	12.7%	4.9%	17.6%

TABLE 5.2.6

Seasonal Frequency of Occurrence Wind Speed Intervals - Night

Period	Calm	Wind Direction	0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Autumn	35.4%	SW ±45°	10.8%	4.6%	15.4%
		WSW ±45°	12.6%	5.5%	18.1%
		W ±45°	13.0%	5.6%	18.6%
		WNW ±45°	12.8%	5.2%	18.0%
		NW ±45°	11.5%	5.3%	16.8%
		NNW ±45°	10.3%	5.0%	15.3%
Winter	33.1%	W ±45°	10.5%	3.6%	14.1%
		WNW ±45°	12.5%	5.7%	18.1%
		NW ±45°	14.6%	7.3%	21.8%
		NNW ±45°	15.1%	7.3%	22.4%
		N ±45°	14.5%	6.2%	20.7%
		NNE ±45°	12.1%	4.0%	16.1%

Seasonal wind records indicate that winds of up to 3 m/s are a feature of the area, as the frequency of such wind from the western sector exceeds the 30% threshold for autumn and winter evenings. During summer and autumn nights winds from the westerly sector (based on Albion Park data) are above the 30% threshold, however, the local weather station at Dunmore does not show the same trend during Autumn. Further information from the Dunmore weather station is required to establish a trend based on 12 months of data. Winds from the western sector, during evening and night periods, have been treated as significant for the purpose of this investigation.

Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night time during winter, or about 2 nights per week.

The EPA Industrial Noise Policy states that temperature inversions need only be considered for the night noise assessment period (ie after 10.00 pm).

Although no measurement of temperature inversion was available from the Albion Park weather station it has been assumed that temperature inversions are a feature of the area.

6 IMPACT ASSESSMENT NOISE GOALS

6.1 Quarry Noise Emission Design Goals

The noise emission design goals for the proposed continued operation of Dunmore Quarry have been established with reference to the INP.

The intrusiveness criteria have been set from RBL's determined in the absence of noise from the Dunmore Quarry. The RBL's used for the assessment were determined from the noise monitoring results contained within **Table 5.1.2**.

The amenity criteria have been set with reference to the industrial noise contribution, measured at the monitoring locations, in accordance with the INP. The existing LAeq noise levels, measured in the vicinity of the Dunmore Quarry, include natural sources, some passing traffic noise and noise from the existing quarrying operations. The amenity criteria are set from LAeq measurements of only industrial noise sources in the area (ie excluding noise from transportation, natural sources and Dunmore Quarry). Extracts from the INP that relate to the setting of amenity criteria are given in **Table 6.1.1** and **Table 6.1.2**. The residences surrounding Dunmore Quarry are best described under the rural and urban categories.

TABLE 6.1.1

Amenity Criteria - Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Daytime	50 dBA	55 dBA
		Evening	45 dBA	50 dBA
		Night	40 dBA	45 dBA
Residence	Urban	Daytime	60 dBA	65 dBA
		Evening	50 dBA	55 dBA
		Night	45 dBA	50 dBA

Note: Monday to Saturday - Daytime 7.00 am - 6.00 pm; Evening 6.00 pm 10.00 pm; Night-time 10.00pm - 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm 8.00 am
The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period

TABLE 6.1.2

Modification to Acceptable Noise Level (ANL)* to Account for Existing Levels of Industrial Noise

Total Existing L_{Aeq} noise level from Industrial Noise Sources	**Maximum L_{Aeq} Noise Level for Noise from New Sources Alone, dBA**
≥ Acceptable noise level plus 2 dBA	If existing noise level is *likely to decrease* in future acceptable noise level minus 10 dBA If existing noise level is *unlikely to decrease* in future existing noise level minus 10 dBA
Acceptable noise level plus 1 dBA	Acceptable noise level minus 8 dBA
Acceptable noise level	Acceptable noise level minus 8 dBA
Acceptable noise level minus 1 dBA	Acceptable noise level minus 6 dBA
Acceptable noise level minus 2 dBA	Acceptable noise level minus 4 dBA
Acceptable noise level minus 3 dBA	Acceptable noise level minus 3 dBA
Acceptable noise level minus 4 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 5 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 6 dBA	Acceptable noise level minus 1 dBA
< Acceptable noise level minus 6 dBA	Acceptable noise level
* ANL = recommended acceptable LAeq noise level for the specific receiver, area and time of day from **Table 6.1.1**.	

The resulting project specific noise design goals for the Dunmore Quarry site are given in **Table 6.1.3**.

The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

In those cases where the INP project specific assessment criteria are not achieved, it does not automatically follow that all people exposed to the noise would find the noise unacceptable. In subjective terms, exceedances of the INP project specific assessment criteria can be generally described as follows.

- Negligible noise level increase <1 dBA
  (Not noticeable by all people)
- Marginal noise level increase 1 dBA to 2 dBA
  (Not noticeable by most people)
- Moderate noise level increase 3 dBA to 5 dBA
  (Not noticeable by some people but may be noticeable by others)
- Appreciable noise level increase >5 dBA (Noticeable by most people)

TABLE 6.1.3

Dunmore Quarry Project Specific Noise Design Goals

Location	Description		Intrusiveness Criterion $L_{Aeq(15minute)}$	Amenity Criterion L_{Aeq}
Location A McParland Residence	Daytime	7 am to 6 pm	35	50
	Evening	6 pm to 10 pm	35	45
	Night	10 pm to 7 am	35	40
	Shoulder	6 am to 7am	35	45
	Shoulder	6 am to 7am	54	53
Location K Stocker Residence	Daytime	7 am to 6 pm	49	60
	Evening	6 pm to 10 pm	44	50
	Night	10 pm to 7 am	38	45
	Shoulder	6 am to 7am	47	53

In view of the foregoing, **Table 6.1.4** presents the methodology for assessing noise levels which may exceed the INP project specific noise assessment criteria.

TABLE 6.1.4

Dunmore Quarry Noise Impact Assessment Methodology

Assessment Design Goals	Project Specific Design Goals	Noise Management Zone	Noise Affectation Zone
Intrusive	Rating background level plus 5 dBA	≤ 5 dBA above project specific goal	> 5 dBA above project specific goal
Amenity	INP based on existing industrial level	≤ 5 dBA above project specific goal	> 5 dBA above project specific goal

For the purposes of assessing the potential noise impacts the project specific, management and affectation criteria are further defined as follows:

INP Project Specific Design Goal
Most people in the broader community would generally consider exposure to noise levels corresponding to this zone acceptable, i.e. when noise from the industrial source are less than or equal to 5 dB(A) above the nominated RBL.

Noise Management Zone

Depending on the degree of exceedance of the project specific design goal (1 dB(A)to 5 dB(A)) noise impacts could range from negligible to moderate. It is recommended that management procedures be implemented including:

- Prompt response to any community issues of concern.
- Noise monitoring on site and within the community.
- Refinement of on site noise mitigation measures and quarry operating procedures where practical.
- Consideration of acoustical mitigation at receivers.
- Consideration of negotiated agreements with property holders.

Noise Affectation Zone

Exposure to noise levels of greater than 5 dB(A) above the project specific design goals may be considered unacceptable by some property holders and it is recommended that the quarry explore the following:

- Discussions with relevant property holders to assess concerns and provide solutions.
- Implementation of acoustical mitigation at receivers.
- Negotiated agreements with property holders where required.

6.2 Sleep Disturbance Goals

The EPA NSW Industrial Noise Policy (INP) dated 2000 has an objective to establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity. The INP however, does not provide a mechanism for directly addressing sleep disturbance issues. Policy documents that provide some guidance in addressing sleep disturbance are the Environmental Noise Control Manual (ENCM) dated 1994 and the EPA Environmental Criteria for Road Traffic Noise (ERCTN) dated 1999.

The ENCM provides limited guidance in the determination of sleep disturbance goals and states that *the L1 level of any specific source should not exceed the background noise level L90 by more that 15 dBA when measured at the bedroom window.*

The ECRTN being a more recent document provides a more comprehensive treatment of sleep disturbance issues.

The policy recognises that "*because the relationship between noise, sleep disturbance and health is not fully understood at this stage, it is not possible to define fully how the different characteristics of road traffic should be measured to best estimate effects on sleep."*

The EPA ECRTN policy document draws the following conclusions in relation to sleep disturbance:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions.
- One or two noise events per night, with maximum internal noise levels of 65 dBA to 70 dBA (inside dwellings) are not likely to affect health and well being significantly.
- At the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance.

The DEC current preferred method to determine a morning shoulder RBL is to take the midpoint between the daytime and night-time period, as it is claimed that the 10th percentile method does not give a statistically valid ABL level. In the Dunmore Quarry case the current EPA approach grossly under estimates the actual ambient noise level during this period. A conservative approach has been used in this report where the minimum LA90 level recorded in the morning shoulder period has been used as the ABL level instead of the 10 th percentile levels. An RBL level using the modified ABL levels was then calculated.

At Location K (Stocker) the background noise level recorded in the vicinity of the residence/school house has been used without adjustment as this reflects the background noise that may be experienced adjacent to a rear facing bedroom window.

To reduce the likelihood of awakening reactions at Location J (Creagan) the sleep disturbance goal has been reduced to 65 dBA.

The appropriate night-time sleep disturbance criteria from this analysis are set out in **Table 6.2.1**.

TABLE 6.2.1

Dunmore Quarry Sleep Disturbance Goals

Location	Description	Sleep Disturbance Goal $L_{A1(1minute)}$
Location A McParland Residence	**Night** 10.00 pm to 6.00 am	45 dBA
	Morning Shoulder 6.00 am to 7.00 am	45 dBA
Location J Creagan Residence	**Night** 10.00 pm to 7.00 am	51 dBA
	Morning Shoulder 6.00 am to 7.00 am	65 dBA
Location K Stocker Residence	**Night** 10.00 pm to 7.00 am	48 dBA
	Morning Shoulder 6.00 am to 7.00 am	55 dBA
Location N Dunmore Sand and Soil Residence (Quarrying company owned)	**Night** 10.00 pm to 7.00 am	47 dBA
	Morning Shoulder 6.00 am to 7.00 am	61 dBA

6.3 Traffic Noise Design Goals

The Environment Protection Authority released the "Environmental Criteria for Road Traffic Noise" in May 1999.

The policy sets out noise criteria applicable to different road classifications for the purpose of defining traffic noise impacts.

Dunmore Quarry uses the Princes Highway to despatch the majority of the finished product to the customer. This roadway clearly falls into the category of "arterial road" and it is for this reason the noise criteria outlined in **Table 6.4.1** have been adopted.

TABLE 6.3.1

EPA Environmental Criteria for Road Traffic Noise

Policy	Descriptor	Traffic Noise Goal
8. Land use developments with the potential to create additional traffic on a freeway or arterial road	$L_{Aeq(15hour)}$ daytime	60 dBA*
	$L_{Aeq(9hour)}$ night-time	55 dBA*
* In all cases (where criteria are already exceeded), traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA.		

7 ASSESSMENT OF NOISE IMPACTS

7.1 Operational Noise Modelling

A computer model was used to predict the noise emissions from Dunmore Quarry. The Environmental Noise Model (ENM) used has been produced in conjunction with the former EPA and is the preferred noise modelling package for industrial sites. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. The model used this map, together with the noise source data, ground cover, shielding by barriers and/or adjacent buildings and atmospheric information to predict noise levels. Mobile noise sources (such as haul trucks and product trucks) were modelled at worst case locations on each respective haulage route and assumed to operate in repetitive cycles. Noise modelling was carried out for calm and prevailing atmospheric conditions. The noise model also accounted for the noise attenuation from the implementation of the Noise Mitigation Strategy for Dunmore Quarry.

Noise Mitigation Strategy

In order to reduce the noise impact on residential receivers surrounding Dunmore Quarry, Best Environmental Practice together with Best Achievable Technology have been considered and incorporated into the noise mitigation strategy for the quarry. The mitigation strategy includes:

- Construction of a 4 m high acoustic bund approximately 50 m from Location K (Stocker).
- Construction of an acoustic bund on the south-western corner of the Croome Farm development to shield Location A (McParland) from noise from quarrying activity. The construction of this bund is ongoing.
- The construction of an acoustic wall (at RL 7 m) adjacent to the product stockpile area and rail loading area.
- The cladding of Screen 1. The cladding has been constructed on the southern and eastern side and includes a solid floor at screen level. Chutes below screen level have been shielded on the southern and eastern sides.
- Drilling would only be conducted between 6.00am and 10.00pm, however, for the evening period, between 6.00pm and 10.00pm, drilling would be confined to the second bench level or lower.
- Boral has a negotiated agreement with the landholder of Location J (Creagan), Locations L and N (Dunmore Sand and Soil) acknowledging/accepting exceedances to EPA noise goals. Readymix has verbally advised it would be prepared to complete a similar negotiated agreement for Location M. Noise assessment at these locations does not form part of this report.

Noise Management Strategy for Evening Operation

In order to further reduce the impact of operation of Dunmore Quarry in periods of adverse weather conditions (wind from the west) in the evening period Best Management Practice strategies are currently being employed:

- Wind speed and direction is monitored using a weather station located at the quarry. The recently installed weather station has a sensor height of 10 m. The weather station is linked to the quarry primary feeder. When wind speeds between 2 m/s and 3 m/s are detected from the westerly sector the primary feeder is automatically shut down. The weather station monitors average winds speeds over a 30 minute period from the west $\pm 45^{o}$ to determine the activation of an automatic shutdown.

This means that the primary jaw crusher, gyratory crusher, and primary screen ceases operation. This results in the ceasing of extraction operations including loading and transporting of primary feed to the plant. It should be noted that the secondary/tertiary section of the plant continues to operate from a surge pile of primary crushed material. Stockpiling and sales also operates as normal.

Noise Management Strategy for Night Period

In order to reduce the impact of operations of Dunmore Quarry during the night period it is recommended that the following management strategies be employed.

- All processing and extraction will cease at 10.00 pm.
- Sales activity, which includes the transfer of finished product from processing plant bins to the product stockpile area (10.00 pm to midnight) and loading delivery vehicles and trains, should continue from 10.00 pm to 7.00 am (Monday to Saturday).

During periods when temperature inversions are likely or westerly wind of between 2 m/s and 3m/s are measured the quarry operation should:

- Operate one front end loader to load materials for sale.

Noise Model Calibration and Verification
A calibration noise survey was conducted to verify the accuracy of the noise model. A series of controlled activity noise surveys were undertaken at a range of distances from the Dunmore Quarry plant to determine the contribution of the crushing plant and, in particular, the primary plant. The monitoring points were accurately located with a hand held GPS and a description of each location is contained within **Table 7.1.1**.

TABLE 7.1.1

Noise Monitoring Locations Controlled Activity Survey

Location*	GPS Co-ordinate	Distance From Screen No.1 (metres)
Location 1	6167756 N 300253 E	65
Location 2	6167655 N 300443 E	278
Location 3	6167504 N 300670 E	550

* See locations on **Figure 2**, **Appendix A**

During the controlled activity survey the crushing plant was operated continuously and at full capacity. Noise levels were recorded with the primary plant “on” (jaw crusher, primary gyratory crusher and No.1 Screen) and primary plant “off” to determine the contribution of the primary plant to the overall quarry noise level. Normal quarry raw material was used to feed the jaw crusher, which consisted of a range of material sizes from greater than 150 mm diameter to less than 1000 mm diameter.

In order to more accurately calibrate the noise model the predicted noise levels were compared to the measured noise levels. The results of these measurements/predictions for calm conditions are given in **Table 7.1.2**.

TABLE 7.1.2

Calibration Noise Survey (Controlled Activity)

Location*	**L_{Aeq} Contribution from Primary Plant dB(A)**		**Total L_{Aeq} Contribution from Quarry dB(A)**	
	Predicted	Measured	Predicted	Measured
Location 1	72	70	74	70
Location 2	60	64	64	66
Location 3	53	52	56	57
* See locations on **Figure A3, Appendix A**				

Predicted noise levels were within an acceptable degree of tolerance to those measured in the field.

7.2 Noise Level Prediction

Noise levels were predicted at all residential locations surrounding Dunmore Quarry. Noise contours were produced for Dunmore Quarry operation during daytime, evening and night periods. These are presented as Figures 3, 4 and 5 in **Appendix G**.

A summary of the predicted noise levels at the most potentially affected non-company owned residences is presented in **Table 7.2.1**.

TABLE 7.2.1

Noise Impact Assessment Calm Weather Conditions

Location	Predicted Noise Level dB(A)		Project Specific Design Goal dB(A)	
	Existing	Proposed	Period	$L_{Aeq(15minute)}$
Location A McParland Residence	33	33	Daytime	35
	31	31	Evening	35
	<20	<20	Night	35
	31	31	Shoulder	35
Location K Stocker Residence	40	40	Daytime	49
	40	40	Evening	44
	34	34	Night	38
	40	40	Shoulder	47
Location O Dunmore Lakes Estate	33	33	Daytime	49
	33	33	Evening	44
	30	30	Night	38
	33	33	Shoulder	47

Noise Impact under Calm Conditions
Predicted noise levels, for the existing and proposed production rates, given in **Table 7.2.1** show that full quarry operation (all equipment with the exception of the hydraulic rock hammer and dozer during the morning shoulder and evening period) will comply with the EPA project specific goals under calm weather conditions at all residential locations for daytime, evening, night and morning shoulder periods.

Noise Prediction under Prevailing Weather Conditions Evening Period
Noise levels were predicted under prevailing weather conditions at all residences surrounding the Dunmore Quarry for each operational stage of development. Noise modelling was conducted using the following meteorological conditions:

- **MWE** - Moderate Wind Enhancement Winter Evening – Prior to wind switch activation
  Wind speed 0.5 m/s to 2 m/s
  Temp 9^0 C RH 95%
  Wind direction 258^0 to 348^0

- **SWE** - Severe Wind Enhancement Winter Evening – Following wind switch activation
  Wind speed 2 m/s to 3 m/s
  Temp 9^0 C RH 95%
  Wind direction 258^0 to 348^0

The potential noise enhancement due atmospheric conditions was comprehensively modelled to consider all significant adverse weather conditions. Atmospheric conditions which produced worst case noise enhancement typically included periods of wind from the west.

Predicted noise levels received at the potentially worst affected non-company owned residences are presented in **Table 7.2.2**.

TABLE 7.2.2

Noise Impact Assessment under Prevailing Weather Conditions Evening Period

Location	Predicted Noise Level (dBA)				Project Specific Design Goal dB(A)
	Existing		Proposed		Evening Period
	MWE	SWE	MWE	SWE	$L_{Aeq(15minute)}$
Location A McParland Residence	30	<20	30	<20	35
Location K Stocker Residence	44	44	44	**45**	44
Location O Dunmore Lakes Estate	37	41	37	41	44

Noise Impact Evening Period under Prevailing Weather Conditions
Predicted noise levels for the operation of Dunmore Quarry during the evenings in autumn and winter, under adverse winds, will comply with the project specific noise levels at all locations with the exception Location K (Stocker) where a minor exceedance of 1 dBA may occur for the proposed operating situation.

An increase in noise level above the project specific goals of up to 46 dB(A) may occur at Location K (Stocker) for short periods prior to activation of the wind switch.

Noise Prediction under Prevailing Weather Conditions Night Period
Noise levels were predicted under prevailing weather conditions at all residences surrounding the Dunmore Quarry for each operational stage of development. Noise modelling was conducted for the following meteorological conditions:

- **SWE** - Severe Wind Enhancement Autumn Night
  Wind speed 2 m/s to 3 m/s
  Temp 9^0 C RH 95%
  Wind direction 258^0 to 348^0

- **I** - F class temperature inversion for winter night-time conditions (air temperature 9^oC, relative humidity 95%, temperature gradient $3^oC/100$ m and wind speed 0 m/s).

A summary of the predicted noise levels at the most potentially affected non-company owned residences is presented in **Table 7.2.3**.

TABLE 7.2.3

Noise Impact Assessment under Prevailing Weather Conditions Night

Location	Predicted Noise Level (dBA)				Project Specific Design Goal dB(A)
	Existing		Proposed		Night Period
	SWE	I	SWE	I	$L_{Aeq(15minute)}$
Location A McParland Residence	<30	<30	<30	<30	35
Location K Stocker Residence	32	32	35	34	38
Location O Dunmore Lakes Estate	35	35	35	36	38

Noise Impact Night Period under Prevailing Weather Conditions
Predicted noise levels for the operation of Dunmore Quarry during the nights in autumn and winter, under adverse winds and temperature inversion conditions, will comply with the project specific noise levels at all locations.

It should be noted that night-time sales loading is currently approved from 10.00 pm to midnight and from 5.00 am to 6.00 am.

Noise Prediction under Prevailing Weather Conditions Morning Shoulder Period
Noise levels were predicted under prevailing weather conditions at all residences surrounding the Dunmore Quarry for each operational stage of development. Noise modelling was conducted using the following meteorological conditions:

- **MWE** - Moderate Wind Enhancement Winter Morning – Prior to wind switch activation
  Wind speed 0.5 m/s to 2 m/s
  Temp 9^0 C RH 95%
  Wind direction 258^0 to 348^0

- **SWE** - Severe Wind Enhancement Winter Morning – Following wind switch activation
  Wind speed 2 m/s to 3 m/s
  Temp 9^0 C RH 95%
  Wind direction 258^0 to 348^0

- **I** - F class temperature inversion for winter night-time conditions (air temperature 9^oC, relative humidity 95%, temperature gradient 3^oC/100 m and wind speed 0 m/s).

A summary of the predicted noise levels at the most potentially affected non-company owned residences is presented in **Table 7.2.4**.

TABLE 7.2.4

Noise Impact Assessment under Prevailing Weather Conditions Morning Shoulder Period

Location	Predicted Noise Level (dBA)						Project Specific Design Goal dB(A)
	Existing			Proposed			Morning Period $L_{Aeq(15minute)}$
	MWE	SWE	I	MWE	SWE	I	
Location A McParland Residence	30	<20	34	30	<20	34	35
Location K Stocker Residence	44	44	45	44	45	45	47
Location O Dunmore Lakes Estate	37	41	42	37	41	42	47

Noise Impact Morning Shoulder Period under Prevailing Weather Conditions

Predicted noise levels for the operation of Dunmore Quarry during the morning shoulder period in autumn and winter, under adverse winds and temperature inversion conditions, will comply with the project specific noise levels at all locations for the existing and proposed quarry production rates.

7.3 Sleep Disturbance

There is potential for sleep disturbance at Dunmore Quarry during the night-time and morning shoulder periods.

Night Period 10.00 pm to 6.00 am

To predict the possible occurrence of sleep disturbance from operation at night the LA1 levels of the loading of material into truck and rail bodies (the most likely cause of sleep disturbance) were measured. These levels were used as input to the acoustic model for the site and predictions were made at surrounding residences. A summary of the predicted noise levels at the most affected residential locations surrounding the site are given in **Table 7.3.1**.

TABLE 7.3.1

Predicted Sleep Disturbance Noise Levels Night Period

Location	Predicted Noise Level $L_{A1(1minute)}$ dB(A)		Project Specific Design Goal dB(A)	
	Loading Operation Calm Conditions	Loading Operation Adverse Weather Conditions	Period	Sleep Disturbance Criterion $L_{A1(1minute)}$
Location A McParland Residence	<30	<30	Night	47
Location K Stocker Residence	34	37	Night	48
Location O Dunmore Lakes Estate	29	41	Night	48

The predicted results contained in **Table 7.3.1** show that the Dunmore Quarry will meet the sleep disturbance criterion at night.

Morning Shoulder Period

Dunmore Quarry currently operates at full production in the 6.00 am to 7.00 am period. With an increase in production there will be no change to the types of events likely to cause sleep disturbance. The impact, with respect to awakening reactions, in the morning shoulder operation occurs at Location J (Creagan) and Location K (Stocker) and is a result of the operation of the crushing plant. At other locations the impact noise associated with operation of the crushing plant is less of an issue and levels more applicable to night-time operation would prevail. To gain an appreciation of the type and magnitude of emergence events in the morning shoulder period, noise measurements were conducted at Location J (Creagan) and Location K (Stocker) with, and without, Dunmore Quarry in operation. A summary of the measurements are contained within **Table 7.3.2**.

TABLE 7.3.2

Measured Sleep Disturbance Noise Levels Morning Shoulder Period

LOCATION	SLEEP DISTURBANCE LEVEL LA1(1MINUTE) dB(A)	DESCRIPTION OF EVENT	BACKGROUND NOISE LEVEL LA90(15MINUTE) dB(A)	SLEEP DISTURBANCE GOAL LA1(1MINUTE) dB(A)
Location K (Stocker) 14/10/03 6.40 am Dunmore Quarry Operating	53	Car On Swamp Rd	48	55
	56	Birds		
	53	Quarry Rock On Metal		
	57	Birds		
	51	Quarry Rock On Metal		
	51	Quarry Rock On Metal		
	54	Quarry Rock On Metal		
Location K (Stocker) 15/10/03 6.25 am Dunmore Quarry Not Operating	54	Bird	43	55
	56	Bird		
	55	Bird		
	55	Bird		
	51	Traffic		
	55	Bird		
	64	Truck On Swamp Road		
	52	Traffic		

The measurements summarised in **Table 7.3.2** at Location K (Stocker) typically ranged between 51 dBA and 54 dBA. LA1(1minute) noise levels of similar magnitude (cars 53 dB(A), trucks on Swamp Road up to 64 dB(A), birds up to 55 dB(A)) were recorded without the quarry in operation.

The outcome of this comparative study of sleep disturbance noise levels indicates that the potential for sleep disturbance from quarry noise sources is low. This is due to the fact that noise levels from ambient noise sources, such as those from passing and distant traffic, area similar or greater than those generated by the quarry. Quarry noise sources which have the potential to cause sleep disturbance are not considered as significant emergence events as they are not greater than 15dB(A) above background noise levels at the time of survey.

Intermittent quarry activities that may produce noise levels with the potential to cause awaking reactions have been identified and are as follows:

- Haul trucks loading raw material into the empty boot bin
- Oversized rocks in primary crusher
- Rock impact noise on chutes below No.1 screen
- Loading of finished product into empty rail wagons and truck bodies

The following factors must be taken into account when determining the likelihood of noise events from quarry operations causing sleep disturbance during the morning shoulder period:

- The probability of an emergence noise event from quarry operations coinciding with a period of reduced background noise during a lull in traffic flow is reasonably low.
- The level of the noise emergence events from the quarry operation is similar in magnitude to those from traffic events.
- The magnitude of noise emergence events from quarry operations is below an external level of 65 dBA which is documented as a noise level that is unlikely to cause awakening reactions in most people.
- Boral has recently completed a Pollution Reduction Programme at Dunmore Quarry to reduce noise from the operation.
- Dunmore Quarry has operated between 6.00 am to 7.00 am over many years.

Management of Sleep Disturbance Issues during Morning Shoulder Period

Although the operation of Dunmore Quarry generally complies with the proposed sleep disturbance goals, it is recommended that a programme of noise reduction measures be implemented to reduce the likelihood of quarry operational noise causing awakening reactions in the morning shoulder period. A description of the proposed noise reduction measures are given in **Table 7.3.3**.

TABLE 7.3.3

Noise Reduction measures Sleep Disturbance

Description of Process	Noise Reduction Measure
Loading raw material by haul truck into empty boot bin	Ensure boot bin is left full prior to the morning start-up
Oversized rock in primary crusher	Avoid, where possible, oversized raw feed between 6.00 am and 7.00 am
Rock impact noise on chutes below No.1 screen	Redesign and provide noise damping on chutes on No.1 screen
Loading of finished product into empty rail wagons and truck bodies	Designate an early morning loading area close to the existing stockpile bunds to shield loading process

7.4 CUMULATIVE NOISE IMPACT ASSESSMENT

As discussed in **Section 4.1** the NSW Industrial Noise Policy (INP) prescribes detailed calculation routines for establishing "project specific" LAeq(15minute) intrusive criteria and LAeq(period) amenity criteria at potentially affected receivers for a development (in isolation).

Potential cumulative noise impacts from existing and successive resource developments are embraced by the INP procedures by ensuring that the appropriate noise emission criteria (and consent limits) are established with a view to maintaining acceptable noise *amenity* levels for residences.

In order to assess potential cumulative noise impacts it is important to appreciate and distinguish between the INP's first and second environmental noise control objectives as follows:

Intrusive Noise Criteria LAeq(15minute)
The INP's first objective, that the intrusive noise emission from any single source does not exceed the background level by more than 5 dBA, relates to each individual development and the intrusive noise limit is generally specified in the Development Consent and/or Licences and Approvals.

There is not an established procedure (or regulatory requirement) to determine the cumulative intrusive LAeq(15minute) noise criterion in relation to the simultaneous operation of Dunmore Quarry, Dunmore concrete batching operation and the proposed Dunmore Sand and Soil Stage 2 and Stage 3 development.

Cumulative Noise Amenity Criteria LAeq(period)
The INP's second objective is that the LAeq(period) amenity level does not exceed the specified "acceptable" level appropriate for the particular locality and land use. This goal is aimed at restricting the potential cumulative increase in noise *amenity* levels (otherwise known as "background creep").

Based on the INP, the acceptable LAeq(period) noise *amenity* level in relation to the simultaneous operation of Dunmore Quarry and the proposed Dunmore Sand and Soil Stage 2 development during the daytime is 50 LAeq(11hour) at Location A and 60 LAeq(11hour) at Locations K, L, and M.

Indicative Cumulative Noise Impact Assessment
An indicative cumulative noise impact assessment has been based upon an evaluation of the predicted worst case noise emission levels produced by the existing and future operations of the Dunmore Quarry, Dunmore concrete batching operation, the proposed Dunmore Sand and Soil Stage 2 and Stage 3 development. Readymix Albion Park Quarry and Cleary Bros Albion Park Quarry were considered in the assessment but were deemed to have a negligible impact on the residential receivers in question due to their distance and topographic shielding from the project site. Operational noise levels for Dunmore Sand and Soil Stage 2 and Stage 3 were obtained from a recent noise impact assessment being conducted by the proponent. The results of the cumulative impact assessment are contained within **Table 7.4.1**.

In order to prepare the indicative assessment the following assumptions have been made:

- The individual LAeq(15minute) emission limits from each development are simultaneously additive to give a total LAeq(15minute) intrusive level.
- The cumulative LAeq(period) amenity level is approximately 3 dBA less than the total LAeq(15minute) intrusive level.
- The Dunmore Sand and Soil Stage 2 and Stage 3 will operate during daytime hours only.

TABLE 7.4.1

Indicative Maximum Cumulative Noise Impact Assessment Summary

Operation	Location A McParland LAeq(15minute) Daytime dB(A		Location K Stocker LAeq(15minute) Daytime	
	Shoulder	Day	Shoulder	Day
Dunmore Quarry	34	33	45	40
Dunmore Sand and Soil Stage 2 & 3	N/A	<20	N/A	40
Dunmore concrete batching plant	<20	<20	34	30
Cumulative Amenity level	**31**	**30**	**42**	**40**
Acceptable Amenity Level	**45**	**50**	**53**	**60**

Note: Cumulative impact could not be calculated at residences owned by Dunmore Sand and Soil as no noise predictions have been made at these company owned residences.

Based on the foregoing, the estimated cumulative LAeq(period) amenity levels are below the INP's acceptable amenity criteria during the daytime, evening and night-time periods.

7.5 TRANSPORT NOISE IMPACT

7.5.1 Road Transport

Existing Road Traffic

Dunmore Quarry products are transported from the quarry via road and rail predominantly to the Sydney market. Transport of products by rail will increase from the existing level of 300,000 tonnes up to approximately 750,000 tonnes by the year 2004.

Current road access to the quarry site is from the Princes Highway. The Roads and Traffic Authority (RTA) proposes to construct an overpass over the rail siding at Dunmore Quarry as part of an upgrade of the Princes Highway. The upgrade will involve the closure of the Shellharbour Road intersection and the overpass has been designed for traffic to only enter and leave Dunmore quarry from the north. Traffic travelling south from the quarry will need to initially travel north to a proposed interchange at Oak Flats before turning south towards Kiama.

Existing road traffic along the Princes Highway was obtained from a RTA permanent traffic monitoring station located just to the north of Dunmore Quarry between Shellharbour Road and Pioneer Drive. The traffic numbers were recorded during August 2000 and were classified according to vehicle type. A summary of the traffic information is contained within **Table 7.5.1.1**.

TABLE 7.5.1.1

Existing Princes Highway Traffic Movements (including existing Dunmore Quarry Traffic)

Day	Period	Vehicles North Bound	Vehicles South Bound	Total Vehicles	Total % Heavy Vehicles
Sunday	Day	9632	6275	15907	2.5
	Night	1854	989	2843	15.3
Monday	Day	6547	7338	13885	9.9
	Night	1725	1007	2732	16.3
Tuesday	Day	6098	7398	13496	11.2
	Night	1684	586	2270	15.4
Wednesday	Day	6452	2494	8946	9.9
	Night	1635	1015	2650	17.0
Thursday	Day	6452	7811	14263	10.0
	Night	1566	1064	2630	17.4
Friday	Day	7104	10288	17392	8.0
	Night	846	1041	1887	13.0
Saturday	Day	6899	8919	15818	3.6
	Night	556	851	1407	6.0
Average weekday	Day	6468	7106	13574	9.9
	Night	1544	900	2444	16.6

Annual Average Daily Traffic (AADT) data and percentage of heavy vehicles are given in **Table 7.7.1.2** for the Princes Highway in the vicinity of Dunmore Quarry.

TABLE 7.5.1.2

Traffic Volume Data

Road	Location	Period	AADT March 2003 (vehicles/day)	% Heavy Vehicles
Princes Highway	0.8km North of Shellharbour Road	Monday - Friday	20 000	10.5%
		Saturday - Sunday	20 000	3.5%
	0.8 km South of Shellharbour Road	Monday - Friday	26 000	2.7%
		Saturday - Sunday	28 500	2.5%

Proposed Dunmore Traffic Movement

The traffic generated from the quarry will rise with the proposed increase in production output from the plant. The estimated increase in despatches of heavy vehicles for the projected production volumes are given in **Table 7.5.1.3**.

TABLE 7.5.1.3

Estimated Additional Dunmore Quarry Despatches

Period	Estimated Average Boral Heavy Vehicle Traffic Movements	
	Existing	Proposed
Daytime 7.00 am to 10.00 pm	100	208
Night-time 10.00 pm to 7.00 am	26	40

Note: Existing movements are based on 500 000 tonnes/annum, 280 working days per year, an average load of 28.7 tonnes.

Proposed movements are based on 1 000 000 tonnes/annum, 280 working days per year and an average load of 28.7 tonnes.

Prediction of Road Traffic Noise

Calculation of the daytime LAeq(15hour) and the night-time LAeq(9hour) traffic noise levels have been conducted using a computer prediction model for residences in the vicinity of the Princes Highway. The prediction method included allowances for speed of vehicle, percentage of heavy vehicles, road surface and grade of road. Consideration was given to the projected annual increase in traffic on the Princes Highway as well as to the proposed additional Dunmore Quarry vehicles.

The noise from road traffic was predicted at distances of 10 m, 25 m and 50 m from the roadway and is summarised in **Table 7.5.1.4**.

TABLE 7.5.1.4

Predicted Traffic Noise

Description	Distance to Receiver					
	10 m		25 m		50 m	
	Day $L_{Aeq(15hour)}$	Night $L_{Aeq(9hour)}$	Day $L_{Aeq(15hour)}$	Night $L_{Aeq(9hour)}$	Day $L_{Aeq(15hour)}$	Night $L_{Aeq(9hour)}$
Current Princes Highway Traffic including existing Boral heavy vehicles	73.0 dBA	67.0 dBA	69.2 dBA	63.3 dBA	66.2 dBA	60.3 dBA
Future Princes Highway traffic with additional Boral heavy vehicles	73.6 dBA	67.5 dBA	69.8 dBA	63.8 dBA	66.8 dBA	60.8 dBA

Traffic Impact Assessment

The area of greatest potential impact from an increase in quarry traffic would occur at Albion Park where some residences are within 10 m of the Highway. The existing traffic noise level for daytime LAeq(15hour) of 73.0 dBA and night-time LAeq(9hour) of 67.0 dB(A) exceeds the EPA road traffic criteria. The EPA policy states that where traffic noise criteria are already exceeded traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA. The results presented in **Table 7.5.1.4** show that the proposed Dunmore Quarry road traffic movements are estimated to increase the current Princess Highway contributed traffic noise level by up to 0.6 dBA. The LAmax noise level from existing heavy vehicle movements would remain unchanged.

7.5.2 Rail Transport

7.5.2.1 Introduction

The use of rail to transport quarry products between Dunmore Quarry and Sydney is recognised as strategically, economically and environmentally important. The considerable investment in rail infrastructure at the rail loading and unloading points is an acknowledgement of Boral'se commitment to the long-term, efficient and environmentally responsible delivery of its quarry products to city markets.

A rail siding from the Illawarra Railway Line has been in existence within Dunmore Quarry for a number of decades. Quarry products have been despatched by rail for a number of years except for a six year period between 1993 and 1999 when all products were despatched by road. Prior to early 2000, when Boral recommenced the despatch of quarry products by rail, almost 1.1 million tonnes of products were being despatched northwards by road from its Kiama and Dunmore Quarries.

7.5.2.2 Existing Train Movements

Details of the current transportation of quarry products by train from the Project Site are set out in **Table 7.5.2.2.1**. It is noted that the times of train arrivals and departures listed in **Table 2.9** relate to current timetables which can be changed by the service provider and beyond Boral's control.

TABLE 7.5.2.2.1

Current Train Movements to and from Dunmore Quarry

	Transport Rate	Typical Time of Day Arrival/Departure	Capacity of Train
Train 1	6 days per week	1.30am/11.35am	30 x 70 tonne wagons (2100t)
Train 2	5 days per week	4.51pm/9.00pm	14 x 70 tonne wagons (980t)
.			

At the above transport rates, the total tonnage of products currently despatched per week is approximately 17 500 tonnes. Annually, the quantity of products currently despatched by rail varies between approximately 700 000 tonnes and 900 000 tonnes per annum. A quantity of 900 000 tonnes is equivalent to approximately 31 360 truck loads (Average load = 28.7 tonnes).

7.5.2.3 Proposed Train Movements

Boral proposes to despatch approximately 1.5 million tonnes of its products annually from Dunmore Quarry to its St Peters and Enfield rail terminals in Sydney. It is proposed to progressively increase the number of wagons on the morning and evening trains. Ultimately, the products would be despatched in two x 45 wagon trains per day (6 days per week) each capable of carrying 3 100 tonnes.

It is envisaged that the arrival/despatch times for all trains would be comparable to those currently in place, namely:

- 1.30am arrival/11.35am departure, and
- 4.51pm arrival/9.00pm departure.

It is noted that train arrival and departure times are set by the service provider and not controlled by Boral. Current timetables could change throughout the life of the quarry.

It is proposed that up to 12 train loads of quarry products, or up to 37 200 tonnes of products would be despatched per week. On average, Boral expects that each train would carry approximately 750 000 tonnes of quarry products annually.

7.5.2.4 Rail Impact Assessment

The noise impact of train arrival and departure at Dunmore Quarry will not change significantly due to the proposed increase in material to be despatched by rail.

Noise from trains on the Project Site is considered to be part of the operational noise from the quarry and has therefore formed part of the noise modelling and prediction of on-site noise emissions. The noise from trains entering, leaving and being loaded has been considered in noise predictions for the operation of Dunmore Quarry during the day, evening and night periods.

On leaving the Project Site and entering the rail corridor noise from Dunmore Quarry rail movements would need to comply with the condition of the Environment Protection Licence held by the Rail Infrastructure Corporation for the rail network to Sydney. The noise licence conditions applicable to this situation state that *"the licensee is required to work towards the goal of 60 dB(A)Leq, (24hr) and 85 dB(A) max pass-by noise, (24hr) at one metre from the facade of the nearest affected residential property".*

Giving consideration to the fact that the proposed Dunmore Quarry train despatches will not result in any additional rail movements, but just trains of greater length, it is envisaged that the change in noise level, when compared to that for the existing rail movements on the line, would be insignificant.

8 TRIAL OPERATING PERIOD

8.1 Introduction

A nine month trial of extended hours of operation, between 6.00 pm and 10.00 pm, at Dunmore Quarry commenced on the 9 July 2003. During the trial period noise monitoring and assessment has been undertaken. The objectives of the noise monitoring assessment were as follows.

- Measure the ambient noise levels at the four receiver locations surrounding the quarry. Noise surveys comprise both continuous unattended monitoring and operator-attended monitoring, in 15 minute intervals, coinciding with morning shoulder, daytime and evening periods. Particular emphasis was given to measurement and analysis of noise levels within the 6.00 pm to 10.00 pm extension to hours of operation of Dunmore Quarry. Statistical indices recorded include LAmax, LA1, LA10, LA90 and LAeq.

- Qualify all sources of noise within each of the attended surveys, including estimated contribution or maximum level of each source.

- Assess the noise emissions of Dunmore Quarry in relation to project specific noise goals for the site and with regard to wind speed and direction during the noise surveys.

- Compare measured noise levels with predicted noise levels for the site.

8.2 Noise Assessment Trial Operating Period

Monitoring Locations
Ambient noise surveys were conducted at four locations surrounding the Dunmore Quarry site from the 9 July 2003 to 5 August 2003. The details of the monitoring locations are contained within **Table 8.2.1**.

TABLE 8.2.1

Monitoring Locations

Noise Monitoring Location	Description
A	McParland Residence
J	Creagan Residence, Swamp Road
K	Stocker Residence, Swamp Road
Control Point*	Boral owned land between Stocker Residence and quarry
* See **Figure A3, Appendix A**	

It is noted that a negotiated agreement is in place with Mrs Creagan for Location J. Additional operator-attended noise monitoring was conducted at a point on the quarry side of the noise bund adjacent to the Stocker Residence. The results of continuous unattended noise monitoring were analysed during the evening period for calm, moderate wind enhancement and severe wind enhancement using the preceding weather parameters. Both post-mitigation (quarry operating) evening periods and pre-mitigation (quarry not operating) evening periods were analysed.

A comparison of the results of noise measurement, noise monitoring analysis and noise prediction for calm and wind enhanced conditions are contained in **Table 8.1.2**, **Table 8.1.3** and **Table 8.1.4**.

TABLE 8.1.2

Predicted and Measured Noise Levels - Calm Conditions Winter Evening

Location		Noise Emission Level LAeq(15minutes)			
		J - Creagan	K - Stocker	Control Point	Intermediate Point Quarry Side of Bund Near Stocker
Predicted	Calm	45 dBA	40 dBA	48 dBA	47 dBA
	Temp Inversion	51 dBA	45 dBA	51 dBA	51 dBA
Measured Quarry Contribution (operator-attended)		51 dBA (I)	46 dBA (I)	49 dBA	Not measured
Ambient during Trial (continuous unattended)		57 dBA	53 dBA	56 dBA	Not measured
Ambient Pre-trial (continuous unattended)		56 dBA	53 dBA	56 dBA	Not measured
Project Specific Noise Goal Evening Period		47 dBA	44 dBA	N/A	N/A

(I) Suspected inversion present

TABLE 8.1.3

Predicted and Measured Noise Levels - Wind 0.5 m/s to 2 m/s from Western Sector Winter Evening

Location		Noise Emission Level LAeq(15minutes)			
		J - Creagan	K - Stocker	Control Point	Intermediate Point Quarry side of Bund Near Stocker
Predicted	Wind 2 m/s	52 dBA	46 dBA	52 dBA	51 dBA
	Wind 1 m/s	50 dBA	44 dBA	50 dBA	49 dBA
Measured Quarry Contribution (operator-attended)		Not measured	42 dBA (1 m/s) 44 dBA (0.7 m/s)	51 dBA (0.9 m/s)	50 dBA (0.7 m/s)
Ambient during Trial (continuous unattended)		57 dBA	51 dBA	55 dBA	Not measured
Ambient Pre-trial (continuous unattended)		55 dBA	53 dBA	56 dBA	Not measured
Project Specific Noise Goal Evening Period		47 dBA	44 dBA	N/A	N/A

TABLE 8.1.4

Predicted and Measured Noise Levels - Wind 2 m/s to 3 m/s from Western Sector Winter Evening

Location		Noise Emission Level LAeq(15minutes)			
		J - Creagan	**K - Stocker**	**Control Point**	**Intermediate Point Quarry side of Bund Near Stocker**
Predicted	Wind 3 m/s	54 dBA	49 dBA	54 dBA	53 dBA
	With Wind Switch	52 dBA	43 dBA	49 dBA	48 dBA
Measured Quarry Contribution (operator-attended)		Not measured	47 dBA (3m/s) on threshold of wind trip	Not measured	48 dBA (W)
Ambient during Trial (continuous unattended)		55 dBA (W)	50 dBA (W)	55 dBA (W)	Not measured
Ambient Pre-trial (continuous unattended)		47* dBA	53* dBA	59* dBA	Not measured
Project Specific Noise Goal Evening Period		47 dBA	44 dBA	N/A	N/A

* Based on a small data set.
(W) wind switch activated

Continuous Unattended Noise Monitoring

In order to determine the quarry noise contribution during the evening period, from continuous unattended monitoring, it was intended to compare the ambient unattended continuous noise monitoring results of trial (post-mitigation) evening periods (quarry operating) with pre-trial (quarry not operating) evenings. This was only possible at Location J (Creagan) as at other locations the LAeq levels were unchanged or decreased during the trial period indicating a significant noise contribution from sources other than the quarry. The results of the logarithmic subtraction of post-mitigation evening levels (quarry operating) from pre-mitigation (quarry not operating) levels are contained within **Table 8.1.5**.

TABLE 8.1.5

Continuous Unattended Monitoring Pre-Trial and Post-Trial Location J (Creagan)

Location	Measured Ambient LAeq		
	Calm Conditions	**Wind 0.5 m/s to 3 m/s Western Sector (258^0 to 348^0)**	**Wind 2 m/s to 3 m/s Western Sector (258^0 to 348^0)**
Trial evening period (quarry operating)	56.6 dBA	56.7 dBA	54.6 dBA
Pre-trial evening period (no quarry)	56.5 dBA	55.2 dBA	Data set too small to accurately reflect noise level
Estimated Quarry Contribution	40 dBA	51 dBA	N/A

Noise Model validation

A comparison between the predicted and measured noise levels under a range of weather conditions are given in **Table 8.1.6**.

The predicted noise levels for the operation of Dunmore Quarry (post mitigation) correlate well (typically within an accuracy of 2 dB) to measured quarry contributions at various locations under a range of atmospheric conditions.

TABLE 8.1.6

Predicted versus Measured Quarry Contribution

Location		Noise Emission Level LAeq(15mintes)			
		J - Creagan	K - Stocker	Control Point	Intermediate Point Quarry Side of Bund Near Stocker
Wind 3 m/s	Predicted	54 dBA	49 dBA	54 dBA	53 dBA
	Measured	Not measured	47 dBA	Not measured	Not measured
Wind 3 m/s wind switch activated	Predicted	52 dBA	43 dBA	49 dBA	48 dBA
	Measured	Not measured	Not measured	Not measured	48 dBA
Wind 2 m/s	Predicted	52 dBA	46 dBA	52 dBA	51 dBA
	Measured	51 dBA#	Not measured	51 dBA	Not measured
Wind 1 m/s	Predicted	50 dBA	44 dBA	50 dBA	49 dBA
	Measured	Not measured	44 dBA 42 dBA	Not measured	50 dBA
Inversion 3^0C	Predicted	51 dBA	45 dBA	51 dBA	51 dBA
	Measured	51 dBA	46 dBA	Not measured	Not measured
Calm	Predicted	45 dBA	39 dBA	48 dBA	47 dBA
	Measured	40 dBA#	<45 dBA	49 dBA	Not measured

Results of continuous unattended monitoring

8.3 Noise Assessment Of Quarry Trial Period Post Mitigation

Location K - Stocker

Evening Period Calm Conditions
The results of noise prediction and operator-attended measurements indicate that noise emissions from the quarry would be below the project specific goals for the evening period under calm conditions.

Evening Period Calm Conditions during Temperature Inversion
The results of noise prediction and operator-attended measurements indicate that noise emissions from the quarry would be up to 2 dBA above the project specific goals for the evening period. It is considered that the noise exceedance is due to weather effects that, in accordance with the INP, are not classified as significant.

Evening Period Moderate Wind Enhancement
Moderate wind enhancement is likely to occur for approximately 16% and 22% of the time during autumn and winter evenings respectively. The results of noise prediction and operator-attended measurements indicate that noise emissions from the quarry would approach the project specific goals for the evening period and may be exceeded by up to 2 dBA* for short periods prior to the activation of the wind switch.

Evening Period Severe Wind Enhancement
Severe wind enhancement is likely to occur for approximately 4% and 8% of the time during autumn and winter evenings respectively. The results of noise prediction and operator-attended measurements indicate that noise emissions from the quarry would meet the project specific goals following the activation of the wind switch. It is possible that some exceedances of the project specific noise levels may occur for a short period of time prior to the activation of the wind switch. In any event, the likely increase during such a wind period would be in the order of 2 to 3 dB(A).

Note*: The INP states that "*a development will be deemed to be in non-compliance with a noise consent or licence condition if the monitored noise level is more than 2 dB above the statutory noise limit specified in the consent or licence condition*".

9 BLASTING

9.1 Introduction

Explosives are used in quarrying in order to dislodge and fracture rock to enable its extraction and processing. To achieve this end, holes are drilled into the rock in a designed pattern giving strict attention to their angle, depth and spacing. These holes are then filled with an explosive charge consisting of an emulsion type explosive. The charge is initiated with the aid of primers and detonators. The detonation of each hole is delayed in a pre-designed sequence to ensure that each hole is fired individually in close succession. This delayed firing technique improves the efficiency of the blast and also reduces its environmental impacts.

9.2 Blasting Practice

A typical blast design is presented in **Table 9.2.1**.

TABLE 9.2.1

Typical Blast Design Details

Blast Design Parameter	Typical Dimension
Bench height	15 m to 18 m
Burden	3.8 to 4.5 m
Spacing	4.5 to 5.1 m
Stemming length	3 m
Number of Holes	50 to 80
Delay timing	Nonel (single hole per delay)
Column explosive	Emulsion

9.3 Blasting Emissions Criteria

The EPA has set down guidelines for blasting based on human comfort levels. The guidelines have been adapted from the ANZECC Guidelines "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration"* and are as follows:

Airblast
The recommended maximum level for airblast is 115 dB Linear Peak.
The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB Linear Peak at any time.

Ground Vibration
The recommended maximum level for ground vibration is 5 mm/s (peak particle velocity [ppv]). It is recommended that a level of 2 mm/s be considered as a long term regulatory goal.
The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

Times and Frequency of Blasting
Blasting should only generally be permitted during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays.
Blasting should generally take place no more than once per day.

9.4 Assessment Of Blasting Impacts

The impacts of blasting will not change as a result of this proposal. The frequency of blasting will change from an average of 36 times per annum increasing to approximately 72 times per annum. It is intended for blasting at Dunmore Quarry to be carried out between 9.00 am and 5.00 pm Mondays to Saturdays in accordance with the EPA guidelines and in line with current practice.

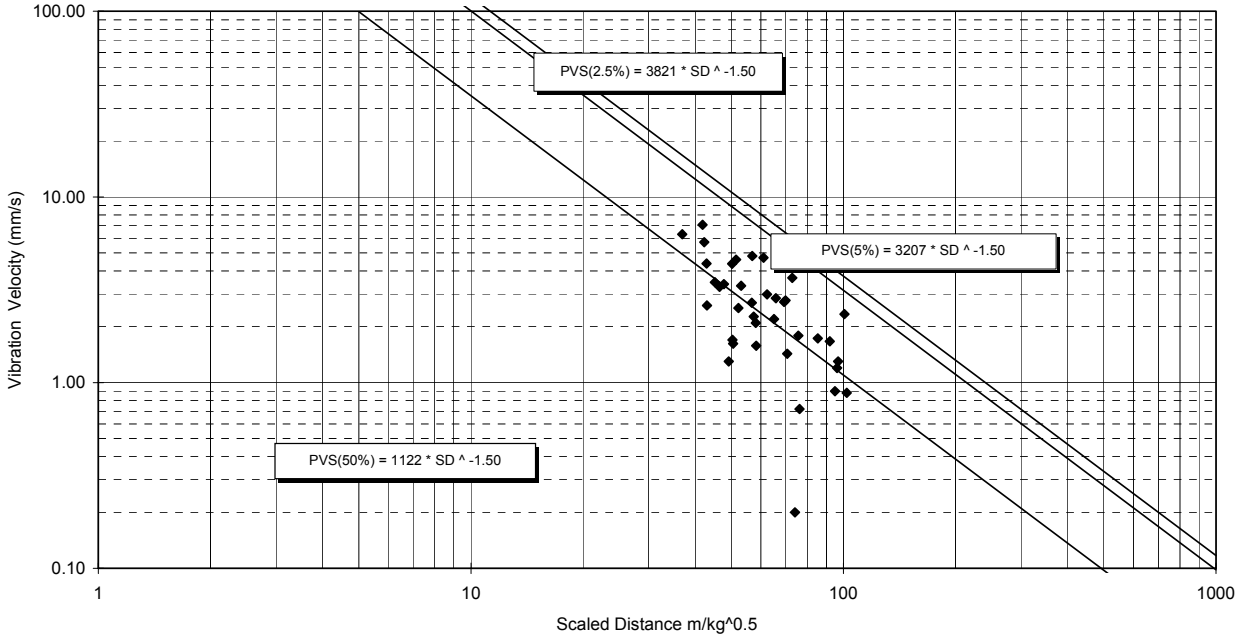
In order to predict the levels of blast emissions (ground vibration and airblast) at the surrounding receivers from the proposed blasting at Dunmore Quarry, the measured ground vibration and airblast levels from recent blasting operations were used to develop blast emissions site laws.

9.5 Ground Vibration And Airblast Site Laws

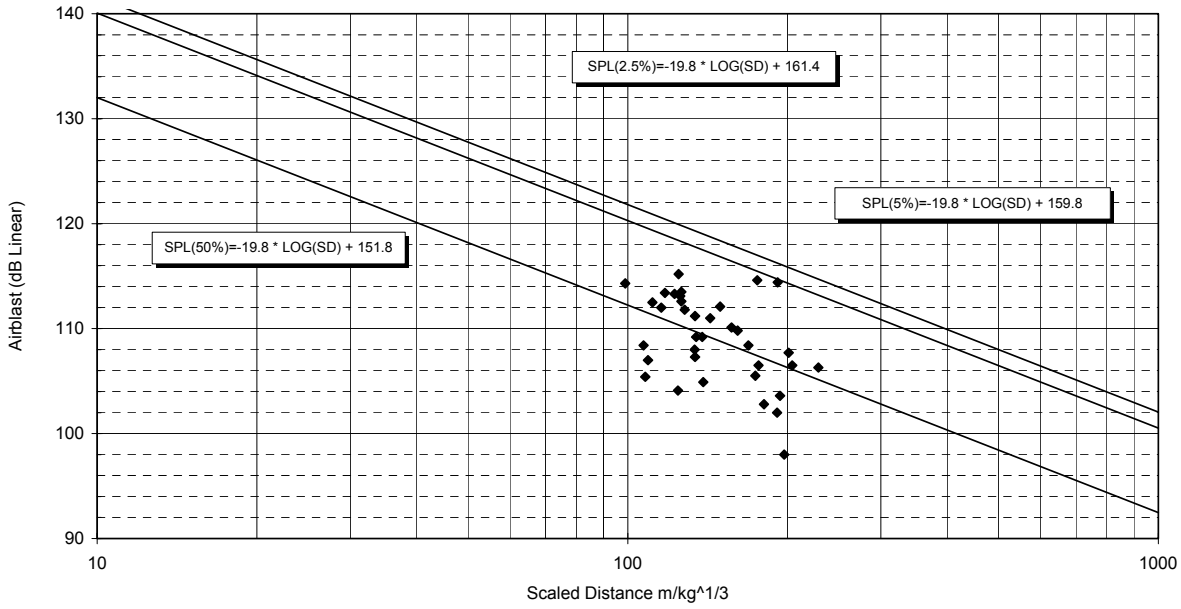
The current measured blast emission data was measured by Boral at the reference point on the boundary to the west of the Croome Farm extraction area (see **Appendix A Figure A2**) and is presented in **Appendix H**. This data was used to develop prediction site laws for Dunmore Quarry. Airblast levels recorded due to high wind events were not used in the analysis.

These site laws for ground vibration and airblast are presented graphically as follows:

30-1142 Dunmore Quarry
PVS Ground Vibration Velocity Site Law



30-1142 Dunmore Quarry
Peak Linear Airblast Site Law



For each site law plot, the lower of each pair of lines (labelled 50%) is based on the median of the measured data. However, the ground vibration and airblast criteria advocated by the EPA and ANZECC (refer Section 5.2), cater for the inherent variation in emission levels from a given blast design by allowing a five percent exceedance of a general criterion up to a (never

to be exceeded) maximum. Correspondingly, the "5% exceedance" lines have also been included in the blast emission site laws.

The 5% site laws for ground vibration and airblast are:

Ground Vibration

$$PVS\ (5\%) = 3207\ (SD1)^{-1.50}$$

Airblast

$$SPL(5\%) = 159.8 - 19.8 \log (SD2)$$

where PVS (5%) and SPL (5%) are the levels of ground vibration (Peak Vector Sum - mm/s) and airblast (dB Linear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

SD1 and SD2 are the ground vibration and airblast scaled distances, where:

$$SD1 = \frac{Distance}{\sqrt{MIC}} \qquad (m.kg^{-0.5})$$

and,

$$SD2 = \frac{Distance}{3\sqrt{MIC}} \qquad (m.kg^{-0.33)}$$

9.6 Predicted Levels of Blast Emission

The level of airblast and ground vibration has been predicted using the developed site laws for Dunmore Quarry assuming current blasting practice. A summary of the predicted levels for future blasting within the Croome Farm extraction area is contained within **Table 9.6.1 and 9.6.2**. The blasting predictions contained within the tables reflect the levels that would be experienced when blasting within the Croome Farm extraction area (as extraction moves towards the south-west) and at the south-western extremity of the resource at the closest point to Location A (McParland). The maximum instantaneous charge (MIC) will vary, and be limited, depending on the location of the area being quarried and its relation to the nearest affected receiver. It is intended that the site laws for Dunmore Quarry will continually be refined and be used to design the MIC for each individual blast based on the environmental constraints at the nearest affected receiver. This will continue to be the practice for future quarry development. Recent monitoring at a residence in Dunmore Lakes Estate established that two blasts did not trigger any recording, i.e. the gorund vibrations levels were <0.3mm/s.

Table 9.6.1

Predicted Blasting Levels – Croome Farm Extraction Area- (MIC 100 kg)

Residential Location	Predicted Quarry Blasting Level	
	Airblast dB Linear	Ground Vibration mm/s
Location A (McParland)	115	4.2
Location J (Creagan)	106	0.8
Location K (Stocker)	105	0.8
Location L (Dunmore Sand & Soil)	110	1.6
Location M (Readymix)	109	1.5
Location N (Dunmore Sand & Soil)	106	0.9
Location O (Dunmore Lakes Estate)	104	0.6

Table 9.6.2

Predicted Blasting Levels – Croome Farm extraction Area South-western extremity (MIC 30 kg)

Residential Location	Predicted Quarry Blasting Level	
	Airblast dB Linear	Ground Vibration mm/s
Location A (McParland)	115	3.5
Location J (Creagan)	102	0.3
Location K (Stocker)	102	0.3
Location L (Dunmore Sand & Soil)	106	0.6
Location M (Readymix)	105	0.5
Location N (Dunmore Sand & Soil)	102	0.3
Location O (Dunmore Lakes Estate)	101	0.3

The predicted blast results presented in **Tables 9.6.1** and **9.6.2** show that airblast and ground vibration levels will meet the EPA guidelines for proposed blasting at all residential locations surrounding the development with appropriate MIC limits in place. .

10 SUMMARY OF FINDINGS AND RECOMMENDATIONS

10.1 Operational Noise Issues

Quarrying noise emissions, within the proposed hours of operation, for the existing and proposed quarry production levels under calm weather conditions, are predicted to comply with all project specific noise levels at all residential locations for daytime, evening, night and morning shoulder periods.

Predicted noise levels for the operation of Dunmore Quarry during the evenings in autumn and winter, under adverse winds, will comply with the project specific noise levels at all locations with the exception Location K (Stocker) where a minor exceedance of 1 dBA may occur for the proposed operating situation.

Measurements of noise levels during shutdown periods, associated with wind switch activation, have established that a reduction of 2 to 3 dB(A) is possible as a result of implementing this control measure. An increase in noise level of up to 46 dB(A) may occur at Location K (Stocker) for short periods prior to activation of the wind switch.

Predicted noise levels for the operation of Dunmore Quarry during the nights in autumn and winter, under adverse winds and temperature inversion conditions, will comply with the project specific noise levels at all locations.

Predicted noise levels for the operation of Dunmore Quarry during the morning shoulder period in autumn and winter, under adverse winds and temperature inversion conditions, will comply with the project specific noise levels at all locations for the existing and proposed quarry production rates.

The cumulative impact of the Dunmore Quarry operation, Dunmore Sand and Soil's Dunmore Lakes Stage 2 and Stage 3 proposal and Dunmore concrete batching plant will comply with the appropriate amenity noise goals.

- It should be noted that Boral has a negotiated agreement with the landholder of Location J (Creagan) and Locations L and N (Dunmore Sand and Soil) acknowledging/accepting exeedences of the noise design goals at these locations. Readymix has verbally advised it would be prepared to complete a similar negotiated agreement for Location M.

10.2 Sleep Disturbance

The predicted sleep disturbance levels for the existing and proposed quarry production levels indicate that Dunmore Quarry will meet the sleep disturbance criterion at night.

During the morning shoulder period the operation of Dunmore Quarry complies with the proposed sleep disturbance goals. However, to reduce the likelihood of quarry operational noise causing awakening reactions in this period, it is recommended that a programme of noise reduction measures be implemented. A description of the proposed noise reduction measures are given in **Table 10.2.1**.

TABLE 10.2.1

Noise Reduction Measures to Limit Sleep Disturbance

Description of Process	Noise Reduction Measure
Loading raw material by haul truck into empty boot bin	Ensure boot bin is left full prior to the morning start-up
Oversized rock in primary crusher	Avoid, where possible, oversized raw feed between 6.00 am and 7.00 am
Rock impact noise on chutes below No.1 screen	Redesign and provide noise damping on chutes on No.1 screen
Loading of finished product into empty rail wagons and truck bodies	Designate an early morning loading area close to the existing stockpile bunds to shield loading process

10.3 Noise Mitigation And Management

10.3.1 Noise Mitigation Strategy

In order to reduce the noise impact on residential receivers surrounding Dunmore Quarry, Best Environmental Practice together with Best Achievable Technology have been considered and incorporated into the noise mitigation strategy for the quarry. The mitigation strategy includes:

- Construction of a 4 m high acoustic bund adjacent to residence K (Stocker).
- Construction of an acoustic bund on the south-western corner of the Croome Farm development to shield Location A (McParland) from noise from quarrying activity. The construction of this bund is ongoing.
- The construction of an acoustic wall (at RL 7 m) adjacent to the stockpile area and rail loading area.
- The cladding of Screen 1. The cladding has been constructed on the southern and eastern side and includes a solid floor at screen level. Chutes below screen level have been shielded on the southern and eastern sides.
- Drilling would only be conducted between 6.00am and 10.00pm, however, for the evening period, between 6.00pm and 10.00pm, drilling would be confined to the second bench level or lower.
- Boral has a negotiated agreement with the landholder of Location J (Creagan), Locations L and N (Dunmore Sand and Soil) acknowledging/accepting exceedances to EPA noise goals. Readymix has verbally advised it would be prepared to complete a similar negotiated agreement for Location M.

Noise Management Strategy for Evening Operation

In order to further reduce the impact of operation of Dunmore Quarry in periods of adverse weather conditions (wind from the west) in the evening period Best Management Practice strategies are currently being employed:

- Wind speed and direction is monitored using a weather station located at the quarry. The recently installed weather station has a sensor height of 10 m. The weather station is linked to the quarry primary feeder. When wind speeds between 2 m/s and 3 m/s are detected from the westerly sector the primary feeder is automatically shut down. The weather station monitors average winds speeds over a 30 minute period from the west ±45^{o} to determine the activation of an automatic shutdown.

This means that the primary jaw crusher, gyratory crusher, and primary screen cease operation. This results in the ceasing of extraction operations including loading and transporting of primary feed to the plant. It should be noted that the secondary/tertiary section of the plant continues to operate from a surge pile of primary crushed material. Stockpiling and sales also operate as normal. Measurements of noise levels during shutdown periods, associated with wind switch activation, have established that a reduction of 2 to 3 dB(A) is possible as a result of implementing this control measure.

Noise Management Strategy for Night Period

In order to reduce the impact of operation of Dunmore Quarry during the night period it is recommended that the following management strategies be employed:

- All processing and extraction will cease at 10.00 pm.
- Sales activity, which includes hauling of finished product from processing plant bins to stockpile (10.00 pm to midnight) and loading delivery vehicles and trains, should continue from 10.00 pm to 7.00 am.

During periods when temperature inversions are likely or westerly wind of between 2 m/s and 3m/s are measured the quarry operation should:

- Employ one front-end loader only to load materials for sale.

10.3.2 Contemporary Best Management Environmental Standards

There is no known database of currently accepted best environmental management practice relating to noise from the quarrying industry. Normally, a Government Authority (such as DEC formerly the EPA) or some industry organisation (eg Institue of Quarrying) would provide a database which would allow a benchmarking evaluation to be carried out against best environmental management practice in a particular industry.

Some guidance as to what is considered best environmental practice is given in a document "*Best Practice Environmental Management in Mining*" produced by the Department of Environment and Heritage in 1998 for the mining industry. It should be noted that some of the measures outlined apply more specifically to the mining industry which is different in scope and scale to that of the quarrying industry. The measures outlined in the document which are commonly adopted to reduce noise include (in order of decreasing effectiveness) follows.

- Selecting low noise plant and equipment incorporating available noise control kits. This should be among one of the first measures chosen to minimise noise impact. For example, exhaust and radiator silencers on large earthmoving plant will generally result in a 5 dBA noise reduction of that piece of equipment.

- Adding attenuators to mine ventilation fans. As with silenced plant items, this should be one of the first management options to ensure that fan noise levels will be reduced by a predetermined margin and emissions will not exceed acceptable limits.

- Providing acoustical enclosures and acoustical treatment of process buildings. This is a very effective solution for crushing plant, coal washeries and the like. A reduction in the order of 10 dBA can be expected from a lightweight sheet metal enclosure. Ventilation openings should be oriented away from noise sensitive receivers.

- Regulating emissions from reversing alarms. "Smart" alarms can be selected which limit the reversing signal to 10 dBA above the ambient noise level, thus reducing intrusiveness particularly at night.

- Optimum placement of waste dumps, location of haul roads, location of fixed plant such as crushers and loading hoppers. Waste dumps, stockpiles etc can be used to shield fixed items of plant which generate noise.

- Eliminating tonal, impulsive or intermittent noise emission characteristics. These characteristics are more likely to cause annoyance because the likelihood of complaints is less for a continuous broadband noise than one which is intermittent and/or tonal. Tonal components are often due to a fault in the machinery and may be eliminated by appropriate maintenance.

- Provision of sound walls and acoustical screening. This option is generally effective when plant is operating at ground level in close proximity to the bund wall. Also, earth embankments can often be constructed from overburden, etc from stripping and initial excavation works and provide an alternative means of stockpiling soil for future rehabilitation works. However, the use of bunding becomes less effective the further the noise source and the receiver are located from the bund.

- Incorporating optimum buffer zones and setback distances. This is only of use where large distances are involved. In general, doubling the distance between the source and receiver will result in a 6 dBA reduction in noise level.

- Acoustically treating dwellings. This is generally seen as a last resort as the overall reduction achieved often does not justify the cost involved. Also, no improvement in outdoor amenity is achieved.

A comparison to the Department of Environment and Heritage best practice noise mitigation guideline is given in **Table 10.3.2.1**.

Table 10.3.2.1
Contemporary Best Management Environmental Standards Comparison

Contemporary Best Management Environmental Standards	Dunmore Quarry Mitigation Measures
Low noise plant and equipment	New silencers for haul trucks are being evaluated (one has been installed). Remainder of fixed plant and mobile equipment is existing.
Adding attenuators to mine ventilation fans	N/A
Providing acoustical enclosures and acoustical treatment of process buildings	Jaw crusher fully enclosed Secondary/Tertiary crushers fully enclosed Tertiary screens fully enclosed Primary screen (No.1 Screen) shielded Investigating enclosing of primary gyratory crusher
Regulating emissions from reversing alarms	Reversing alarms not being used during night period, flashing light is connected to headlight of machine
Optimum placement stockpiles, haul roads and fixed plant	Night-time loading is to be conducted near stockpile bund
Eliminating tonal, impulsive or intermittent noise emission characteristics.	The replacement of the single large start-up siren with a series of smaller localised sirens.
Provision of sound walls and acoustical screening.	Acoustic bund at RL7 (aproximatley 5 m in height) near stockpile area has been constructed Acoustic bund near Location K (Stocker) 4m in height has been constructed Acoustic bund is under construction on the north-western corner of the Croome Farm extraction area Wind switch which shuts down primary plant during adverse winds
Incorporating optimum buffer zones and setback distances.	Boral has acquired considerable landholding in the general area to act as a buffer for the development. The Project site is approximately 264 hectares. The project site and buffer zones total approximately 854 hectares
Acoustically treating dwellings.	Boral has made an offer to an adjoining landowner to acoustically treat their dwelling

It should be noted that the INP states *"that the scope for applying feasible and reasonable mitigation measures to existing noise sources is usually far more limited than that for new developments. Careful consideration of noise impact and feasible and reasonable mitigation measures available at these sites may result in less stringent noise limits than would ideally apply".*

Giving consideration to the recognised difficulties in retro fitting noise mitigation measures to existing operations the mitigation measures currently adopted at Dunmore Quarry are consistent with best industry practice. The reduction in total noise level achieved from these mitigation measures has been in the order of 13 dBA under calm atmospheric conditions (Location K (Stocker)) from originally measured/predicted noise levels.

10.4 Transport Noise Issues

Road Traffic Impact

Predictions of road traffic noise from the Princes Highway indicate that the proposed increase in heavy vehicle movements from Dunmore Quarry along the Princes Highway for the increase in production levels will be maintained within 2 dBA of the existing traffic noise levels during daytime and night-time periods.

The predicted noise levels indicate that the proposed Dunmore Quarry road traffic movements are estimated to increase the current Princess Highway contributed traffic noise level by up to 0.6 dBA. The LAmax noise level from existing heavy vehicle movements would remain unchanged.

10.5 Blasting

There will be no additional blasting impacts as a result of this proposal. However, the frequency of blasting will increase from an average of 36 times per annum to approximately 72 times per annum. Blasting will be carried out within the hours of 9.00 am to 5.00 pm Mondays to Saturdays. Current consents allow blasting between 8.30 am and 5.00 pm Monday to Friday.

The blast predictions demonstrate that airblast and ground vibration levels will meet the EPA and ANZECC guidelines for proposed blasting at all residential locations surrounding the development with appropriate MIC limits in place.

11 NOISE AND BLAST MONITORING PROGRAMME

In order to evaluate the environmental noise and blasting performance of Dunmore Quarry over time a monitoring programme is proposed as follows. It is important for the noise monitoring program to be flexible to accommodate changes with site activities, surrounding land ownership and the monitoring results themselves.

11.1 Noise Monitoring Procedures

General Requirements

The noise measurement procedures employed throughout the monitoring programme should be guided by the requirements of AS 1055-1997 “Acoustics - Description and Measurement of Environmental Noise” and the Environment Protection Authority’s (EPA’s) Industrial Noise Policy.

Operator-Attended Noise Surveys

Operator-attended noise measurements and recordings should be conducted to quantify the intrusive noise emissions from extraction, processing sales activity and rail loading as well as the overall level of ambient noise.

The operator should quantify and characterise the maximum (LAmax and the energy equivalent (LAeq) intrusive noise level from extraction, processing sales activity and rail loading over a 15 minute measurement period. In addition, the operator should quantify and characterise the overall levels of ambient noise (ie LAmax, LA1, LA10, LA50, LA90, LA99, LAmin and LAeq) over the 15 minute measurement interval.

Unattended Continuous Noise Logging

In order to supplement the operator-attended measurements, unattended continuous noise logging should be conducted, at the key monitoring locations identified in **Table 11.1.1**, to quantify overall ambient noise amenity levels resulting from extraction, processing sales activity, rail loading and other environmental noise sources.

Monitoring Locations and Intervals

Operator-attended noise measurements should be conducted, as a minimum, one day per calender quarter and at the commencement of any significant operational event at the potentially most affected receiver location(s). Operator-attended noise measurements should be carried out during day, evening and night-time periods at monitoring locations identified in **Table 11.1.1**.

Unattended continuous noise logging should be carried out on a quarterly basis for a minimum period of one week at monitoring locations identified in **Table 11.1.1.**

Table 11.1.1
Key Noise Monitoring Locations

Noise Monitoring Location	Description
A	McParland Residence
K	Stocker Residence, Swamp Road
O	Dunmore Lake Estate

Instrumentation and Measurement Parameters

All acoustic instrumentation employed throughout the monitoring programme has been designed to comply with the requirements of AS 1259.2-1990, “Sound Level Meters” and carries current NATA or manufacturer calibration certificates. All instrumentation should be programmed to record continuously statistical noise level indices in 15 minute intervals which may include the LAmax, LA1, LA5, LA10, LA50, LA90, LA99, LAmin and the LAeq.

The statistical noise exceedance levels (LAN) are the levels exceeded for N% of the 15 minute interval. The LA90 represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The LAeq is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The LAmax is the maximum noise level recorded over the interval.

Instrument calibration should be checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

Weather Monitoring Instrumentation

All noise measurements should be accompanied by both qualitative description (including cloud cover) and quantitative measurements of prevailing local weather conditions throughout the survey period.

Meteorological measurements should be guided by the requirements of AS 2923-1987 "Ambient Air-Guide for Measurements of Horizontal Wind for Air Quality Applications" and the EPA. An automatic weather station located at Dunmore Quarry should be used to continuously record the meteorological parameters as shown in **Table 11.1.2**.

Table 11.1.2

Meteorological Measurement Parameters

Measured Parameter	Unit	Sample Interval
Mean wind speed	m/s	30 minute
Mean wind direction	Degrees	30 minute
Aggregate rainfall	mm	30 minute
Mean air temperature	^{o}C	30 minute

Plant and Equipment Observations and Log

During the attended noise measurements, the operator should record any significant quarry generated noise sources (ie haul trucks, dozers, etc). In addition, the operator should obtain copies of the relevant fixed plant and mobile equipment quarrying operating shift logs and attach it to the report.

Data Presentation and Reporting

The measured LAeq(15minute) noise level contributions from extraction, processing, sales activity, rail loading as well as the overall ambient noise levels together with the weather and quarry operating conditions should be reported on a quarterly basis.

The unattended ambient noise logger data from each monitoring location, together with the weather and quarry operating conditions, should be presented graphically on a daily basis.

It should be noted that the ambient noise levels do not necessarily reflect the contributed level of noise emissions from quarrying operations. The ambient noise level data quantifies the overall noise level at a given location independent of its source or character.

Prior to further analysis, the ambient noise level data from each monitoring location which correlates with periods of unstable weather (ie rainfall greater than 0.5 mm or wind speed greater than 5 m/s) should be discarded. The remaining ambient noise level data should be processed using an acceptable statistical technique and reported.

11.2 Blast Monitoring Protocol

Monitoring Locations and Intervals

All blasting at Dunmore Quarry should be monitored. Key monitoring locations are identified in **Table 11.2.1**. Blasts should be monitored at the reference location for each blast and at the residential location at least once per month.

Table 11.2.1
Key Blast Monitoring Locations

Noise Monitoring Location	Description
Reference Location	6168290 N 298512E
A	McParland Residence

Boral proposes to assess the need for an additional (or replacement) blast monitoring site once extraction resumes in the original Dunmore Quarry. The assessment would be undertaken in consultation with the Department of Environment and Conservation.

Instrumentation Requirements

Blast Emission Monitors

Blast monitoring instrumentation should be employed to meet the following primary specifications presented in **Table 11.2.2**. The instrumentation should be installed, operated and maintained by suitably qualified or trained personnel. The instruments should be externally calibrated at regular intervals throughout the life of the project.

Table 11.2.2
Blast Monitor Specifications

Specification	Seismic	Air Blast
Sample Rate	Minimum 1024 samples per second per channel	
Frequency Response	2 Hz to 250 Hz (3 dB points)	
Resolution	0.016 mm/s	0.1 dB
Range	0.1 mm/s to 254 mm/s	88 dB to 148 dB
Accuracy	3% at 15 Hz	0.2 dB at 30 Hz
Communications Link	Keyboard and Modem	
Recording Mode	Full Waveform Recording and archiving	

Vibration velocity geophones should be coupled to the ground via a “star stake” embedded in the consolidated surface approximately 25 m from the subject building or structure, with the microphone positioned in the free-field.

Weather Monitoring Equipment

Weather monitoring should be conducted as per the noise monitoring programme.

Blast Design Records and Predicted Emission Levels

Boral proposes to continue to forward all blast monitoring data to the Department of Environment and Conservation as is current practice. Blast design records should be maintained for individual blast events. The purpose of the record is to assist in the design and optimisation of future events, planning and control of blasting emissions and to provide a traceable system of documentation in case of accident or complaint.

The blasting contractor should record the blast parameters for each blast event and include the location co-ordinates (East, North, RL) of the blast site and the maximum explosive mass (MIC) to be detonated in any 8 ms interval.

Appendices

(No. of pages excluding this page = 73)

Appendix A	**Figures A1 and A2**
Appendix B	**Equipment Sound Power Levels**
Appendix C	**Statistical Ambient Noise Levels Location K (Stocker)**
Appendix D	**Statistical Ambient Noise Levels Location J (Creagan)**
Appendix E	**Statistical Ambient Noise Levels Location A (McParland)**
Appendix F	**Statistical Ambient Noise Levels Location N**
Appendix G	**Figures G1, G2 and G3**

APPENDIX A

(No. of pages excluding this page = 2)

Locality and Location Maps

APPENDIX B

(No. of pages excluding this page = 1)

Equipment Sound Power Levels

Job Number 30-1142
Job Description Dunmore Quarry
Project Manager JC

Directory C:\ C:\
Source File Name

Source	Equipment Description	Octave Band Centre Frequency (Hz) - dBL re 1pW										dB	ENM (m)		Ground	Elevation
		31.5	63	125	250	500	1k	2k	4k	8k	16K	Overall	East	North	RL(m)	RL(m)
Processing Plant																
	Primary Crusher	127	122	117	119	115	114	110	107	99	87	129 dB				enc 2
	Primary Gyratory Crusher	109	107	110	109	113	111	111	108	97	93	119 dB	2807	3221	14	15.5
	Primary Screen No.1	116	118	121	121	124	125	124	117	107	107	131 dB				enc 1
	Secondary/Tertiary Crushers	118	119	120	119	123	119	111	103	93	91	128 dB				enc 3
	Tertiary Screens	110	107	104	103	98	98	98	96	91	91	113 dB	3120	3155	6	17.5
	Barmac Crusher	100	107	109	108	106	106	101	97	91	79	115 dB	3120	3155	6	7.5
Mobile Plant																
	Front end loader Cat 992	105	115	112	117	115	108	117	107	112	98	123 dB	2621	3594	59.5	61.5
	Front end loader Cat 988	99	104	107	110	108	107	107	101	91	79	116 dB	3553	3266	3.5	5.5
	Front end loader Cat 980	114	112	108	106	103	103	103	104	99	89	118 dB	3553	3266	3.5	5.5
	Haul trucks Cat 773	107	111	118	114	118	111	111	104	92	83	123 dB	2826	2393	37	39.5
	Water Cart Cat 773	107	111	118	114	118	111	111	104	92	83	123 dB	2622	3595	60	62.5
	Hydraulic rock drill	107	117	106	101	107	109	111	113	110	99	121 dB	1604	3977	154	155.5
	Delivery truck	95	115	109	105	102	100	98	95	87	79	117 dB	3550	3260	3.5	5
	Hydraulic rock hammer	112	110	114	116	122	121	119	115	107	107	127 dB	1815	4035	133	135
	Dozer	109	111	105	108	109	107	105	98	93	93	117 dB	1604	3977	152	153.5
	Haul trucks Cat 775	108	112	119	115	119	112	112	105	93	84	124 dB	2826	2393	37	39.5
	Grader	92	97	99	109	104	107	109	106	102	103	115 dB	2622	3595	60	62.5
	Excavator	106	105	110	101	100	101	99	96	87	87	113 dB	2621	3594	59.5	61.5
	Train	118	114	107	102	104	100	95	90	82	82	120 dB	3577	3141	3.5	5

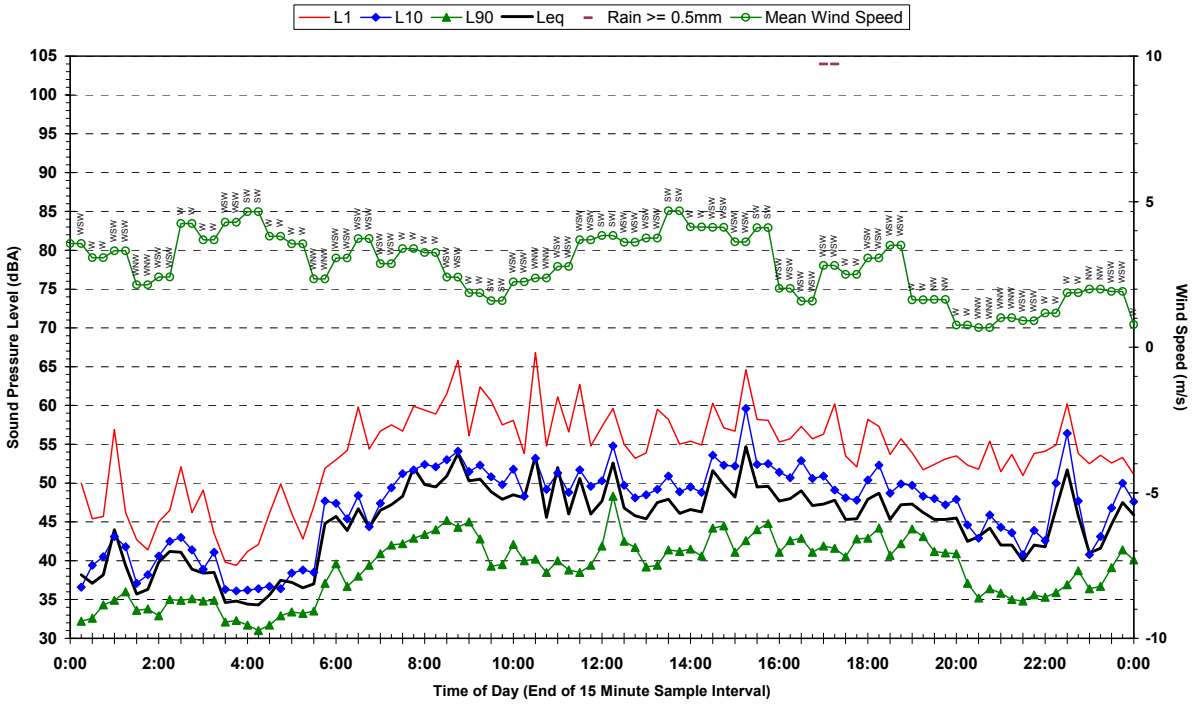
Appendix B
RHA Report 30-1142
Page 1 of 1
Equipment Sound Power Levels

APPENDIX C

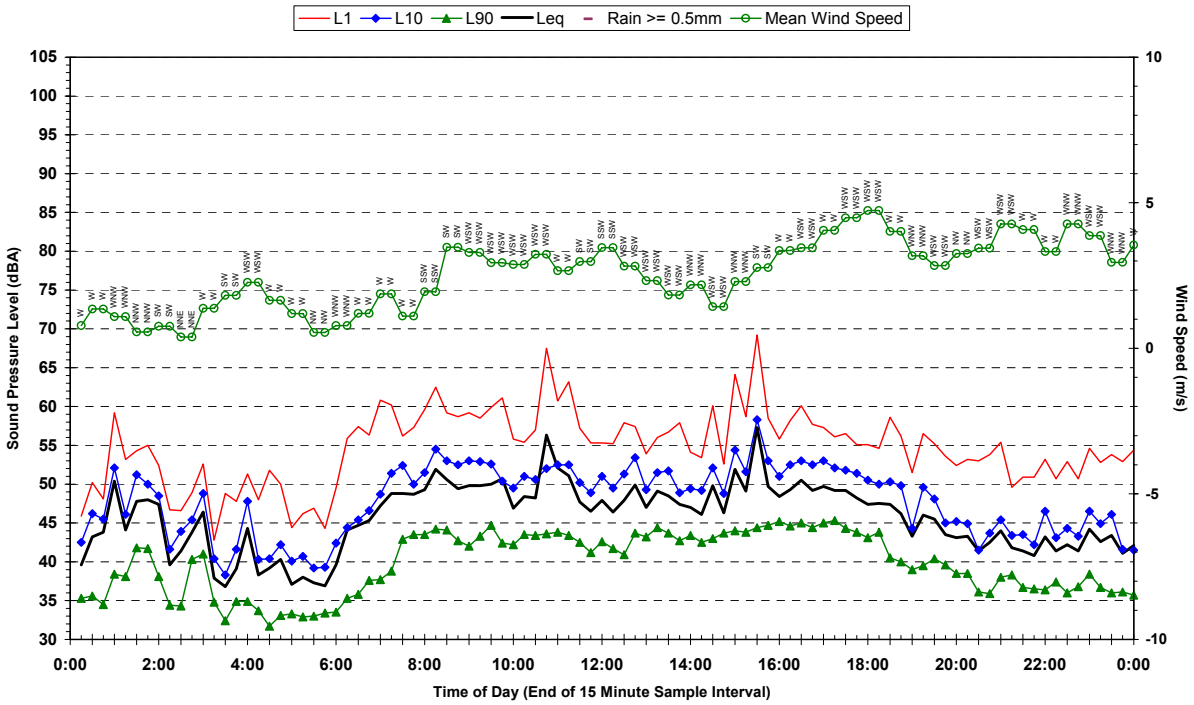
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Statistical Ambient Noise Levels Location K (Stocker)

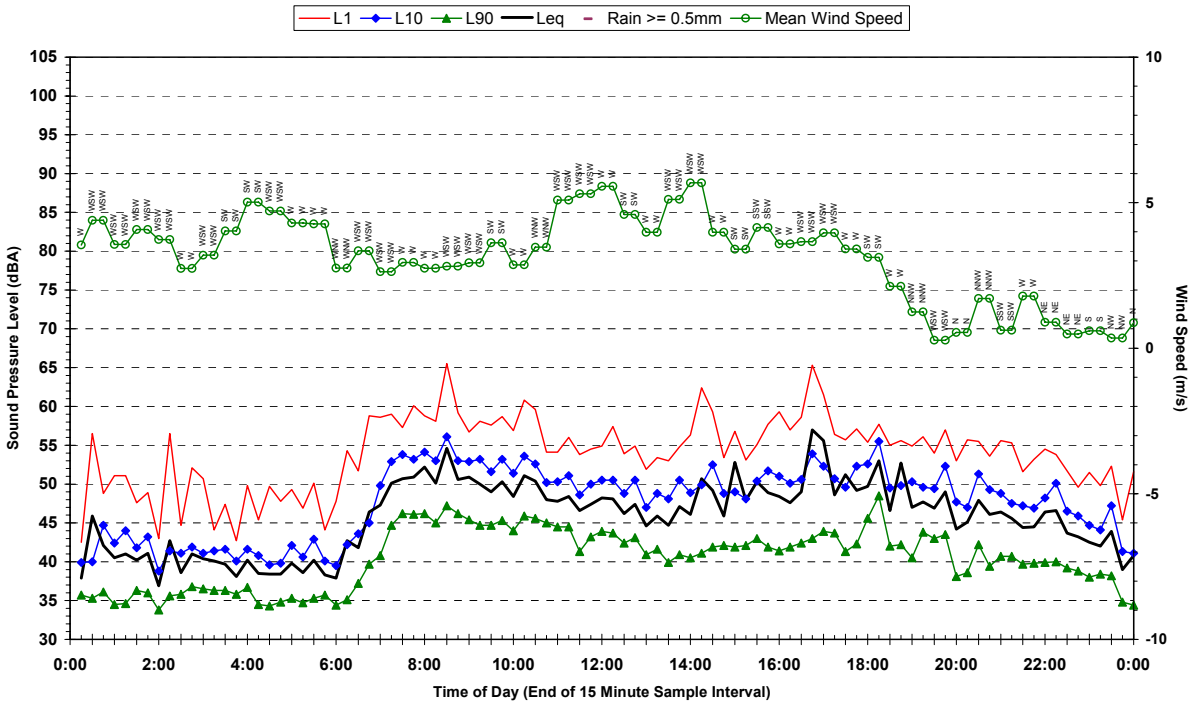
Statistical Ambient Noise Levels
Stocker - Tuesday 1 July 2003



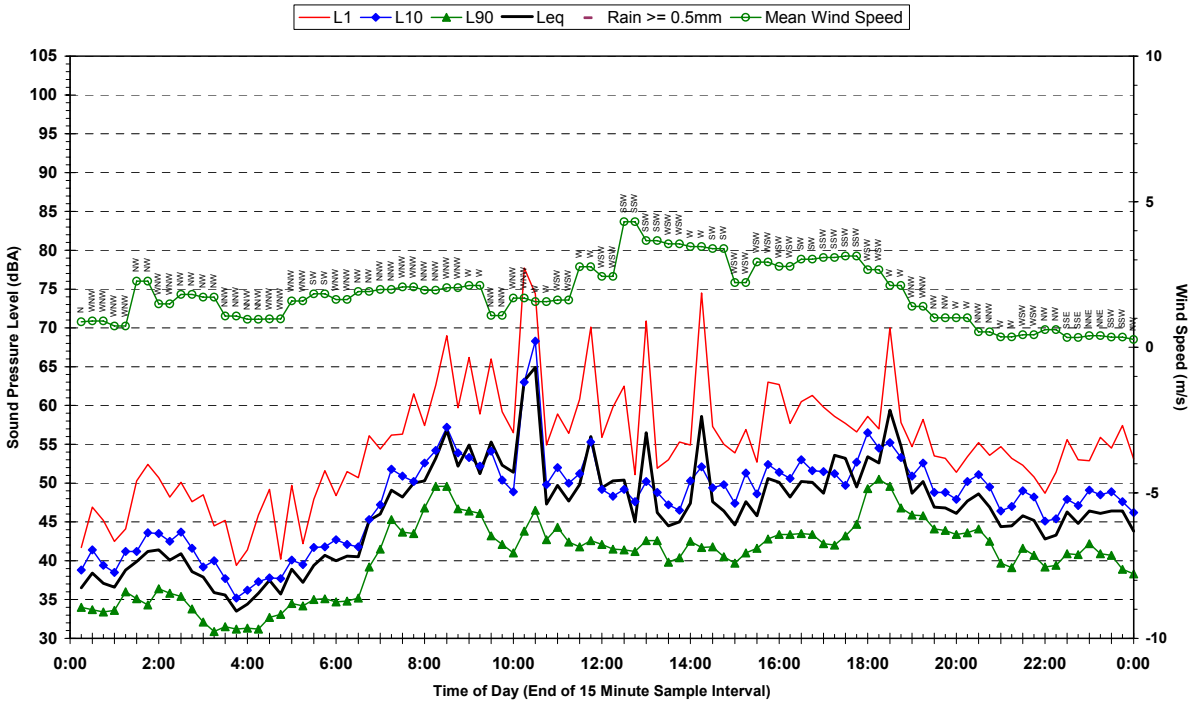
Statistical Ambient Noise Levels
Stocker - Wednesday 2 July 2003



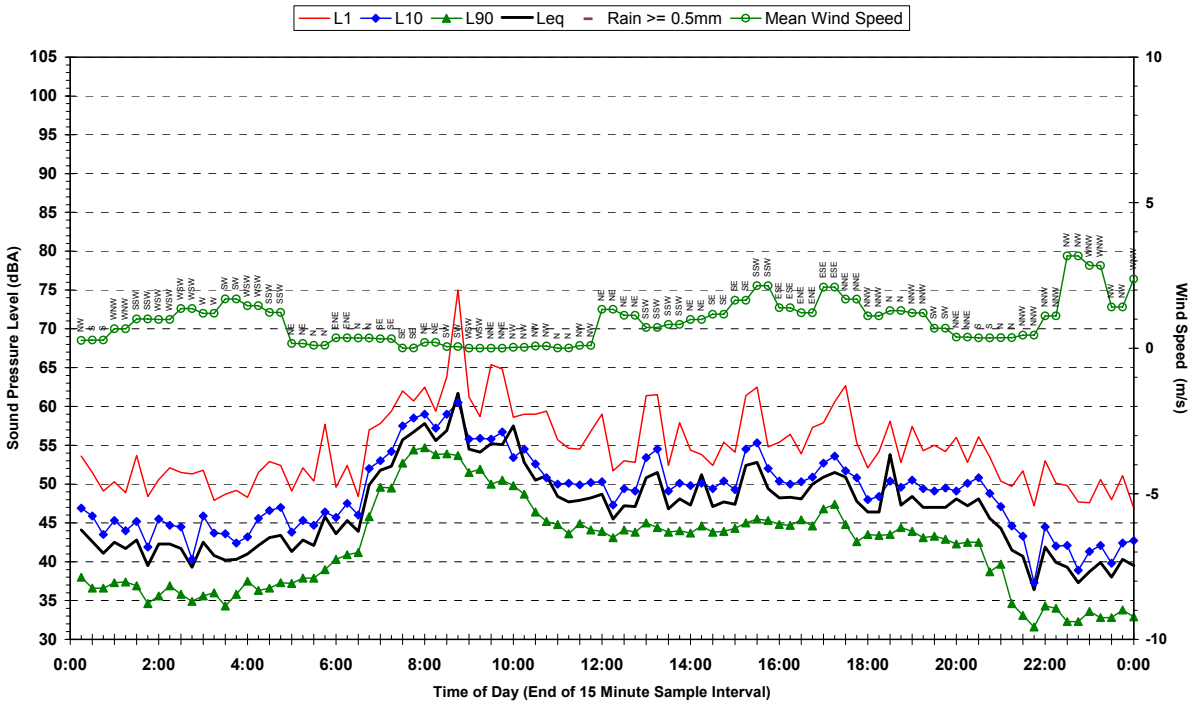
Statistical Ambient Noise Levels
Stocker - Thursday 3 July 2003



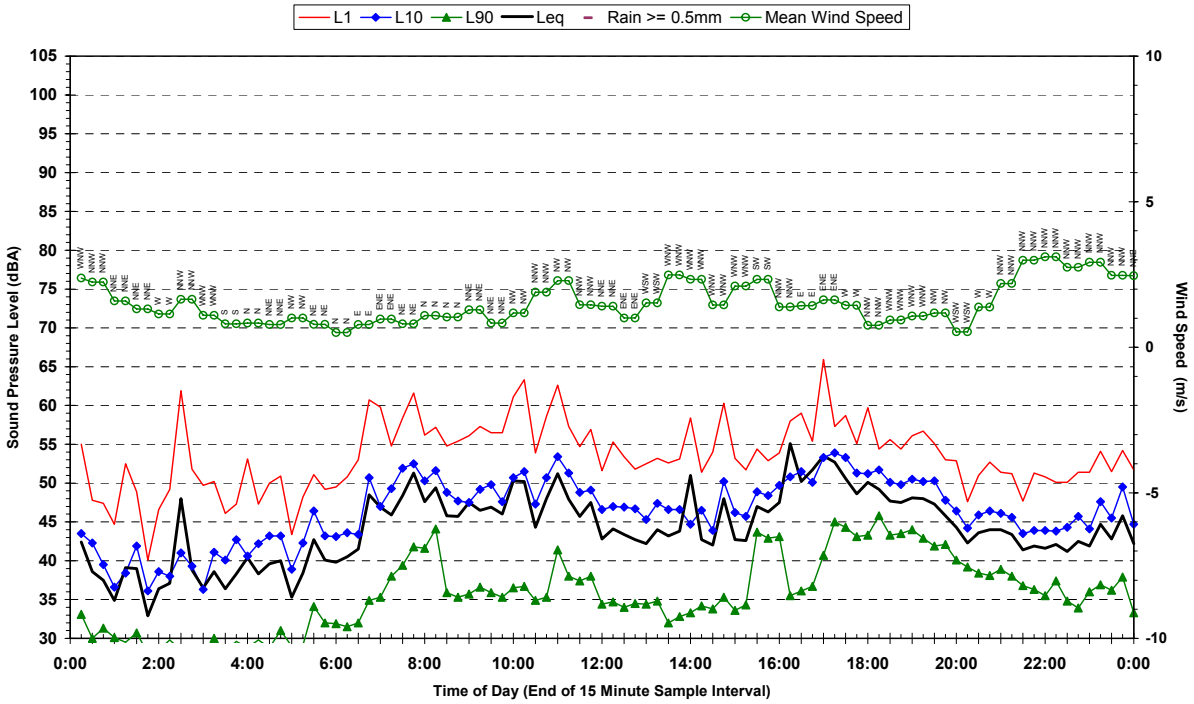
Statistical Ambient Noise Levels
Stocker - Friday 4 July 2003



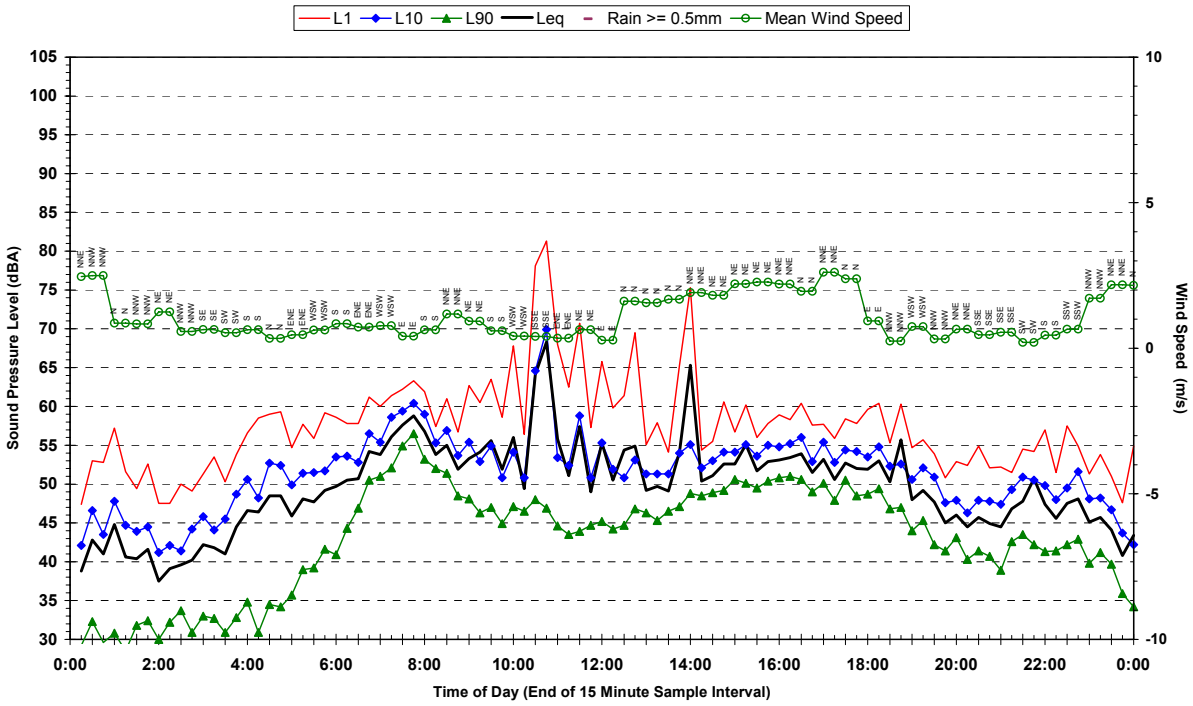
Statistical Ambient Noise Levels
Stocker - Saturday 5 July 2003



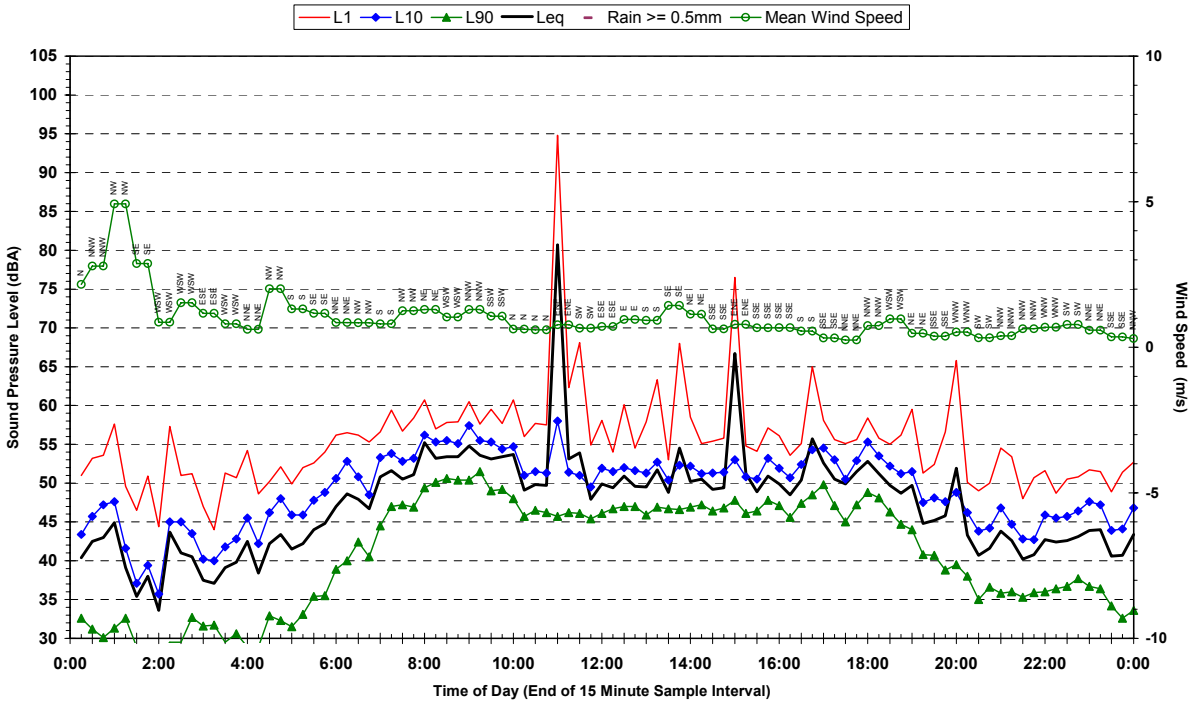
Statistical Ambient Noise Levels
Stocker - Sunday 6 July 2003



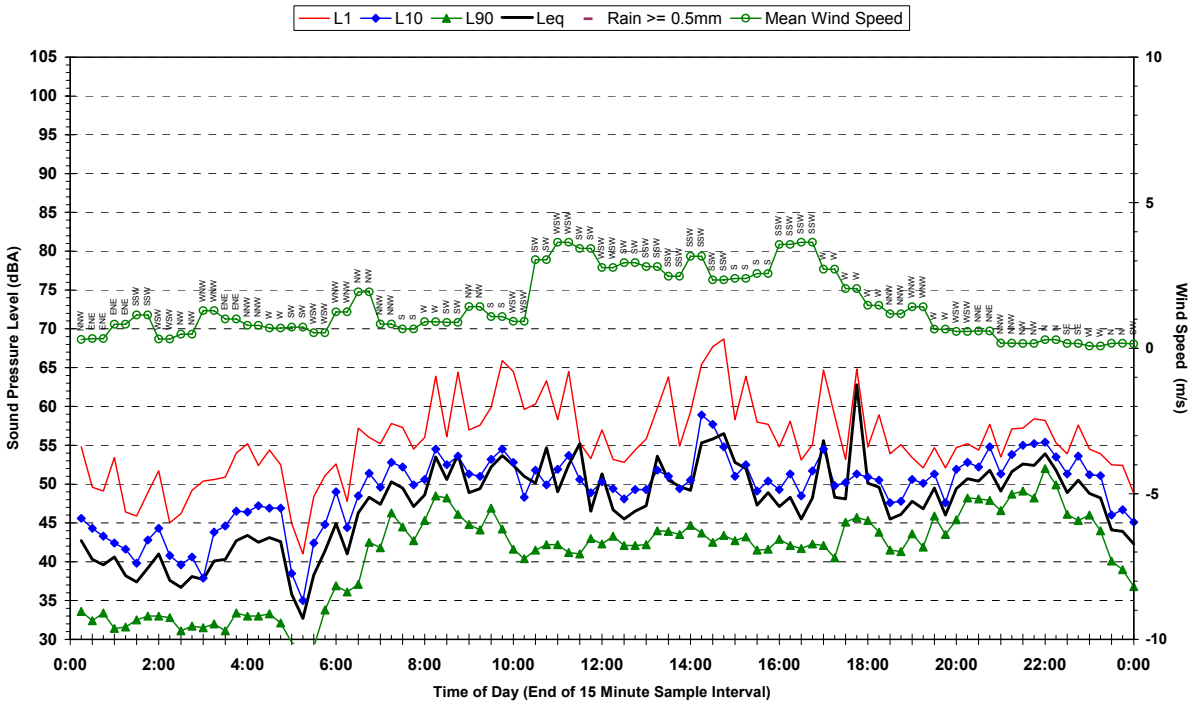
Statistical Ambient Noise Levels
Stocker - Monday 7 July 2003



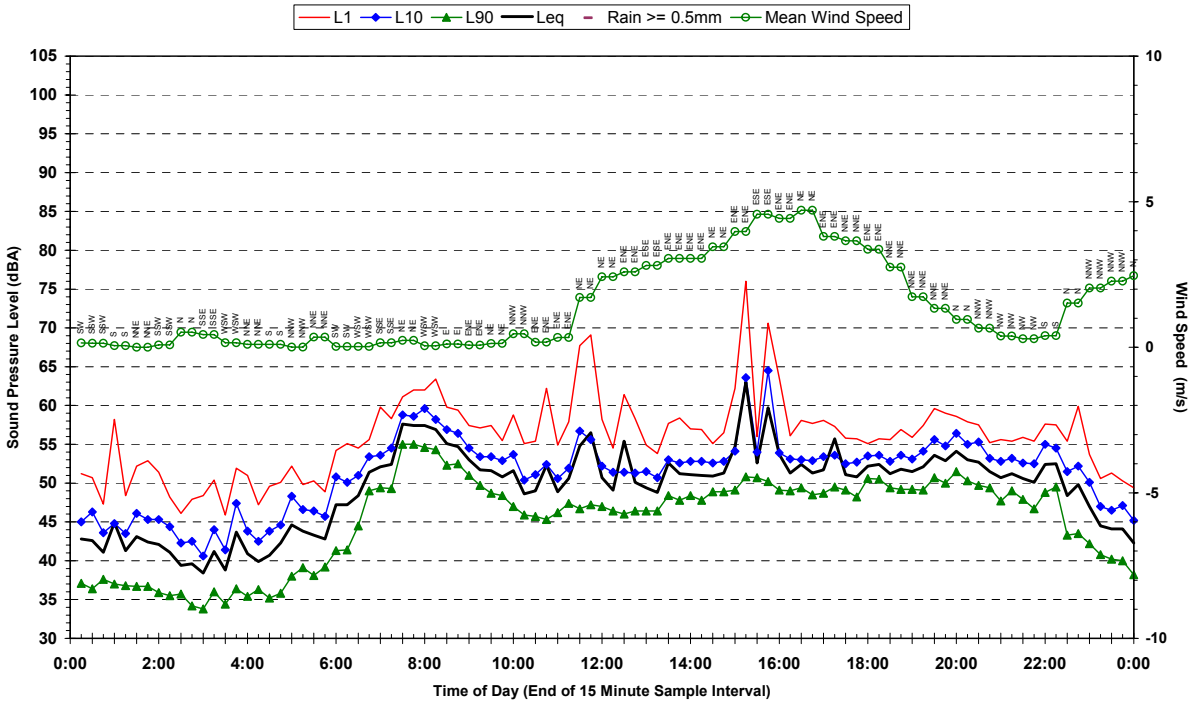
Statistical Ambient Noise Levels
Stocker - Tuesday 8 July 2003



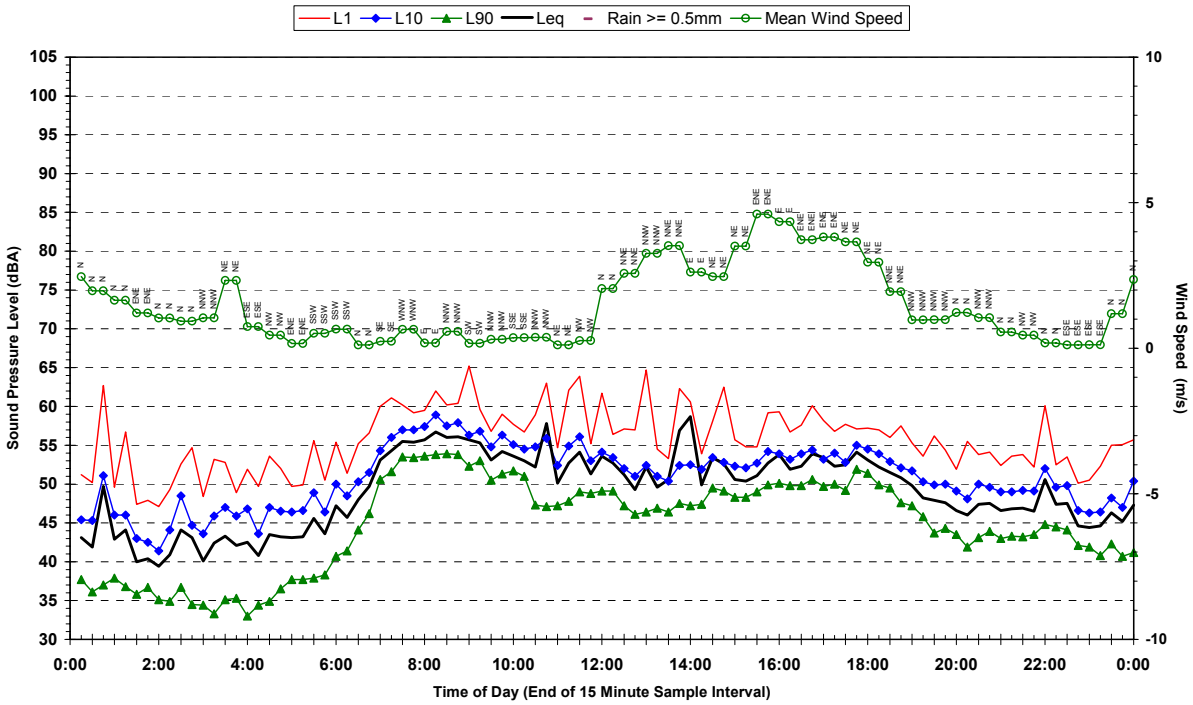
Statistical Ambient Noise Levels
Stocker - Wednesday 9 July 2003



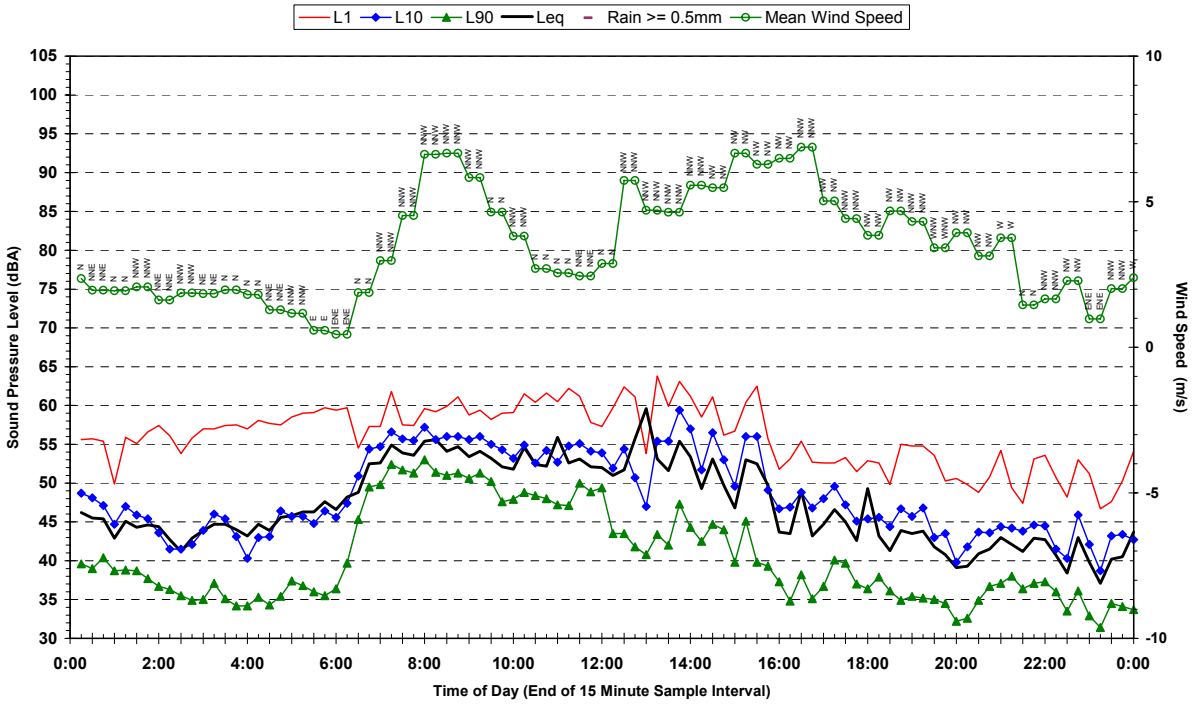
Statistical Ambient Noise Levels
Stocker - Thursday 10 July 2003



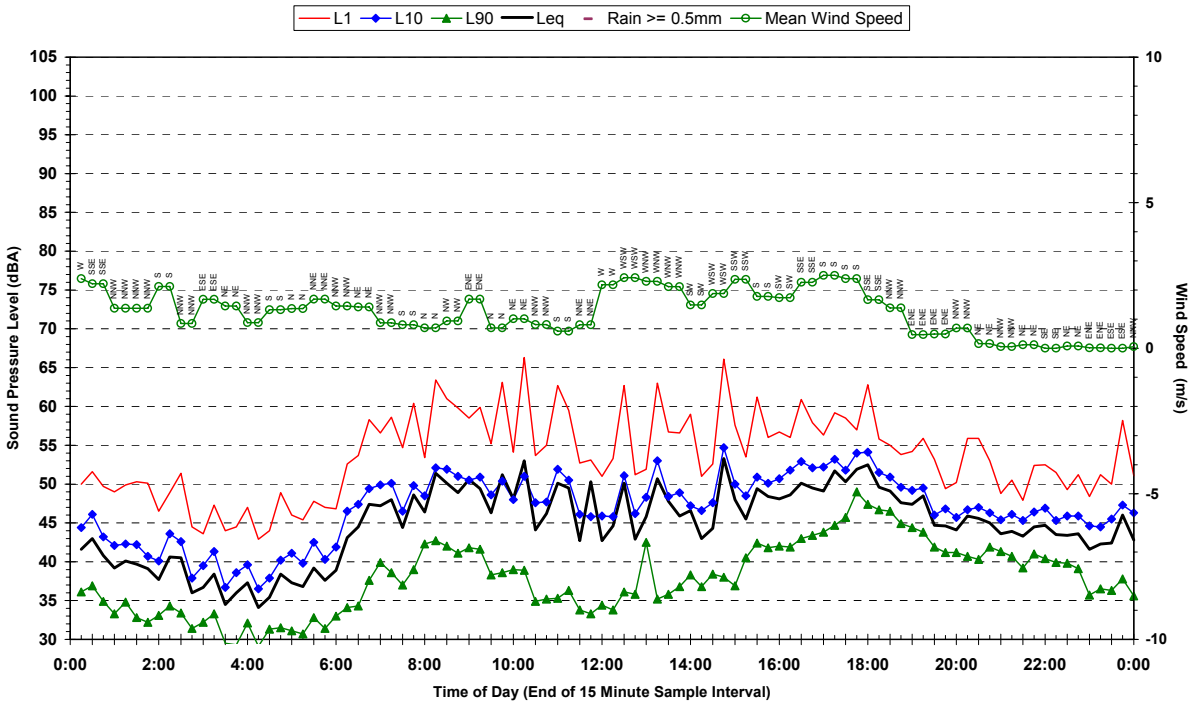
Statistical Ambient Noise Levels
Stocker - Friday 11 July 2003



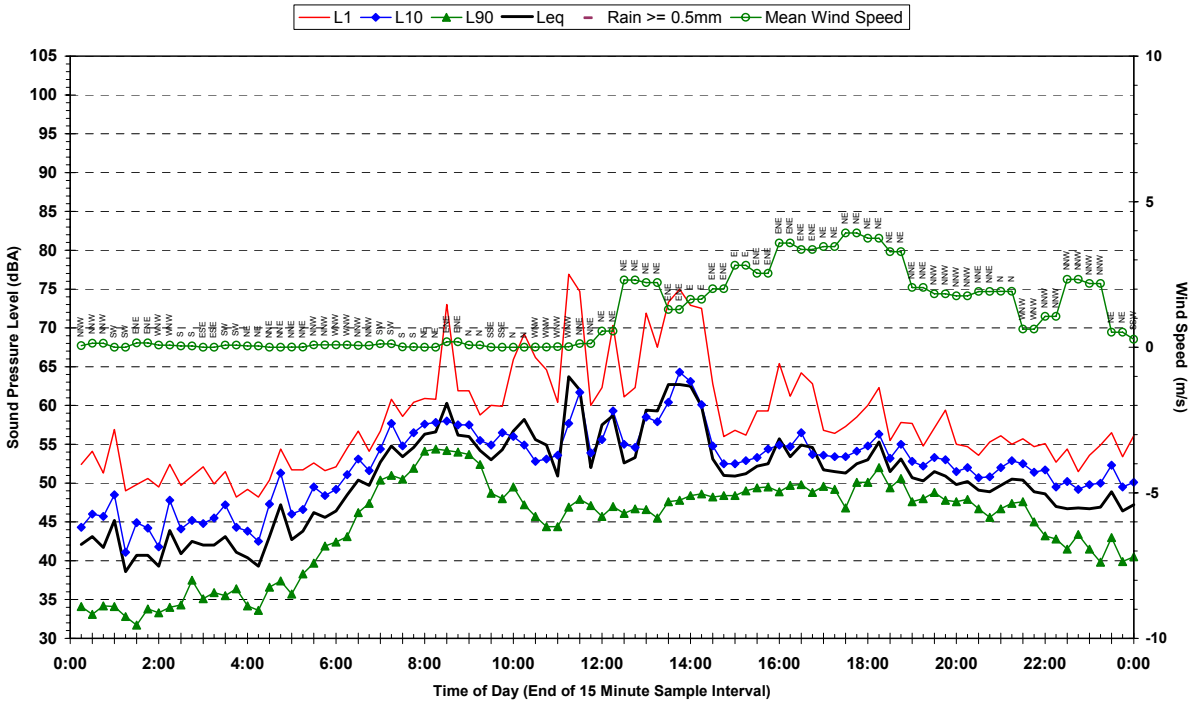
Statistical Ambient Noise Levels
Stocker - Saturday 12 July 2003



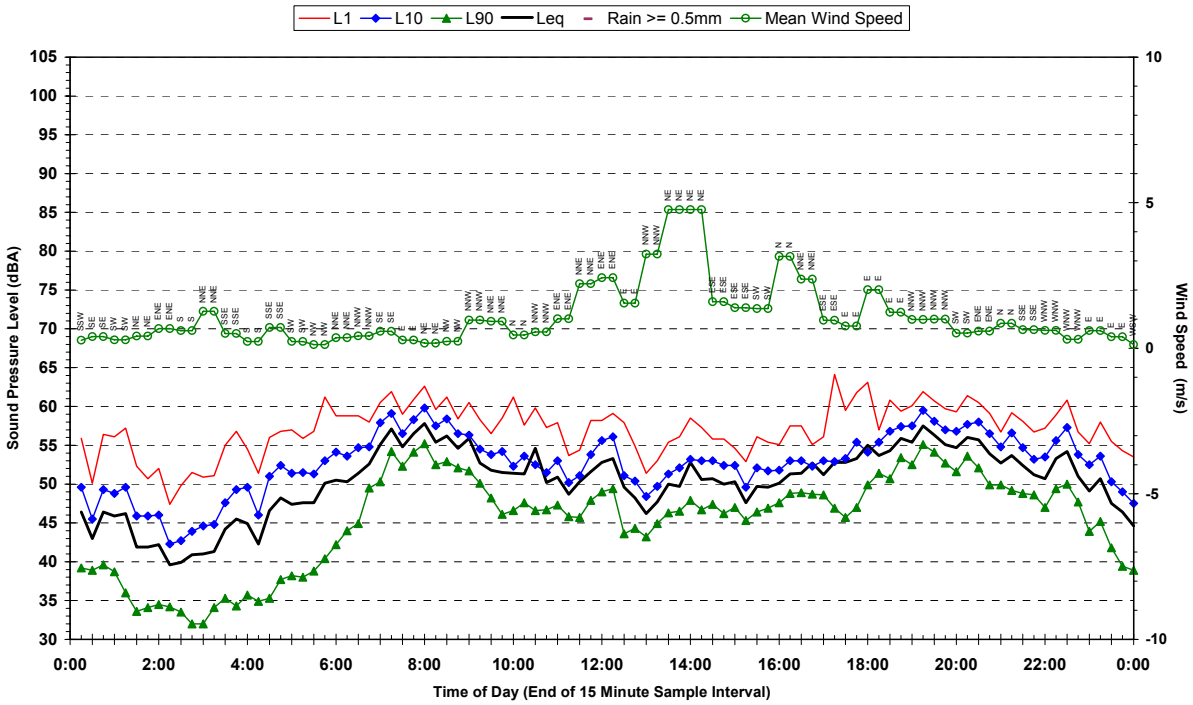
Statistical Ambient Noise Levels
Stocker - Sunday 13 July 2003



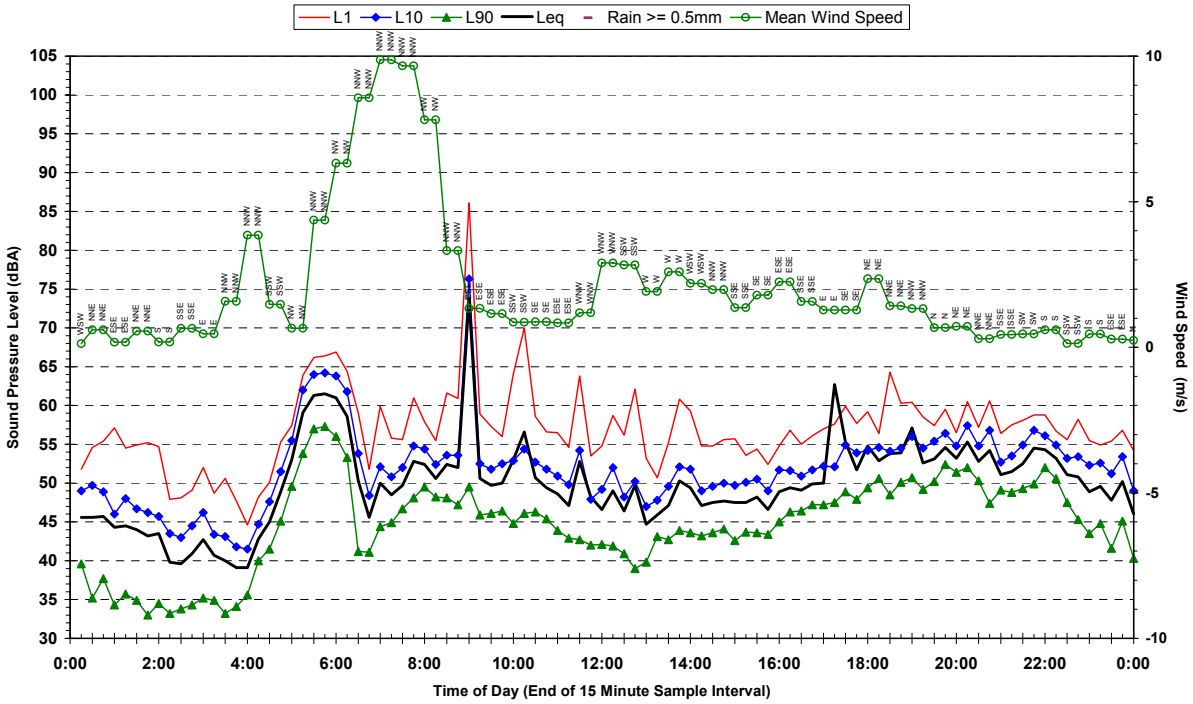
Statistical Ambient Noise Levels
Stocker - Monday 14 July 2003



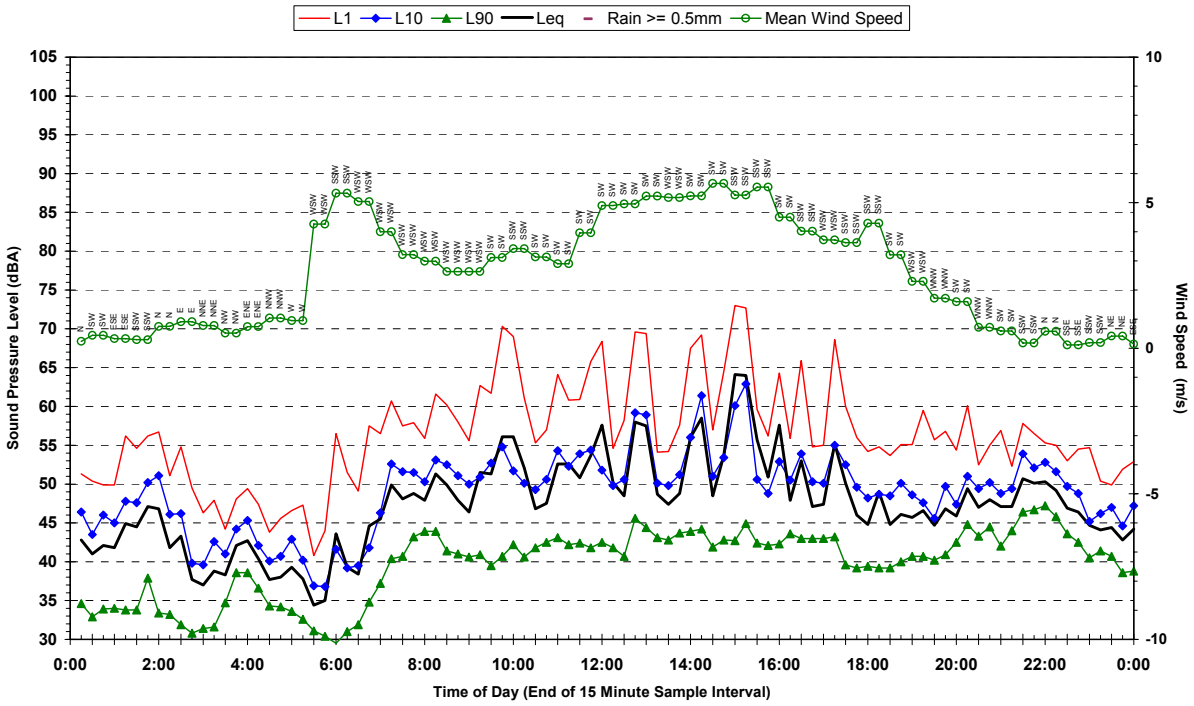
Statistical Ambient Noise Levels
Stocker - Tuesday 15 July 2003



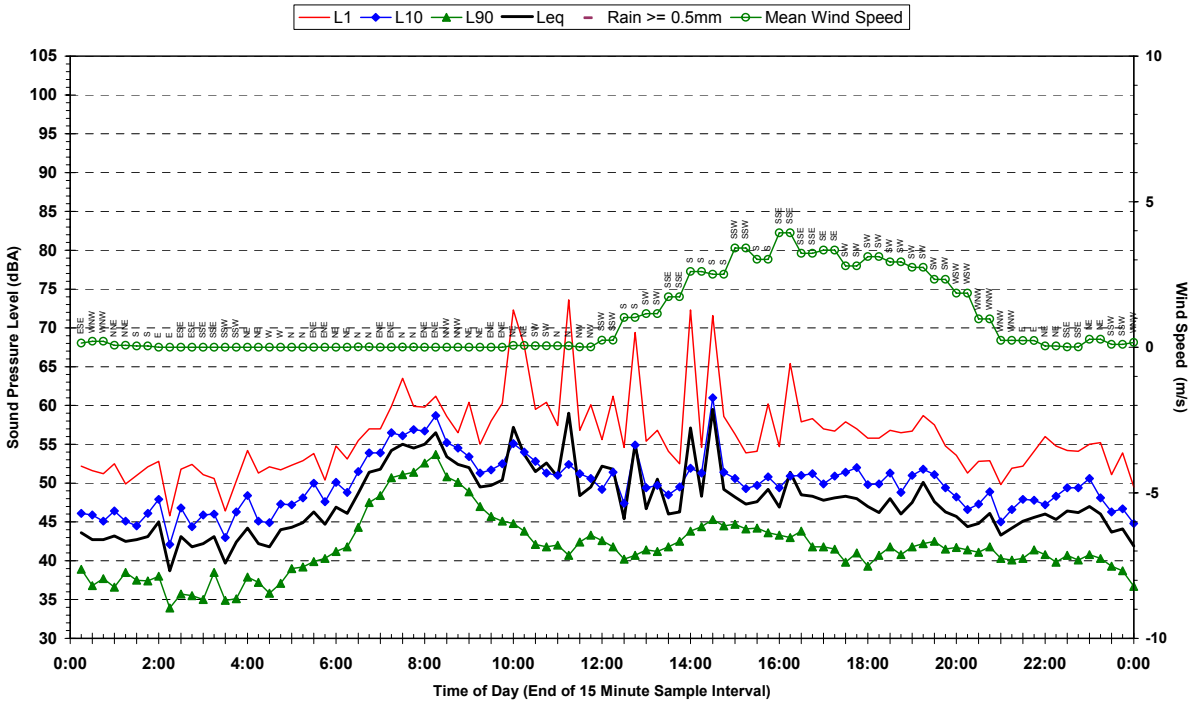
Statistical Ambient Noise Levels
Stocker - Wednesday 16 July 2003



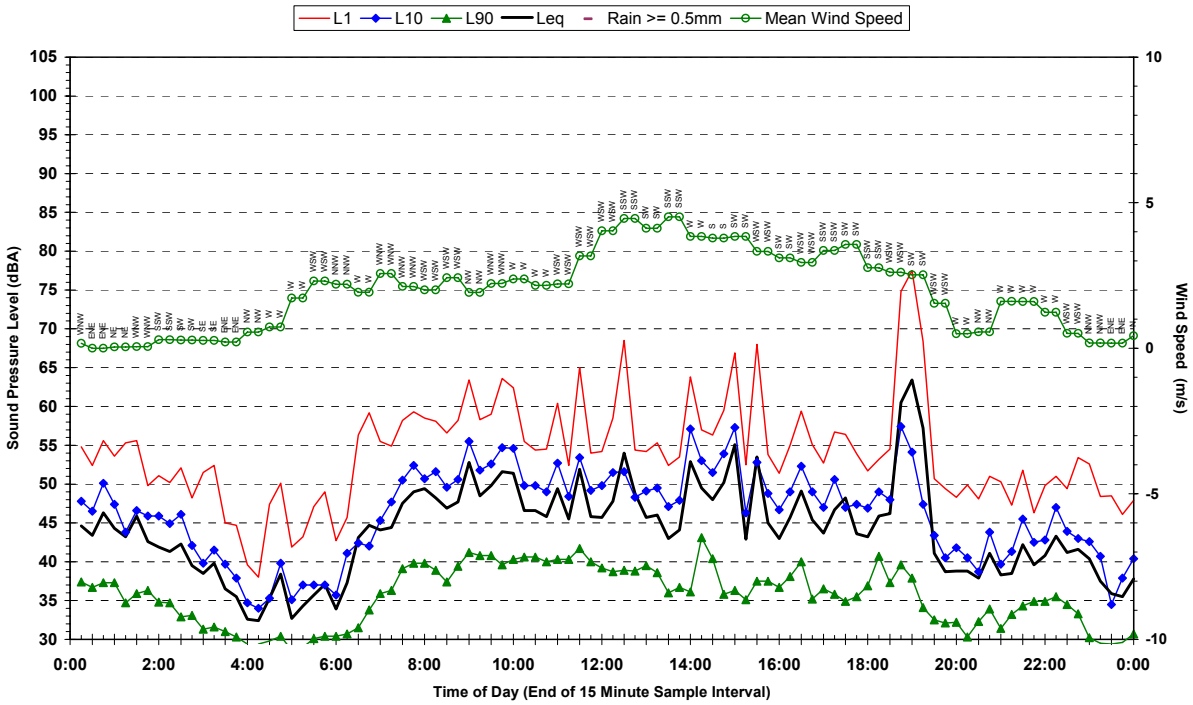
Statistical Ambient Noise Levels
Stocker - Thursday 17 July 2003



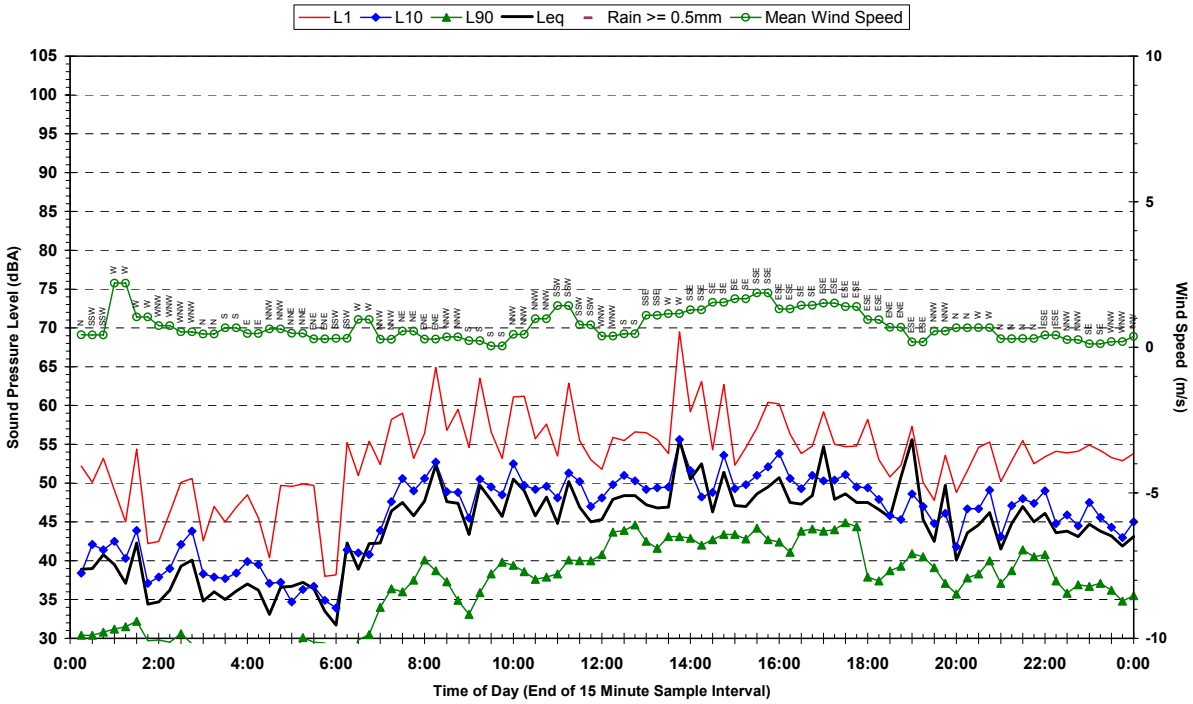
Statistical Ambient Noise Levels
Stocker - Friday 18 July 2003



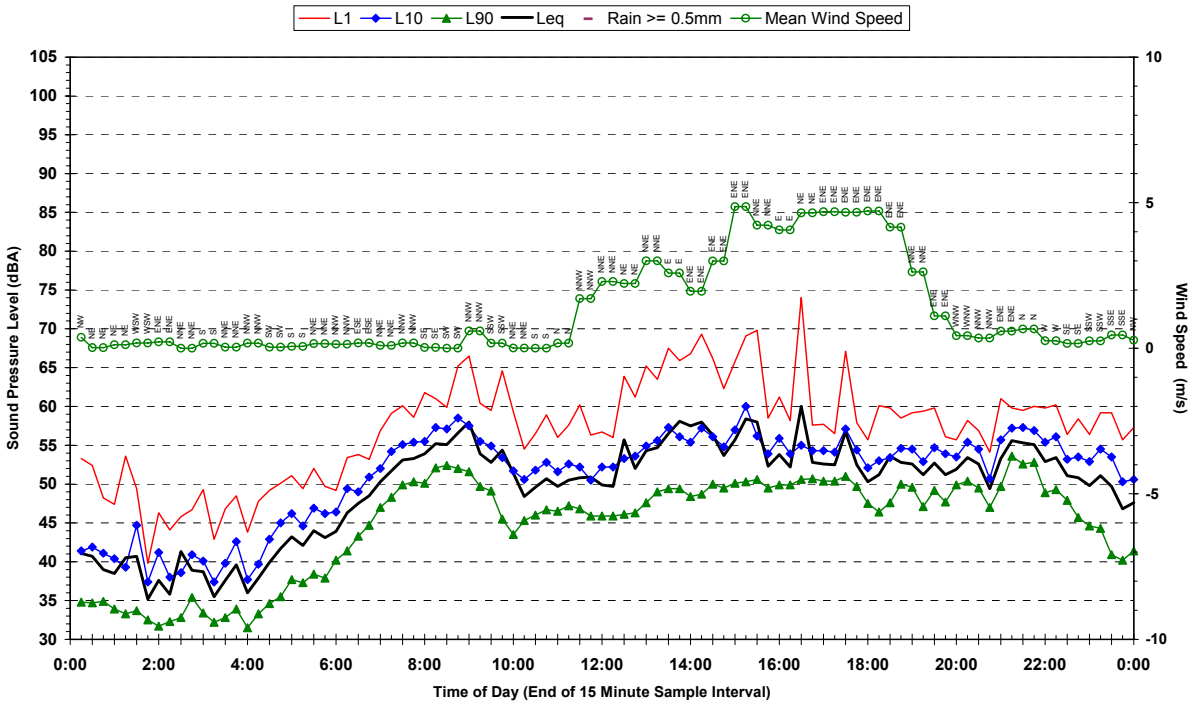
Statistical Ambient Noise Levels
Stocker - Saturday 19 July 2003



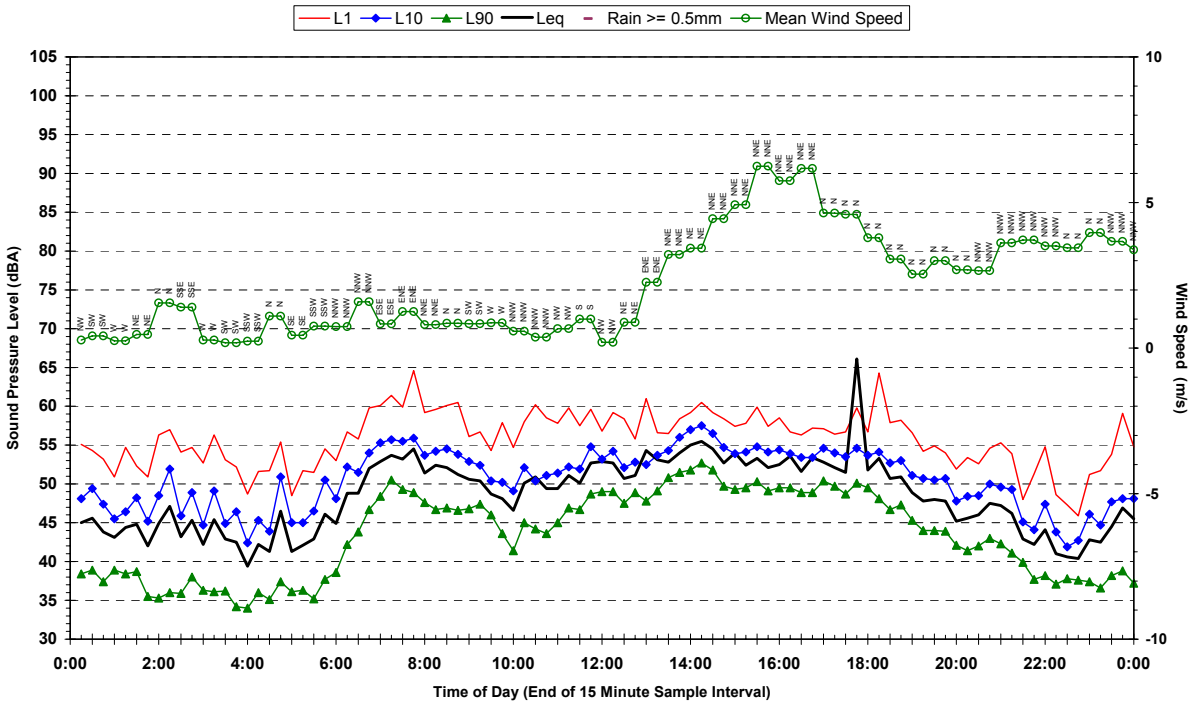
Statistical Ambient Noise Levels
Stocker - Sunday 20 July 2003



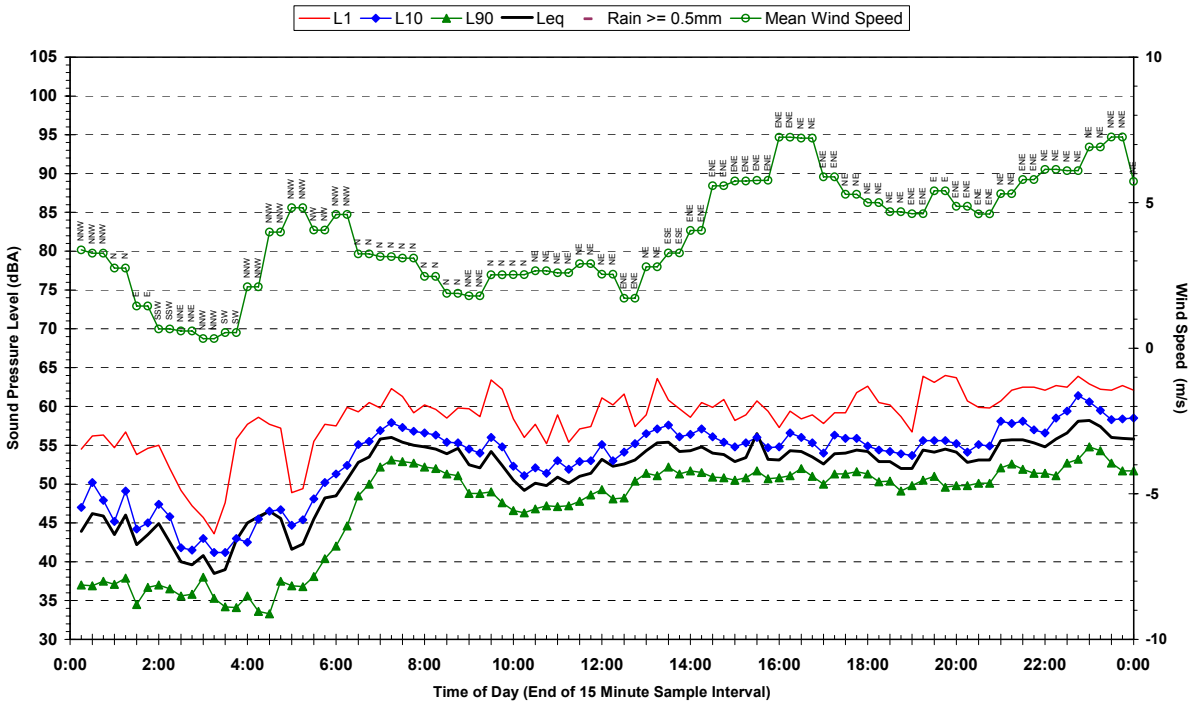
Statistical Ambient Noise Levels
Stocker - Monday 21 July 2003



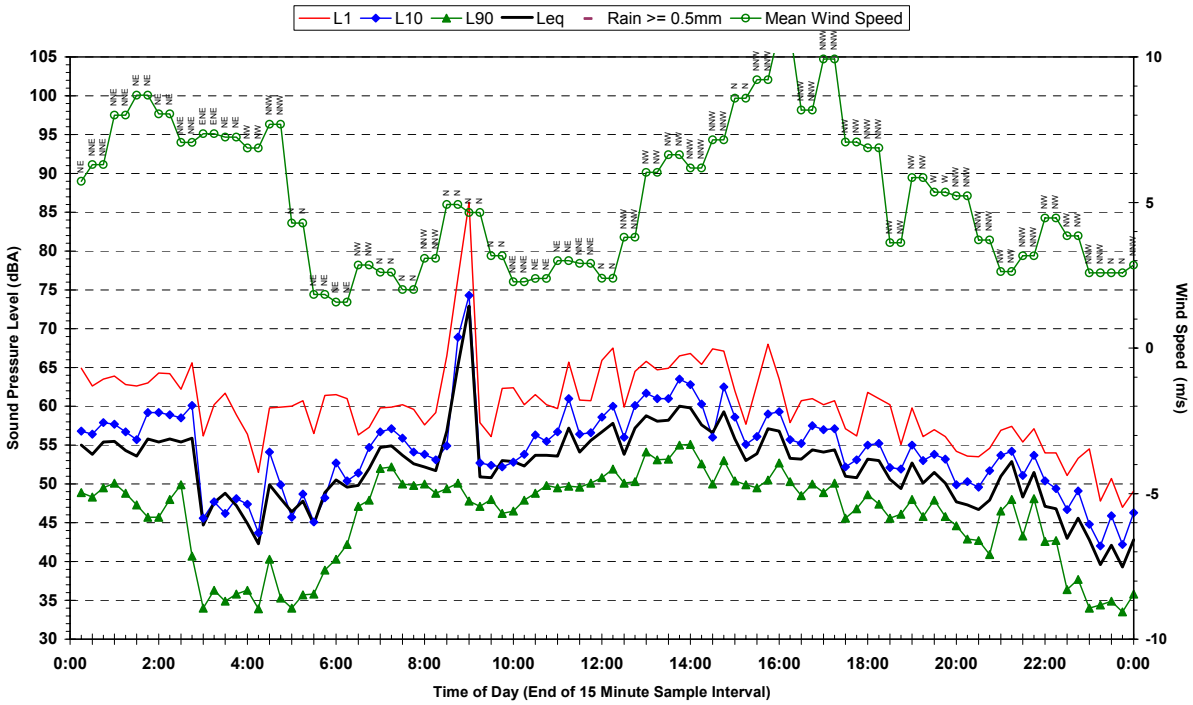
Statistical Ambient Noise Levels
Stocker - Tuesday 22 July 2003



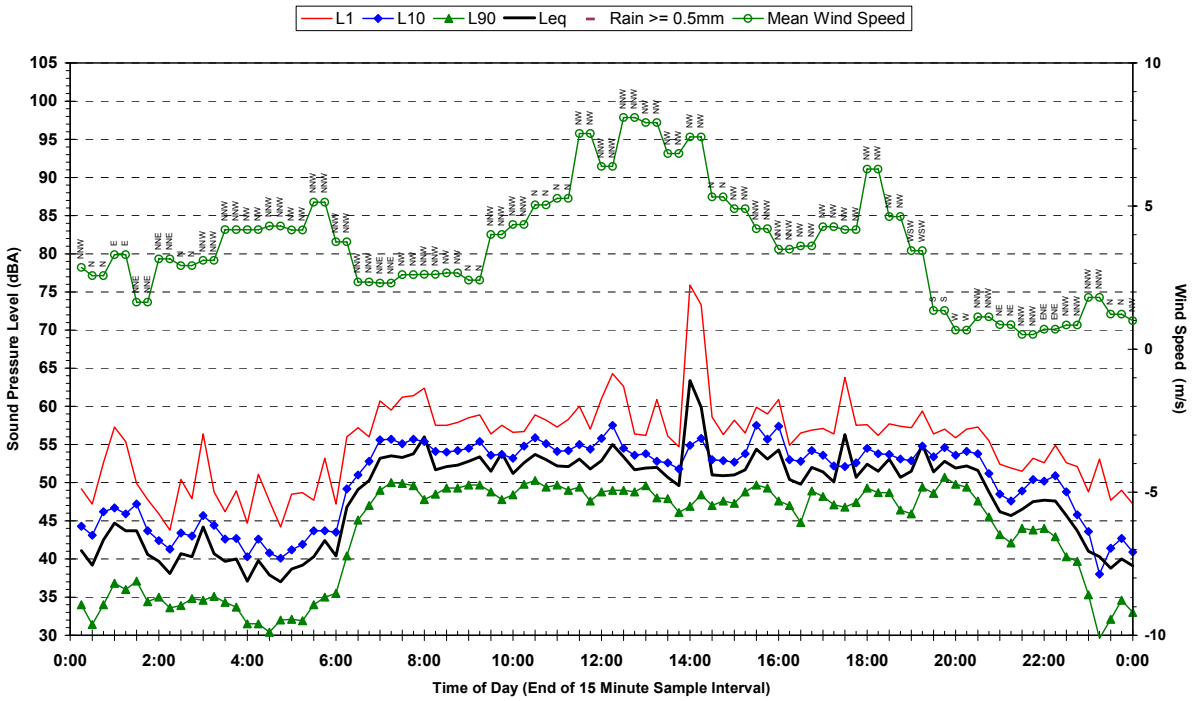
Statistical Ambient Noise Levels
Stocker - Wednesday 23 July 2003



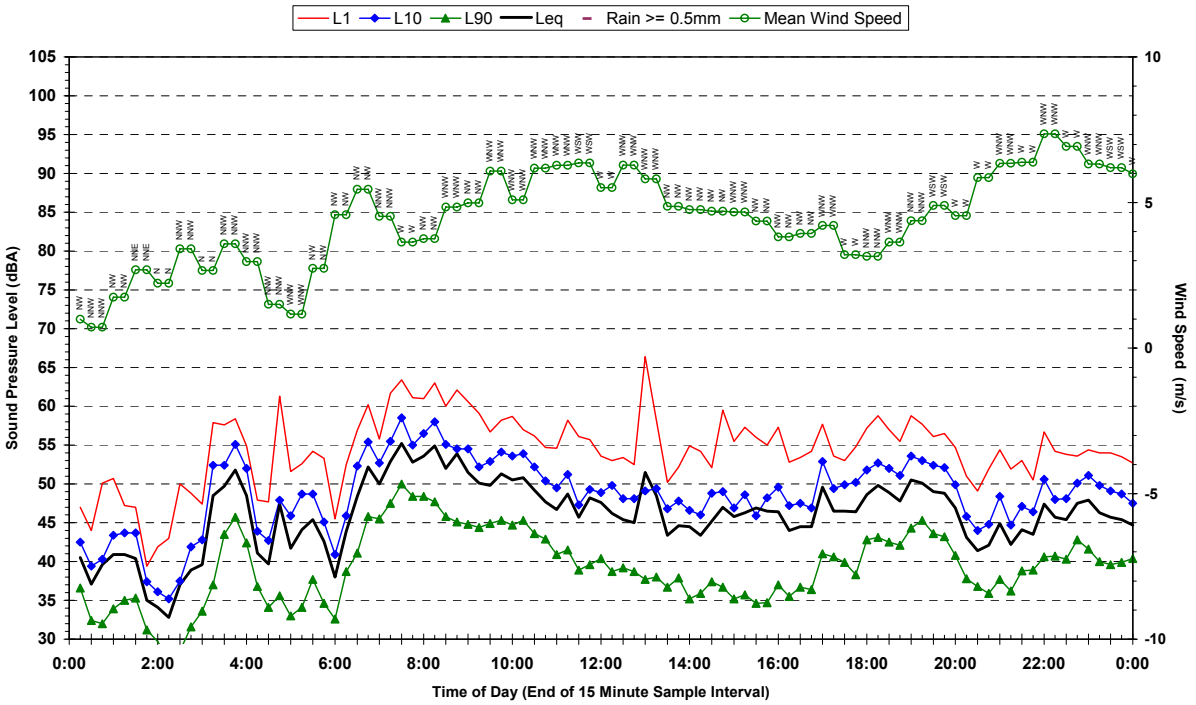
Statistical Ambient Noise Levels
Stocker - Thursday 24 July 2003



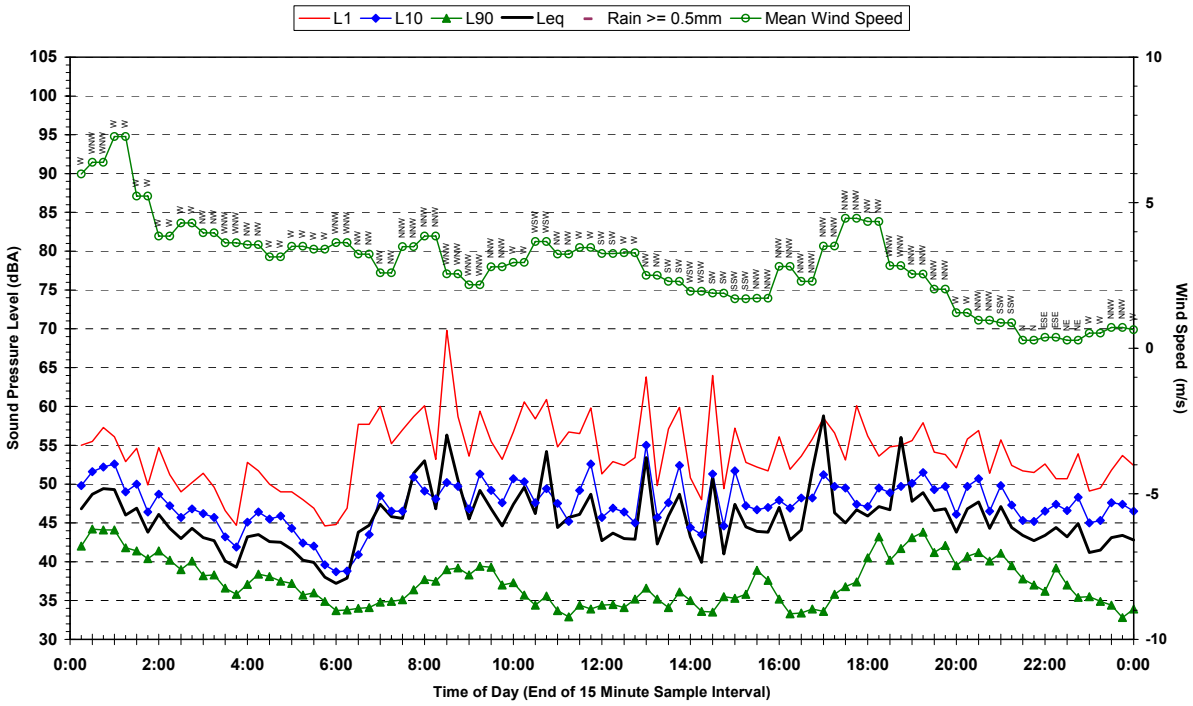
Statistical Ambient Noise Levels
Stocker - Friday 25 July 2003



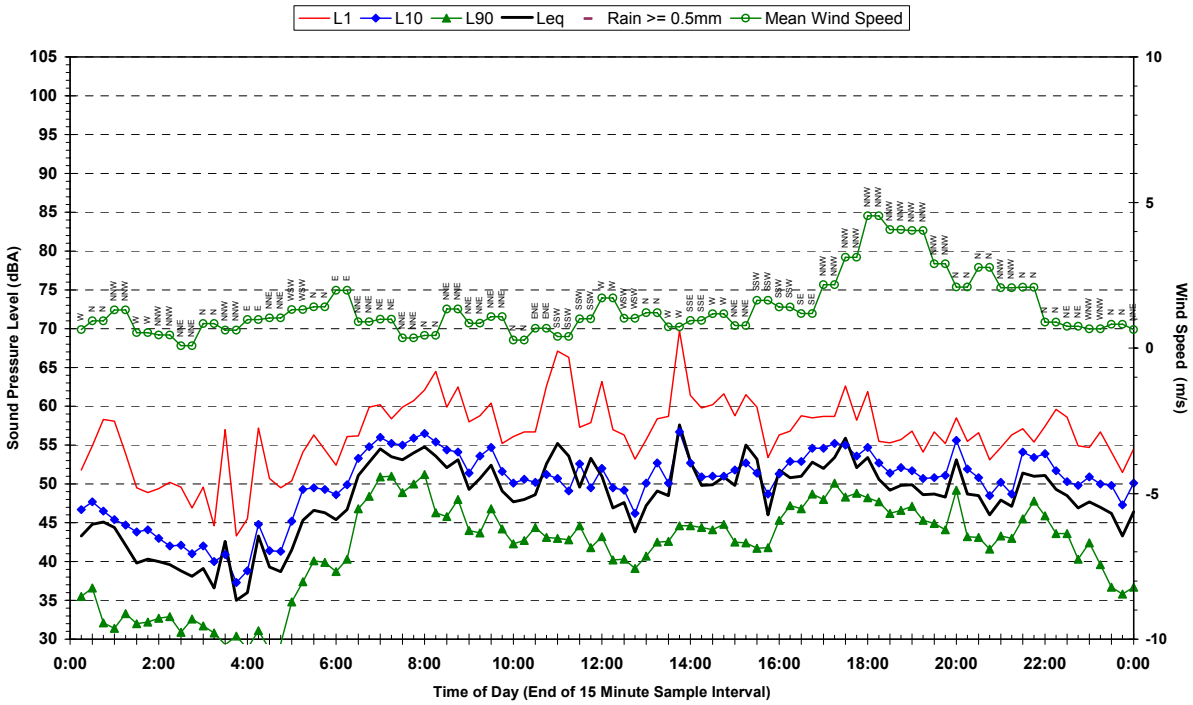
Statistical Ambient Noise Levels
Stocker - Saturday 26 July 2003



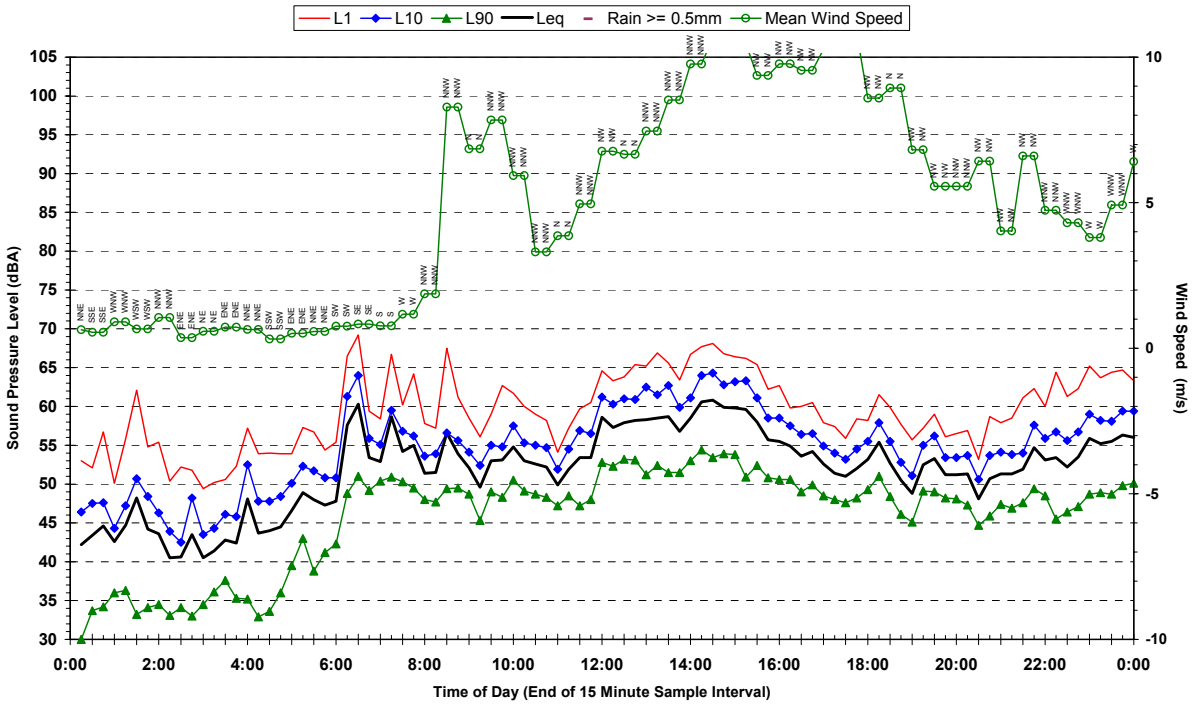
Statistical Ambient Noise Levels
Stocker - Sunday 27 July 2003



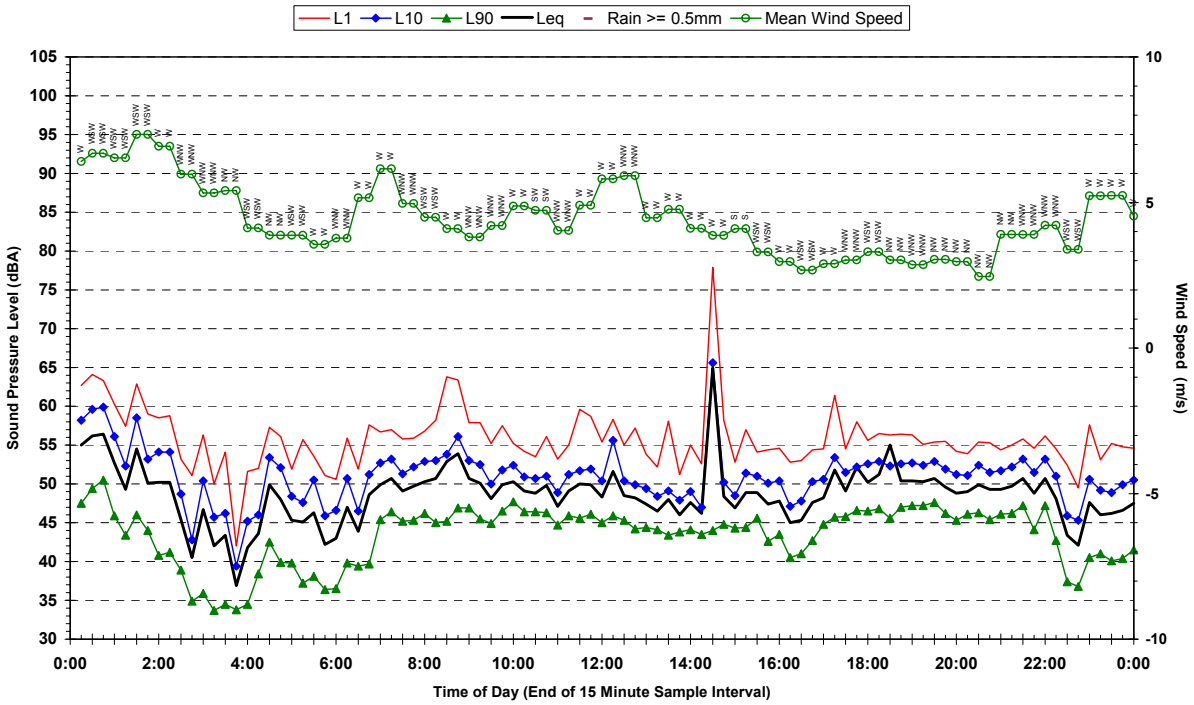
Statistical Ambient Noise Levels
Stocker - Monday 28 July 2003



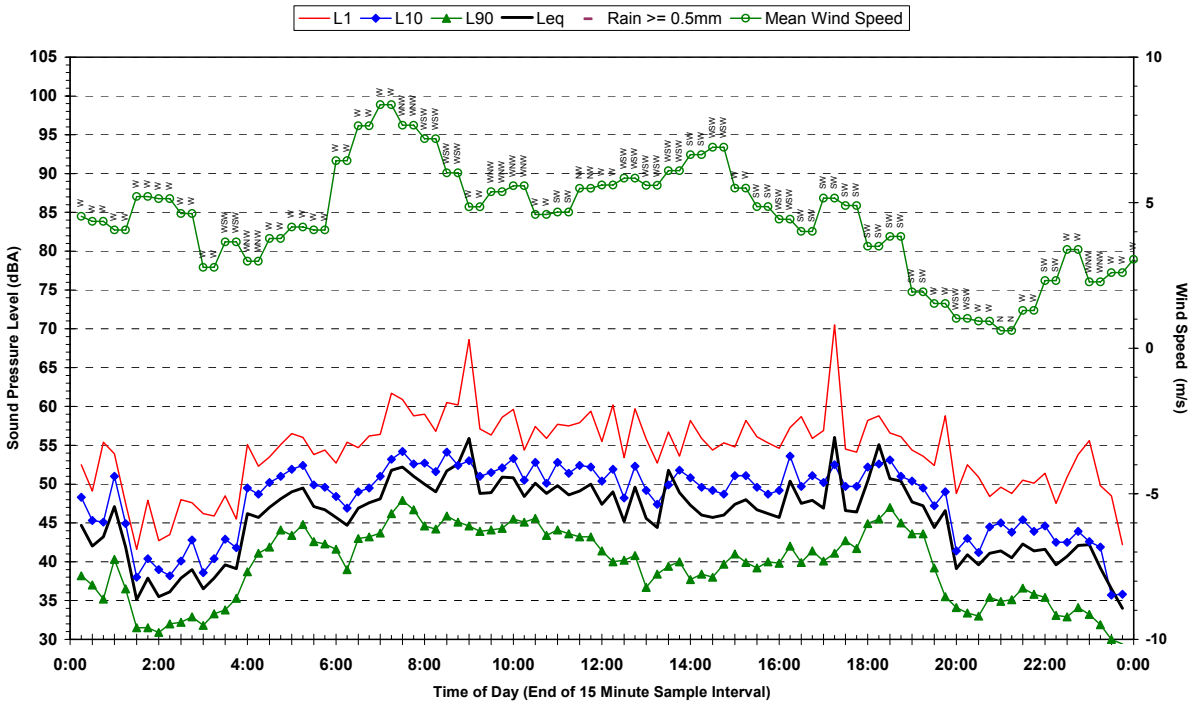
Statistical Ambient Noise Levels
Stocker - Tuesday 29 July 2003



Statistical Ambient Noise Levels
Stocker - Wednesday 30 July 2003



Statistical Ambient Noise Levels
Stocker - Thursday 31 July 2003

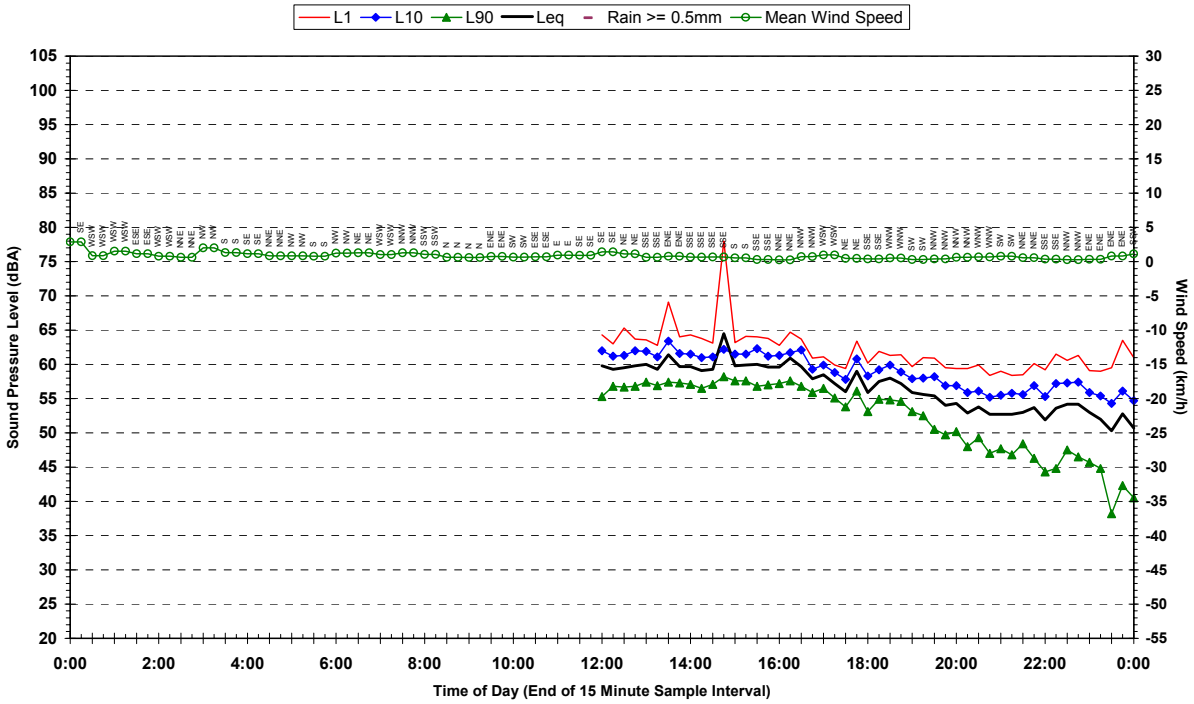


APPENDIX D

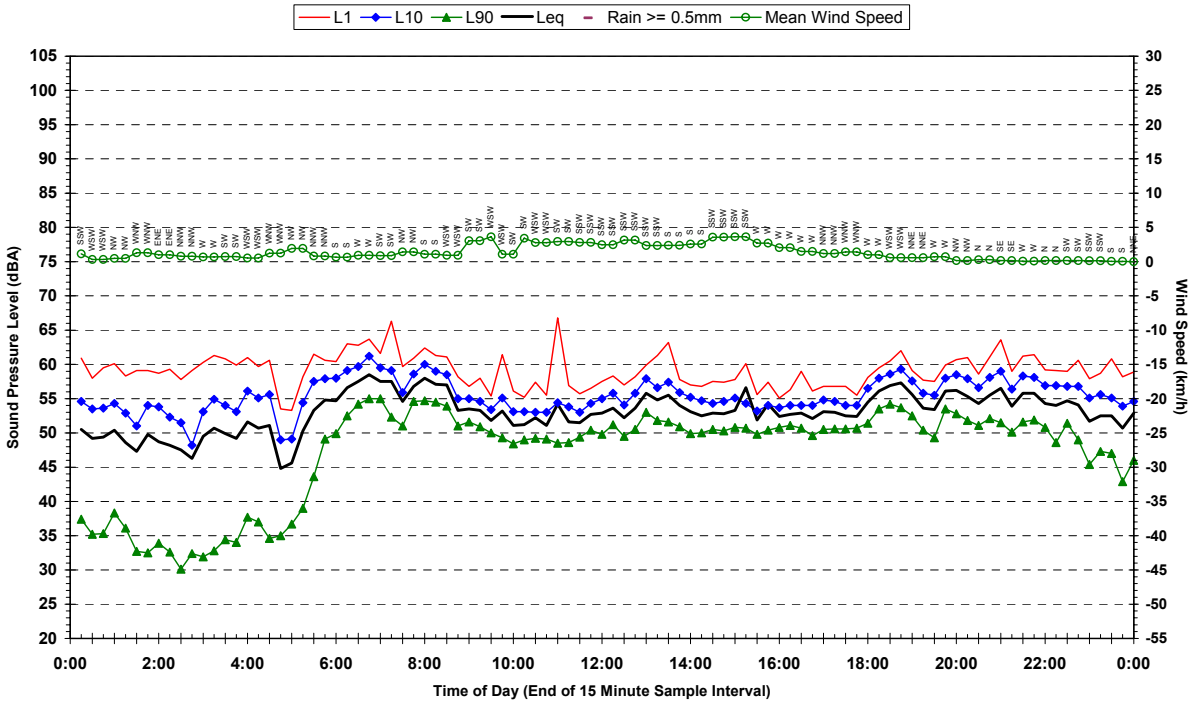
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Statistical Ambient Noise Levels Location J (Creagan)

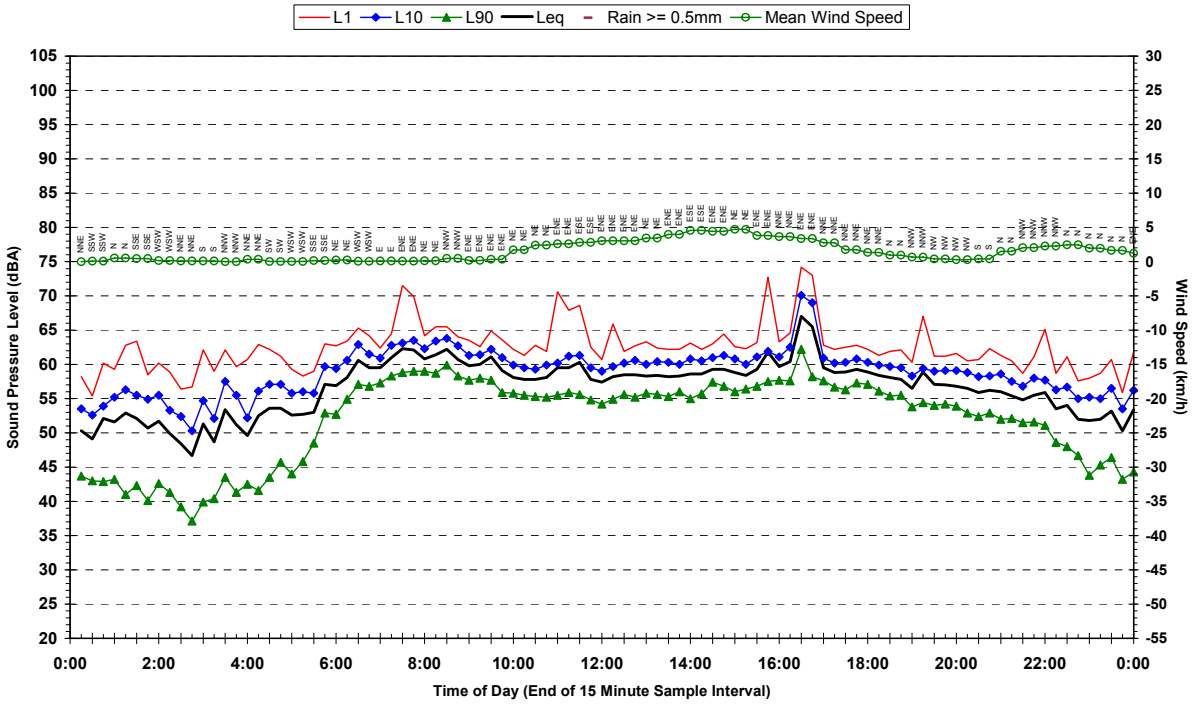
Statistical Ambient Noise Levels
Creagan Trial Period - Tuesday 8 July 2003



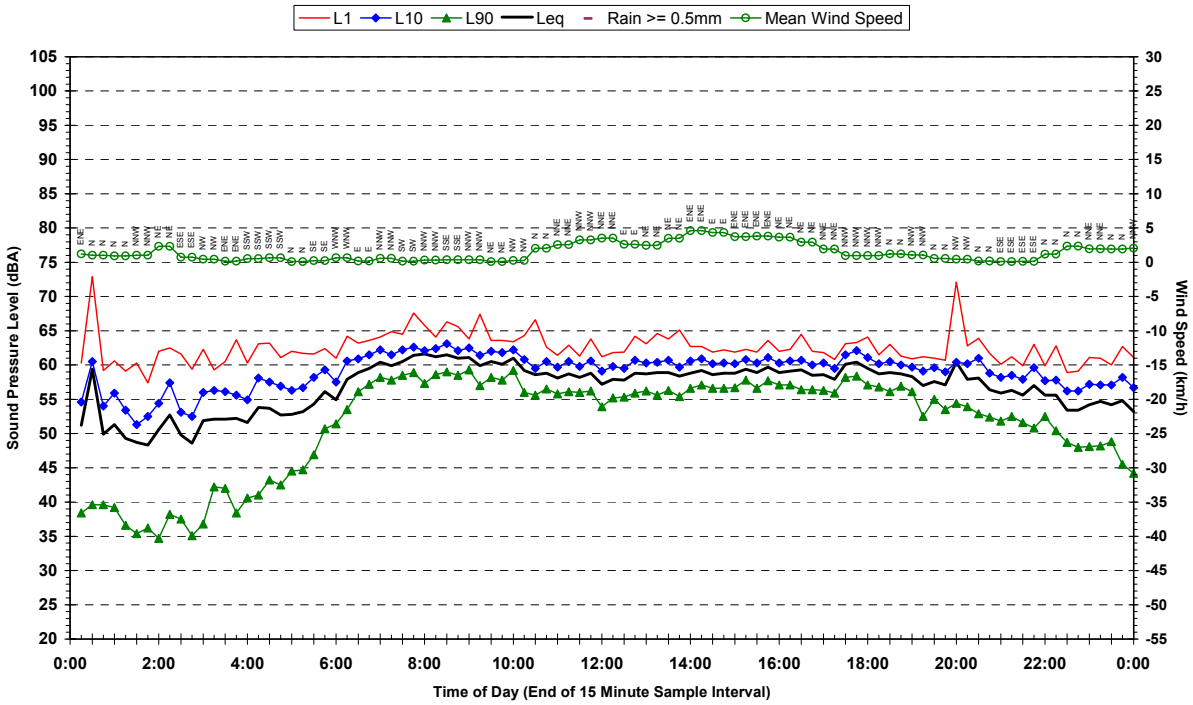
Statistical Ambient Noise Levels
Creagan Trial Period - Wednesday 9 July 2003



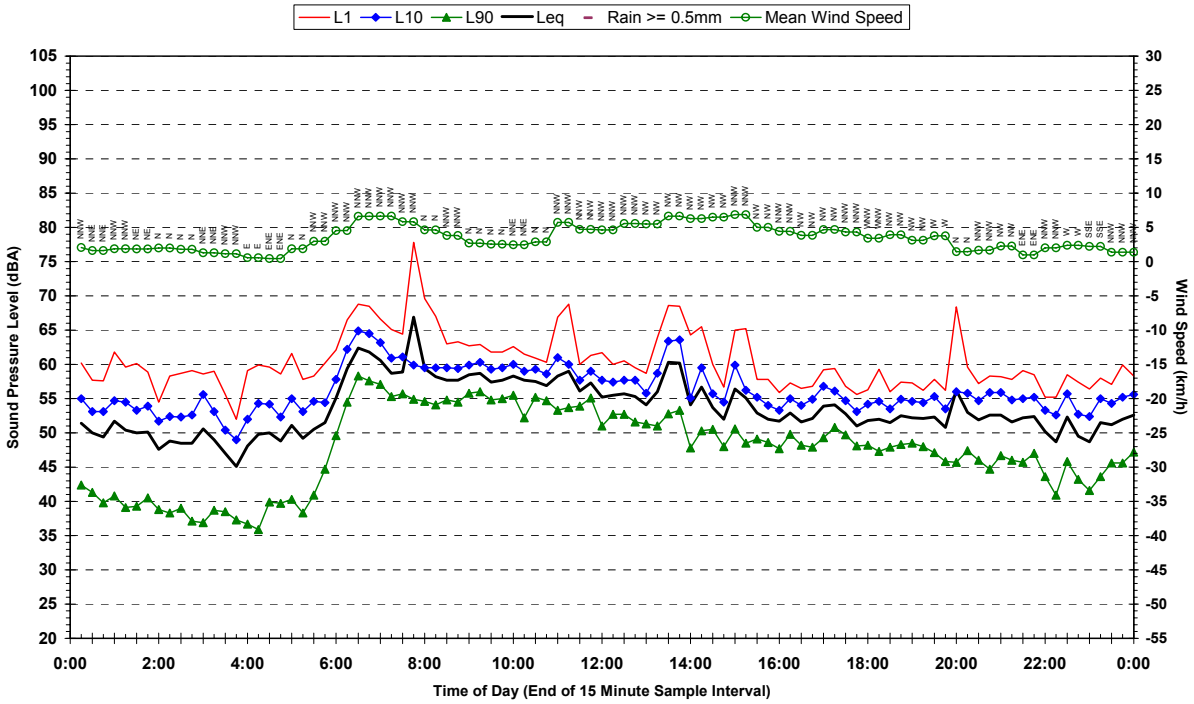
Statistical Ambient Noise Levels
Creagan Trial Period - Thursday 10 July 2003



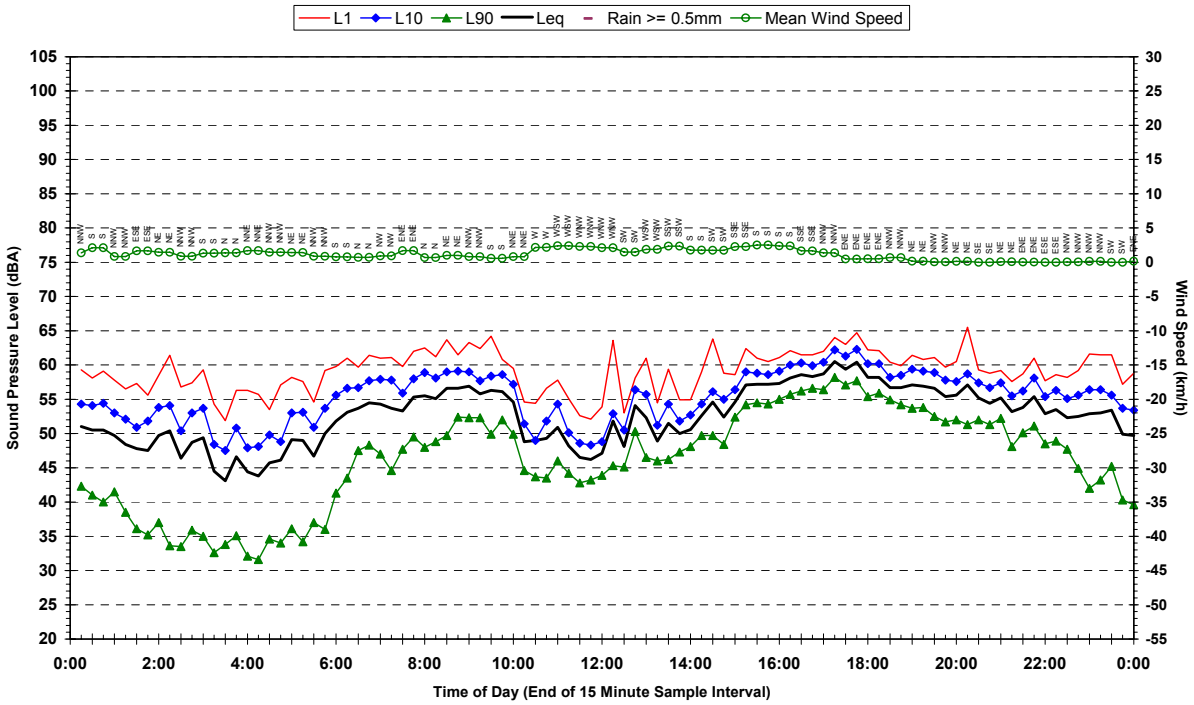
Statistical Ambient Noise Levels
Creagan Trial Period - Friday 11 July 2003



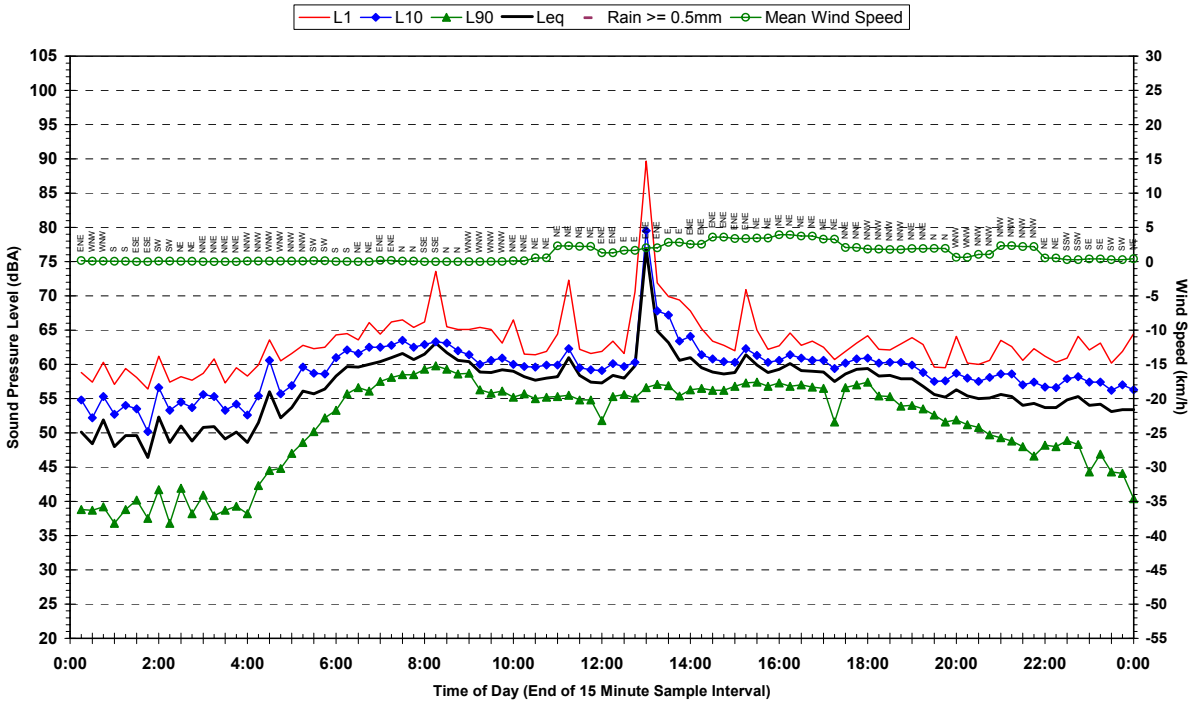
Statistical Ambient Noise Levels
Creagan Trial Period - Saturday 12 July 2003



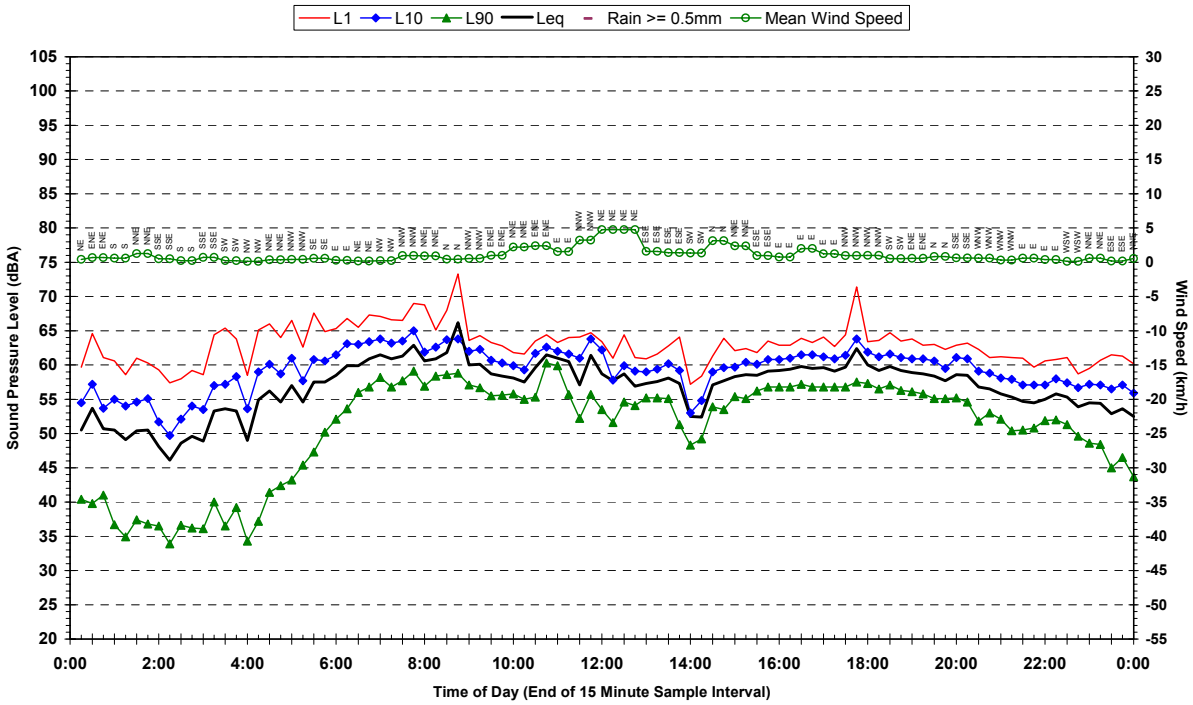
Statistical Ambient Noise Levels
Creagan Trial Period - Sunday 13 July 2003



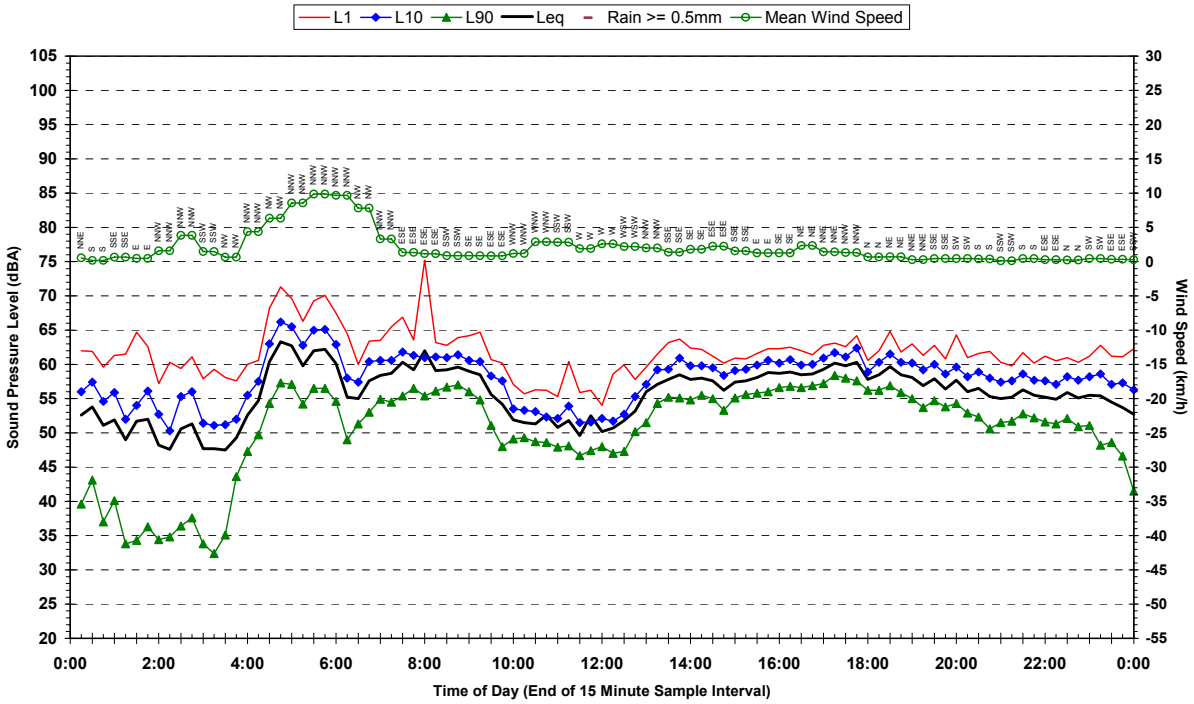
Statistical Ambient Noise Levels
Creagan Trial Period - Monday 14 July 2003



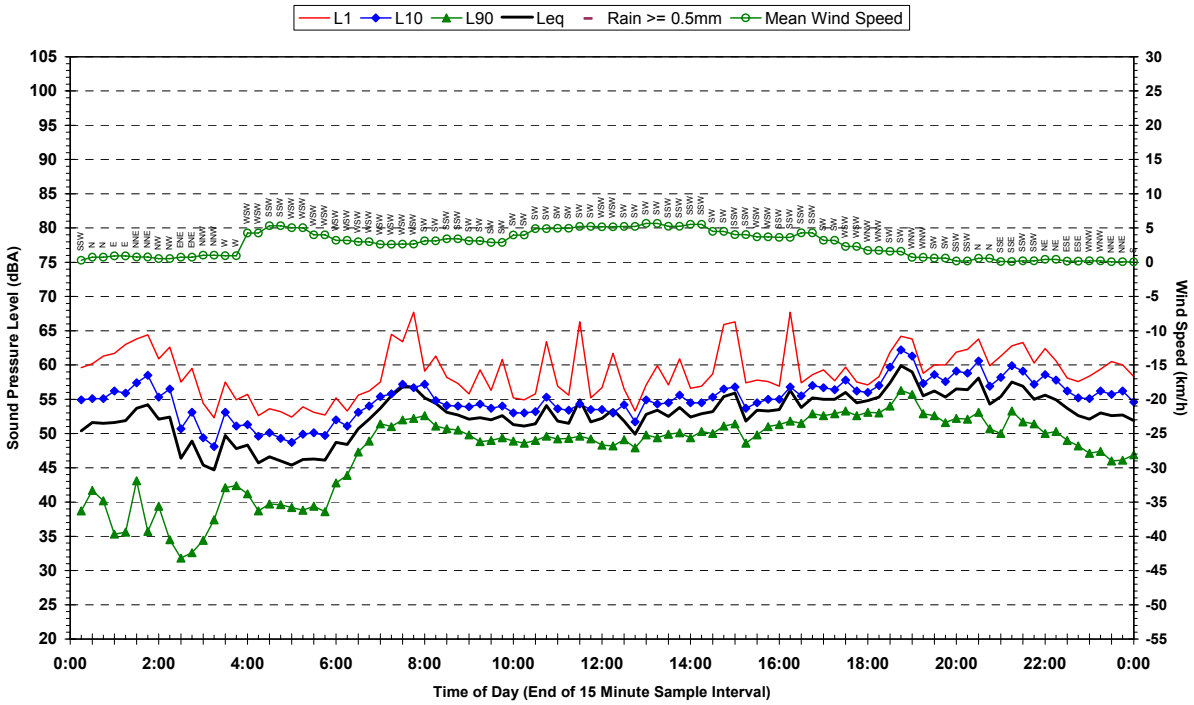
Statistical Ambient Noise Levels
Creagan Trial Period - Tuesday 15 July 2003



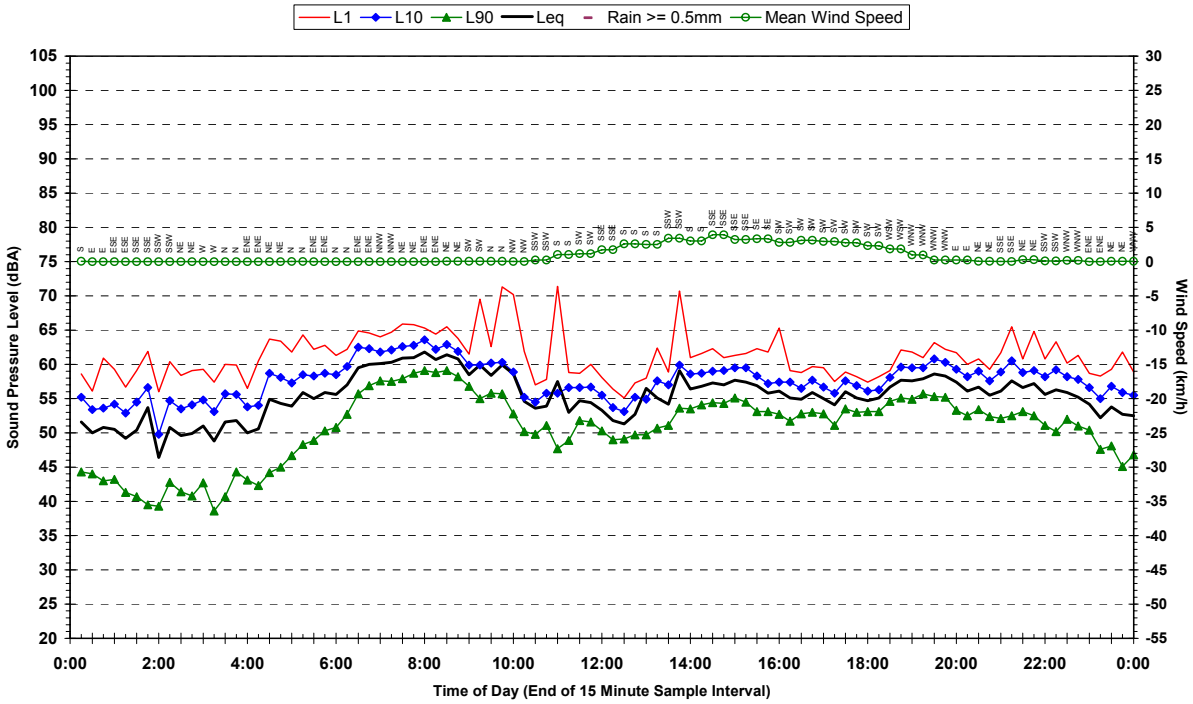
Statistical Ambient Noise Levels
Creagan Trial Period - Wednesday 16 July 2003



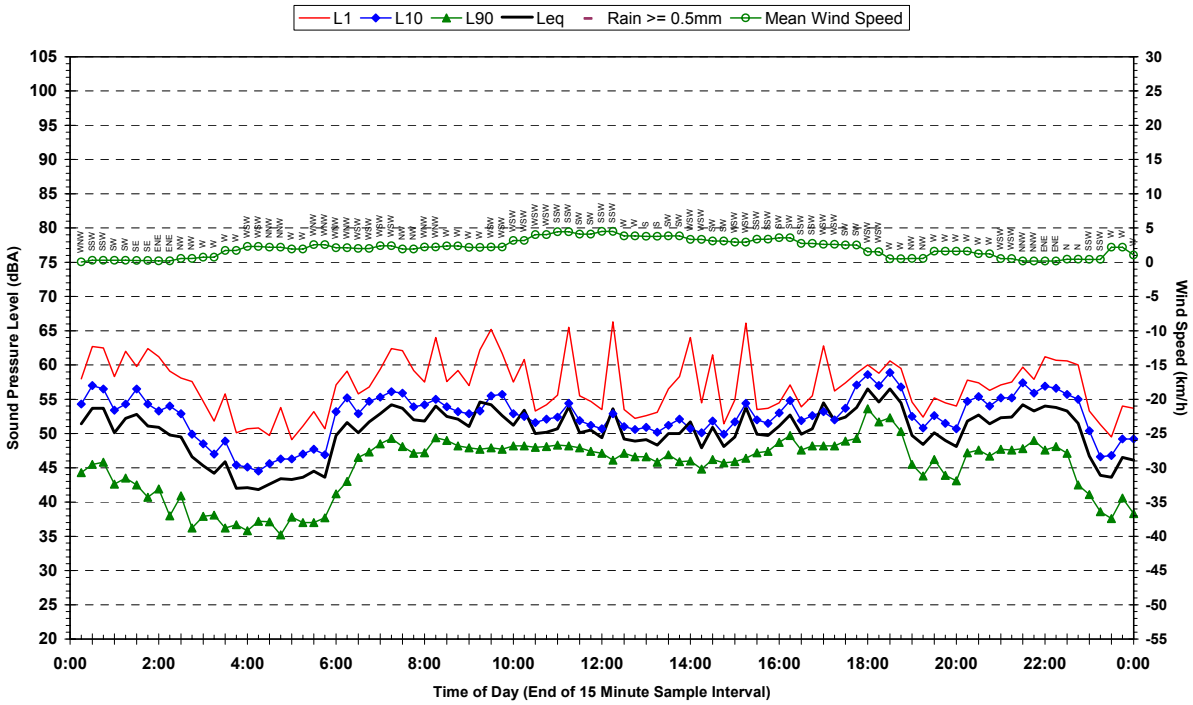
Statistical Ambient Noise Levels
Creagan Trial Period - Thursday 17 July 2003



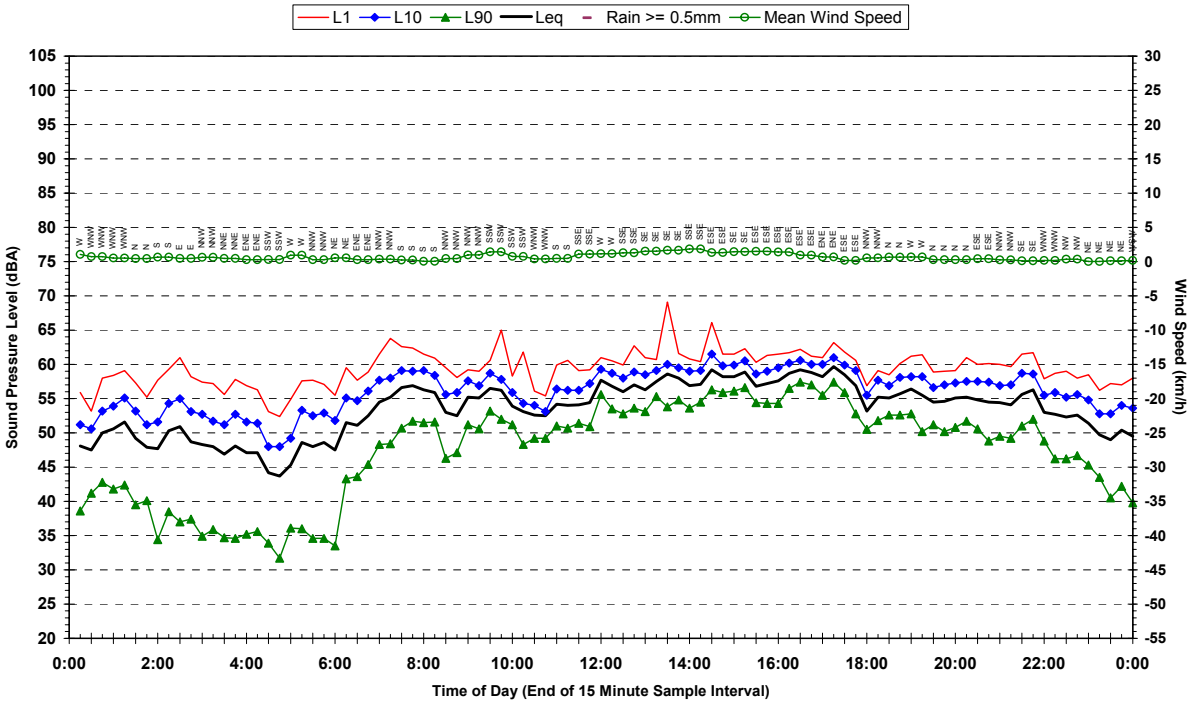
Statistical Ambient Noise Levels
Creagan Trial Period - Friday 18 July 2003



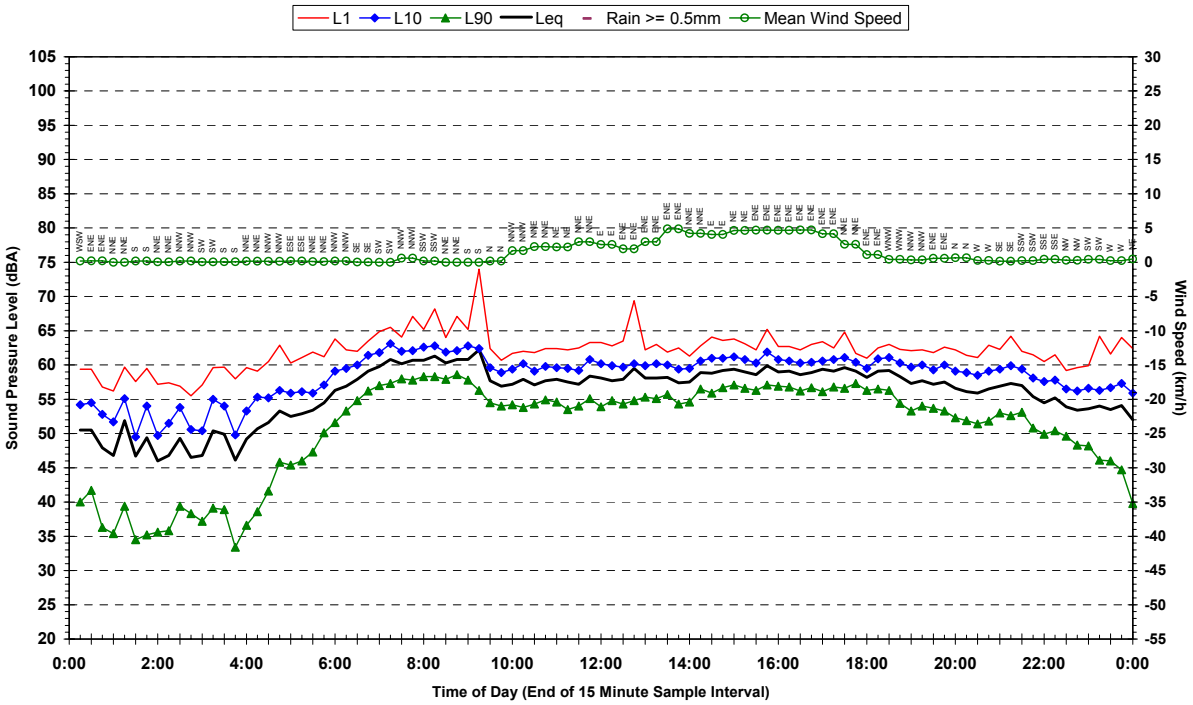
Statistical Ambient Noise Levels
Creagan Trial Period - Saturday 19 July 2003



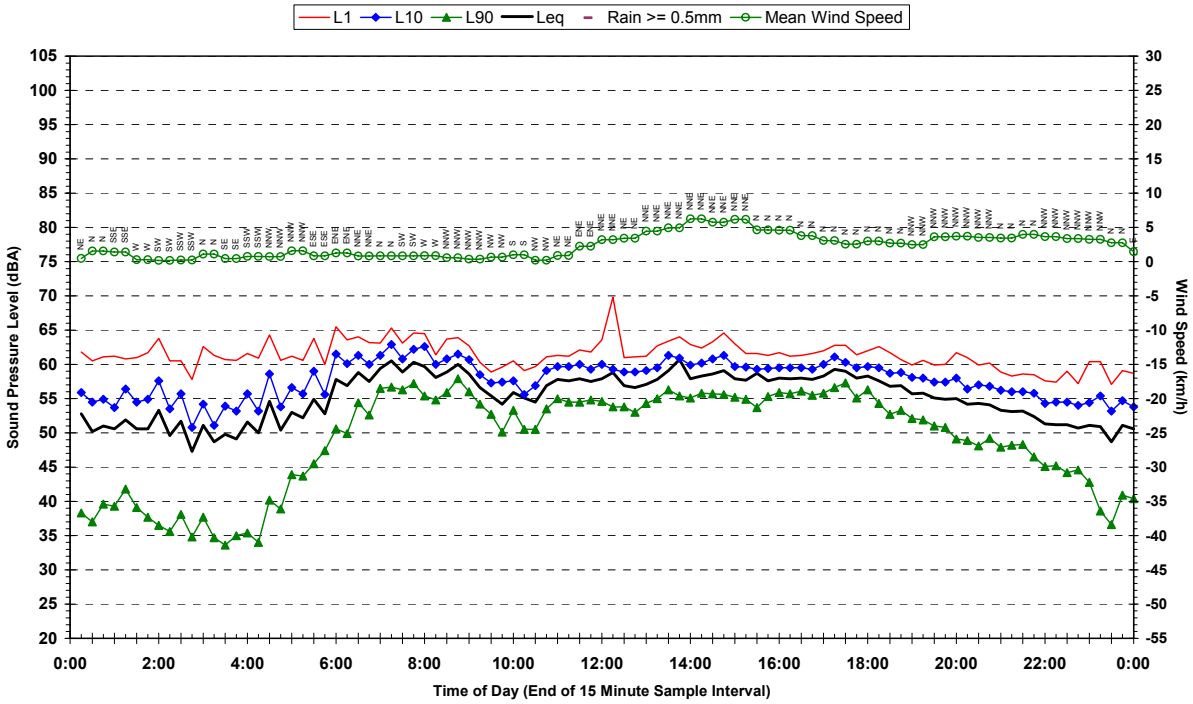
Statistical Ambient Noise Levels
Creagan Trial Period - Sunday 20 July 2003



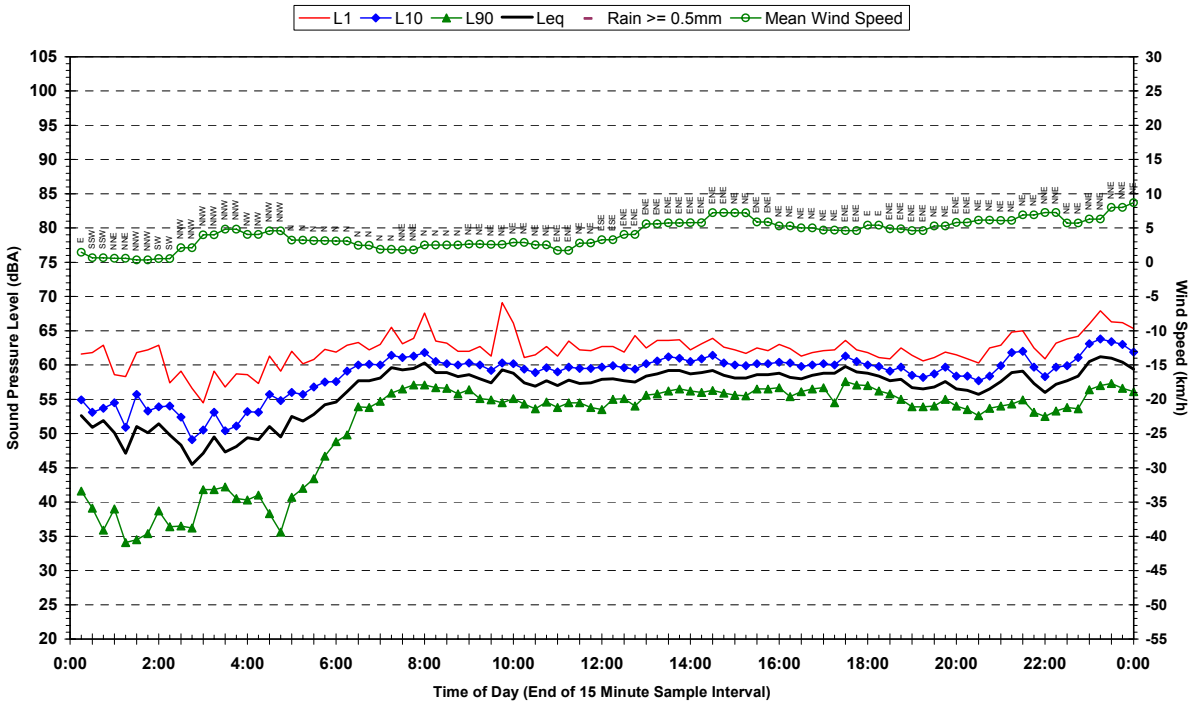
Statistical Ambient Noise Levels
Creagan Trial Period - Monday 21 July 2003



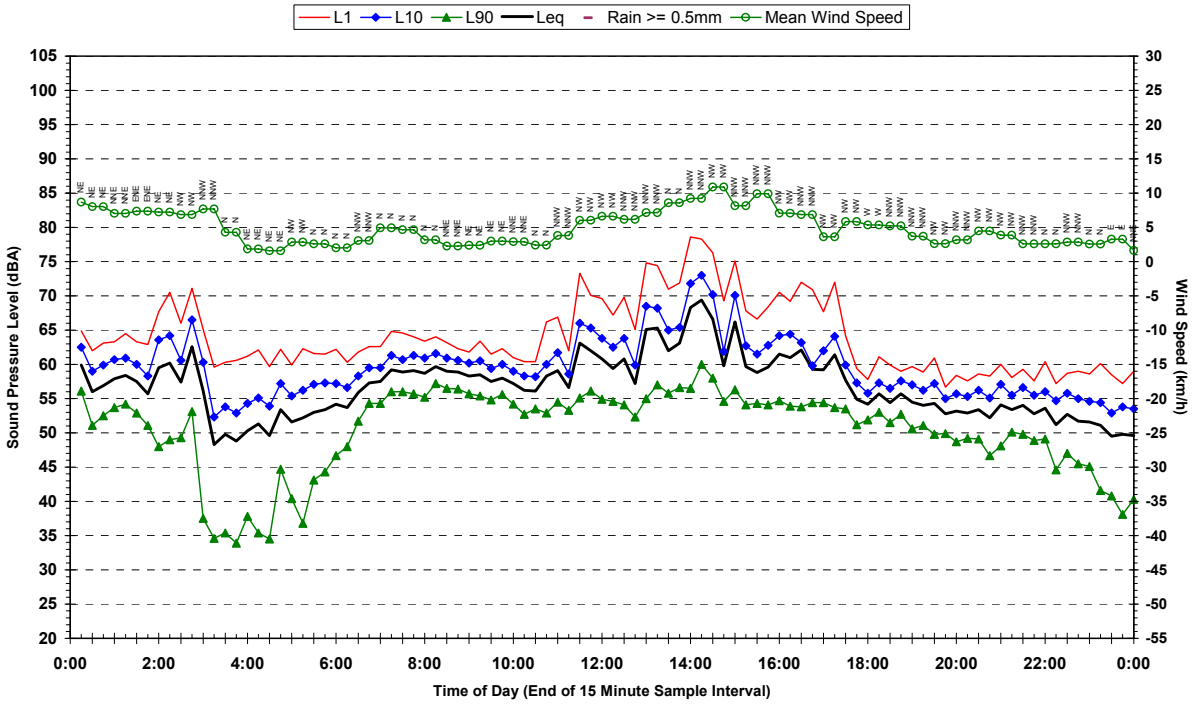
Statistical Ambient Noise Levels
Creagan Trial Period - Tuesday 22 July 2003



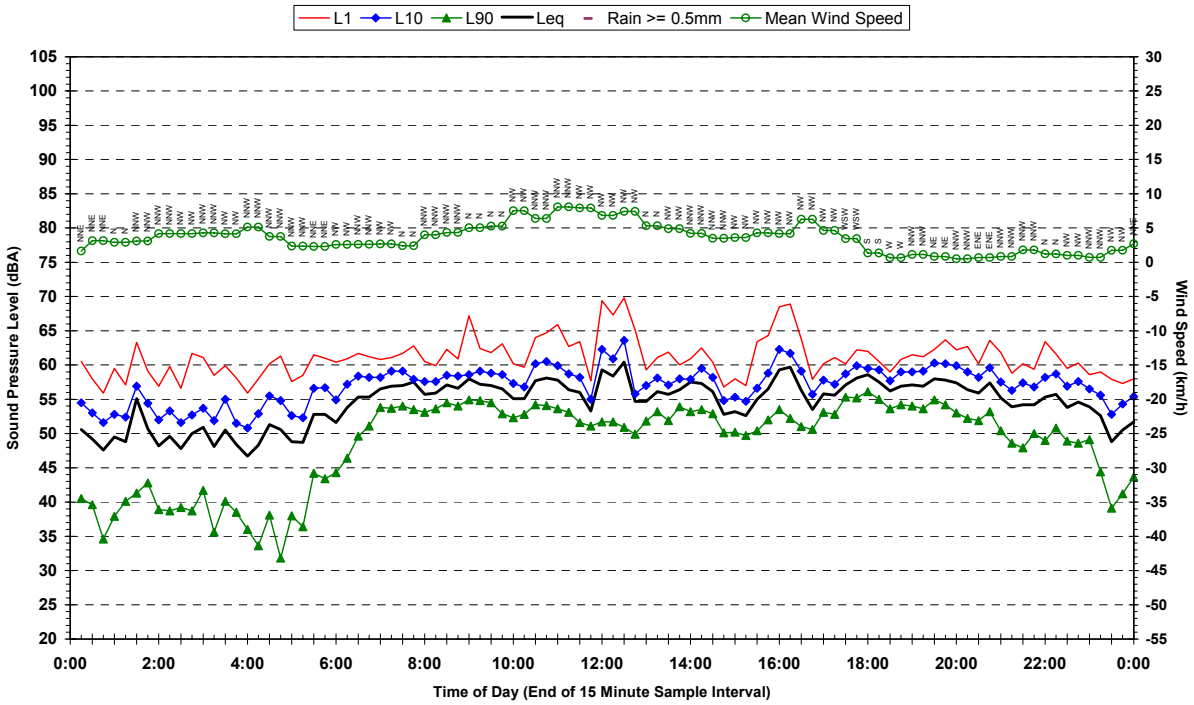
Statistical Ambient Noise Levels
Creagan Trial Period - Wednesday 23 July 2003



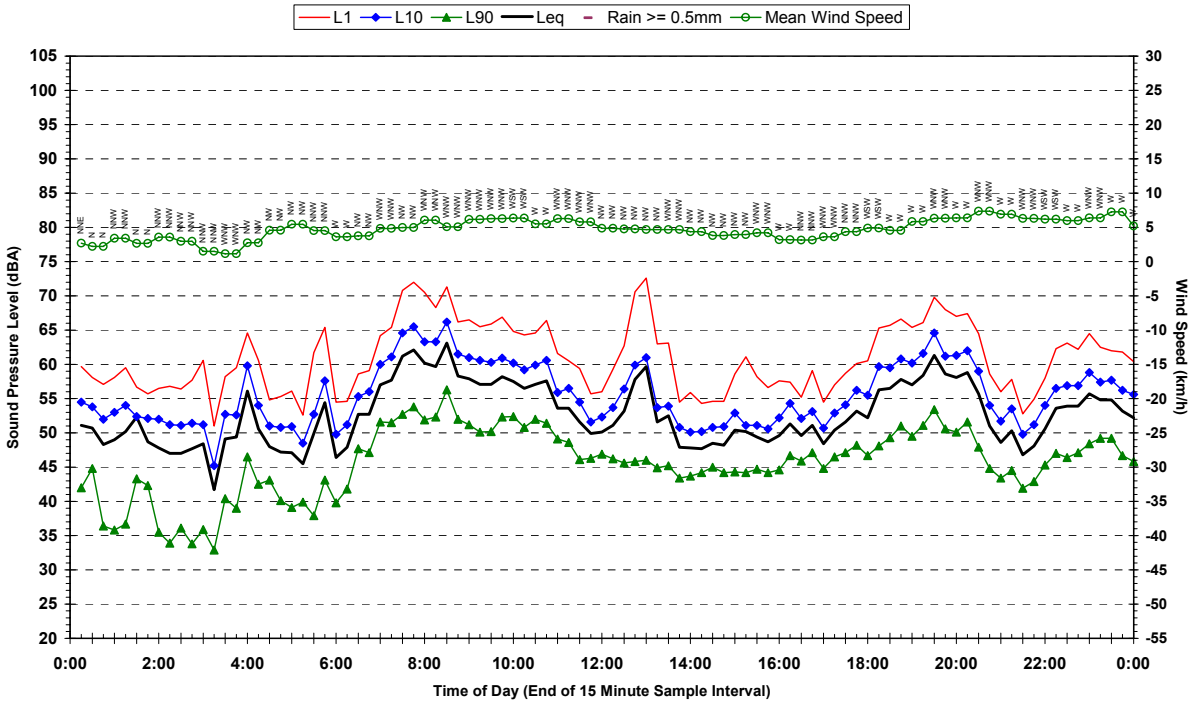
Statistical Ambient Noise Levels
Creagan Trial Period - Thursday 24 July 2003



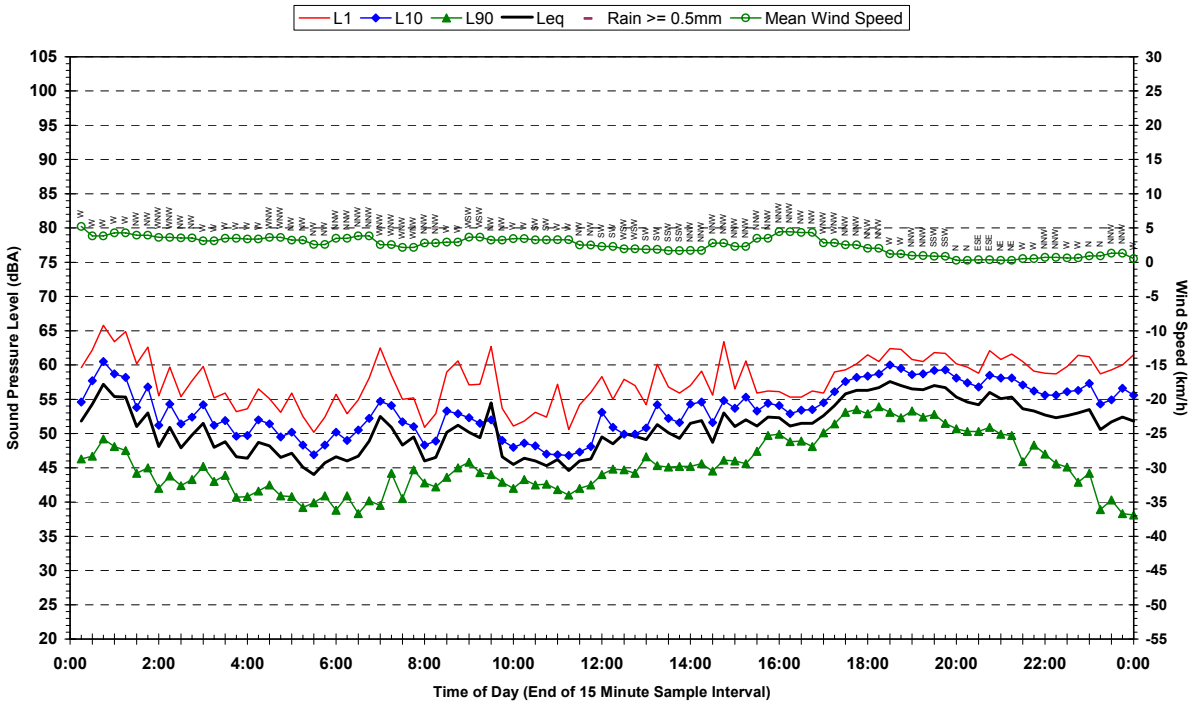
Statistical Ambient Noise Levels
Creagan Trial Period - Friday 25 July 2003



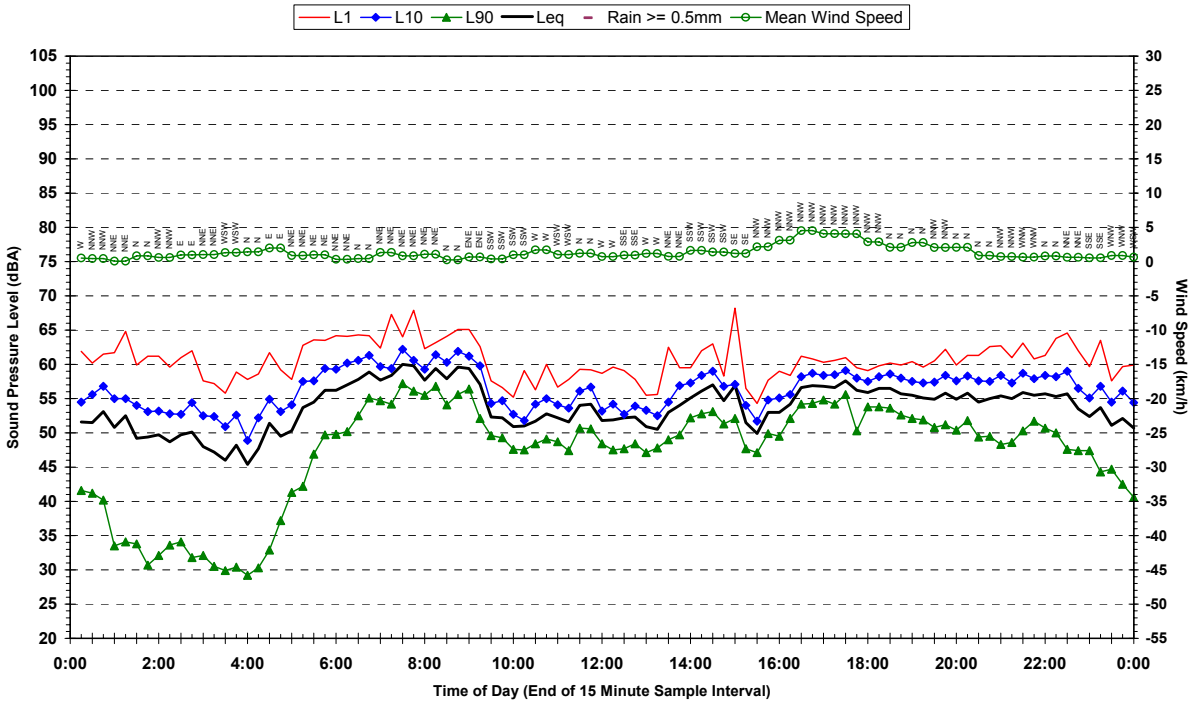
Statistical Ambient Noise Levels
Creagan Trial Period - Saturday 26 July 2003



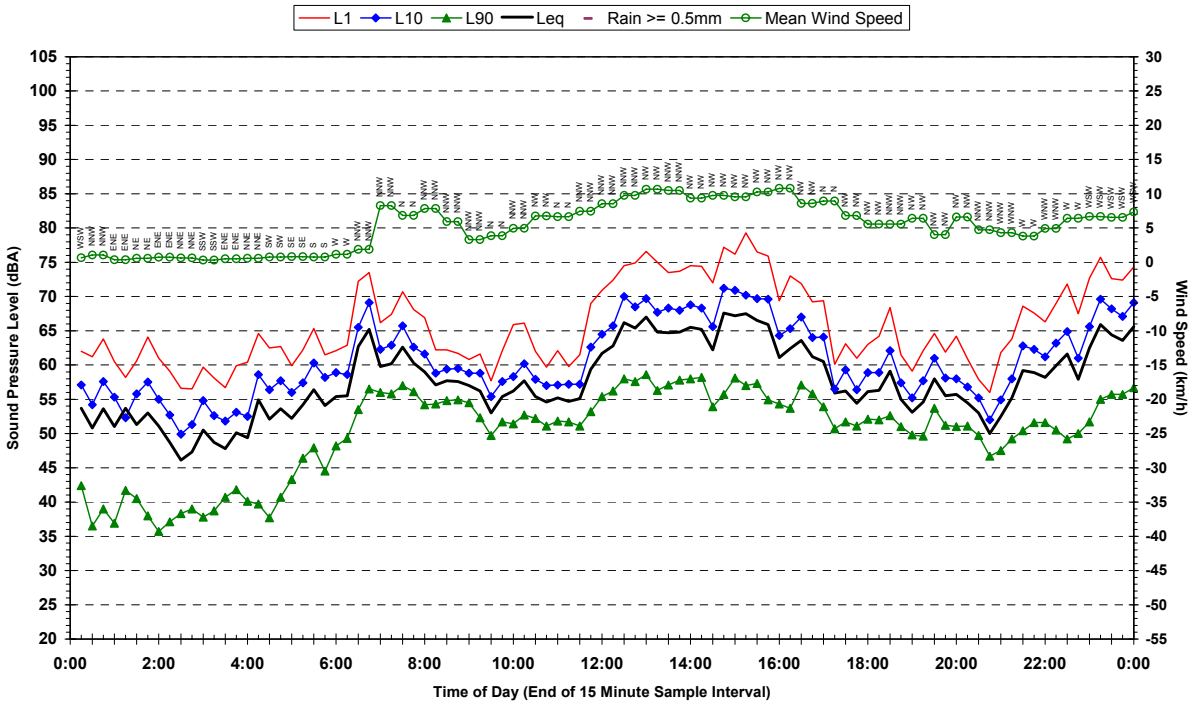
Statistical Ambient Noise Levels
Creagan Trial Period - Sunday 27 July 2003



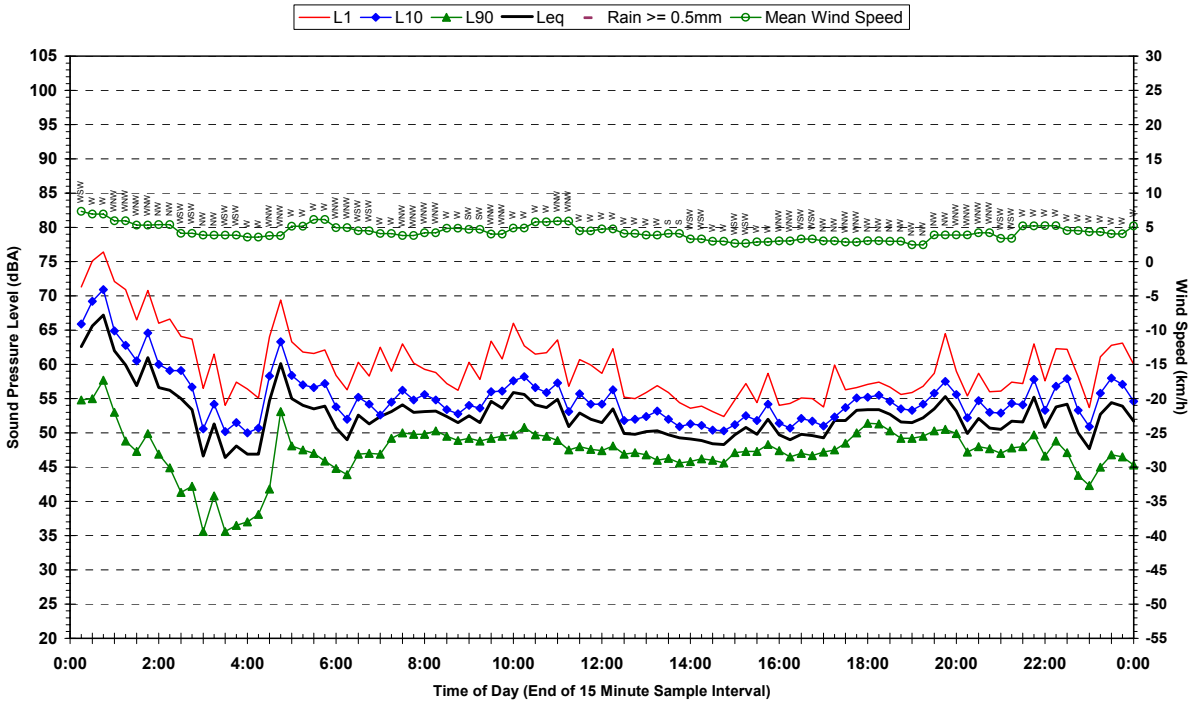
Statistical Ambient Noise Levels
Creagan Trial Period - Monday 28 July 2003



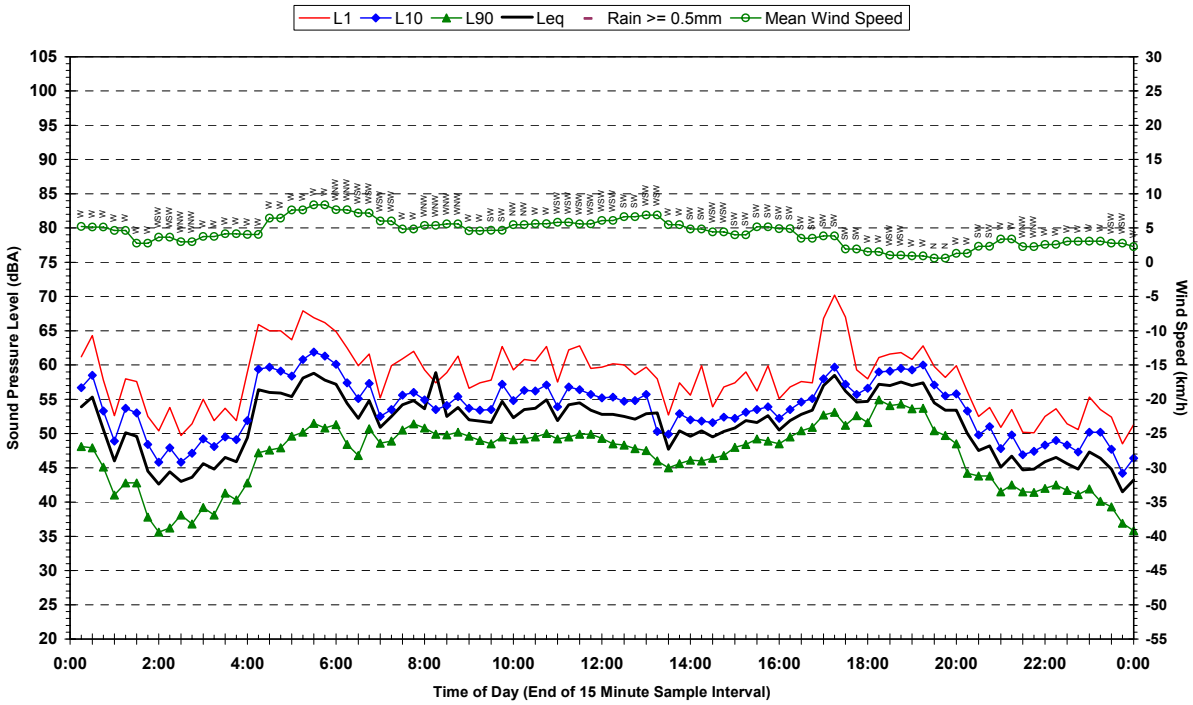
Statistical Ambient Noise Levels
Creagan Trial Period - Tuesday 29 July 2003



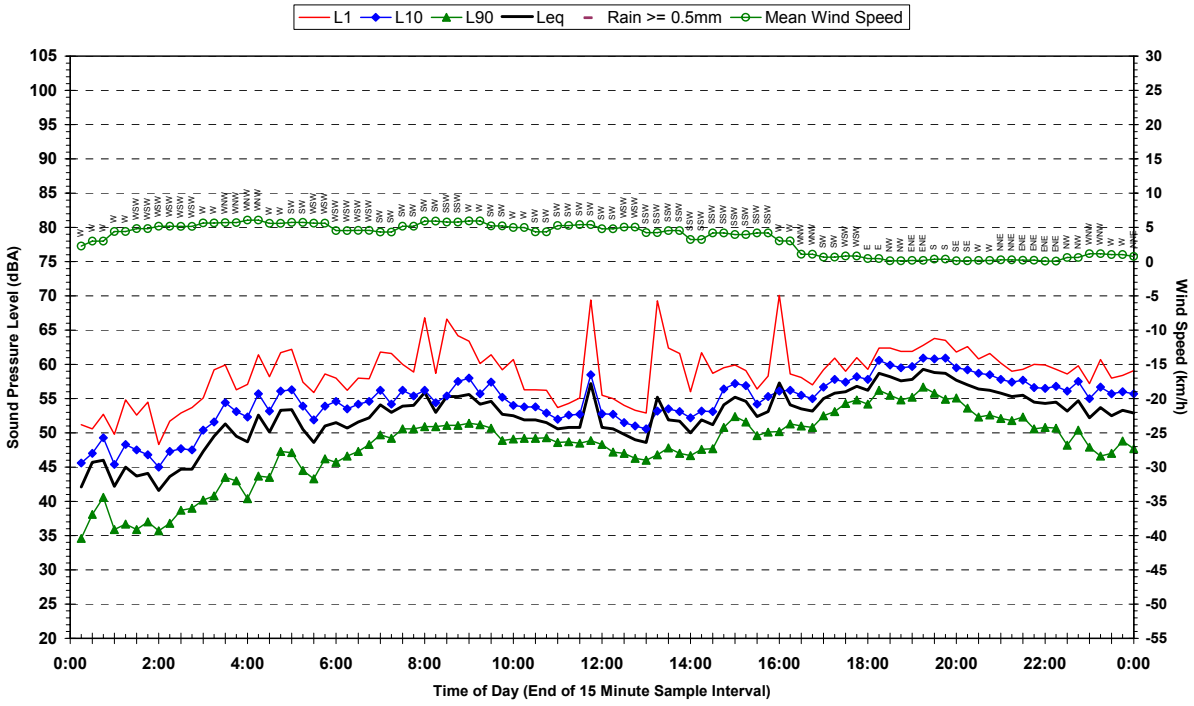
Statistical Ambient Noise Levels
Creagan Trial Period - Wednesday 30 July 2003



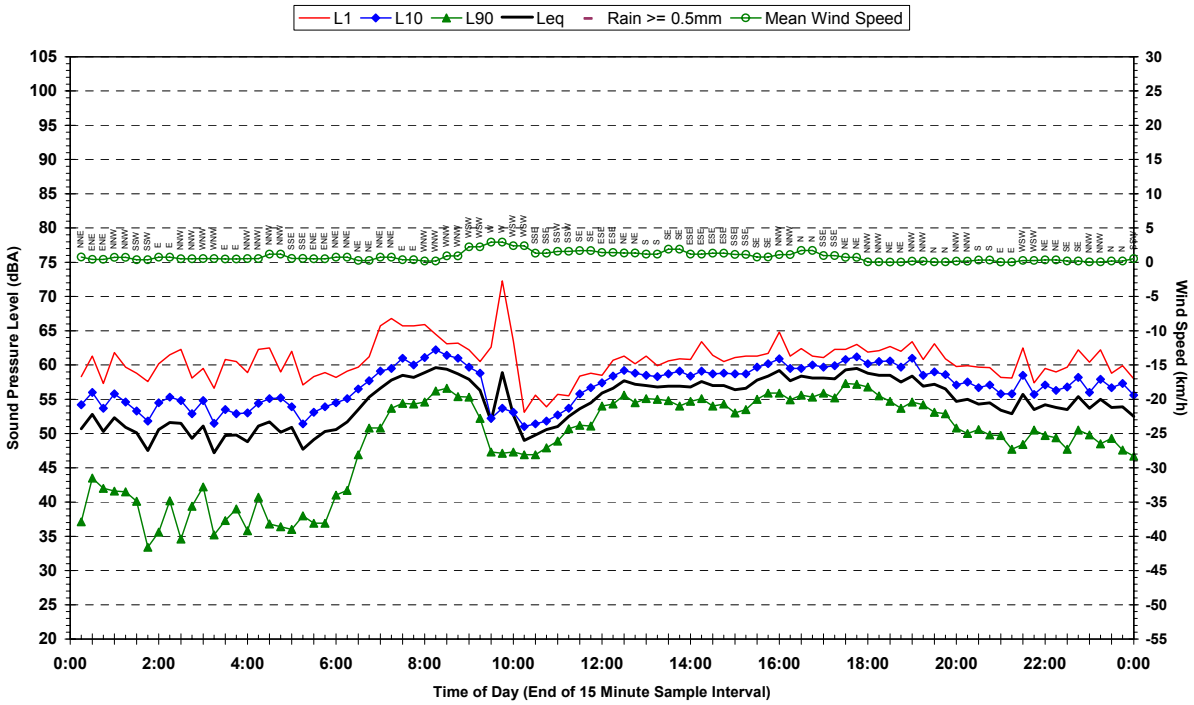
Statistical Ambient Noise Levels
Creagan Trial Period - Thursday 31 July 2003



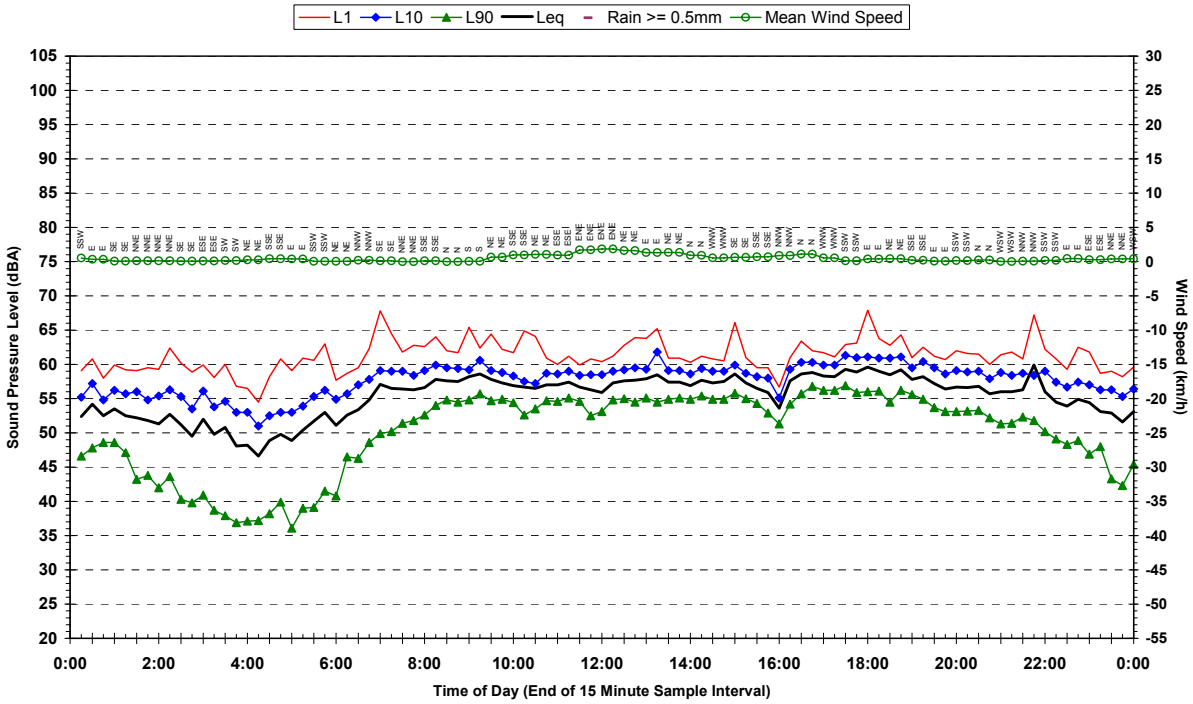
Statistical Ambient Noise Levels
Creagan Trial Period - Friday 1 August 2003



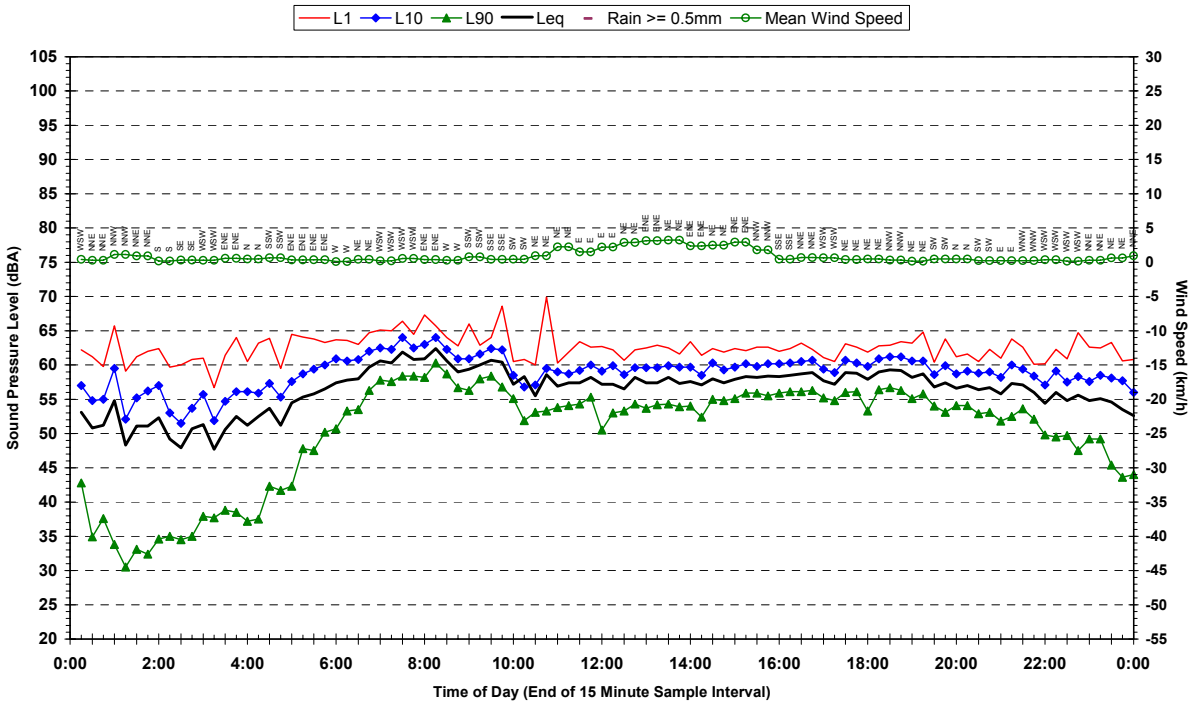
Statistical Ambient Noise Levels
Creagan Trial Period - Saturday 2 August 2003

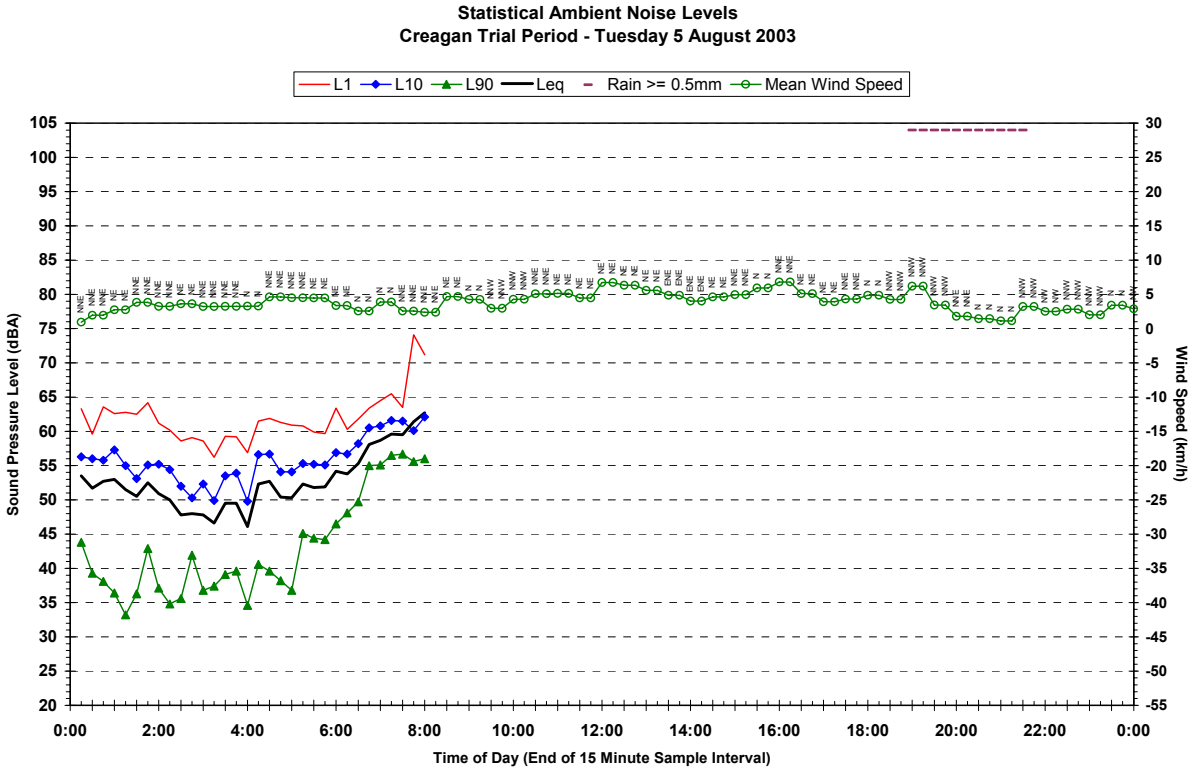


Statistical Ambient Noise Levels
Creagan Trial Period - Sunday 3 August 2003



Statistical Ambient Noise Levels
Creagan Trial Period - Monday 4 August 2003



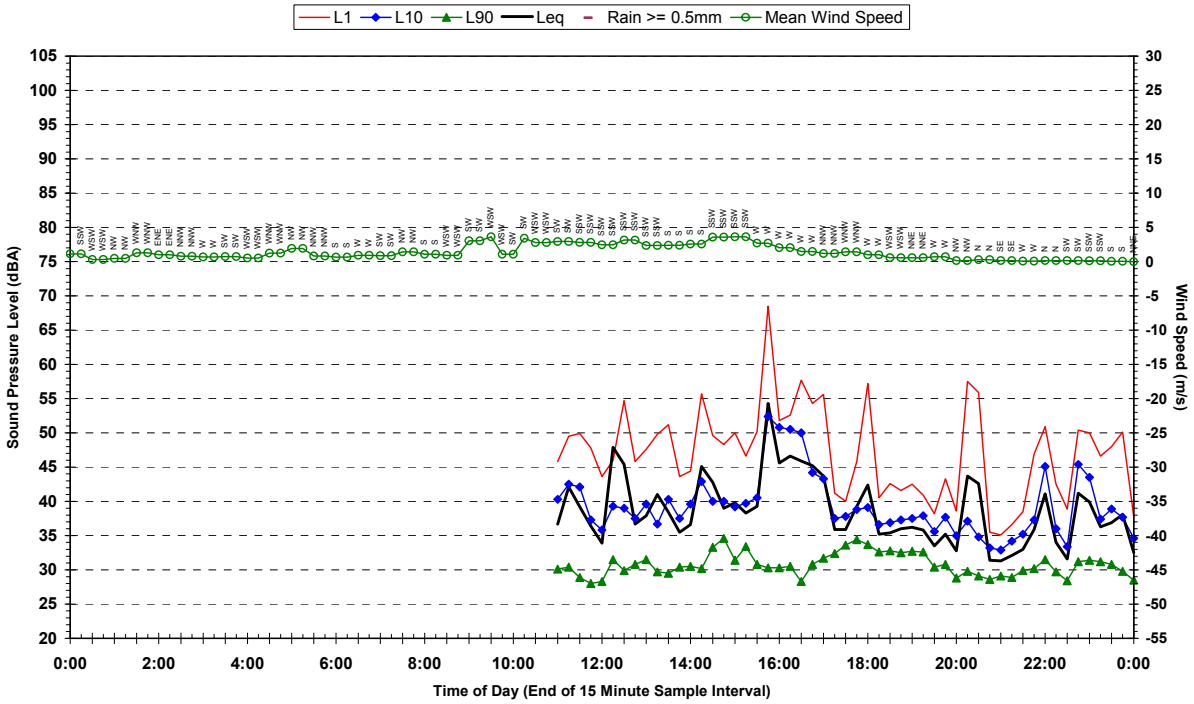

Statistical Ambient Noise Levels
Creagan Trial Period - Tuesday 5 August 2003
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (km/h)
Time of Day (End of 15 Minute Sample Interval)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00

APPENDIX E

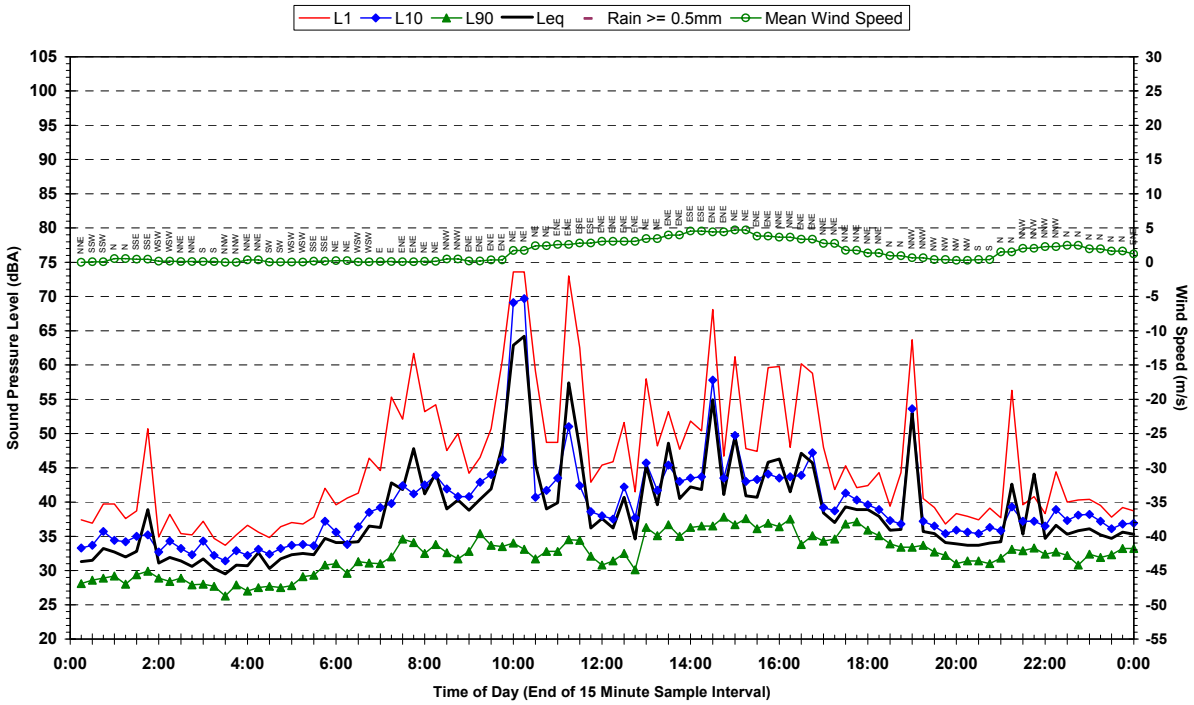
(No. of pages excluding this page = 14)

Statistical Ambient Noise Levels Location A (McParland)

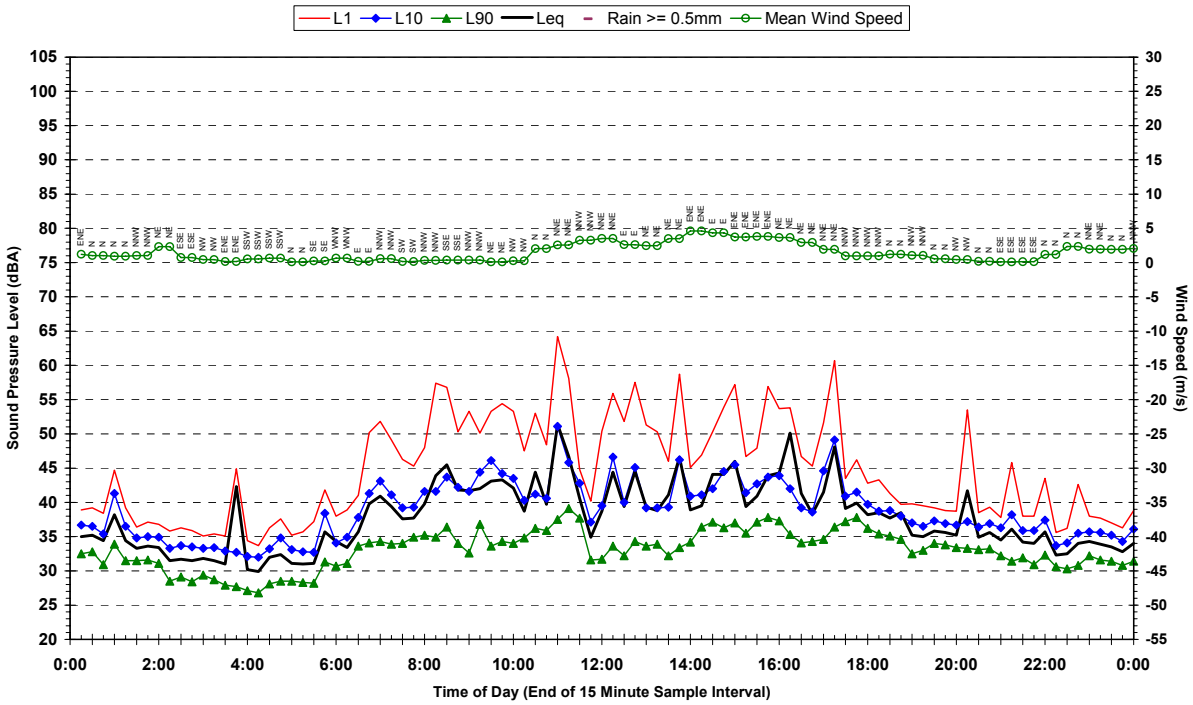
Statistical Ambient Noise Levels
McParland - Trial Period - Wednesday 9 July 2003



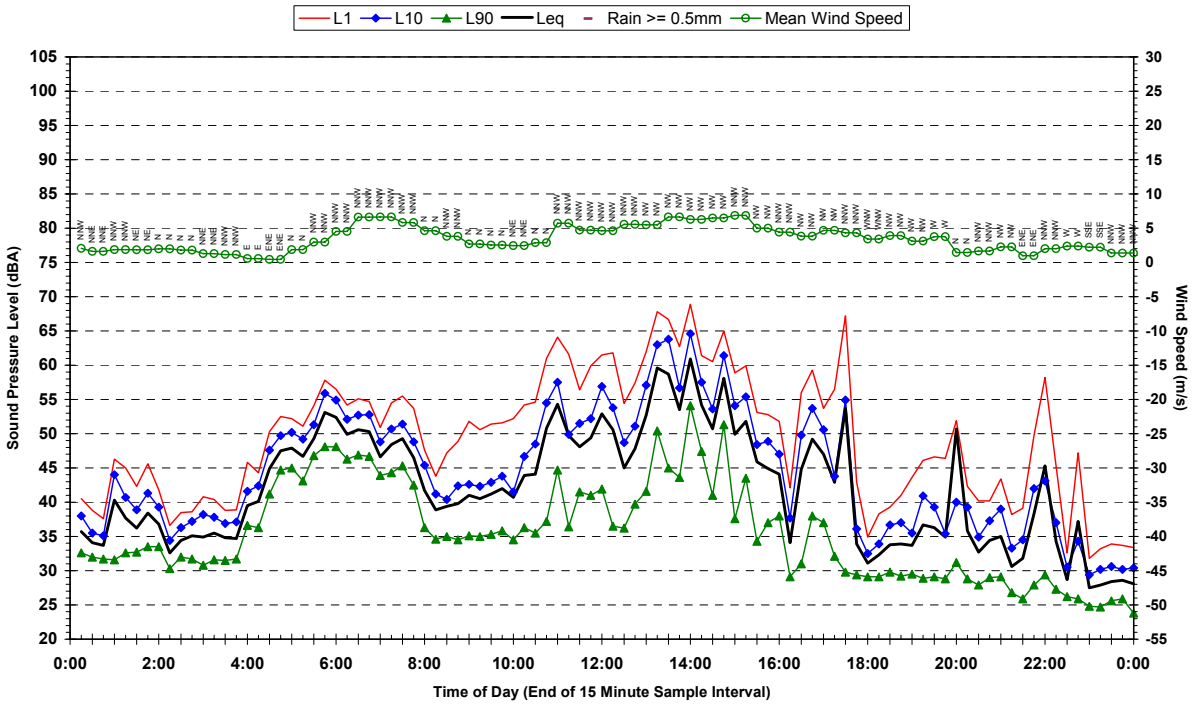
Statistical Ambient Noise Levels
McParland - Trial Period - Thursday 10 July 2003



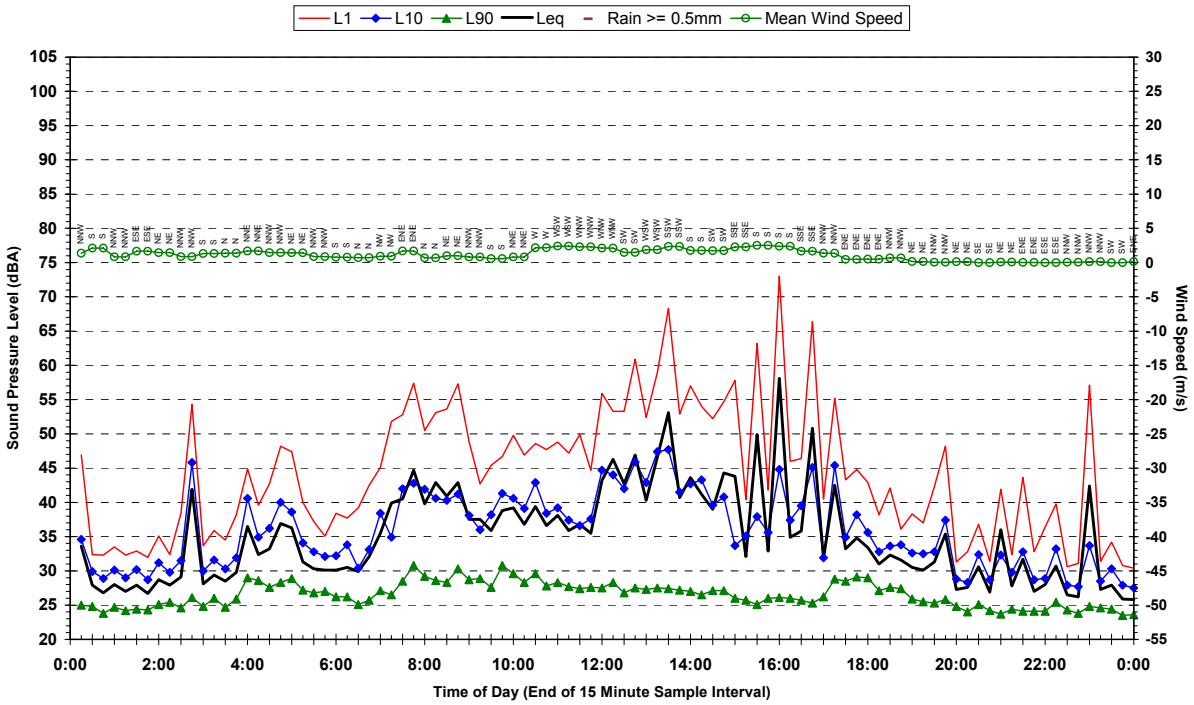
Statistical Ambient Noise Levels
McParland - Trial Period - Friday 11 July 2003



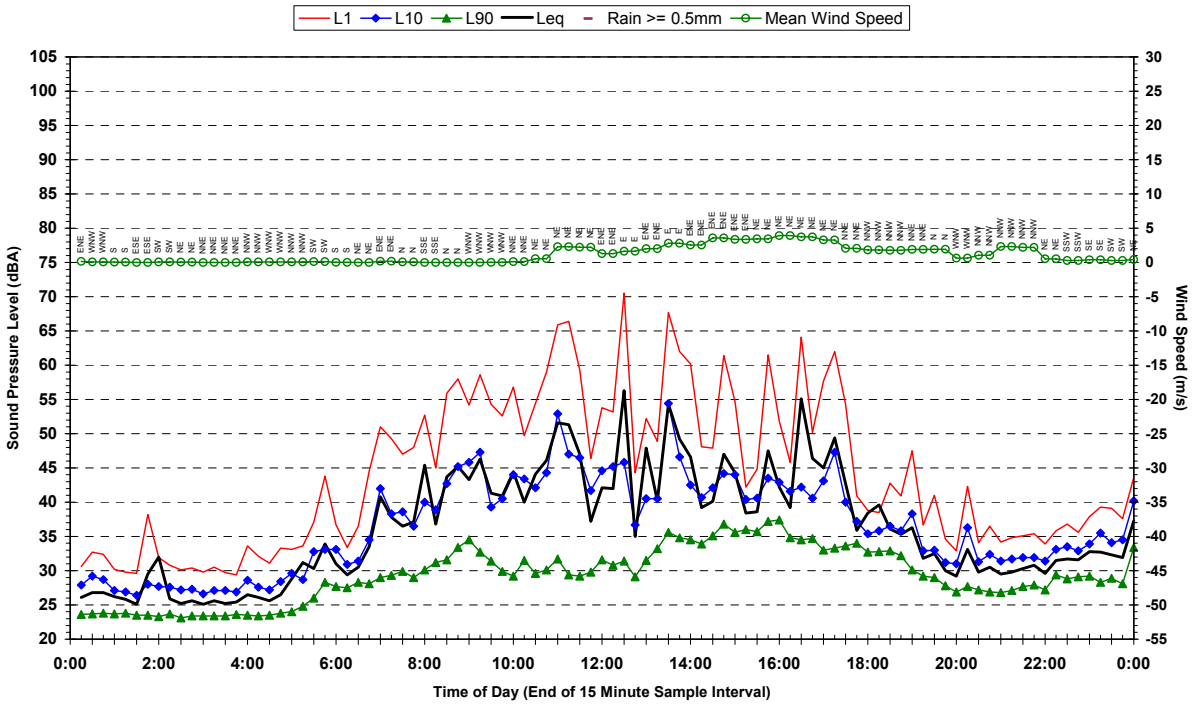
Statistical Ambient Noise Levels
McParland - Trial Period - Saturday 12 July 2003



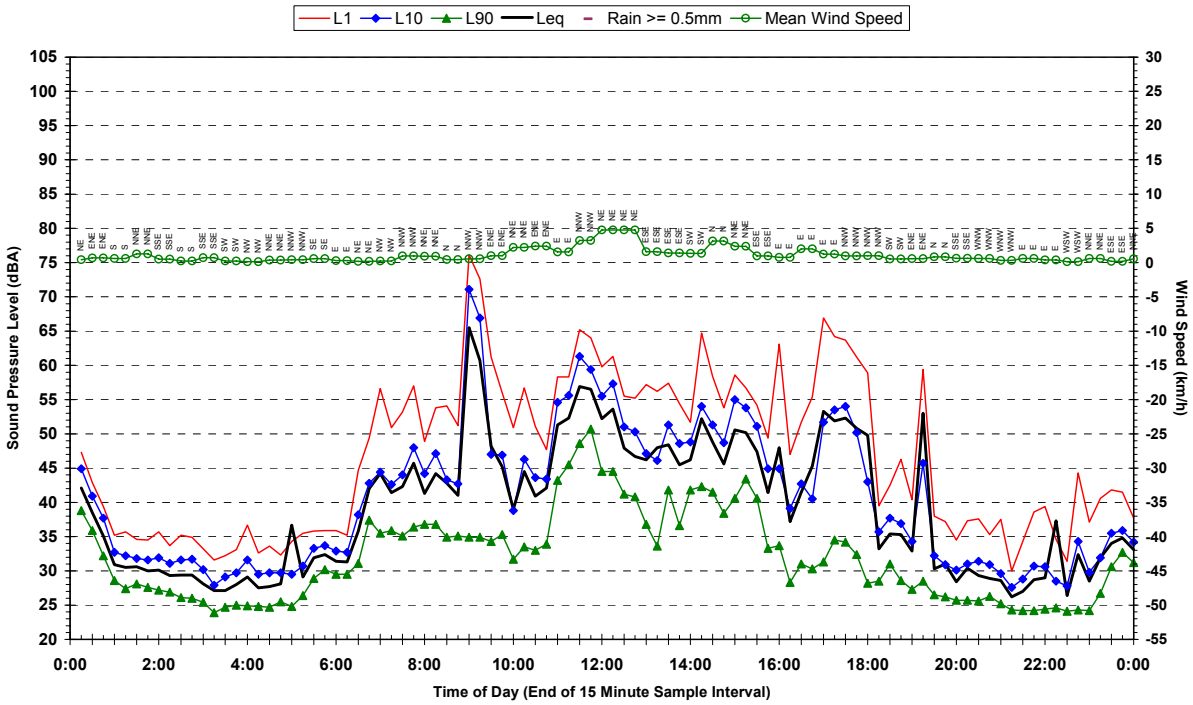
Statistical Ambient Noise Levels
McParland - Trial Period - Sunday 13 July 2003



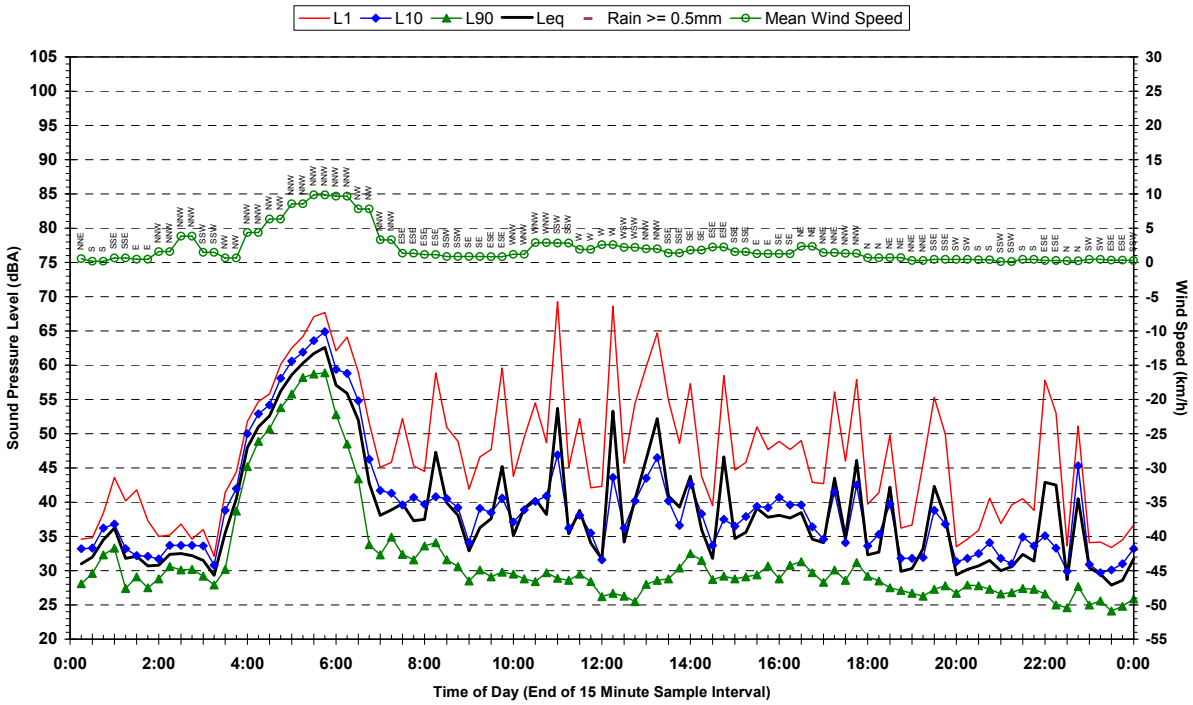
Statistical Ambient Noise Levels
McParland - Trial Period - Monday 14 July 2003



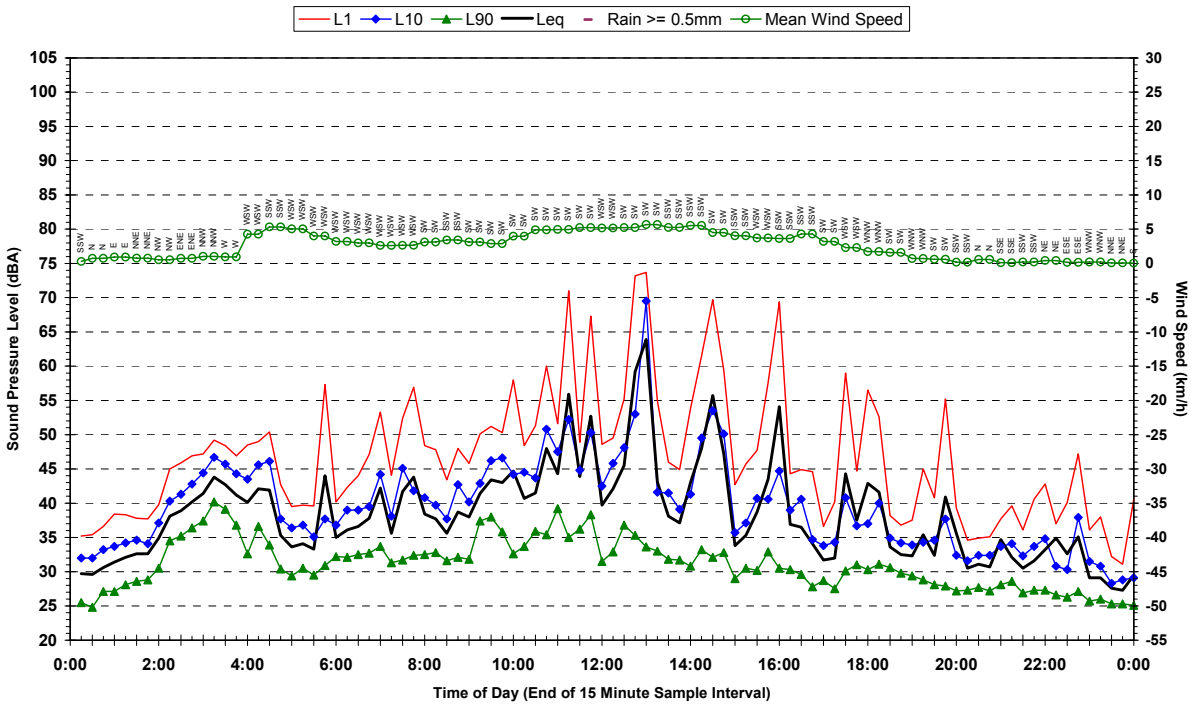
Statistical Ambient Noise Levels
McParland - Trial Period - Tuesday 15 July 2003



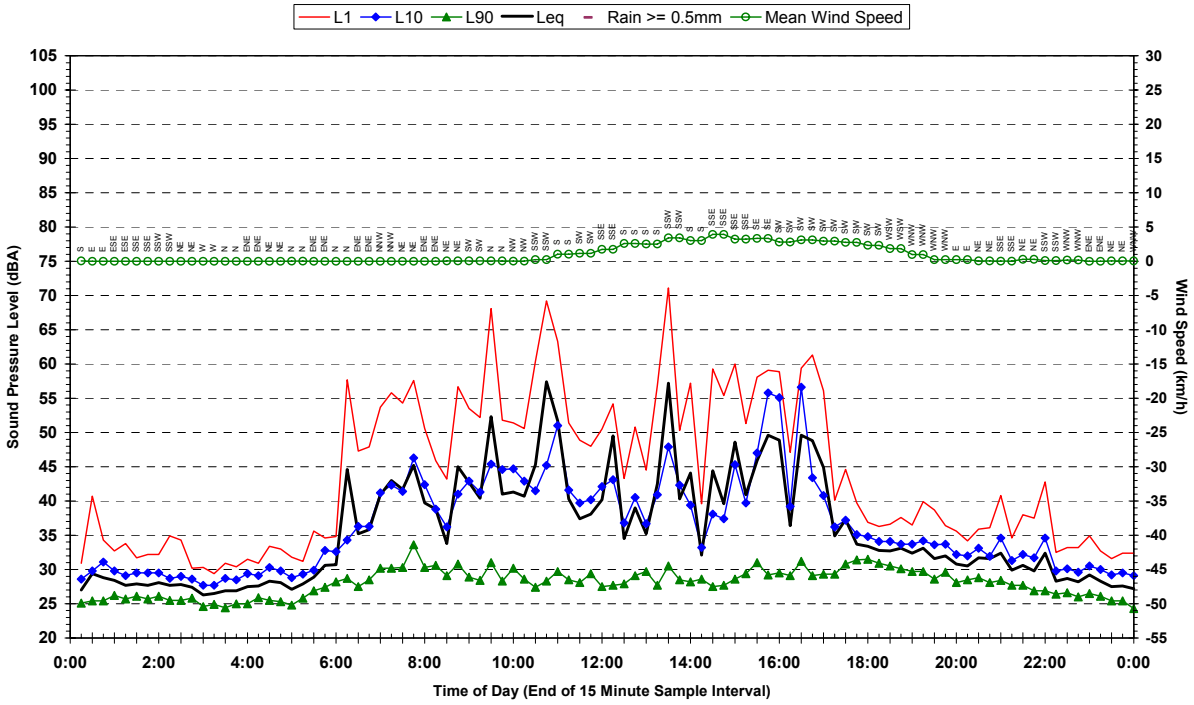
Statistical Ambient Noise Levels
McParland - Trial Period - Wednesday 16 July 2003



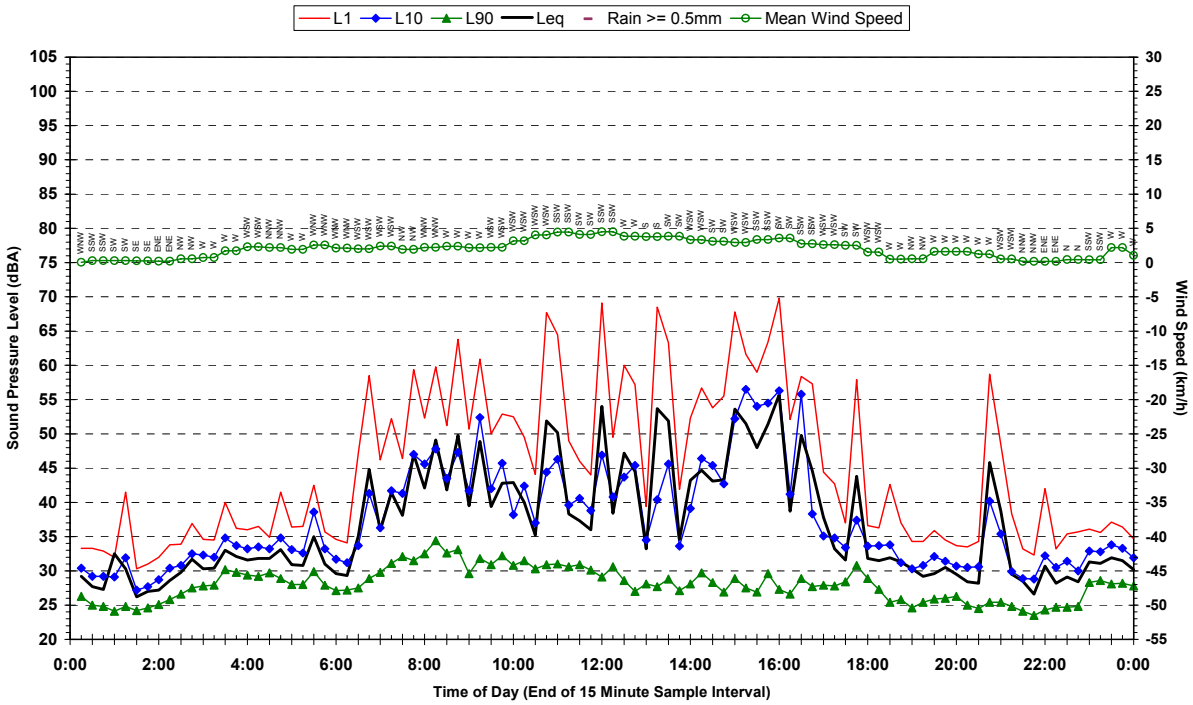
Statistical Ambient Noise Levels
McParland - Trial Period - Thursday 17 July 2003



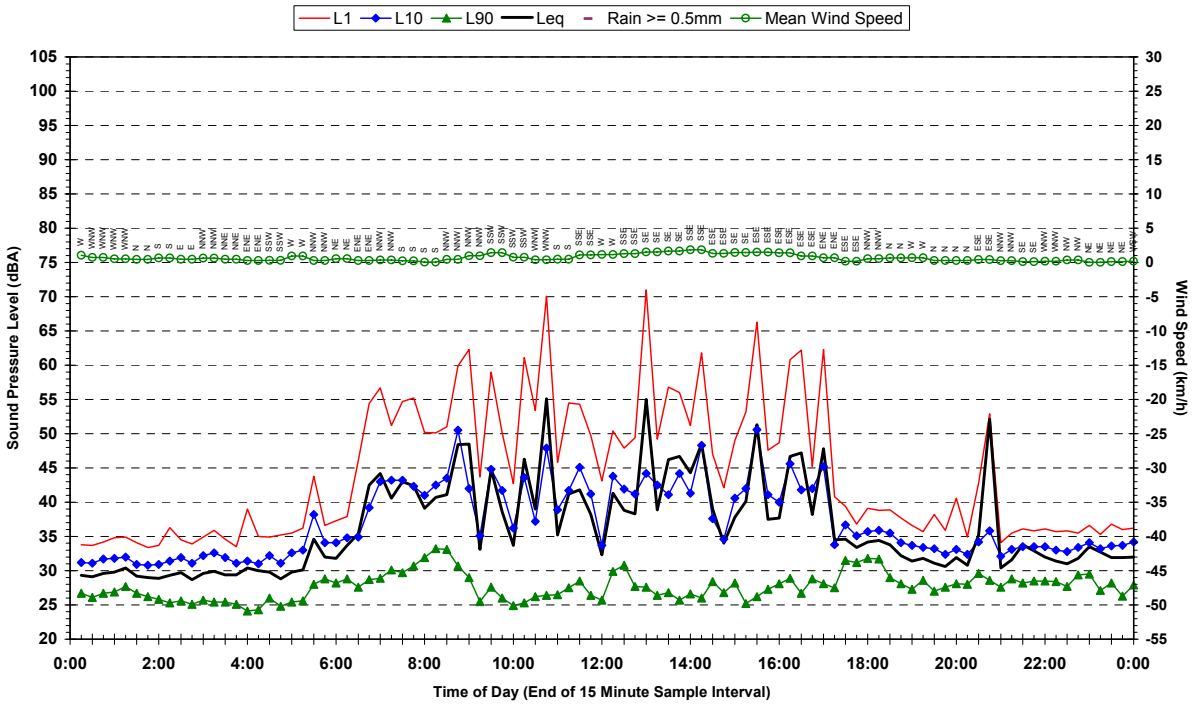
Statistical Ambient Noise Levels
McParland - Trial Period - Friday 18 July 2003



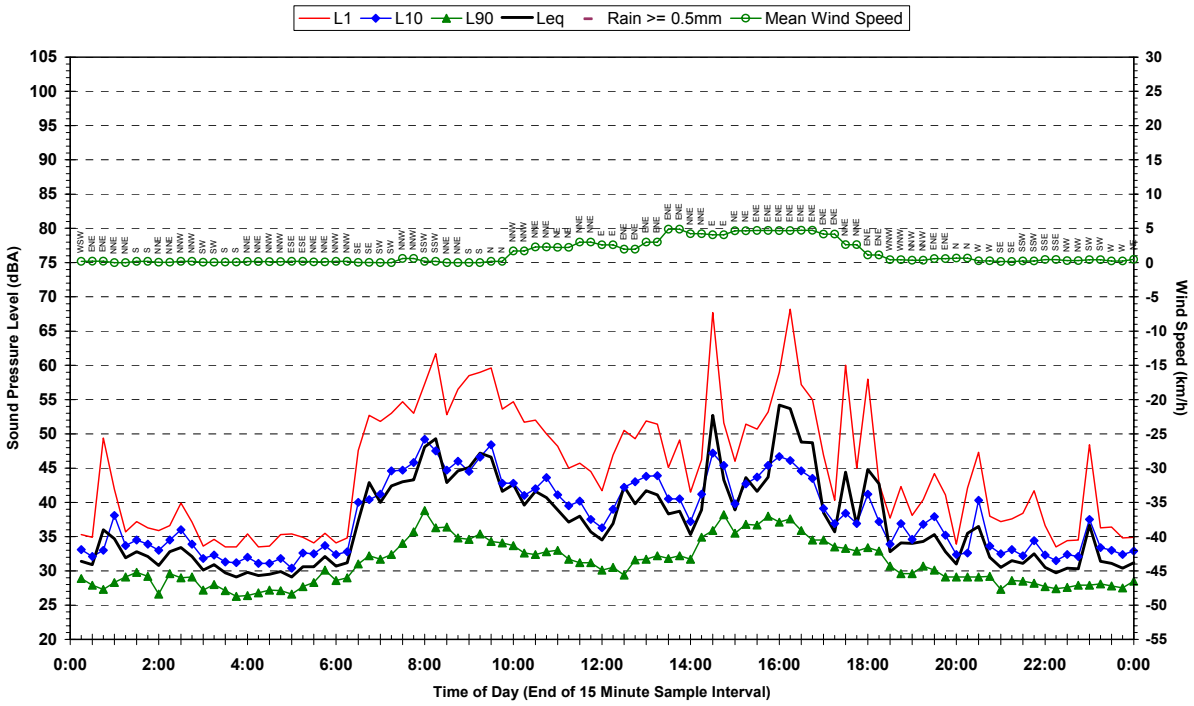
Statistical Ambient Noise Levels
McParland - Trial Period - Saturday 19 July 2003



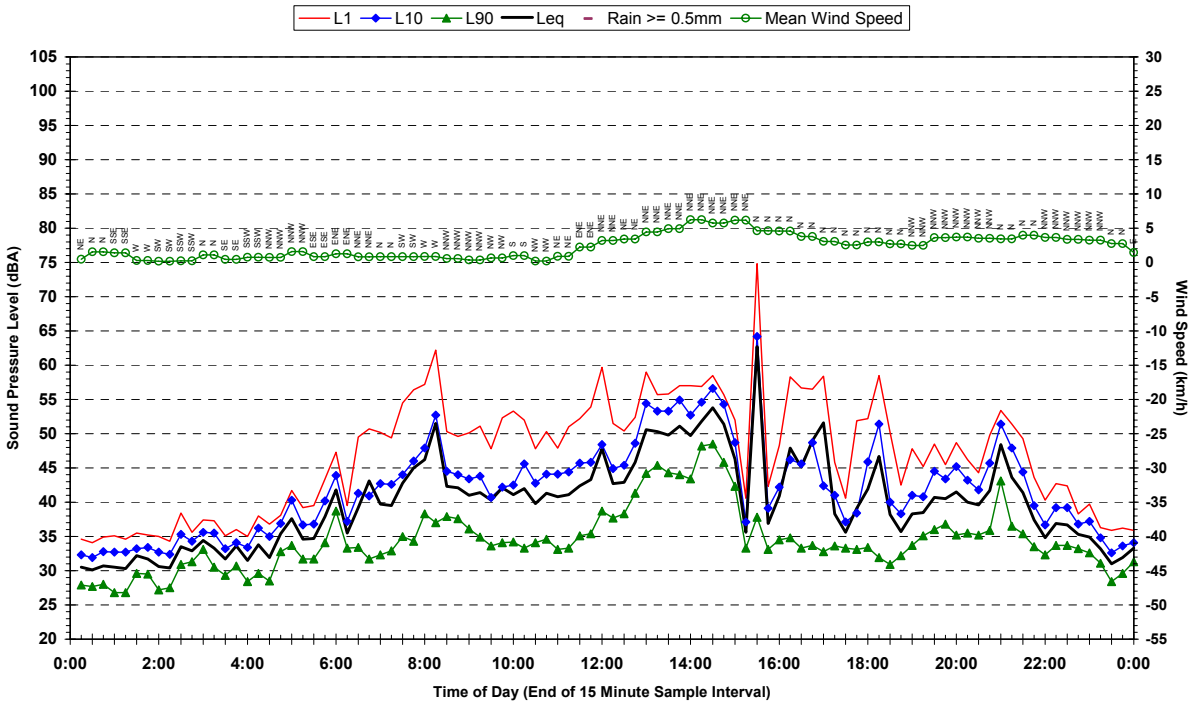
Statistical Ambient Noise Levels
McParland - Trial Period - Sunday 20 July 2003



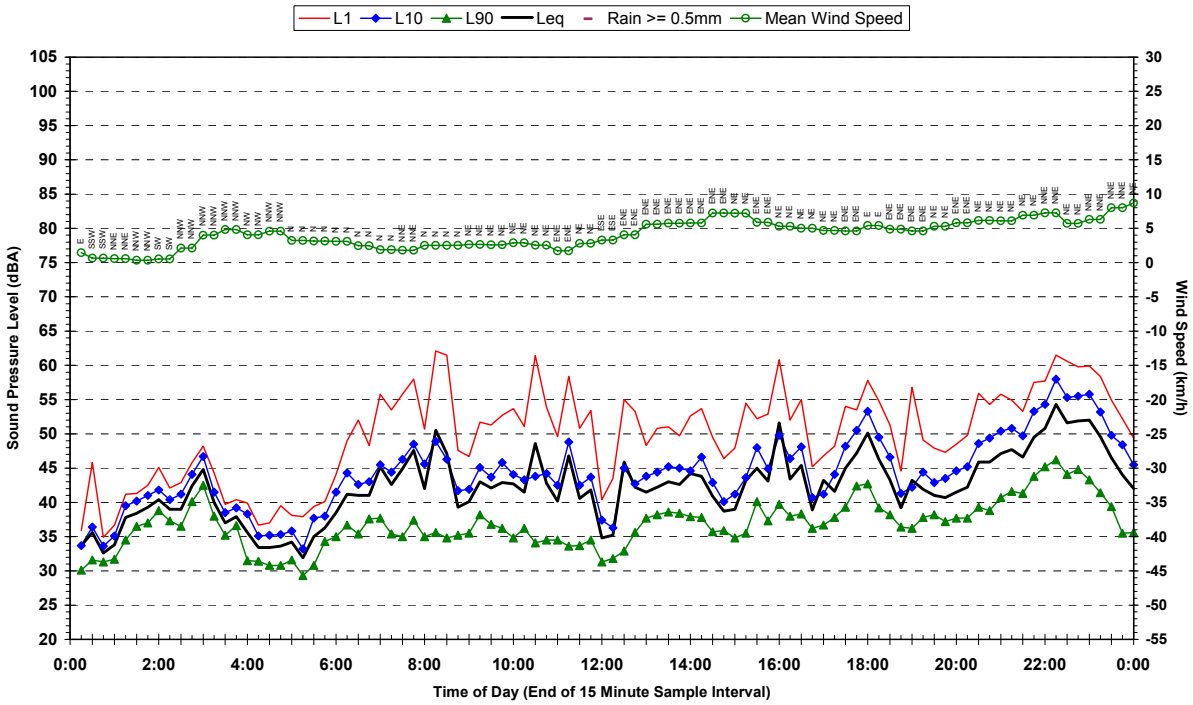
Statistical Ambient Noise Levels
McParland - Trial Period - Monday 21 July 2003



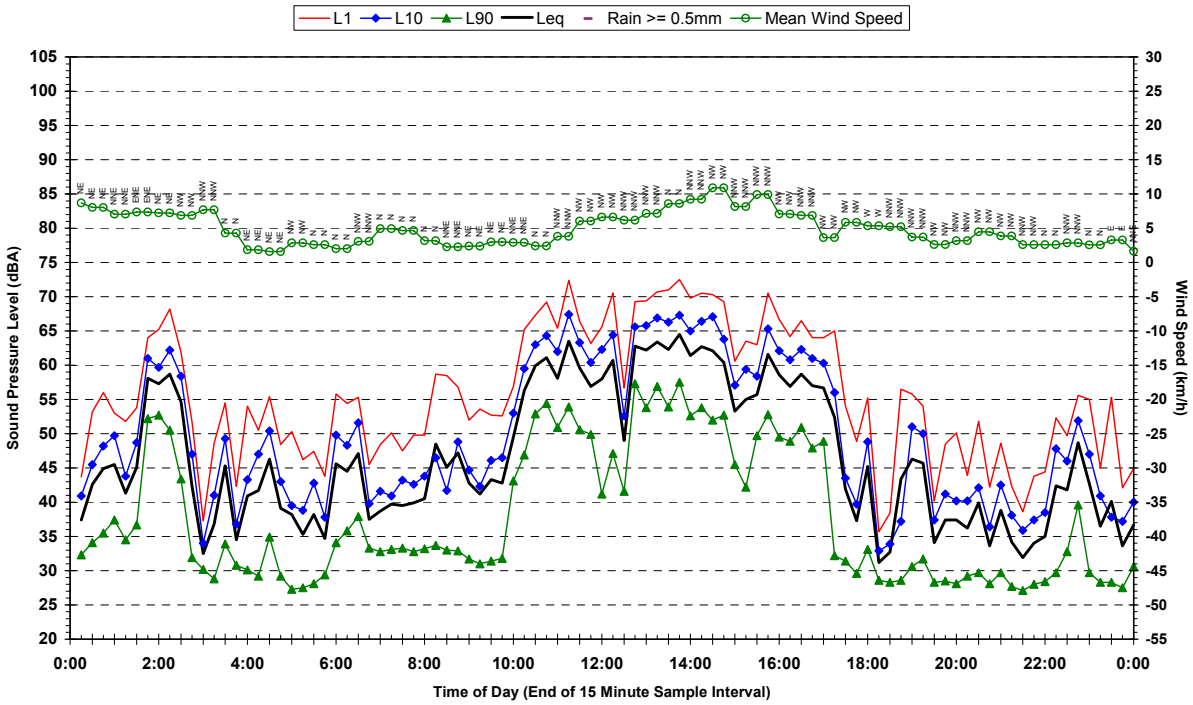
Statistical Ambient Noise Levels
McParland - Trial Period - Tuesday 22 July 2003



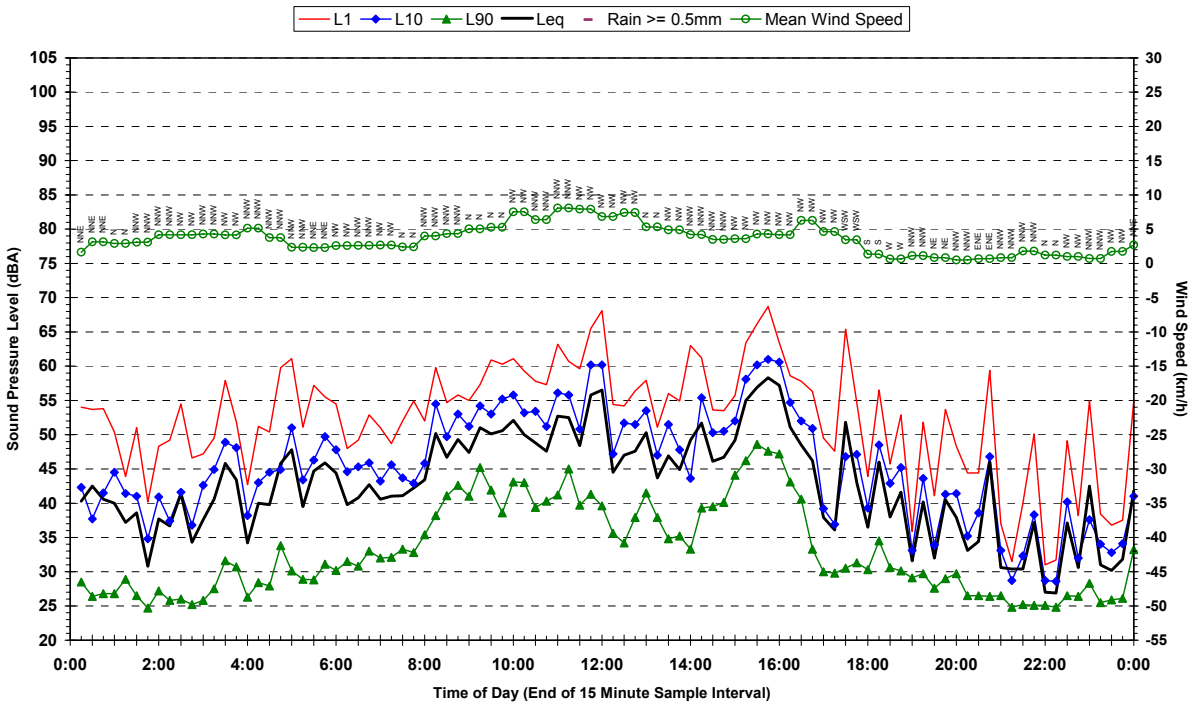
Statistical Ambient Noise Levels
McParland - Trial Period - Wednesday 23 July 2003



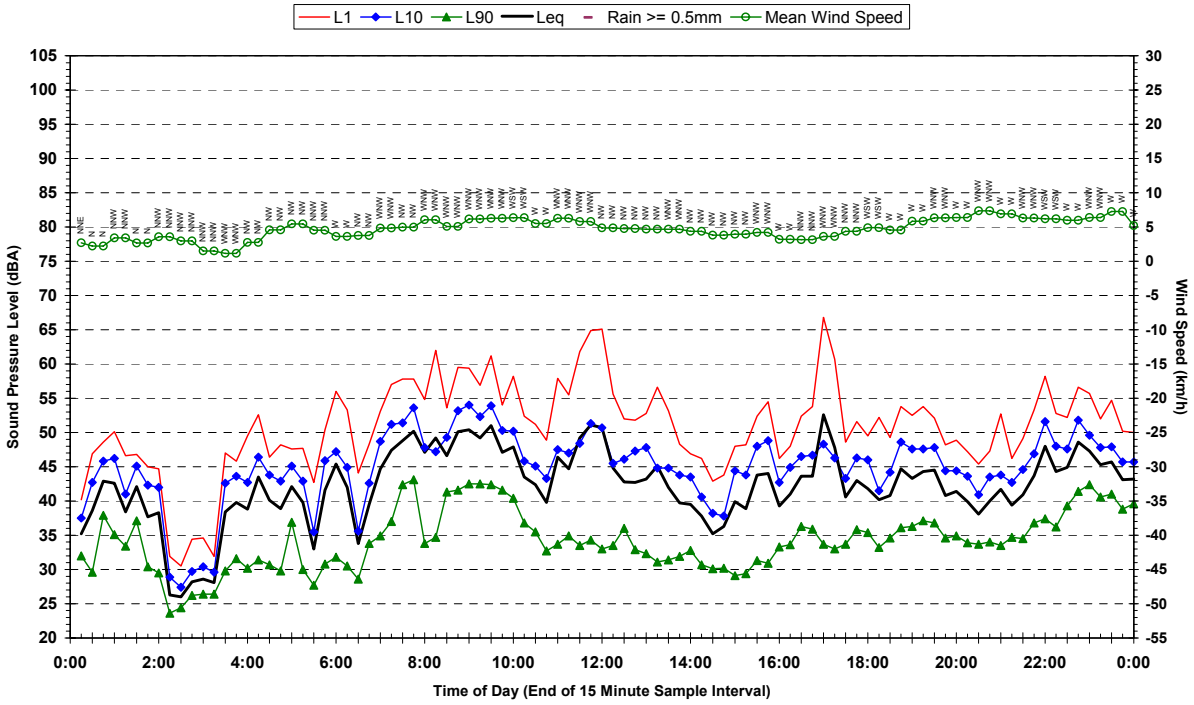
Statistical Ambient Noise Levels
McParland - Trial Period - Thursday 24 July 2003



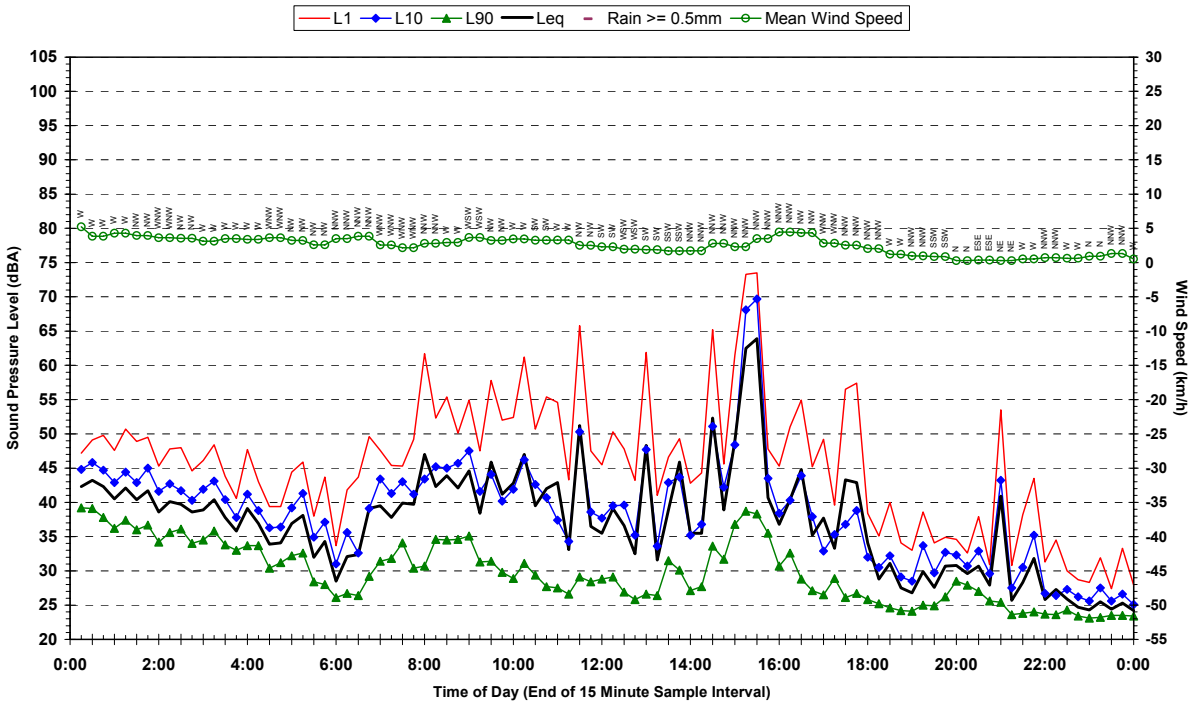
Statistical Ambient Noise Levels
McParland - Trial Period - Friday 25 July 2003



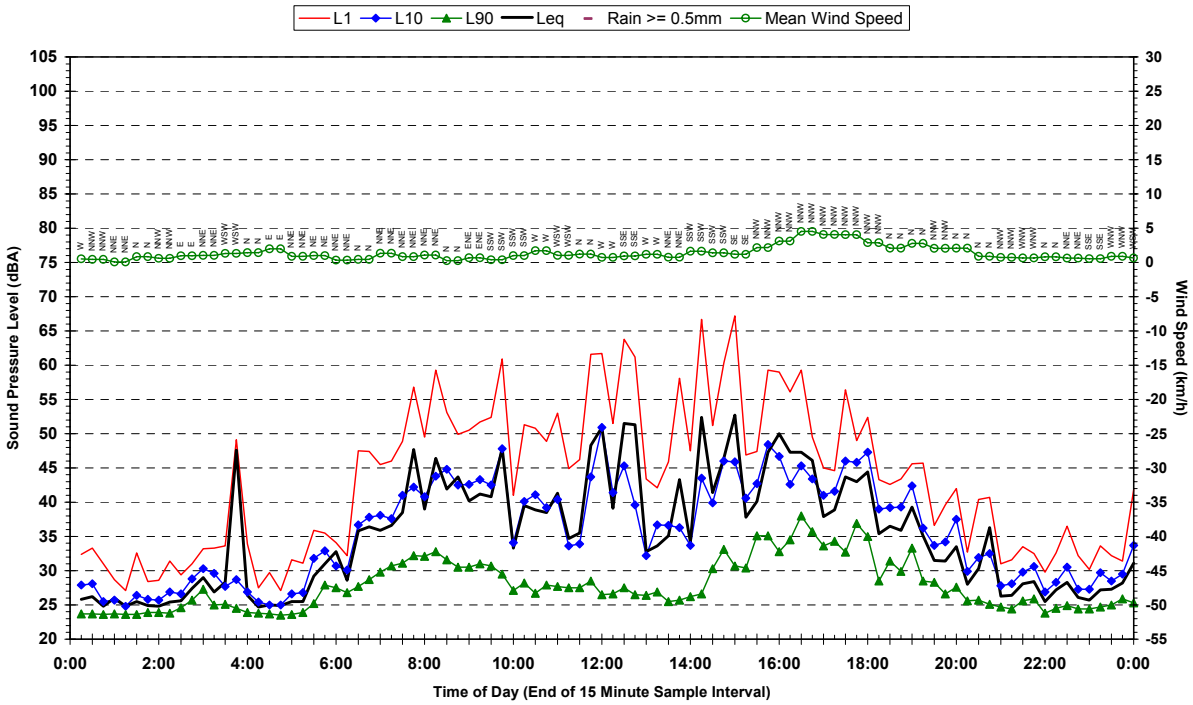
Statistical Ambient Noise Levels
McParland - Trial Period - Saturday 26 July 2003



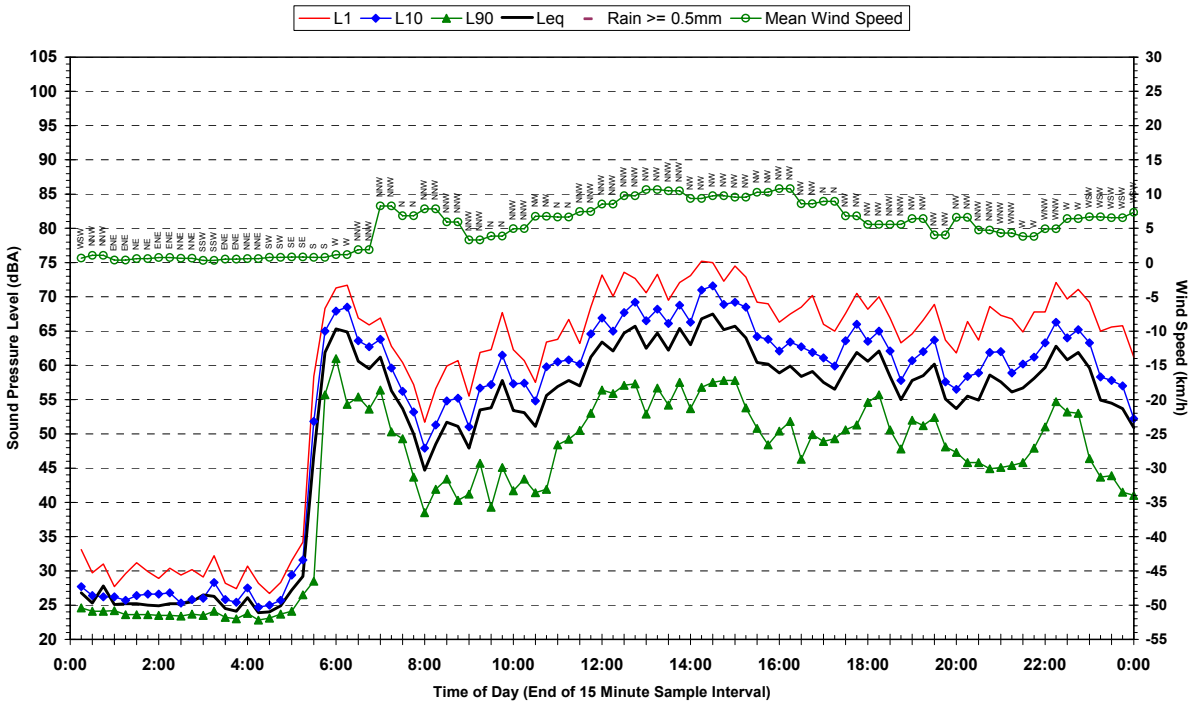
Statistical Ambient Noise Levels
McParland - Trial Period - Sunday 27 July 2003



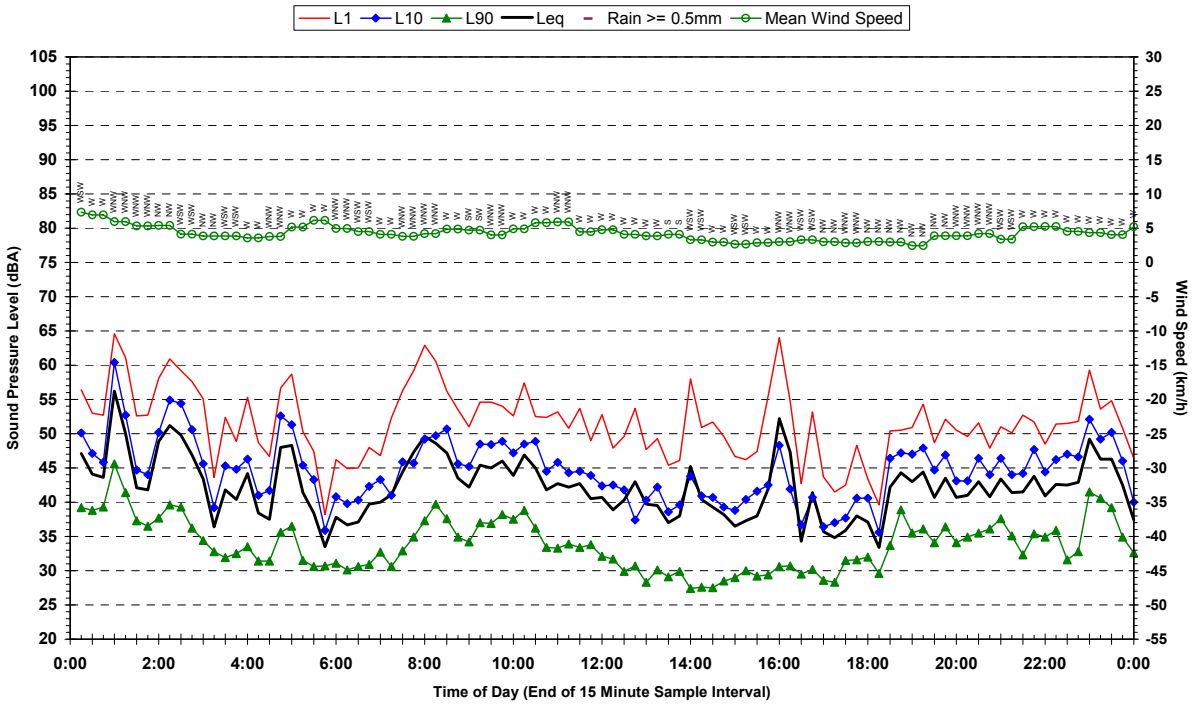
Statistical Ambient Noise Levels
McParland - Trial Period - Monday 28 July 2003



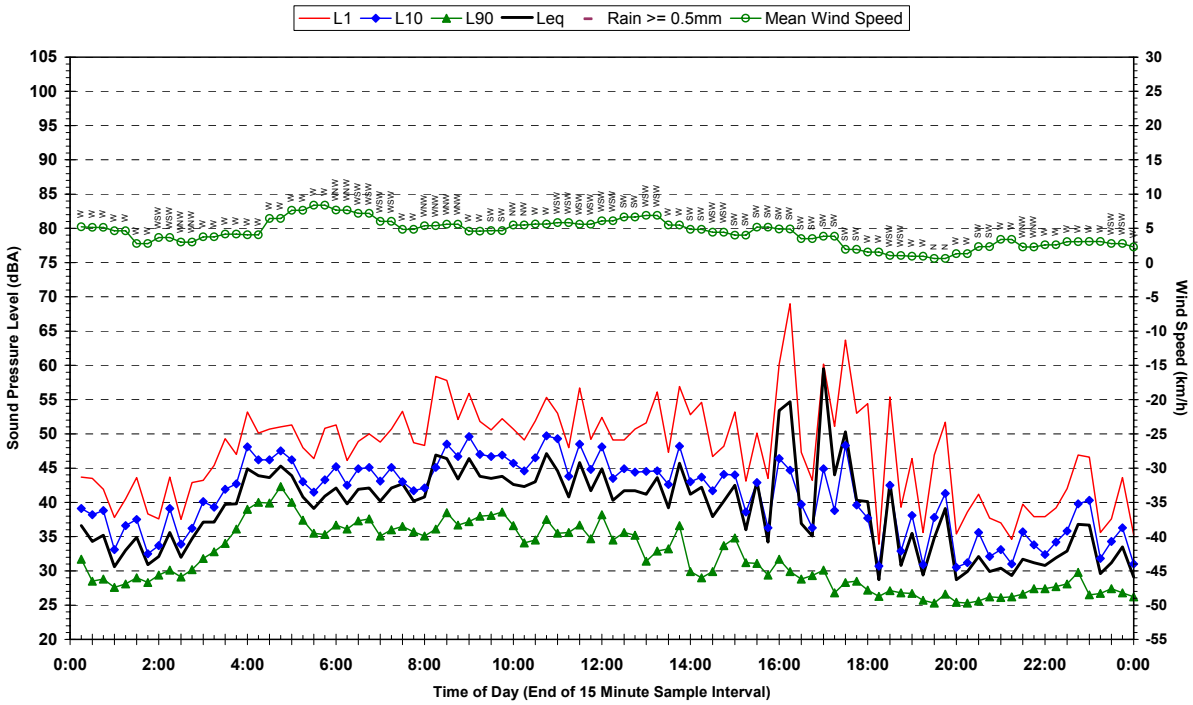
Statistical Ambient Noise Levels
McParland - Trial Period - Tuesday 29 July 2003



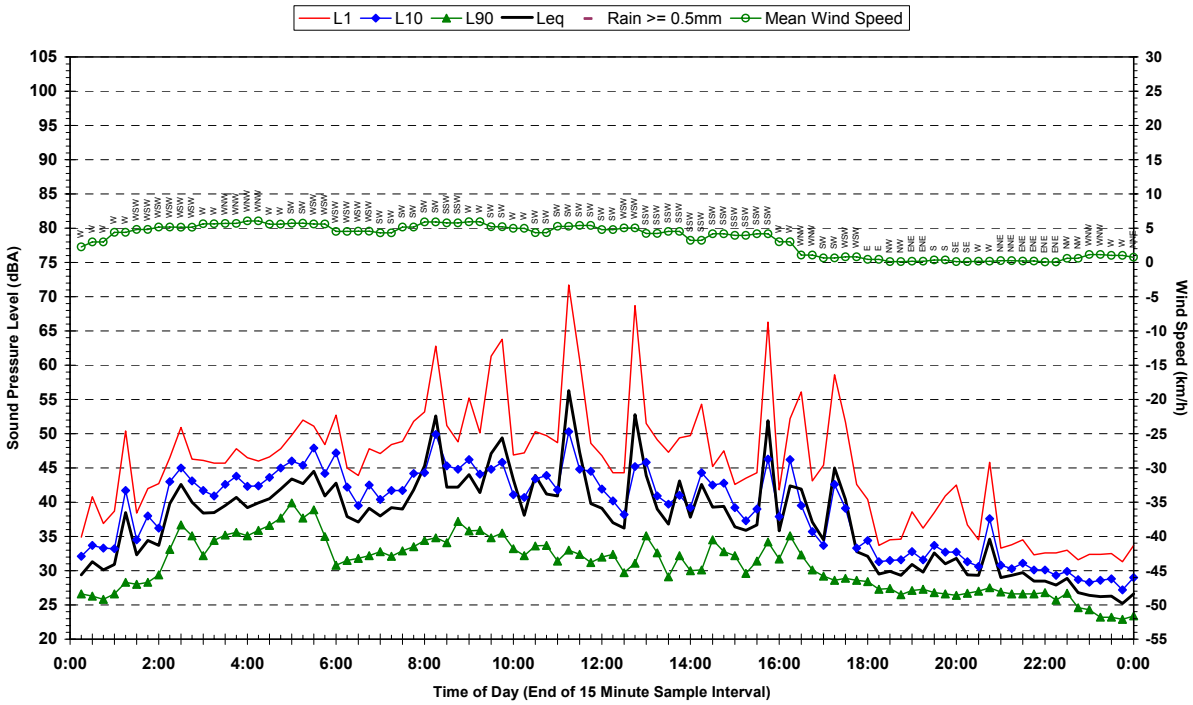
Statistical Ambient Noise Levels
McParland - Trial Period - Wednesday 30 July 2003



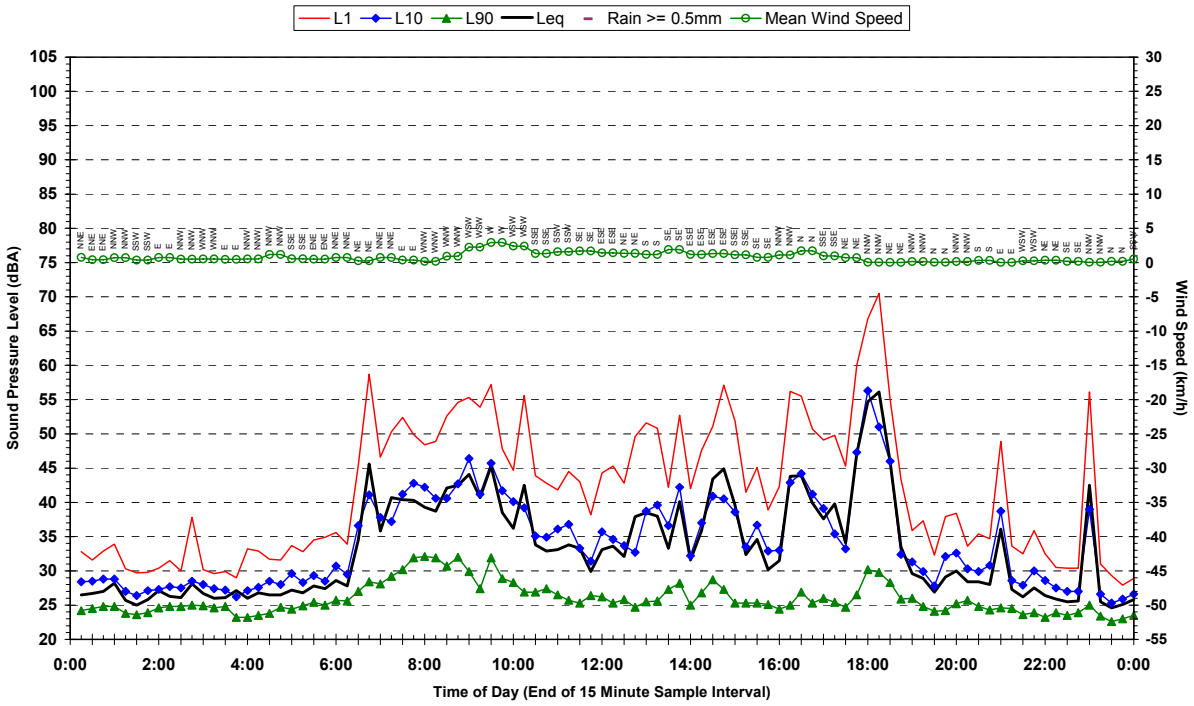
Statistical Ambient Noise Levels
McParland - Trial Period - Thursday 31 July 2003



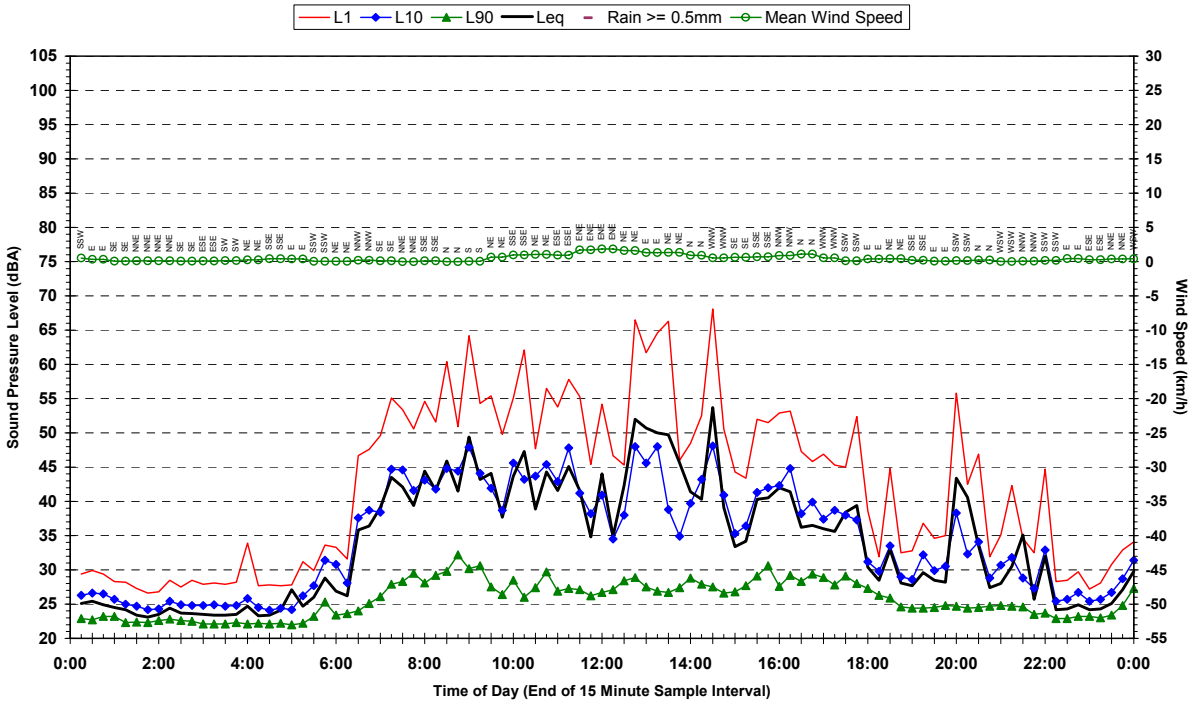
Statistical Ambient Noise Levels
McParland - Trial Period - Friday 1 August 2003



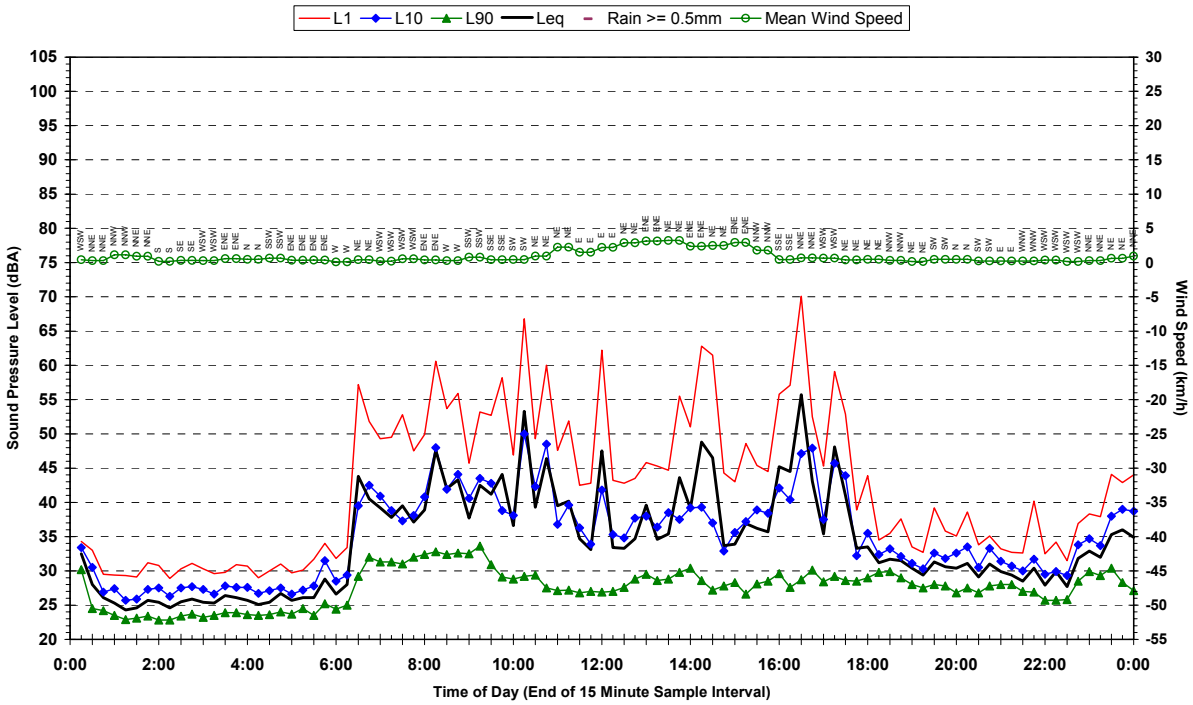
Statistical Ambient Noise Levels
McParland - Trial Period - Saturday 2 August 2003



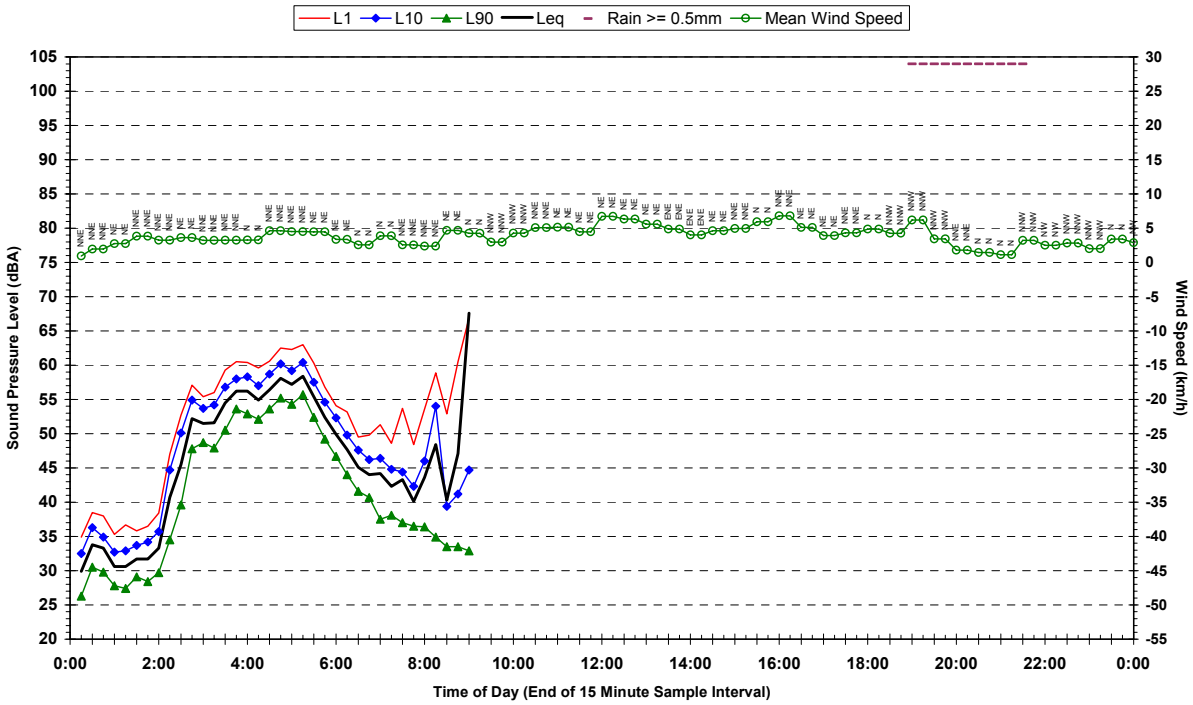
Statistical Ambient Noise Levels
McParland - Trial Period - Sunday 3 August 2003



Statistical Ambient Noise Levels
McParland - Trial Period - Monday 4 August 2003



Statistical Ambient Noise Levels
McParland - Trial Period - Tuesday 5 August 2003

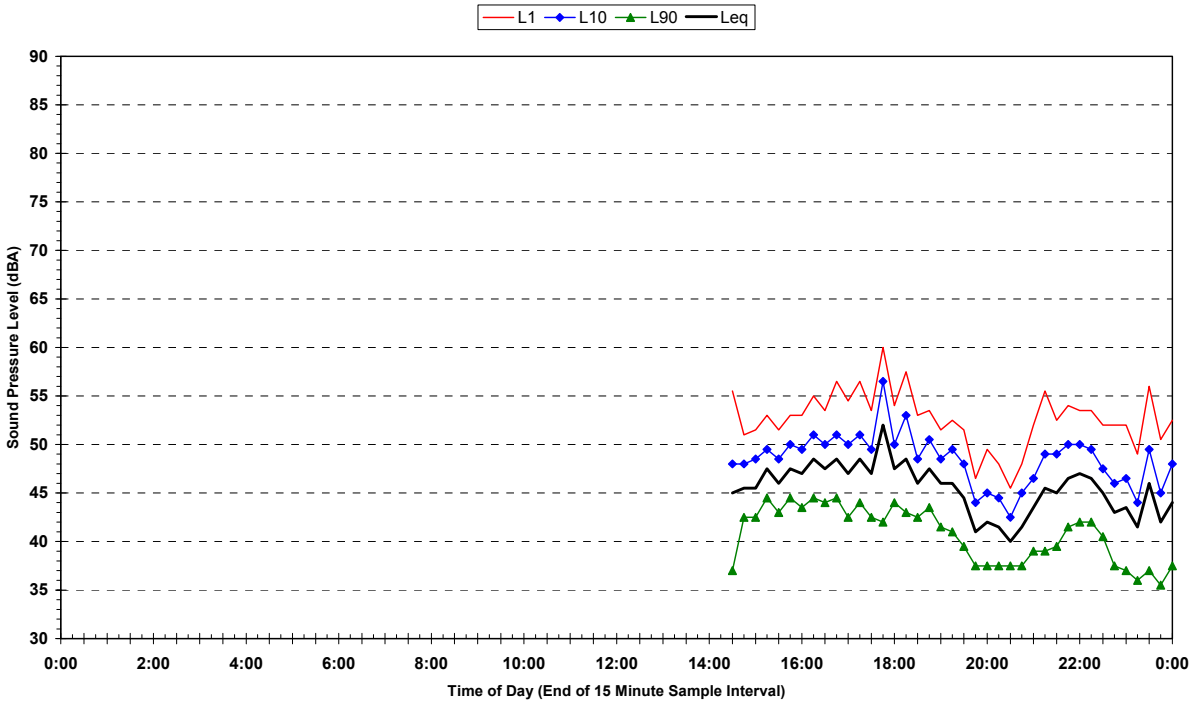


APPENDIX F

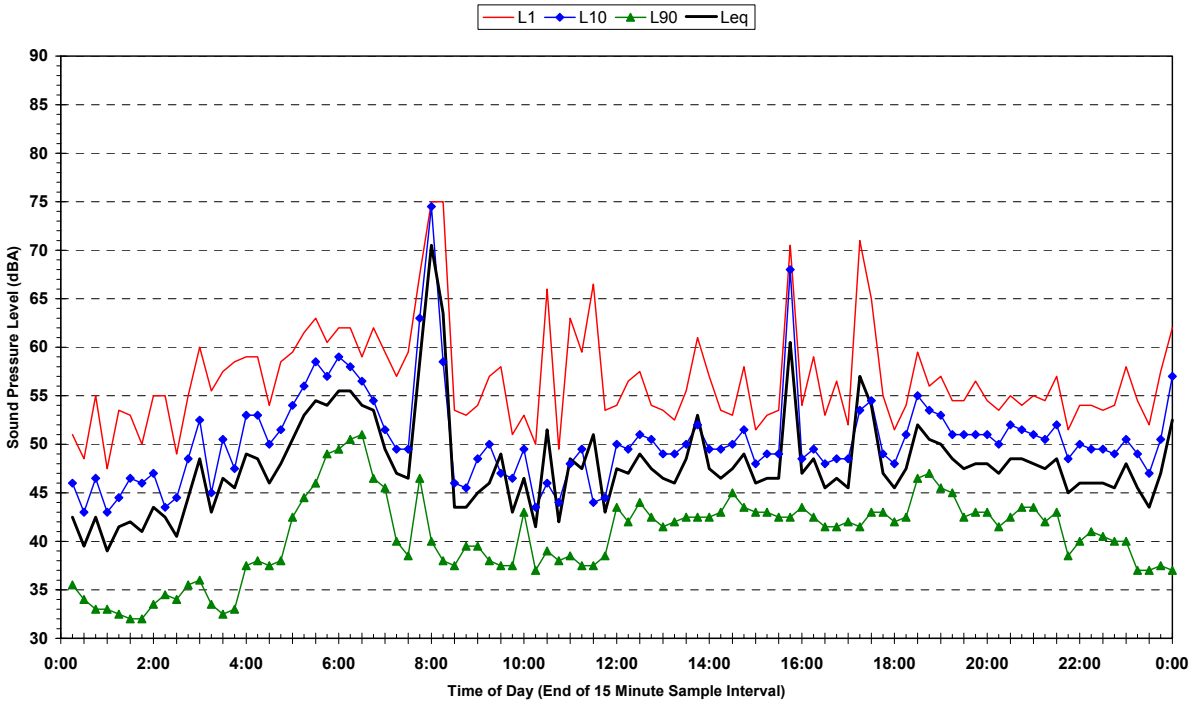
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Statistical Ambient Noise Levels Location N

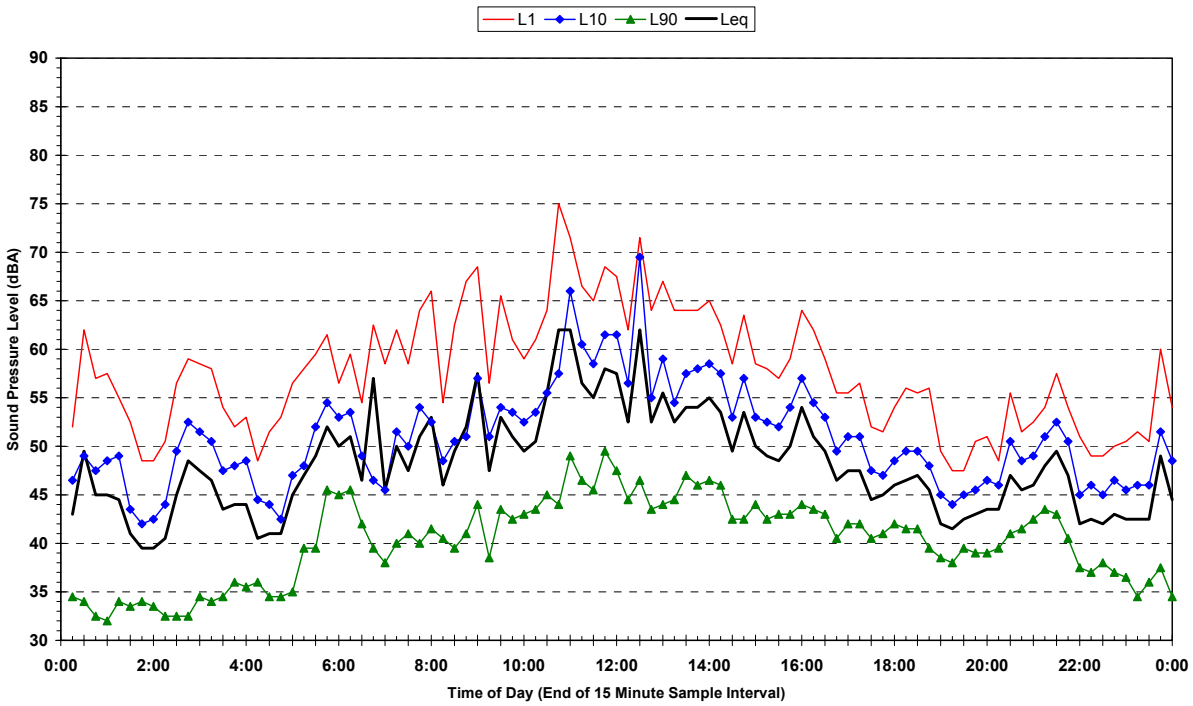
Statistical Ambient Noise Levels
30-1142 Location N - Tuesday 16 October 2001



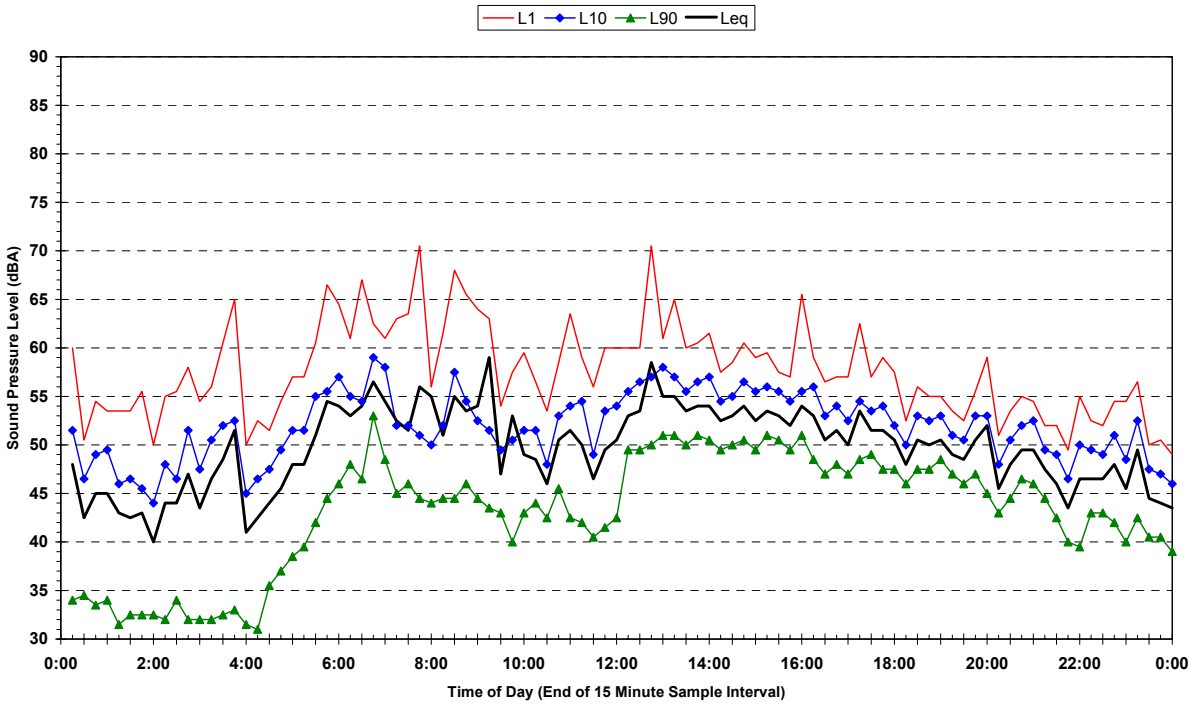
Statistical Ambient Noise Levels
30-1142 Location N - Wednesday 17 October 2001



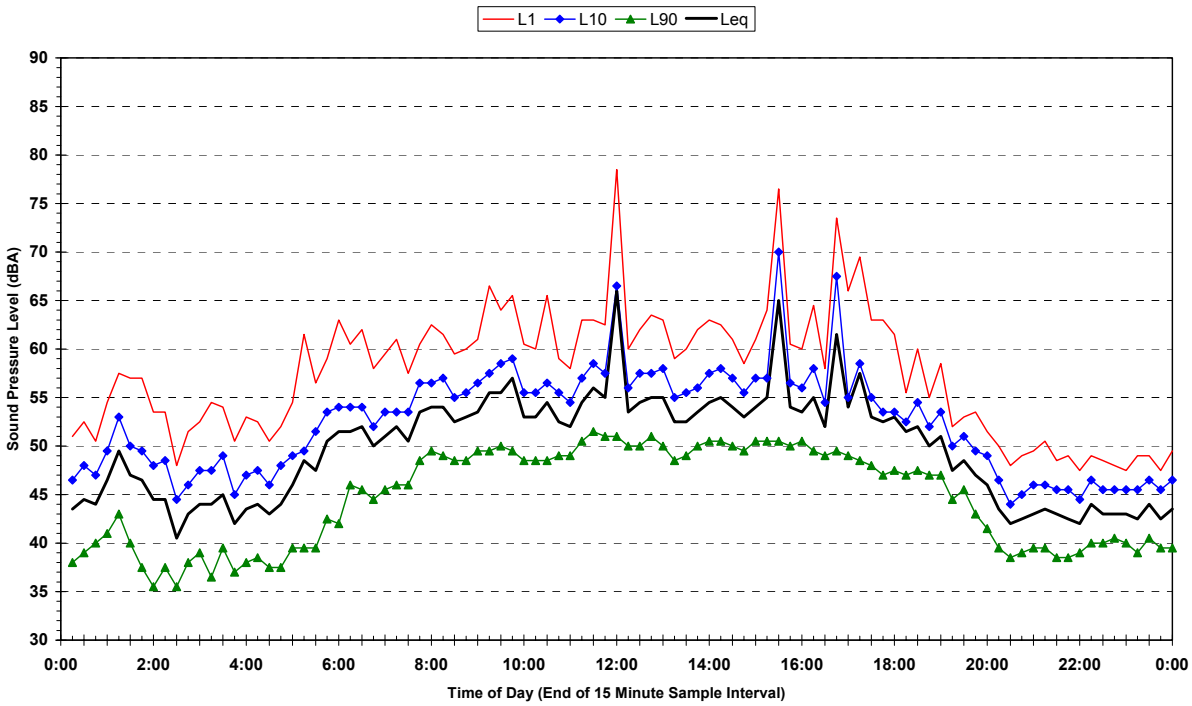
Statistical Ambient Noise Levels
30-1142 Location N - Thursday 18 October 2001



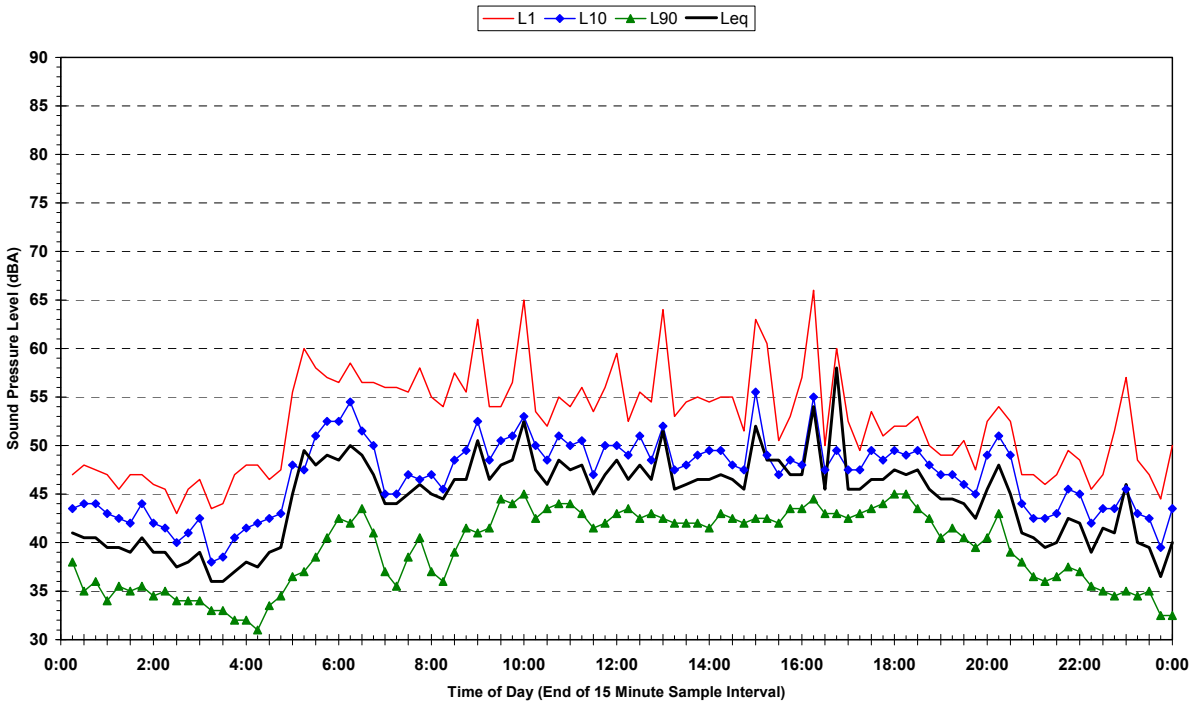
Statistical Ambient Noise Levels
30-1142 Location N - Friday 19 October 2001



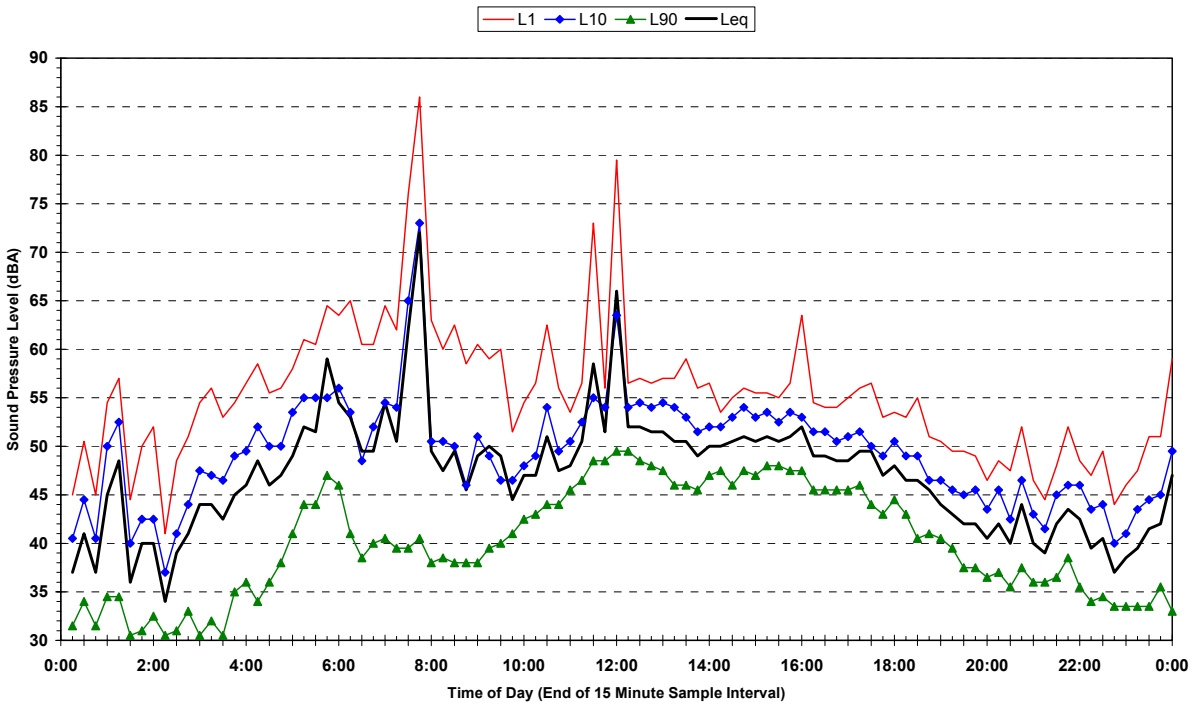
Statistical Ambient Noise Levels
30-1142 Location N - Saturday 20 October 2001



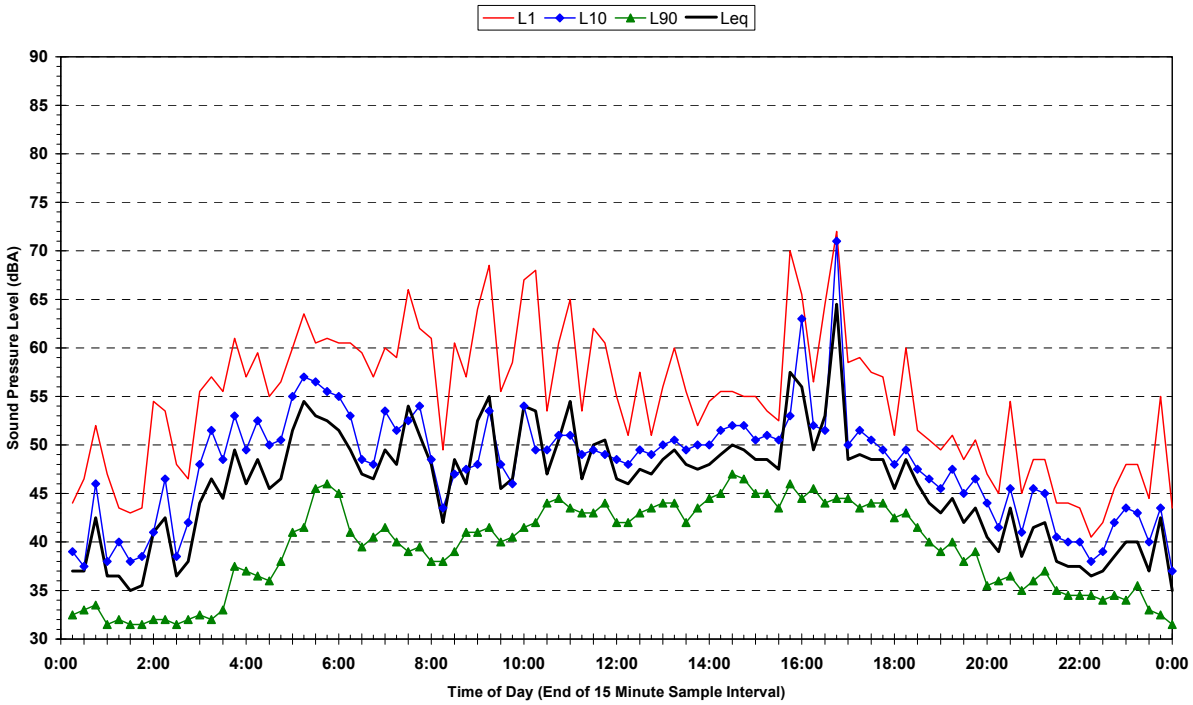
Statistical Ambient Noise Levels
30-1142 Location N - Sunday 21 October 2001

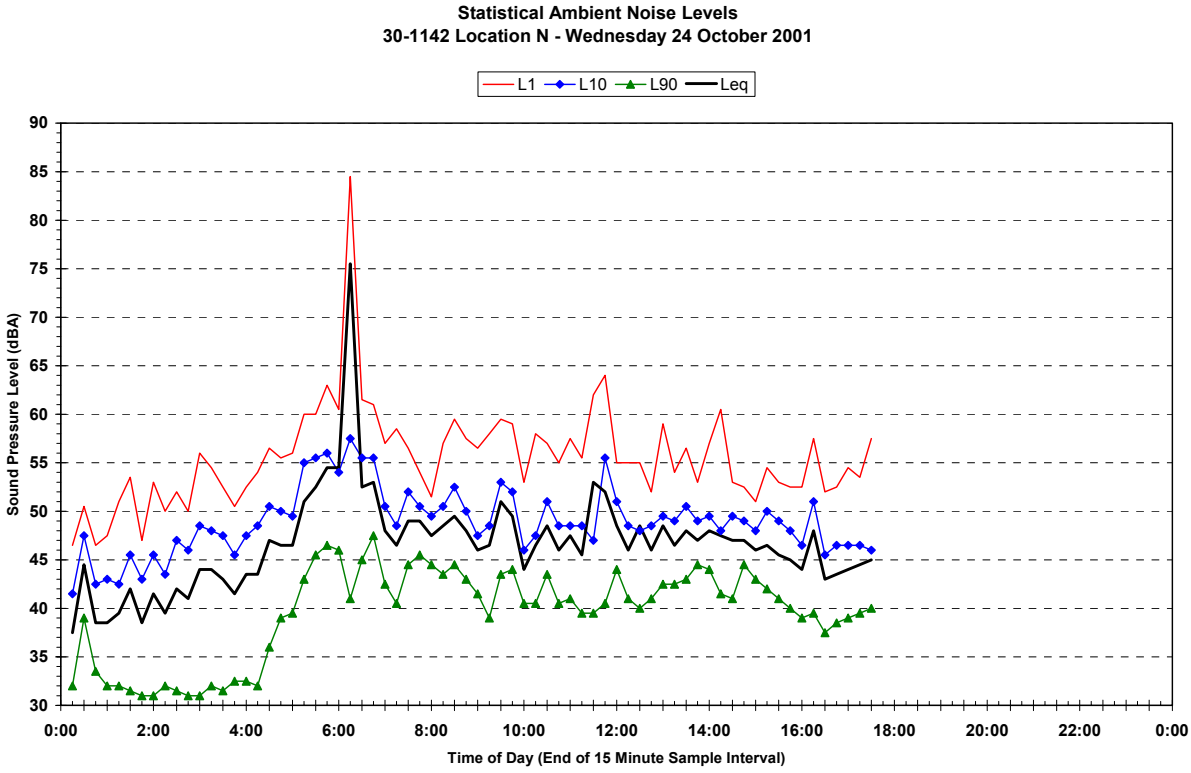


Statistical Ambient Noise Levels
30-1142 Location N - Monday 22 October 2001



Statistical Ambient Noise Levels
30-1142 Location N - Tuesday 23 October 2001

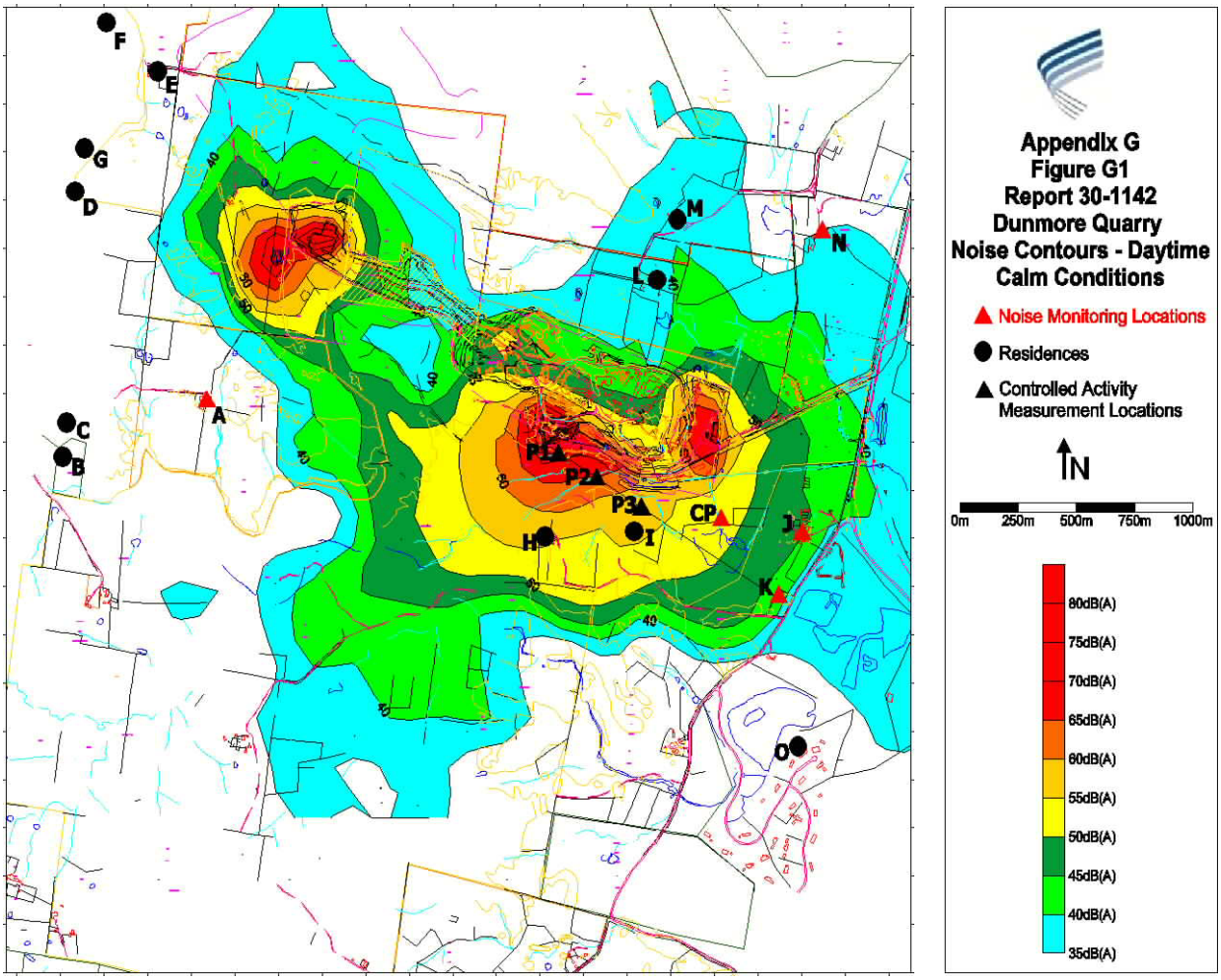


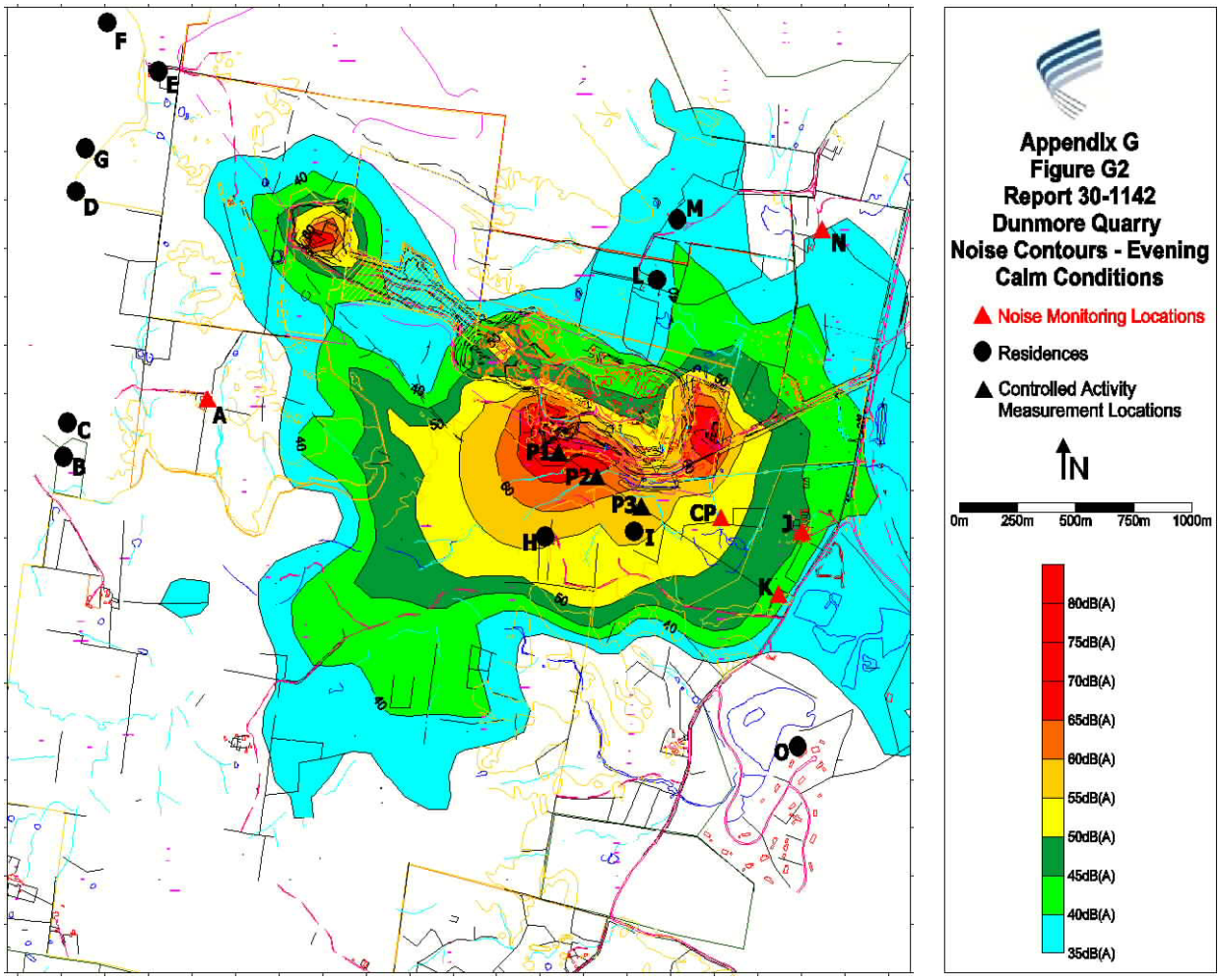

Statistical Ambient Noise Levels
30-1142 Location N - Wednesday 24 October 2001
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

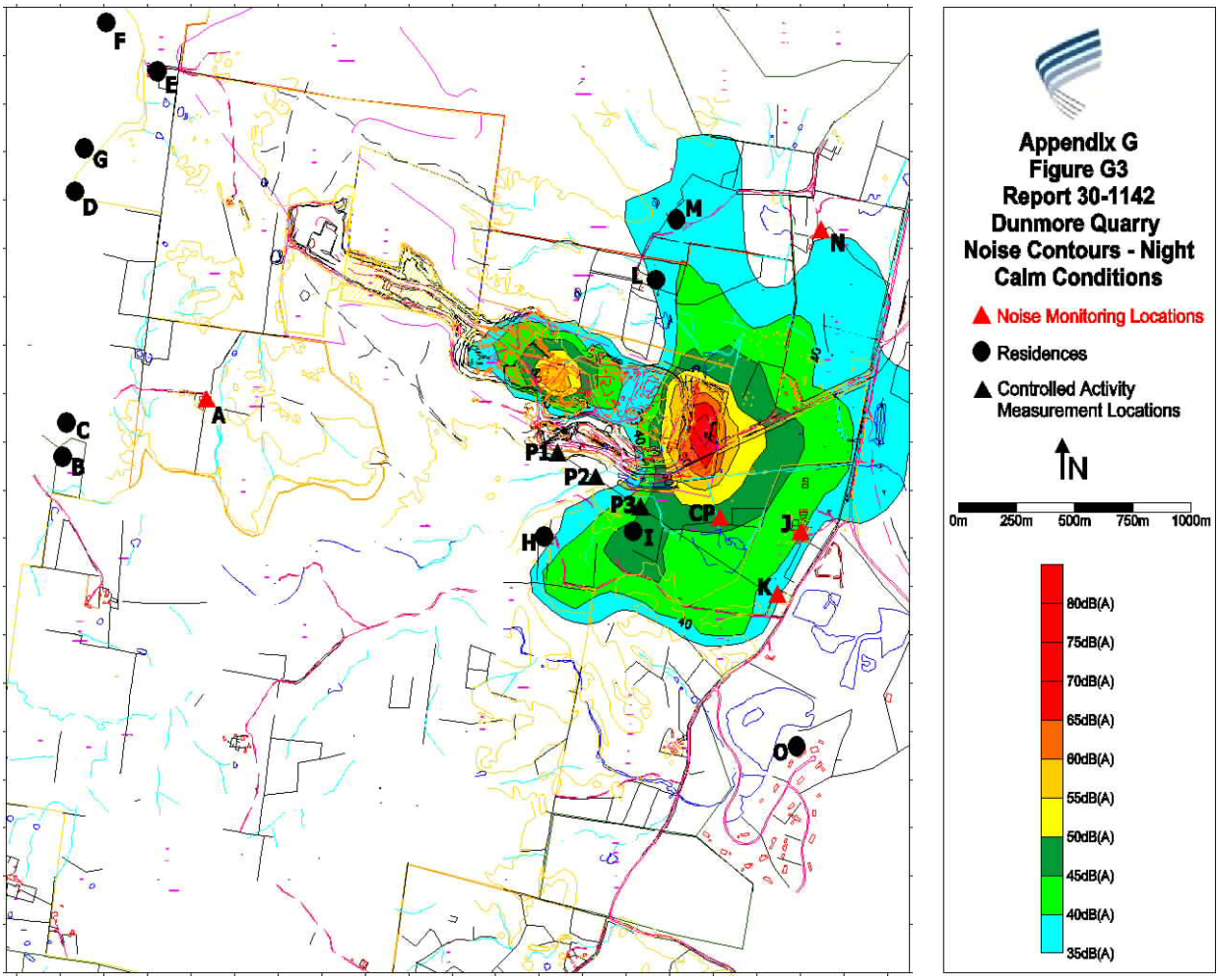
APPENDIX G

(No. of pages excluding this page = 3)

Noise Contours


F
E
G
D
M
N
L
A
C
B
P1
P2
P3
CP
J
H
I
K
O
40
45
50
Appendix G
Figure G1
Report 30-1142
Dunmore Quarry
Noise Contours - Daytime
Calm Conditions
Noise Monitoring Locations
Residences
Controlled Activity
Measurement Locations
N
0m
250m
500m
750m
1000m
80dB(A)
75dB(A)
70dB(A)
65dB(A)
60dB(A)
55dB(A)
50dB(A)
45dB(A)
40dB(A)
35dB(A)


F
E
G
D
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L
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C
B
P1
P2
P3
CP
H
I
J
K
O
40
45
50
55
60
65
80
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Figure G2
Report 30-1142
Dunmore Quarry
Noise Contours - Evening
Calm Conditions
Noise Monitoring Locations
Residences
Controlled Activity
Measurement Locations
N
0m 250m 500m 750m 1000m
80dB(A)
75dB(A)
70dB(A)
65dB(A)
60dB(A)
55dB(A)
50dB(A)
45dB(A)
40dB(A)
35dB(A)


F
E
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55dB(A)
50dB(A)
45dB(A)
40dB(A)
35dB(A)

APPENDIX H

(No. of pages excluding this page = 1)

Current Blast Monitoring Results

Shot	Distance (m)	Mic (kg)	Ground Vibration (mm/s)	Airblast (dBl)	Comments
10	1008	185	0.2	120	High Wind
11	817	64	0.88	106.5	
12	689	112	2.2	111	
13	750	60	1.3	114.4	
14	764	230	1.7	115.2	
15	745	300	2.6	112.5	
16	710	370	6.3	114.3	
17	787	67	1.2	103.6	
18	750	260	3.28	113.4	
19	717	138	4.71	104.9	
20	795	250	4.37	112.6	
21	700	280	7.08	108.4	
1	806	285	3.39	113.3	
2	784	240	1.62	113.5	
3	769	217	2.52	111.8	
4	991	185	3.67	105.5	
5	756	280	3.47	112	
6	705	270	4.38	107	
7	961	185	1.43	108.4	
8	649	50	1.67	106.5	
9	742	170	4.81	111.2	
10	1014	177	0.72	102.8	
11	817	275	1.3	113.1	
12	940	260	1.58	122.3	High Wind
13	702	275	5.7	105.4	
14	780	180	2.1	109.2	
15	904	308	4.6	107.3	
16	740	170	2.69	108	
17	889	182	2.85	110.1	
18	1220	260	1.79	102	
19	1055	153	1.73	98.9	
20	1102	248	2.77	114.6	
21	1181	138	2.34	106.3	
23	737	165	2.27	109.2	
24	900	90	0.9	107.7	
25	682	165	3.32	104.1	
22	854	187	2.99	112.1	
26	870	158	2.72	109.8	

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RHA Report 30-1142
Page 1 of 1
Current Blast Monitoring Results

Boral Resources (NSW) Pty Limited

ABN: 51 000 756 507

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 2: AIR QUALITY ASSESSMENT

Prepared by

Holmes Air Sciences

November, 2003

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 2: AIR QUALITY ASSESSMENT

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November, 2003

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EXECUTIVE SUMMARY

The following report presents an assessment of the air quality impacts that would be associated with the increased level of production at Boral Resources' quarry operations at Dunmore, south of Wollongong. The report forms part of an Environmental Impact Statement prepared by R. W Corkery and Co Pty Ltd.

Dispersion modelling has been used to quantitatively assess air quality impacts likely to arise from an increase in extraction rates and operating hours at the quarry. The approach adopted for the assessment was as follows.

- Review the existing environment with respect to the meteorology and existing air quality
- Estimate dust emissions from the existing and proposed quarry operations
- Use a computer-based dispersion model to predict ground-level dust concentration and deposition level in the local area due to emissions from the operations
- Examine the contribution of the existing quarry to local air quality
- Compare the predicted air quality impact of the proposed operational scenario with the predicted existing scenario
- Compare predicted dust concentration and deposition levels with relevant air quality criteria

It was concluded from the study that air quality goals would not be exceeded at nearby residences due to the proposed production increase and extended operating hours. The air quality impacts due to the proposed operation were, however, predicted to be higher than those predicted for the existing operations.

Dispersion modelling suggested that the contribution of the quarry to dust in the local environment was significantly lower than the data recorded by dust deposition gauges in the area.

1 INTRODUCTION

This report has been prepared by Holmes Air Sciences for R. W Corkery and Co. Pty Ltd who are in turn acting on behalf of Boral Resources (NSW) Pty Ltd (Boral). Boral is seeking approval to increase extraction rates and operating hours at its Dunmore Quarry to the south of Wollongong. The purpose of this report is to quantitatively assess the change in dust impacts likely to arise from the proposed operational changes.

The assessment is based on the use of a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the quarry. To assess the effect that the dust emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality goals.

The assessment is based on a conventional approach following the procedures outlined in the New South Wales Environment Protection Authority's (NSW EPA, now known as Department of Environment and Conservation or DEC) document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" (NSW EPA, 2001).

In summary, the report provides information on the following.

- The existing and proposed extraction, processing and transportation operations
- Air quality goals that need to be met to protect the air quality environment
- Meteorological conditions in the area
- A discussion of the likely existing air quality conditions in the area
- The methods used to estimate dust emissions and the way in which dust emissions from the proposal would disperse and fallout
- The expected dispersion and dust fallout patterns due to emissions from the quarry and a comparison between the predicted dust concentration and fallout levels and the relevant air quality criteria
- Control methods which can be used to reduce dust impacts

The report also includes a review of the air quality monitoring data collected within and surrounding Dunmore Quarry on site, particularly before and after the commencement of the 9 month trial period.

2 PROJECT DESCRIPTION

Dunmore Quarry is located west of the Princes Highway at Dunmore. **Figure 1** shows the location of the Project Site for Boral's development application and the surrounding study area. Terrain in the study area is shown in **Figure 2**. The operation has an annual production typically of 1.2 Mtpa with normal operating hours between 6.00 am and 6.00 pm. Boral is currently operating with a trial period of extended hours that permits extraction and processing to 10.00 pm Monday to Saturday. Boral proposes to increase annual production from the existing 1.2 Mtpa to 2.5 Mtpa by about 2005.

Hard rock is presently extracted from two extraction areas named Croome Farm and Rail Infrastructure Corporation (RIC). The location of these areas, and processing and product stockpile areas, are shown in **Figure 3**. The extraction operations include the drilling and blasting from either Croome Farm or RIC. Rock is transported by 50 t dump trucks to the processing plant where it is crushed and screened into various product sizes. The product is then distributed to the on-site stockpiles by 50 t dump trucks before being either loaded to road truck or to train for transportation off-site.

It is proposed to progress the extraction operations to the south within the approved Croome Farm extraction area as the production increases. There would be no further expansion of the area of disturbance within the RIC area. Rather, Boral proposes to simply progress deeper in this area.

The main sources of dust associated with the operation of the quarry are as follows.

- Drilling and blasting of rock within the active extraction areas
- Vehicles travelling on unpaved surfaces
- Crushing and screening of rock within the processing plant
- Loading and unloading of material to trucks, crushers, stockpiles and trains
- Wind erosion from stockpiles and unpaved exposed areas

A concrete batching plant (CBP) also operates within the eastern boundary of the Project Site. It produces approximately 24000 m^3 of concrete per year. Overhead bins and silos are used to store raw materials before they are reclaimed through a gravity fed system to bottom discharge gates. Coarse aggregates, sand and cementicious material are batched with water in transit mixers before departure. Approximately 5700 vehicle movements per year are associated with the operation of the CBP, made up of agitators (4800 vehicle movements per year), cement and flyash tankers (180 vehicle movements per year) and sand trucks (720 vehicle movements per year). Aggregates are supplied from the quarry and fed into the plant via front-end loader.

Table 1 summarises the operations for two annual production scenarios. These two scenarios have been used in the dispersion modelling.

TABLE 1
Summary of existing and proposed quarry operations at Dunmore

Scenario	Existing 1.2 Mtpa	Proposed 2.5 Mtpa
Annual production	1.2 Mtpa (maximum 1.4 Mtpa)	2.5 Mtpa
Extraction areas	Croome Farm (70%), RIC (30%)	Croome Farm extension (100%)
Hours of operation	6 am to 6 pm	6 am to 10 pm
Product out by road	300000 to 500000 t/y	1000000 t/y
Product out by train	700000 to 900000 t/y	1500000 t/y
Concrete production by CBP	24000 m^3/y	24000 m^3/y

3 AIR QUALITY GOALS

Table 2 and **Table 3** summarise the air quality assessment criteria that are relevant to this study. The air quality goals relate to the total dust burden in the air and not just the dust from the project. In other words, some consideration of background levels needs to be made when using these goals to assess impacts. This is discussed further in Section 4.3.

TABLE 2
Air quality assessment criteria for particulate matter concentrations

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	NHMRC
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	DEC (formerly NSW EPA)
	30 $\mu g/m^3$	Annual mean	DEC long-term reporting goal
	50 $\mu g/m^3$	(24-hour average, 5 exceedances permitted per year)	NEPM
Particulate matter < 2.5 μm ($PM_{2.5}$)	8 $\mu g/m^3$	Annual mean	NEPM*
	25 $\mu g/m^3$	24-hour maximum	NEPM*

** Long-term reporting goal, not yet applied to projects in NSW.*

Also included in **Table 2** are the NEPM goals for the fine fraction of PM_{10} namely $PM_{2.5}$. Epidemiological studies (Dockery et al, 1993 for example) indicate that it is the finer particles, that is those below 2.5 μm in diameter and referred to as $PM_{2.5}$, that cause health impacts as they are taken deeper into the lung. As yet, Australia has no ambient goal for $PM_{2.5}$ applied on a project basis.

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 3** shows the maximum acceptable increase in dust deposition over the existing dust levels. These criteria for dust fallout levels are set to protect against nuisance impacts (NSW EPA, 2001).

TABLE 3
NSW EPA criteria for dust fallout

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

4 EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing dust levels in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCST3, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[1] and mixing height[2]. Four sources of meteorological data have been reviewed for this study to determine the most representative dataset for the site.

Boral has been collecting meteorological data at Dunmore Quarry since July 2002. The location of the meteorological monitoring station is shown in **Figure 1**. These data consist of hourly records of wind speed and wind direction and have been processed into a form suitable for use in the ISCST3 dispersion model. Temperature in this meteorological data file has been set to 25 degrees Celsius. For non-buoyant volume sources, as applied for quarry dust sources, this assumption of constant temperature makes no difference to the model result. The meteorological data file contains 8760 hours of data (100% of one year) for use in the dispersion modelling.

The Bureau of Meteorology collects data from Albion Park (Wollongong Airport) which is approximately 6 km to the north-west of the Project Site. These data contain hourly records of temperature, wind speed and wind direction. The Albion Park dataset contains 8698 hours which corresponds to a data recovery amount of 99% of one year.

Meteorological data has also been collected by Holmes Air Sciences on behalf of Sydney Water at Gerroa. This site is approximately 15 km to the south of Dunmore Quarry and consist of 10-minute records of wind speed and wind direction for 2001. Approximately 95% of data for 2001 was collected.

In addition to the data collected by local weather stations, the CSIRO's prognostic model (known as TAPM) has been used to generate one year of meteorological data specifically for

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

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

the Project Site site. TAPM (The Air Pollution Model, Version 2) is capable of producing a range of meteorological parameters on an hourly basis for any location within Australasia. The Bureau of Meteorology's Limited Area Prediction System (LAPS) database is used to define synoptic meteorology for input into TAPM. Landuse and terrain for the specific location are also drawn from databases. Model parameters have been selected with minimal deviation from CSIRO default model settings and computational grids have been nested down from an outer domain 750 km by 750 km with a 30 km grid spacing to a final domain 25 km by 25 km and 1 km spacing. Output from TAPM would be expected to be accurate to within TAPM capabilities. The model is fully described in the accompanying user manual (Hurley, 2002).

The Dunmore Quarry, Albion Park, Gerroa and TAPM data have been prepared into meteorological data files suitable for use in dispersion modelling. Comparisons of the wind patterns from the Dunmore Quarry, Albion Park, Gerroa and site specific TAPM generated data are presented as windroses in **Figures 4** to **7** respectively. It can be seen from these figures that the wind patterns from the four datasets exhibit similarities but some marked variations are obvious, note for example the very much reduced occurrence of westerly winds at Dunmore in winter compared with the other sites. Annually, the most common winds are from the west and south-west for all four sites with winds from the north-east also prevalent. The Gerroa site shows the most defined wind directions of the four datasets with few wind directions recorded outside the north-east and west directions (**Figure 6**). Both the Albion Park and TAPM data also exhibit some contribution from southerly winds.

Seasonally, wind patterns from all four datasets are similar with westerly winds more common in winter and NE and ENE winds (sea breezes) more common in the warmer months. Few periods when the wind speed was below 0.5 m/s (calms) were obtained from the Albion Park and TAPM datasets while calm periods accounted for 10% to 20% of the time for the Gerroa and Dunmore Quarry data. The annual average wind speeds from the Dunmore Quarry, Albion Park, Gerroa and TAPM data were 2.6, 3.7, 4.3 and 4.0 m/s respectively.

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. For the Dunmore Quarry and Albion Park datasets, a stability class was assigned to each hour of the meteorological data using cloud cover information and the method of Turner (Turner, 1970). Stability for the Gerroa data was determined using sigma-theta according to the method recommended by the US EPA (US EPA, 1986). **Table 4** shows the frequency of occurrence of the stability categories expected in the area from the four meteorological datasets.

The most common stability occurrences for all four sites were calculated to be D class. This would suggest that the dispersion conditions would be such that dust emissions would disperse rapidly for a significant proportion of the time. As for the comparison between wind patterns for the four sites, analysis of **Table 4** shows that the Dunmore Quarry, Albion Park and TAPM data are the most comparable.

TABLE 4
Frequency of occurrence of stability in the study area

Stability Class	Dunmore Quarry 2002/2003	Albion Park 1990/2000	Gerroa 2001	TAPM 2001
A	4.8	1.4	1.7	0.4
B	14.3	11.6	1.3	9.3
C	15.1	19.6	3.6	16.9
D	25.2	23.5	67.1	40.8
E	7.0	8.0	19.1	21.5
F	33.5	18.4	7.2	11.2
Total	100	100	100	100

The Dunmore Quarry site data has been chosen for use in the dispersion modelling. This is because its proximity to the area of interest ensures that it is representative of local conditions. As will be seen later, it also provides a more conservative assessment for the closest residences to the processing areas. Joint wind speed, wind direction and stability class frequency tables for the Dunmore Quarry data are provided in **Appendix A**.

4.2 Local Climatic Conditions

The Bureau of Meteorology also collects climatic information that may be representative of climate in the study area. A range of meteorological data collected from Wollongong University are presented in **Table 5** (Bureau of Meteorology, 2003).

Temperature data show that January and February are typically the warmest months with mean daily maximums of 25.6 ^{o} C. July is the coldest month with a mean daily minimum of 8.4 ^{o} C. Rainfall data collect in the Wollongong area show that March is the wettest month with a mean rainfall of 176 mm over 14 rain days. Annually the area experiences, on average, 1374 mm of rain per year.

TABLE 5
Climate information for the Wollongong University

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean daily maximum temperature - deg C	25.6	25.6	24.5	22.5	20	17.5	16.9	18.2	20.1	22	22.8	25	21.7	29.8
Highest daily Max Temp - deg C	42.3	41.7	40.2	35.4	28.5	24.7	25.7	30.3	34.2	36.6	40.6	41.5	42.3	30
Mean daily minimum temperature - deg C	17.9	18.3	16.8	14.2	11.9	9.5	8.4	8.8	10.6	12.7	14.4	16.6	13.3	30
Lowest daily Min Temp - deg C	9.6	10.3	9.5	5.6	0.5	-0.5	0.8	2	3.3	5.7	5.4	8.5	-0.5	30
Mean 9am air temp - deg C	22.1	22.2	21.3	19.3	16.7	13.9	13	14.3	16.6	18.5	19.3	21.3	18.3	30.3
Mean 9am wet bulb temp - deg C	18.6	18.9	17.7	15.3	13.2	10.5	9.4	10.2	11.9	14.1	15.4	17.4	14.5	28.7
Mean 9am dew point - deg C	16.1	16.7	15.1	12.1	9.9	6.7	5.1	5.3	6.9	9.9	12.1	14.4	10.9	29.9
Mean 9am relative humidity - %	70	73	69	64	66	63	61	57	55	61	65	66	64	28.4
Mean 9am wind speed - km/h	7.7	7.8	8	8.7	9.7	11.8	11.9	12.1	12.5	11.6	9.8	9.1	10.1	29.2
Mean 3pm air temp - deg C	23.6	23.9	22.8	20.8	18.7	16.2	15.6	16.7	18.1	19.5	20.6	22.8	20	30.3
Mean 3pm wet bulb temp - deg C	19.7	19.9	18.6	16.4	14.4	12	11	11.8	13.1	15	16.3	18.4	15.6	27.7
Mean 3pm dew point - deg C	17	17.4	15.6	12.9	10.6	7.3	5.6	6.1	8	10.8	12.9	15.1	11.6	29.9
Mean 3pm relative humidity - %	68	68	66	62	61	58	53	53	55	62	63	64	61	27.4
Mean 3pm wind speed - km/h	15.6	14.7	13.3	12.4	11	11.6	11.9	14.6	15.8	16.1	16.7	16.4	14.2	29.5
Mean monthly rainfall - mm	141.5	156.4	176	129.4	111.6	117.6	58.2	92.7	69.1	106.1	117.5	97.3	1373.5	30.6
Median (5th decile) monthly rainfall - mm	115.6	107.8	152.2	71.9	88.5	85.6	46.2	28.5	51.7	62.2	103	74.6	1364.7	30
Mean no. of raindays	13.9	13.9	14.4	10.8	10.9	9.6	8.4	7.7	9.2	11.5	13.2	12.9	136.5	30.6
Highest monthly rainfall - mm	423.9	488.3	484.1	655.8	338.1	637.6	249.7	763.8	214.6	400.4	367.6	367.8		30.6
Lowest monthly rainfall - mm	22.8	20.1	11.5	1.8	1.9	7.4	0.4	0.6	2.8	4.4	16	14.3		30.6
Highest recorded daily rainfall - mm	137.7	240.5	247.7	212.2	158.4	224.8	198.8	316	101.6	102.6	145.8	149.1	316	30.6
Mean no. of clear days	6.5	5.9	7	8.5	9	9.4	12.3	14.4	10.6	8	6.5	6.2	104.3	30.3
Mean no. of cloudy days	13.8	12.3	13.1	10.8	12.1	10.9	8.4	7.4	8.6	11.3	13.2	12.7	134.6	30.3
Highest recorded wind gust - km/h	96.5	83.5	88.9	105.5	107.6	118.4	131.4	148.3	124.2	111.2	107.6	92.5	148.3	14.6

Climate averages for Station: 068188 WOLLONGONG UNIVERSITY. Commenced: 1970; Last record: 2001; Latitude (deg S): -34.4033; Longitude (deg E): 150.8772; State: NSW

Source : Bureau of Meteorology (2003)

4.3 Existing Air Quality

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

4.3.1 Dust Deposition

There are no long term dust concentration measurements made in the vicinity of Dunmore Quarry, however, dust deposition is monitored at four sites in the study area. The location of each of the dust deposition gauges are shown in **Figure 1**. Dust deposition gauges use a simple device consisting of a funnel and bottle to record the rate at which dust settles onto the surface over periods approximating one month.

Data collected from the four dust deposition gauges in the study area are summarised in **Table 6**. These data are also shown graphically in **Figure 8**. These measurements will include all background sources relevant to that location, including any contribution which may occur from the existing Dunmore Quarry operations.

The ash component of the dust deposition measurements have also been included in **Table 6**. Insoluble solids include ash and combustible but otherwise insoluble material. Dust from the quarry would report to both insoluble solids and ash but since dust from the quarry would be non-combustible, the ash would be a more accurate indicator of the contribution from the quarry.

TABLE 6
Dust deposition data from Dunmore Quarry

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Month	Insoluble solids (g/m^2/month)				Ash (g/m^2/month)			
	DG1	**DG2**	**DG3**	**DG4**	**DG1**	**DG2**	**DG3**	**DG4**
Jan-97	3.8	2	3.14	3.3	2	1.12	2	1.87
Feb-97	6.96	3.86	3.81	4.96	4.74	2.34	2.42	2.73
Mar-97	2.92	2.05	4.59	2.45	2.32	1.43	2.89	1.7
Apr-97	2.06	1.96	2.12	1.82	1.27	0.86	1.32	1.12
May-97	22.81	5.68	3.5	2.59	8.7	4.61	2.63	1.74
Jun-97	9.08	3.87	3.51	4.65	4.36	2.89	2.41	3.4
Jul-97	2.25	0.74	1.17	1.22	0.95	0.36	0.87	0.94
Aug-97	2.75	0.97	2.17	1.45	1.68	0.58	1.52	0.97
Sep-97	3.09	3.73	3.72	3.64	2.01	2.67	2.18	2.19
Oct-97	2.22	2.31	2.23	1.94	1.41	1.33	1.48	1.25
Nov-97	2.3	1.87	5.88	3.25	1.44	1.06	5.25	2.07
Dec-97	3.84	3.03		3.2	1.64	1.61	0	1.57
Annual 1997	**5.3**	**2.7**	**3.3**	**2.9**	**2.7**	**1.7**	**2.1**	**1.8**

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Month	Insoluble solids (g/m^2/month)				Ash (g/m^2/month)			
	DG1	DG2	DG3	DG4	DG1	DG2	DG3	DG4
Jan-98	3.42	2.49	6.45	12.44	1.74	1.47	4.04	3.94
Feb-98	6.66	3.71	11.13	16.7	3.51	2.29	4.87	4.09
Mar-98	3.17	1.89	4.12	3.65	1.85	1.29	3.12	1.91
Apr-98	2.4	3.45	5.94	4.68	1.22	2.04	4	2.33
May-98	1.22	2.25	3.05	3.16	1.78	1.59	2.16	2.03
Jun-98	1.49	1.32	1.78	3.86	1.06	0.97	1.32	2.31
Jul-98	2.25	2.11	1.62	17.24	0.97	0.88	1.2	4.1
Aug-98	5.18	19.42	2.62	15.29	3.19	13.33	1.88	7.92
Sep-98	-	4.42	2.44	1.34	0	2.99	2.01	0.76
Oct-98	-	2.54	1.71	2.73	0	1.62	1.36	1.8
Nov-98	12.41	2.63	2.34	2.8	2.21	1.35	1.44	1.36
Dec-98	5.85	1.57	2.67	1.91	4.56	0.88	1.59	1.06
Annual 1998	**4.4**	**4.0**	**3.8**	**7.2**	**1.8**	**2.6**	**2.4**	**2.8**
Jan-99	7.09	4.16	2.97	3.16	4.28	2.67	2.08	2.02
Feb-99	21.07	3.67	4.42	5.4	9.22	1.97	2.78	2.95
Mar-99	12.29	11.8	2.96	4.16	3.44	1.79	1.62	2.74
Apr-99	3.86	2.01	2.77	8.38	2.1	1.18	1.73	2.72
May-99	2.83	1.46	1.94	2.01	1.85	0.93	1.34	1.32
Jun-99	1.65	0.6	2.38	1.39	1.52	0.5	1.94	0.99
Jul-99	2.07	2.21	4.42	2.26	1.31	1.23	2	1.46
Aug-99	1.48	2.52	4.36	2.33	0.87	1.09	2.62	1
Sep-99	2.12	2.55	3.78	3.24	1.27	1.11	2.05	2.03
Oct-99	2.74	3.31	4.46	3.31	2.06	1.87	2.94	1.64
Nov-99	6.34	2.58	3.64	2.38	2.58	1.31	2.17	1.21
Dec-99	5.45	1.79	4.91	3.86	1.27	1.1	2.05	2.15
Annual 1999	**5.7**	**3.2**	**3.6**	**3.5**	**2.6**	**1.4**	**2.1**	**1.9**
Jan-00	1.96	2.7	6.19	5.82	1.07	1.61	3.8	1.93
Feb-00	1.92	3.38	5.35	3	1.28	1.92	3.82	1.69
Mar-00	2.2	3.1	3.09	6.44	1.68	2.18	1.98	1.84
Apr-00	4.19	2.04	2.45	1.55	1.66	1.27	1.39	0.9
May-00	1.33	3.03	2.52	1.6	0.78	1.42	1.67	0.98
Jun-00	1.63	1.71	2.56	2.85	1.18	1.14	1.8	2.03
Jul-00	-	2.59	2.63	-	0	1.93	1.01	0
Aug-00	2.67	0.98	3.37	1.04	1.98	0.5	0.91	0.85
Sep-00	2.49	3.28	3.3	4.95	1.62	1.43	1.84	3.31
Oct-00	3.3	3.87	2.78	3.87	1.8	1.73	1.72	2.17
Nov-00	14.84	2.41	1.32	2.64	6.82	1.54	1.29	1.61
Dec-00	2.02	7.52	5.24	6.53	1.37	5.04	2.98	4.89
Annual 2000	**3.5**	**3.1**	**3.4**	**3.7**	**1.8**	**1.8**	**2.0**	**1.9**
Jan-01	7.52	5.13	16.09	7.12	3.51	3.03	7.45	3.98
Feb-01	3.23	3.54	4.14	3.28	2.02	1.9	2.59	1.77
Mar-01	2.42	2.64	3.4	2.43	1.34	1.3	1.84	1.37
Apr-01	3.07	2.45	5.42	2.43	1.44	1.25	3.63	1.51
May-01	1.62	5.35	3.88	2.12	0.88	2.36	2.31	1.31
Jun-01	1.01	1.17	3.3	1.78	0.61	0.75	1.54	1.18
Jul-01	3.13	3.05	4.31	3.24	1.42	0.96	1.87	1.76
Aug-01	1.86	2.08	2.52	3.13	0.99	1.22	1.75	1.65
Sep-01	1.69	7.54	3.93	2.3	0.93	3.24	1.83	1.27
Oct-01	1.67	2.18	3.98	2.47	0.75	0.85	2.53	1.22
Nov-01	1.3	3.24	7.61	9.61	0.78	1.68	3.93	4.33
Dec-01	1.75	3.71	7.25	3.71	0.95	1.81	3.39	2.23

Month	Insoluble solids (g/m^2/month)				Ash (g/m^2/month)			
	DG1	DG2	DG3	DG4	DG1	DG2	DG3	DG4
Annual 2001	**2.5**	**3.5**	**5.5**	**3.6**	**1.3**	**1.7**	**2.9**	**2.0**
Jan-02	1.45	1.76	2.79	4.29	1.2	1.38	1.66	3.84
Feb-02	2.21	3.03	9.15	2.87	2.12	1.79	4.52	1.67
Mar-02	2.25	2.91	4.56	4.34	1.42	1.57	2.58	1.73
Apr-02	2.06	2.09	8.27	2.76	1.2	1.21	6.95	1.57
May-02	10.6	2.28	3.23	2.19	2.41	1.1	2.1	1.56
Jun-02	1.96	2.07	2.97	2.05	1.16	1.3	1.63	1.4
Jul-02	3.89	2.14	2.52	2.82	2.05	1.16	1.68	1.66
Aug-02	14.58	2.76	2.91	2.15	4.69	1.23	1.91	1.21
Sep-02	-	1.95	3.16	-	0	1.16	2.05	0
Oct-02	1.91	1.52	1.57	1.54	1.17	0.82	0.88	0.79
Nov-02	6.19	4.86	4.07	4.73	2.78	3.22	2.96	3.25
Dec-02	2.72	5.8	5.24	4.52	1.34	4.3	3.27	2.61
Annual 2002	**4.5**	**2.8**	**4.2**	**3.1**	**1.8**	**1.7**	**2.7**	**1.8**
Jan-03	1.22	3.11	3.21	3.13	0.95	2.33	2.29	2.08
Feb-03	2.02	4.69	5	5.77	1.56	3.12	3.33	3.72
Mar-03	2.76	2.75	3.61	3.62	1.53	1.68	2.31	2.31
Apr-03	5.26	2.41	5.69	2.89	2.23	1.44	2.76	1.8
May-03	1.58	1.32	2.3	1.14	0.61	0.71	1.23	0.8
Jun-03	2.35	1.71	4.38	2.47	1.3	0.99	2.23	1.52
Jul-03	0.91	0.9	1.91	1.34	0.81	0.72	1.64	1.03
Aug-03	5.78	1.17	2.44	1.95	3.03	0.68	1.69	1.3
Sep-03	2.01	2.15	4.84	2.11	1.29	1.3	3.92	1.35
Annual for 9 months of 2003	**2.7**	**2.2**	**3.7**	**2.7**	**1.5**	**1.4**	**2.4**	**1.8**

It should be noted that a nine month trial at the quarry began on 9 July 2003.

From the dust deposition data collected since 1998, there is no one gauge which consistently records annual average dust deposition levels higher than the other three gauges. The NSW EPA 4 g/m^2/month dust fallout criteria has been equaled or exceeded for at least one year for each gauge.

There is likely to be some contribution from the quarry to the dust deposition levels measured at the gauges and it is important to estimate this contribution in order to determine the dust fallout exclusive of the quarry operations. To quantify the air quality impact from the existing operations, the dust deposition data have been analysed in conjunction with the frequency of winds towards each gauge by month. The meteorological data from Dunmore Quarry begins in July 2002 and monthly windroses from July 2002 to December 2002 have been created from these data (**Figure 9**).

The pattern of winds by month can be seen from the windroses. It was hypothesised that higher monthly dust deposition levels would be recorded during months when there was a higher frequency of winds towards the gauge. **Table 7** provides an analysis of the wind frequency and dust deposition data by month for each gauge.

TABLE 7
Analysis of wind direction and dust deposition data

Gauge ID	**DG1**	**DG2**	**DG3**	**DG4**
Direction(s) to quarry from gauge	SSE, SE	NE, ENE, E, ESE	NW, WNW	SW, WSW, W
Percentage of month when wind is blowing from quarry towards gauge (measured deposition, g/m^2/month)				
Jul-02	16% (3.89)	44% (2.14)	1% (2.52)	3% (2.82)
Aug-02	12% (14.58)	36% (2.76)	2% (2.91)	5% (2.15)
Sep-02	3% (-)	18% (1.95)	15% (3.16)	14% (-)
Oct-02	8% (1.91)	20% (1.52)	6% (1.57)	17% (1.54)
Nov-02	8% (6.19)	27% (4.86)	3% (4.07)	22% (4.73)
Dec-02	5% (2.72)	27% (5.8)	7% (5.24)	22% (4.52)
Jan-03	7% (1.22)	29% (3.11)	2% (3.21)	20% (3.13)
Feb-03	10% (2.02)	37% (4.69)	2% (5.00)	12% (5.77)
Mar-03	8% (2.76)	15% (2.75)	3% (3.61)	23% (3.62)
Apr-03	5% (5.26)	9% (2.41)	8% (5.69)	38% (2.89)
May-03	4% (1.58)	5% (1.32)	13% (2.30)	36% (1.14)
Jun-03	2% (2.35)	9% (1.71)	17% (4.38)	18% (2.47)

From the data presented in **Table 7,** there does not appear to be a strong correlation between more frequent winds from the quarry towards gauges and higher recorded dust deposition levels. For example, in August 2002, DG1 recorded high dust deposition (14 g/m^2/month) with the wind blowing from the quarry towards this gauge for 12% of the time while DG2 recorded 2.76 g/m^2/month and winds were blowing from the quarry to DG2 for 36% of the time.

The monthly wind frequency and dust deposition data have been plotted together in **Figure 10**. Clearly from this figure, the dust deposition data shows no correlation with frequency of winds from the quarry direction by month. There is no systematic increase in observed dust deposition with increasing frequency of winds from the quarry to the deposition gauges. This suggests that the emissions from the quarry do not contribute significantly to fallout levels at the gauge sites. Continuous dust concentration measurements compared with meteorological conditions would improve the level of confidence of this analysis.

An assessment of the deposited dust levels recorded during the first three months of the nine month trial has also been undertaken. **Table 8** presents the dust deposition monitoring data both before and after the trial. As the trial has only been running for three months, averages of the previous years data have been made for the same months of the year; July, August and September.

TABLE 8
Dust deposition before and during quarry trial period

Period	Insoluble solids (g/m^2/month)			
	DG1	DG2	DG3	DG4
Average for Jul Aug Sep 1997	2.70	1.81	2.35	2.10
Average for Jul Aug Sep 1998	3.72	8.65	2.23	11.29
Average for Jul Aug Sep 1999	1.89	2.43	4.19	2.61
Average for Jul Aug Sep 2000	2.58	2.28	3.10	3.00
Average for Jul Aug Sep 2001	2.23	4.22	3.59	2.89
Average for Jul Aug Sep 2002	9.24	2.28	2.86	2.49
Average for Jul Aug Sep 2003*	2.90	1.41	3.06	1.80

** Trial quarry conditions*

From the data presented in **Table 8,** there is no conclusive evidence to suggest that operations during the trial period have resulted in higher or lower dust deposition measured at the dust deposition gauges.

Directional dust deposition gauges have also been installed at the four gravimetric dust deposition gauge locations. Data have been collected from these gauges for approximately six months and are used to determine dust deposition due to different wind directions. There is difficulty interpreting data from directional dust gauges due to the nature of measuring technique. Different wind speeds can cause different collection efficiencies within each directional gauge and analysing values for the month is difficult since the wind may be predominantly from one direction during that month. There has been no analysis of the directional dust deposition data given the limited duration of the monitoring.

4.3.2 Dust Concentration

There are no on-site long term measurements of TSP or PM_{10} concentrations. The study area is well vegetated in parts and remote from sources of particulate matter apart from the quarry. The major contributor to TSP and PM_{10} would be traffic on the Princes Highway and perhaps sea-salt.

Measurements of annual average PM_{10} concentrations in relatively unpolluted suburban areas of Sydney are of the order of 15 $\mu g/m^3$ (for example, the EPA station at Lindfield recorded an annual average PM_{10} concentration of 15.7 $\mu g/m^3$ in 1997). Non-industrial areas in NSW (south coast) record lower concentrations. For example, EPA PM_{10} data for Nowra recorded annual average PM_{10} concentrations of 8.5, 10.3 and 9.9 $\mu g/m^3$ in 1999, 2000 and 2001 respectively. Rural areas remote from sources of particulate matter would record even lower concentrations.

A value of 5 $\mu g/m^3$ has been taken to be the annual average PM_{10} background level that would be recorded on the Dunmore site in the absence of the quarry. Assuming that TSP levels would be double the PM_{10} level an annual average background TSP level would be 10 $\mu g/m^3$.

5 ESTIMATED DUST EMISSIONS

Dust emissions arise from various activities at quarries. Total dust emissions at Dunmore Quarry have been estimated by analysing the activities taking place at the site during both existing and proposed operations. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. There have been significant revisions to the US EPA emission factors for quarry operations in 2003. The emission factors applied are considered to be the most up-to-date methods for determining dust generation rates.

The assessment is based on the existing operations and the proposed operating scenario that has been developed by the proponent. These cover impacts arising for annual productions of 1.2 Mtpa and 2.5 Mtpa. The emission estimates for the existing operations have been based on a maximum production of 1.4 Mtpa to reflect a few months production that were above average and would lead to annualised production of 1.4 Mtpa. Hence, the annual emission estimates could be considered to be conservative for the existing operations.

The most significant dust generating activities from the quarry operations have been identified and the dust emission estimates during the two operational scenarios are presented below in **Table 9**. Details of the calculations of the dust emissions are presented in **Appendix B**.

TABLE 9
Estimated dust emissions due to Dunmore Quarry operations

Activity	***TSP emission rate (kg/y)***	
	Existing (at 1.4 Mtpa)	***Proposed (2.5 Mtpa)***
Stripping topsoil	560	560
Drilling (Croome Farm)	880	1,759
Blasting (Croome Farm)	229	458
FEL loading to trucks (Croome Farm)	1,653	4,218
Hauling to hopper (Croome Farm)	58,800	150,000
Drilling (RIC)	377	0
Blasting (RIC)	98	0
FEL loading to trucks (RIC)	709	0
Hauling to hopper (RIC)	18,480	0
Dumping to hopper	2,362	422
Primary crushing and screening	2,128	3,800
Secondary crushing and screening	42,756	76,350
Tertiary crushing and screening	32,067	57,263
Conveying to stockpiles or truck	2,362	4,218
Transporting to stockpiles	61,600	110,000
Dumping to stockpiles	2,362	4,218
Loading product to road trucks	844	1,687
Transport product off-site (unsealed rd)	11,538	23,077
Transport product off-site (sealed rd)	4,615	9,231
Loading product to trains	1,478	2,490
FEL working on stockpiles	3,542	3,542
Wind erosion from exposed areas	7,087	7,087
Wind erosion from product stockpiles	142	142
CBP : Vehicles on site (unsealed rd)	6,840	6,840
CBP : Vehicles on site (sealed rd)	1,368	1,368
TOTAL ANNUAL DUST (kg)	**264,878**	**468,730**
Annualised production (t)	**1,400,000**	**2,500,000**
Ratio of dust to production (kg/t)	**0.19**	**0.19**

6 DUST CONTROL MEASURES

The controls that are available for quarry operations can be summarised in three broad categories:

1. Engineering controls

2. Planning controls (which increase the separation between dust emission sources on the plant and sensitive areas)

3. Operational controls which vary operations when adverse meteorological conditions occur

Engineering controls involve measures such as shielding and enclosing crushers and screens, conveyors, transfer points and the installation of spray systems on stockpiles etc. Planning controls include the maintenance of adequate buffer distances between dust sources and sensitive receptors. Generally these type of controls would be implemented before a project commences.

The following list presents a range of dust control measures available for quarry operations of this type. Some controls have been assigned a status for the proposed development operating at 2.5 Mtpa.

- covering of conveyors - partial
- enclosing of crushing plant with dust extraction system fitted - partial
- traffic confined to identified haul road routes - full
- removal and rehabilitation of unnecessary roads
- exposed areas kept to a minimum - partial
- watering of haul roads - full
- cleaning of areas which could become sources of wind erosion dust due to build-up of settled fine material - partial
- fitting drill with either water sprays or dry dust collection devices
- review of meteorological conditions prior to blasting to minimise the exposure of residences to dust emissions
- controlling stockpiles of fine material with water sprays - partial

These measures would ensure that a high level of dust control is maintained at the site. Dust control measures that form part of the quarry operations and which have been taken into account in the modelling include enclosure of crushing, screening and transfer points and water sprays used periodically as required on haul roads and product stockpiles.

7 APPROACH TO ASSESSMENT

In August 2001, the NSW EPA published new guidelines for the assessment of air pollution sources using dispersion models (NSW EPA, 2001). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. The approach taken in this assessment follows as closely as possible the approaches suggested by the guidelines.

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

The model used was the US EPA ISCST3 model. The model is fully described in the user manual and the accompanying technical description (US EPA, 1995[A]). The modelling has been based on the use of three particle-size categories (0 to 2.5 μm - referred to as $PM_{2.5}$, 2.5 to 10 μm - referred to as CM (coarse matter) and 10 to 30 μm - referred to as the Rest). Mass emission rates in each of these size ranges have been determined using the factors derived from the SPCC (1986) study and TSP emission rates calculated using emission factors derived from US EPA (1985) and NERDDC (1988) work (see **Appendix B**).

The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 0.0468 of the TSP
- $PM_{2.5\text{-}10}$ (CM) is 0.3440 of TSP
- $PM_{10\text{-}30}$ (Rest) is 0.6090 of TSP.

Modelling was done using three ISC source groups. Each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 μm. The predicted concentration in the three plot output files for each group were then combined according to the weightings above to determine the concentration of PM_{10} and TSP.

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

For the current study, the operations were represented by a series of volume sources located according to the site layout. **Figure 11** shows the location of the modelled sources. Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISC model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at a quarry site would correspond with periods of low dust generation (because wind erosion and other wind dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted in the vicinity of the project area for the existing and proposed operational scenarios. Local terrain has been included in the modelling.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. For non-wind erosion sources, an average of 12 working hours per day (6 am to 6 pm) was assumed for existing operations while 24 working hours per day was assumed for proposed operations. Dust emissions from wind erosion sources have been modelled for 24 hours per day in both modelling scenarios. Model predictions have made at 221 discrete receptors located in the study area. The location of theses receptors have been chosen to provide finer resolution closer to the quarry dust sources and nearby residences.

As an example the ISCST3 model input file is provided in **Appendix C**.

A calibration study was undertaken as part of the EIS for the Warkworth mine in the Hunter Valley (Holmes Air Sciences, 2002). The calibration was done by comparing the predicted maximum 24-hour average PM_{10} concentrations in the period 1 November 2000 to 31 October 2001 at the several mine operated monitors. The maximum measured PM_{10} concentration and TSP concentrations at four sites over the same period were then determined by inspection of the monitoring data records. The TSP concentrations have been converted to equivalent PM_{10} concentrations assuming that PM_{10} constitutes 40% of the TSP in this area. The results are shown below in **Table 10.**

TABLE 10
Comparison of measured and predicted maximum 24-hour PM_{10} concentrations

Monitoring site	Maximum predicted 24-hour PM_{10}	Maximum measured or inferred 24-hour PM_{10}	Ratio of predicted to measured concentration
HV1	100	170 x 0.4 = 68	1.5
HV2	140	140 x 0.4 = 56	2.5
Bulga PM_{10}	160	44 (direct measurement)	3.6
Bulga TSP	160	102 x 0.4 = 41	3.9
Lot 543	95	138 x 0.4 = 55	1.7
Average			2.6

** Note, PM_{10} concentrations are only measured at the Bulga monitoring site, the other sites measure TSP only*

The average extent of over prediction was a factor of 2.6; that is unadjusted model predictions appear to over predict 24-hour PM_{10} concentrations by 260%. This factor was used to adjust the model predictions for the Warkworth EIS downwards to obtain a calibrated prediction of the worst-case 24-hour PM_{10} concentrations for all scenarios that were assessed. This same factor has been used for the current assessment.

Particulate matter from a basalt quarry is likely to be composed of denser material than the sandstone-derived dust. The dispersion modelling takes account of the higher fallout rate of the denser particles and this would not be expected to significantly change the calibration factor of 2.6.

8 ASSESSMENT OF IMPACTS

8.1 Introduction

This section provides an interpretation of the predicted dust concentrations and deposition levels.

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

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

The maximum 24-hour average contour plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that occurred at each location. The maxima are used to show concentrations which can possibly be reached under the modelled conditions. It should be noted that the contour plots show predicted concentrations and deposition levels due only to Dunmore quarry dust sources. That is, the predictions do not include contribution from existing non quarry sources.

The model ISCST3 was used in this instance as it has been the most widely used model in NSW for assessing the dust impacts of extractive industries. AUSPLUME is the NSW EPA's model of first choice but it has had limited use in dust modelling applications. Dust impacts and model predictions using ISCST3 are presented as contour plots in **Figures 12** to **19**. Comparisons of model predictions (Holmes Air Sciences, 2003) have shown that AUSPLUME predicts almost 50% lower than ISCST3 for maximum 24-hour average concentrations. Annual average predictions using AUSPLUME are slightly lower than ISCST3 predictions. The ISCST3 results provide a conservative estimate of impacts.

Model predictions for each assessment scenario have also been presented in tabular form for the nearest residences that are not on Project-related land (**Table 11**). **Figure 1** shows the identification label given to each residence. Predicted concentrations and deposition levels above the relevant air quality criteria have been highlighted. Interpretation and analysis of the model predictions for each assessment scenario is provided below.

8.2 Assessment Criteria

The air quality criteria used for deciding which properties are likely to experience air quality impacts are those specified in the EPA's modelling guidelines as interpreted by recent conditions of consent for mines in the Hunter Valley (and from **Table 2** and **Table 3**). The criteria are:

- 50 μg/m^3 for 24-hour PM_{10} for the quarry considered separately
- 30 μg/m^3 for annual average PM_{10} due to the quarry and all other sources
- 90 μg/m^3 for annual TSP concentrations due to the quarry and all other sources
- 2 g/m^2/month for annual average deposition (insoluble solids) due to the quarry considered separately, and
- 4 g/m^2/month for annual predicted cumulative deposition (insoluble solids) due to the quarry and all other sources

TABLE 11
Dust predictions at nearest residences due to quarry operations

Residence ID	Maximum 24-hour PM_{10} (μg/m^3) Goal : 50 μg/m^3	Annual average PM_{10} (μg/m^3) Goal : 30 μg/m^3 (Model predictions with estimated background are shown in parentheses)	Annual average TSP (μg/m^3) Goal : 90 μg/m^3 (Model predictions with estimated background are shown in parentheses)	Annual average dust deposition (g/m^2/month) Goal : 2 g/m^2/month
1.4 Mtpa production				
A	9.6	1.6 (6.6)	2.1 (12.1)	0.1
B	5.4	0.8 (5.8)	1.1 (11.1)	0.1
C	5.3	0.9 (5.9)	1.1 (11.1)	0.1
D	9.4	1.1 (6.1)	1.4 (11.4)	0
E	6.3	0.8 (5.8)	1.1 (11.1)	0
F	4.7	0.6 (5.6)	0.7 (10.7)	0
G	8.9	0.9 (5.9)	1.2 (11.2)	0
J	13.4	1.5 (6.5)	2.1 (12.1)	0.2
K	9.5	1.4 (6.4)	1.8 (11.8)	0.1
L	9	4.1 (9.1)	6.0 (16.0)	0.6
M	6.9	2.6 (7.6)	3.7 (13.7)	0.3
N	6.4	1.8 (6.8)	2.6 (12.6)	0.3
2.5 Mtpa production				
A	25.7	4.5 (9.5)	5.4 (15.4)	0.2
B	8.7	2.2 (7.2)	2.9 (12.9)	0.1
C	12.6	2.5 (7.5)	3.1 (13.1)	0.1
D	30.8	3.8 (8.8)	4.3 (14.3)	0.1
E	12.4	2.3 (7.3)	2.6 (12.6)	0.1
F	7.9	1.5 (6.5)	1.7 (11.7)	0
G	29	2.8 (7.8)	3.2 (13.2)	0.1
J	22.7	6.9 (11.9)	7.9 (17.9)	0.3
K	19.6	5.7 (10.7)	6.4 (16.4)	0.2
L	27	10.5 (15.5)	13.4 (23.4)	0.9
M	18.4	6.7 (11.7)	8.4 (18.4)	0.5
N	19.3	5.2 (10.2)	6.5 (16.5)	0.5

8.3 Assessment of Impacts for Existing Operations

Dispersion model predictions for the existing quarry operations (at an annualised production rate of 1.4 Mtpa) are presented in **Figures 12** to **15** and are summarised in **Table 11**.

Comparing the model predictions with air quality goals, the following conclusions can be made for the existing operations.

- Maximum 24-hour average PM_{10} concentrations due to the operations are below the 50 $\mu g/m^3$ goal at all residences.
- Annual average PM_{10} concentrations due to the operations are below the 30 $\mu g/m^3$ goal at all residences. If an annual average background PM_{10} of 5 $\mu g/m^3$ is added to the model predictions, concentrations at all residences are still below the 30 $\mu g/m^3$ goal.
- Annual average TSP concentrations due to the operations are below the 90 $\mu g/m^3$ goal at all residences. If an annual average background TSP of 10 $\mu g/m^3$ is added to the model predictions, concentrations at all residences are still below the 90 $\mu g/m^3$ goal.
- The predicted contribution of the quarry to dust deposition levels are below the 2 g/m^2/month criteria at all residences.

Analysis of the predicted annual average dust deposition figure (**Figure 15**) indicates that the contribution of the quarry to existing levels is low in comparison to the dust deposition measured by the monitoring gauges. The predicted annual average dust deposition levels at each gauge for existing operations is around 0.1 to 0.3 g/m^2/month. Significantly higher annual average dust deposition levels recorded by the dust deposition gauges (from **Section 4.3**) may suggest that there are other dust sources in the area contributing considerably to dust deposition. This assessment is supported by the simple analysis presented in **Section 4.3**.

8.4 Assessment of Impacts for Proposed Operations

Dispersion model predictions for 6.00 am to 10.00 pm quarry operations and an annual production of 2.5 Mtpa are presented in **Figures 16** to **19**. The results are summarised in **Table 11**.

The predicted dust concentration and deposition levels due to the operations at the nearest residences are higher than for the existing operations. This is due largely to the increased activity on-site and increased processing of material.

Comparing the model predictions with air quality goals, the following conclusions can be made for the proposed 2.5 Mtpa operations.

- Maximum 24-hour average PM_{10} concentrations due to the operations are below the 50 $\mu g/m^3$ goal at all residences.
- Annual average PM_{10} concentrations due to the operations are below the 30 $\mu g/m^3$ goal at all residences. This is also true if an annual average background PM_{10} of 5 $\mu g/m^3$ is added to model predictions.
- Annual average TSP concentrations due to the operations are below the 90 $\mu g/m^3$ goal at all residences. If an annual average background TSP of 10 $\mu g/m^3$ is added to the model predictions, concentrations are also predicted to be below the 90 $\mu g/m^3$ goal.
- The predicted contribution of the quarry to dust deposition levels are below the 2 g/m^2/month criteria for all residences.

9 CUMULATIVE IMPACTS

Cumulative air quality effects may arise from Project-related dust sources adding to non-Project related dust sources which contribute to the local air quality. Other possible non-Project-related dust generating sources in the Dunmore – Albion Park area may include the existing and proposed activities of Dunmore Sand and Soil, and the existing Readymix and Cleary Bros hard rock quarries at Albion Park, sea salt and traffic related dust from the main road and local road network. The dust monitoring data collected at Dunmore Quarry (see **Section 4.3**) is likely to include contributions from all these sources to various degrees. It is noted that the Readymix and Cleary Bros. quarries also extract and process latite. It is likely that because of the high density of this material, that like Dunmore Quarry, any dust generated would settle close to its source.

Dunmore Sand and Soil is a wet dredge and processing operation and would be expected to contribute very little to particulate matter loadings in the area. The closest Albion Park quarry is approximately one kilometre to the north of Dunmore Quarry and separated by moderately densely vegetated land. The annual wind patterns tend to be aligned north-east to south-west (see **Figure 4**) and this would tend to produce parallel rather than overlapping plumes. Thus, there is likely to be little interaction between the Albion Park quarries and areas close to Dunmore Quarry.

The approach to the air quality assessment has been to estimate background dust levels due to non-Project related sources and add these estimates to dispersion model predictions for the Project. This approach assesses the cumulative aspect of the Project.

10 GREENHOUSE ISSUES

Quarry activities result in the emission of carbon dioxide (CO_2) during the combustion of diesel fuel (used primarily in diesel-powered equipment) and indirectly in the use of electricity to power quarrying equipment. These are the only significant sources of greenhouse gases involved in the Project. Use of these energy source will result in emissions of CO_2, CH_4 and N_2O, all of which are greenhouse gases. The electrical and fuel requirements for these sources have been used to estimate CO_2-equivalent[3] (CO_2-e) emission rates for the existing and proposed quarry operations. **Table 12** summarises the estimated CO_2–e emissions from the Project for each production scenario.

[3] CO_2-e includes the effects of CH_4, N_2O as well as CO_2.

TABLE 12
Summary of estimated CO_2 emissions from Project

Production	1.2 Mtpa	2.5 Mtpa	Reference
Diesel equipment			
Diesel usage by on-site equipment (l/month)	80000	166667	EIS
Diesel usage by on-site equipment (l/y)	960000	2000000	EIS
Diesel usage by trains (l/trip)	1500	1500	EIS
Train trips per year	572	1192	EIS
Diesel usage by trains (l/y)	858000	1787500	
Diesel usage by road trucks (l/km)	0.5	0.5	R W Corkery
Road truck return travel distance (km)	200	200	R W Corkery
Tonnes per year by truck (t/y)	480000	1000000	EIS
Tonnes per truck load (t)	28.7	29	EIS
Truck trips per year	16725	34483	EIS
Diesel usage by road trucks (l/y)	1672474	3448276	
Total diesel usage (l/y)	3490474	7235776	
CO_2–e equivalent emission factor (t/l)	0.0027	0.0027	Table 11, AGO (2003)
CO_2–e emissions (t/y)	9424	19537	
Electricity usage			
Electricity usage per year (kWh/y)	4500000	7000000	R W Corkery
CO_2–e emissions from electricity usage (t/kWh)	0.001012	0.001012	Table 4, AGO (2003)
CO_2–e from electricity usage (t/y)	4554	7084	
TOTAL			
Total CO_2-equivalent emission from operations (t/y)	13978	26621	
Estimated National CO_2-e emissions for 2000 (t)	535300000	535300000	AGO (2002)
CO_2–e emission as % of National 2000 CO_2-e emissions	0.003	0.005	

These figures can be compared with the CO_2 equivalent emission estimates from Australia's National Greenhouse Gas Inventory (Australian Greenhouse Office, 2002). There are two widely accepted methods for estimating greenhouse gas emissions (1) the United Nations Framework Convention on Climate Change (UNFCCC) and (2) the Kyoto protocol method. The differences between the two methods relate to the way in which forest sinks are treated. The estimated national CO_2-equivalent emission for the two methods for all sectors are as follows:

- UNFCCC – 535.3 Mt
- Kyoto – 503.3 Mt

For the purposes of this discussion the UNFCCC figure only is referenced. The 1990 national emission using the UNFCCC methodology is 535.3 Mt.

There are no practical alternative fuels for quarry operations of this type. However, alternative quarry methods can lead to greater efficiency in the use of fuels and electricity. These include:

- Minimising haul distances for quarry rock and product
- Minimising double handling of materials
- Using the most practical and efficient machinery
- Maximising the material transported off-site by rail rather than by road

11 AIR QUALITY MONITORING PROGRAM

The existing air quality monitoring program includes four dust deposition gauges. **Section 4.3** provided the details on the location of these gauges and a summary of the data collected by these gauges.

The dispersion model predictions indicated an increased level of off-site dust concentration and dust deposition levels due to an increase in the quarry's production. It will be important to monitor any change in air quality arising from a change in the quarry activities.

As part of the air quality monitoring program for Dunmore Quarry it is recommended that the dust deposition monitoring at the four dust deposition gauges continue.

12 CONCLUSIONS

This report has assessed the air quality impacts associated with existing and proposed operations at Dunmore Quarry. Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities associated with the quarry. The dispersion modelling took account of the local meteorology and terrain information and used dust emission estimates to predict the air quality impacts for two operational scenarios. The scenarios included existing operations where the quarry operates (on average) 12 hours per day and with a maximum annualised production of 1.4 Mtpa. The proposed scenario included 16 hour per day operations and increased production to 2.5 Mtpa.

Dust deposition data from four monitoring sites were available for the study however it was difficult to quantify the contribution from the quarry and other sources.

Modelling for the existing operations suggested that the contribution of the quarry to existing dust deposition levels was only a small fraction of the total measured dust deposition. This assessment was further supported by an analysis of dust deposition levels and prevailing winds.

The conclusions of the assessment can be summarised as follows.

- The air quality impacts from the proposed 2.5 Mtpa operational scenario are predicted to be higher than for the existing operations
- Air quality goals are not predicted to be exceeded at nearby residences due to quarry operations with a production rate of 2.5 Mtpa and extended operating hours

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US EPA (1995[B])

"User's Guide for the Industrial Source Complex (ISC3) Dispersion Models - Volume 2 Description of Model Algorithms" US Environmental Protection Agency, Office of Air Quality Planning and Standards Emissions, Monitoring, and Analysis Division, Research Triangle Park, North Carolina 27711.

FIGURES

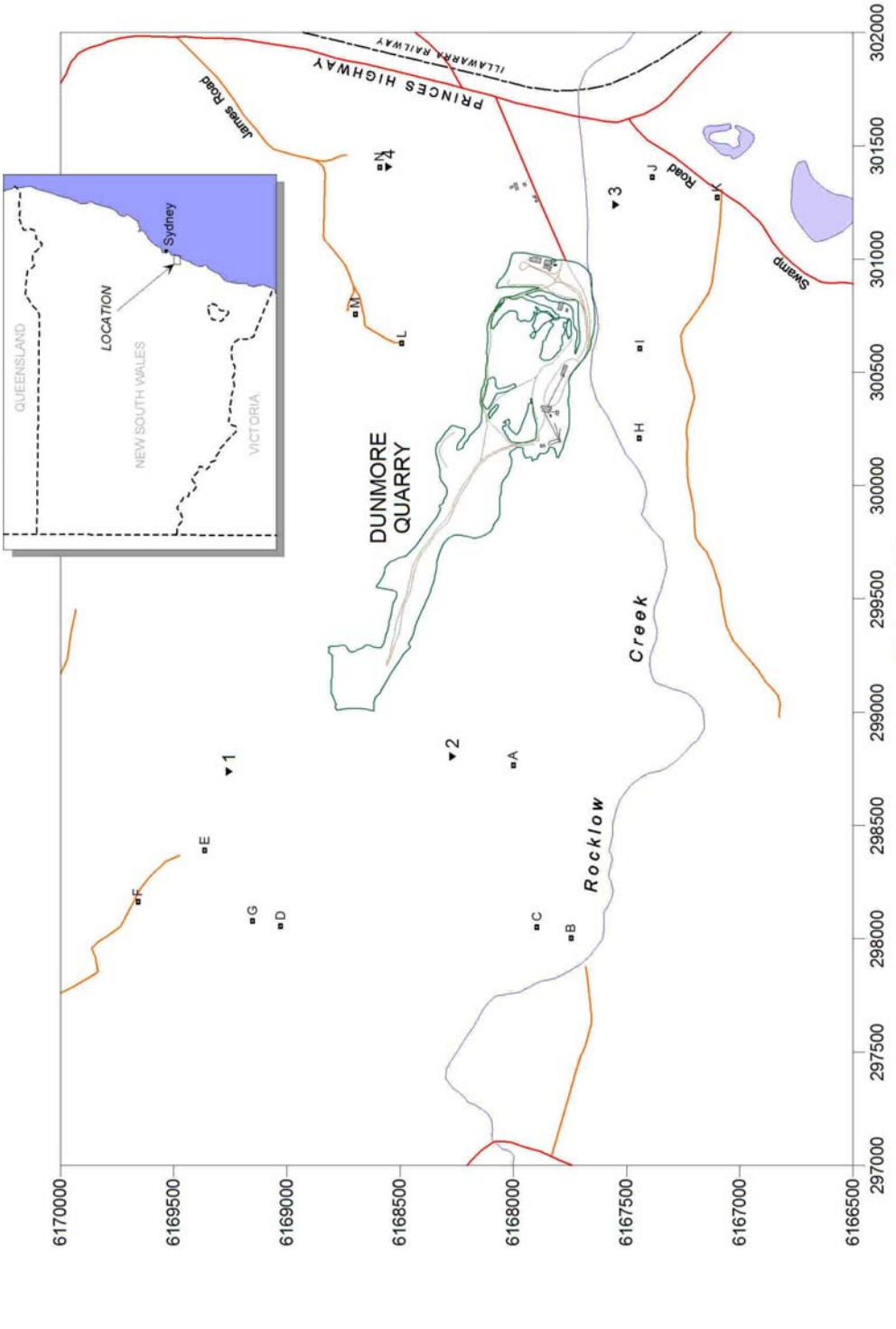


FIGURE 1

Location of study area and Project site

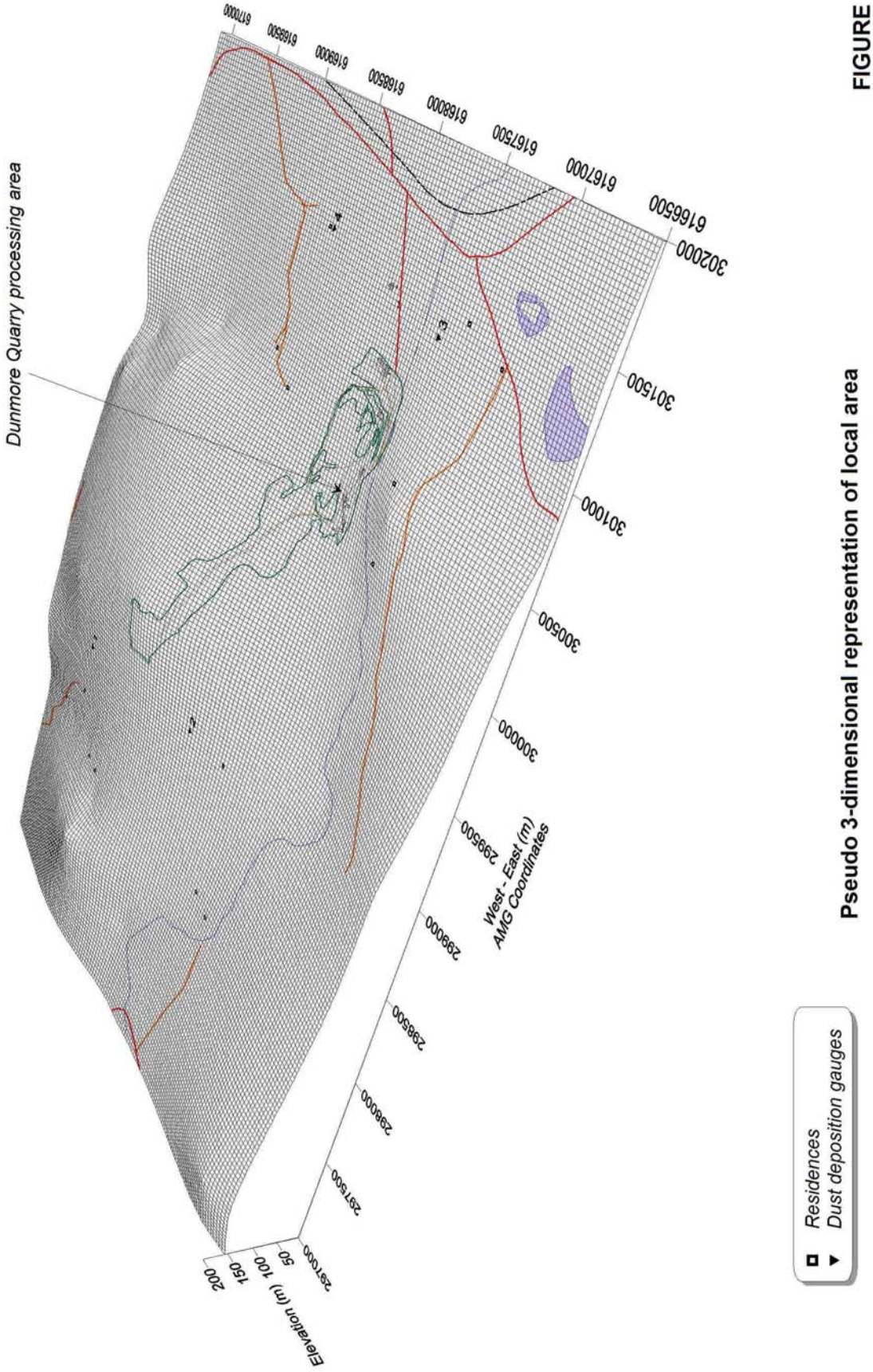


FIGURE 2

Pseudo 3-dimensional representation of local area

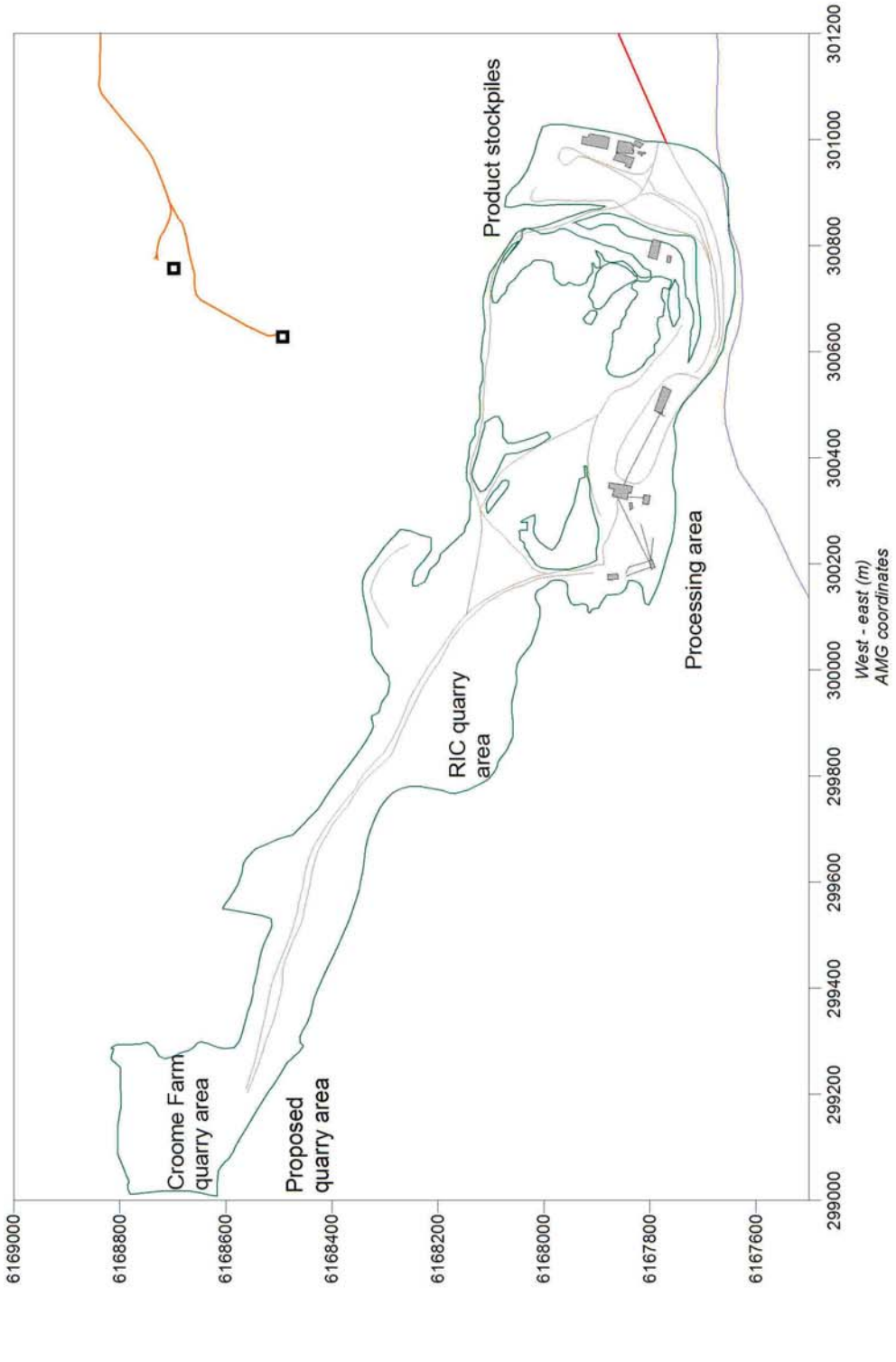


FIGURE 3

Quarry layout

Annual and Seasonal Windroses for Dunmore Quarry (Jul-2002 to Jun-2003)

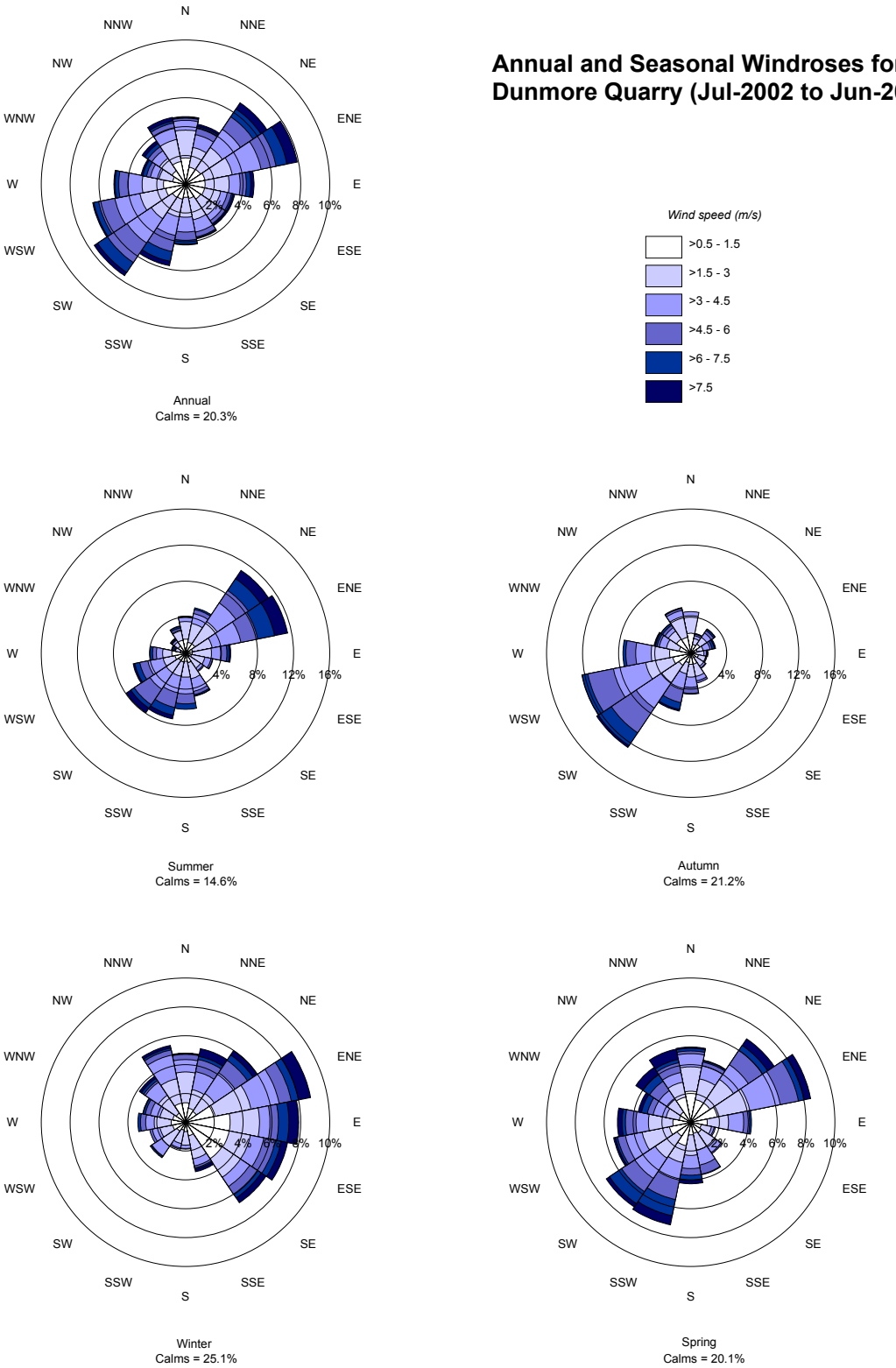


FIGURE 4

Annual and Seasonal Windroses for Albion Park 1999/2000

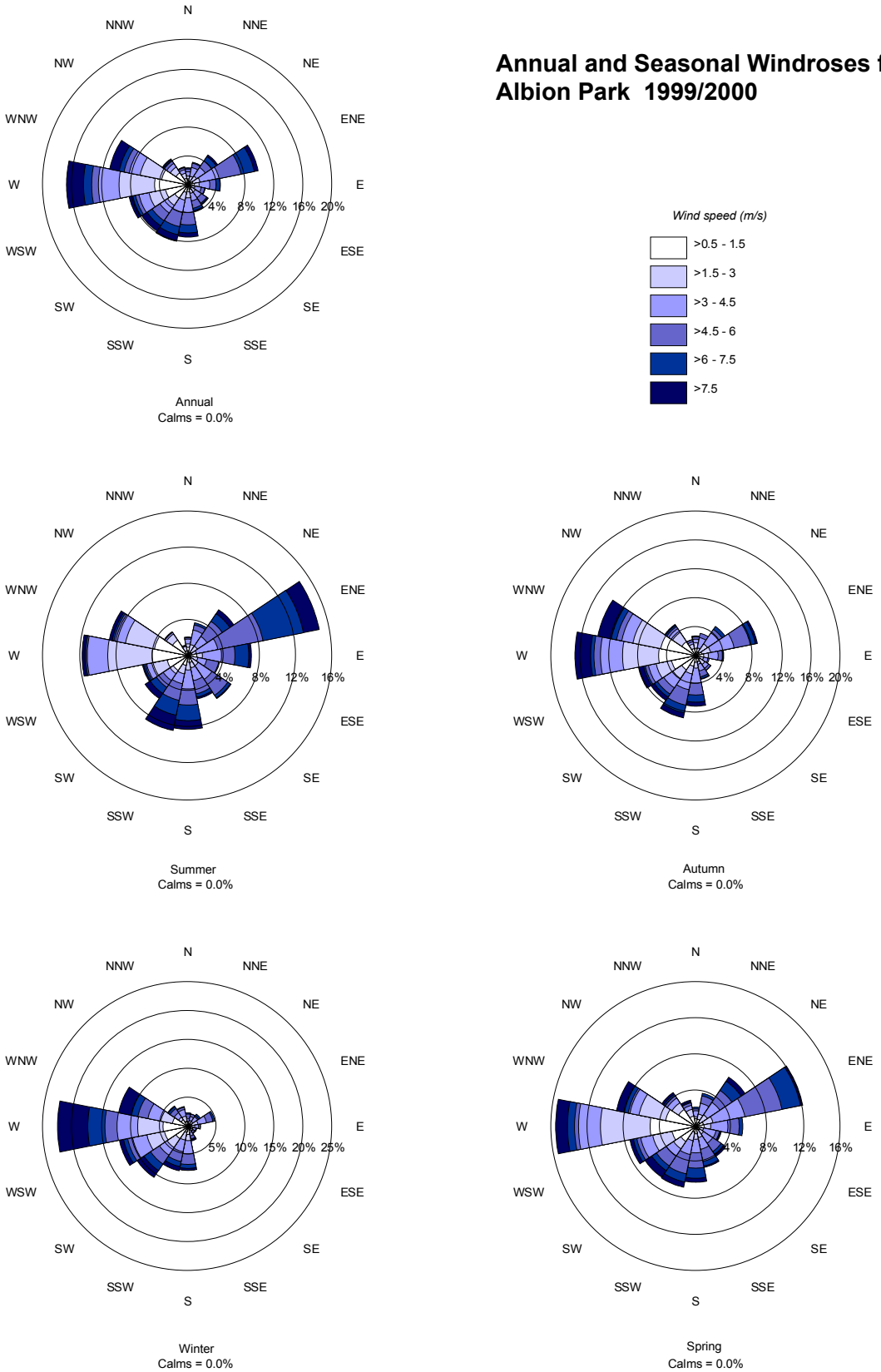


FIGURE 5

Annual and Seasonal Windroses for Gerroa 'Beirnfels' for 2001

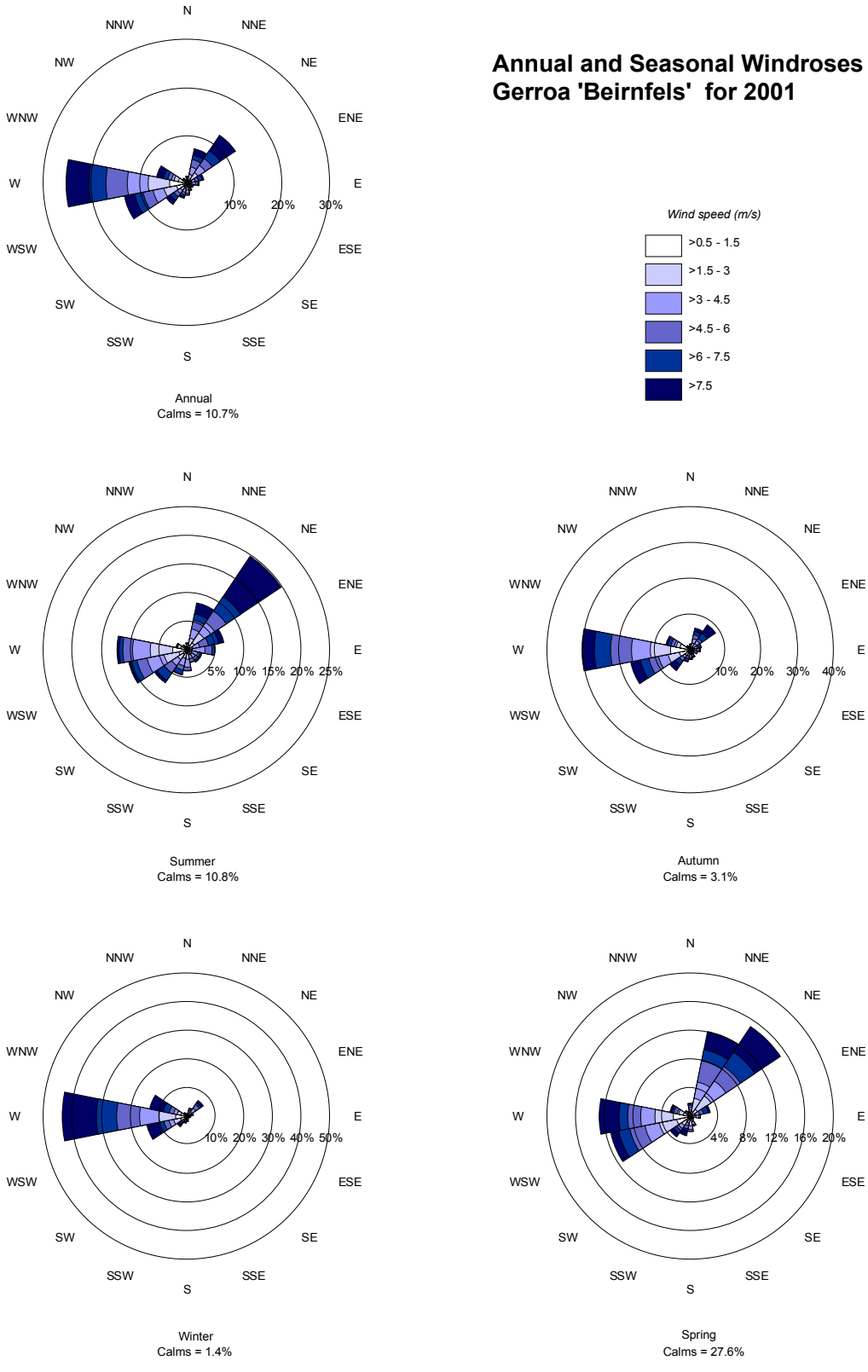


FIGURE 6

Annual and Seasonal Windroses for Dunmore Quarry 2001 (TAPM)



FIGURE 7

Dust deposition data from Dunmore Quarry

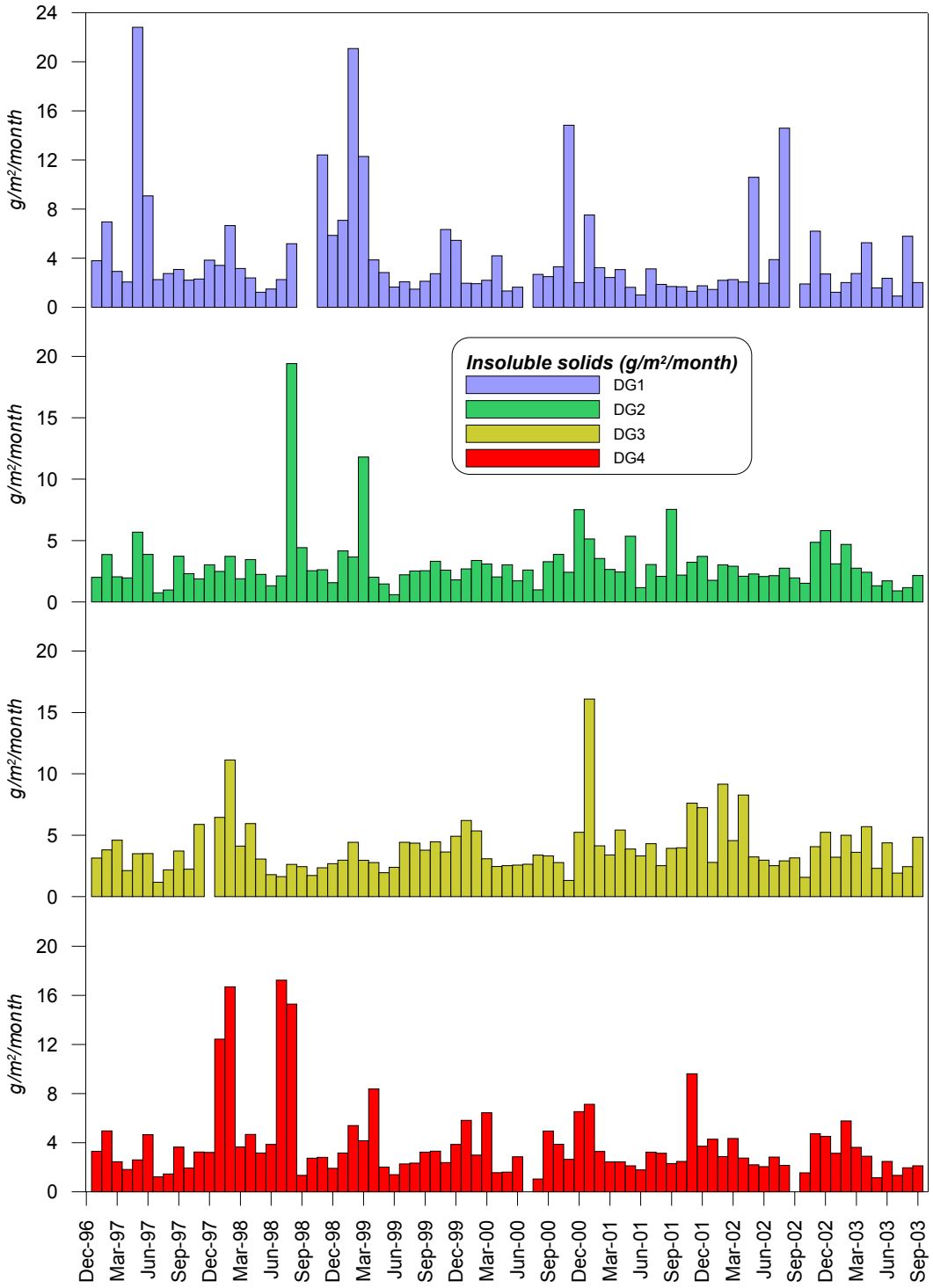
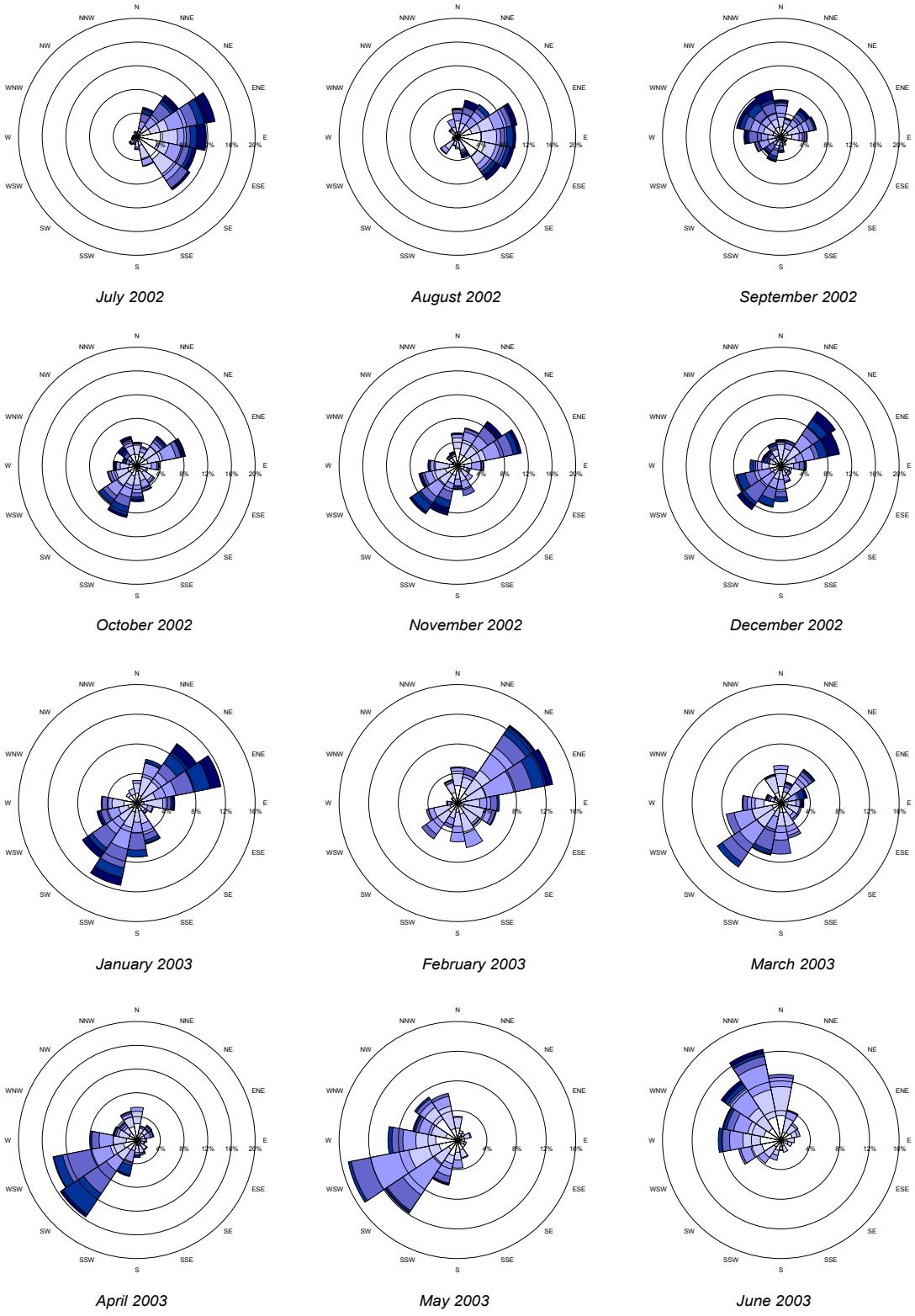


FIGURE 8



Monthly windroses for Dunmore Quarry (Jul-2002 to Jun-2003)

FIGURE 9

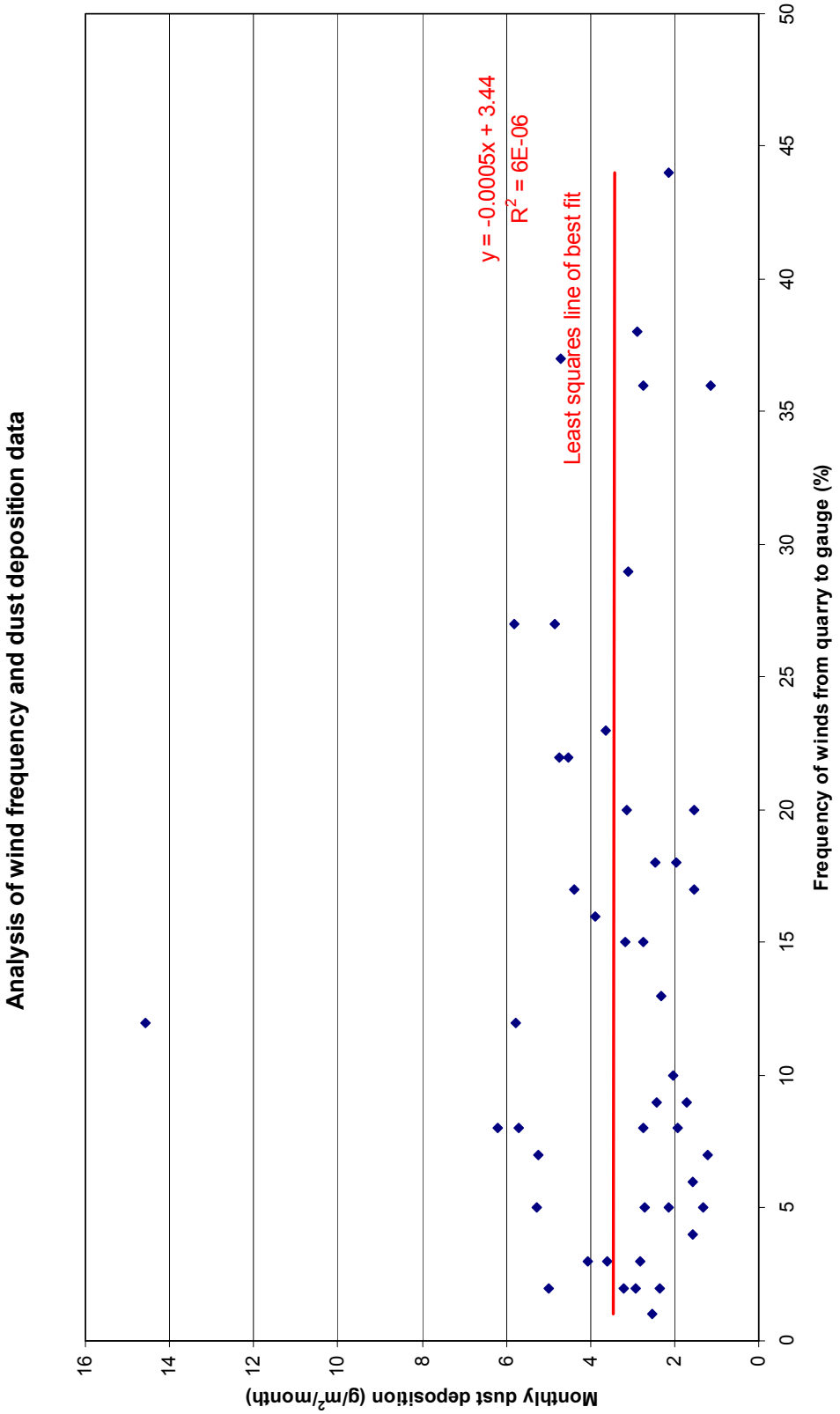

Analysis of wind frequency and dust deposition data
Monthly dust deposition (g/m²/month)
Frequency of winds from quarry to gauge (%)
y = -0.0005x + 3.44
R² = 6E-06
Least squares line of best fit
0
2
4
6
8
10
12
14
16
0
5
10
15
20
25
30
35
40
45
50

FIGURE 10

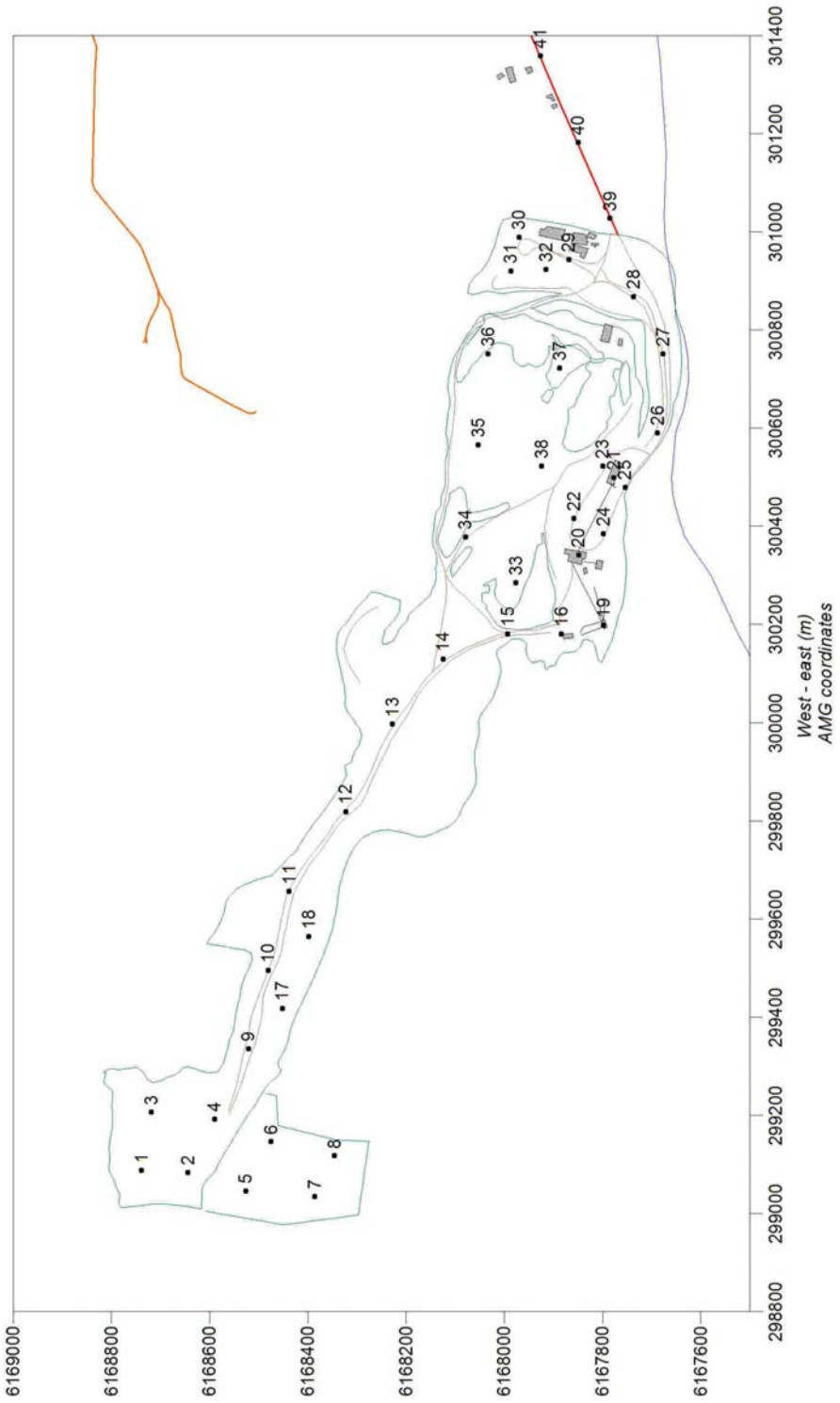
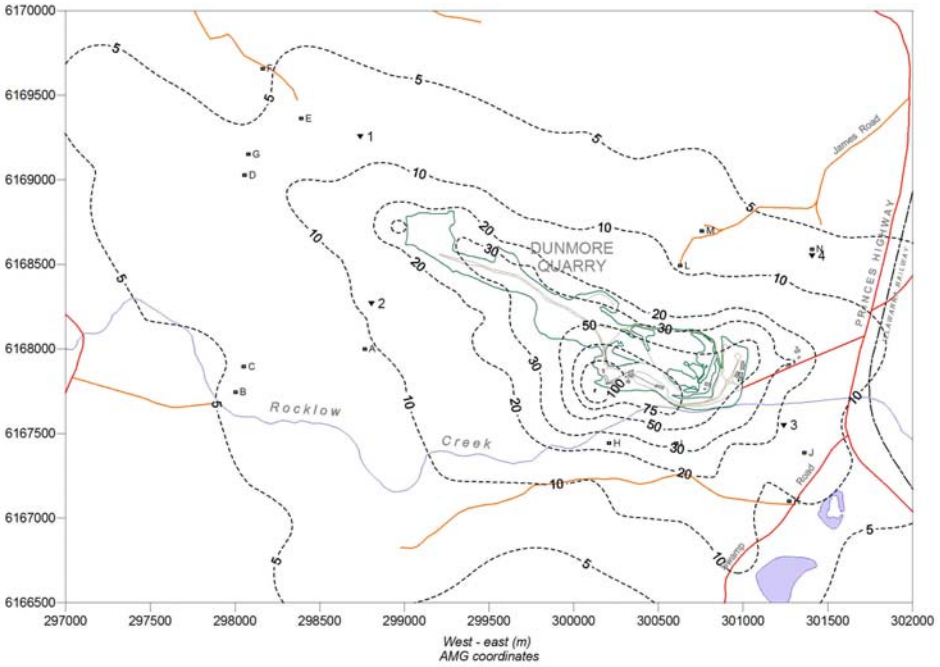
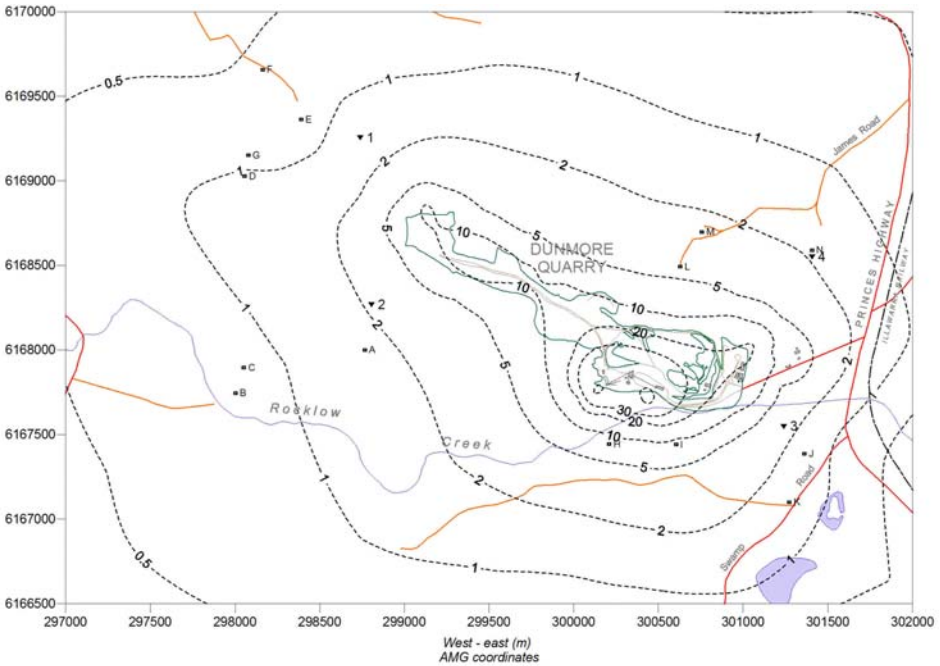


FIGURE 11

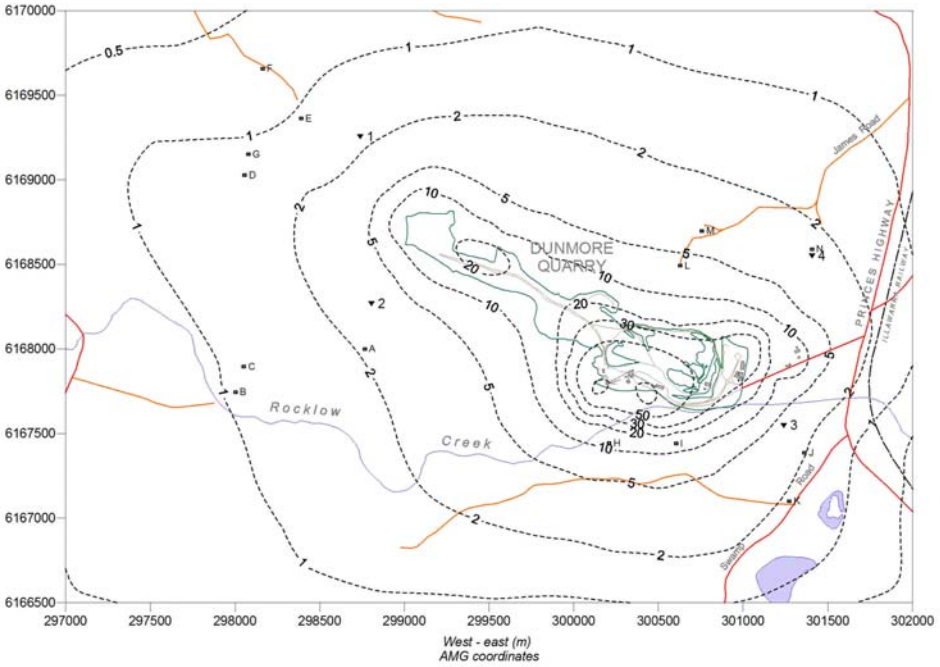
Location of dust emission sources



Predicted maximum 24-hour PM_{10} concentrations due to existing operations at 1.4 Mtpa (µg/m^3) **FIGURE 12**

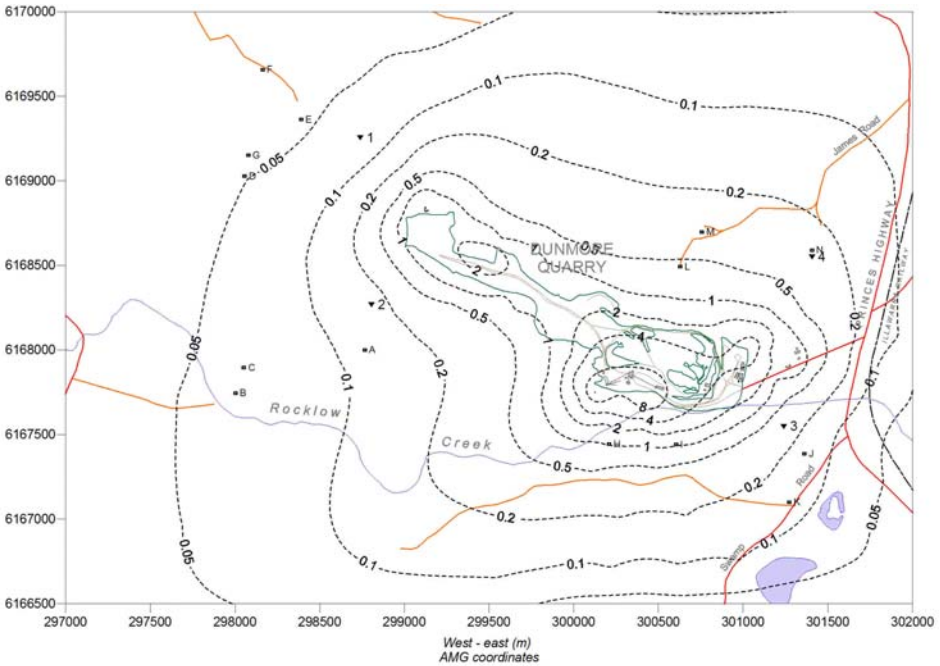


Predicted annual PM_{10} concentrations due to existing operations at 1.4 Mtpa (µg/m^3) **FIGURE 13**



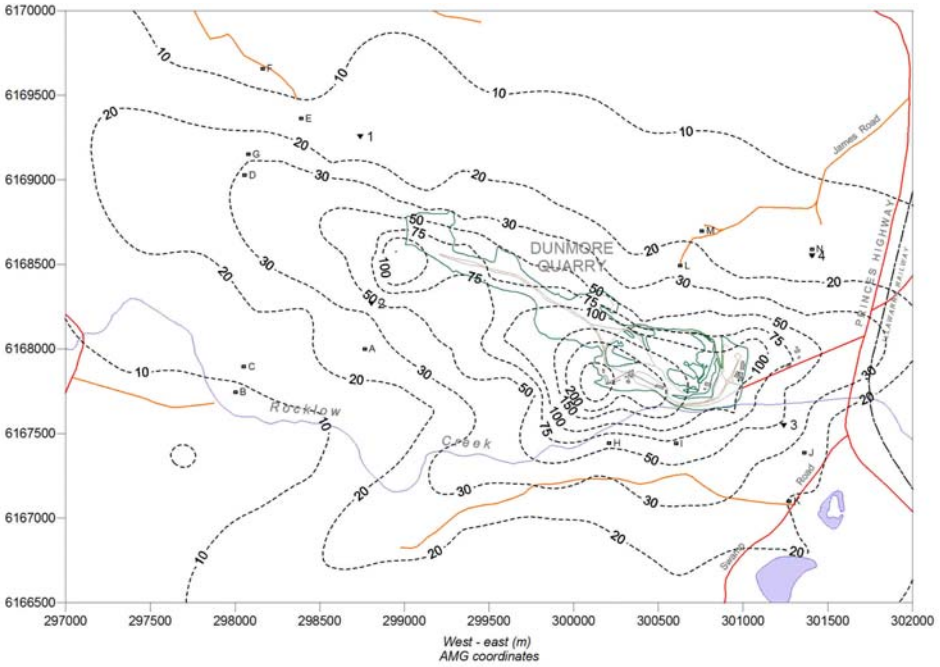
Predicted annual TSP concentrations due to existing operations at 1.4 Mtpa (µg/m^3)

FIGURE 14



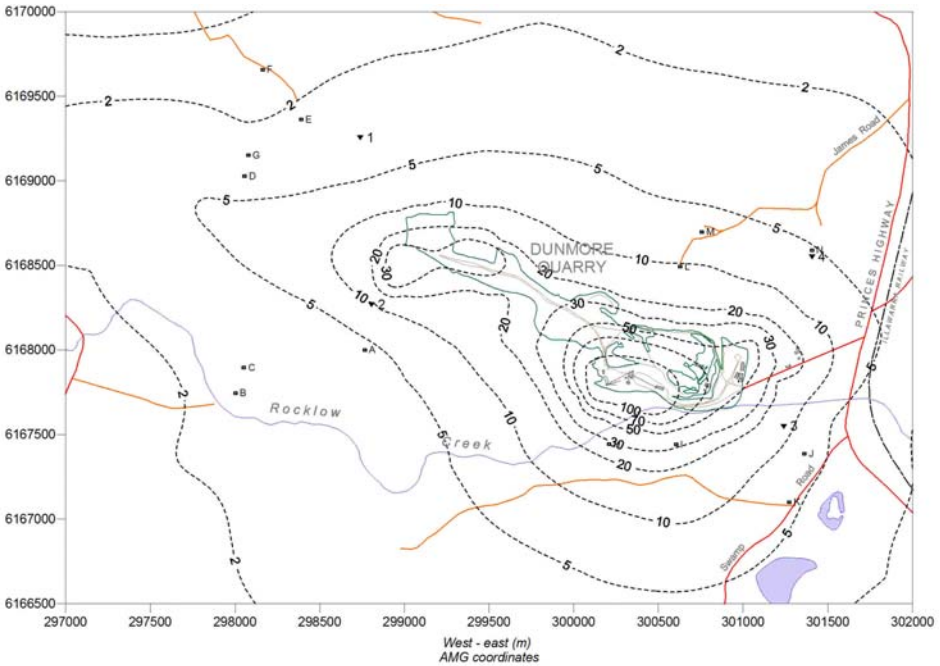
Predicted annual dust deposition due to existing operations at 1.4 Mtpa (g/m^2/month)

FIGURE 15



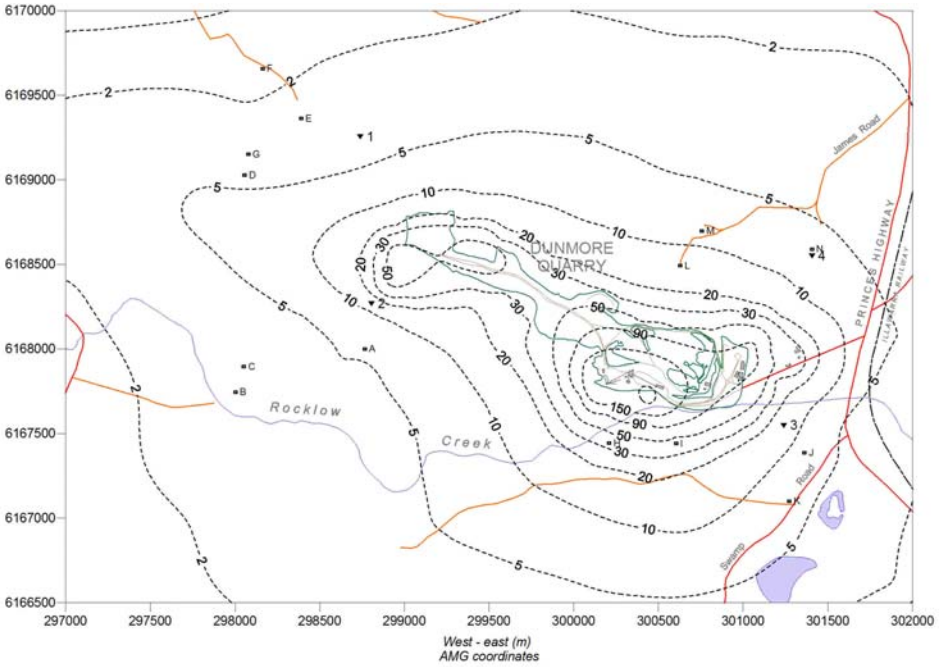
Predicted maximum 24-hour PM_{10} concentrations due to future operations at 2.5 Mtpa ($\mu g/m^3$)

FIGURE 16



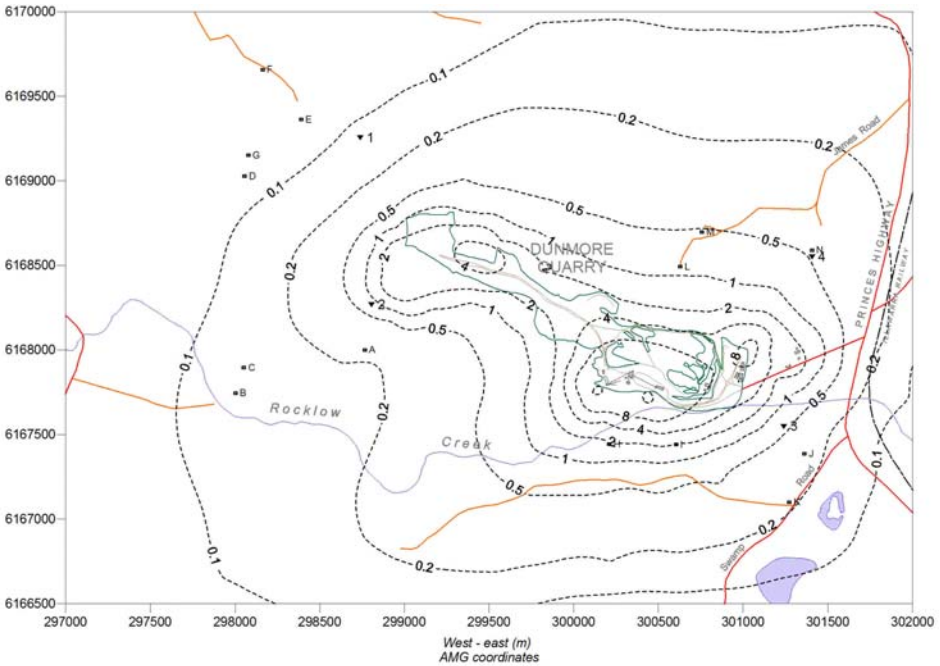
Predicted annual PM_{10} concentrations due to future operations at 2.5 Mtpa ($\mu g/m^3$)

FIGURE 17



Predicted annual TSP concentrations due to future operations at 2.5 Mtpa (µg/m^3)

FIGURE 18



Predicted annual dust deposition due to future operations at 2.5 Mtpa (g/m^2/month)

FIGURE 19

APPENDICES

(No. of pages excluding this page = 19)

Appendix A: Joint wind speed, wind direction and stability class frequency tables

Appendix B: Estimated dust emissions

Appendix C: ISCST3 model input file

APPENDIX A

(No. of pages excluding this page = 4)

JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY TABLES

STATISTICS FOR FILE: C:\Dunmore\metdata\Dunmore quarry\dunm0203.isc
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000913	0.001370	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002283
NE	0.000571	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002055
ENE	0.001142	0.002626	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003767
E	0.001484	0.002397	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003881
ESE	0.001598	0.002169	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003767
SE	0.001826	0.001027	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002854
SSE	0.001027	0.001826	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002854
S	0.001484	0.000913	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002397
SSW	0.000799	0.000913	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001712
SW	0.001027	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002511
WSW	0.000799	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001370
W	0.000685	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002169
WNW	0.000114	0.001370	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001484
NW	0.000571	0.001256	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001826
NNW	0.000228	0.001027	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001256
N	0.000342	0.001598	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001941
CALM									0.010046
TOTAL	0.014612	0.023516	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.048174

MEAN WIND SPEED (m/s) = 1.45
NUMBER OF OBSERVATIONS = 422

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001826	0.002626	0.004224	0.000342	0.000000	0.000000	0.000000	0.000000	0.009018
NE	0.002740	0.003539	0.003311	0.000685	0.000000	0.000000	0.000000	0.000000	0.010274
ENE	0.002397	0.003881	0.006164	0.000685	0.000000	0.000000	0.000000	0.000000	0.013128
E	0.001256	0.002397	0.002740	0.000342	0.000000	0.000000	0.000000	0.000000	0.006735
ESE	0.002397	0.003082	0.001826	0.000342	0.000000	0.000000	0.000000	0.000000	0.007648
SE	0.001941	0.004680	0.002055	0.000000	0.000000	0.000000	0.000000	0.000000	0.008676
SSE	0.002854	0.004795	0.003425	0.000342	0.000000	0.000000	0.000000	0.000000	0.011416
S	0.002511	0.004452	0.001712	0.000000	0.000000	0.000000	0.000000	0.000000	0.008676
SSW	0.001712	0.003082	0.002169	0.000228	0.000000	0.000000	0.000000	0.000000	0.007192
SW	0.001142	0.003425	0.003425	0.000342	0.000000	0.000000	0.000000	0.000000	0.008333
WSW	0.001484	0.002626	0.002854	0.000228	0.000000	0.000000	0.000000	0.000000	0.007192
W	0.001370	0.001027	0.001484	0.000342	0.000000	0.000000	0.000000	0.000000	0.004224
WNW	0.000913	0.001370	0.000571	0.000228	0.000000	0.000000	0.000000	0.000000	0.003082
NW	0.001027	0.002055	0.001941	0.000114	0.000000	0.000000	0.000000	0.000000	0.005137
NNW	0.001256	0.001370	0.003653	0.000342	0.000000	0.000000	0.000000	0.000000	0.006621
N	0.002626	0.002854	0.002283	0.000000	0.000000	0.000000	0.000000	0.000000	0.007763
CALM									0.018379
TOTAL	0.029452	0.047260	0.043836	0.004566	0.000000	0.000000	0.000000	0.000000	0.143493

MEAN WIND SPEED (m/s) = 2.26
NUMBER OF OBSERVATIONS = 1257

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002169	0.001712	0.001598	0.001712	0.000000	0.000114	0.000228	0.000000	0.007534
NE	0.001598	0.001941	0.002511	0.003196	0.000799	0.000228	0.000114	0.000000	0.010388
ENE	0.001256	0.003196	0.003881	0.004452	0.001370	0.000685	0.000571	0.000342	0.015753
E	0.001484	0.002740	0.001712	0.001598	0.000685	0.000114	0.000000	0.000000	0.008333
ESE	0.001484	0.001484	0.000685	0.000799	0.000457	0.000000	0.000000	0.000000	0.004909
SE	0.001142	0.001826	0.001027	0.001370	0.000228	0.000114	0.000114	0.000000	0.005822
SSE	0.000571	0.002511	0.003196	0.001370	0.000228	0.000000	0.000000	0.000000	0.007877
S	0.000685	0.001712	0.003425	0.002854	0.000228	0.000228	0.000000	0.000000	0.009132
SSW	0.001027	0.001484	0.003881	0.004338	0.000913	0.000457	0.000000	0.000000	0.012100
SW	0.000913	0.001826	0.003311	0.003881	0.000571	0.000228	0.000000	0.000000	0.010731
WSW	0.001598	0.000913	0.002968	0.002397	0.000571	0.000114	0.000000	0.000000	0.008562
W	0.001142	0.001256	0.001484	0.001370	0.000342	0.000000	0.000000	0.000000	0.005594
WNW	0.000913	0.000685	0.001256	0.000913	0.000799	0.000000	0.000000	0.000000	0.004566
NW	0.001256	0.000685	0.000685	0.000799	0.000457	0.000342	0.000342	0.000114	0.004680
NNW	0.001484	0.001256	0.001142	0.001484	0.000571	0.000342	0.000228	0.000228	0.006735
N	0.001598	0.001941	0.001027	0.000799	0.000114	0.000114	0.000000	0.000000	0.005594
CALM									0.023174
TOTAL	0.020320	0.027169	0.033790	0.033333	0.008333	0.003082	0.001598	0.000685	0.151484

MEAN WIND SPEED (m/s) = 3.29
NUMBER OF OBSERVATIONS = 1327

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001027	0.001826	0.001484	0.002055	0.001370	0.000457	0.000457	0.000342	0.009018
NE	0.001598	0.003311	0.004224	0.005251	0.005479	0.002968	0.000571	0.000571	0.023973
ENE	0.001027	0.004680	0.006621	0.005023	0.006393	0.003425	0.001598	0.001370	0.030137
E	0.000685	0.003311	0.002055	0.001712	0.002397	0.001027	0.000457	0.000685	0.012329
ESE	0.000799	0.002740	0.001484	0.001027	0.000685	0.000685	0.000000	0.000457	0.007877
SE	0.001484	0.002626	0.000342	0.000913	0.000457	0.000571	0.000114	0.000000	0.006507
SSE	0.000571	0.002740	0.001826	0.001598	0.000457	0.000114	0.000342	0.000228	0.007877
S	0.000913	0.002854	0.004224	0.002740	0.002055	0.000000	0.000228	0.000114	0.013128
SSW	0.001484	0.002968	0.006164	0.006507	0.006393	0.001941	0.000457	0.000000	0.025913
SW	0.000913	0.003082	0.009817	0.010959	0.007534	0.001941	0.000685	0.000114	0.035046
WSW	0.002169	0.004909	0.009132	0.009018	0.002740	0.000685	0.000114	0.000000	0.028767
W	0.001712	0.002740	0.003196	0.003995	0.002283	0.000228	0.000228	0.000342	0.014726
WNW	0.000799	0.000571	0.001712	0.000685	0.001712	0.000799	0.000342	0.000114	0.006735
NW	0.000799	0.001370	0.001484	0.001370	0.002169	0.000685	0.000000	0.000685	0.008562
NNW	0.001484	0.001598	0.000457	0.001370	0.000913	0.000799	0.000228	0.000685	0.007534
N	0.001027	0.002626	0.001142	0.000457	0.000571	0.000228	0.000000	0.000114	0.006164
CALM									0.007648
TOTAL	0.018493	0.043950	0.055365	0.054680	0.043607	0.016553	0.005822	0.005822	0.251941

MEAN WIND SPEED (m/s) = 4.66
NUMBER OF OBSERVATIONS = 2207

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000000	0.002626	0.001256	0.000228	0.000000	0.000000	0.000000	0.000000	0.004110
NE	0.000000	0.003082	0.003082	0.000685	0.000000	0.000000	0.000000	0.000000	0.006849
ENE	0.000000	0.002283	0.003539	0.001256	0.000000	0.000000	0.000000	0.000000	0.007078
E	0.000000	0.001027	0.000685	0.000571	0.000000	0.000000	0.000000	0.000000	0.002283
ESE	0.000000	0.000799	0.000799	0.000913	0.000000	0.000000	0.000000	0.000000	0.002511
SE	0.000000	0.000685	0.000342	0.000228	0.000000	0.000000	0.000000	0.000000	0.001256
SSE	0.000000	0.001598	0.000571	0.000114	0.000000	0.000000	0.000000	0.000000	0.002283
S	0.000000	0.001826	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.002397
SSW	0.000000	0.002055	0.000685	0.000114	0.000000	0.000000	0.000000	0.000000	0.002854
SW	0.000000	0.004566	0.002511	0.000799	0.000000	0.000000	0.000000	0.000000	0.007877
WSW	0.000000	0.003995	0.002740	0.000342	0.000000	0.000000	0.000000	0.000000	0.007078
W	0.000000	0.003653	0.002740	0.000913	0.000000	0.000000	0.000000	0.000000	0.007306
WNW	0.000000	0.001256	0.002169	0.000913	0.000000	0.000000	0.000000	0.000000	0.004338
NW	0.000000	0.000799	0.001484	0.000799	0.000000	0.000000	0.000000	0.000000	0.003082
NNW	0.000000	0.002283	0.001712	0.000799	0.000000	0.000000	0.000000	0.000000	0.004795
N	0.000000	0.003082	0.000799	0.000228	0.000000	0.000000	0.000000	0.000000	0.004110
CALM									0.000000
TOTAL	0.000000	0.035616	0.025685	0.008904	0.000000	0.000000	0.000000	0.000000	0.070205

MEAN WIND SPEED (m/s) = 3.18
NUMBER OF OBSERVATIONS = 615

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.006849	0.004338	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.011758
NE	0.005023	0.004110	0.001027	0.000000	0.000000	0.000000	0.000000	0.000000	0.010160
ENE	0.008790	0.003311	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.013242
E	0.008447	0.004338	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.013014
ESE	0.007078	0.001712	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.008904
SE	0.005822	0.002283	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.008447
SSE	0.005137	0.001826	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006963
S	0.003653	0.001941	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.005936
SSW	0.005708	0.002169	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.007991
SW	0.006507	0.003196	0.000799	0.000000	0.000000	0.000000	0.000000	0.000000	0.010502
WSW	0.008219	0.005137	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.013813
W	0.010388	0.004566	0.000799	0.000000	0.000000	0.000000	0.000000	0.000000	0.015753
WNW	0.006735	0.004680	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.011872
NW	0.007192	0.003881	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.011644
NNW	0.011758	0.008219	0.001027	0.000000	0.000000	0.000000	0.000000	0.000000	0.021005
N	0.012100	0.006849	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.020091
CALM									0.143607
TOTAL	0.119406	0.062557	0.009132	0.000000	0.000000	0.000000	0.000000	0.000000	0.334703

MEAN WIND SPEED (m/s) = 1.04
NUMBER OF OBSERVATIONS = 2932

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.012785	0.014498	0.009132	0.004338	0.001370	0.000571	0.000685	0.000342	0.043721
NE	0.011530	0.017466	0.014155	0.009817	0.006279	0.003196	0.000685	0.000571	0.063699
ENE	0.014612	0.019977	0.021347	0.011416	0.007763	0.004110	0.002169	0.001712	0.083105
E	0.013356	0.016210	0.007420	0.004224	0.003082	0.001142	0.000457	0.000685	0.046575
ESE	0.013356	0.011986	0.004909	0.003082	0.001142	0.000685	0.000000	0.000457	0.035616
SE	0.012215	0.013128	0.004110	0.002511	0.000685	0.000685	0.000228	0.000000	0.033562
SSE	0.010160	0.015297	0.009018	0.003425	0.000685	0.000114	0.000342	0.000228	0.039269
S	0.009247	0.013699	0.010274	0.005594	0.002283	0.000228	0.000228	0.000114	0.041667
SSW	0.010731	0.012671	0.013014	0.011187	0.007306	0.002397	0.000457	0.000000	0.057763
SW	0.010502	0.017580	0.019863	0.015982	0.008105	0.002169	0.000685	0.000114	0.075000
WSW	0.014269	0.018151	0.018151	0.011986	0.003311	0.000799	0.000114	0.000000	0.066781
W	0.015297	0.014726	0.009703	0.006621	0.002626	0.000228	0.000228	0.000342	0.049772
WNW	0.009475	0.009932	0.006164	0.002740	0.002511	0.000799	0.000342	0.000114	0.032078
NW	0.010845	0.010046	0.006164	0.003082	0.002626	0.001027	0.000342	0.000799	0.034932
NNW	0.016210	0.015753	0.007991	0.003995	0.001484	0.001142	0.000457	0.000913	0.047945
N	0.017694	0.018950	0.006393	0.001484	0.000685	0.000342	0.000000	0.000114	0.045662
CALM									0.202854
TOTAL	0.202283	0.240068	0.167808	0.101484	0.051941	0.019635	0.007420	0.006507	1.000000

MEAN WIND SPEED (m/s) = 2.64
NUMBER OF OBSERVATIONS = 8760

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 4.8%
B : 14.3%
C : 15.1%
D : 25.2%
E : 7.0%
F : 33.5%

APPENDIX B

(No. of pages excluding this page = 5)

ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : DUNMORE QUARRY OPERATIONS

The emissions inventory below provides an example of the assumed emission factors, intensity of operations and calculations for existing operations.

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Stripping topsoil (not much required)	560	40	h/y	14	kg/h						
Drilling (Croome Farm)	880	1491	holes/y	0.59	kg/hole						
Blasting (Croome Farm)	229	21	blasts/y	10.912	kg/blast	1350	Area of blast in square metres				
FEL loading to trucks (Croome Farm)	1653	980000	t/y	0.0017	kg/t	1.425	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling to hopper (Croome Farm)	58800	980000	t/y	0.06	kg/t	50	t/truck load	3	km/return trip	1	kg/VKT
Drilling (RIC)	377	639	holes/y	0.59	kg/hole						
Blasting (RIC)	98	9	blasts/y	10.912	kg/blast	1350	Area of blast in square metres				
FEL loading to trucks (RIC)	709	420000	t/y	0.0017	kg/t	1.425	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling to hopper (RIC)	18480	420000	t/y	0.044	kg/t	50	t/truck load	2.2	km/return trip	1	kg/VKT
Dumping to hopper	2362	1400000	t/y	0.0017	kg/t	1.425	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	2128	1400000	t/y	0.0152	kg/t	90	%reduction				
Secondary crushing and screening	42756	1400000	t/y	0.1527	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	32067	1050000	t/y	0.1527	kg/t	90	%reduction	2	No. stages		
Conveying to stockpiles or truck	2362	1400000	t/y	0.0017	kg/t	1.425	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Transporting to stockpiles	61600	1400000	t/y	0.044	kg/t	50	t/truck load	2.2	km/return trip	1	kg/VKT
Dumping to stockpiles	2362	1400000	t/y	0.0017	kg/t	1.425	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	844	500000	t/y	0.0017	kg/t	1.425	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Transport product off-site (unsealed rd)	11538	500000	t/y	0.0231	kg/t	26	t/truck load	0.6	km/return trip	1	kg/VKT
Transport product off-site (sealed rd)	4615	500000	t/y	0.0092	kg/t	26	t/truck load	1.2	km/return trip	0.2	kg/VKT

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Loading product to trains	1478	876000	t/y	0.0017	kg/t	1.425	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
FEL working on stockpiles	3542	1460	h/y	2.4259	kg/h	2	silt content in %	2	moisture content (%)		
Wind erosion from exposed areas	7087	20	ha	354.36	kg/ha/y	137	Average number of raindays	10	silt content (%)	11.85	% of winds above 5.4 m/s
Wind erosion from product stockpiles	142	2	ha	70.873	kg/ha/y	137	Average number of raindays	2	silt content (%)	11.85	% of winds above 5.4 m/s
CBP : Vehicles on site (unsealed rd)	6840					5700	trips/y	1.2	km/return trip	1	kg/VKT
CBP : Vehicles on site (sealed rd)	1368					5700	trips/y	1.2	km/return trip	0.2	kg/VKT

Summary of dust emission estimates for each activity, activity type and location of emission sources are provided below. The location of the sources can be obtain either from **Figure 11** or from the ISCST3 model input file in **Appendix C**.

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 DUST EMISSION CALCULATIONS  Existing Operations 1.4 Mtpa
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Output emissions file  : C:\Dunmore\iscst3\existing\emiss.dat
 Meteorological file    : C:\Dunmore\metdata\Dunmore quarry\dunm0203.isc
 Number of dust sources : 41
 Number of activities   : 25
 Wind speed factor      : 1.425
 Av. cubed wind speed   : 72.171

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (not much required)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 560 kg/y
 FROM SOURCES  : 6
1 2 3 4 17 18

 ACTIVITY NAME : Drilling (Croome Farm)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 880 kg/y
 FROM SOURCES  : 4
1 2 3 4

 ACTIVITY NAME : Blasting (Croome Farm)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 229 kg/y
 FROM SOURCES  : 4
1 2 3 4

 ACTIVITY NAME : FEL loading to trucks (Croome Farm)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1653 kg/y
 FROM SOURCES  : 4
1 2 3 4

 ACTIVITY NAME : Hauling to hopper (Croome Farm)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 58800 kg/y
 FROM SOURCES  : 12
1 2 3 4 9 10 11 12 13 14 15 16

 ACTIVITY NAME : Drilling (RIC)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 377 kg/y
 FROM SOURCES  : 2
17 18

 ACTIVITY NAME : Blasting (RIC)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 98 kg/y
 FROM SOURCES  : 2
17 18

 ACTIVITY NAME : FEL loading to trucks (RIC)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 709 kg/y
 FROM SOURCES  : 2
17 18

 ACTIVITY NAME : Hauling to hopper (RIC)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 18480 kg/y
 FROM SOURCES  : 8
11 12 13 14 15 16 17 18

 ACTIVITY NAME : Dumping to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2362 kg/y
 FROM SOURCES  : 1
16

 ACTIVITY NAME : Primary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2128 kg/y
 FROM SOURCES  : 1
16

 ACTIVITY NAME : Secondary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 42756 kg/y
 FROM SOURCES  : 3
```

```
19 20 21

 ACTIVITY NAME : Tertiary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 32067 kg/y
 FROM SOURCES  : 3
19 20 21

 ACTIVITY NAME : Conveying to stockpiles or truck
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2362 kg/y
 FROM SOURCES  : 3
19 20 21

 ACTIVITY NAME : Transporting to stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 61600 kg/y
 FROM SOURCES  : 11
22 23 24 25 26 27 28 29 30 31 32

 ACTIVITY NAME : Dumping to stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2362 kg/y
 FROM SOURCES  : 3
30 31 32

 ACTIVITY NAME : Loading product to road trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 844 kg/y
 FROM SOURCES  : 3
30 31 32

 ACTIVITY NAME : Transport product off-site (unsealed rd)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11538 kg/y
 FROM SOURCES  : 3
28 29 30

 ACTIVITY NAME : Transport product off-site (sealed rd)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4615 kg/y
 FROM SOURCES  : 3
39 40 41

 ACTIVITY NAME : Loading product to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1478 kg/y
 FROM SOURCES  : 1
28

 ACTIVITY NAME : FEL working on stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3542 kg/y
 FROM SOURCES  : 9
30 31 32 33 34 35 36 37 38

 ACTIVITY NAME : Wind erosion from exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 7087 kg/y
 FROM SOURCES  : 10
1 2 3 4 33 34 35 36 37 38

 ACTIVITY NAME : Wind erosion from product stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 142 kg/y
 FROM SOURCES  : 4
29 30 31 32

 ACTIVITY NAME : CBP : Vehicles on site (unsealed rd)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6840 kg/y
 FROM SOURCES  : 5
24 25 26 27 28

 ACTIVITY NAME : CBP : Vehicles on site (sealed rd)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1368 kg/y
 FROM SOURCES  : 3
39 40 41
```

----EMISSIONS SUMMARY-----(g/s)

Source	Wind_insensitive	Wind_sensitive	Wind_erosion
01	0.1671	0.0131	0.0225
02	0.1671	0.0131	0.0225
03	0.1671	0.0131	0.0225
04	0.1671	0.0131	0.0225
05	0.0000	0.0000	0.0000
06	0.0000	0.0000	0.0000
07	0.0000	0.0000	0.0000
08	0.0000	0.0000	0.0000
09	0.1554	0.0000	0.0000
10	0.1554	0.0000	0.0000
11	0.2286	0.0000	0.0000
12	0.2286	0.0000	0.0000
13	0.2286	0.0000	0.0000
14	0.2286	0.0000	0.0000
15	0.2286	0.0000	0.0000
16	0.2961	0.0749	0.0000
17	0.0837	0.0112	0.0000
18	0.0837	0.0112	0.0000
19	0.7909	0.0250	0.0000
20	0.7909	0.0250	0.0000
21	0.7909	0.0250	0.0000
22	0.1776	0.0000	0.0000
23	0.1776	0.0000	0.0000
24	0.2210	0.0000	0.0000
25	0.2210	0.0000	0.0000
26	0.2210	0.0000	0.0000
27	0.2210	0.0000	0.0000
28	0.3429	0.0469	0.0000
29	0.2995	0.0000	0.0011
30	0.3120	0.0339	0.0011
31	0.1901	0.0339	0.0011
32	0.1901	0.0339	0.0011
33	0.0125	0.0000	0.0225
34	0.0125	0.0000	0.0225
35	0.0125	0.0000	0.0225
36	0.0125	0.0000	0.0225
37	0.0125	0.0000	0.0225
38	0.0125	0.0000	0.0225
39	0.0632	0.0000	0.0000
40	0.0632	0.0000	0.0000
41	0.0632	0.0000	0.0000

APPENDIX C

(No. of pages excluding this page = 7)

ISCST3 MODEL INPUT FILE
ISCST3 INPUT FILE

```
**  ISCST3 model input runstream : Existing 1.4 Mtpa operations, Dunmore Quarry
CO STARTING
   TITLEONE ISCST3 Dust Model Run
   MODELOPT RURAL CONC DDEP DRYDPLT
   AVERTIME 24 PERIOD
   POLLUTID TSP
   ERRORFIL Error.MSG
   TERRHGTS ELEV
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  POINT1  VOLUME  299088 6168739 152.7
   LOCATION  POINT2  VOLUME  299083 6168644 144.9
   LOCATION  POINT3  VOLUME  299206 6168719 159.7
   LOCATION  POINT4  VOLUME  299192 6168590 145.2
   LOCATION  POINT5  VOLUME  299045 6168527 129.6
   LOCATION  POINT6  VOLUME  299146 6168475 127.8
   LOCATION  POINT7  VOLUME  299034 6168386 111.4
   LOCATION  POINT8  VOLUME  299117 6168346 108.7
   LOCATION  POINT9  VOLUME  299335 6168521 136.1
   LOCATION  POINT10  VOLUME  299495 6168481 120.2
   LOCATION  POINT11  VOLUME  299656 6168438 101
   LOCATION  POINT12  VOLUME  299819 6168323 73.6
   LOCATION  POINT13  VOLUME  299997 6168228 50.3
   LOCATION  POINT14  VOLUME  300129 6168125 32.2
   LOCATION  POINT15  VOLUME  300180 6167993 19.9
   LOCATION  POINT16  VOLUME  300180 6167884 14.5
   LOCATION  POINT17  VOLUME  299418 6168452 121.7
   LOCATION  POINT18  VOLUME  299564 6168398 103.3
   LOCATION  POINT19  VOLUME  300198 6167798 13.7
   LOCATION  POINT20  VOLUME  300341 6167849 13.3
   LOCATION  POINT21  VOLUME  300499 6167777 16
   LOCATION  POINT22  VOLUME  300415 6167858 13
   LOCATION  POINT23  VOLUME  300522 6167800 15.1
   LOCATION  POINT24  VOLUME  300384 6167798 14.6
   LOCATION  POINT25  VOLUME  300479 6167754 17.1
   LOCATION  POINT26  VOLUME  300590 6167688 21
   LOCATION  POINT27  VOLUME  300751 6167677 19.2
   LOCATION  POINT28  VOLUME  300868 6167737 14.9
   LOCATION  POINT29  VOLUME  300943 6167869 11.4
   LOCATION  POINT30  VOLUME  300989 6167970 12.3
   LOCATION  POINT31  VOLUME  300920 6167987 12.8
   LOCATION  POINT32  VOLUME  300923 6167915 11.2
   LOCATION  POINT33  VOLUME  300284 6167976 16.1
   LOCATION  POINT34  VOLUME  300378 6168079 19.9
   LOCATION  POINT35  VOLUME  300565 6168053 16.1
   LOCATION  POINT36  VOLUME  300751 6168033 14.6
   LOCATION  POINT37  VOLUME  300722 6167887 12.4
   LOCATION  POINT38  VOLUME  300522 6167924 12.8
   LOCATION  POINT39  VOLUME  301027 6167785 12.4
   LOCATION  POINT40  VOLUME  301182 6167850 11.3
   LOCATION  POINT41  VOLUME  301359 6167927 11.0
   LOCATION  POINT42  VOLUME  299088 6168739 152.7
   LOCATION  POINT43  VOLUME  299083 6168644 144.9
   LOCATION  POINT44  VOLUME  299206 6168719 159.7
   LOCATION  POINT45  VOLUME  299192 6168590 145.2
   LOCATION  POINT46  VOLUME  299045 6168527 129.6
   LOCATION  POINT47  VOLUME  299146 6168475 127.8
   LOCATION  POINT48  VOLUME  299034 6168386 111.4
   LOCATION  POINT49  VOLUME  299117 6168346 108.7
   LOCATION  POINT50  VOLUME  299335 6168521 136.1
   LOCATION  POINT51  VOLUME  299495 6168481 120.2
   LOCATION  POINT52  VOLUME  299656 6168438 101
   LOCATION  POINT53  VOLUME  299819 6168323 73.6
   LOCATION  POINT54  VOLUME  299997 6168228 50.3
   LOCATION  POINT55  VOLUME  300129 6168125 32.2
   LOCATION  POINT56  VOLUME  300180 6167993 19.9
   LOCATION  POINT57  VOLUME  300180 6167884 14.5
   LOCATION  POINT58  VOLUME  299418 6168452 121.7
   LOCATION  POINT59  VOLUME  299564 6168398 103.3
   LOCATION  POINT60  VOLUME  300198 6167798 13.7
   LOCATION  POINT61  VOLUME  300341 6167849 13.3
   LOCATION  POINT62  VOLUME  300499 6167777 16
   LOCATION  POINT63  VOLUME  300415 6167858 13
   LOCATION  POINT64  VOLUME  300522 6167800 15.1
   LOCATION  POINT65  VOLUME  300384 6167798 14.6
   LOCATION  POINT66  VOLUME  300479 6167754 17.1
   LOCATION  POINT67  VOLUME  300590 6167688 21
   LOCATION  POINT68  VOLUME  300751 6167677 19.2
   LOCATION  POINT69  VOLUME  300868 6167737 14.9
   LOCATION  POINT70  VOLUME  300943 6167869 11.4
   LOCATION  POINT71  VOLUME  300989 6167970 12.3
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   LOCATION  POINT73  VOLUME  300923 6167915 11.2
   LOCATION  POINT74  VOLUME  300284 6167976 16.1
   LOCATION  POINT75  VOLUME  300378 6168079 19.9
   LOCATION  POINT76  VOLUME  300565 6168053 16.1
   LOCATION  POINT77  VOLUME  300751 6168033 14.6
   LOCATION  POINT78  VOLUME  300722 6167887 12.4
   LOCATION  POINT79  VOLUME  300522 6167924 12.8
   LOCATION  POINT80  VOLUME  301027 6167785 12.4
   LOCATION  POINT81  VOLUME  301182 6167850 11.3
   LOCATION  POINT82  VOLUME  301359 6167927 11.0
   LOCATION  POINT83  VOLUME  299088 6168739 152.7
   LOCATION  POINT84  VOLUME  299083 6168644 144.9
   LOCATION  POINT85  VOLUME  299206 6168719 159.7
   LOCATION  POINT86  VOLUME  299192 6168590 145.2
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   LOCATION  POINT88  VOLUME  299146 6168475 127.8
   LOCATION  POINT89  VOLUME  299034 6168386 111.4
   LOCATION  POINT90  VOLUME  299117 6168346 108.7
   LOCATION  POINT91  VOLUME  299335 6168521 136.1
   LOCATION  POINT92  VOLUME  299495 6168481 120.2
   LOCATION  POINT93  VOLUME  299656 6168438 101
   LOCATION  POINT94  VOLUME  299819 6168323 73.6
   LOCATION  POINT95  VOLUME  299997 6168228 50.3
   LOCATION  POINT96  VOLUME  300129 6168125 32.2
   LOCATION  POINT97  VOLUME  300180 6167993 19.9
   LOCATION  POINT98  VOLUME  300180 6167884 14.5
   LOCATION  POINT99  VOLUME  299418 6168452 121.7
   LOCATION  POINT100  VOLUME  299564 6168398 103.3
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   LOCATION  POINT102  VOLUME  300341 6167849 13.3
   LOCATION  POINT103  VOLUME  300499 6167777 16
   LOCATION  POINT104  VOLUME  300415 6167858 13
   LOCATION  POINT105  VOLUME  300522 6167800 15.1
   LOCATION  POINT106  VOLUME  300384 6167798 14.6
   LOCATION  POINT107  VOLUME  300479 6167754 17.1
   LOCATION  POINT108  VOLUME  300590 6167688 21
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   LOCATION  POINT110  VOLUME  300868 6167737 14.9
   LOCATION  POINT111  VOLUME  300943 6167869 11.4
   LOCATION  POINT112  VOLUME  300989 6167970 12.3
   LOCATION  POINT113  VOLUME  300920 6167987 12.8
   LOCATION  POINT114  VOLUME  300923 6167915 11.2
   LOCATION  POINT115  VOLUME  300284 6167976 16.1
   LOCATION  POINT116  VOLUME  300378 6168079 19.9
   LOCATION  POINT117  VOLUME  300565 6168053 16.1
   LOCATION  POINT118  VOLUME  300751 6168033 14.6
   LOCATION  POINT119  VOLUME  300722 6167887 12.4
   LOCATION  POINT120  VOLUME  300522 6167924 12.8
   LOCATION  POINT121  VOLUME  301027 6167785 12.4
   LOCATION  POINT122  VOLUME  301182 6167850 11.3
   LOCATION  POINT123  VOLUME  301359 6167927 11.0
** Point Source       QS   RH  IL   IV
** Parameters        ----  --- ---  ---
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   SRCPARAM  POINT1   1.0 2.0  20.  2.
   SRCPARAM  POINT2   1.0 2.0  20.  2.
   SRCPARAM  POINT3   1.0 2.0  20.  2.
   SRCPARAM  POINT4   1.0 2.0  20.  2.
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   SRCPARAM  POINT13   1.0 2.0  20.  2.
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   SRCPARAM  POINT32   1.0 2.0  20.  2.
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SRCPARAM  POINT86   1.0 2.0  20.  2.
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SRCPARAM  POINT90   1.0 2.0  20.  2.
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SRCPARAM  POINT92   1.0 2.0  20.  2.
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SRCPARAM  POINT102   1.0 2.0  20.  2.
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SRCPARAM  POINT106   1.0 2.0  20.  2.
SRCPARAM  POINT107   1.0 2.0  20.  2.
SRCPARAM  POINT108   1.0 2.0  20.  2.
SRCPARAM  POINT109   1.0 2.0  20.  2.
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SRCPARAM  POINT111   1.0 2.0  20.  2.
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SRCPARAM  POINT114   1.0 2.0  20.  2.
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SRCPARAM  POINT116   1.0 2.0  20.  2.
SRCPARAM  POINT117   1.0 2.0  20.  2.
SRCPARAM  POINT118   1.0 2.0  20.  2.
SRCPARAM  POINT119   1.0 2.0  20.  2.
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   SRCPARAM  POINT122   1.0 2.0  20.  2.
   SRCPARAM  POINT123   1.0 2.0  20.  2.
   PARTDIAM  POINT1-POINT41  1.0
   PARTDIAM  POINT42-POINT82  5.0
   PARTDIAM  POINT83-POINT123  17.3
   MASSFRAX  POINT1-POINT123  1.0
   PARTDENS  POINT1-POINT123  2.7
   SRCGROUP  FP  POINT1-POINT41
   SRCGROUP  CM  POINT42-POINT82
   SRCGROUP  REST  POINT83-POINT123
SO FINISHED

RE STARTING
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RE DISCCART 298975 6168820 147.7
RE DISCCART 298953 6168720 141.0
RE DISCCART 298942 6168575 128.4
RE DISCCART 298931 6168419 111.0
RE DISCCART 298997 6168297 98.8
RE DISCCART 299164 6168242 94.5
RE DISCCART 299297 6168308 104.0
RE DISCCART 299397 6168319 102.5
RE DISCCART 299574 6168297 88.8
RE DISCCART 299663 6168242 75.2
RE DISCCART 299730 6168142 58.0
RE DISCCART 299796 6168019 40.5
RE DISCCART 299974 6167975 27.4
RE DISCCART 300074 6167908 18.9
RE DISCCART 300129 6167752 14.2
RE DISCCART 300263 6167708 16.5
RE DISCCART 300440 6167697 20.2
RE DISCCART 300573 6167619 26.4
RE DISCCART 300773 6167586 23.5
RE DISCCART 300951 6167619 17.1
RE DISCCART 301051 6167730 13.2
RE DISCCART 301062 6167919 11.5
RE DISCCART 301062 6168030 13.2
RE DISCCART 300951 6168108 16.5
RE DISCCART 300818 6168108 17.0
RE DISCCART 300607 6168130 18.8
RE DISCCART 300407 6168164 24.4
RE DISCCART 300285 6168286 38.2
RE DISCCART 300096 6168364 57.6
RE DISCCART 299941 6168364 69.1
RE DISCCART 299752 6168475 97.1
RE DISCCART 299519 6168553 127.8
RE DISCCART 299364 6168608 147.2
RE DISCCART 299352 6168764 162.6
RE DISCCART 299574 6168653 133.7
RE DISCCART 299863 6168542 94.8
RE DISCCART 300185 6168464 60.9
RE DISCCART 300418 6168297 32.6
RE DISCCART 300618 6168264 23.9
RE DISCCART 300807 6168242 20.5
RE DISCCART 301040 6168197 16.8
RE DISCCART 301173 6167986 11.7
RE DISCCART 301195 6167808 11.5
RE DISCCART 301128 6167641 14.2
RE DISCCART 301006 6167519 18.7
RE DISCCART 300818 6167486 26.9
RE DISCCART 300607 6167497 36.7
RE DISCCART 300407 6167575 30.1
RE DISCCART 300185 6167608 19.2
RE DISCCART 300030 6167719 14.0
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RE DISCCART 299674 6167930 37.0
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RE DISCCART 299475 6168041 58.5
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RE DISCCART 298820 6168275 90.8
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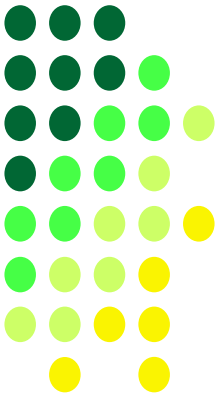
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Boral Resources (NSW) Pty Limited
ABN: 51 000 756 507



DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 3 - TRAFFIC ASSESSMENT

Prepared by
Transport and Urban Planning

November, 2003

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 3 - TRAFFIC ASSESSMENT

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EXECUTIVE SUMMARY

INTRODUCTION AND PROPOSAL

Boral Resources NSW Pty Ltd ("Boral") operate a hard rock quarry at Dunmore on the NSW South Coast. The quarry is located beyond the end of Tabbita Road west of Princes Highway.

Boral proposes to progressively increase production at the Dunmore Quarry to 2.5 million tonnes per annum (Mtpa) from existing levels in the order of 1.2Mtpa. Boral intends to seek a new consent which would also replace a number of existing, and at times, conflicting consents that the Dunmore Quarry currently operates under. The progressive increase in production would take place over a period of approximately 2 years. Based on market projections, it is anticipated the following production rates would be achieved by 2004 and 2005.

- 2004 2.2Mt
- 2005 2.5Mt

The increase in production would be achieved by a combination of increased operating hours and minor changes to equipment types and configuration, mainly within the crushing and conveying circuit.

An increase in operating hours would allow operation of an additional shift, employing up to 15 additional people to the current pre-trial period permanent work force of 31.

Boral intends to seek a consistent set of operating hours for the following activities on the Project Site.

- Extraction and Processing — Monday – Saturday, 6.00am – 10pm
- Product transfer to Stockpiles — Monday – Saturday, 6.00am - midnight
- Sales — Monday – Saturday, 24 hours, 7 days a week
  Sunday 6.00am –10.00pm
- Maintenance — 24 hours, 7 days a week

The increased quantity of quarry products would be distributed by both road and rail. Boral would attempt to maximise the distribution of products by rail although there would be an incremental increase in truck traffic to and from the quarry. Currently Dunmore Quarry is serviced by two trains per day. Each train currently carries approximately 2,100 tonnes and 980 tonnes respectively of products, principally to St Peters. A second rail terminal has been established in Sydney to receive quarry products.

The existing dual transport system of rail and truck transport would be maintained. A substantial proportion of the proposed additional products would be transported by rail, with a plan to increase to two larger capacity trains. The planned progressive upgrade of the Princes Highway (by RTA) would also improve road transport access to and from Dunmore Quarry. Importantly, prior to 2000, all quarry products, were transported by road. Boral currently transport around 900 000 tonnes per annum of product by rail and 500 000 tonnes per annum by road.

This assessment aims to evaluate the increase in both road and rail traffic in the context of the completion of construction of the North Kiama Bypass and the Albion Park to Dunmore Princes Highway upgrade. A preliminary assessment carried out (by the RTA) in 2001 indicated that with the completion of these road works, there would be no significant traffic issues that would preclude the rationalisation of the various consents.

There will be no change to the existing road transport routes for the distribution of products from Dunmore Quarry which are Princes Highway and F6 to Wollongong and Sydney or south on the Princes Highway to Kiama and surrounds. The existing split of 93% to the north and 7% to the south will remain unchanged through the life of the proposal.

The product truck fleet will continue to include B doubles, semi-trailer tippers, rigid trucks with and without dog trailers, although greater use of the larger vehicles is expected, increasing average loads from the existing 28.7 tonnes to 29 tonnes.

There are currently some 80 two way trips per day (i.e. 40 in / 40 out) associated with employee and maintenance of the quarry. These are expected to increase to around 50 in / 50 out trips per day.

ASSESSMENT OF EXISTING TRAFFIC CONDITIONS

The principal road network around the Dunmore Quarry is constructed to a good standard with a high level of traffic management provided along the road network.

The existing intersection treatment at Princes Highway / Tabbita Road is also constructed to an acceptable standard with adequate provision for quarry trucks turning from Tabbita Road into the Princes Highway. Sight distance at the intersection is good and exceeds Austroad requirements for the operating vehicle speeds and speed limit.

Proposals by the RTA will see this intersection partially grade separated (northbound) and the adjoining intersection with Shellharbour Road significantly improved by end 2005.

Traffic conditions in Tabbita Road adjacent the quarry site are considered to be good and in the order of 409 vehicles per day on a weekday and 319 vehicles per day over a 7 day period with heavy vehicles comprising around 60% of total vehicles.

Traffic volumes on the Princes Highway vary from day to day but are in the order of 20,000 to 26,000 (10.5% heavy vehicles) vehicles per day on a weekday when product sales and transportation from the quarry are consistent with the 85th percentile day. Traffic volumes on a typical Saturday / Sunday are higher at up to 28 500 vehicles per day.

The assessment of traffic conditions including road safety at the principal intersections and immediately adjacent the quarry indicates that traffic conditions are satisfactory and consistent with a Level of Service B operation.

ASSESSMENT OF TRAFFIC IMPACTS AND FUTURE ROAD IMPROVEMENTS

The proposal to increase sales and transportation by road from 0.5 million tonnes per annum existing to 1.0 million tonnes per annum will result in increased product truck movements arriving and departing from Dunmore Quarry.

The proposal will (by Year 2005) result in additional truck movements (two way) on the Princes Highway:

- 246 truck movements on an average day; and
- 288 truck movements on the 85th percentile day.

Boral expects the existing 93:7 split between the north and south destinations for product truck movements to be retained during the life of the proposal.

Based on the hourly truck distribution, an additional 2-3 truck movements per hour would access the quarry on an average day and 11 truck movements during the peak hour on the 85th percentile day.

A review of traffic projections suggests that the increase in product trucks will be:

- 61 and 55 truck movements per day and up to 11 truck movements in the peak hour in Tabbita Road on the average and 85th percentile days;
- 56 and 52 truck movements per day and up to 10 truck movements in the peak hour in the Princes Highway north of Tabbita Road; and
- up to 5 truck movements per day and 1 additional truck movement in the peak hour in Princes Highway south of Tabbita Road.

The increase in employee/visitor and/or maintenance vehicle trips due to the proposal would be in the order of 50 trips in / out per day, i.e. a total of 100 light vehicle movements.

The increase in vehicle movements due to the proposal is small in real terms and no change is expected to the traffic conditions on the road network due to the proposal in the shorter term. In the longer term, i.e. by 2010, following the completion of the RTA route improvements for the Princes Highway, traffic conditions and associated service levels in this section of the Highway through Dunmore should significantly improve.

The principal road network around the Dunmore Quarry is to be progressively upgraded by the RTA during the period 2004 to 2010 to a divided 4 lane standard with a high level of traffic management provided along the road network.

The existing channelisation at the intersection of Princes Highway / Tabbita Road provides a safe intersection design which easily caters for the vehicle movements that use the intersection. Safety and service levels at this intersection will improve further with the RTA's partial grade separation proposals.

The increase of up to 11 additional truck movements per hour by 2005 will not affect the capacity of the intersection and/or road safety at the intersection. The intersection will continue to operate at an acceptable level of service operation which indicates good traffic conditions.

The increase of 10 truck movements per hour using Princes highway north of Tabbita Road will have no measurable impact on road capacity or traffic conditions. This section of the Princes Highway currently carries between 2100 and 2400 vehicles per hour (Monday-Friday), 10.5% of which are heavy vehicles.

Similarly the increase of 1 additional truck movement per hour using the Princes Highway, south of Tabbita Road will have no measurable impact. An additional truck movement per hour will not alter the existing traffic conditions.

Traffic conditions in the Princes Highway adjacent Tabbita Road are satisfactory with good sight distance, moderate vehicle speeds and regular gaps in the Princes Highway traffic flow which allows vehicles arriving and departing the Quarry to safely turn into and out of the Princes Highway. In particular, these traffic conditions are likely to improve further with the RTA's proposal and grade separation.

On the wider road network for trips to either Sydney or Wollongong, the additional 11 truck movements per hour associated with the proposal will have no noticeable impact on the road network and are comparative to those truck levels realised up to until 1999 when all product was transported by road.

CONCLUSION

This assessment has found that the increase in traffic including product truck movements due to the proposal is small in real terms and no change is expected to the traffic conditions on the broader road network.

The existing road network and traffic management adjacent the quarry are constructed to an acceptable standard. The existing traffic conditions on the arterial road network north and south of the site are expected to improve by end of 2004 with the proposal in place.

1 INTRODUCTION

Boral Resources (NSW) Pty Ltd ("Boral") operates a hard rock quarry at Dunmore on the NSW South Coast. The quarry is located beyond the end of Tabbita Road, west of the Princes Highway. (see **Figure 1**)

Boral proposes to progressively increase production at the Dunmore Quarry to 2.5 million tonnes per annum (Mtpa) from existing levels in the order of 1.2Mtpa. Boral intends to seek a new Development Consent to increase production levels and also replace a number of existing, and at times, conflicting consents that the Dunmore Quarry currently operates under. The progressive increase in production would take place over a period of up to 2 years.

The relative breakdown of future rail / road product despatch at 2.5Mtpa is as follows:

- 2004 (2.2Mtpa i.e. 1.4Mtpa rail + 0.8Mtpa road)
- 2005 (2.5Mtpa i.e. 1.5Mtpa rail + 1.0Mtpa road)

In order to achieve these production rates, Boral requires Development Consent to be granted by late March 2004 which will virtually coincide with the completion of the current trial of the extended hours of operation.

The increase in production would be achieved by a combination of increased operating hours, mobile equipment upgrades and minor changes to equipment types and configuration, mainly within the crushing and conveying circuit and an increase in rail and road transport.

An increase in operating hours would allow the continuation of an additional shift, which is currently employing up to 15 additional people to the pre-trial period permanent work force of 31.

The NSW Roads and Traffic Authority, as part of its Illawarra regional works program, is proposing to upgrade the Princes Highway between Oak Flats and North Kiama by 2010.

The critical timeframes for the section of the Princes Highway upgrade at Dunmore adjacent the Boral site is as follows:

Stage 1 the implementation of an interim road improvement scheme in late 2005 associated with the North Kiama Bypass.

Stage 2 the completion of the ultimate upgrading of the Princes Highway between Dunmore and Oak Flats by 2010.

Stage 3 The completion of the Princes Highway between Oak Flat and Yallah (currently unscheduled).

Figure 1 shows the location of each of these stages.

This report has been prepared to determine the impact of the proposal on traffic volumes and types in the region. The assessment is based on the projected traffic volumes presented in the Environmental Impact Statement for the proposal. Reference is also made to the Environmental Impact Statement for the proposed Dunmore Lakes Sand Extraction Project – Stages 2 and 3 which outlines the proposed traffic movements for that operation via Tabbita Road, the same road used by trucks travelling to and from the Boral Dunmore Quarry (EIS currently in preparation).

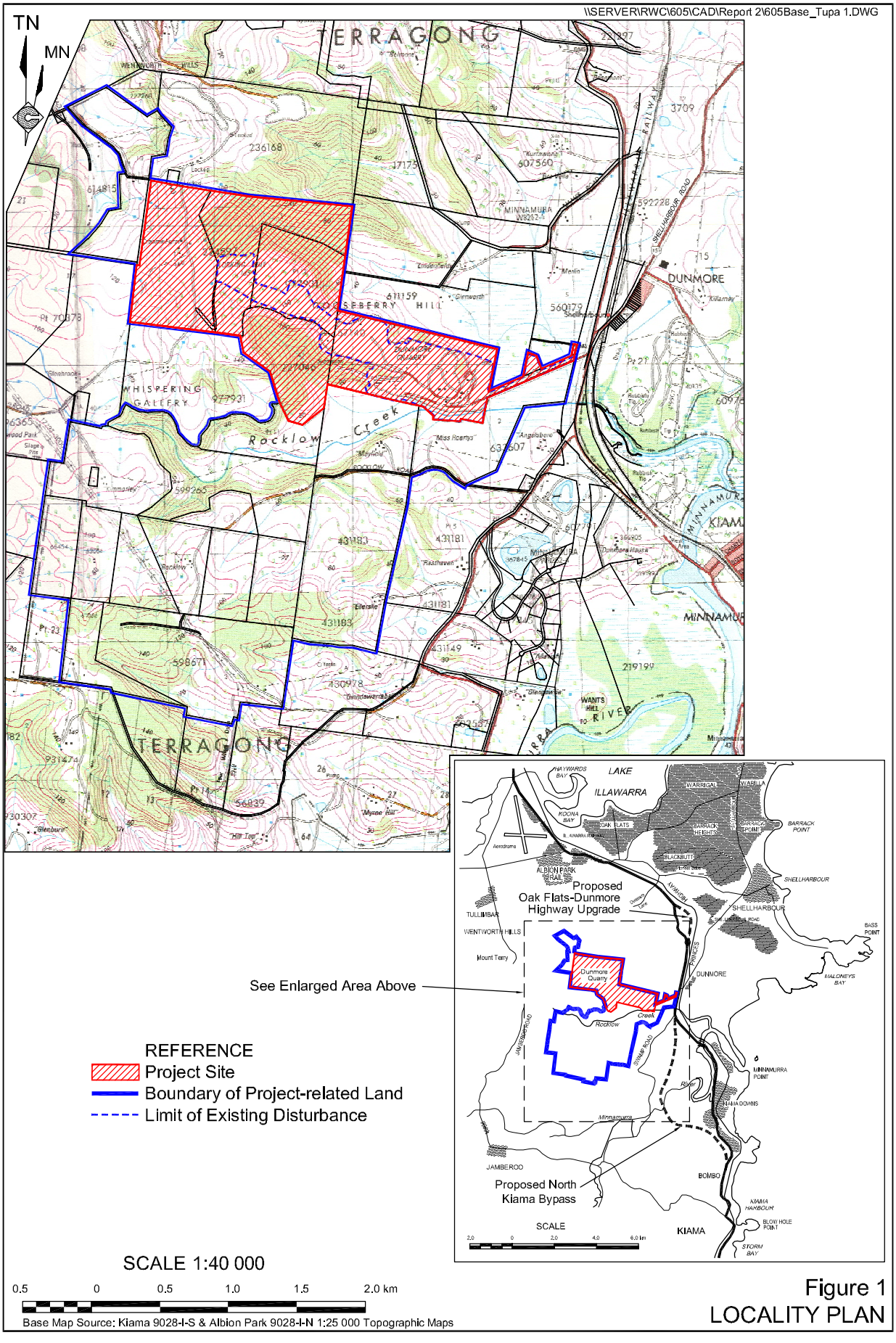


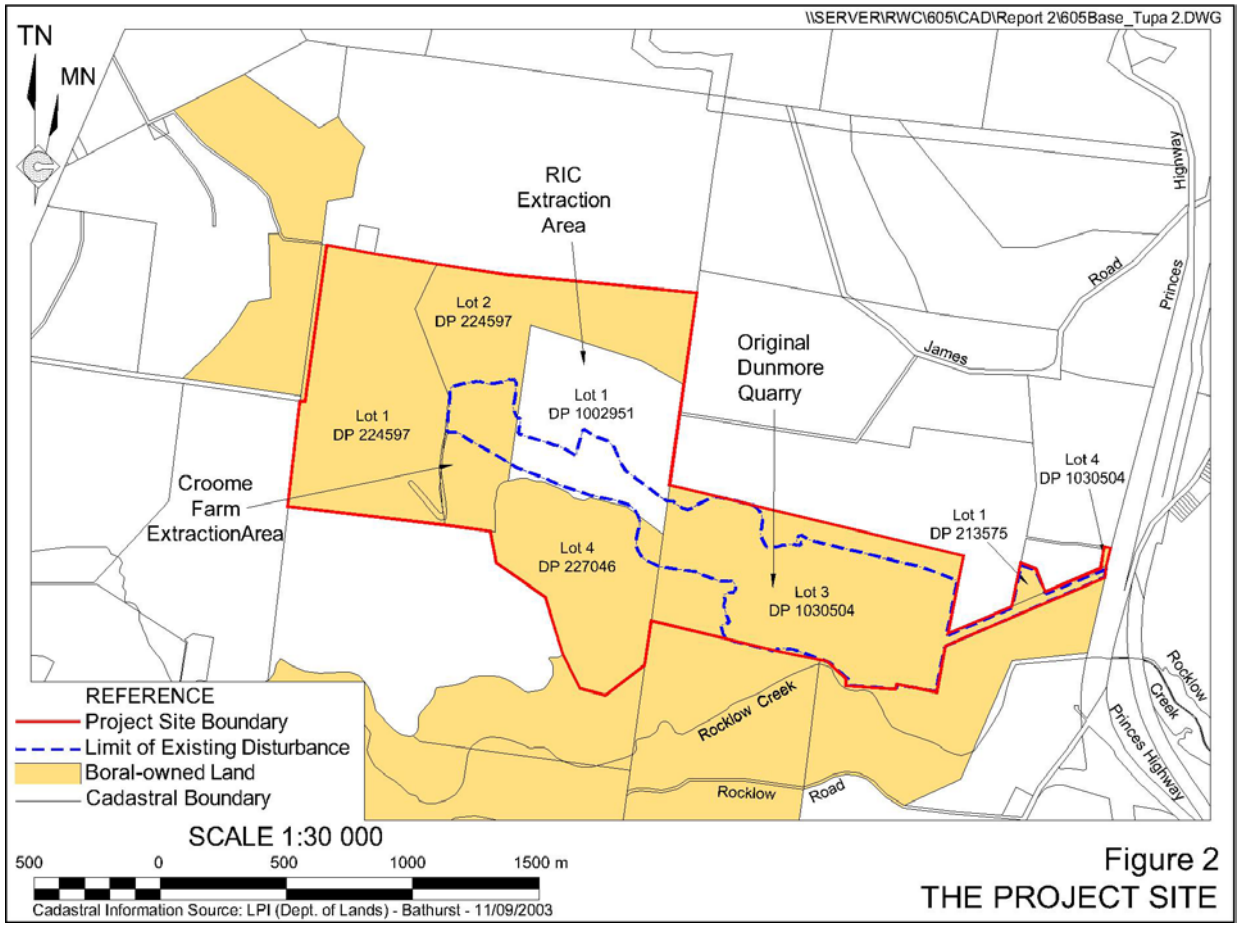
Figure 1
LOCALITY PLAN

This assessment aims to evaluate the increase in both road and rail traffic in the context of the completion of construction of the North Kiama Bypass and the Albion Park to Dunmore Princes Highway upgrade. A preliminary assessment carried out in 2001 indicated that with the completion of these road works, there would be no significant traffic issues that would preclude the rationalisation of the various consents.

2 DUNMORE QUARRY EXISTING QUARRY OPERATIONS

2.1 EXISTING APPROVALS

Figure 2 shows the existing operations occur within three areas.



Original Dunmore Quarry

The lawful existence of the original Dunmore Quarry has been acknowledged by the Shellharbour City Council as Boral has existing use rights over this entire area in which hours of operation, sales, maintenance and volumes to be extracted are not limited.

(Rail Infrastructure Corporation – RIC) – Consent 86/161

Boral has consent to extract approximately 10 million tonnes of latite at a rate of up to 450 000 tpa. The approved hours of operation for activities within this area are:

• Extraction	Mondays to Fridays Saturdays	6.00am to 4.00pm 6.00am to noon
• Maintenance	Mondays to Fridays Saturdays	2.30pm to 10.30pm noon to 4.00pm

There are no restrictions for sales and processing hours and there are no limits placed upon the amount of aggregates / road pavement materials to be hauled by road.

Croome Farm – Consent 94/168

Boral has consent to extract approximately 15 million tonnes of latite at a rate of 750 000 tpa. The hours of operation for activities in this area are:

• Extraction	Mondays to Saturdays	6.00am to 6.00pm
• Processing	Mondays to Saturdays	6.00am to 6.00pm
• Maintenance	Mondays to Fridays Saturdays	4.00pm to midnight 6.00am to 6.00pm
• Sales	Mondays to Saturdays	5.00am to midnight

A limit is imposed by this consent upon the volumes of quarry products to be hauled by road, to 500 000 tpa.

2.2 TRIAL HOURS OF OPERATION

On 14 December 2002, Boral submitted an application to Shellharbour City Council to modify Development Consent No's. 161/1986, 71/1993 and 186/1994 to provide a consistent set of extended operating hours. Modifications to this effect were approved on 13 March 2003 to allow the following operating hours for a nine month period, once a series of mitigation measures were in place.

• Extraction	Monday to Saturday	6.00am to 10.00pm
• Sales	Monday to Saturday	5.00am to midnight
• Maintenance	24 hour, 7 days a week	

Boral commenced the 9 month trial on 9 July 2003.

2.3 PRODUCT TRANSPORTATION

2.3.1 Introduction

Dunmore Quarry produces a range of products including various sizes of concrete and road aggregates, prepared road bases and fine crushed rock, rail ballast and gabion rock. These products are supplied to markets on the South Coast and Sydney metropolitan area, either to third party consumers or supplied directly to Boral concrete and asphalt manufacturing plants. A dual transport system of rail and truck transport is used by Boral for the delivery of all Dunmore Quarry products. It is noted that prior to mid 2000, all Dunmore Quarry products were transported by road, i.e. up to 1.1Mtpa between 1993 and 1999.

2.3.2 Rail Transportation

Currently two trains transporting 2100 tonnes (30 wagons) and 980 tonnes (14 wagons) respectively depart from the quarry daily Monday to Friday and one train departs the quarry on a Saturday. The trains deliver the quarry products principally to St Peters but more recently have commenced deliveries to Boral's quarry rail siding at Enfield. When annualised, the current level of product despatch by rail is between 700 000 tonnes and 900 000 tonnes.

2.3.3 Truck Transportation

Product despatches from Dunmore Quarry by road currently vary from approximately 25 000 tonnes to 48 000 tonnes per month. When annualised the current level of product despatch by road is between 300 000 tonnes and 500 000 tonnes.

Existing road transport routes are via Tabbita Road and then either north or south onto the Princes Highway. On average, 93% of trucks per day are northbound and 7% of trucks per day are southbound on the Princes Highway. Most product truck trips to the north travel along the Princes Highway to the F6 via Albion Park. Some 88% of all road transport currently travels up Mount Ousley with 5% of product being absorbed into Wollongong and Illawarra destinations. Product truck trips to the south (7%) travel along the Princes Highway to Kiama and beyond.

The current product truck levels vary from day to day based on market conditions namely minimum of 49 loads per weekday and maximum of 140 loads per weekday. On an average day, 62 loads are despatched from the quarry. Average loads are presently 28.7 tonnes.

Product truck movement generated by the quarry on an average day are 124 trucks (i.e. 62 in / 62 out). Based on the existing records of the quarry, the 85th percentile day generates 89 loads or 178 truck movements (i.e. 89 in / 89 out).

The current product truck fleet include B-doubles, semi-trailer tippers, rigid trucks (tippers) with and without dog trailers.

Recorded hourly movements during August 2003 are set out in **Table 2.1**

TABLE 2.1

Existing Product Truck Loads

Time	Product Truck Distribution	Loads per Hour	
		Average Day	**85th% Day**
6am – 7am	21%	13	19
7am – 8am	5%	3	4
8am – 9am	10%	6	9
9am – 10am	6.5%	4	6
10am – 11am	10%	6	9
11am – 12 noon	6.5%	4	6
12 noon – 1pm	4.5%	3	4
1pm – 2pm	9%	6	8
2pm – 3pm	8%	5	7
3pm – 4pm	10%	6	9
4pm – 5pm	4.5%	3	4
5pm – 6pm	3.5%	2	3
6pm – 7pm	1.5%	1	1
Total Daily	**100%**	**62**	**89**

Based on 280 days per year and average loads of 28.7 tonnes

Note: One load generates two truck movements.

2.3.4 Other Trips

In addition to the product transportation, other trips generated by the quarry include employee trips and trips by maintenance personnel. These are estimated as follows

- Employee trips 30 in / 30 out trips per day
- Visitor trips 10 in / 10 out trips per day
- Concrete Batching Plant 34 in / 34 out trips per day

3 THE PROPOSAL

3.1 PRODUCTION INCREASE

Boral proposes to increase the annual production of saleable products from the Dunmore Quarry to 2.2 million tonnes per annum by 2004 and thence to 2.5 million tonnes per annum by 2005. This increase in production would be achieved through greater utilisation of the existing approved hours of operation, mobile equipment upgrade and improved efficiencies arising from minor changes to equipment configuration.

The proposal envisages the following transport modal splits for product departures:

- 2.2 million tonnes per annum (2004)
  Train - 1.4 million tonnes pa
  Road - 0.8 million tonnes pa, i.e. 100 truck loads per average day @ 28.7 tonne loads.

- 2.5 million tonnes per annum (2005)
  Train - 1.5 million tonnes pa
  Road - 1.0 million tonnes pa, i.e. 123 trucks per average day @ 29 tonne loads.

3.2 HOURS OF OPERATION

Boral intends to seek a consistent set of operating hours for the following activities on the Project Site.

• Extraction and Processing	Monday to Saturday	6.00am – 10.00pm
• Product transfer to Stockpiles	Monday to Saturday	6.00am –midnight
• Sales	Monday to Saturday, 24 hours, 7 days a week Sunday 6.00am – 10.00pm	
• Maintenance	24 hours, 7 days a week	

3.3 ROAD TRANSPORTATION

There would be no change to the existing transportation route along the Princes Highway. It is anticipated the destination breakdown, i.e. trucks turning north or south onto the Princes Highway from Tabbita Road would remain approximately the same at 93% and 7% respectively.

It is anticipated there would be very little change to the vehicle types and truck / trailer configurations used to deliver the quarry products. Nevertheless, any changes would generally reflect gradual changes to the overall transport industry, such as a growing increase in the use of larger capacity trucks (eg. B-doubles) which in turn permits an increase in average loads and a general reduction in total vehicle movements.

Based on annual sales of 2.5 million tonnes, i.e. 1.0Mtpa by road, 280 operating days per year average loads of 29 tonnes, an average of approximately 123 loaded trucks would be

despatched daily generating 246 truck movements daily. On an average day, 3 570 tonnes of quarry products would be despatched by road. **Table 3.1** displays the predicted hourly truck movements to and from the quarry for the average day and 85th percentile day, based on the existing distribution of trucks leaving the quarry over a 4 week period in August 2003 and projections of increased movements beyond the existing 6.00am to 7.00pm period.

TABLE 3.1

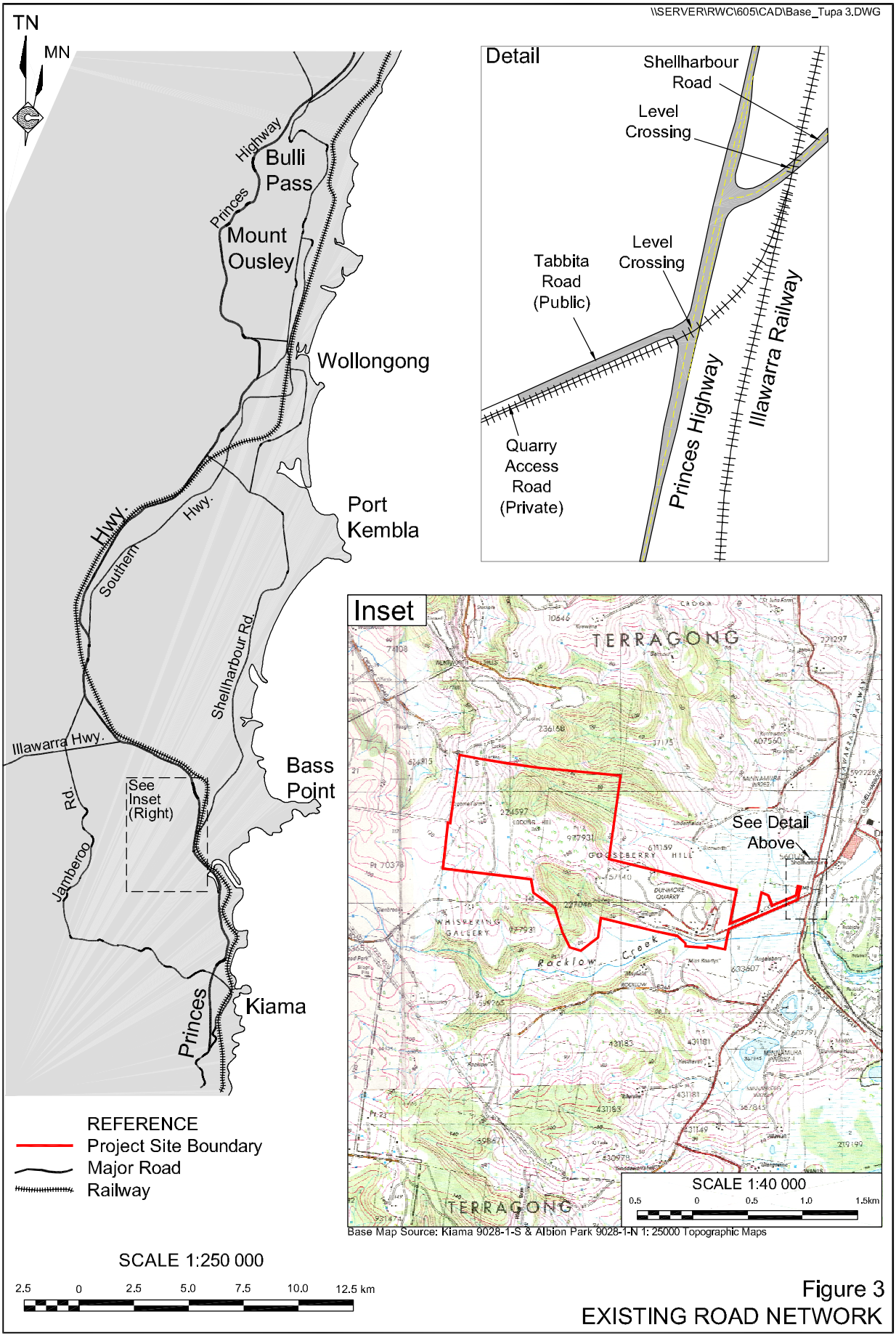
Proposed Product Loads

Time	Product Truck Distribution	Loads per Hour	
		Average Day	85th% Day
5am – 6am	10%	12	15
6am – 7am	19%	24	27
7am – 8am	5%	6	7
8am – 9am	7%	9	10
9am – 10am	5%	6	7
10am – 11am	8%	10	11
11am – 12 noon	5%	6	7
12 noon – 1pm	3%	4	4
1pm – 2pm	6%	7	9
2pm – 3pm	6%	7	9
3pm – 4pm	8%	10	11
4pm – 5pm	3%	4	4
5pm – 6pm	2.5%	3	4
6pm – 7pm	2.5%	3	4
7pm – 8pm	2%	3	4
8pm – 9pm	2%	2	3
9pm – 10pm	2%	2	3
10pm – 11pm	2%	2	3
11pm – 12 midnight	2%	2	2
Total Daily	**100%**	**123**	**144**
Based on 280 days per year and average loads of 28.7 tonnes			
Note: One load generates two truck movements.			

4 ROAD AND TRAFFIC CONDITIONS

4.1 EXISTING ROAD NETWORK

The Project Site is well located to the State Road Network (see **Figure 3**). Access to the Dunmore Quarry is from Tabbita Road. Tabbita Road forms a T junction intersection with the Princes Highway (SH1), 130 metres south of Shellharbour Road at Dunmore. Tabbita Road is essentially a private road that provides direct access to Dunmore Quarry and Boral's concrete batching plant. Tabbita Road is 10 metres wide near the Princes Highway but is of variable width. Tabbita Road has one sealed lane in each direction with a truck stop area near the intersection of Princes Highway. Entry into Boral's Dunmore Quarry is controlled at the site office and weighbridge facility and a large employee and visitor parking area is provided adjacent to the weighbridge.



Base Map Source: Kiama 9028-1-S & Albion Park 9028-1-N 1: 25000 Topographic Maps

Figure 3
EXISTING ROAD NETWORK

The Princes Highway is a State Highway and is an important regional / state / national road in the Illawarra and South Coast road network. The Princes Highway in the section north of Shellharbour Road to south of Tabbita Road is 4 lanes wide. The existing traffic management at this intersection with Tabbita Road includes:

- 2 lanes in northern approach of the Princes Highway, with the kerbside lane ending 100 metres south of Tabbita Road;
- 2 lanes in southern approach of the Princes Highway with the median lane feeding the right turn lane into Shellharbour Road.
- One approach and departure lane in Tabbita Road with Tabbita Road subject to Give Way control at the Princes Highway.

Sight distance at the Princes Highway / Tabbita Road intersection is good with sight distance to the north and south in excess of 300 metres. This meets the AUSTROAD requirements for safe intersection sight distance for the operating speed limit of 100km/h, which is 250 metres.

The quarry's rail siding runs along the southern side of Tabbita Road and crosses the Princes Highway at grade on the southern side of the Tabbita Road intersection. This spur line connects the Boral Hard Rock Quarry with the main southern rail line. Rail level crossing warning signs and flashing lights are provided at the level crossing.

Shellharbour Road forms a T junction intersection with the Princes Highway 130 metres north of Tabbita Road.

Other adjacent intersections include Swamp Road which forms a T junction intersection with the Princes Highway some 670 metres south of Tabbita Road.

Upgrading of the Princes Highway is currently being undertaken and planned by the RTA of NSW. The two main projects affecting the Princes Highway include the North Kiama Bypass and the Oak Flats to Dunmore upgrading works. As a result of these projects, to be completed by 2010, the Princes Highway in the vicinity of the Project Site will provide 2 lanes in each direction with a central median and upgraded intersections including a railway overpass and on and off ramps at Tabbita Road. The North Kiama Bypass is currently under construction and the Oak Flats to Dunmore project is to commence once the North Kiama Bypass is completed.

Shellharbour Road (MR 522) is a scenic route that follows the coast through Shellharbour to the southern suburbs of Wollongong. This road provides one lane in each direction, with localised widening at intersections and some overtaking lanes.

Swamp Road is a local road to the south of the Quarry. This narrow sealed roadway provides access to rural and rural residential properties located to the south of the Quarry.

4.2 EXISTING TRAFFIC VOLUMES

4.2.1 Daily Volumes

Princes Highway

Annual average daily traffic (AADT) volumes as recorded by the RTA for the Princes Highway some 0.8km north and south of Shellharbour Road (MR 522) indicates AADT volumes for years 1994 to 2000 as follows:

TABLE 4.1

Average Annual Daily Traffic (AADT)

Location	Year		
	1994	**1997**	**2000**
0.8km north of MR 522	18,992	19,995	20,928
0.8km south of MR 522	25,118	27,174	27,956

Source: RTA Traffic Volumes Data Southern Region, 2000

In addition, (advance) AADT traffic data for March 2003 as made available by the RTA, Southern Region, indicates current traffic volumes in the order of 20 000 vehicles per day (see **Table 4.2**).

TABLE 4.2

Average Annual Daily Traffic (March 2003)

Location	Monday – Friday	Saturday – Sunday
0.8km north of MR 522	20000 veh/day incl 10.5% heavy vehicles	20000 veh/day incl 3.5% heavy vehicles
0.8km south of MR 522	26000 veh/day incl 2.7% heavy vehicles	28500 veh/day incl 2.5% heavy vehicles

Tabbita Road

More recent volumes and classification counts were undertaken in Tabbita Road (west of the Princes Highway) by Corner Counters in September, 2003. See **Appendix 1**.

The recorded 5 day (weekday) average and 7 day average traffic volumes for the week 6 September to 12 September, 2003 are set out in **Table 4.3**.

TABLE 4.3

Tabbita Road Daily Volumes (September 2003)

Direction	Weekday Average veh/day	7 Day Average veh/day
Eastbound	207	164
Westbound	202	155
Total	**409 ***	**319 ***

* *includes all vehicles (Borals and others)*

Heavy vehicles, i.e. Austroad Classes 3-12, accounted for some 60% of total vehicles as averaged over the 7 day period with up to 28% of total vehicles being Class 9 truck combination, i.e. six axle articulated vehicle including truck and dog trailer.

During the survey period 6 September to 12 September 2003, Boral averaged 356 vehicles per day Monday – Friday comprising 216 heavy trucks i.e. 182 quarry trucks + 23 large and 11 light concrete trucks. No traffic entered or exited the site on Sunday and only 58 trucks accessed / departed the site on Saturday.

4.2.2 Peak Hour Volumes

Peak hour traffic volumes at the intersections of Princes Highway with Tabbita Road and Shellharbour Road were recorded by Corner Counters on Tuesday 9 September, 2003 during the hours of 6.30am to 9.30am and 2.30pm to 5.30pm.

Traffic volumes using these intersections during the AM (7.30am – 8.30am) and PM (3.30pm – 4.30pm) peak hours are shown on **Figure 2**. Reference to **Figure 2** reveals that at the Princes Highway / Tabbita Road intersection during the AM and PM peak hour:

- Northbound traffic on the Princes Highway is 1195 vph in the AM peak and 1022 vph in the PM peak;
- Southbound traffic on the Princes Highway is 825 vph in the AM peak and 1262 vph during the PM peak;
- The right turn into Tabbita Road from the Princes Highway numbers 3 up to 13 vehicles per hour (2.30pm – 3.30pm);
- The left turn out of Tabbita Road numbers up to 18 vehicles per hour with the right turn out up to 7 vehicles per hour;
- The left turn into Tabbita Road numbers up to 14 vehicles per hour.

The AM peak hour had the highest volumes of traffic turning into and out of Tabbita Road.

Tabbita Road provides access to the Boral Hard Rock Quarry and virtually all traffic that currently use Tabbita Road is generated by the Boral operations. During the 6 hours of the traffic count, the classification of the vehicles that used Tabbita road was as follows:

TABLE 4.4

Tabbita Road Vehicle Classification (September 2003)

	AM (6.30-9.30am)	**PM (2.30-5.30pm)**
Light vehicles (Austroads 1 and 2)	11%	40%
Heavy Vehicles (Austroads 3 – 12)	89%	60%

Existing traffic service levels on the Princes Highway north of Kiama Downs are poor due to slow travel times during peak (seasonal) demands, unsatisfactory accident records, capacity constraints and inadequate traffic controls / management at side junctions. The NSW RTA North Kiama Bypass route improvement proposal aims to address these issues.

4.3 FUTURE ROAD NETWORK

4.3.1 Overview

The Roads and Traffic Authority have confirmed that the proposed upgrading of the Princes Highway at Dunmore will be completed in two stages.

- Stage 1 which involves the construction of an interim arrangement which will be completed in late 2004;

- Stage 2 which is the completion of the ultimate proposed scheme for Princes Highway between Oak Flats and North Kiama by 2010.

A third stage (currently unscheduled) is the completion of the Oak Flats to Yallah link which will follow a route to the west of Albion Park (behind the airport) to rejoin the Princes Highway at Yallah south of the F6 Freeway.

Each of these stages are shown in **Figure 4**. Details of these arrangements are described below.

4.3.2 Interim Scheme (Stage 1)

The interim scheme for traffic using the Tabbita Road/Princes Highway intersection is shown in concept form in **Figure 5(a)**.

The major components of the interim scheme at Dunmore will include:

- A new elevated northbound carriageway on the Princes Highway with a bridge over Tabbita Road. An off-load ramp will be provided from the new carriageway to the existing Princes Highway to provide access to Tabbita Road and Shellharbour Road.

- A new on-load ramp will be provided from Tabbita Road for vehicles to travel north;

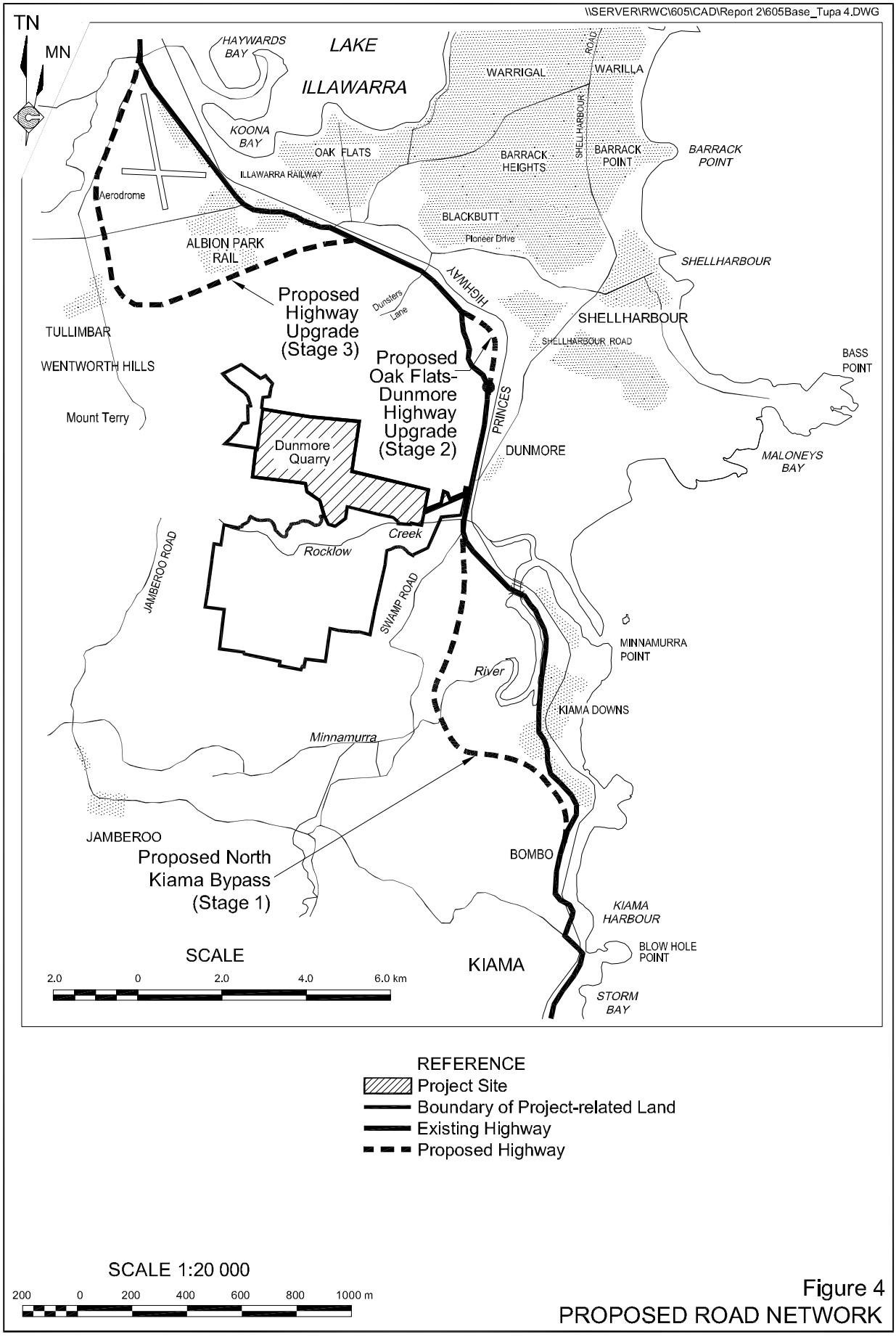


Figure 4
PROPOSED ROAD NETWORK

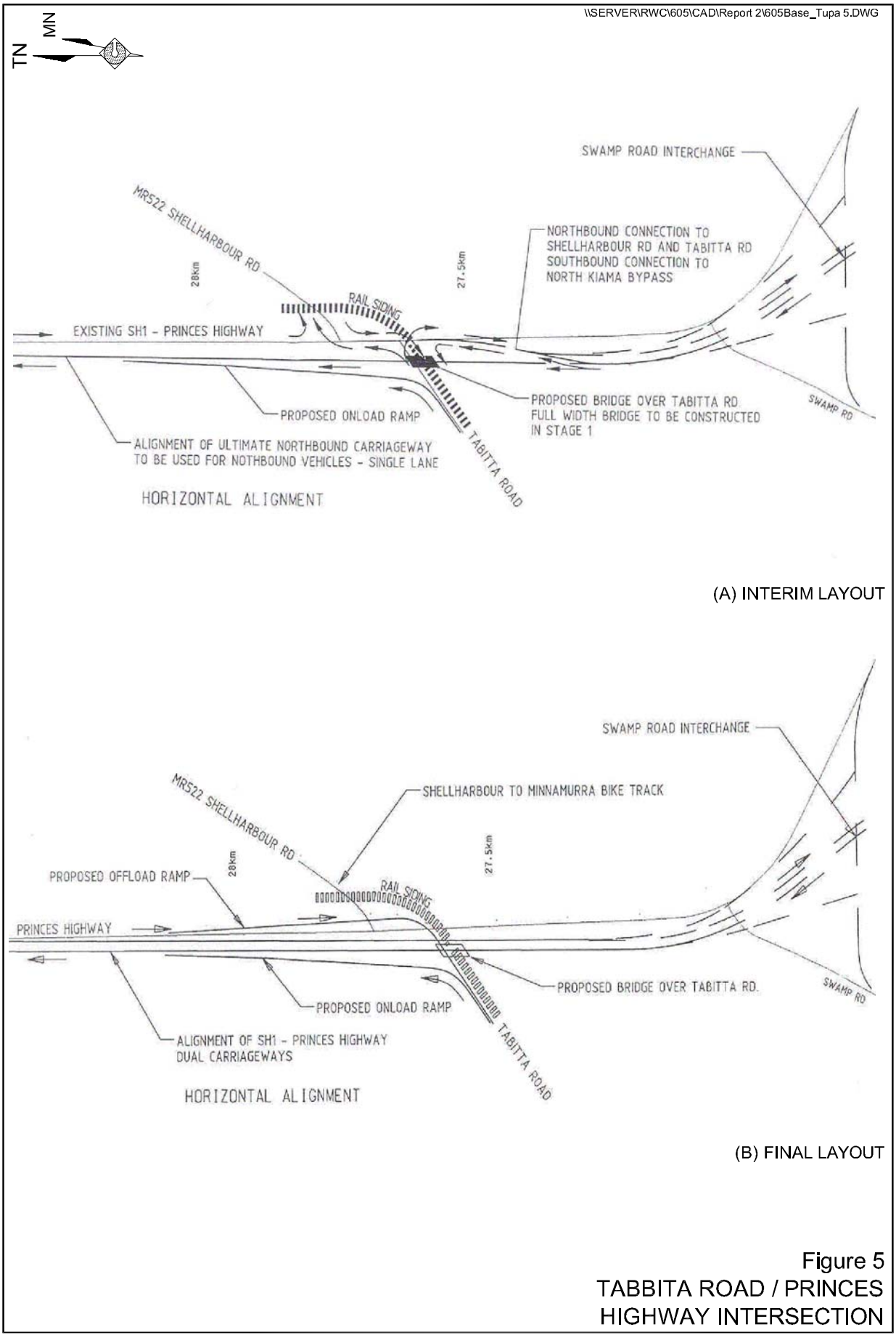


Figure 5
TABBITA ROAD / PRINCES HIGHWAY INTERSECTION

- The southbound carriageway will be the existing Princes Highway between north of Shellharbour Road to south of Tabbita Road where it connects to the new southbound carriageway.

- The Swamp Road interchange (on the Princes Highway) will be provided south of Tabbita Road.

- No right turn restrictions from Shellharbour Road to the Princes Highway will be introduced once the North Kiama Bypass is operational.

Access to and from Tabbita Road and Shellharbour Road under the interim arrangement will be as follows:

- The left turn from Tabbita Road to travel north will be via the new on-load ramp;

- The right turn out of Tabbita Road to travel south will be via the existing Princes Highway;

- Access between Shellharbour Road and Tabbita Road will be left / right turns using the existing Princes Highway.

- Vehicles exiting from Shellharbour Road to travel north will be required to turn left and travel south to the Swamp Road interchange to 'U' turn and then travel north.

- The left turn into Tabbita Road from the south will be via the existing Princes Highway. A new access ramp located on the eastern side of the northbound carriageway will be provided for access for northbound vehicles to Tabbita Road and Shellharbour Road.

The detailed design of the Interim Scheme was not finalised at the time of preparing this report. However, it is expected that the Interim Scheme will be designed by the Authority in accordance with its (the Authority) road design standards to suit the future traffic conditions at Dunmore (i.e. until 2010).

The Roads and Traffic Authority have advised that the Authority may amend the proposed interim concept to incorporate an additional ramp (lane) on the western side of northbound carriageway between the northbound carriageway and Tabbita Road. This ramp will be available for that traffic travelling to either Tabbita Road and Shellharbour Road that enters the Princes Highway (to travel north) from the Swamp Road interchange.

4.3.3 Ultimate Scheme (Stage 2)

The ultimate scheme will be completed by 2010 and is shown in concept form in **Figure 5(A)**. The main components of the ultimate scheme at the intersection of Tabbita Road and the Princes Highway will include the following:

- Elevated two (2) lane northbound and southbound carriageways in the Princes Highway at Tabbita Road.

- An on-load ramp from Tabbita Road to travel north on the Princes Highway (same as Interim Scheme).

- An off-load ramp from the southbound carriageway of the Princes Highway to access Tabbita Road. The road / ramp will pass under the elevated Princes Highway carriageways.

- A new elevated roundabout 2km north of Tabbita Road will be constructed to provide access to and from Shellharbour Road (**NB**. Shellharbour Road will be closed at Dunmore).

The Princes Highway and the on-load and off-load ramps will be designed by the Roads and Traffic Authority to a freeway / motorway standard (i.e. high standard) in accordance with the Authority's road design standards.

Access to and from Tabbita Road under the ultimate scheme will be as follows:

- The left turn out of Tabbita Road to travel north will be via the on load ramp.

- There will be no right turn out of Tabbita Road to travel south. Access will be via left turn (to the Princes Highway) and north to the new roundabout for a 'U' turn to head south.

- There will be no left turn from new highway into Tabbita Road (from the south). Access will be north via the new roundabout for a 'U' turn then south to Tabbita Road via the underpass.

4.3.4 Oak Flats to Yallah (Stage 3)

The Princes Highway, Oak Flats to Yallah proposals are currently unscheduled and specific details are not available, but advice from the RTA suggests the route will follow an alignment to the west of Albion Park to SH25 (Illawarra Highway) thence SH1 (Princes Highway) at Yallah and F6 Freeway. The route is likely to comprise a four lane dual carriageway road. The future road design would comply with relevant road design parameters.

4.3.5 Illawarra's Action for Transport

Illawarra's Action for Transport was launched in 1999 to address the specific transport issues in the Illawarra Coastal Plan – Wollongong, Shellharbour and Kiama Council areas.

As a living document, Illawarra's Action for Transport 2002-2006 is being updated by the Illawarra's Transport Taskforce (the T-Team). In accordance with the original Strategy, a major review is undertaken every three years. The review document presents draft revised actions for public comment.

This is an essential part of the review process, which includes extensive consultation with key government organisations and transport providers, followed by an independently facilitated community Stakeholder Workshop.

Under the current Action Strategies – Infrastructure Provisions: Significant transport infrastructure projects that are identified to facilitate regional economic development. Such projects will support the continuing and effective movement of both people and goods. Significant costs and timeframes are involved in the provision of major infrastructure items.

Key elements of the Action Strategies for Infrastructure Provisions include:

- Identify future key freight links and plan for improved freight movement on these links.
- Examine the feasibility of intermodal freight interchanges.
- Upgrade Princes Highway from Yallah to the Kiama Bypass (4 lane dual carriageway): Stage 1 North Kiama Bypass, Stage 2 Oak Flats-Dunmore, Stage 2 – Yallah – Oak Flats;
- Widen remaining sections of Mount Ousley Road to six lanes between the University and Picton Road. Also Harry Graham Drive to Picton Road northbound and Truck Inspection Bay to start of F6 southbound;
- Improve road accessibility between northern Wollongong and Sydney, including Northern Distributor and investigating Bulli Pass alternatives.

4.4 FUTURE TRAFFIC LEVELS

The future weekday peak hour traffic volumes at Dunmore have been estimated based on the traffic growth figures forecasted in the North Kiama Bypass EIS dated May 1996 prepared for the Roads and Traffic Authority by Connell Wagner.

The EIS predicted weekday traffic volumes between 1996 and 2011 at 5 year intervals on the Princes Highway between Bombo and Kiama. The traffic growth forecasted between 2001 and 2011 was 19% which represents a growth rate of approximately 2% per year averaged over this period. These traffic growth forecasts were based on a medium growth scenario.

Applying these growth figures to our September 2003 peak hour traffic count data for the years 2005 and 2011 provides the estimated traffic volumes at the Princes Highway / Tabbita Road intersection.

Tables 4.5 and 4.6 show the estimated AM peak hour and PM peak hour traffic volumes at the Princes Highway / Tabbita Road intersection, based on a 2% predicted increase by 2004 and 16% predicted increase by 2011 from 2003.

The right turn volume from the Princes Highway in Shellharbour Road is also shown for the year 2009, as this traffic will be using the existing northbound Princes Highway carriageway under the interim traffic scheme.

TABLE 4.5

Predicted Future AM Peak Hour Traffic Volumes

Movement	Traffic Volumes veh/hr		
	Existing 2003	2004	2011
Right turn into Shellharbour Road	450	459	-
Princes Highway northbound at Tabbita Road	1181	1205 *	1370 *
Princes Highway southbound at Tabbita Road	819	835	950 *
Right turn into Tabbita Road	6	6	7
Left turn into Tabbita Road	14	14	16
Right turn out of Tabbita Road	8	8	9
Left turn out of Tabbita Road	5	5	6

* on elevated road carriageway

TABLE 4.6

Predicted Future PM Peak Hour Traffic Volumes

Movement	Traffic Volumes veh/hr		
	Existing 2003	2004	2011
Right turn into Shellharbour Road	217	221	-
Princes Highway northbound at Tabbita Road	1018	1038*	1180 *
Princes Highway southbound at Tabbita Road	1262	1287	1464 *
Right turn into Tabbita Road	3	3	3
Left turn into Tabbita Road	4	4	5
Right turn out of Tabbita Road	0	0	0
Left turn out of Tabbita Road	6	6	7

* on elevated road carriageway

4.5 ADJOINING DEVELOPMENTS

Dunmore Sand and Soil Pty Ltd is proposing to develop Stages 2 and 3 of the Dunmore Lakes Sand Extraction Project (EIS in preparation). It is noted that a considerable proportion of the Stage 3 area occurs on land owned by Boral.

The development of Stages 2 and 3 would extend the availability of fine sand products, processed coarse sands and blended products in the Illawarra and Sydney Metropolitan area. Stage 2 will also incorporate Dunmore Sand and Soil's centre for the Illawarra region to be transferred from its existing Buckley Road Quarry where it will ultimately operate its mobile screening and raw material blending operations.

The Dunmore Lakes Stages 2 and 3 site is proposed with access from Tabbita Road, Dunmore.

In terms of the timing of the Stage 2 activities for the Dunmore Lakes proposal, the Company proposes to commence the dispatch of its product from the Stage 2 site after the interim roadworks for the Princes Highway proposed by the Roads and Traffic Authority are completed in late 2004.

By year 2009 there will be a total of 132 trucks to Dunmore Lakes proposal entering and leaving the Stage 2 Project site using the public road system on an average day, with the average hourly figure of 13 return truck movements per hour. These figures allow for reloading.

Table 4.7 below shows the origins and destinations of the incoming and outgoing trucks to Dunmore Lakes proposal using the Tabbita Road and the Princes Highway on an average day.

TABLE 4.7

Projected Average Dunmore Lakes Daily Truck Loads on Public Road Network in 2009

Origin / Destination	Truck Loads	%
North (Princes Highway)	76	58%
South (Princes Highway)	20	15%
Shellharbour Road	36	27%
Total (Tabbita Road)	**132**	**100%**

To assess the traffic impacts associated with the Dunmore Sand and Soil proposal in the AM and PM peak hours, an 85th percentile hourly figure of 15 return truck movements has been adopted for the number of incoming and outgoing trucks.

Assuming the return trip for each truck load, the traffic assignment for the AM and PM peak design hour is estimated to be:

- to and from the north - 9 truck movements per hour
- to and from the south - 2 truck movements per hour
- to and from Shellharbour Road - 4 truck movements per hour

Total Design Hour - 15 truck movements per hour

5 ASSESSMENT OF TRAFFIC IMPACTS OF PROPOSAL

5.1 PROPOSED TRAFFIC LEVELS

The proposal to increase sales and transportation by road from 0.5 million tonnes per annum existing to 1.0 million tonnes per annum will result in increased product truck movements arriving and departing the Boral quarry similar to that which occurred in the 1990's when the rail was not operating.

The proposal will (by Year 2006) result in future truck movements (two way) on the Princes Highway:

- 246 truck movements on an average day; and

- 288 truck movements on the 85th percentile day.

Boral expects the existing 93:7 split between the north and south destinations for product truck movements to be retained during the life of the proposal.

Based on the hourly truck distribution shown in **Table 3.1**, an additional 2-3 truck movements per hour would access the quarry on an average day and 7-8 truck movements per hour on the 85th percentile day.

Table 5.1 summarises the daily and maximum hourly increases in product load despatches using the road network due to the proposal.

TABLE 5.1

Daily Product Load Despatches - 2005

	Tabbita Rd			Princes Highway north of Tabbita Rd			Princes Highway south of Tabbita Rd		
	Existing	Proposal	Increase	Existing	Proposal	Increase	Existing	Proposal	Increase
Average Day	62	123	**61**	58	114	**+56**	4	9	**+5**
85th% Day	89	144	**+55**	82	134	**+52**	7	10	**+3**
Maximum Hour	13	24	**11**	12	22	**10**	1	2	**+1**
Maximum Hour 85th percentile Day	19	27	**8**	18	25	**+7**	1	2	**+1**

NB. Excludes additional traffic from Dunmore Sand and Soil

Note: One load generates two truck movements.

The increase in employee and/or maintenance vehicle trips due to the proposal is likely to be approximately 10 additional trips in/out per day.

A review of **Table 5.1** suggests that the increase in product trucks loads will be:

- 61 and 55 truck loads per day and up to 11 truck loads in the peak hour in Tabbita Road on the average and 85th percentile days;
- 56 and 52 truck loads per day and up to 10 truck loads in the peak hour in the Princes Highway north of Tabbita Road; and
- up to 5 truck loads per day and 1 additional truck load in the peak hour in Princes Highway south of Tabbita Road.

The total employee/visitor and/or maintenance vehicle trips due to the proposal would be in the order of 50 trips in / out per day, i.e. a total of 100 light vehicle movements.

Table 5.2 projects the cumulative additional traffic flows on Tabbita Road and Princes Highway due to the Boral proposal and Dunmore Sand and Soil Proposal.

TABLE 5.2

Combined Product Load Despatches due to the Boral and Dunmore Sand and Soil Proposals - 2009

	Tabbita Rd			Princes Highway north of Tabbita Rd			Princes Highway south of Tabbita Rd		
	Dunmore *	Boral Quarry	Total Traffic	Dunmore *	Boral Quarry	Total Traffic	Dunmore*	Boral Quarry	Total Traffic
Average Day	66	123	**189**	56	114	**170**	10	9	**19**
85th% Day	76	144	**220**	65	134	**199**	11	10	**21**
Maximum Hour	13	24	**37**	11	22	**33**	2	2	**4**
Maximum Hour 85th% Day	15	27	**42**	13	25	**38**	2	2	**4**

** Dunmore Sand and Soil*

5.2 ASSESSMENT OF IMPACT ASSOCIATED WITH INCREASED TRAFFIC LEVELS

The increase in vehicle movements due to the proposal is small in real terms and no change is expected to the traffic conditions on the road network due to the proposal in the shorter term. In the longer term, i.e. by 2010, following the completion of the RTA route improvements for the Princes Highway, traffic conditions and associated service levels in this section of the Highway through Dunmore should significantly improve.

As noted in Section 4.0 of this report, the principal road network around the Dunmore Quarry is to be progressively upgraded by the RTA 2004 to 2010 to a divided 4 lane standard with a high level of traffic management provided along the road network.

The existing channelisation at the intersection of Princes Highway / Tabbita Road provides a safe intersection design which easily caters for the vehicle movements that use the intersection. Safety and service levels at this intersection will improve further with the RTA's partial grade separation proposals.

The increase of up to 11 additional truck loads per hour by 2005 will not affect the capacity of the intersection and/or road safety at the intersection. The intersection will continue to operate at an acceptable level of service operation which indicates good traffic conditions.

The increase of 10 truck loads per hour using Princes highway north of Tabbita Road will have no measurable impact on road capacity or traffic conditions. This section of the Princes Highway currently carries between 2100 and 2400 vehicles per hour (Monday-Friday), 10.5% of which are heavy vehicles.

Similarly the increase of 1 additional truck movement per hour using the Princes Highway, south of Tabbita Road will have no measurable impact. An additional truck movement per hour will not alter the existing traffic conditions.

As noted previously, traffic conditions in the Princes Highway adjacent Tabbita Road are satisfactory with good sight distance, moderate vehicle speeds and regular gaps in the Princes Highway traffic flow which allows vehicles arriving and departing the Quarry to safely turn into and out of the Princes Highway. In particular, these traffic conditions are likely to improve further with the RTA's proposal and grade separation.

On the wider road network for trips to either Sydney or Wollongong, the additional 11 truck movements per hour associated with the proposal will have no noticeable impact on the road network and are comparative to those truck levels realised up to until 1999 when all product was transported by road.

5.3 ISSUES RAISED BY RTA

5.3.1 Pavement Life

Increased product transportation by road would impact on pavement condition and life. Boral ensures that all trucks leave Dunmore Quarry with legal loads to ensure there is no inappropriate loadings on the road pavement. The maintenance of the road pavement is the responsibility of the RTA. Funding for maintenance is drawn from a range of sources including the registration fees for trucks ($4000 to $8000 per truck depending on axle loadings) and diesel levies paid by trucking companies through their expenditure on fuel.

It is concluded that transportation of quarry products from Dunmore Quarry would have a comparatively negligible impact on the operation of the surrounding road network and particularly upon the cumulative impact of the additional heavy vehicle movements in the long run on Mount Ousley. In reality, the proposed increase in truck traffic levels as a result of the increase in production would be comparable to the levels generated by Dunmore and Kiama Quarries prior to the recommencement of rail transportation in late 1999. The RTA has acknowledged the importance of the section of the Princes Highway between North Kiama and Dunmore and has recently commenced improvement works which would readily accommodate an additional 11 trucks per hour (by 2005) from the proposed development.

5.3.2 Princes Highway Construction / Upgrade

The RTA's primary concern is the timing and impact of the proposal in relation to the construction of the North Kiama Bypass and the Oak Flats to Dunmore Deviation and the impact that transportation of additional product by road will have on the safety and efficiency of the Princes Highway.

Completion of the North Kiama Bypass is currently expected at the end of 2005. It is not anticipated that construction of the Oak Flats to Dunmore Deviation will commence before North Kiama Bypass has opened to traffic. It is expected that the completion of the Bypass will significantly improve safety and efficiency of turning movements in and out of Tabbita Road, especially to and from the north and into Shellharbour Road.

Significant increase in existing road transport movements to / from the site are not envisaged prior to the completion of the North Kiama Bypass.

5.3.3 Princes Highway - Mt Ousley

There has been considerable growth in total traffic volumes using the State road network in the Wollongong / Illawarra Regions over the last 20 years including the Princes Highway at Mt Ousley.

It is expected that future traffic volumes on the road network in the Illawarra Region will continue to increase along with population and economic growth of the Illawarra and South Coast Regions.

While the number of trucks travelling between the Sydney Region and Dunmore via Mt Ousley are a small proportion of the total traffic using the road network there are advantages in reducing the potential friction between these vehicles and other road users, particularly in busier hours on these roads.

Since 1984 there have been significant improvements made to the roads that form the haulage routes. A detailed review and assessment based on road safety audit principles of the roads that form the haulage routes between Appin and Port Kembla Coal Terminal (including Mt Ousley Road and the F6) has found that the roads are constructed to a good standard with a high level of traffic facilities including delineation, guidance, signposting, hazard protection and traffic management implemented on each road.

A recent detailed review of road safety on Mt Ousley has found that both the total accident rate and the injury accident rate has reduced significantly since 1986, as measured against the traffic volumes using this road. An assessment of the accidents that have occurred on the route between 1996 and 2000 indicates that there is no identifiable treatment for the majority of these accidents and the level of accidents and the accident rate does not indicate that the route has an adverse road safety problem.

Traffic monitoring of traffic volumes and vehicle classification during November and December 2002 period did not show an appreciable change in the number of heavy vehicles using the road network as compared to other periods, or a significant change in the number of heavy vehicles using the road network at night.

The likely impacts of increased road transportation of Dunmore Quarry products on the Princes Highway, Mt Ousley is projected to be in the order of an additional 52 trucks per 85th percentile day by 2005. With an assumed level of 18.5% of heavy vehicles on the Princes Highway at Mount Ousley, the average number of trucks per day would be 4397 (18.5% of 23767 AADT). It is estimated that an 85th percentile day will see approximately 134 truck movements from the Boral Dunmore Quarry along Mount Ousley Road, comprising approximately 4% of the total heavy vehicle traffic.

5.4 SUMMARY

This assessment has found that the increase in traffic including product truck movements due to the proposal is small in real terms and no change is expected to the traffic conditions on the broader road network.

The existing road network and traffic management adjacent the quarry are constructed to an acceptable standard. The existing traffic conditions on the arterial road network north and south of the site are expected to improve by end of 2004 with the proposal in place.

APPENDIX 1

(No. of pages excluding this page = 2)

Criteria for Interpreting Intanal Analysis

CRITERIA FOR INTERPRETING RESULTS OF INTANAL ANALYSIS

I. Level of Service (LS)

LS	Traffic Signals and Roundabouts	Average Vehicle Delay in Seconds
A	Good	0-14
B	Good with minimal delays and spare capacity	15-28
C	Satisfactory with spare capacity	29-42
D	Satisfactory but operating near capacity	43-56
E	At capacity and incidents will cause excessive delays	57-60
F	Unsatisfactory and requires additional capacity	>70

LS	Give Way and Stop Signs	Highest Movement Delay (in Seconds)
A	Good	0-14
B	Acceptable delays and spare capacity	15-28
C	Satisfactory but accident study required	29-42
D	Near capacity and accident study required	43-56
E	At capacity and requires other Control Delays Mode	57-60
F	Unsatisfactory and requires other Control Mode	>70

2. Average Vehicle Delay (AVD)

The AVD provides a measure of the operational performance of an intersection. For intersections controlled by traffic signals or a roundabout, satisfactory intersection performance is achieved where:

- the TOTAL average delay of the intersection is less than 70 secs; and
- no individual movement through the intersection experiences a delay greater than 120 secs.

For intersections controlled by GIVE WAY or STOP signs, satisfactory intersection performance is achieved where no individual movement (Highest Movement Delay) through the intersection experiences a delay greater than 40 secs.

3. Highest Movement Delay (HMD)

Highest Movement Delay is the Highest average delay for any movement at an intersection. It is useful for determining the delay for minor movements at intersections controlled by Stop/Give Way signs or roundabouts.

4. Total Delay

Total Delay is the intersections total delay expressed in vehicle hours per hour, ie. the sum of all delay which occurs at an intersection, during the modelled period, which in most cases is a one-hour of the modelled peak.

Some caution is required in interpreting Total Delay as Total Delay will always increase with the traffic volumes.

Also, for intersections controlled by STOP or GIVE WAY control, only the minor movements such as the turning movements from the major road and the movements out of the minor road face delays. For this reason total delay for intersections controlled by STOP or GIVE WAY signs tend to be lower than for intersections controlled by traffic signals. In this situation Level of Service and Degree of Saturation are better performance measures, particularly when assessing if another form of control is required.

Total Delay should be used to assist in comparing the likely improvements to be gained in terms of overall delay for geometric improvements, control and operation for roundabouts and traffic signals.

Therefore its main use should be for comparing different/competing design improvements for the same intersection which is controlled by either roundabouts or traffic signals.

5 Degree of Saturation (DS)

The DS is another measure of the operational performance of individual intersections. DS is calculated for all movements at the intersection. The DS displayed is usually the highest DS for any single movement at the intersection during the period modelled.

For intersections controlled by traffic signals[1] both queue length and delay increase rapidly as DS approaches 1, and it is usual to attempt to keep DS to less than 0.9. Values of DS in the order of 0.7 generally represent satisfactory intersection operation. When DS exceeds 0.9 queues can be anticipated.

At lower cycle lengths a DS around 0.9 can be acceptable as are small increases in DS between different designs.

For intersections controlled by a roundabout or GIVE WAY or STOP signs, satisfactory intersection operation is indicated by a DS of 0.8 or less.

6. Average Vehicle Cost or Total $ Cost per Vehicle (AVC)

This is calculated as Total Cost / Total Vehicles using the intersection and represents the Average Vehicle Cost. It is useful in comparing different design scenarios which may have increased traffic volumes for some scenarios, as it calculates the average cost per vehicle.

It should be used for examining the operation of traffic signal and roundabouts.

There is no threshold for determining what is an acceptable average cost, however this cost increases significantly as an intersection becomes over saturated. i.e. level of service E & F.

[1] The values of DS for intersections under traffic signal control are only valid for cycle length of 120 seconds

Boral Resources (NSW) Pty Limited

ABN: 51 000 756 507

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 4 - FLORA & FAUNA ASSESSMENT

Prepared by

Kevin Mills & Associates

November, 2003

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 4 - FLORA & FAUNA ASSESSMENT

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EXECUTIVE SUMMARY

This report forms of the flora and fauna component of an Environmental Impact Statement (EIS) being prepared by R. W. Corkery & Co on behalf of Boral Resources (NSW) Pty limited, who are proposing an increase in production at their hard rock quarry at Dunmore, in the City of Shellharbour.

The study brief is to carry out field investigations on the quarry site, identify, describe and assess the flora and fauna present there and to asses the potential impact of the proposed increase in production on flora and fauna, particularly those matters listed under the NSW *Threatened Species Conservation Act 1995*.

The report provides a description of the flora and fauna of the Project Site, incorporating the results of previous studies where relevant. A vegetation map and lists of the flora and fauna recorded in the area, including native and exotic species, are provided.

The Project Site is divided into two Sections, an eastern Section, where Boral requires development consent for an increase in production, and a western section, where the company already has development consent to carry out expanded quarrying operations.

An assessment has been undertaken under the provisions of the NSW *Threatened Species Conservation Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

The conclusion reached under the "eight-part test", as provided for under the TSC Act, for the eastern Section is that an increase in production would not significantly impact on any listed species, communities or populations. One endangered plant, the shrub *Zieria granulata*, occurs in the eastern Section, and two listed fauna species, the Grey-headed Flying-fox and the Powerful Owl, may occur there from time to time. There is also a small stand of the endangered community known as *Melaleuca armillaris* Tall Shrubland in the eastern Section. None of these species and community would be affected by the proposed development.

The above threatened species and community also occur, or are likely to occur in the case of the fauna, in the western Section. The expansion of quarrying in this Section will result in the removal of about 5.4 hectares of the above threatened community. The plants of *Zieria granulata* will not be affected.

It is concluded that the proposed increase in production will not have a significant impact on any species or communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. One vulnerable species, the Grey-headed Flying-fox, probably visits the trees on the site in summer, while some listed migratory species may occasional visit the site.

Recommendations are made in the report to better control weeds on the site, reinforce the plantings in the wildlife corridor to the west of the Project Site and to include the endangered species *Zieria granulata* and the shrub *Melaleuca armillaris* in planting programs.

1 INTRODUCTION

1.1 BACKGROUND

Boral Resources (NSW) Pty Limited owns and operates a hard rock quarry in the southern part of the City of Shellharbour, known as the Dunmore Quarry (see **Figure 1**). The Dunmore Quarry is located on Lot 1, DP 213575; Lots 3 and 4, DP 1030504; Lot 4, DP 227046; Lot 1, DP 1002951, and Lots 1 and 2, DP 224597 (see **Figure 2**). These lots are collectively referred to as the Project Site. The approved extraction area is also identified on **Figure 2**.

Boral is seeking development consent that will rationalise the existing development consents and existing use rights provisions to allow a progressive increase in production from about 1.2 Mtpa to 2.5 Mtpa. This increase would take about 2 years to achieve.

Boral requires a development consent to enable the increased production to be achieved. Development consent will be sought from the Minister for Infrastructure, Planning and Natural Resources as the proposed development is classified as a State significant development. The Development Application will be accompanied by a comprehensive Environmental Impact Statement and this report provides the flora and fauna input to the EIS.

1.2 STUDY BRIEF

The following tasks have been identified for the flora and fauna component of the documentation for the EIS.

(i) Conduct a literature review of previous flora and fauna surveys and studies carried out on the Study Area and its surrounds.

(ii) Undertake a field investigation to describe the existing flora and fauna populations.

(iii) Compile a draft report for the flora and fauna investigation covering the following:

- A description of the existing flora and fauna environment within the Study Area and in a regional context including any species/habitats of conservation value;
- Any constraints flora and fauna may pose for the proposal;
- The impact of the proposed extraction activities on the flora and fauna communities, including extent of impact and timeframe. This impact assessment will need to meet the requirements of both the *Threatened Species Conservation Act, 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*;
- Confirmation of the appropriateness of current mitigation measures, and
- Any other matter(s) identified by the selected consultant and approved by the Applicant.

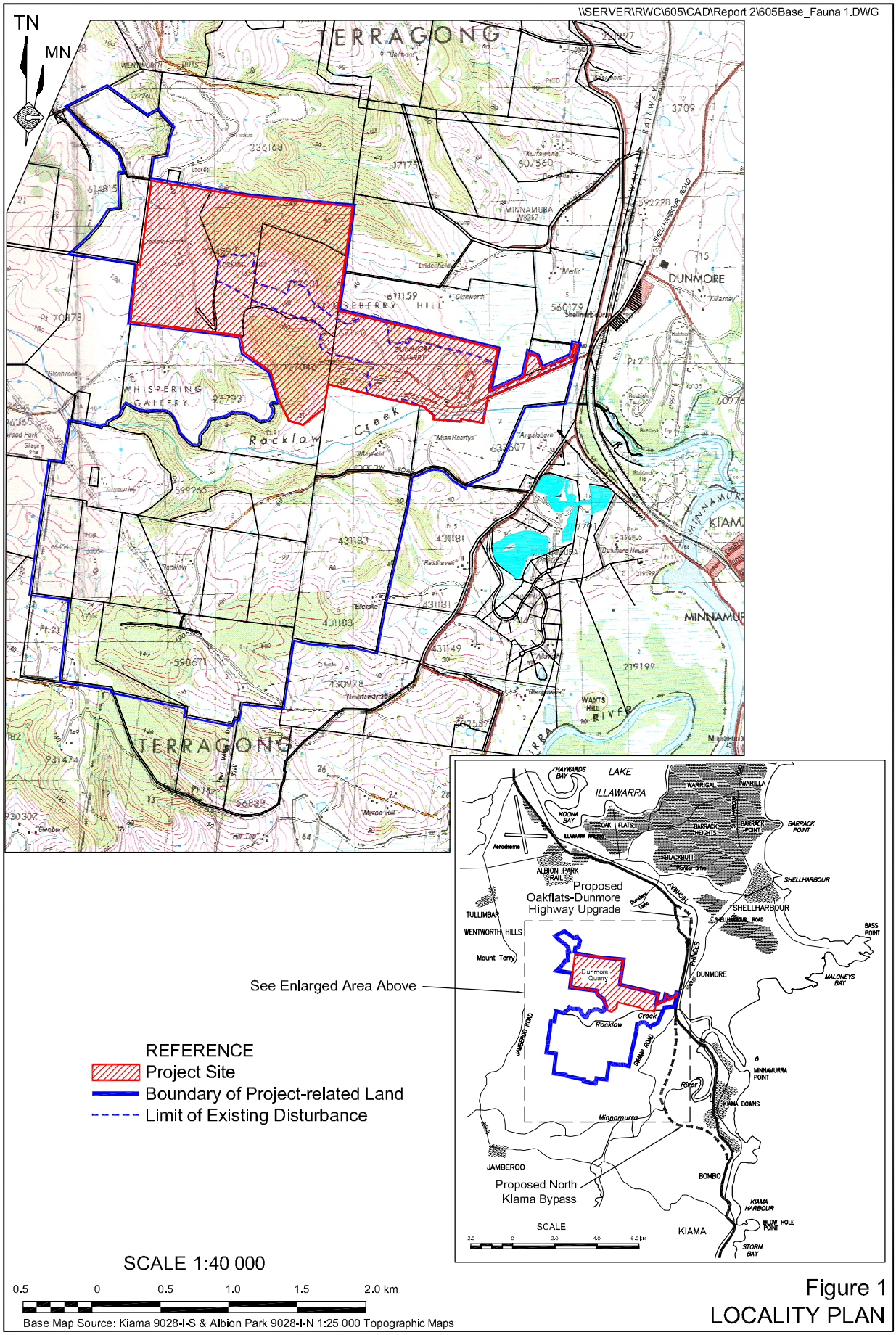
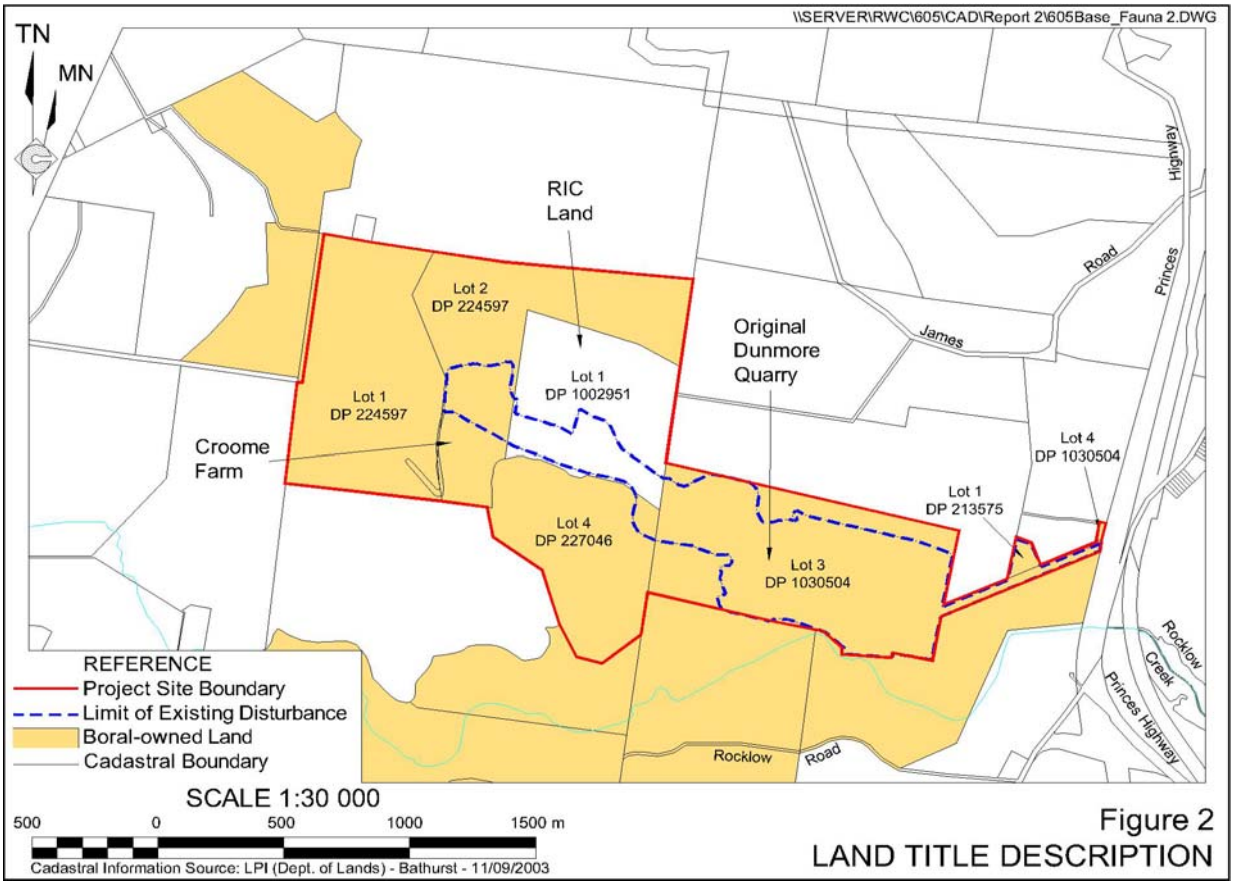


Figure 1
LOCALITY PLAN



(iv) The requirements provided by the Director-General for the Department of Infrastructure, Planning and Natural Resources should also be addressed particularly the presence of *Zieria granulata*.

(v) Review all relevant sections in Draft EIS relating to flora and fauna.

(vi) Finalise the flora and fauna report as the EIS is also being finalised.

2 THE PROJECT SITE

2.1 LOCATION AND SETTING

The Project Site is known as the Boral Hard Rock Quarry, Dunmore. The quarry is located in the City of Shellharbour, about 800 metres to the west of the Princes Highway along Tabbita Road at Dunmore, near the southern edge of the city (see **Figure 1**). The quarry is located on the eastern edge of the ridges that make up the Dunmore Hills; specifically, the ridge where the quarry is located is known as Gooseberry Hill.

The above hills are part of an extensive area of volcanic rock known as the Gerringong Volcanics. These are of Permian age and composed of latites and volcanic sandstone. The Project Site itself extends for about two kilometres along an east-west ridge about 100 metres above the adjacent floodplains to the east. The existing quarry is extensive and has been operating since 1921. The remainder of the Project Site around the quarry is partly cleared grazing land, and partly supports natural vegetation, principally rainforest and paperbark shrubland.

2.2 PREVIOUS STUDIES

There have been several previous investigations of flora and fauna that have included the Project Site. These have been in association with previous development applications or have been broader studies that have incorporated the Boral land. The main studies are listed below; relevant information has been incorporated into this report.

Kevin Mills & Associates Pty Limited (1996). Dunmore Quarry, Croome Farm Extraction Area, Vegetation Management Plan, City of Shellharbour. Prepared for Boral Construction Materials, Boral Resources (NSW) Pty Ltd, Shellharbour, February.

Kevin Mills & Associates Pty Limited (1995). Supplementary Report, Dunmore Quarry, Croome Farm Extension, Municipality of Shellharbour. Prepared for Sinclair Knight Merz, June.

Sinclair Knight Merz (1995). Support Document to the Dunmore Quarry – Proposed Croome Farm Extension EIS, July.

BMG Resources Limited (1986). Environmental Impact Statement for the Further Development of Dunmore Quarry.

Antcliff Ecological Surveys (AES) (1992). Fauna Survey, Proposed Extension of Dunmore Quarry, September.

Sinclair Knight Merz (1994). Dunmore Quarry – Proposed Croome Farm Extension, Environmental Impact Statement, June.

Chafer, C.J., Brandis, C.C.P. & Wright, D. (1999). A Handbook of Birds found in the Illawarra, Shoalhaven and Adjacent Tablelands.

Kevin Mills & Associates Pty Limited (2001). The Natural Vegetation in the City of Shellharbour. Prepared for Shellharbour City Council, September.

Kevin Mills & Associates Pty Limited (2000). Nature Conservation Study, Rural Lands Study Area, City of Shellharbour. Prepared for Shellharbour City Council, June.

3 FLORA

3.1 FLORA SURVEY METHOD

3.1.1 Site Reference Material

A vegetation survey was undertaken on the Project Site on 16 and 21 October 2003. The extent of the Project Site was determined from a marked up colour aerial photograph and various site plans provided by R. W. Corkery & Co., and the Albion Park 1:25,000 topographic map produced by the Central Mapping Authority of New South Wales. The site plans showed contours, creeks and drainage lines, the extent of the quarry, etc.

3.1.2 Objectives of the Vegetation Survey

The principal objectives of the vegetation survey were;

(i) to classify and describe the vegetation communities;

(ii) to prepare a map showing their distribution on the site;

(iii) to record as many as possible of the plant species present; and

(iv) to search for threatened plants.

3.1.3 Techniques

The vegetation communities were classified on the basis of their structure and the name(s) of the dominant species in the tallest stratum. Each community was also given an identification code, selected from a list of codes devised by the consultant for Council to standardise the classification of the vegetation in the Shellharbour local government area (Kevin Mills & Associates 2001).

The approximate boundaries of the various communities were marked onto a copy of the site plan. A vegetation map was prepared later, with the assistance of an aerial photograph.

The characteristic species in each community were recorded, and notes were made on the structure and condition of the vegetation. A general description of each community was then prepared.

All plant species observed during the survey were recorded, and a targeted survey for threatened plant species was undertaken. The survey was fairly thorough, so most of the native plant species present would have been detected; however, additional species can almost always be found during longer surveys and in different seasons.

3.1.4 Nomenclature

The plant species names in this report are the current names published by the National Herbarium of New South Wales in the *Flora of New South Wales* (Harden 1990-1993) and in the supplement to Volume 1 (Harden & Murray 2000). Most of the common names are from the *Flora of New South Wales* (op. cit.) and *Australian Plant Genera* by Baines (1981).

3.2 VEGETATION COMMUNITIES

The vegetation on the Project Site is described below, separately for each of the two study areas.

3.2.1 Eastern Section (Lot 3 DP 1030504)

Most of the natural vegetation within the eastern section of the Project Site has been removed many years ago where much of the area is now bare ground, being within the quarry or part of the road system (see **Figure 3**). The vegetation in the area today is mainly Lantana thicket and planted native forest trees, with scattered remnant rainforest trees and other native and weed species regrowth.

The patches of vegetation around the quarry are largely composed of Lantana *Lantana camara*, which in many places is growing very thickly. Amongst the Lantana there are numerous other weeds and also some native species, particularly creepers and scattered hardy rainforest trees. The common weed species include Castor Oil Plant *Ricinus communis,* Cape Ivy *Delairea odorata,* White Passionfruit *Passiflora subpeltata,* Tobacco Bush *Solanum mauritianum,* Morning Glory *Ipomoea indica* and Crofton Weed *Ageratina adenophora.* The hardy rainforest plants present in the area include the trees Red Ash *Alphitonia excelsa*, Sweet Pittosporum *Pittosporum umdulatum*, and the creepers/vines Wonga Vine *Pandorea pandorana* and Slender Grape *Cayratia clematidea*, as well as Black Wattle *Acacia mearnsii* and Maiden's Wattle *Acacia meadeni.*

On the south-facing slope in the south-western corner of the eastern Section, there is a very dense and extensive stand of Lantana *Lantana camara*, with many other weeds, as listed above. Also in this area there are small stands of subtropical rainforest trees, and regenerating smaller rainforest plants are quite common. Those native species that are most prominent include Red Ash *Alphitonia excelsa*, Native Hibiscus *Hibiscus heterophyllus*, Sweet Pittosporum *Pittosporum umdulatum* and Brush Kurrajong *Commersonia fraseri*. Old specimens of Cabbage Plan *Livistona australis* and Moreton Bay Fig *Ficus macophylla* probably date from the original rainforest that covered this slope.

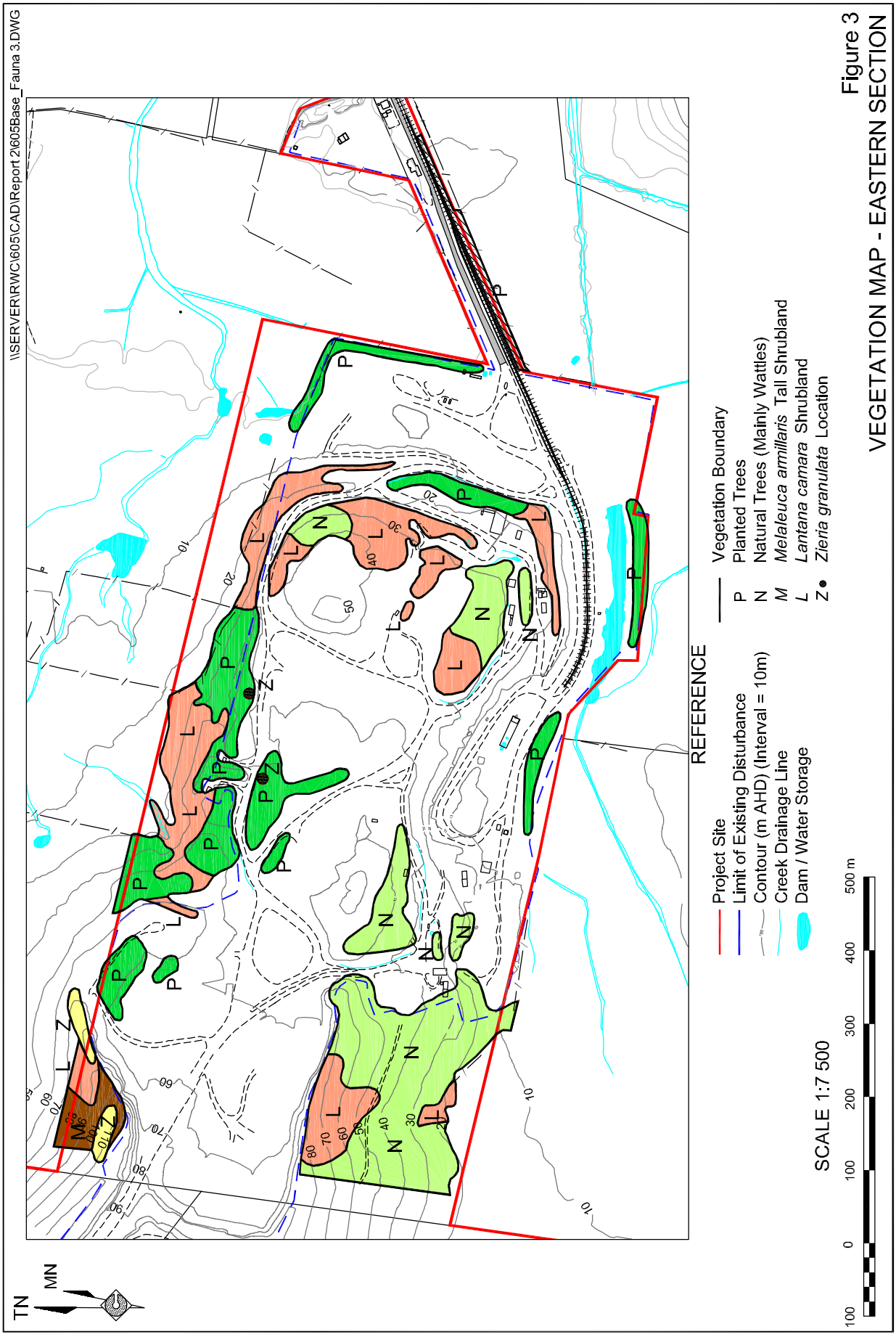
In the far north-western corner of the eastern section, on the higher part of the ridge that remains largely undisturbed, there is a stand of *Melaleuca armillaris* Tall Shrubland. This is contiguous with stands extending to the west along the outside edge of the western section; see **Figure 3**.

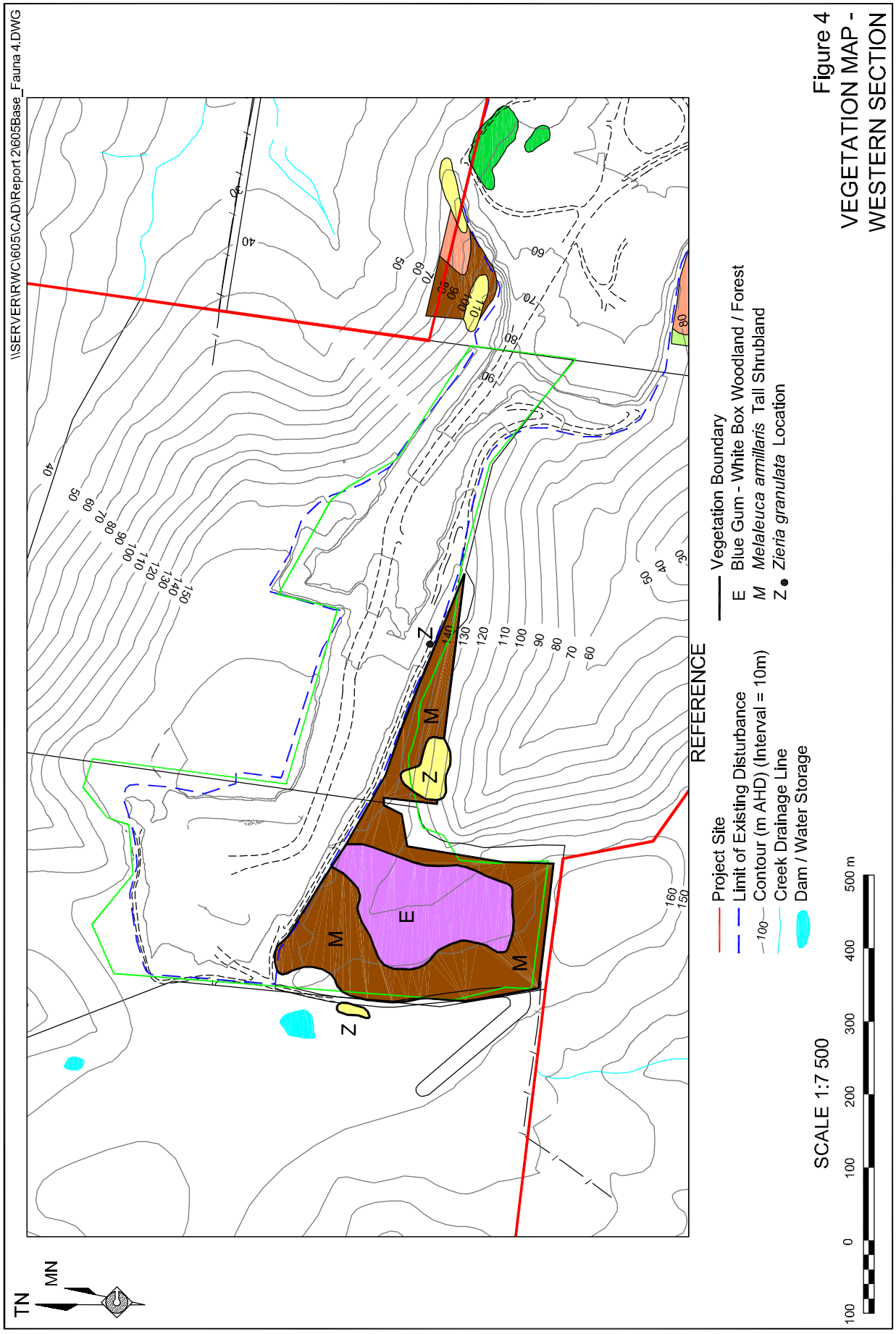
The *Melaleuca armillaris* Tall Shrubland contains several characteristic native species, as well as various introduced plants, the most common being Lantana *Lantana camara*. The natives in this area include Blunt Spurge *Phyllanthus gasstroemii*, Mulga Fern *Cheilanthes sieberi*, Winged Broom-pea *Jacksonia scoparia*, Brush Kurrajong Commersonia fraseri, Giant Hop-bush *Dodonaea viscosa*, Love-grass *Eragrostis* sp. and Illawarra Zeiria *Zeiria granulata*. At least some of the *Zeiria granulata* plants appear to have been planted in this area; see discussion below.

3.2.2 Western Section (1994 approved extraction area)

The vegetation within the western Section of the Project Site is mainly natural ridge top and gully vegetation and is found along the southern part of the area (see **Figure 4**).

Two distinct natural communities can be identified within this area; *Melaleuca armillaris* Tall Shrubland and Blue Gum – White Box Woodland/Forest. The distribution of these vegetation communities is shown on **Figure 4**. The only other vegetation in the area, apart from thickets of Lantana in and around the edges of the above two communities, is exotic grassland dominated by Kikuyu Grass *Pennisetum clandestinum*.


\\SERVER\RWC\605\CAD\Report 2\605Base_Fauna 3.DWG
Figure 3
VEGETATION MAP - EASTERN SECTION
REFERENCE
Project Site
Limit of Existing Disturbance
Contour (m AHD) (Interval = 10m)
Creek Drainage Line
Dam / Water Storage
Vegetation Boundary
P Planted Trees
N Natural Trees (Mainly Wattles)
M Melaleuca armillaris Tall Shrubland
L Lantana camara Shrubland
Z Zieria granulata Location
SCALE 1:7 500
100 0 100 200 300 400 500 m
TN MN


\\SERVER\RWC\605\CAD\Report 2\605Base_Fauna 4.DWG
Figure 4
VEGETATION MAP - WESTERN SECTION
REFERENCE
Vegetation Boundary
E Blue Gum - White Box Woodland / Forest
M Melaleuca armillaris Tall Shrubland
Z Zieria granulata Location
Project Site
Limit of Existing Disturbance
Contour (m AHD) (Interval = 10m)
Creek Drainage Line
Dam / Water Storage
SCALE 1:7 500
0 100 200 300 400 500 m
TN
MN

The stand of woodland/forest, occurring in a shallow gully, contains the trees Coast White Box *Eucalyptus quadrangulata*, Blue Gum *Eucalyptus botryoides/E. saligna* and Forest Red Gum *Eucalyptus tereticornis*. Other smaller trees present include Black Wattle *Acacia mearnsii*, Native Cherry *Exocarpos cupressiformis* and several rainforest trees, including Hairy Clerodendrum *Clerodendrum tomentosum*, Murrogun *Cryptocarya microneaura* and Red Cedar *Toona ciliata*.

Melaleuca armillaris Tall Shrubland occurs on the dry ridges in the south and south-western part of the western section. The community is in a good natural condition in most places, although towards the gully and the above forest it has a dense Lantana understorey. The characteristic species found in this community include Mulga Fern *Cheilanthes sieberi*, Golden Everlasting *Bracteantha bracteata*, Love-grass Eragrostis sp., Juniper Beard-heath *Leucopogon juniperinus*, Narrow-leaf Mintbush *Prostanthera linearis*, Pale Fan-flower *Scaevola albida* and Cockspur Flower *Plectranthus graveolens*. This is an endangered ecological community under the NSW *Threatened Species Conservation Act 1995*, see below.

3.2.3 Summary of Vegetation in the Project Site and Nearby

A summary of the vegetation communities in the Project Site are summarised in **Table 1**. Their distribution on the Project Site is shown on the vegetation map in **Figures 3** and **4**.

TABLE 1

Vegetation Communities on the Project Site and Nearby

Community	Key Species	Distribution
1. Subtropical Rainforest	*Ficus macrophylla* *Alphitonia excelsa*	Occurs as remnant trees, etc in the valley to the south of the quarry, and in some places as good quality stands in the nearby gorge. trees on the slope to the south
2. Blue Gum – White Box Woodland/Forest	*Eucalyptus botryoides/* *E. saligna* *Eucalyptus quadranulata* *Eucalyptus tereticornis*	In a shallow gully in the south-western corner of the quarry western section (see areas marked “E” on **Figure 4**).
4. Planted Eucalypt Forest	*Eucalyptus maculata* *Eucalyptus tereticornis* *Acacia mearnsii*	Occurs in patches on bund walls and adjacent slopes in various places in the eastern Section of the quarry. (see areas marked “P” on **Figures 3** and **4**
3. Paperbark Shrubland	*Melaleuca armillaris* *Leucopogon juniperinus* *Cheilanthes sieberi* *Prostanthera linearis*	Occurs in the southwest of the western section and northwest of the eastern section, as well as extensively on adjoining ridges. (see areas marked “M” on **Figures 3** and **4**
4. Lantana Shrubland	*Lantana camara* *Acacia mearnsii*	Occurs over much of the site in the eastern part of the site, mostly on highly disturbed sites. (see areas marked “L” on **Figure 3**)

3.3 PLANT SPECIES

The native plant species recorded on the Project Site are listed in **Table 2**; the area is fairly diverse, as several different vegetation communities re represented, including rainforest, eucalypt woodland/forest and paperbark shrubland; 104 native species being recorded.

TABLE 2

Native Plant Species recorded on the Project Site

Taxonomic Name	Common Name	East Section	West Section
Acacia binervata	Two-veined Hickory	E	
Acacia maidenii	Maiden's Wattle	E	W
Acacia mearnsii	Black Wattle	E	W
Alphitonia excelsa	Red Ash	E	W
Amyema congener	Mistletoe	E	W
Asplenium flabellifolium	Necklace Fern	E	
Bracteantha bracteata	Golden Everlasting	E	W
Breynia oblongifolia	Breynia	E	W
Calandrinia sp.	Purslane		W
Carex longebrachiata	Bergalia Tussock	E	
Cayratia clematidea	Slender Grape	E	W
Cheilanthes distans	Bristly Cloak Fern	E	W
Cheilanthes sieberi	Mulga Fern	E	W
Chloris truncata	Windmill Grass	E	
Cissus antarctica	Kangaroo Vine	E	
Claoxylon australe	Brittlewood		W
Clematis aristata	Traveller's Joy		W
Clerodendrum tomentosum	Hairy Clerodendrum	E	W
Commersonia fraseri	Brush Kurrajong	E	W
Crassula ? sieberiana	Austral Stonecrop	E	W
Croton verreauxii	Native Cascarilla	E	
Cryptocarya microneura	Murrogun		W
Cyathea australis	Rough Tree Fern	E	
Cynodon dactylon	Couch Grass	E	W
Danthonia sp.	Wallaby Grass	E	W
Desmodium varians	Slender Tick-trefoil	E	
Dianella ? longifolia	Long-leaved Flax-lily		W
Dichelachne sp.	Plume-grass		W
Dichondra repens	Kidney-weed	E	W
Diploglottis australis	Native Tamarind	E	
Dodonaea viscosa	Hop-bush	E	W
Doodia aspera	Rasp Fern		W
Duboisia myoporoides	Corkwood		W
Ehretia acuminata	Koda	E	
Einadia hastata	Saloop	E	W
Entolasia marginata	Bordered Panic		W
Eragrostis sp.	Love-grass	E	W
Eucalyptus botryoides/E. saligna	Blue Gum		W
Eucalyptus quadrangulata	Coast White Box		W
Eucalyptus tereticornis	Forest Red Gum	E	W
Eustrephus latifolius	Wombat Berry		W
Exocarpos cupressiformis	Native Cherry	E	W

TABLE 2 (Continued)

Native Plant Species recorded on the Project Site

Taxonomic Name	Common Name	East Section	West Section
Ficus macrophylla	Moreton Bay Fig	E	
Ficus rubiginosa	Port Jackson Fig	E	
Geijera salicifolia var. *latifolia*	Brush Wilga	E	
Geitonoplesium formosum	Scrambling Lily		W
Geranium solanderi	Austral Crane's-bill	E	
Glycine clandestina	Twining Glycine	E	W
Glycine tabacina	Variable Glycine	W	
Guioa semiglauca	Guioa	E	
Helichrysum rutidolepis	Pale Everlasting		W
Hibbertia scandens	Twining Guinea Flower		W
Hibiscus heterophyllus	Native Hibiscus	E	
Hydrocotyle laxiflora	Stinking Pennywort		W
Indigofera australis	Austral Indigo	E	
Jacksonia scoparia	Winged Broom-pea	E	W
Juncus usitatus	Common Rush	E	
Kennedia rubicunda	Dusky Coral-pea	E	W
Legnephora moorei	Round-leaf Vine	E	
Leucopogon juniperinus	Juniper Beard-heath	E	W
Livistona australis	Cabbage Palm	E	
Lythrum hyssopifolia	Hyssop Loosestrife	E	
Maclura cochinchinensis	Cockspur Thorn	E	
Marsdenia rostrata	Common Milk Vine		W
Melaleuca armillaris	Bracelet Honey-myrtle	E	W
Melia azedarach	White Cedar	E	
Microlaena stipoides	Weeping Grass		W
Muehlenbeckia gracillima	Slender Lignum	E	
Notelaea venosa	Native Olive		W
Omalanthus nutans	Native Bleeding Heart	E	
Oplismenus aemulus	Australian Basket-grass	E	W
Oplismenus imbecillis	Pademelon Grass	E	W
Oxalis? *perennans*	Wood Sorrel	E	
Ozothamnus diosmifolius	Everlasting		W
Pandorea pandorana	Wonga Vine	E	W
Parsonsia straminea	Monkey-rope Vine	E	
Passiflora herbertiana	Native Passion-flower		W
Pelargonium australe	Native Stork's-bill	E	W
Pellaea falcata	Sickle Fern	E	
Pellaea paradoxa	-		
Persicaria decipiens	Slender Knotweed	E	
Phyllanthus gasstroemii	Blunt Spurge	E	W
Pittosporum undulatum	Sweet Pittosporum	E	W
Plectranthus graveolens	Cockspur Flower		W
Plectranthus parviflorus	Cockspur Flower	E	W
Poa sieberiana	Poa Tussock	E	W
Polyscias elegans	Celerywood	E	
Polyscias sambucifolia	Elderberry Panax	E	
Protanthera linearis	Narrow-leaved Mintbush		W
Rapanea howittiana	Muttonwood	E	
Rhodamnia rubescens	Scrub Turpentine		W
Scaevola albida	Pale Fan-flower	E	W

TABLE 2 (Continued)

Native Plant Species recorded on the Project Site

Taxonomic Name	Common Name	East Section	West Section
Senecio hispidulus	Rough Fireweed	E	W
Senecio quadridentatus	Cotton Fireweed	E	
Sigesbeckia orientalis	Indian Weed	E	W
Stellaria flaccida	Forest Starwort	E	W
Stephania japonica	Snake Vine		W
Streblus brunonianus	Whalebone Tree	E	
Syzygium australe	Brush Cherry	E	
Toona ciliata	Red Cedar	E	W
Trema aspera	Native Peach	E	W
Tylophora barbata	Beared Tylophora		W
Wahlenbergia gracilis	Australian Bluebell	E	
Zieria granulata	Illawarra Zieria	E	W

Table 3 lists the species of introduced (exotic) flora found on the Project Site. In total, 69 exotic species of plant were found on the Project Site, and many more are expected to occur there. Those species that are declared noxious weeds in the City of Shellharbour (*sensu Noxious Weeds Act 1993*) and those considered to be environmental weeds, i.e. a threat to natural bushland, are noted in column three.

TABLE 3

Introduced Plant Species recorded on the Project Site

Taxonomic Name	Common Name	Status[1]
Acacia binervia	Coast Myall	
Ageratina adenophora	Crofton Weed	E
Albizia lophantha	Crested Wattle	
Anagallis arvensis	Blue Pimpernel	
Andropogon virginicus	Whisky Grass	E
Araujia hortorum	Moth Vine	E
Argemone ochroleuca	Mexican Poppy	
Arundo donax	Bamboo	
Aster subulatus	Bushy Starwort	
Bidens pilosa	Cobbler's Pegs	
Brassica sp.	Brassica	
Bromus cartharticus	Prairie Grass	
Centaurium erythraea	Common Centaury	
Cerastium glomeratum	Mouse-eared Chickweed	
Chloris gayana	Rhodes Grass	E
Chrysanthemoides monilifera	Bitou Bush	N
Ciclospermum leptophyllum	Slender Celery	
Cirsium vulgare	Spear Thistle	
Conyza sp.	Fleabane	
Cyperus eragrostis	Umbrella Sedge	
Delairea odorata	Cape Ivy	E
Echium plantagineum	Paterson's Curse	
Emex australis	Spiny Emex	
Erythrina x *sykesii*	Coral Tree	

TABLE 3 (Continued)

Introduced Plant Species recorded on the Project Site

Taxonomic Name	Common Name	Status[1]
Euphorbia peplus	Petty Spurge	
Foeniculum vulgare	Fennell	
Gnaphalium americanum	American Cudweed	
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	
Holcus lanatus	Yorkshire Fog	
Hydrocotyle bonariensis	Pennywort	
Hypochaeris radicata	Flatweed	
Ipomoea indica	Morning Glory	E
Lactuca serriola	Prickly Lettuce	
Lantana camara	Lantana E	
Lepidium bonarience	Peppercress	
Ligustrum lucidum	Large-leaved Privet	E
Ligustrum sinense	Small-leaved Privet	E
Melilotis sp.	Melilot	
Misopates orontium	Lesser Snapdragon	
Modiola caroliniana	Red-flowered Mallow	
Petrorhagia nantenuilii	Proliferous Pink	
Oenothera sp.	Primrose	
Olea europaea	Wild Olive	E
Papaver somniferum	Opium Poppy	
Paspalum dilatatum	Paspalum	
Passiflora subpeltata	White Passion-flower	E
Pennisetum clandestinum	Kikuyu Grass	
Physalis peruviana	Cape Gooseberry	
Phytolacca octandra	Inkweed	
Plantago lanceolata	Ribbed Plantain	
Prunus sp.	Plum	
Ricinus communis	Castor Oil Plant	E
Rubus fruticosus	Blackberry	N
Rumex crispus	Curled Dock	
Salvia verbenaca	Wild Sage	
Senecio madagascariensis	Fireweed	
Senna pendula	Winter Senna	
Sida rhombifolia	Paddy's Lucerne	
Solanum mauritianum	Wild Tobacco	E
Solanum nigrum	Black Nightshade	
Sonchus asper	Prickly Sow-thistle	
Sonchus oleraceus	Common Sow-thistle	
Sporobolus indicus	Parramatta Grass	
Tagetes minuta	Stinking Roger	
Tropaeolum majus	Nasturtium	
Verbascum thapsus	Great Mullein	
Verbena bonariensis	Purpletop	
Verbena officinalis	Common Verbena	
Vicia sp.	Vetch	

1. N: Noxious in the City of Shellharbour;
   E: considered to be an environmental weed, i.e. a threat to natural bushland.

Various native trees have been planted in the eastern part of the Project Site, these appear to date mainly in the period 1994-1996. Those planted species identified on the site are listed in Table 4; all but *Acacia decurrens* occurs naturally locally (Fuller & Mills 1985).

TABLE 4

Planted Native Tree and Shrub Species on the Project Site

Taxonomic Name	Common Name
Acacia decurrens	Sydney Green Wattle
Acacia mearnsii	Black Wattle
Allocasuarina littoralis	Black She-oak
Casuarina glauca	Swamp Oak
Eucalyptus eugenioides	Thin-leaved Stringybark
Eucalyptus maculata	Spotted Gum
Eucalyptus robusta	Swamp Mahogany
Eucalyptus saligna/E.botryoides	Blue Gum
Eucalyptus tereticornis	Forest Red Gum
Melaleuca styphelioides	Prickly-leaved Paperbark
Zieria granulata	Illawarra Zieria

4 FAUNA

4.1 FAUNA SURVEY METHOD

4.1.1 The Survey

A diurnal fauna survey was undertaken on 16 and 21 October 2003, concentrating on mammals, birds, frogs and reptiles. The survey particularly involved an assessment of the habitats present within the Project Site, with the aim of determining if those habitats would be likely to support threatened animal species; see Section 4.2.

4.1.2 Objectives of the Fauna Survey

(i) to detect as many fauna species as possible;

(ii) to describe the fauna habitats on the site; and

(iii) to assess the potential for the habitats on the site to support threatened fauna.

The survey results indicate which species were found at the time of the survey; however, a full species inventory could be obtained only during a much longer and intensive study.

4.1.3 Techniques

All animals observed were identified and recorded. Species were identified by call-recognition as well as direct observation, and a ground search was conducted for scats, tracks, diggings and other signs of mammals; these signs were interpreted, where possible, to identify the species associated with them (Triggs 1988).

4.1.4 Nomenclature

The fauna species nomenclature in this report is based on the Australian Museum's *The Mammals of Australia* (Strahan 1995), *Australian Bats* (Churchill 1998), *The Taxonomy and Species of Birds of Australia and its Territories* (Christidis & Boles 1994) and *Reptiles and Amphibians of Australia* (Cogger 1992).

4.2 FAUNA HABITAT

The type of habitat in an area influences which animals occur there, as well as the diversity and abundance of fauna. The habitat assessment therefore has an important role in predicting whether threatened fauna are likely to occur in an area. The information collected during the surveys included the type of vegetation present, the presence or absence of rock outcrops, tree hollows, watercourses, wetlands, special food plants for fauna and any other habitat features with the potential to attract threatened fauna.

The habitats available to fauna in the study area are reflected in the vegetation descriptions provided in Section 3. These are essentially treed areas, with mainly wattles and eucalypts that have been planted, and lantana shrubland, usually very dense. Rainforest plants occur throughout the area and are particularly attractive to some species, such as fruit-eating birds. The trees are mostly small with no hollows that could be utilised by fauna. The largest trees are in the Blue Gum - White Box woodland/forest in the south-western corner of the western section; here there are many trees with hollows. Large old fig trees *Ficus spp*, found here and there on the site, provide foraging habitat for fruit-eating birds and mammals.

There is a settlement pond in the south of the eastern section, but this is not particularly attractive to wetland fauna.

4.3 FAUNA SPECIES

The vertebrate fauna species recorded in the Project Site or immediately adjacent to it are listed in **Table 5**. The species listed are only an indication of the species likely to be present, as a full species inventory would take much longer and extend over all seasons during a year. The aim was to characterise the native fauna of the Project Site, rather than try to find every species present there. As noted elsewhere, particular attention was given to investigating and assessing any habitats that were likely to be utilised by threatened species.

TABLE 5

Fauna Species recorded on and near the Project Site

Species		This Study	Previous Studies
Mammals			
Bush Rat	*Rattus fuscipes*		2
Cattle*	*Bos taurus*		2
Fox*	*Vulpes vulpes*	1	2
Horse*	*Equus caballus*		2
House Mouse*	*Mus musculus*		2
Rabbit*	*Oryctolagus cuniculus*	1	2
Short-beaked Echidna	*Tachyglossus aculeatus*		2
Swamp Wallaby	*Wallabia bicolor*	1	
Birds			
Australian Magpie	*Gymnorhina tibicen*	1	2
Australian Pelican	*Pelecanus conspicillatus*		2
Australian Raven	*Corvus coronoides*	1	2
Australian White Ibis	*Threskiornis molucca*		2
Australian Wood Duck	*Chenonetta jubata*		2
Black Swan	*Cygnus atratus*	1	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	1	2
Black-winged Stilt	*Himantopus himantopus*		2
Brown Cuckoo-Dove	*Macropygia amboinensis*		2
Brown Gerygone	*Gerygone mouki*	1	2
Brown Goshawk	*Accipiter fasciatus*		2
Brown Thornbill	*Acanthiza pusilla*	1	2
Brown Quail	*Coturnix ypsilophora*		2
Cattle Egret	*Ardea ibis*	1	2
Chestnut Teal	*Anas castanea*	1	2
Clamorous Reed-Warbler	*Acrocephalus stentoreus*		2
Common Mynah*	*Acridotheres tristis*	1	2
Common Starling*	*Sturnus vulgaris*	1	2
Crimson Rosella	*Platycercus elegans*	1	2
Dollarbird	*Eurystomus orientalis*	1	
Dusky Moorhen	*Gallinula tenebrosa*		2
Eastern Rosella	*Platycercus eximius*		2
Eastern Spinebill	*Acanthorhynchus tenuirostris*	1	2
Eastern Whipbird	*Psophodes olivaceus*	1	2
Eastern Yellow Robin	*Eopsaltria australis*	1	2
European Goldfinch*	*Carduelis carduelis*		2
Fairy Martin	*Hirundo ariel*		2
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	1	2
Galah	*Cacatua roseicapilla*		2
Green Catbird	*Ailuroedus crassirostris*		2
Grey Butcherbird	*Cracticus torquatus*	1	2
Grey Fantail	*Rhipidura fuliginosa*	1	2
Grey Shrike-thrush	*Colluricincla harmonica*	1	2
Hardhead	*Aythya australis*		2

TABLE 5 (Continued)

Fauna Species recorded on and near the Project Site

Species		This Study	Previous Studies
House Sparrow*	*Passer domesticus*	1	
Leaden Flycatcher	*Myiagra rubecula*		2
Lewin's Honeyeater	*Meliphaga lewinii*	1	2
Little Pied Cormorant	*Phalacrocorax melanoleucos*		2
Magpie-lark	*Grallina cyanoleuca*	1	2
Masked Lapwing	*Vanellus miles*		2
Mistletoebird	*Dicaeum hirundinaceum*	1	2
New Holland Honeyeater	*Phylidonyris novaehollandiae*		2
Noisy Friarbird	*Philemon corniculatus*		2
Pacific Black Duck	*Anas superciliosa*	1	2
Pied Currawong	*Strepera graculina*		2
Purple Swamphen	*Porphyrio porphyrio*	1	
Red Wattlebird	*Anthochaera carunculata*		2
Red-browed Finch	*Neochmia temporalis*	1	2
Red-whiskered Bulbul*	*Pycnonotus jocosus*	1	2
Richard's Pipit	*Anthus novaeseelandiae*		2
Rock Dove*	*Columba livia*		2
Rose Robin	*Petroica rosea*		2
Rufous Whistler	*Pachycephala rufiventris*	1	2
Satin Bowerbird	*Ptilonorhynchus violaceus*	1	2
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		2
Silvereye	*Zosterops lateralis*	1	2
Southern Boobook	*Ninox novaeseelandiae*		2
Spotted Pardalote	*Pardalotus punctatus*	1	
Spotted Turtle-Dove*	*Streptopelia chinensis*		2
Sulphur-crested Cockatoo	*Cacatua galerita*	1	
Superb Fairy-wren	*Malurus cyaneus*	1	2
Variegated Fairy-wren	*Malurus lamberti*	1	
Welcome Swallow	*Hirundo neoxena*	1	2
Whistling Kite	*Haliastur sphenurus*		2
White-browed Scrubwren	*Sericornis frontalis*	1	2
White-faced Heron	*Egretta novaehollandiae*		2
White-necked Heron	*Ardea pacifica*		2
White-throated Gerygone	*Gerygone olivacea*		2
White-throated Treecreeper	*Cormobates leucophaeus*	1	
Willie Wagtail	*Rhipidura leucophrys*	1	2
Yellow Thornbill	*Acanthiza nana*	1	2
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		2
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*		2
Frogs			
Brown-striped Frog	*Limnodynastes peronii*		2
Common Eastern Froglet	*Crinia signifera*	1	2
Peron's Tree Frog	*Litoria peronii*		2
Reptiles			
Eastern Blue-tongued Lizard	*Tiliqua scincoides*		2
Eastern Water Skink	*Eulamprus quoyii*		2
Delicate Skink	*Lampropholis delicata*	1	
Grass Skink	*Lampropholis guichenoti*		2
Red-bellied Black Snake	*Pseudechis porphyriacus*	1	2
Three-toed Skink	*Saiphos equalis*	1	2

*Introduced species.

5 ASSESSMENT OF CONSERVATION VALUES

5.1 THREATENED FLORA

Threatened plant species are listed on schedules under the New South Wales *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under the TSC Act, they are classified either as "endangered" (Schedule 1, Part 1), "vulnerable" (Schedule 2) or "presumed extinct" (Schedule 1, Part 4). Under the EPBC Act, they are classified as "extinct", "critically endangered", "endangered" or "vulnerable".

Information on the occurrence of threatened plant species in New South Wales can be obtained from the NSW Wildlife Atlas, which is maintained by the former National Parks and Wildlife Service (NPWS). A search of the Wildlife Atlas has revealed that six threatened plant species have previously been recorded in the local area, within about 10 kilometres of the Dunmore Quarry. These have been listed below, in **Table 6**, with their classification under the TSC and EPBC Acts, and a summary assessment of their potential to occur on the Project Site.

TABLE 6

Threatened Plant Species known to occur in the Local Area

Page 1 of 2

Species	TSC Act[1]	EPBC Act[1]	Potential to occur on the Project Site (Low/Medium/High)
White-flowered Wax Plant *Cynanchum elegans*	E	E	High. *Cynanchum elegans* is a vine that occurs mainly in dry subtropical rainforest and thickets of Lantana. The species was not seen on the Project Site, although it could occur in Lantana thickets or stands of rainforest.
Illawarra Socketwood *Daphnandra* sp. C	E	E	Low. This small tree species inhabits subtropical rain forest, often in rocky gullies. The species was not seen on the Project Site, although it is conceivable that it could occur within stands of moist rainforest.
Illawarra Irene *Irenepharsus trypherus*	E	E	Low. *Irenepharsus trypherus* is a small herb that occurs in moist gullies and ravines. The species was not seen on the Project Site and is not expected to occur there; there is no suitable habitat.
Spike Rice-flower *Pimelea spicata*	E	E	Low. *Pimelea spicata* is a small shrub that occurs in patches of native grassland, or mixed native and introduced grasses. It was not seen on the Project Site, and is not expected to occur in these heavily grazed paddocks dominated by introduced pasture species.

TABLE 6 (Continued)

Threatened Plant Species known to occur in the Local Area

Illawarra Greenhood *Pterostylis gibbosa*	E	E	Low. The habitat on the Project Site is not suitable for this small terrestrial orchid, which occurs in dry forest and woodland.
Illawarra Zieria *Zieria granulata*	E	E	Present. *Zieria granulata* grows on rock outcrops in subtropical rainforest, dry woodland and paperbark scrub. It occurs in several places within the Project Site, but essentially outside the areas disturbed by extraction operations.

1. V vulnerable; E endangered; - not listed.

Zeiria granualata

One threatened plant species was recorded on the Project Site, namely the shrub *Zieria granulata* (Family: Rutaceae). The species was located in the eastern and the western sections of the quarry; in some places it has clearly been planted as part of the planting program around the quarry, undertaken some years ago.

Eastern Section

This species was found at two locations on the lower part of the quarry, where it is almost certainly to have been planted as part of revegetation works undertaken in 1994 to 1996. The locations, shown in **Figure 3**, contain only six specimens of *Zieria granulata*.

The species also occurs in the far north-western corner of the eastern section, in the area mapped as *Melaleuca* shrubland on **Figure 3**. Here, there are at least 92 plants, some of which appear to have been planted along the edged of the quarry.

Western Section

On the southern side of the RIC extraction area about 40 plants were found in a natural situation within *Melaleuca* shrubland, just beyond the current limit of extraction - this was near aerial survey peg no. 30. Plants were also found further to the south, on the rocky edges of the gorge, where the plant is fairly common. The approximate location of these plants is shown on **Figure 4**.

One plant was found in rubble on the edge of the RIC extraction area (see **Figure 4)**.

Other Plant Species

The vine *Cynanchum elegans* could also occur in the rainforest or Lantana thickets on the site, although it was not found during this study, despite searches in all accessible areas. The vine can grow in dense Lantana and be somewhat difficult to find.

5.2 THREATENED FAUNA

Threatened fauna species are also listed under the TSC Act and EPBC Act, where they are classified in the same manner as threatened plant species; see Section 5.1. Information on the occurrence of threatened fauna species in New South Wales can also be obtained from the NSW Wildlife Atlas.

A search of the Wildlife Atlas confirms that many threatened fauna have previously been recorded in the local area, within about 10 kilometres of Dunmore Quarry . These have been listed in **Table 7**, with their classification under the TSC and EPBC Acts, and a summary assessment of their potential to occur on the Project Site. Coastal and marine species have been excluded, because there is obviously no habitat for them on the Project Site, which is well inland.

No threatened fauna species have been recorded on the site and none are expected to occur there. The Australasian Bittern, however, is the threatened species most likely to occur there.

TABLE 7

Threatened Fauna Species known to occur in the Local Area

Page 1 of 2

Species	TSC Act[+]	EPBC Act[+]	Potential to occur on the Project Site (Low/Medium/High)
Mammals			
Grey-headed Flying-fox *Pteropus poliocephalus*	V	V	High. Grey-headed Flying-foxes are common in the local area, and are **not** expected to occur on the Project Site because of the occurrence of figs and other native trees.
Large Bentwing-bat *Miniopterus schreibersii*	V	-	Moderate. They could turn up almost anywhere briefly, but are not expected to occur on the Project Site because of the lack of roosting opportunities within the Quarry.
Large-eared Pied Bat *Chalinolobus dwyeri*	V	-	
Large-footed Myotis *Myotis adversus*	V	-	Low. Also known as the fishing-bat, Large-footed Myotis scan the surface of water for prey. Because there are no large expanses of water on the Project Site, this species is not expected to occur there.
Birds			
Australasian Bittern *Botaurus poiciloptilus*	V	-	Low. Australasian Bitterns inhabit fresh and brackish wetlands. They have been recorded on the floodplain of Rocklow Creek, and in the reed beds near the highway, just north of Dunmore railway station (Chafer 1997). There are no suitable wetlands on the Project Site.
Barking Owl *Ninox connivens*	V	-	Low. This species occurs mainly in forest, and is very rare locally.
Black Bittern *Ixobrychus flavicollis*	V	-	Low. Black Bitterns occur fairly regularly in the saline wetlands associated with the Minnamurra River. There are no suitable wetlands on the Project Site.
Blue-billed Duck *Oxyura australis*	V	-	Low. Blue-billed Ducks are almost totally aquatic. They occur in deep, permanent swamps and lakes. There is no suitable habitat on the Project Site.
Comb-crested Jacana *Irediparra gallinacea*	V	-	Low. The Comb-crested Jacana has been recorded in the Shellharbour local government area on only one previous occasion, in 1984, at Dunmore Swamp. There are no suitable wetlands on the Project Site.

TABLE 7 (Continued)

Threatened Fauna Species known to occur in the Local Area

Species	TSC Act[+]	EPBC Act[+]	Potential to occur on the Project Site (Low/Medium/High)
Freckled Duck *Stictonetta naevosa*	V	-	Low. Freckled Ducks occur in densely vegetated freshwater wetlands, lagoons and lakes. There is no suitable habitat on the Project Site.
Glossy Black-Cockatoo *Calyptorhynchus lathami*	V	-	Low. There is no suitable habitat on the Quarry Site for Glossy Black-Cockatoos, which occur in stands of mature Black She-oak *Allocasuarina littoralis*.
Pink Robin *Petroica rodinogaster*	V	-	Low. Pink Robins inhabit moist forest in south-eastern Australia, especially Tasmania. The species is only an occasional winter migrant to this district.
Powerful Owl *Ninox strenua*	V	-	Moderate. Powerful Owls occur in forest and woodland. The species could conceivably occur in the small areas of trees on the Project Site.
Regent Honeyeater *Xanthomyza phrygia*	E	E	Low. Regent Honeyeaters occur in woodland and open forest, wooded farmland and urban areas with mature trees. This highly nomadic species is not expected to occur on the Project Site; there is one previous record from the local area.
Rose-crowned Fruit-Dove *Ptilinopus regina*	V	-	Low. Rose-crowned Fruit-Doves occur in rainforest near the coast. The species has been recorded at Bass Point but is very rare in this district.
Superb Parrot *Polytelis swainsonii*	V	V	Low. This species occurs in forest and woodland, usually with a grassy understorey, west of the great divide. The local record would almost certainly be of an aviary escapee.
Swift Parrot *Lathamus discolor*	E	E	Moderate. There is suitable treed habitat on the Project Site for Swift Parrots, although it is not very good habitat for these parrots.
Amphibians			
Green and Golden Bell Frog *Litoria aurea*	E	V	Low. Green and Golden Bell Frogs occur in Killalea Lagoon, and were recorded on the old Shellharbour golf course in 1987. The species has not been found in any other wetlands in the Shellharbour district.

1. V vulnerable; E endangered; - not listed.

5.3 MIGRATORY SPECIES

In addition to threatened species, the EPBC Act allows for the listing of internationally protected migratory species, i.e. species listed under the Japan-Australia Migratory Bird Agreement (JAMBA), the China - Australia Migratory Bird Agreement (CAMBA) and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Various bird species recorded during this and previous surveys on and near the Project Site are internationally protected migratory species; for example, the Australian Wood Duck, Chestnut Teal, Hardhead, Masked Lapwing, Brown Goshawk and Pacific Black Duck. Many common Australian bird species have been listed under the EPBC Act, so other listed species would also occur on or near the Project Site. The Wanderer Butterfly is also an internationally protected migratory species; this common butterfly species was also seen on the Project Site.

5.4 ENDANGERED POPULATIONS

Endangered populations are listed under the TSC Act (Schedule 1, Part 2). No endangered populations have been declared on or near this site.

5.5 ENDANGERED ECOLOGICAL COMMUNITIES

Endangered ecological communities are listed under the TSC Act (Schedule 1, Part 3) and under the EPBC Act. The vegetation types on this site are not endangered communities under the EPBC Act.

Two endangered ecological communities under the TSC Act occur on the Project Site; Illawarra Subtropical Rainforest and *Melaleuca armillaris* Tall Shrubland. The Final Determinations made by the NSW Scientific Committee for these communities are provided in **Appendices 1** and **2**, respectively. The distribution of the communities on the quarry site is shown on **Figures 3** and 4.

The area of *Melaleuca armillaris* Tall Shrubland to be cleared on the western section of the Project Site is about 5.4 hectares. It is noted that development consent already exists for the removal of this vegetation. The area of this community occurring in the far north-western corner of the eastern section, about 0.5 hectares, will not be affected.

The remnant subtropical rainforest is mainly outside the Project Site, such as in the gorge to the south. However, the slope in the south-western part of the southern section supports small stands of rainforest trees and contains many rainforest species; this area was once covered in subtropical rainforest. This area will not be affected by ongoing quarry operations.

The Blue Gum – White Box Woodland/Forest in the south-western part of the western section of the quarry was considered as an example of another endangered community known as Illawarra Lowland Grass Woodland. It is considered that this is not part of that community, as the only similarity between the two is the presence of occasional Forest Red Gum in the community on the Project Site. The Final Determination for this community is provided in **Appendix 3**.

5.6 SEPP 44 - KOALA HABITAT PROTECTION

Shellharbour is one of the local government areas in which *State Environmental Planning Policy No. 44 - Koala Habitat Protection* (SEPP 44) (New South Wales 1995) applies. SEPP 44 encourages the conservation and management of natural vegetation that provides habitat for Koalas, to ensure a permanent free-living population over the species' present range and to reverse the current trend of Koala population decline.

SEPP 44 aims to identify "potential Koala habitat", which means "areas of native vegetation where the trees of the types listed in Schedule 2 [of SEPP 44] constitute at least 15% of the total number of trees in the upper or lower strata of the tree component". If no Schedule 2 tree species are present or if they constitute less than 15% of the total number of trees present, then no further provisions of the Policy apply.

If more than 15% of the trees in the area are Schedule 2 tree species, then an assessment must be made by a qualified person to determine whether the area contains "core Koala habitat", a term applied to "an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population".

There is only one Schedule 2 Koala food tree species on the quarry site: Forest Red Gum *Eucalyptus tereticornis* has been planted on the site and some trees are naturally occurring there. Because of the low percentage of trees that are this species and the fact that there have been no Koala observations in the lowlands of Shellharbour for many decades, the area is not considered to be "potential Koala habitat". No further provisions of the Policy apply.

6 IMPACTS OF THE PROPOSAL

6.1. IMPACT ON VEGETATION AND FAUNA HABITAT

6.1.1 Eastern Section

The proposed increase in quarry production will not have any impact on the natural vegetation or habitats in the eastern section of the Project Site. This is because a raised production level will not result in any habitat areas being cleared or modified.

6.1.2 Western Section

Approximately 7.8ha of the existing natural vegetation in the western section of the Project Site will be removed as the Croome Farm extraction area is extended albeit only within the area already approved for extraction under Development Consent No. 168/1994(am1). The vegetation communities to be removed in this area are estimated to be:

Melaleuca armillaris Tall Shrubland	5.4 hectares
Blue Gum - White Box Woodland/Forest	2.4 hectares

The species of most importance in the area is the endangered shrub *Zieria granulata*. The survey found about 40 plants beyond the southern edge of the existing RIC extraction (see **Figure 3**). Boral does not plan to extend the RIC extraction area any further south, consequently, there would be no impact upon this group of plants.

6.2 THREATENED SPECIES CONSERVATION ACT

The impact assessment in this report focuses on the eastern section where there has been no previous impact assessment. The western area, and the Croome Farm extraction area in particular, has previously been assessed and no further assessment is considered necessary given Boral has no plans to extend beyond the area approved for extraction in 1996.

The *Threatened Species Conservation Act 1995* requires that the following matters be taken into account when considering whether a proposal is likely to have a significant effect on threatened species, populations or ecological communities, and whether a Species Impact Statement (SIS) is required. This process, commonly referred to as the "eight part test", has been applied below to the proposed increase in production in the eastern section of the Project Site.

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The proposed increase in quarry production is unlikely to disrupt the life cycle of any threatened species to the extent that a viable local population would be placed at risk of extinction. Based on the assessment undertaken in Section 5 of this report, particularly the assessment of habitat, the only threatened species in the eastern part of the area is *Zieria granulata*. Six planted specimens of this shrub were found in the northern-central part eastern section of the Project Site; see **Figure 3**. A much larger population occurs in the far north-western corner of the eastern section. None of these plants will be affected.

There is a possibility that the Grey-headed Flying-fox and the Powerful Owl may visit the treed parts of the site occasionally. As no trees or other vegetation will be removed or modified, it is concluded that these species will not be affected.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

No endangered populations have been declared on, or adjacent to, the site.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The Project Site does not contain a “significant area of known habitat” for any threatened plant or animal species, populations or ecological communities. The expansion of production at the quarry will not involve the removal of any habitat that the threatened animals discussed above could occasionally visit.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

No threatened species, populations or ecological communities are likely to become isolated due to the proposed increase in quarry production.

(e) whether critical habitat will be affected

"Critical habitat" is "habitat declared to be critical under Part 3" of the Act. No critical habitat has been declared on this site.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region

Zieria granulata is not adequately reserved in the region.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

A "threatening process" is "a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities". "Key threatening processes" are listed under Schedule 3 of the Act.

To date, the NSW Scientific Committee has listed 18 key threatening processes under the Act. The applicability of these processes to the quarry proposal has been summarised below.

Key Threatening Process	Applicable; Yes/No
Alteration to the natural flow regimes of rivers, etc.	No.
Anthropogenic Climate Change	No.
Bushrock removal	No.
Clearing of native vegetation	No.
Competition and grazing by feral European Rabbit	No.
Competition from Feral Honey Bees	No.
High frequency fire resulting in the disruption of life cycle processes	No.
Importation of Red Imported Fire Ants	No.
Invasion of native plant communities by exotic perennial grasses	No.
Infection of native plants by *Phytophthora cinnamomi*	No.
Invasion of native plant communities by *Chrysanthemoides monilifera*	No.
Infection of frogs by amphibian chytrid	No.
Infection by Psittacine Circoviral Disease in Parrots	No.
Loss and/or degradation of sites used for hill-topping by butterflies	No.
Predation by *Gambusia holbrooki*	No.
Predation by the European Red Fox	No.
Predation by the Feral Cat	No.
Predation from the Ship Rat on Lord Howe Island	No.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

Zieria granulata has a very limited distribution so is always close to its distributional limit. The animals species mentioned are no where near their limit of distribution.

"Eight Part Test" Conclusion
The increase in quarry production is not likely to have a significant effect on any threatened species, populations or ecological communities, or their habitats, occurring in the eastern section of the Project Site so the preparation of a Species Impact Statement is not required.

6.3 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT

6.3.1 Introduction

The Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) specifies that approval is required from the Commonwealth Minister for the Environment for actions that have, will have or are likely to have a significant impact on a matter of "national environmental significance".

The Act identifies six matters of national environmental significance; these are:

(i) declared World Heritage Areas,

(ii) declared RAMSAR wetlands,

(iii) listed threatened species and ecological communities,

(iv) listed migratory species,

(v) nuclear actions, and

(vi) the environment of Commonwealth marine areas.

Actions on or outside Commonwealth land that have, will have or are likely to have a significant impact on the environment on or outside Commonwealth land must also be referred to the Commonwealth Minister for assessment and approval, as well as the actions of Commonwealth agencies inside or outside the Australian jurisdiction that have, will have or are likely to have a significant impact on the environment inside or outside the Australian jurisdiction.

Environment Australia has published *Administrative Guidelines for Determining whether an Action has, will have, or is likely to have a Significant Impact on a Matter of National Environmental Significance under the Environmental Protection and Biodiversity Conservation Act 1999* (Environment Australia 2000), to assist proponents to decide whether a proposed action should be referred to the Minister for assessment and approval.

Some of the criteria in the guidelines refer to the concept of "habitat critical to the survival of a species or ecological community". The guidelines state, "habitat critical to the survival of a species or ecological community . . . includes the critical habitat for any species or community identified in recovery plans for those species/communities and the critical habitat on the Register maintained by the Minister for the Environment under the Act. However, there may not be recovery plans in place for all listed species and communities, as plans take some time to prepare. Similarly, the Register may not be comprehensive. The absence of a recovery plan or the fact that an area may not be listed on the Register of Critical Habitat does not mean that there is no habitat critical to the survival of the species or community."

"Habitat critical to the survival of a species or ecological community may include areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal,
- for succession,
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species/community."

"Habitat critical to the survival of a species or ecological community will depend largely on the particular requirements of the species/community in question. For example, areas only incidentally used by a vulnerable species, and which the species is unlikely to be dependent upon for its survival or recovery, are not areas of habitat critical to the survival of a species or ecological community."

"Some of the criteria below refer to actions likely to lead to a "long-term decrease" in the size of a population or a "long-term adverse effect" on a community. Depending on the level of endangerment and the nature of the action, not all actions which create an immediate decrease in the population of a naturally listed threatened species or impact on a community will have long-term consequences. For example, an act which causes injury or death to only one or a very small number of a species will not, except in the case of the most endangered of species, generally lead to a long-term or irreversible decrease in the population that normal processes, rates of mortality and recruitment could not buffer."

6.3.2 Criteria for Endangered Species

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- lead to a long-term decrease in the size of a population, or
- reduce the area of occupancy of the species, or
- fragment an existing population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of a population, or
- modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or
- interferes with the recovery of the species.

Zieria granulata occurs in several places in the eastern section of the quarry site, but none of these will be affected. The increase in quarry production will not lead to any of the above impacts on this species.

6.3.3 Criteria for Vulnerable Species

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- lead to a long-term decrease in the size of an *important population* of a species, or
- reduce the area of occupancy of an *important population*, or
- fragment an existing *important population* into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of an *important population*, or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or
- interferes substantially with the recovery of the species.

(*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.)

An *important population* is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

The Grey-headed Flying-fox is expected to occasionally visit the rainforest and eucalypt trees on the Project Site, mainly during summer. The foraging area for this species will not be significantly affected by the proposed expansion of production. The figs and other trees that are present in the eastern section will remain undisturbed.

6.3.4 Criteria for Listed Migratory Species

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of *important habitat* of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established* in an area of *important habitat* of the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an *ecologically significant proportion* of the population of the species.

(*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.)

An area of *important habitat* is:

a) habitat utilised by a migratory species occasionally or periodically within a region that supports an *ecologically significant proportion* of the population of the species, or

b) habitat utilised by a migratory species which is at the limit of the species range, or

c) habitat within an area where the species is declining.

The proposal is not likely to have a significant impact on any internationally protected migratory species. There is no "important habitat" for these species on the subject land. Nor is an "ecologically significant proportion" of a population of these species likely to occur on the eastern section of the Project Site.

6.4 RECOMMENDATIONS

The following recommendations are made regarding the ongoing operation of the quarry at the increased level of production and its operations and flora and fauna.

(i) The weed management plan prepared by Kevin Mills & Associates (1996) should be reviewed and any necessary control measures undertaken. It is noted that the Project Site contains various noxious and environmental weeds (see **Table 3** in Section 3.3). The most important weeds that require control in the Project Site are:

Bitou Bush	*Chrysanthemoides monilifera*
Blackberry	*Rubus fruticosus*
Castor Oil Plant	*Ricinus communis*
Crofton Weed	*Ageratina adenohpra*
Large-leaved privet	*Ligustrum lucidum*
Morning Glory	Ipomoea indica
Small-leaved Privet	*Ligustrum sinense*

(ii) The corridor of planted trees along the western edge of the quarry site, planted around 1996, can be improved. Many trees have died, and as a consequence the spacing between trees is far too much (trees should be planted at no more than two metre centres) and there is a gap in the plantings around the dam (this should be fenced and planted as well).

(iii) The threatened plant *Zieria granulata*, sourced from the site, should continue to be used in the planting programs. If *Zieria granulata* plants are cleared form the western section then cuttings should be taken from these plants and used in the revegetation in other parts of the Quarry Site.

(iv) The following species of trees re shrubs are suitable for planting in the quarry area and within the western wildlife corridor; they all occur naturally on the site. The rainforest species should be used in gully or protected situations. The eucalypts used on site to date, for example Spotted Gum *Eucalyptus maculata*, should not be used again as they are not native to this area.

TABLE 8

Species Suitable for Planting

Taxonomic Name	Common Name
Acacia binervata	Two-veined Hickory
Acacia maidenii	Maiden's Wattle
Acacia mearnsii	Black Wattle
Alphitonia excelsa	Red Ash
Breynia oblongifolia	Breynia
Claoxylon australe	Brittlewood
Clerodendrum tomentosum	Hairy Clerodendrum
Commersonia fraseri	Brush Kurrajong
Croton verreauxii	Native Cascarilla
Cryptocarya microneura	Murrogun
Diploglottis australis	Native Tamarind
Dodonaea viscosa	Hop-bush
Duboisia myoporoides	Corkwood
Ehretia acuminata	Koda
Eucalyptus botryoides/E. saligna	Blue Gum
Eucalyptus quadrangulata	Coast White Box
Eucalyptus tereticornis	Forest Red Gum
Exocarpos cupressiformis	Native Cherry
Ficus macrophylla	Moreton Bay Fig
Ficus rubiginosa	Port Jackson Fig
Geijera salicifolia var. *latifolia*	Brush Wilga
Guioa semiglauca	Guioa
Hibiscus heterophyllus	Native Hibiscus
Indigofera australis	Austral Indigo
Jacksonia scoparia	Winged Broom-pea
Leucopogon juniperinus	Juniper Beard-heath
Livistona australis	Cabbage Palm
Maclura cochinchinensis	Cockspur Thorn
Melaleuca armillaris	Bracelet Honey-myrtle
Melia azedarach	White Cedar
Notelaea venosa	Native Olive
Omalanthus nutans	Native Bleeding Heart
Ozothamnus diosmifolius	Everlasting
Pittosporum undulatum	Sweet Pittosporum
Polyscias elegans	Celerywood
Polyscias sambucifolia	Elderberry Panax
Protanthera linearis	Narrow-leaved Mintbush
Rapanea howittiana	Muttonwood
Rhodamnia rubescens	Scrub Turpentine
Streblus brunonianus	Whalebone Tree
Syzygium australe	Brush Cherry
Toona ciliata	Red Cedar
Trema aspera	Native Peach
Zieria granulata	Illawarra Zieria

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APPENDICES

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Appendix 1: Final Determination: Illawarra Subtropical Rainforest

Appendix 2: Final Determination: *Melaleuca Armillaris* Tall Shrubland

Appendix 3: Final Determination: Illawarra Lowlands Grassy Woodland

APPENDIX 1

(No. of pages excluding this page = 3)

(Final Determination: Illawarra Subtropical Rainforest)

APPENDIX 1

FINAL DETERMINATION: ILLAWARRA SUBTROPICAL RAINFOREST

Threatened Species Conservation Act 1995
NSW Scientific Committee

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Illawarra Subtropical Rainforest in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. The listing of endangered ecological communities is provided for by Part 2 of the Act. The Scientific Committee has found that:

1. Illawarra Subtropical Rainforest is the name given to the ecological community on high nutrient soils in the Illawarra area within the Sydney Basin Bioregion and is characterised by the following assemblage of species.

Adiantum formosum	*Alectryon subcinereus*
Alphitonia excelsa	*Baloghia inophylla*
Brachychiton acerifolius	*Cassine australis*
Cayratia clematidea	*Celastrus australis*
Cissus antarctica	*Citriobatus pauciflorus*
Dendrocnide excelsa	*Diospyros pentamera*
Diploglottis australis	*Doodia aspera*
Ehretia acuminata	*Ficus* spp.
Guioa semiglauca	*Hibiscus heterophyllus*
Legnephora moorei	*Maclura cochinchinensis*
Malaisia scandens	*Pennantia cunninghamii*
Piper novaehollandiae	*Planchonella australis*
Podocarpus elatus	*Scolopia braunii*
Streblus brunonianus	*Toona ciliata*
Wilkiea huegliana	

2. The total species list of the community is considerably larger than that given above, with many species present in only one or two sites or in very small quantity. The species composition of a site will be influenced by the size of the site, recent rainfall or drought condition and by its disturbance (including fire) history. The number of species, and the above ground relative abundance of species will change with time since fire, and may also change in response to changes in fire regime (including changes in fire frequency). At any one time, above ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Illawarra Subtropical Rainforest has been recorded from the local government areas of Wollongong City, Shellharbour City, Shoalhaven City and Kiama Municipality (within the Sydney Basin Bioregion) and may occur elsewhere in the Bioregion.

4. Illawarra Subtropical Rainforest includes Subtropical Rainforest (Type 1), Moist Subtropical Rainforest (Type 2) and Dry Subtropical Rainforest (Type 3) of Mills, K & Jakeman, J. (1995 *Rainforests of the Illawarra District* (Coachwood Publishing, Jamberoo). (The classification of Mills & Jakeman was developed specifically for the Illawarra - in a broader context much of the community recognised here would fall within dry forest (suballiance 23) in Floyd, A. G. (1990). *Australian rainforests in New South Wales* (Vols 1 and 2, Surrey Beatty and Sons, Chipping Norton). Although rainforest canopies are generally closed, in highly disturbed stands the canopy may be irregular and open. Canopy height varies considerably, and structurally some stands are scrub.

5. Characteristic tree species in the Illawarra Subtropical Rainforest are *Baloghia inophylla, Brachychiton acerifolius, Dendrocnide excelsa, Diploglottis australis, Ficus* spp., *Pennantia cunninghamii* and *Toona ciliata.* Stands may have species of *Eucalyptus*, *Syncarpia* and *Acacia* as emergents or incorporated into the dense canopy.

6. Illawarra Subtropical Rainforest occurred mainly on the coastal Permian volcanics, but can occur on a range of geological substrates, mainly between Albion Park and Gerringong (termed the Illawarra Brush by Mills and Jakeman 1995) and north of Lake Illawarra on the Berkeley Hills (termed the Berkeley Brush by Mills & Jakeman 1995). The Illawarra Brush and Berkeley Brush originally covered about 13 600 ha and made up about 60% of the rainforest of the Illawarra area. Outlying occurrences of Illawarra Subtropical Rainforest also occur south to the Shoalhaven River and westwards into Kangaroo Valley, where areas of Permian volcanic soils occur. The community generally occurs on the coastal plain and escarpment foothills, rarely extending onto the upper escarpment slopes.

7. Illawarra Subtropical Rainforest provides habitat for the tree *Daphnandra* sp. C Illawarra, and in some drier stands the endangered vine *Cynanchum elegans*. The shrub *Zieria granulata* may grow near stands of Illawarra Subtropical Rainforest and in regrowth stands (K. Mills pers. comm.).

8. Small areas of Illawarra Subtropical Rainforest occur in Budderoo National Park, Macquarie Pass National Park, Morton National Park, Cambewarra Range Nature Reserve, Devils Glen Nature Reserve and Rodway Nature Reserve.

9. Large areas of Illawarra Subtropical Rainforest have been cleared for agriculture. Only about 3400 ha remains with about 13% of this (440 ha) in reserved areas (Mills & Jakeman 1995, L. Mitchell pers. comm). Illawarra Subtropical Rainforest occurs mainly on private land and is inadequately protected. Compared with warm temperate rainforest it is under-represented in conservation reserves.

10. Remnants are small and fragmented and their long term viability is threatened. Weed invasion is a major threat and invasive exotic species include *Lantana camara, Araujia sericiflera, Ageratina riparia, Ageratina adenophora, Delairea odorata, Senna pendula* var *glabra, Senna septemtrionalis, Tradescantia fluminensis, Cinnamomum camphora, Olea europea* subsp*. africana, Hedychium gardnerianum, Ligustrum lucidum, Ligustrum sinense, Passiflora subpeltata* and *Solanum mauritianum*. Other threats include further clearing, quarrying, grazing, inappropriate fire regimes, rubbish dumping and hobby farm developments.

11. In view of the above the Scientific Committee is of the opinion that Illawarra Subtropical Rainforest in the Sydney Basin Bioregion is likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Proposed Gazettal date: 01/11/02
Exhibition period: 01/11/02 – 05/12/02

APPENDIX 2

(No. of pages excluding this page = 2)

(Final Determination: Melaleuca Armillaris Tall Shrubland)

APPENDIX 2

FINAL DETERMINATION: *MELALEUCA ARMILLARIS* TALL SHRUBLAND

NSW Scientific Committee
Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list *Melaleuca armillaris* Tall Shrubland in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. The listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. *Melaleuca armillaris* Tall Shrubland is the name given to the ecological community found on outcrops of volcanic soils on dry rocky ridges in the Illawarra area (within the Sydney Basin Bioregion) and is characterised by the following assemblage of species:

Acacia mearnsii	*Alphitonia excelsa*
Bracteantha bracteata	*Calandrinia pickeringii*
Cheilanthes distans	*Cheilanthes sieberi*
Commelina cyanea	*Commersonia fraseri*
Crassula sieberiana	*Dodonaea viscosa* subsp. *angustifolia*
Hibiscus heterophyllus	*Melaleuca armillaris*
Plectranthus graveolens	*Prostanthera linearis*
Zieria granulata	

2. The total species list of the community is considerably larger than that given in 1 (above), with many species present in only one or two sites or in very small quantity. In any particular site not all of the assemblage listed in 1 may be present. At any one time, some species may only be present as seeds in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance history. The number of species and the above-ground composition of species will change with time since fire, and may also change in response to changes in fire frequency. The community includes a diverse fauna, both vertebrate and invertebrate, but it is poorly known. The threatened species *Zieria granulata* is closely associated with *Melaleuca armillaris* Tall Shrubland (Mills & Jakeman 1993).

3. *Melaleuca armillaris* Tall Shrubland may be up to about 5 m tall and is dominated by the large Paperbark shrub *Melaleuca armillaris*. It occurs in sites away from the coast on very dry rocky ridges, at Dunmore and in Jamberoo Valley on volcanic soils overlying latite, and in small patches near Killalea. Rock outcrops are common within the Community. Because the soils on which it grows are shallow and are unable to retain enough moisture, the shrubs may die back during drought. (Dense stands of *M. armillaris* on coastal headlands are not included within this ecological community).

4. *Melaleuca armillaris* Tall Shrubland has been recorded from the local government areas of Shellharbour City, and Kiama Municipality (within the Sydney Basin Bioregion) and may occur elsewhere in the Bioregion.

5. Small stands of *Melaleuca armillaris* Tall Shrubland occur in Killalea State Park.

6. Many areas of *Melaleuca armillaris* Tall Shrubland have been cleared. Most remnants are small and fragmented and their longterm viability is threatened. Threats include further clearing, grazing, including by rabbits, quarrying, inappropriate fire regimes, weed invasion, rubbish dumping, housing and hobby farm developments.

7. In view of the above the Scientific Committee is of the opinion that *Melaleuca armillaris* Tall Shrubland in the Sydney Basin Bioregion is likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Proposed Gazettal date: 23/08/02
Exhibition period: 23/08/02 – 27/09/02

Reference

Kevin Mills & Associates (2000) Nature Conservation Study, Rural Lands Study Area, City of Shellharbour. Prepared for Shellharbour City Council.

APPENDIX 3

(No. of pages excluding this page = 2)

(Final Determination: Illawarra Lowlands Grassy Woodland)

APPENDIX 3
FINAL DETERMINATION: ILLAWARRA LOWLANDS GRASSY WOODLAND

NSW Scientific Committee
Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule I of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. The Illawarra Lowlands Grassy Woodland is the name given to the plant community from the local government areas of Wollongong City, Shellharbour City, and Kiama Municipality (within the Sydney Basin Bioregion) that is characterised by the following assemblage of species:

Acacia falcata
Acacia implexa
Acacia maidenii
Acacia mearnsii
Acacia stricta
Allocasuarina littoralis
Angophora floribunda
Aristida ramosa
Aristida vagans
Athropodium milleflorum
Boronia polygalifolia
Bothriochloa macra
Brachychiton populneus
Brunoniella pumilio
Bursaria spinosa
Callistemon salignus
Carex longebrachiata
Cheilanthes sieberi
Citriobatus pauciflorus
Commelina cyanea
Cymbopogon refractus
Daviesia genistifolia
Daviesia ulicifolia
Desmodium rhytidophyllum
Desmodium varians
Dianella revoluta
Dichondra repens
Dodonaea viscosa var angustifolia
Echinopogon caespitosus
Echinopogon ovatus
Entolasia stricta
Eragrostis sp.
Eucalyptus amplifolia
Eucalyptus bosistoana
Eucalyptus botryoides
Eucalyptus botryoideslsaligna
Eucalyptus eugenioides
Eucalyptus longifolia
Eucalyptus pilularis
Eucalyptus tereticornis
Gahnia radula
Geitonoplesium cymosum
Geranium solanderi
Glycine sp.
Goodenia hederacea subsp *hederacea*
Hardenbergia violacea
Hibbertia aspera
Hypericum gramineum
Hypoxis hygrometrica
Jacksonia scoparia
Kennedia rubicunda
Lepidosperma laterale
Leucopogon juniperinum
Lomandra filiformis
Lomandra multiflora
Melaleuca decora
Melaleuca styphelioides
Microlaena stipoides
Oplismenus aemulus
Oplismenus imbecillis
Panicum sp.
Parsonsia straminea
Plectranthus parviflorus
Poa labillardieri
Pratia purpurascens
Pultenaea retusa
Pultenaea villosa
Rubus parvifolius
Stellaria flaccida
Themeda australis
Tricoryne elatior
Veronica calycina
Wahlenbergia sp.

2. The total species list of the community is considerably larger than that given in 1 (above), with many species present in only one or two sites or in very small quantity. In any particular site not all of the assemblage listed in 1 may be present. At any one time, seeds of some species may only be present in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site and by its recent disturbance history. The number

of species and the above-ground composition of species will change with time since fire, and may also change in response to changes in fire frequency.

3. Illawarra Lowlands Grassy Woodland has been recorded from the local government areas of Wollongong City, Shellharbour City and Kiama Municipality (within the Sydney Basin Bioregion).

4. Illawarra Lowlands Grassy Woodland includes the Yallah Woodland and Mills' (1997) communities of the Floodplains, communities of the Ridges and Slopes (Dry communities) and communities of the lower escarpment (Moist communities), but does not include Floodplain Communities dominated by *Casuarina* species or rainforest on latite soils.

5. Characteristic tree species in the Illawarra Lowlands Grassy Woodland are *Eucalyptus tereticornis, Eucalyptus eugenioides, Eucalyptus longifolia, Eucalyptus bosistoana and Melaleuca decora.*

6. Illawarra Lowlands Grassy Woodland occurs on relatively gently sloping to undulating lands less than about 200m elevation on Berry Siltstone, Budgong Sandstone and Quaternary alluvium.

7. Illawarra Lowlands Grassy Woodland provides habitat for the endangered orchid *Pterostylis gibbosa.*

8. No areas of Illawarra Lowlands Grassy Woodland are presently included in formal conservation reserves though some occur in small council reserves including Blackbutt Reserve and Croome Road Reserve in Shellharbour.

9. Large areas of Illawarra Lowlands Grassy Woodland have been cleared. Most remnants are small and fragmented and their long term viability is threatened. Some remnants consist of regrowht after clearing or other disturbances. Identified threats include further clearing, grazing, weed invasion, selective logging, rubbish dumping, housing and hobby farm developments and physical damage from recreational activities.

10. In view of the small size of existing remnants, the threat of further clearing and other threatening processes, the Scientific Committee is of the opinion that Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion is likely to become extinct in nature unless factors threatening its survival or evolutionary development cease to operate and that listing as an endangered ecological community is warranted.

Dr Chris Dickman
Chairperson
Scientific Committee

Gazetted: 24/12/99
Exhibition period: 24/12/99 – 4/2/00

Reference: Kevin Mills & Associates (1997) *Ecological Study Figtree Estate and Forest Red Gum Communities of the Illawarra Coastal Plain.* (prepared for Stockland Trust Group Ltd Sydney).

Boral Resources (NSW) Pty Limited

ABN: 51 000 756 507

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 5 - ABORIGINAL HERITAGE ASSESSMENT

Prepared by

Robert Paton Archaeological Studies Pty Ltd

November, 2003

DUNMORE QUARRY PRODUCTION INCREASE

Specialist Consultant Studies Compendium

PART 5 - ABORIGINAL HERITAGE ASSESSMENT

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EXECUTIVE SUMMARY

Robert Paton Archaeological Studies Pty Ltd was commissioned by R. W. Corkery & Co. Pty Limited on behalf of Boral Resources (NSW) Pty Ltd, to carry out the Indigenous cultural heritage component of the environmental assessment for the proposed increase production at the Dunmore Hard Rock Quarry. This report presents the findings of the Indigenous Cultural Heritage Assessment for the Study Area principally covering areas not previously.

The principal aims of this study are as follows.

- To identify any Indigenous cultural heritage sites or areas which may have been previously recorded in the Study Area.
- Review the available archaeological information for the study region.
- Carry out a field survey assessment of the undisturbed parts of Lot 3.
- Record and plot the location of any identified Indigenous cultural heritage sites within the Study Area.
- Identify areas of potential archaeological sensitivity within the Study Area.
- Assess the significance of all Indigenous cultural heritage sites or objects identified within the Study Area.
- Develop a set of management procedures for all heritage sites and areas of potential archaeological sensitivity identified within the Study Area.

The field survey was carried out on the 22nd of September, 2003, by archaeologist Rob Paton and Shane Trindal (Wodi Wodi Elders Corporation).

No Aboriginal archaeological sites were located in the Study Area. Based on these findings, the following recommendations are provided:

1. The quarry extension should be allowed to proceed without further archaeological work in the Study Area. This finding is supported by the Wodi Wodi Elders Corporation as outlined in **Appendix 1**.

2. It should be noted that all Aboriginal objects in NSW are protected under the NPWS Act. Should any objects be uncovered during construction, work at that part of the development should cease and the NPWS should be informed of the find. A management strategy for the objects can then be devised in consultation with appropriate parties. It is an offence under the Acts to disturb or destroy Aboriginal objects without permission. The proponent should also make all its staff and contractors aware of their responsibilities in this regard under the NSW NPWS Act 1974.

3. Copies of this report should be supplied to:

   The NSW NPWS;
   The Wodi Wodi Elders Corporation and the Illawarra Local Aboriginal Land Council

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Boral Resources (NSW) Pty Ltd (Boral) proposes to increase production at the Dunmore Hard Rock Quarry (**Figure 1**) to meet increased demand for its product. Boral proposes to achieve the increased production from within the area already approved for extraction. Boral is seeking development consent that will rationalise the existing development consents and existing use rights provisions to allow a increase in production over 2 years from 1.2 million tonnes per annum (Mtpa) to 2.5Mtpa.

The Dunmore Quarry is located on Lot 1, DP 213575; Lots 3 and 4, DP 1030504; Lot 4, DP 227046; Lot 1, DP 1002951, and Lots 1 and 2, DP 224597. These lots are collectively referred to as the "Project Site". The approved extraction area is also identified on **Figure 2**.

Unlike other lots within the Project Site, Lot 3, DP 1030504 had not been previously surveyed for archaeological sites (Officer and Navin 1992; Haenckel 1986) for previous surveys), as operations on those Lots have been undertaken by virtue of "existing use rights". Accordingly, Boral now requires a survey to be undertaken that addresses the presence (or absence) of Aboriginal heritage items with these lots – referred to as the "Survey Area". These lots cover approximately 69ha, of which 18ha remains relatively undisturbed by quarrying and related activities.

Given that there are already three development consents in place for a number of the existing activities within the wider Project Site, the Department of Infrastructure, Planning and Natural Resources has advised Boral that it can rely on previous assessments (eg for Aboriginal Heritage) within these approved areas to the extent that these assessments are still relevant. Clearly, it will be necessary for this report to refer to previous studies (Officer and Navin 1992; Haenckel 1986) and for the consultation with the Local Aboriginal Land Council to again support previous recommendations.

Robert Paton Archaeological Studies Pty Ltd was commissioned by R. W. Corkery & Co. Pty Limited on behalf of Boral, to carry out the Indigenous cultural heritage component of the environmental assessment. This report presents the findings of the Indigenous Cultural Heritage Assessment for the Study Area as shown on **Figure 3**.

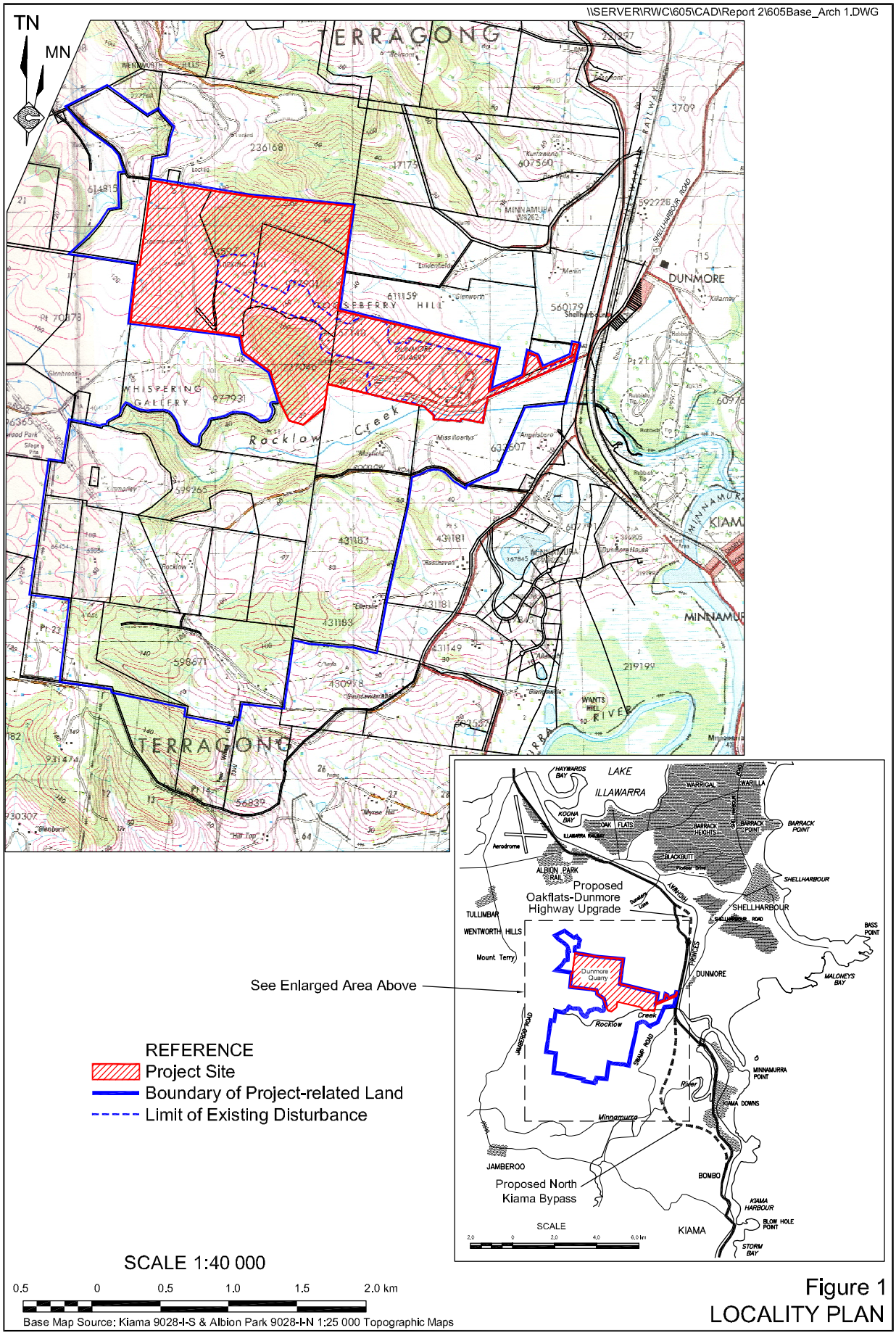


Figure 1
LOCALITY PLAN

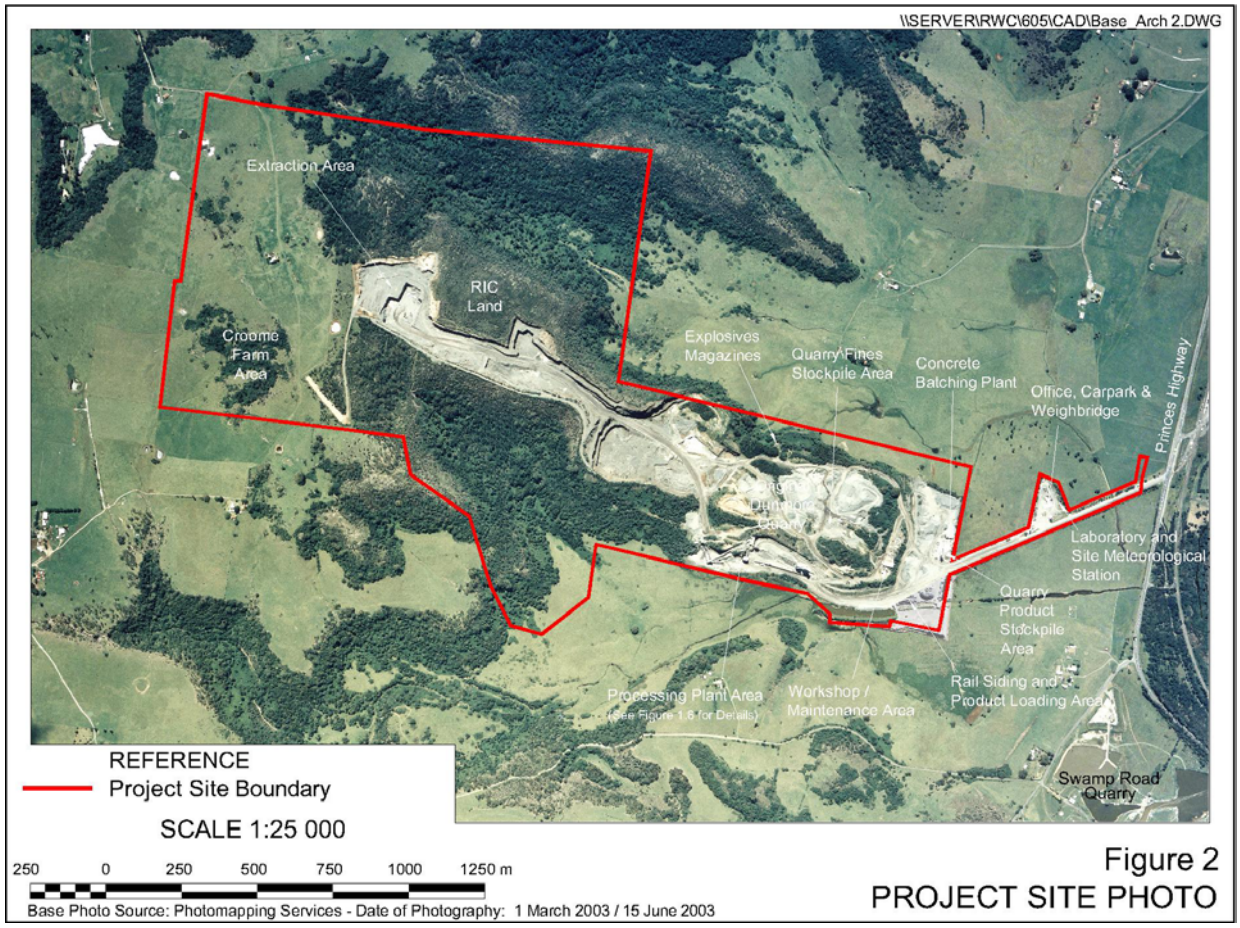
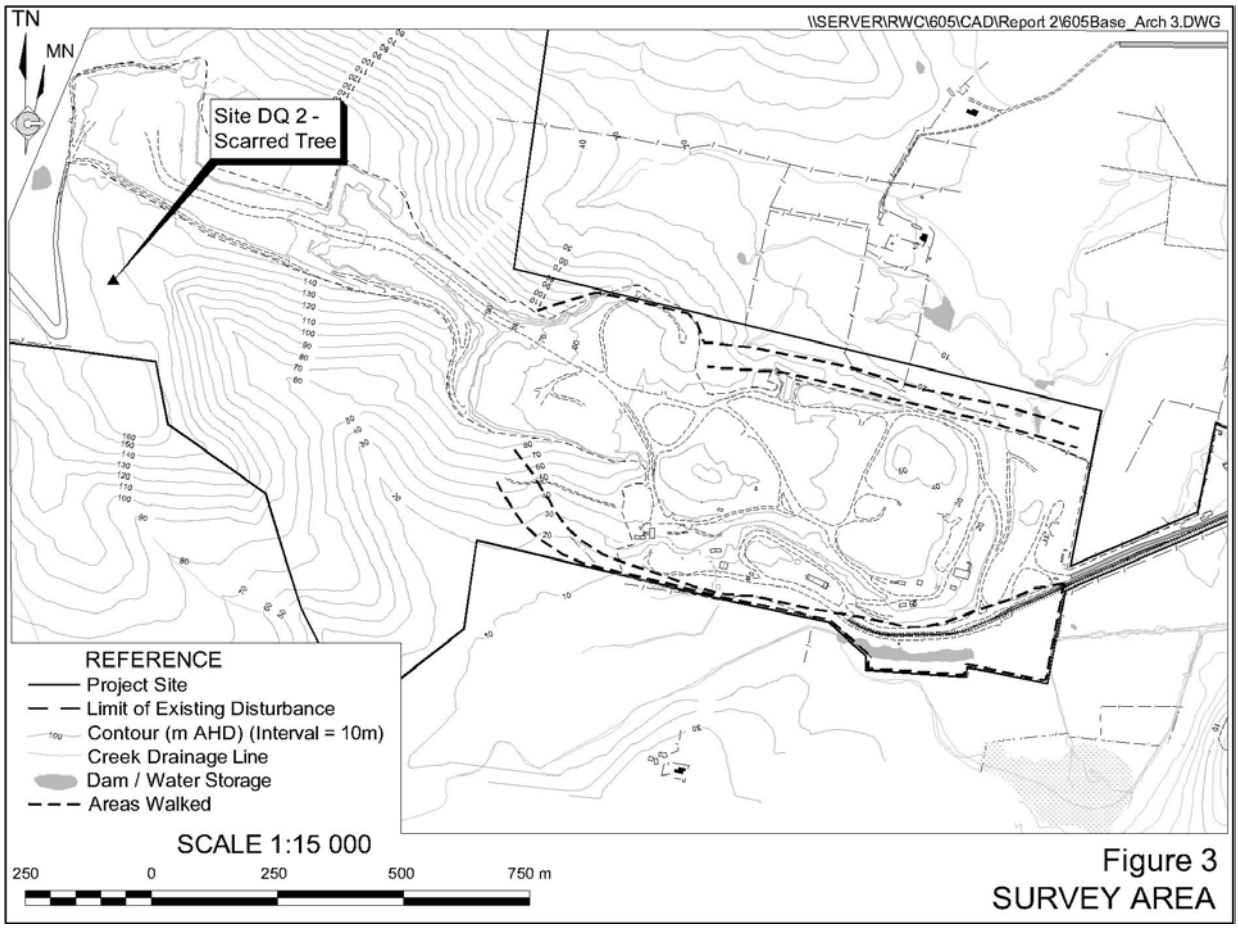


Figure 2
PROJECT SITE PHOTO

1.2 STUDY AIMS

The principal aims of this study are as follows.

- To identify any Indigenous cultural heritage sites or areas which may have been previously recorded in the Study Area.
- Review the available archaeological information for the study region.
- Carry out a field survey assessment of the undisturbed parts of Lot 3.
- Record and plot the location of any identified Indigenous cultural heritage sites within the Study Area.
- Identify areas of potential archaeological sensitivity within the Study Area.
- Assess the significance of all Indigenous cultural heritage sites or objects identified within the Study Area.
- Develop a set of management procedures for all heritage sites and areas of potential archaeological sensitivity identified within the Study Area.



2 CONSULTATION WITH INDIGENOUS GROUPS

Bowdler (1983:26) recognises two kinds of sites that are significant to Aboriginal people. The first relates to pre-contact times, the second to the period since colonisation. Some of these sites may be recognisable due to landscape modification or material remains whereas others may consist of a noticeable but natural physical feature. Bowdler (1983:30) stresses that,

> identification of sacred sites and sites of significance to Aboriginal people is of necessity a matter for Aboriginal people. No-one else can decide either the fact of significance or the degree of that significance to an Aboriginal community, except members of that community.

It is for this reason that members of the Aboriginal community are consulted during heritage studies such as this.

The Department of Environment and Conservation, formerly the NSW National Parks and Wildlife Service (NSW NPWS) also have a policy that Local Aboriginal Land Councils and any relevant groups should be consulted and actively involved in the Cultural Heritage Assessment process. The proposed development site falls within the boundary of the Illawarra Local Aboriginal Land Council. Prior to the survey, the archaeologist contacted the Illawarra Local Aboriginal Land Council by phone. The Land Council advised that heritage issues are facilitated through Mr Jim Davis of the Wodi Wodi Elders Corporation. Mr Davis was contacted and has been consulted regarding the study.

Representatives from this organisation have been involved in the field assessment process, and in the formulation of management recommendations. A letter from the Corporation is included in **Appendix 1** of this report.

3 LEGISLATIVE REQUIREMENTS

3.1 STATE LEGISLATION

Indigenous Cultural Heritage

The protection of indigenous cultural heritage in New South Wales is principally governed by the *National Parks and Wildlife Act 1974* ("the NSW Act").

When seeking approval for development, certain conditions will usually be imposed - one of which is that an assessment be made of any potential impact on sites or places of indigenous cultural heritage.

For the purposes of dealing with indigenous land issues, NSW has been 'divided' into areas each of which are under the control of Local Aboriginal Land Councils ("LALCS"). NSW NPWS requires that 'sufficient consultation' be undertaken with each LALC in which the development is to take place. In addition, NSW NPWS requires that Traditional Owners of land who have lodged a Native Title claim may also be included in the consultation process.

Section 86 of the NSW *National Parks and Wildlife Act 1974* requires that any disturbance of the land (to collect indigenous artefactual material) or collection of that material can only be undertaken under a permit issued by the NSW NPWS. The permit will be issued subject to any terms and conditions that the Director General of NSW NPWS thinks fit (s.88). Again these terms and conditions will include sufficient consultation with LALCs and Native Title claimants. Failure to do so will result in a rejection of the permit application and the inability to undertake any collection of artefactual material (outside of the developmental area) or sub-surface testing.

Each person has a duty to report the discovery of an Aboriginal Object to NSW NPWS within a reasonable period of time unless they have reason to believe that NSW NPWS is already aware of its existence (s.91).

Unless otherwise stated, all legislative section references relate to the National Parks and Wildlife Act 1974 (NSW) which can be accessed at the following Website:
http://www.austlii.edu.au/au/legis/nsw/consol_act

3.2 COMMONWEALTH OF AUSTRALIA

Indigenous

Indigenous cultural heritage is also protected by Federal legislation in the form of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1987*. Any Aboriginal or Torres Strait Islander person or organization may apply to the Commonwealth Minister for a temporary or permanent 'Stop Order' for protection of threatened areas or objects of significant indigenous cultural heritage.

Accordingly failure to carry out a thorough assessment and management process pursuant to the State requirements may result in such an application being made to the Commonwealth, with resultant delays in development.

The Commonwealth Act 'overrides' State legislation if the Commonwealth Minister is of the opinion that the State legislation (or undertaken process) is insufficient to protect the threatened areas or objects. Thus, in the event that an application is made to the Commonwealth Minister for a Stop Order, the Commonwealth Minister will, as a matter of course, contact the Queensland Environmental Protection Agency to ascertain what protection is being imposed by the State and/or what mitigation procedures have been proposed by the landuser/developer.

Unless otherwise stated, all legislative section references relate to the Aboriginal and Torres Strait Islander Heritage Protection Act 1987 (Cth) which can be accessed at the following Website:
http://www.austlii.edu.au/au/legis/cth/consol_act

4 DESCRIPTION OF STUDY AREA

Numerous investigations within Eastern Australia have revealed that the nature and distribution of archaeological sites across the landscape are strongly influenced by environmental factors. The bedrock geology of a region, its landforms, soils, vegetation, and climate, all combine to influence the distribution and availability of resources considered to be of importance to prehistoric Aboriginal groups (these being, plant and animal foods, water, raw materials for tool making, ochre and suitable campsites). Such factors will also affect the ease with which people could travel across the landscape. It stands to reason then, that in order to properly understand, or indeed predict patterns of Aboriginal activity within a region, one must first be familiar with the environmental setting of the study region.

The Study Area is located in the coastal hinterland, on the Illawarra Plain. This coastal plain extends from the coast westward, to the foothills of the Illawarra Escarpment. The plain is at most approximately twenty kilometres wide near Albion Park and comprises low alluvial terraces and gentle dividing ranges and hills. Drainage is predominately to the east, with streams typically draining into estuaries, and coastal wetlands and lacustrine basins. Major fluvial corridors in the local area include the Rocklow Creek which now drains into the Minnimurra River. Prior to modern drainage channels being built these waterways on the gently sloping plain were unconfined by topography and had extensive floodplains (Nanson & Young 1981).

Generally the coastal plain is comprised of Permian rocks from the Sydney basin, belonging to the Shoalhaven Group, together with Quaternary sediments on the valley floors and coastal margins. Berry Siltstone and Budgong sandstone are also found in this area, and rounded pebbles and cobbles of basic to intermediate volcanics and quartz are to be found within conglomerate beds (Navin 1987). To the west of the plain, foothill spurs have been formed where latite flows outcrop near the escarpment, such as at Marshall Mount and north of Duck Creek. One of these isolated latite hills actually forms the spur which comprises the present Study Area. This spur was originally a prominent southeast sloping ridge. Quarrying over several decades has removed the core of the ridge, leaving only a narrow rim of the original feature. This remnant lip has steeply sloping sides and has been extensively disturbed over decades by ancillary quarrying activities.

Prior to European settlement, almost all of the coastal plain, the area below 100 m a.s.l., was forested, the forested area being dependent on rainfall, soils and moisture. Today, most of the original vegetation on the coastal plain has been removed. The escarpment zone, above 100 m a.s.l. supported both rainforest, which was largely confined to gullies and the more sheltered benches, where there was protection from westerly winds and higher moisture supplies, and dense sclerophyll forest dominated by eucalypts (Mills 1983). Descriptions by early settlers of the Illawarra region emphasise the beauty and lushness of its forests, often giving the impression that the region was once covered by luxuriant rainforest. In the Wollongong-Shellharbour-Kiama area, only 8% forest cover remains below 100m elevation and the composition of the forest cover on the escarpment slopes and plateau has been changed through logging, clearing and altered fire regimes since European settlement.

Existing vegetation in the Study Area typically reflects the wider changes that have occurred in the region. Clearing, agriculture, changed fire regimes and most importantly quarrying have resulted in all of the natural vegetation being removed at various times. What remains today is a scrubby regrowth consisting largely of imported weeds with a small amount of natural regrowth.

In terms of archaeology, perhaps the most significant feature of the landscape is its heavily disturbed character. Of the 69ha comprising the study area, only 18ha remains relatively in tact. The remaining 51ha have been entirely removed to a depth of 40-50 metres over many years of quarrying or is used as an access road, railway line and equipment storage areas. What remains of the original ridge today is a hollowed our rim of original high ground. This narrow strip of land comprises the outer slope of the ridge and as such it tends to be very steeply sloping. Years of quarrying and other activities have had a marked and significant effect on this “original” terrain. Much of it is covered by quarry activities and has been modified by heavy machinery movement and quarry-related activities. Only a small percentage could be regarded in any sense as being untouched.

5 STUDY METHODOLOGY

In order to fulfil the outlined study aims, a three stage methodological approach has been adopted for this study.

Stage 1 (The Background Research)
Stage 1 entailed the background component of the project, wherein the following tasks were undertaken:

- The Illawarra Local Aboriginal Land Council (LALC) and the Wodi Wodi Elders Corporation were contacted by phone and informed of the project details. The purpose of this initial contact was to gauge any concerns that these groups may have, and to invite representatives from the groups to participate in the assessment process.

- A review was made of the NSW NPWS AHIMS heritage site register, to determine if any previously identified Aboriginal sites were located within, or in close proximity to the Study Area.

- The following information was collated :
  - 1 : 25 000 maps of the Study Area;
  - Ethnohistoric and Anthropological literature for the region;
  - Archaeological reports for the Study Area and surrounding region;
  - Environmental reports;
  - References to the land use history of the Study Area.

Stage 2 (FieldWork)
Stage 2 of the project entailed the implementation of a field survey program to locate and record sites within the defined Study Area. The field survey was carried out on the 22nd of September, 2003, by archaeologist Rob Paton and Shane Trindal (Wodi Wodi Elders Corporation).

The Study Area was surveyed by walking numerous transects (**Figure 3**). The transects were placed to achieve optimal coverage. The surveyors inspected any places where visibility was good or there seemed to be a prime site location based on the predictive model below. Where such areas were noted (such as trees, raised flat ground or erosion scalds) the surveyors would divert from the transects to investigate for sites. In addition, all areas of very high ground surface visibility, such as roads and tracks, were surveyed. By this method a total of approximately 3 linear kilometres was inspected. Approximately 50 metres could be inspected along each transect by each surveyor.

Stage 3
Stage three of the project involved the analysis of the data obtained from the field survey. In the analysis, specific attention was paid to:

- the relationship between site types, site densities and environmental factors ;
- an assessment of the results, which takes into account variability in such factors as surface visibility, survey intensity and surveying approaches.

5.1 CONDITIONS OF VISIBILITY

Clearly conditions of ground surface visibility will affect how many sites are found. Visibility may also skew the results of a survey. If, for example, conditions of ground surface visibility vary dramatically between environmental zones, then this in turn will be reflected in the numbers of sites reported for each zone. Zones with the best visibility may be reported as having the most sites (because they are visible on the ground), while another zone with less visibility, but perhaps more sites, will be reported as having very little occupation. It is important therefore to consider the nature of ground surface visibility as part of any archaeological investigation.

The main constraint encountered during the course of this survey was average surface visibility (15-20%). Although, the landscape has been subjected to tree clearance, current grass growth patterns limit today's surface visibility in much of the Study Area. Fortunately, there are several tracks around the rim of the quarry which afford good visibility in large sections.

5.2 COVERAGE ANALYSIS

Witter (Witter and Hughes 1983) discusses the concept of *actual* area surveyed for any study, given that conditions of ground surface visibility and sedimentation etc. will vary from area to area. This is a useful measurement to allow cultural resource managers to assess surveys from adjacent areas and it also allows some meaningful calculation of the actual sample size surveyed.

Witter has calculated actual areas surveyed via the formula: (D1) x (s) x (v) x (b) = (D2) where:

D1 = area in metres square surveyed. In this case approximately 150,000 square metres was intensively surveyed in the Study Area given that 3,000 metres in distance was walked (2 surveyors x 1.5km each) and an area of about 50 metres around the line was closely inspected (i.e. 3000 metres surveyed and about 50 metres around the transects closely inspected: 3,000 x 50 = 150,000).

s = index of sedimentation
0.1 = aggrading surface
0.5 = stable or uncertain
1.0 = degrading surface (applies)

v = index of visibility
0.1 = negligible visibility
0.2 = 10% visibility
0.5 = 20% visibility (applies)
1.0 = 30% and greater visibility

b = background effects (i.e. the presence of natural quartz)
0.1 = massive amounts of natural quartz
0.5 = small amounts of natural quartz
0.9 = minimal amount of natural quartz (applies generally in this case)
1.0 = no natural quartz

D2 = distance in square metres of effective coverage.

Applying the formula the following calculations results:

The total area of the study is approximately 690 000sqm (69ha), but only 180,000 sqm (18ha) could be inspected, as the remainder has been quarried. As there is no significant topographic variation across the unquarried portion of the Study Area it is treated as a single unit.

A total of 150,000 square metres was inspected. This means that about 80% of the unquarried portion of the Study Area was inspected in some form. However, actual coverage is considerably less when the formula is applied (150,000 x 1.0 x 0.5 x 0.9: the actual amount covered is 67,500 sqm, or about 37% of the unquarried portion of the Study Area.

6 ETHNOHISTORIC ACCOUNTS FOR THE REGION

Ethnohistory entails the use of historical literature as a source for constructing ethnographic analogies and models in the study of the prehistory and contact history of indigenous peoples (McBryde 1979). Although ethnohistoric accounts have been recognised as a valuable source for providing insights into the lifeways of prehistoric people, their application can be problematical. These problems relate primarily to the nature of the sources, their accuracy and validity.

The Illawarra region falls into the tribal area delineated by Tindale (1974) as Wodi Wodi, an area which extends from the Shoalhaven River, north to Wollongong and west as far as Picton, Marulan and Moss Vale.

This assessment is similar to that based on a compilation of recent oral traditions amongst the south coast Aboriginal groups. JE Mathews (c 1960) records that Nowra is located on the boundary between two tribes, the Wandanian to the south and the Wodi Wodi to the north (in Tindale 1974). This boundary also marks a language difference, with the Wodi Wodi speaking Dharawal and Wandanian speaking Dhurga. Both of these languages form part of the Yuin linguistic group, which extends southward from Sydney almost to the Victorian border. Contrary to Tindale's tribal boundary along the Shoalhaven River, ethnographers have tended to describe the Aborigines and linguistics of the lower Shoalhaven in terms of one district (Capell 1963:S36; Dixon in Eades 1976:4). It is more probable that the tribal boundary on the coastal plain was further south and, concomitant with the linguistic evidence, adjacent to Jervis Bay. A boundary in this region would be roughly equivalent with the Shoalhaven-Jervis bay watershed. Ethnographic and historical references recognised a single cultural character in the Lower Shoalhaven district. There is no mention of differences amongst the 'Shoalhaven Aboriginals', according to which bank of the river they came from. Howitt refers to the language of the Shoalhaven area as 'Gurungada' (Howitt: 1883, 1904). In all references, the Shoalhaven tribes are apparently treated collectively.

First non-Aboriginal contact with the Aborigines of the area is attributed to two explorers - ensign Francis Barrallier who crossed the area in November 1802, and George Caley, a servant of Joseph Banks, who reached the area in December 1802. European settlement began in the district in 1810. During the following decade a series of conflicts between the increasingly dispossessed Aborigines and the expanding white colony indicates the importance of these fertile areas to Aboriginal subsistence. However by the later 1820s hostilities were no longer evident . The traditional subsistence economy appears to have been predominantly replaced by the 1840s, with Aborigines being employed by Europeans on farms or selling their traditional food items for European goods (Hassell 1902, Jervis 1935, 1949). Specific ethnohistoric references to the Aborigines of the Illawarra Ranges are few. Robert James, a resident of the area, noted that 'blacks were in considerable numbers at Mount Kembla. A camp of about one hundred of the race was situated on the banks of American Creek, near the bottom of the present Mount Kembla incline.

7 ARCHAEOLOGICAL BACKGROUND

7.1 LOCAL STUDIES

No archaeological surveys have been undertaken of the immediate Study Area, and the NSW NPWS AHIMS register shows that there are no recorded sites or surveys within the locality. A search of the register for a wider area 10 km x 10 km showed that 36 sites are known. These consist of 13 open artefacts scatters, 20 middens, 1 scarred tree and 2 grinding groove sites (see **Appendix 2** for AHIMS Report). Such sites as discussed below, are typical for the region.

Officer and Navin (1992) surveyed a portion of a ridgeline spur and plateau located at the Boral Dunmore Quarry, to the west of the present Study Area. The surveyed area is located on a topographically dominant ridge complex, which extends from the Hawkesbury sandstone plateau of the Illawarra escarpment near Yellow Rock, to the coastal plain at Blackbutt. The present Study Area is part of this same ridge. Two Aboriginal sites, an artefact scatter (DQ1

52-2-1791) and a scarred tree (DQ2 52-5-0300), were located during their survey. The scarred tree is located within the Croome Farm extraction area approved for extraction by Shellharbour City Council in 1996. Boral is separately seeking a Section 90 Consent under the *National Parks and Wildlife Act 1974* to remove the tree from the extraction area and position it at a location nominated by the Wodi Wodi Elders Corporation. Haenckel (1986) had previously surveyed another section of this ridge complex for the Boral Quarry – no sites were located during the course of this survey.

7.2 REGIONAL STUDIES

7.2.1 Chronology

Previous studies along the south coast of New South Wales have demonstrated Aboriginal occupation of the region dating back to the height of the last glacial period some 20,000 years ago (Lampert, 1971; Bowdler, 1976). During this period, sea level was much lower than it is today and consequently the shoreline was up to 16km to the east of the present coast. Present sea levels stabilised some 6-7,000 years ago and most coastal sites date from this period. Coastal sites older than 7,000 years would have been submerged by rising sea levels associated with the melting of the glaciers and ice-caps.

Boot (1993) excavated a series of sites in the coastal hinterland. Seven of these sites were rock shelters, with the remaining three sites being open artefact scatters. Boot (1993) has obtained radiocarbon dates for each of these sites. For the rock shelters, the dates range between 250+ 80 BP and 12040 + 630 BP (years Before Present). For the open sites, the dates ranged between 850 + 160 BP and 4050 + 210 BP. These dates show conclusively that the coastal ranges were occupied during the late Pleistocene. Prior to Boot's investigation, the oldest dates for Aboriginal occupation of the coastal ranges was 3770 + 150 BP, which was obtained by Flood (1980) from the Sassafras 1 site (Boot 1993). Based on these findings, Boot (1993) is now of the opinion that Aboriginal occupation of the south coast hinterland during the Pleistocene was probably widespread but sparse. Boot (1993) further postulates that occupation of the hinterland became widespread and very dense in the last 4000 years, particularly since around 3000BP.

7.2.2 Occupation Patterns

The amount of archaeological survey undertaken on the Illawarra coastal plain is considerable and directly reflects the degree of development which has occurred over the past two decades. The most commonly encountered archaeological sites in the region are shell middens and open campsites represented by scatters of stone artefacts. Nearly all of these sites are located directly along the coastal fringe.

Relatively few Aboriginal sites have been located in the course of archaeological surveys within the western coastal plain and foothills region. There are three possible reasons for the paucity of sites. Firstly, lack of ground surface visibility poses a considerable constraint to site detection. Secondly, these areas represent a relatively less economically attractive area than the adjacent coastal and estuarine margins – resource zones which offered the most cost-productive return in terms of food exploitation. A third and related reason may be that most investigations have taken place in the lower country immediately abutting the coastline. Here most sites consist of shell middens and/or surface scatters of stone artefacts associated with the exploitation of the coastal fringe.

All of the studies located in the foothills and associated plains below the Illawarra Escarpment have been either scarred trees or small artefact scatters (sometimes associated with archaeological deposit) on flat ground in close proximity to watercourses. Typically, artefact scatters are small and sparse and are located on dry level ground, both on ridgelines in the foothills and on the coastal plane. They are, with few exceptions, located within fifty metres of drainage lines (Navin 1987:44, 51).

Surveys in the Illawarra foothills have been undertaken by Haglund (1983) and Navin (1992b) at Wongawilli, by Koettig (1987) at Balgownie, at O'Briens Drift and Kemira Valley by Navin (1992b) and by Navin (1993b) at Figree. Prompted mostly by low ground surface visibility, limited sub-surface investigations have been undertaken west of Wollongong by Haglund (1983) at Wongawilli, Silcox (1987) at Balgownie, Saunders (1993) at West Dapto and Navin (1987, 1988) at Wollingurry Creek, Duck Creek, Yallah Gully and Macquarie Rivulet. To date, however, all sub-surface testing has confirmed the results obtained from surface surveys.

The archaeology of the forested hinterland is known mainly from larger studies undertaken by William and Barber (1993) Poiner (1976) and Byrne (1983), Boot (1993) and Knight (1996).

Williams and Barber (1993b) undertook a predictive assessment of Optus Communications' fibre optic cable route between Kembla Grange South and the Victorian border. They proposed a site location model, based on previous archaeological studies, which postulated that sites were 'likely to be concentrated on elevated ground near watercourses in undulating flat terrain, while ridge crests and spur crests were deemed the most sensitive areas in more hilly country' (1995:5). Subsequent limited field inspections located thirteen previously unrecorded sites.

Poiner (1976) argued that Aboriginal occupation of the south coast usually focused upon the resource rich and dependable coastline with occasional hunting and gathering forays into the forested hinterland when the coastal resources were in short supply.

Byrne (1983) completed a systematic study of some of the southern NSW forests and discovered that the most frequently occurring sites in the hinterland are small, surface scatters of stone artefacts. Byrne (1993) found that these sites are most likely to be found on flat ground along ridgelines or on gentle slopes overlooking creeklines. Byrne (1983) interpreted the abundance of small open campsites along ridgelines in the hinterland as reflecting patterns of movement through the generally rugged terrain rather than the result of long-term settlement. Byrne's (1983) report is important not only because he describes the suite of small campsites he found, but also because it emphasises the problems of discovering sites in this difficult terrain. He decisively points to the need for the development of new methods of survey to find sites and to understand their character. His recognition of this need gave a fillip to research directed towards developing new approaches.

At about the same time the Department of Prehistory and Anthropology at the Australian National University was continuing its study of sites along the NSW South Coast near Kiola, under the Directorship of Mr Ian Farrington, Lecturer in Prehistory. Until this point the work, involving Honours students, had primarily focussed on the coastal strip. However, interest began to shift inland as it became apparent that many sites were visible along public roads and forest tracks. Several years later, students have recorded several hundred sites in the hinterland between Ulladulla and Moruya. These sites provide a significant resource for understanding the nature of hinterland occupation.

The archaeological data gathered by the students over the years has been compiled and analysed by Knight (1996). Knight (1996) acknowledges that the analysis of the collated data was carried out at a basic level. However, several important trends in site type distribution were identified. These are as follows.

1) Sites were found to occur in varying degrees throughout all of the environmental zones present in the region.

2) The vast majority of hinterland sites are small surface scatters of stone artefacts numbering less than ten artefacts. Most artefacts at these sites are amorphous flakes and flaked pieces made from quartz, which occurs naturally throughout the region.

3) Site complexity (in terms of frequency occurrence of formal tools at sites) appears to be higher for artefact scatters of the hinterland zone compared to along the coast. In the hinterland zone, formal tool occurrence is apparent for sites of all sizes on all land form features.

4) Large open artefact scatters in the hinterland zone tend to be located at high point linear feature junctions. These locations also tend to be indirectly associated with nearby river or stream valleys.

5) Hinterland valley locations exhibit a lower frequency of larger sites. However, the largest artefact scatters recorded in the study are located on or near stream bank features. The highest frequency of sites containing formal tools also occur at valley locations. It would therefore appear that site size and site complexity is influenced by close proximity to permanent water, mainly large creeks and rivers.

6) Rock shelter sites and grinding groove sites are essentially influenced by geomorphological factors. However, there also appears to be some degree of Aboriginal site selection in operation with regard to the location of grinding grooves.

As part of his PhD Thesis, Boot (1993) carried out extensive research in the hinterland region west of Nowra. In the course of the field surveying, Boot (1996) recorded a total of 410 open artefact scatters, 294 isolated finds and one midden site. Based on the analysis of the data, Boot (1993) made the following observations for site distribution in his Study Area.

1) The greatest density of sites tend to occur along major river valleys and broad well watered ridgelines.

2) Major river valleys show a much higher overall artefact density compared to other environmental zones.

3) The largest sites (in terms of artefact numbers) occurred within the major river valleys. The smallest sites occur at high altitudes, showing that the exploitation of these high altitude areas was not intensive.

Boot (1993) states that the data indicates that Aboriginal people accessed all areas of the south coast hinterland, but that major river valleys appeared to have been favoured over other environments. Some major ridgelines also appear to be a focus of activity, particularly those that were heavily forested (Boot 1993). These areas of high resource availability were probably repeatedly visited and occupied for long periods. Most of the open sites recorded in the hinterland are small, and are likely to be representative of short term campsites (Boot 1993).

7.4 A PREDICTIVE STATEMENT

Based on the above archaeological studies, and on the local environment of the Study Area, it is predicted that in the vicinity of the Study Area:

- sites will generally tend to occur on ridgelines, flatter areas and adjacent to stream banks, with the larger and more complex sites being in relatively close proximity to permanent fresh water; and
- sites are very unlikely to occur on the steeply sloping terrain.

Given that:

- the entire central portion of the ridge on Lot 1 has been quarried;
- there are no local fresh water sources in the Study Area;
- the remaining small rim of the Study Area comprises steeply sloping terrain; and
- the terrain that is still in tact has been very highly disturbed.

It is very unlikely that any Aboriginal archaeological sites will be located in the Study Area.

8 RESULTS AND DISCUSSION

No Aboriginal archaeological sites were located within the Study Area.

The results of this investigation were predictable based on the review of environmental factors and previous archaeological studies. As described previously it was considered very unlikely that Aboriginal people would have extensively used the Study Area, though they may have occasionally passed through. Based on this assessment it is unlikely that the proposed development will affect any Aboriginal objects.

As previously mentioned in Section 7.1, the scarred tree within the Croome Farm extraction area is the subject of a Section 90 Application to remove it. That application is fully supported by the Wodi Wodi Elders Corporation who have provided correspondence in support of Boral's Section 90 Application.

9 RECOMMENDATIONS

No Aboriginal archaeological sites were located in the Study Area. Given the intensity of this study, it seems unlikely that any other sites would be located by further general survey work.

Based on these findings, the following recommendations are provided:

1. The quarry extension should be allowed to proceed without further archaeological work in the Study Area. This finding is supported by the Wodi Wodi Elders Corporation as outlined in **Appendix 1**.

2. It should be noted that all Aboriginal objects in NSW are protected under the NPWS Act. Should any objects be uncovered during construction, work at that part of the development should cease and the NPWS should be informed of the find. A management strategy for the objects can then be devised in consultation with appropriate parties. It is an offence under the Acts to disturb or destroy Aboriginal objects without permission. The proponent should also make all its staff and contractors aware of their responsibilities in this regard under the NSW NPWS Act 1974.

3. Copies of this report should be supplied to:

   The NSW NPWS;
   The Wodi Wodi Elders Corporation and the Illawarra Local Aboriginal Land Council

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PLATES



Plate 1 Northern rim of unquarried ground, showing highly disturbed terrain



Plate 2 Northern rim of unquarried ground showing disturbance



Plate 3 Showing the very steep terrain around the rim of the quarry



Plate 4 showing the quarried section of Lot 1

APPENDICES

(No. of pages excluding this page = 10)

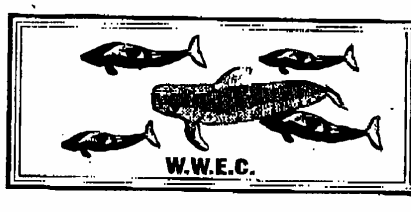
Appendix 1: Letter from Wodi Wodi Elders Corporation

Appendix 2: NPWS AHIMS Report

APPENDIX 1

(No. of pages excluding this page = 1)

(Letter from Wodi Wodi Elders Corporation)



Wodi Wodi Elders Corporation,
484 North Cliffe Drive,
Berkeley, N.S.W. 2506

Phone: (02) 4272 9280

8 October 2003

Re: Site Survey of Lot 1 DP571406 Dunmore Hard Rock Quarry

As part of an archaeological investigation for this area, we inspected the above area.

This area is mostly mined and the small area around the edge of the mine which we inspected was highly disturbed and very rugged.

No sites were located.

We are happy for the development in this area to proceed and we endorse the previous surveys of the other areas.

Yours sincerely

JIM DAVIS - SENIOR SITES OFFICER.

APPENDIX 2

(No. of pages excluding this page = 9)

(NPWS AHIMS Report)

Your Ref:
Our Ref: AHIMS #8298

Rob Paton
14 Fenton st
Downer ACT 2602

Wednesday, 17 September 2003

Attention:

Dear Sir or Madam:

NSW NATIONAL PARKS AND WILDLIFE SERVICE

ABN 30 841 387 271

Re: AHIMS Search for the following area at Wollongong
Zone 56 Eastings: see attached report- Northings: see attached report-

I am writing in response to your recent inquiry in respect to Aboriginal objects and Aboriginal places registered with the NSW National Parks and Wildlife Service (NPWS) at the above location.

A search of the NPWS Aboriginal Heritage Information Management System (AHIMS) has shown that 40 Aboriginal objects and Aboriginal places are recorded in or near the above location. Please refer to the attached report for details.

The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not to be made available to the public.

The following qualifications apply to an AHIMS search:

- AHIMS only includes information on Aboriginal objects and Aboriginal places that have been provided to NPWS;
- Large areas of New South Wales have not been the subject of systematic survey or recording of Aboriginal history. These areas may contain Aboriginal objects and other heritage values which are not recorded on AHIMS;
- Recordings are provided from a variety of sources and may be variable in their accuracy. When an AHIMS search identifies Aboriginal objects in or near the area it is recommended that the exact location of the Aboriginal object be determined by re-location on the ground; and
- The criteria used to search AHIMS are derived from the information provided by the client and NPWS assumes that this information is accurate.

All Aboriginal places and Aboriginal objects are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and it is an offence to destroy, damage or deface them without the prior consent of the NPWS Director-General. An Aboriginal object is considered to be known if;

- It is registered on AHIMS;
- It is known to the Aboriginal community; or
- It is located during an investigation of the area conducted for a development application.

Head Office
43 Bridge Street
PO Box 1967
Hurstville NSW
2220 Australia
Tel: (02) 9585 6111
Fax: (02) 9585 6555
www.npws.nsw.gov.au

If you are considering undertaking a development activity in the area subject to the AHIMS search, NPWS would recommend that an Aboriginal Heritage Assessment be undertaken. You should consult with the relevant consent authority to determine the necessary assessment to accompany your development application.

Yours Sincerely

Vanessa Kendall
Aboriginal Information Officer
Information Systems Unit
Cultural Heritage Division
Phone: (02) 9585 6345
Fax: (02) 9585 6325



List of Sites (List - Short)

ahims8298 Wollongong

Grid Reference Type = AMG Zone = 56 Easting From = 295000 Easting to = 305000 Northing From = 6164000 Northing to = 6174000 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid.Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)
52-2-1159	Karro Bay;Albion Park;	AMG	56	299400	6173680	ETM, SHL, AFT,	Midden	Anderson,A (24-SEP-85)	
		Status Valid							
		Primary Contact							
52-2-1791	DQ1;	AMG	56	299200	6168660	AFT,	Open Camp Site	Officer,K (01-SEP-92)	1992,
		Status Valid							
		Primary Contact							
52-5-0065	Minnamurra River;	AMG	56	296025	6164672	GDG	Axe Grinding Groove		
		Status Valid							
		Primary Contact							
52-5-0066	Minnamurra River;	AMG	56	296025	6164672	ART,	Rock Engraving	ASRSYS, (01-JAN-00)	
		Status Valid							
		Primary Contact							
52-5-0072	Minnamurra;Glengowrie;	AMG	56	301450	6165490	ETM, SHL, AFT,	Midden		687, 1662, 2048,
		Status Valid							
		Primary Contact							
52-5-0076	Shellharbour;	AMG	56	304662	6170680	AFT,	Open Camp Site		2048,
		Status Valid							
		Primary Contact							

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List of Sites (List - Short)

ahims8298 Wollongong

Grid Reference Type = AMG Zone = 56 Easting From = 295000 Easting to = 305000 Northing From = 6164000 Northing to = 6174000 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid.Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)
52-5-0112	Minnamurra;	AMG	56	302052	6165157	ETM, SHL, AFT,	Midden	Sullivan,K (01-JAN-00)	2048,
		Status Valid							
		Primary Contact							
52-5-0116	Dunmore;Killalea;	AMG	56	303852	6167475	ETM, SHL, AFT,	Midden	Sullivan,K (01-JAN-78)	
		Status Valid							
		Primary Contact							
52-5-0117	Minnamurra;	AMG	56	301856	6165793	AFT,	Open Camp Site	Sullivan,K (01-JAN-00)	
		Status Valid							
		Primary Contact							
52-5-0118	Dunmore;	AMG	56	304255	6168860	AFT,	Open Camp Site		
		Status Valid							
		Primary Contact							
52-5-0159	Tabbagong;Tabbagong 1;	AMG	56	301655	6165336	ETM, SHL, AFT,	Midden		
		Status Valid							
		Primary Contact							
52-5-0160	Minnamurra;	AMG	56	301143	6164535	ETM, SHL, AFT,	Midden	ASRSYS, (01-JAN-00)	1472,
		Status Valid							
		Primary Contact							

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AHIMS
Aboriginal Heritage Information Management System

List of Sites (List - Short)

ahims8238 Wollongong

Grid Reference Type = AMG Zone = 56 Easting From = 295000 Easting to = 305000 Northing From = 6164000 Northing to = 6174000 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)
52-5-0162	Minnamurra River;Gainsborough Estate;	AMG	56	302350	6164600	ETM,SHL,AFT,	Midden	Wellington,R. (30-OCT-82)	
		Status Valid							
		Primary Contact							
52-5-0166	Shell Harbour;Shell Harbour 1;	AMG	56	302550	6170400	AFT,	Open Camp Site		656,
		Status Valid							
		Primary Contact							
52-5-0167	Minnamurra;Minnamurra Spit 2;	AMG	56	303250	6166700	ETM,SHL,AFT,	Midden		
		Status Valid							
		Primary Contact							
52-5-0168	Minnamurra;Minnamurra Spit 1;	AMG	56	303450	6166280	ETM,SHL,AFT,	Midden	ASRSYS, (01-JAN-00)	
		Status Valid							
		Primary Contact							
52-5-0169	Minnamurra;Bass Point SRA;	AMG	56	302750	6167400	ETM,SHL,AFT,	Midden	Sullivan,M. (01-JAN-83)	
		Status Valid							
		Primary Contact							

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ahims8298 Wollongong

Grid Reference Type = AMG Zone = 56 Easting From = 295000 Easting to = 305000 Northing From = 6164000 Northing to = 6174000 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid.Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)
52-5-0190	Koona Bay 1;Albion Park;	AMG	56	298500	6173200	ETM,SHL,AFT,	Midden	Anderson,A (20-AUG-85)	
		Status Valid							
		Primary Contact							
52-5-0199	Killalea Beach;S.R.A.;Albion Park;	AMG	56	304150	6168000	ETM,SHL,AFT,	Midden		
		Status Valid							
		Primary Contact							
52-5-0200	Minnamarra;S.R.A.;Albion Park;	AMG	56	302840	6166930	ETM,SHL,AFT,	Midden		
		Status Valid							
		Primary Contact							
52-5-0201	Dunmore Midden;Shellharbour Waste Disposal Dump;	AMG	56	302000	6167600	AFT,	Open Camp Site	Haglund,L (21-FEB-85)	901,
		Status Valid							
		Primary Contact							
52-5-0208	Bevans Island Midden 1;	AMG	56	303290	6173200	ETM,SHL,AFT,	Midden	Dallas,M (01-SEP-87)	1233,
		Status Valid							
		Primary Contact							

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ahims8298 Wollongong

Grid Reference Type = AMG Zone = 56 Easting From = 295000 Easting to = 305000 Northing From = 6164000 Northing to = 6174000 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)
52-5-0213	Dunmore Midden;	AMG	56	302000	6167800	AFT, ETM, SHL,	Midden Open Camp Site	Bonhomme,T (01-FEB-85)	901,
		Status Valid							
		Primary Contact							
52-5-0221	Kurrura point;	AMG	56	298800	6173600	ETM, SHL, AFT,	Midden		1330,
		Status Valid							
		Primary Contact							
52-5-0222	Mogurah Point;	AMG	56	299600	6174000	ETM, SHL, AFT,	Midden		1330,
		Status Valid							
		Primary Contact							
52-5-0235	Tabbogong;	AMG	56	297200	6167000	GDG	Axe Grinding Groove		1330,
		Status Valid							
		Primary Contact							
52-5-0240	Min 1;	AMG	56	300650	6164650	ETM, SHL, AFT,	Midden	Koettig,M (17-AUG-88)	1473,
		Status Valid							
		Primary Contact							

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AHIMS
Aboriginal Heritage Information Management System

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ahims8298 Wollongong
Grid Reference Type = AMG Zone = 56 Easting From = 295000 Easting to = 305000 Northing From = 6164000 Northing to = 6174000 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)
52-5-0241	Minnamurra Site 1;	AMG	56	302800	6165900	ETM, SHL, AFT,	Midden	Liley,I (01-APR-87)	1525,
		Status Valid							
		Primary Contact							
52-5-0242	Minnamurra Site 2;	AMG	56	302900	6165500	ETM, SHL, AFT,	Midden	Liley,I (01-APR-87)	1525,
		Status Valid							
		Primary Contact							
52-5-0243	Green Three"Minnamurra Golf Course";	AMG	56	302300	6165820	ETM, SHL, AFT,	Midden		
		Status Valid							
		Primary Contact							
52-5-0251	Dunmore 1;	AMG	56	301540	6166460	AFT,	Open Camp Site		687, 1662, 2048,
		Status Valid							
		Primary Contact							
52-5-0252	Dunmore 2;	AMG	56	301380	6166530	AFT,	Open Camp Site		1662,
		Status Valid							
		Primary Contact							
52-5-0253	Dunmore 3;	AMG	56	301535	6166930	AFT,	Open Camp Site		687, 1662, 2048,
		Status Valid							
		Primary Contact							
52-5-0254	Dunmore 4;	AMG	56	301480	6167260	AFT,	Open Camp Site		1662,
		Status Valid							
		Primary Contact							

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List of Sites (List - Short)

ahims8298 Wollongong

Grid Reference Type = AMG Zone = 56 Easting From = 295000 Easting to = 305000 Northing From = 6164000 Northing to = 6174000 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid.Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)
52-5-0255	Dunmore 5;	AMG	56	301400	6167110	AFT,	Open Camp Site		1662,
		Status Valid							
		Primary Contact							
52-5-0300	DQ2;	AMG	56	299130	6168350	TRE,	Scarred Tree	Officer,K (01-SEP-92)	1992,
		Status Valid							
		Primary Contact							
52-5-0310	EGP 3-34;Stockyard Mountain;Eastern Gas Pipline;	AMG	56	296370	6168200	AFT,	Isolated Find	Navin,K (01-JUL-95)	
		Status Valid							
		Primary Contact							
52-5-0311	EGP 3-35;Eastern Gas Pipline;	AMG	56	296370	6168200	AFT,	Open Camp Site	Navin,K (01-JUL-95)	
		Status Valid							
		Primary Contact							
52-5-0397	TEST PITTING AREA 15	AMG	56	299650	6164900	AFT,		Hays,S (01-OCT-99)	
		Status Valid							
		Primary Contact							
52-5-0413	Duke -9	AMG	56	297760	6168130	AFT,		Hays,S (01-AUG-99)	
		Status Valid							
		Primary Contact							

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