



Marulan South Quarry *Environmental Assessment Report*

Final
Volume 1

for Boral Resources (NSW) Pty Ltd

October 2006

www.erm.com



Delivering sustainable solutions in a more competitive world



Signature:



Name:

Karl Rosen

Mike Shelly

David Snashall

Date:

27th October 2006

27th October 2006

27th October 2006

This report was prepared in accordance with the scope of services set out in the contract between Environmental Resources Management Australia Pty Ltd ABN 12 002 773 248 (ERM) and the Client. To the best of our knowledge, the proposal presented herein accurately reflects the Client's intentions when the report was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In preparing the report, ERM used data, surveys, analyses, designs, plans and other information provided by the individuals and organisations referenced herein. While checks were undertaken to ensure that such materials were the correct and current versions of the materials provided, except as otherwise stated, ERM did not independently verify the accuracy or completeness of these information sources

SUBMISSION OF ENVIRONMENTAL IMPACT STATEMENT

prepared under Section 75 of the EP&A Act

EIS PREPARED BY

Names:	<u>Karl Rosen</u>	<u>Mike Shelly</u>	<u>David Snashall</u>
Qualifications:	<u>BSc(Hons)</u>	<u>BSc</u>	<u>BEC</u> <u>MEnv.Plan</u>
Address:	<u>Environmental Resources Management Australia</u> <u>Building C, 33 Saunders Street</u> <u>PYRMONT NSW 2009</u>		

PROJECT APPLICATION

Applicant name:	<u>John Worden</u> <u>Development Manager</u> <u>Boral Resources (NSW) Pty Ltd</u>
Applicant address:	<u>PO Box 42</u> <u>Wentworthville NSW 2145</u>
Land to be developed:	<u>Marulan South Road, Marulan South (refer major project</u> <u>application form)</u>
Proposed development:	<u>Marulan South Quarry</u>

ENVIRONMENTAL ASSESSMENT

- ☒ An EA is attached which addresses all matters listed in Section 75 of the EP&A Act and the Director General's requirements

CERTIFICATE

I certify that I have prepared the contents of this EIS and to the best of my knowledge:

- it is in accordance with Section 75 of the EP&A Act and the Director General's requirements;
- it contains all available information that is relevant to the environmental assessment of the development to which the EA relates; and
- it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

Signature:



Name:	<u>Karl Rosen</u>	<u>Mike Shelly</u>	<u>David Snashall</u>
Date:	<u>27th October 2006</u>	<u>27th October 2006</u>	<u>27th October 2006</u>

Boral Resources (NSW) Pty Ltd

Marulan South Quarry

Environmental Assessment - Volume 1

October 2006

**Environmental Resources Management
Australia**

Building C, 33 Saunders Street

Pymont, NSW 2009

Telephone +61 2 8584 8888

Facsimile +61 2 8584 8800

www.erm.com

CONTENTS

1	INTRODUCTION	
1.1	INTRODUCTION	1
1.2	SITE LOCATION	1
1.3	OUTLINE OF THE PROPOSAL	3
1.4	BORAL QUARRIES (NSW) PTY LTD	5
1.5	PROJECT OBJECTIVES	5
1.6	ENVIRONMENTAL ASSESSMENT STRUCTURE AND FUNCTIONS	6
1.6.1	ENVIRONMENTAL ASSESSMENT APPROACH	6
1.6.2	ENVIRONMENTAL ASSESSMENT REPORT STRUCTURE	6
2	PROJECT DESCRIPTION	
2.1	PROJECT LOCATION	9
2.2	LAND USE AND TENURE	11
2.2.1	PROJECT AREA	11
2.2.2	ADJACENT LANDS	11
2.2.3	LAND TENURE	12
2.3	RESOURCE DESCRIPTION	14
2.3.1	MATERIALS	14
2.3.2	DEMAND	14
2.3.3	PRODUCTS	15
2.4	CONSTRUCTION PHASE	15
2.5	QUARRY OPERATIONS	18
2.5.1	OVERVIEW OF CONCEPTUAL QUARRY PLAN	18
2.5.2	EXTRACTION	20
2.5.3	WATER MANAGEMENT	21
2.5.4	PROCESSING	24
2.5.5	RAIL TRANSPORT	24
2.5.6	ROAD HAULAGE	25
2.5.7	FACILITIES AND SERVICES	25
2.5.8	OPERATING HOURS AND WORKFORCE	25
2.6	PROJECT TIMING	26
2.7	ENVIRONMENTAL MANAGEMENT	26
2.8	REHABILITATION AND FINAL LANDUSE	26
3	PROJECT APPROVALS PROCESS	
3.1	INTRODUCTION	31
3.2	ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979, AND REGULATIONS 2000	31
3.2.1	PART 3(A) OF THE EP&A ACT	31
3.2.2	ENVIRONMENTAL ASSESSMENT REQUIREMENTS	34
3.3	STATE ENVIRONMENTAL PLANNING POLICIES	34
3.3.1	STATE ENVIRONMENTAL PLANNING POLICY (MAJOR PROJECTS) 2005	34
3.3.2	STATE ENVIRONMENTAL PLANNING POLICY NO. 11 – TRAFFIC	

CONTENTS

	<i>GENERATING DEVELOPMENTS</i>	35
3.3.3	<i>STATE ENVIRONMENTAL PLANNING POLICY NO. 33 – HAZARDOUS AND OFFENSIVE DEVELOPMENT</i>	35
3.3.4	<i>STATE ENVIRONMENTAL PLANNING POLICY NO. 44 – KOALA HABITAT PROTECTION</i>	36
3.3.5	<i>STATE ENVIRONMENTAL PLANNING POLICY NO. 58 – PROTECTING SYDNEY’S WATER SUPPLY (SEPP 58)</i>	37
3.4	<i>MULWAREE SHIRE LOCAL ENVIRONMENTAL PLAN (LEP) 1995 – AS AMENDED</i>	37
4	<i>STAKEHOLDER CONSULTATION</i>	
4.1	<i>IDENTIFICATION OF KEY STAKEHOLDERS</i>	39
4.2	<i>CONSULTATION WITH GOVERNMENT AUTHORITIES</i>	39
4.2.1	<i>GENERAL</i>	39
4.2.2	<i>LOCAL COUNCIL</i>	39
4.2.3	<i>PLANNING FOCUS MEETING</i>	39
4.3	<i>CONSULTATION WITH LANDHOLDERS AND LOCAL RESIDENTS</i>	42
4.3.1	<i>PRELIMINARY CONTACT</i>	42
4.3.2	<i>NEWSLETTER</i>	44
4.3.3	<i>WEBSITE</i>	44
4.3.4	<i>PUBLIC INFORMATION SESSIONS</i>	44
4.3.5	<i>INQUIRIES (PHONE/FAX/E-MAIL/LETTER)</i>	46
4.3.6	<i>KEY COMMUNITY ISSUES</i>	46
4.4	<i>ABORIGINAL COMMUNITY CONSULTATION</i>	48
5	<i>RISK ASSESSMENT</i>	
5.1	<i>OVERVIEW OF APPROACH</i>	51
6	<i>WATER RESOURCES</i>	
6.1	<i>EXISTING ENVIRONMENT</i>	59
6.1.1	<i>CATCHMENT DESCRIPTION</i>	59
6.1.2	<i>ENVIRONMENTAL VALUE OF RECEIVING WATERS</i>	59
6.1.3	<i>GROUNDWATER</i>	60
6.1.4	<i>RAINFALL AND EVAPORATION</i>	61
6.2	<i>SITE WATER DEMAND</i>	62
6.2.1	<i>RAW WATER DEMAND</i>	62
6.2.2	<i>POTENTIAL WATER STORAGES</i>	63
6.3	<i>WATER MANAGEMENT SYSTEM</i>	66
6.3.1	<i>OVERVIEW</i>	66
6.3.2	<i>SURFACE DRAINAGE FROM UNDISTURBED AREAS</i>	68
6.3.3	<i>PIT WATER AND RUNOFF FROM DISTURBED AREAS</i>	68
6.3.4	<i>STOCKPILE AND HAUL ROAD DUST SUPPRESSION</i>	71
6.3.5	<i>POTABLE WATER SUPPLIES</i>	71
6.3.6	<i>SEWAGE EFFLUENT AND RECYCLING</i>	71

CONTENTS

6.3.7	<i>SPILLS AND DISCHARGES</i>	71
6.3.8	<i>REHABILITATION DRAINAGE</i>	72
6.4	<i>POTENTIAL WATER RESOURCES IMPACTS</i>	72
6.4.1	<i>WATER SUPPLY</i>	72
6.4.2	<i>ALTERATION TO CATCHMENTS AND YIELDS</i>	73
6.4.3	<i>DIVERSIONS AND DOWNSTREAM DRAINAGE</i>	74
6.4.4	<i>WATER QUALITY</i>	74
6.4.5	<i>ENVIRONMENTAL FLOWS</i>	74
6.4.6	<i>GROUNDWATER LEVEL DRAWDOWN IN THE VICINITY OF THE QUARRY</i>	74
6.4.7	<i>POTENTIAL IMPACTS TO LOCAL GROUNDWATER USERS</i>	75
6.4.8	<i>GROUNDWATER DEPENDENT ECOSYSTEMS</i>	76
6.5	<i>MONITORING OF WATER RESOURCES</i>	76
6.5.1	<i>OVERVIEW</i>	76
6.5.2	<i>SURFACE WATER QUALITY MONITORING</i>	77
6.5.3	<i>GROUNDWATER MONITORING</i>	78
6.6	<i>SEPP 58 MATTERS OF CONSIDERATION</i>	78
6.7	<i>CONCLUSIONS</i>	79
7	<i>FLORA AND FAUNA</i>	
7.1	<i>INTRODUCTION</i>	81
7.2	<i>FLORA AND ECOLOGICAL COMMUNITIES</i>	81
7.3	<i>FAUNA</i>	85
7.4	<i>FAUNA HABITAT</i>	86
7.5	<i>IMPACT ASSESSMENT</i>	87
7.5.1	<i>CONSTRUCTION AND CLEARING</i>	87
7.5.2	<i>OPERATION</i>	88
7.6	<i>SUMMARY OF IMPACTS</i>	90
7.7	<i>MITIGATION MEASURES</i>	90
7.8	<i>CONCLUSION</i>	91
8	<i>ABORIGINAL HERITAGE</i>	
8.1	<i>INTRODUCTION</i>	93
8.2	<i>METHODOLOGY OVERVIEW</i>	93
8.3	<i>CONSULTATION</i>	94
8.4	<i>DESKTOP ASSESSMENT</i>	95
8.4.1	<i>SUMMARY OF PREVIOUS HERITAGE REPORTS</i>	95
8.4.2	<i>NSW DEC ABORIGINAL SITES REGISTER</i>	95
8.4.3	<i>ABORIGINAL HERITAGE SITE PREDICTIVE MODELLING</i>	97
8.5	<i>FIELD INVESTIGATION</i>	98
8.6	<i>SIGNIFICANCE ASSESSMENT</i>	101
8.7	<i>IMPACTS</i>	102
8.8	<i>STATUTORY CONTEXT</i>	102
8.8.1	<i>NATIONAL PARKS AND WILDLIFE ACT 1974 (NSW)</i>	103

CONTENTS

8.8.2	<i>HERITAGE ACT 1977 (NSW)</i>	103
8.8.3	<i>ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979 (NSW)</i>	103
8.8.4	<i>ABORIGINAL AND TORRES STRAIT ISLANDER HERITAGE PROTECTION ACT 1984 (COMMONWEALTH)</i>	104
8.9	<i>MITIGATION MEASURES</i>	104
8.10	<i>CONCLUSION</i>	105
9	<i>HISTORICAL HERITAGE ASSESSMENT</i>	
9.1	<i>BACKGROUND</i>	107
9.1.1	<i>LAND USE AND DISTURBANCE</i>	107
9.1.2	<i>HERITAGE DATABASE SEARCHES AND LITERATURE REVIEWS</i>	107
9.2	<i>SURVEY</i>	108
9.3	<i>HISTORICAL HERITAGE SIGNIFICANCE</i>	108
9.4	<i>SIGNIFICANCE AND IMPACTS</i>	109
10	<i>NOISE AND VIBRATION</i>	
10.1	<i>INTRODUCTION</i>	111
10.2	<i>EXISTING BACKGROUND NOISE</i>	111
10.3	<i>NOISE CRITERIA</i>	114
10.3.1	<i>CONSTRUCTION NOISE</i>	114
10.3.2	<i>OPERATIONAL NOISE</i>	114
10.3.3	<i>CUMULATIVE NOISE</i>	115
10.3.4	<i>SLEEP DISTURBANCE</i>	116
10.3.5	<i>RAIL TRAFFIC NOISE</i>	116
10.3.6	<i>BLASTING</i>	117
10.4	<i>NOISE MODELLING</i>	118
10.4.1	<i>CONSTRUCTION NOISE SOURCES</i>	118
10.4.2	<i>CONSTRUCTION NOISE MODELLING</i>	118
10.4.3	<i>OPERATIONAL NOISE SOURCES</i>	119
10.4.4	<i>OPERATIONAL NOISE MODELLING</i>	120
10.4.5	<i>NOISE MODEL VALIDATION</i>	121
10.5	<i>IMPACT IDENTIFICATION</i>	121
10.5.1	<i>CONSTRUCTION NOISE MODEL PREDICTIONS</i>	121
10.5.2	<i>OPERATIONAL NOISE MODEL PREDICTIONS</i>	122
10.5.3	<i>BLASTING NOISE AND VIBRATION</i>	129
10.5.4	<i>ROAD AND RAIL TRAFFIC</i>	130
10.5.5	<i>CUMULATIVE IMPACTS</i>	131
10.5.6	<i>SLEEP DISTURBANCE</i>	132
10.6	<i>NOISE MITIGATION AND MANAGEMENT</i>	133
10.7	<i>CONCLUSIONS</i>	133
11	<i>AIR QUALITY</i>	
11.1	<i>INTRODUCTION</i>	135
11.2	<i>AIR QUALITY ASSESSMENT CRITERIA AND METHODS</i>	135

CONTENTS

11.2.1	ASSESSMENT CRITERIA	135
11.2.2	METHODS	136
11.3	DISPERSION METEOROLOGY	136
11.4	EXISTING AIR QUALITY	139
11.4.1	EXISTING MONITORING	139
11.4.2	CONCENTRATION	139
11.4.3	DEPOSITION	140
11.5	ESTIMATED EMISSIONS	140
11.5.1	EMISSIONS FROM QUARRY	141
11.5.2	IMPACT IDENTIFICATION	146
11.5.3	CUMULATIVE EMISSIONS	146
11.6	MITIGATION MEASURES	150
11.7	MONITORING	151
11.8	CONCLUSION	151
12	TRAFFIC AND TRANSPORT	
12.1	INTRODUCTION	153
12.2	EXISTING TRANSPORT NETWORK	153
12.2.1	LOCAL ROAD NETWORK	153
12.2.2	EXISTING VEHICLE NUMBERS	154
12.2.3	INTERSECTION CAPACITY	157
12.2.4	EXISTING RAIL NETWORK	158
12.3	CONSTRUCTION PHASE TRAFFIC GENERATION	159
12.4	OPERATIONAL TRAFFIC GENERATION	160
12.4.1	ROAD HAULAGE	160
12.4.2	RAIL HAULAGE	160
12.5	MITIGATION MEASURES	161
12.6	CONCLUSIONS	161
13	VISUAL IMPACT ASSESSMENT	
13.1	INTRODUCTION	163
13.2	VISUAL ASSESSMENT CRITERIA	163
13.2.1	VIEWPOINT ASSESSMENT LOCATIONS	163
13.2.2	VIEW TYPE AND CONTEXT	166
13.2.3	VISUAL ABSORPTION CAPACITY	166
13.2.4	EXISTING VIEW QUALITY	166
13.2.5	SIGNIFICANCE OF IMPACT	166
13.3	VISUAL ASSESSMENT RESULTS	167
13.3.1	VIEWPOINT 1 – BUNGONIA LOOKDOWN	167
13.3.2	VIEWPOINT 2 – LONG POINT WALKING TRACK	168
13.3.3	VIEWPOINT 3 – LONG POINT ROAD	169
13.3.4	NORTHERN PROPERTIES	170
13.3.5	RAILWAY SPUR	171
13.3.6	MARULAN SOUTH ROAD	172

CONTENTS

13.4	CONCLUSION	173
14	WASTE	
14.1	INTRODUCTION	175
14.2	IDENTIFIED WASTE STREAMS	175
14.3	MANAGEMENT PROCEDURES	176
14.3.1	NON LIQUID WASTE	176
14.3.2	LIQUID WASTE	177
14.4	MITIGATION MEASURES AND SAFEGUARDS	178
14.5	CONCLUSION	179
15	SOCIO-ECONOMIC CONSIDERATIONS	
15.1	INTRODUCTION	181
15.2	ECONOMIC CONSIDERATIONS	181
15.3	SOCIAL AMENITY	182
15.3.1	LOCAL AMENITY VALUES	182
15.3.2	POTENTIAL IMPACTS	185
15.3.3	CONCLUSION	186
16	CUMULATIVE IMPACTS	
16.1	CUMULATIVE IMPACT SETTING	187
16.2	NOISE	187
16.3	AIR QUALITY	188
16.4	VISUAL ENVIRONMENT	190
16.5	TRAFFIC AND TRANSPORT	191
16.6	WATER SUPPLY	192
17	ENVIRONMENTAL MANAGEMENT	
17.1	ENVIRONMENTAL MANAGEMENT STRUCTURE	193
17.1.1	ENVIRONMENTAL MANAGEMENT CONTEXT	193
17.1.2	BORAL'S APPROACH TO ENVIRONMENTAL MANAGEMENT	194
17.2	STATEMENT OF COMMITMENTS	195
17.2.1	GENERAL	195
17.2.2	ENVIRONMENTAL MANAGEMENT STRATEGY	195
17.2.3	CONSTRUCTION AND OPERATION	196
17.2.4	COMMUNITY CONSULTATION	196
17.2.5	REHABILITATION	197
17.2.6	WATER RESOURCES	197
17.2.7	ECOLOGY	199
17.2.8	ARCHAEOLOGY	199
17.2.9	NOISE AND VIBRATION	200
17.2.10	AIR QUALITY	201
17.2.11	TRAFFIC AND TRANSPORT	202

CONTENTS

17.2.12	<i>VISUAL AMENITY</i>	202
17.2.13	<i>WASTE</i>	203
18	<i>PROJECT ALTERNATIVES AND JUSTIFICATION</i>	
18.1	<i>INTRODUCTION</i>	205
18.2	<i>PROJECT ALTERNATIVES</i>	205
18.2.1	<i>ALTERNATIVE LOCATIONS</i>	205
18.2.2	<i>ALTERNATIVE MATERIALS</i>	205
18.2.3	<i>ALTERNATIVE QUARRY METHODS</i>	206
18.2.4	<i>ALTERNATIVE TRANSPORT</i>	209
18.3	<i>FINDINGS OF THE EA</i>	210
18.3.1	<i>OVERVIEW</i>	210
18.3.2	<i>BIOPHYSICAL CONSIDERATIONS</i>	211
18.3.3	<i>SOCIAL CONSIDERATIONS</i>	212
18.3.4	<i>ECONOMIC CONSIDERATIONS</i>	214
18.4	<i>ECOLOGICALLY SUSTAINABLE DEVELOPMENT</i>	214
18.4.1	<i>PRECAUTIONARY PRINCIPLE</i>	214
18.4.2	<i>SOCIAL EQUITY INCLUDING INTERGENERATIONAL EQUITY</i>	216
18.4.3	<i>CONSERVATION OF BIOLOGICAL DIVERSITY AND MAINTENANCE OF ECOLOGICAL INTEGRITY</i>	217
18.4.4	<i>IMPROVED VALUATION AND PRICING OF ENVIRONMENTAL RESOURCES</i>	217
18.5	<i>CONCLUSION</i>	218

LIST OF TABLES

TABLE 1.1	SPECIALIST COMPANIES INVOLVED IN PREPARATION OF EA	7
TABLE 2.1	ESTIMATED EXTRACTION	18
TABLE 4.1	DIRECTOR GENERAL'S REQUIREMENTS	40
TABLE 4.2	SUMMARY OF CONSULTATION ACTIVITIES OCTOBER 2005 –AUGUST 2006	43
TABLE 5.1	PROJECT RISK ASSESSMENT	52
TABLE 6.1	AVERAGE MONTHLY RAINFALL AND EVAPORATION AT SITE	61
TABLE 6.2	RAW WATER DEMAND	62
TABLE 6.3	MARULAN SITE SUB-CATCHMENTS	63
TABLE 10.1	SURROUNDING REPRESENTATIVE PROPERTIES	111
TABLE 10.2	SUMMARY OF MEASURED BACKGROUND NOISE LEVELS	112
TABLE 10.3	DAYTIME CONSTRUCTION NOISE CRITERIA	114
TABLE 10.4	PROJECT SPECIFIC NOISE LIMITS	115
TABLE 10.5	REPRESENTATIVE SOUND POWER LEVELS FOR CONSTRUCTION EQUIPMENT	118
TABLE 10.6	PLANT ITEMS IN CONSTRUCTION NOISE MODEL	119
TABLE 10.7	EQUIPMENT SOUND POWER LEVELS FOR OPERATIONAL EQUIPMENT	120
TABLE 10.8	CONSTRUCTION NOISE MODELLING RESULTS	122
TABLE 10.9	$L_{EQ,15MINUTE}$ NOISE UNDER CALM CONDITIONS, MITIGATED DB (A)	123
TABLE 10.10	$L_{EQ,15MINUTE}$ NOISE UNDER DAY INP WEATHER CONDITIONS, MITIGATED DB (A)	123
TABLE 10.11	$L_{EQ,15MINUTE}$ NOISE UNDER NIGHT INP WEATHER CONDITIONS, MITIGATED DB (A)	124
TABLE 10.12	BLAST LOCATIONS	129
TABLE 10.13	BLASTING ASSESSMENT	129
TABLE 10.14	RAIL TRAFFIC NOISE FROM MAIN SOUTHERN RAILWAY LINE	130
TABLE 10.15	RAIL SPUR NOISE	131

TABLE 10.16	CUMULATIVE NIGHT-TIME L_{EQ} NOISE LEVELS	131
TABLE 10.17	SLEEP DISTURBANCE IMPACT – CALM AND INP WEATHER CONDITIONS	132
TABLE 11.1	ASSESSMENT CRITERIA FOR PARTICULATE MATTER CONCENTRATIONS	135
TABLE 11.2	DEC CRITERIA FOR DUST FALLOUT	136
TABLE 11.3	DUST CONCENTRATION DATA FOR MARULAN SOUTH QUARRY	139
TABLE 11.4	MODEL PREDICTIONS AT RESIDENTIAL PROPERTIES	145
TABLE 11.5	PREDICTIONS AT RESIDENTIAL PROPERTIES INCLUDING MODELLED EFFECTS OF BCSC	149
TABLE 12.1	INTANAL LEVEL OF SERVICE FOR GIVE WAY AND STOP SIGNS	157
TABLE 12.2	EXISTING HUME HIGHWAY AND MARULAN SOUTH ROAD INTERSECTION PERFORMANCE	158
TABLE 16.1	CUMULATIVE NIGHT-TIME L_{EQ} NOISE LEVELS	188
TABLE 16.2	PREDICTIONS AT RESIDENTIAL PROPERTIES INCLUDING MODELLED EFFECTS OF BCSC	189
TABLE 17.1	NOISE LIMITS	201

LIST OF FIGURES

<i>FIGURE 1.1</i>	<i>PLANT LOCATION</i>	<i>2</i>
<i>FIGURE 1.2</i>	<i>MARULAN SOUTH QUARRY SITE</i>	<i>4</i>
<i>FIGURE 2.1</i>	<i>SITE LOCATION</i>	<i>10</i>
<i>FIGURE 2.2</i>	<i>SURROUNDING LAND TENURE</i>	<i>13</i>
<i>FIGURE 2.3</i>	<i>PROPOSED BUNDING AND OVERBURDEN EMPLACEMENT</i>	<i>17</i>
<i>FIGURE 2.4</i>	<i>MARULAN SOUTH QUARRY SITE</i>	<i>19</i>
<i>FIGURE 2.5</i>	<i>WATER MANAGEMENT SYSTEM</i>	<i>23</i>
<i>FIGURE 3.1</i>	<i>ENVIRONMENTAL ASSESSMENT PROCESS UNDER PART 3(A) OF THE EP&A ACT.</i>	<i>33</i>
<i>FIGURE 6.1</i>	<i>AVERAGE MONTHLY RAINFALL AND EVAPORATION AT SITE</i>	<i>61</i>
<i>FIGURE 6.2</i>	<i>CATCHMENT PLAN</i>	<i>65</i>
<i>FIGURE 6.3</i>	<i>DRAINAGE PLAN</i>	<i>67</i>
<i>FIGURE 6.4</i>	<i>WATER MANAGEMENT SYSTEM</i>	<i>70</i>
<i>FIGURE 6.5</i>	<i>ESTIMATED DRAWDOWN WITH RADIAL DISTANCE FROM THE QUARRY PIT</i>	<i>75</i>
<i>FIGURE 7.1</i>	<i>LOCATION OF PROPOSED DEVELOPMENTS</i>	<i>83</i>
<i>FIGURE 7.2</i>	<i>LOCATION OF THREATENED SPECIES AND ECOLOGICAL WITHIN THE SITE</i>	<i>84</i>
<i>FIGURE 8.1</i>	<i>LOCATIONS OF ABORIGINAL HERITAGE SITES RECORDED AROUND THE SITE (REGISTERED ON DEC AHIMS AS AT 16-08-06)</i>	<i>96</i>
<i>FIGURE 8.2</i>	<i>ABORIGINAL SITES IDENTIFIED DURING THE FIELD SURVEYS</i>	<i>100</i>
<i>FIGURE 10.1</i>	<i>RECEIVER LOCATIONS AND NOISE LOGGER LOCATIONS</i>	<i>113</i>
<i>FIGURE 10.2</i>	<i>20M PIT DAY L_{EQ}(15 MIN) OPERATIONAL NOISE LEVELS – INP WEATHER CONDITIONS, DB(A)</i>	<i>125</i>
<i>FIGURE 10.3</i>	<i>40M PIT DAY L_{EQ}(15 MIN) OPERATIONAL NOISE LEVELS – INP WEATHER CONDITIONS, DB(A)</i>	<i>126</i>
<i>FIGURE 10.4</i>	<i>20M PIT NIGHT L_{EQ}(15 MIN) OPERATIONAL NOISE LEVELS – INP WEATHER CONDITIONS, DB(A)</i>	<i>127</i>
<i>FIGURE 10.5</i>	<i>40M PIT NIGHT L_{EQ}(15 MIN) OPERATIONAL NOISE LEVELS – INP WEATHER CONDITIONS, DB(A)</i>	<i>128</i>

FIGURE 11.1	RECEIVER LOCATIONS AND AIR QUALITY MONITORING LOCATIONS	138
FIGURE 11.2	DISPERSION MODEL RESULTS FOR YEAR 1 QUARRY OPERATIONS	143
FIGURE 11.3	DISPERSION MODEL RESULTS FOR QUARRY OPERATIONS AT 3.5 MTPA	144
FIGURE 11.4	DISPERSION MODEL RESULTS FOR YEAR 1 QUARRY OPERATIONS INCLUDING BCSC OPERATIONS AT 4MTPA	147
FIGURE 11.5	DISPERSION MODEL RESULTS FOR QUARRY OPERATIONS AT 3.5 MTPA INCLUDING BCSC OPERATIONS AT 4MTPA	148
FIGURE 12.1	EXISTING TRANSPORT NETWORK	156
FIGURE 13.1	PROPOSED QUARRY WITH VIEW ASSESSMENT POINT LOCATIONS	164
FIGURE 15.1	SITE LOCATION	184

LIST OF PHOTOGRAPHS

<i>PHOTOGRAPH 13.1</i>	<i>EXISTING VIEW FROM BUNGONIA LOOKDOWN</i>	<i>167</i>
<i>PHOTOGRAPH 13.2</i>	<i>EXPECTED FUTURE VIEW FROM BUNGONIA LOOKDOWN</i>	<i>167</i>
<i>PHOTOGRAPH 13.3</i>	<i>EXISTING VIEW FROM LONGPOINT WALKING TRACK</i>	<i>168</i>
<i>PHOTOGRAPH 13.4</i>	<i>EXPECTED FUTURE VIEW FROM LONGPOINT WALKING TRACK</i>	<i>168</i>
<i>PHOTOGRAPH 13.5</i>	<i>EXISTING VIEW FROM RESIDENCE 1 ON LONG POINT ROAD</i>	<i>169</i>
<i>PHOTOGRAPH 13.6</i>	<i>EXPECTED FUTURE VIEW FROM RESIDENCE 1 ON LONG POINT ROAD</i>	<i>169</i>
<i>PHOTOGRAPH 13.7</i>	<i>EXISTING VIEW FROM NORTHERN PROPERTIES</i>	<i>170</i>
<i>PHOTOGRAPH 13.8</i>	<i>EXPECTED FUTURE VIEW FROM NORTHERN PROPERTIES</i>	<i>170</i>
<i>PHOTOGRAPH 13.9</i>	<i>EXISTING VIEW FROM RAILROAD TRACKS</i>	<i>171</i>
<i>PHOTOGRAPH 13.10</i>	<i>EXPECTED FUTURE VIEW FROM RAILROAD TRACKS</i>	<i>171</i>
<i>PHOTOGRAPH 13.11</i>	<i>EXISTING VIEW FROM MARULAN SOUTH ROAD</i>	<i>172</i>
<i>PHOTOGRAPH 13.12</i>	<i>EXPECTED FUTURE VIEW FROM MARULAN SOUTH ROAD</i>	<i>172</i>

EXECUTIVE SUMMARY

OUTLINE OF THE PROPOSAL

Introduction

Boral Resources (NSW) Pty Ltd proposes to establish and operate a granodiorite quarry at Marulan South to supply the greater Sydney metropolitan area and local markets with high quality construction and building materials including concrete and road sealing aggregate.

Production at the quarry is initially expected to be relatively low, commencing at 1-2 million tonnes per annum (mtpa) and increasing to 3.5 mtpa. Operations are expected to commence in 2008 following a 12 month construction period. The quarry is proposed to operate 24 hours a day 7 days a week.

Marulan South Quarry is proposed be located at Marulan South, 10 kilometres (km) southeast of Marulan in the Southern Tablelands of New South Wales, approximately 175 km southwest of Sydney.

The Blue Circle Southern Cement (BCSC) limestone mine is located immediately south of the proposed quarry. The site is bordered by a steep gorge to the east that extends towards Morton National Park. A small number of rural properties are located to the north and west of the site.

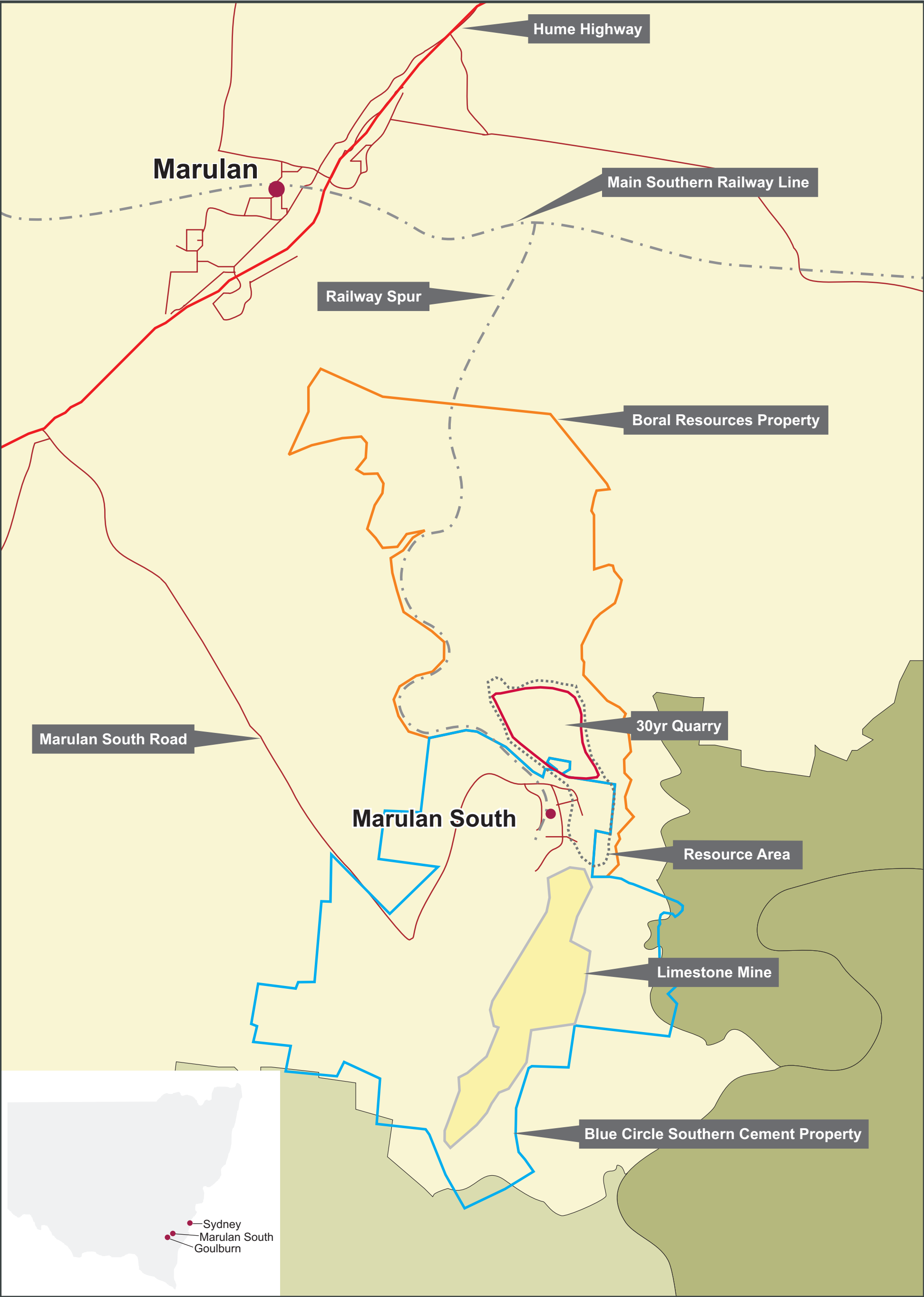
Boral has acquired approximately 650 hectares (ha) which includes the proposed quarry site together with additional granodiorite resources and surrounding land. The location of the proposed quarry with respect to the local setting is shown in *Figure E.1*.

Road access to the Marulan South Quarry site is via Marulan South Road, which extends from an intersection with the Hume Highway. Rail access is available via an existing rail spur which services the adjacent BCSC limestone mine.

Project Description

The Marulan South Quarry has an identified resource of approximately 250 million tonnes which, depending upon extraction rates, would allow quarrying for 70 years or more over an area of approximately 104 ha.

Project approval is being sought for an area sufficient for 30 years of quarrying, commencing in the northern portion of the resource area with an area of approximately 70 ha.



Legend

- Morton National Park
- Bungonia State Conservation Area
- Hume Highway

Figure E.1 **Site Location**

Marulan South Quarry

Initial crushing is proposed to be undertaken in-pit, with conveyors used to haul rock to an out-of-pit processing plant. A rail siding will be built parallel to the existing rail spurline and a tertiary processing plant and rail loading facility will be constructed between the rail spur and Marulan South Road. Two water supply dams are proposed to be constructed within the headwaters of Tangarang Creek immediately to the north of the proposed quarry footprint.

The 30 year quarry footprint, tertiary processing and rail loading facility and the two dams together make up the Marulan South Quarry site.

Quarrying at Marulan South will involve the following four main stages:

- topsoil and overburden removal and emplacement (along with associated bund and dam construction);
- blasting and crushing of raw feed in-pit;
- final crushing, screening and stockpiling out-of-pit; and
- loading, transport and distribution.

The relatively thin layer of soil and overburden will be stripped in progressive stages and hauled to emplacement areas. Suitable overburden will be used to build visual and acoustic bunds and dam walls as required.

After overburden stripping, rock will be drilled and blasted and either trucked to or loaded directly into the in-pit crushing plant. From here, the crushed rock will be conveyed to the out-of-pit processing plant for final crushing, screening, blending and stockpiling. The processing plant will be fully enclosed to control noise and dust.

All material from Marulan South Quarry is proposed to be transported by rail. Trains will traverse the BCSC spur line to the Medway Junction and onto the Main Southern Railway for transportation to Boral's Sydney rail terminals and perhaps other sites.

The Proponent

Boral Limited operates internationally and is Australia's largest building and construction materials supplier, with 670 operating sites and 15,800 personnel worldwide. Boral Quarries is the proponent for the proposal, which comes under Boral's Australian Construction Materials division and is a major producer of concrete and asphalt aggregates, roadbase, subbase and specific landscape products for the greater Sydney metropolitan area.

Boral currently operates four quarries that supply the Sydney Metropolitan Region with construction and building materials including Peats Ridge, Dunmore, Emu Plains (within the Penrith Lakes scheme) and Prospect. With the latter two quarries ceasing operation within the next six years, Boral has proposed the establishment of a hard rock quarry at Marulan South to meet current and future market demands in the local and Sydney Metropolitan Area.

ENVIRONMENTAL ASSESSMENT STRUCTURE

Legislative Framework

This Environmental Assessment (EA) has been undertaken by Environmental Resources Management Australia Pty Ltd to assess the significance of the potential environmental impacts associated with the construction and operation of the proposed Marulan South Quarry. The EA has been undertaken in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulations, 2000* (EP&A Regs).

Marulan South Quarry has been identified as being a 'Major Project' in Clause 75 (b), Part 3(A) of the EP&A Act. This EA has been prepared in accordance with the requirements of the State Environmental Planning Policy - Major Projects 2005, the requirements of the Director General of the Department of Planning (DoP) and issues raised by relevant government agencies, non-government organisations and the community.

Environmental Assessment Approach

An environmental envelope approach has been undertaken for the assessment to allow for maximum flexibility of quarry operations within acceptable environmental parameters. The EA has been prepared using conservative scenarios for assessments to develop a range of acceptable environmental and social parameters within which the proposal can operate. The quarry operations are therefore proposed to remain flexible within the constraints of the identified environmental envelope.

Stakeholder Consultation

Consultation with government and community stakeholders was considered integral to the identification of key issues for the assessment process. Consultation was undertaken to both inform the stakeholders of the project and to allow any issues of concern to be raised at an early stage of the assessment process and incorporated into the EA.

Regular consultation has been maintained with State government agencies and the Goulburn Mulwaree Council. Consultation has been both formal and informal and has been used to refine the proposal and develop the assessment methodology.

Key meetings during the preparation of the EA included a meeting with Goulburn Mulwaree Council staff and the Mayor on the 13th of October, 2005 and a Planning Focus Meeting (PFM) on the 3rd of November, 2005. The PFM was coordinated by the NSW Department of Planning (DoP) and attended by local and state government stakeholders. The PFM is an essential component of the EA process, facilitating information exchange between relevant government agencies and the proponent relating to the details of the proposal and potential issues relevant to each agency. The Director General's Requirements for the preparation of this EA were developed from the issues raised at the PFM and subsequent agency consultation.

Consultation with the local community has been undertaken throughout the preparation of the EA and included the following activities:

- preparation of newsletters outlining the proposal and assessment process;
- information provision on the proposed project via Boral website;
- individual meetings with potentially affected landowners;
- distribution of flyers and advertisements in the local newspaper and local magazine advertising the public information session;
- two information sessions held at the former Marulan South Country Club;
- presentation to the neighbouring Tallong Community Focus Group; and
- receipt of and response to phone calls, faxes, letters and other submissions throughout the EA.

Issues raised by the local community have been considered as part of the assessment process and assisted in developing the statement of commitments for the proposal.

The local Aboriginal community and traditional owners were identified as stakeholders for the development. The DEC's interim guidelines for Aboriginal consultation were used to guide the Aboriginal consultation program. Five groups were involved with the consultation program and had the opportunity to participate in fieldwork and input into the assessment process for the project.

ENVIRONMENTAL INTERACTIONS

Water Resources

A water management system has been developed which aims for the proposed operations to be 100% self sufficient in water use so that there are no further pressures placed upon the potable water supply system or withdrawals from Tallong Weir.

The water management system has been designed to incorporate the diversion of catchment run-off to clean water dams and the retention, treatment and recycling of all water used in quarrying to minimise demand for top-up water from the clean water dams and to minimise the flow of dirty water to the pit storage.

Environmental flows will be maintained, equivalent to 10% of average daily flows, through the occasional spills from clean water dams during floods and allocated environmental flows.

Groundwater at the site occurs in discrete fracture zones, the most significant of which is the interface between the overburden the underlying granodiorite. Significant water level drawdown caused by quarrying is expected to be constrained to the immediate vicinity of the pit, and as such is not anticipated to affect either local groundwater users or potential groundwater fed ecosystems in the gorge.

Water quality and quantity will be monitored to confirm the efficiency of the proposed water management system and avoid detrimental impacts upon groundwater systems or surface receiving waters.

Ecology

The majority of the site has been previously cleared for agriculture, and only scattered native trees and isolated patches of woodland remain. Development and operation of the proposed Marulan South Quarry and associated infrastructure will remove 2.6 hectares of the endangered White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland), while the remainder of the site is cleared grassland and pasture with scattered and isolated trees. Clearing and indirect impacts from operation of the quarry and associated infrastructure is not anticipated to have a significant impact on species or ecological communities.

The removal of 28 hollow-bearing trees may have an immediate impact on the roosting and nesting habitat of individual animals, however, there is abundant replacement foraging and nesting habitat available within the surrounding area.

To reduce the minor ecological impacts that would be caused by the Marulan South Quarry proposal, fauna boxes will be installed in trees adjacent to the quarry, all hollow bearing trees will be checked for animals prior to clearing, the perimeter bund will be planted with local endemic plants and a revegetation zone will be established, twice the size of the area of Box Gum Woodland proposed to be cleared.

Heritage

Aboriginal and historic heritage assessments included a review of previous investigations, predictive modelling of archaeological potential and field survey in consultation with representatives of the local Aboriginal community.

A review of landform, soil characteristics and established pattern of local Aboriginal site occurrence suggests that stone artefact scatters or isolated artefacts are likely to occur within the project boundary (study area). Past and current stock grazing, land clearing and cultivation has resulted in an extensively disturbed landscape across the majority of the study area. Tangarang Creek has experienced less disturbance and is relatively intact. Aboriginal artefacts are more likely to be present below the surface.

Eighteen Aboriginal sites were found within the study area, the majority of which were of low scientific significance and representative of open stone artefact sites in the local area and region. Disturbance over the proposed area of Dam 1 is fairly low and this area has moderate archaeological research potential. Sites within the proposed area of Dam 1 are of sufficient scientific value to warrant salvage prior to construction of the dam.

No items of European heritage will be impacted by the proposal.

Noise and Vibration

The acoustic assessment included modelling of all major quarrying equipment for representative construction and operational scenarios. The assessment incorporated attended and unattended noise monitoring, analysis of site specific hourly meteorological data, noise modelling during calm and adverse weather conditions and site specific validation of the modelling results.

Modelling indicates that under calm weather conditions all receiver locations experience noise levels below the EPA's noise goals. Modelling under worst case weather conditions indicates that operational noise levels will meet the EPA goals at all surrounding properties during night-time, with a potential exceedance at one residential property during daytime operations. All feasible and reasonable mitigation measures have been incorporated into the design of quarry operations to minimise potential noise impacts upon nearby residential locations.

Mitigation measures incorporated into the design and operation of the quarry include:

- limiting in-pit operations to the day period (7am to 7.00pm);
- initial crushing and screening to be in-pit;
- construction of a 10m high earth bund around the perimeter of the quarry pit;
- use of covered conveyors from the pit to the enclosed out of pit processing plant; and
- modification of the proposed overburden stripping fleet to minimise noise.

Given the concerted effort applied to mitigate noise and the level of impact, negotiation with the resident and the regulator is proposed. This will involve demonstration by the proponent that all feasible and reasonable noise mitigation has been considered and will be applied as part of the Statement of Commitments.

Sleep disturbance and cumulative noise impact due to the proposal are not considered likely. Rail traffic noise due to the proposal was also found to be within relevant criteria.

Blast design will incorporate control on the maximum instantaneous charge to ensure acceptable overpressure and vibration.

Air Quality

A detailed air quality assessment has been undertaken using a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the quarry.

Existing dust deposition and concentrations were monitored in the vicinity of the proposed quarry and results incorporated into the modelling to assist with the assessment of cumulative impacts. Dispersion model predictions have been compared to relevant air quality goals and mitigation methods provided to reduce dust emissions and associated impacts from the proposal.

The dust dispersion modelling was based upon conservative assumptions and indicates that the annual average dust concentrations and deposition levels would be below relevant air quality criteria at the nearest residential properties. Short-term (24-hour average) air quality impacts due to the quarry operations are also predicted to be within the air quality criteria.

The modelling suggests there may be some potential for minor short-term air quality impacts to be observed at residence 2 due to the combined effects of the quarry at 3.5 mtpa with the adjacent BCSC limestone mine at 4 mtpa. However, given the conservative nature of the dust emission estimates, adverse air quality impacts at the nearest residential locations would not be expected. Adoption of an appropriate monitoring program to allow the identification of impacts and the implementation of appropriate management practices will ensure the proposed Marulan South Quarry is operating with relevant criteria and minimising adverse impacts upon nearby receivers.

Transport and Traffic

Boral proposes to transport all quarry product by rail and currently only seeks approval for road usage during construction and for employee, maintenance and delivery vehicles during quarry operations. Delivery of sand from Penrose Quarry or other sources for blending with fines is expected to occur through the back-loading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period of time.

The site is serviced by Marulan South Road, which is a dedicated restricted access haulage route with ample capacity to accommodate the small number of additional movements associated with the proposal.

All extracted material from Marulan South Quarry is proposed to be transported by rail via the existing private rail spur and the main southern line. An average of three or four train loads per day will be transported from the site at full production, resulting in a small incremental increase in rail movements on the Main Southern Line. Advice from ARTC indicates that there is adequate capacity on the railway corridor to accommodate the additional movements.

Visual

Marulan South Quarry will be predominantly shielded from view from all nearby receptors due to natural topography. A series of viewpoints were selected for the assessment to represent the maximum extent of potential visibility of the proposed quarry. Prominent views of the site can only be obtained from the immediate vicinity of the proposal.

The proposal will not be visible from Bungonia Lookdown and views of the quarry will be extremely limited from the spurline along the Long Point walking trail. Provision of bunding around the perimeter of the site will minimise potential views of the site from recreational areas.

The assessment has found that landscape around the proposed development, generally has a high visual absorption capacity due to the existing terrain and scattered vegetation. The high visual absorption capacity corresponds directly with the generally low significance of visual impacts to views from the proposal.

Economic Considerations

The major economic benefit for the proposed Marulan South Quarry is to provide surety in the supply of construction materials to meet the demand from the Sydney Metropolitan Region.

The estimated cost for the establishment of the Marulan South quarry is \$150 million, much of which will be expended on initial construction. The operation of the quarry will continue to contribute to the local economy through ongoing operational expenditure, employment and local and regional spending.

A construction workforce of approximately 20 people will be required for the establishment of the quarry. The expected workforce for the operational quarry is up to 30 full time, on-site employees with 2-3 shifts with additional opportunities created in transport and support industries.

CONCLUSION

This EA has assessed the potential environmental impacts associated with the Marulan South Quarry proposal. Project approval is being sought for an area sufficient for 30 years of quarrying.

The EA was prepared having regard to biophysical, economic and social considerations and the principles of ecological sustainable development. There were no significant environmental impacts identified throughout the assessment process that cannot be mitigated by appropriate management strategies.

The environmental assessment process has been used to drive the development of the quarry and ensure operations will be sustainable and create minimal disruption to the local community. Quarry operations have been designed to be self sufficient in water use, minimise truck movements on Marulan South Road, ensure acceptable noise and dust emissions and to minimise the visibility of the operations. All mitigation measures and management practices identified in the EA form part of the statement of commitments for the proposal and will be incorporated into the environmental management plans for construction and quarry operations.

The quarry will provide a long term viable supply of construction material to the greater Sydney metropolitan area. The proposal can be implemented with minimal adverse environmental impacts as demonstrated throughout this assessment and is justified in terms of the overall economic benefits to both the local, state and national economies.



Annex A

Environmental Assessment Study Team

1 INTRODUCTION

1.1 INTRODUCTION

Boral Resources (NSW) Pty Ltd proposes to establish and operate a quarry at Marulan South to supply the Sydney metropolitan area and local markets with high quality construction and building materials.

The proposal provides a long term viable option for supplying the Sydney area with construction and building materials. The identified resource is granodiorite, an intrusive igneous rock which can be used as high quality concrete and road sealing aggregate.

Production at the quarry is initially expected to be relatively low, commencing at 1-2 million tonnes per annum (mtpa) and growing to 3.5 mtpa. Initial operation of the quarry is expected to commence in 2008 following a 12 month construction period and is proposed to operate 24 hours a day 7 days a week.

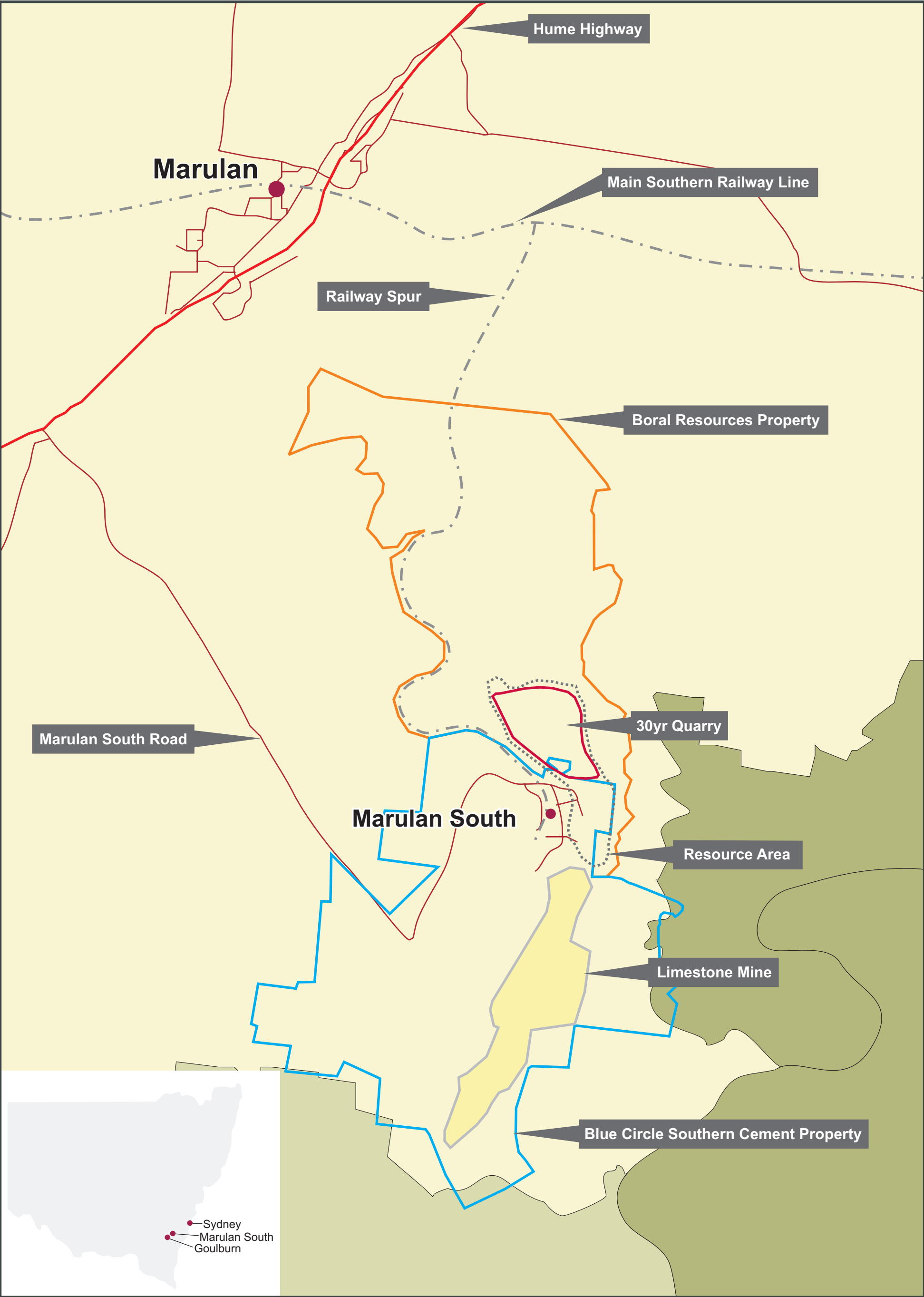
1.2 SITE LOCATION

Marulan South Quarry is proposed be located at Marulan South, 10 kilometres (km) southeast of Marulan in the Southern Tablelands of New South Wales, approximately 175 km southwest of Sydney.

The Blue Circle Southern Cement (BCSC) limestone mine is located immediately south of the proposed quarry. The site is bordered by a steep gorge to the east that extends towards Morton National Park. A small number of rural properties are located to the north and west of the site.

Boral has acquired approximately 650 hectares (ha) which includes the proposed quarry site together with additional granodiorite resources and surrounding land. The location of the proposed quarry with respect to the local setting is shown in *Figure 1.1*.

Road access to the Marulan South Quarry site is via Marulan South Road, which extends from an intersection with the Hume Highway. Rail access is also available via an existing rail spur which currently services the adjacent BCSC limestone mine.



The Marulan South Quarry has an identified resource of approximately 250 million tonnes which, depending upon extraction rates, would allow quarrying for 70 years or more over an area of approximately 104 ha.

Project approval is being sought for an area sufficient for 30 years of quarrying, commencing in the northern portion of the resource area with an area of approximately 70 ha.

Crushing is proposed to be undertaken in-pit, with conveyors used to haul rock to an out-of-pit processing plant. A rail siding will be built parallel to the existing rail spurline and a tertiary processing plant and rail loading facility area will be constructed between the rail spur and Marulan South Road. Two water supply dams are proposed to be constructed within the headwaters of Tangarang Creek immediately to the north of the proposed quarry footprint.

The 30 year quarry footprint, tertiary processing and rail loading facility and the two dams together make up the Marulan South Quarry site as shown on *Figure 1.2*.

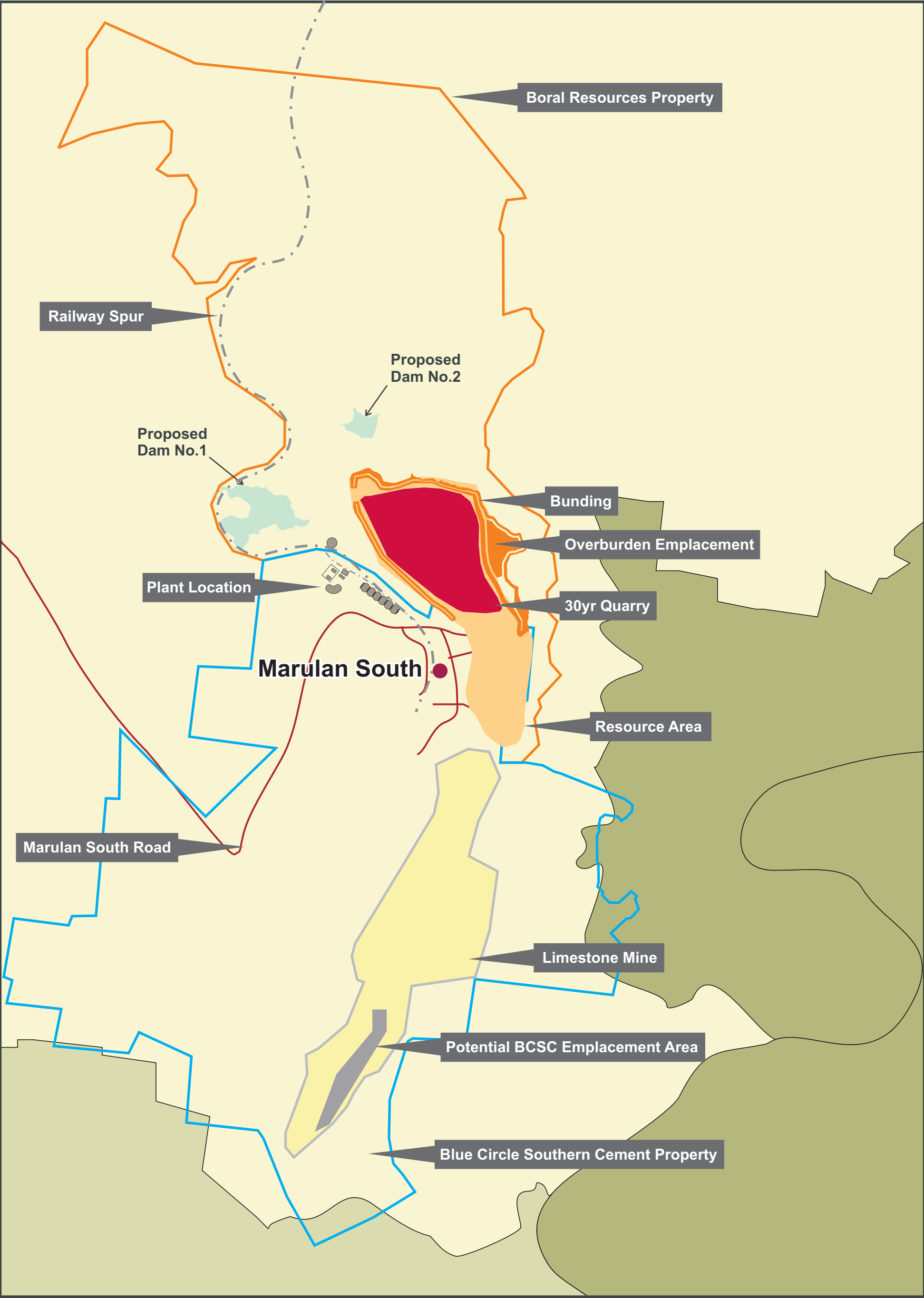
Quarrying at Marulan South will involve the following four main stages:

- topsoil and overburden removal and emplacement (along with associated bund and dam construction);
- blasting and crushing of raw feed in-pit;
- final crushing, screening and stockpiling out-of-pit; and
- loading, transport and distribution.

The relatively thin layer of soil and overburden will be stripped off the quarry in progressive stages and hauled to emplacement areas. Suitable overburden will be used to build visual and acoustic bunds and dam walls as required.

After overburden stripping, rock will be drilled and blasted and either trucked to or loaded directly into the primary and secondary crushing plant. From here, the crushed rock will be conveyed to the tertiary plant for final crushing, screening, blending and stockpiling. The tertiary plant will be fully enclosed to control noise and dust emissions.

All despatched material from Marulan South quarry is currently proposed to be transported by rail. Trains will traverse the BCSC spur line to the Medway Junction and onto the Main Southern Railway for transportation to Boral's Sydney rail terminals.



0 1km
Approximate only

Legend

- Morton National Park
- Bungonia State Conservation Area

Figure 1.2 Marulan South Quarry Site

Marulan South Quarry

1.4

BORAL QUARRIES (NSW) PTY LTD

Boral Limited operates internationally and is Australia's largest building and construction materials supplier, with 670 operating sites and 15,800 personnel worldwide. The proponent for the project, Boral Quarries, comes under Boral's Australian Construction Materials division and is a major producer of concrete and asphalt aggregates, roadbase, subbase and specific landscape products for the Greater Sydney Metropolitan Region.

Boral currently operates four quarries that supply the Sydney Metropolitan Region with construction and building materials including Peats Ridge, Dunmore, Emu Plains (within the Penrith Lakes scheme) and Prospect. With the latter two quarries ceasing operation within the next six years, Boral has proposed the establishment of a hard rock quarry at Marulan South to meet current and future market demands in the local and Sydney Metropolitan Area.

Boral's assets in the Southern Tablelands include the Marulan South limestone mine and lime works and the Blue Circle Southern Cement works at Berrima operating under Boral's Cement division. Other assets include a sand quarry at Penrose and a number of concrete batching plants.

1.5

PROJECT OBJECTIVES

The objectives of the proposal are to:

- establish a 3.5 million tonnes per annum (mtpa) hard rock quarry and associated infrastructure at Marulan South;
- provide a long term viable supply of construction material to the Greater Sydney Metropolitan area;
- develop a quarry with operational flexibility and maximum resource recovery while meeting industry best practice in terms of environmental performance and community relations;
- optimise use of the granodiorite resource whilst maintaining the economic viability of the quarry; and
- contribute to local and regional economies through provision of employment, capital expenditure, and the supply of construction material.

1.6

ENVIRONMENTAL ASSESSMENT STRUCTURE AND FUNCTIONS

1.6.1

Environmental Assessment Approach

This Environmental Assessment (EA) has been undertaken to assess the significance of the potential environmental impacts associated with the construction and operation of the proposed Marulan South Quarry. The EA has been undertaken in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Environmental Planning and Assessment Regulations, 2000 (EP&A Regs).

Marulan South Quarry has been identified as being a 'Major Project' in Clause 75 (b), Part 3(A) of the EP&A Act. This EA has been prepared in accordance with the requirements of the State Environmental Planning Policy - Major Projects (SEPP-MP) 2005, the requirements of the Director General of the Department of Planning (DoP) and issues raised by relevant government agencies, non-government organisations and the community.

The environmental assessment has been based on the Director General's Requirements (DGRs) developed by DoP in conjunction with a range of other government agencies. An environmental envelope approach has been undertaken for the assessment to allow for maximum flexibility for quarry operations within acceptable environmental parameters. The EA has been prepared using conservative scenarios for assessments to develop a range of acceptable environmental and social parameters within which the proposal can operate. The quarry operations can therefore remain flexible within the constraints of the identified environmental envelope.

1.6.2

Environmental Assessment Report Structure

This EA contains two volumes incorporating the main text of the EA within Volume 1 and appendices and specialist technical studies in Volume 2. Volume 1 is divided into a number parts including:

Executive Summary

The executive summary provides a brief overview of the project, key environmental issues and assessment results, and an outline of environmental management procedures.

Part A – The Proposal

Part A contains two chapters; it provides an introduction to the development and a detailed description of the proposal.

Part B – Planning Framework, Consultation and Issues Identification

Part B contains three chapters; it provides a description of the legislative considerations and approval requirements for the proposed development, an outline of the issues identification process; government and community considerations and a risk assessment used to develop the scope of environmental assessment.

Part C – Environmental Interactions

Part C contains ten chapters; it describes the interactions between the proposed quarry and the biophysical environment. It provides an assessment of the potential environmental impacts associated with the proposal and describes the mitigation measures, which form a part of the proposal to control the environmental impacts as described.

Part D – Environmental Management and Project Justification

Part D provides an outline of the environmental management procedures and environmental mitigation measures to be adopted as a part of the proposal and provides the justification for the proposal. This section also includes a statement of commitments.

Part E – References, Acronyms, Glossary and Abbreviations

Part E contains a list of references used in this EA and a glossary containing a description of key terms used throughout the document.

Environmental Resources Management Australia Pty Ltd (ERM) has been commissioned by Boral Resources (NSW) Pty Ltd to undertake the environmental assessment and prepare the associated report for the project. Sub consultants undertaking specific assessments for ERM are included in *Table 1.1* below. This assessment report will accompany a project application submitted to the Minister for Planning under Part 3A.

Table 1.1 Specialist Companies Involved in Preparation of EA

Sub Consultant	Assessment
Christopher Stapleton Consulting	Traffic
Holmes Air Sciences	Air Quality
Site Image / Virtual Ideas	Visual Assessment

2.1 PROJECT LOCATION

Marulan South Quarry is proposed to be located at Marulan South, approximately 10km southeast of Marulan in the Southern Tablelands of New South Wales, approximately 175 km southwest of Sydney.

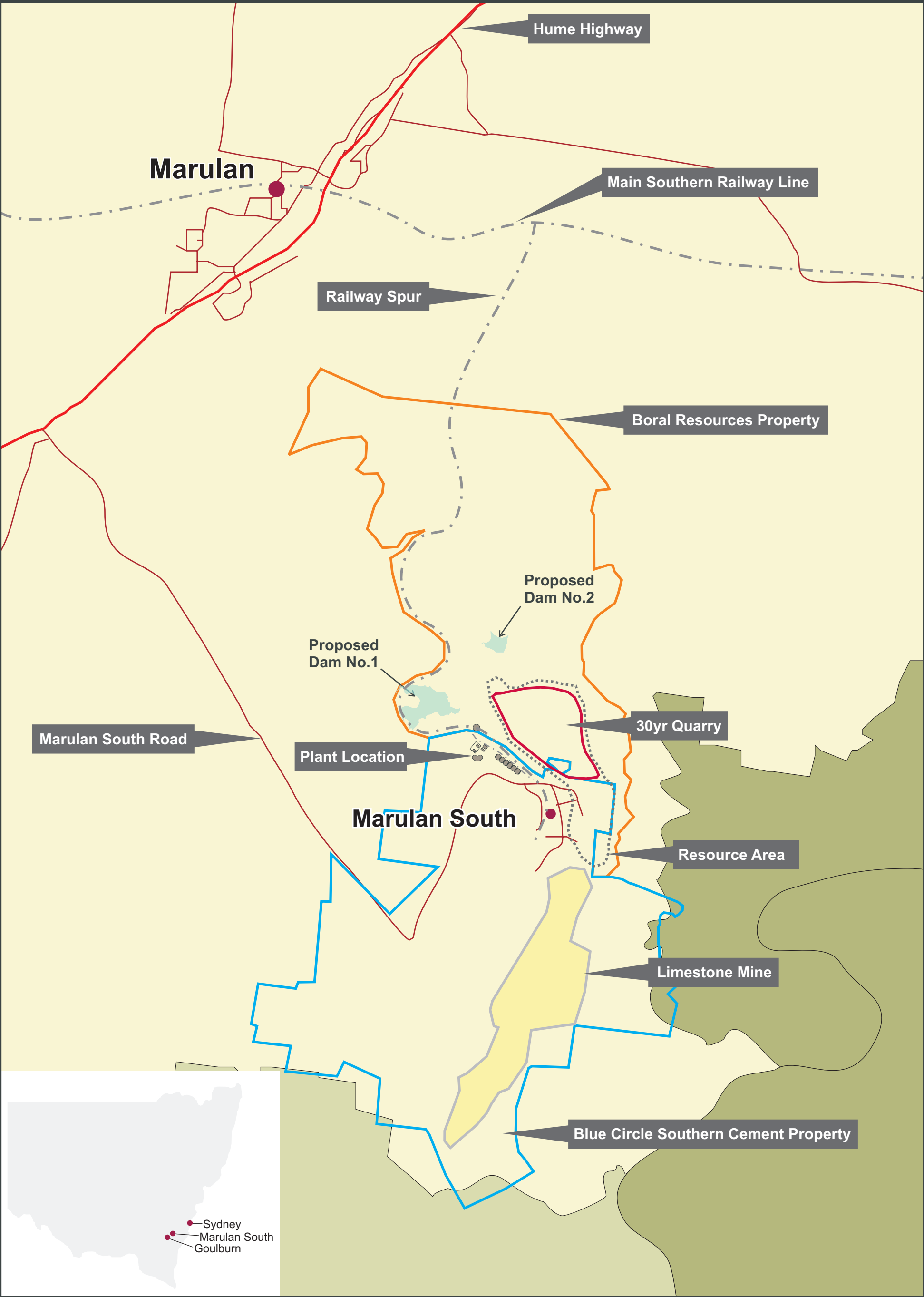
Access to the proposed quarry site is via Marulan South Road, which extends from an intersection with the Hume Highway. Marulan South Road services the existing BCSC limestone mine and a small number of rural properties including poultry farms and limestone processing industries and a recently approved fireworks factory.

Access to the site is also available via rail on an existing rail spur which currently services the adjacent BCSC limestone mine. The rail spur connects with the Main Southern Railway at Medway Junction approximately seven kilometres north of Marulan South.

The identified resource area covers approximately 104 ha on the eastern edge of a 600m Australian Height Datum (AHD) plateau adjacent to the former village of Marulan South in the Southern Tablelands of NSW. The BCSC limestone mine is located immediately south of the site.

The Marulan South Quarry proposal incorporates a 30 year operations area of approximately 70 ha commencing in the northern portion of total resource area. A tertiary processing plant and rail loading area will be built adjacent to the rail spur that currently services the BCSC mine. Two water supply dams are proposed to be constructed within the headwaters of Tangarang Creek immediately to the north of the proposed quarry.

The 30 year quarry area, tertiary processing / rail loading facility and the two dams together make up the Marulan South Quarry site as shown on *Figure 2.1*.



2.2 *LAND USE AND TENURE*

2.2.1 *Project Area*

The site consists primarily of cleared farming land used for sheep and cattle grazing and fodder crop cultivation since at least the 1940s. Vegetation over the site is generally improved pasture with small, isolated stands of trees scattered throughout the site.

Several patches of remnant woodland exist at the southern and northern extent of the identified resource area and surrounding the former Marulan South village. The site also contains a number of farm dams on ephemeral drainage lines.

2.2.2 *Adjacent Lands*

Landuse in the immediate surrounds of the plateau is predominately mining and grazing. The site of the former village of Marulan South is between the proposed quarry site and the existing limestone mine on land owned by BCSC. Marulan South was established principally to service the limestone mine and has been essentially closed down since the late 1990's. The majority of town infrastructure has been demolished over the years with little remaining apart from a disused hall and former bowling club.

A small number of rural properties are located to the north and west of the site including poultry farms, limestone processing industries and a recently approved fireworks factory. The properties are accessed via Marulan South Road and the BCSC railway spur separates them from the proposed quarry.

Rural residential properties are also located to the east of the site along Long Point Road. The properties are separated from the proposed quarry site by the deep Barbers Creek gorge.

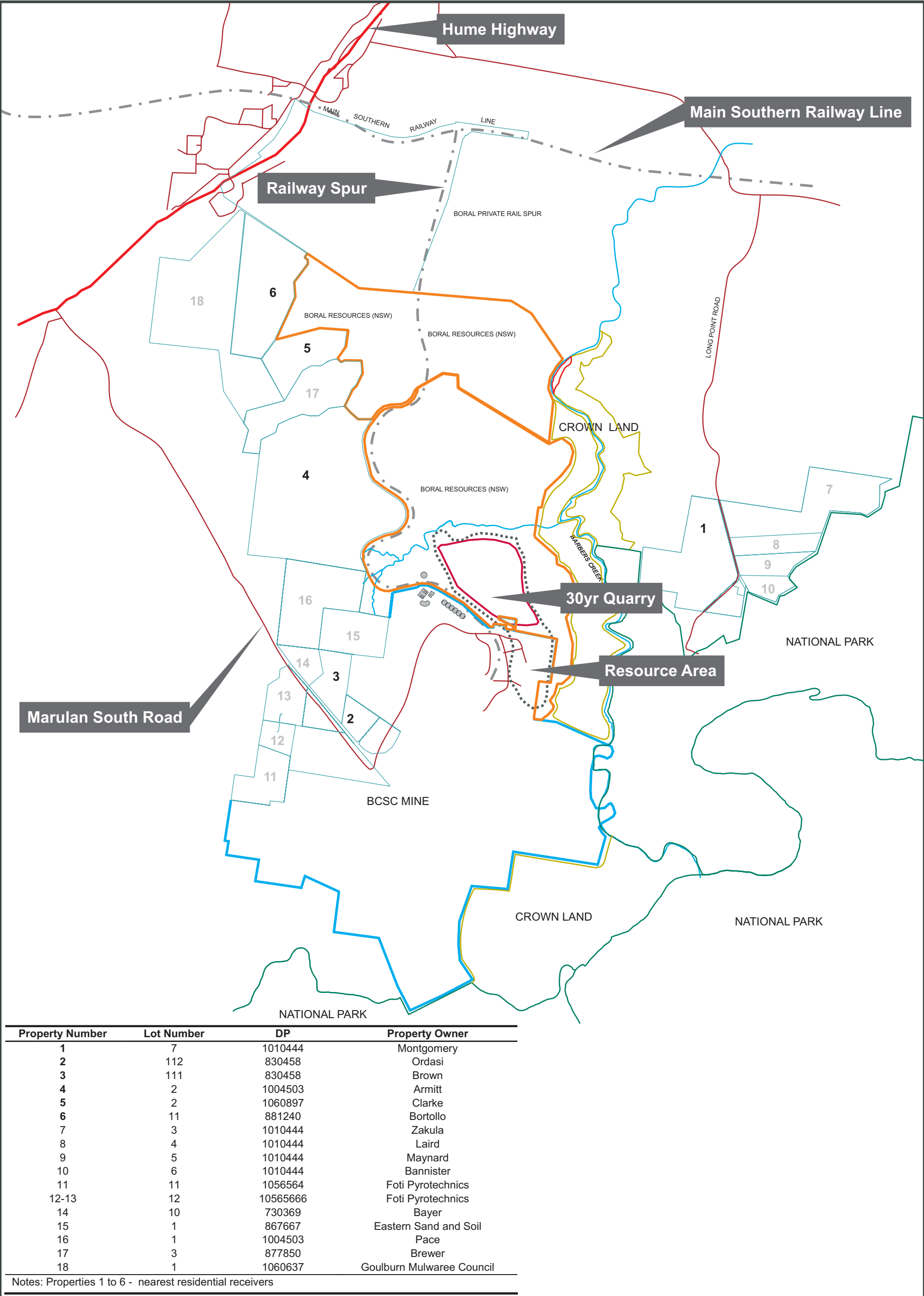
The western face of Barbers Creek gorge to the east of the site is Crown Land, with Morton National Park adjoining to the east of Barbers Creek. Gorges forming Bungonia Creek and the Shoalhaven River border the plateau to the south and southeast respectively. Bungonia State Conservation Area is located on the southern side of Bungonia Creek, 5km to the south of the site.

The village of Marulan is on the Hume Highway approximately ten kilometres to the northwest of the site.

2.2.3

Land Tenure

Boral Resources (NSW) Pty Ltd owns 650 ha of land abutting Boral's BCSC limestone mine. The acquired property includes the Marulan South Quarry site, an identified resource area and surrounding land. Privately owned land surrounding the Marulan Quarry Site is shown on *Figure 2.2*.



- Legend**
- Resource Boundary
 - 30 Year Resource Boundary
 - Blue Circle Southern Cement Property Boundary
 - Boral Resources Property Boundary
 - 1 - 6 Nearest Residential Receivers
 - 7 - 18 Other Privately Owned Land

Figure 2.2
Surrounding Land Tenure
Marulan South Quarry

2.3 *RESOURCE DESCRIPTION*

2.3.1 *Materials*

The identified resource area contains significant volumes of high quality granodiorite suitable for use as construction and building material. Granodiorite is an intrusive igneous rock, pale to medium grey in colour with medium-sized grains. It is similar in composition to granite (although it contains a higher proportion of mafic minerals), and is commonly associated with granitic batholiths. Granitoid bodies are widely distributed across the region and have intruded the Palaeozoic units underlying the Marulan region. The local geologies are listed below from youngest to oldest:

- an overlying sequence of sediments and volcanics forming the Cookbundoon Syncline that extends north-south as a broad unit centred on Goulburn, to the west of Marulan. A belt of volcanics, the Bindook Complex, forms a parallel belt through the Marulan area;
- a sequence of volcanics and sediments (the Towrang Beds and De Drack formation) to the south west of Marulan; and
- basement sediments of Ordovician age, which form north-south belts.

The granitoid bodies are the resource targeted for extraction at the Marulan South site and are related to the thin sheets of basalt, north of Goulburn, covering parts of the Cookbundoon Syncline. Approximately 250 million tonnes of granodiorite has been identified, 105 million of which is within the proposed 30 year quarry. Limestone, another common component of the strata outcrops immediately south of the proposed quarry site and is mined at the adjacent BCSC limestone mine.

2.3.2 *Demand*

Boral currently operates several hard rock aggregate quarries in the greater Sydney metropolitan area to supply current market demands for aggregates used in construction and building. These include Peats Ridge, Dunmore, Prospect and Emu Plains quarries. Emu Plains is a component of the Penrith Lakes Scheme that is quarried by its shareholders (Readymix, Boral and Hanson). The scheme currently provides approximately 60% of building and construction materials to the Greater Sydney Metropolitan market. Termination of operations at Prospect is imminent and quarrying of the Penrith Lakes Scheme is likely to end around 2012 as these resources are exhausted.

Closure of the Penrith Lakes Scheme will result in a shortage of construction material in the Sydney and regional markets unless viable alternatives are brought on-stream. Boral has already instigated measures to source additional resources and received approval for increased production rates at the Peats Ridge and Dunmore quarries in 2004 and provision for recycling at Widemere and St Peters depots.

The proposed quarrying at Marulan South is expected to begin initial operations in 2008 at 1 to 2 million tonnes per annum (mtpa). Extraction rates are expected to increase to a rate of 3.5 mtpa as Prospect and Emu Plains are taken off-line. Establishment of Marulan South Quarry is expected to supply further market demands for the supply of construction material in Sydney Metropolitan areas.

2.3.3 *Products*

Products from the quarry will include a range of aggregates shaped and sized for different purposes. The main production will be of concrete and asphalt aggregates, although larger aggregates for armour or gabion baskets may be produced, along with railway ballast. The fines produced by crushing have traditionally been considered a waste, but in this case Boral intends to blend the fines with sand from its Penrose quarry and possibly other sources to produce a marketable manufactured sand. This has significant environmental benefits as the production of manufactured sand reduces the need to otherwise dispose of the fines and reduces the demand for natural sand. Production of manufactured sand and road base may require the installation and use of some additional equipment within the tertiary processing area. The tertiary plant may also be designed with future provision for pre-coating of aggregates for spray seal.

2.4 *CONSTRUCTION PHASE*

The Marulan South Quarry is a greenfield site and limited construction is required prior to the commencement of aggregate delivery. While the Marulan South Quarry and the BCSC limestone mine will operate separately, the proximity of the two sites will facilitate the sharing of transport infrastructure. The existing B-double haulage route along Marulan South Road will provide for adequate access to the site during construction and the existing rail spur minimises the requirement for the construction of new transport infrastructure for the operation of the quarry.

Principle construction activities are expected to be complete within 6-12 months of commencement with potential further expansions staged throughout the life of the quarry as production increases to meet market demands.

Activities undertaken during construction will include:

- establishment of a construction compound, site offices and laydown areas;
- construction of a rail siding;
- operation of temporary or mobile crushing and screening equipment;
- construction of a tertiary crushing and screening plant, stockpiling and road and rail loading facilities and associated services;
- topsoil and overburden stripping and construction of earth bunding; and
- construction of water storage dams and associated water management facilities.

The construction compound will be established within the area of the proposed tertiary plant location between Marulan South Road and the BCSC railway spur as shown on *Figure 2.1*.

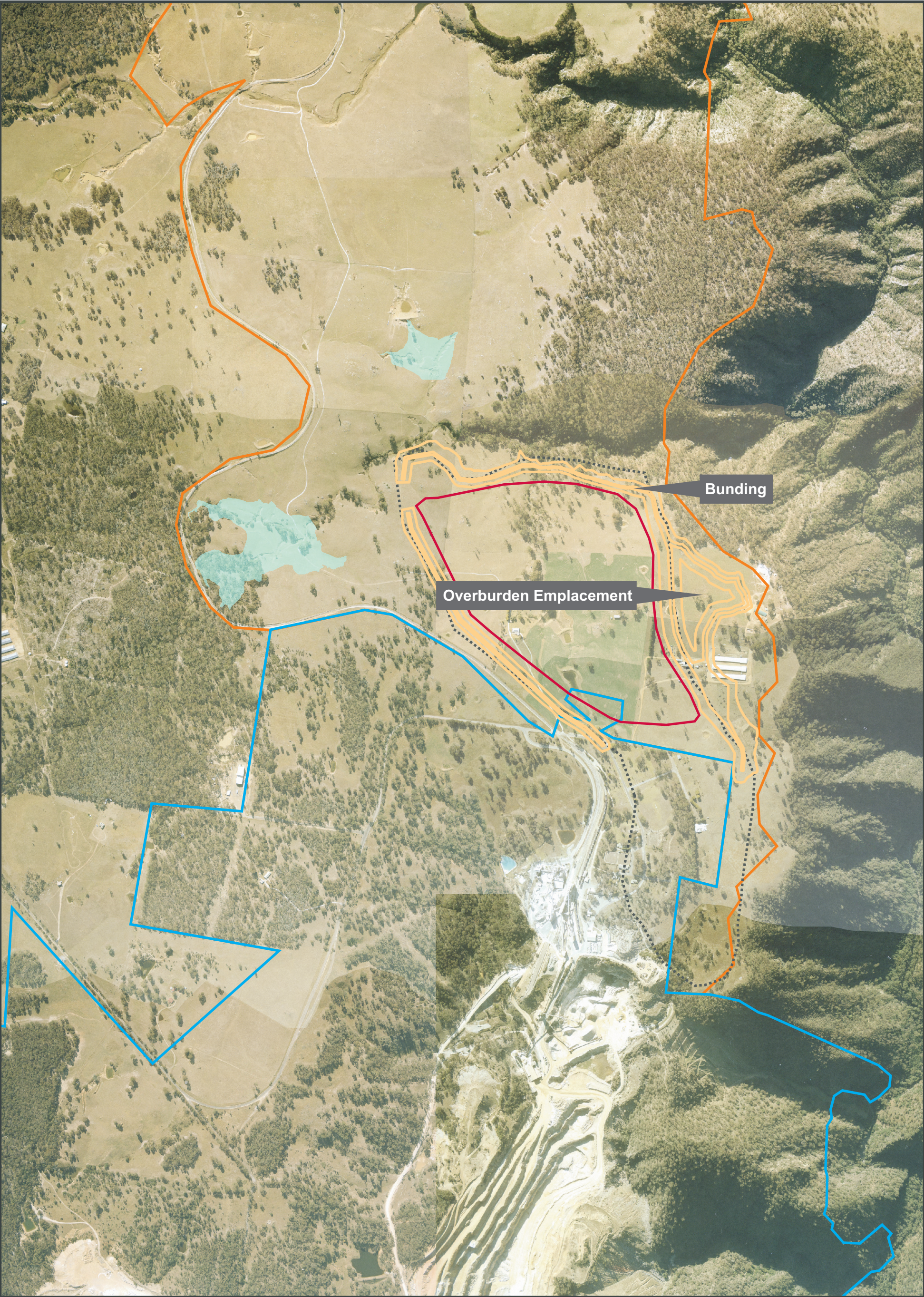
Construction vehicles will access the site via Marulan South Road which has more than adequate capacity to service the expected vehicle movements. Construction traffic will consist of around 2-3 heavy vehicle deliveries per week, together with staff movements over a 6-12 month period.

A rail siding will be built immediately south of the existing BCSC rail spur to facilitate rail loading from Marulan South Quarry with minimal interruption to BCSC operations. The rail siding will be constructed approximately parallel and at grade to the existing rail spur minimising the need for major civil construction and earthworks.

A tertiary crushing and screening plant will be established immediately to the south of the rail siding. The tertiary plant will consist of product stockpiles, screens and a rail loading area. A site office, workshop area and refuelling facilities may be built within the tertiary plant area.

Topsoil and overburden will be stripped from the initial quarrying area to enable construction of a 10 metre high earth bund around the perimeter of the 30 year quarry plan as shown on *Figure 2.3*. The bunding will be constructed with between 2:1 and 3:1 horizontal to vertical outside batters and 10 metre wide crest to allow vehicle access.

Two dams are proposed to be constructed within the headwaters of Tangarang Creek, to enable quarry operations to be self sufficient in water. Dam 1 is the primary storage dam and will be constructed in the first stage of quarry development using overburden. An off-line constructed wetland will also be built upstream of Dam 1 to improve the quality of catchment runoff and water directed from pit storages to the dam. The second dam will be constructed as production increases to meet site water demand if required.



- Legend**
- Proposed Dam Locations
 - Boral Resources Property Boundary
 - Blue Circle Southern Cement Property Boundary
 - Resource Boundary
 - 30 Year Resource Boundary
 - Proposed Bunding and Overburden Placement

Figure 2.3 **Proposed Bunding and Overburden Emplacement**
Marulan South Quarry

2.5 QUARRY OPERATIONS

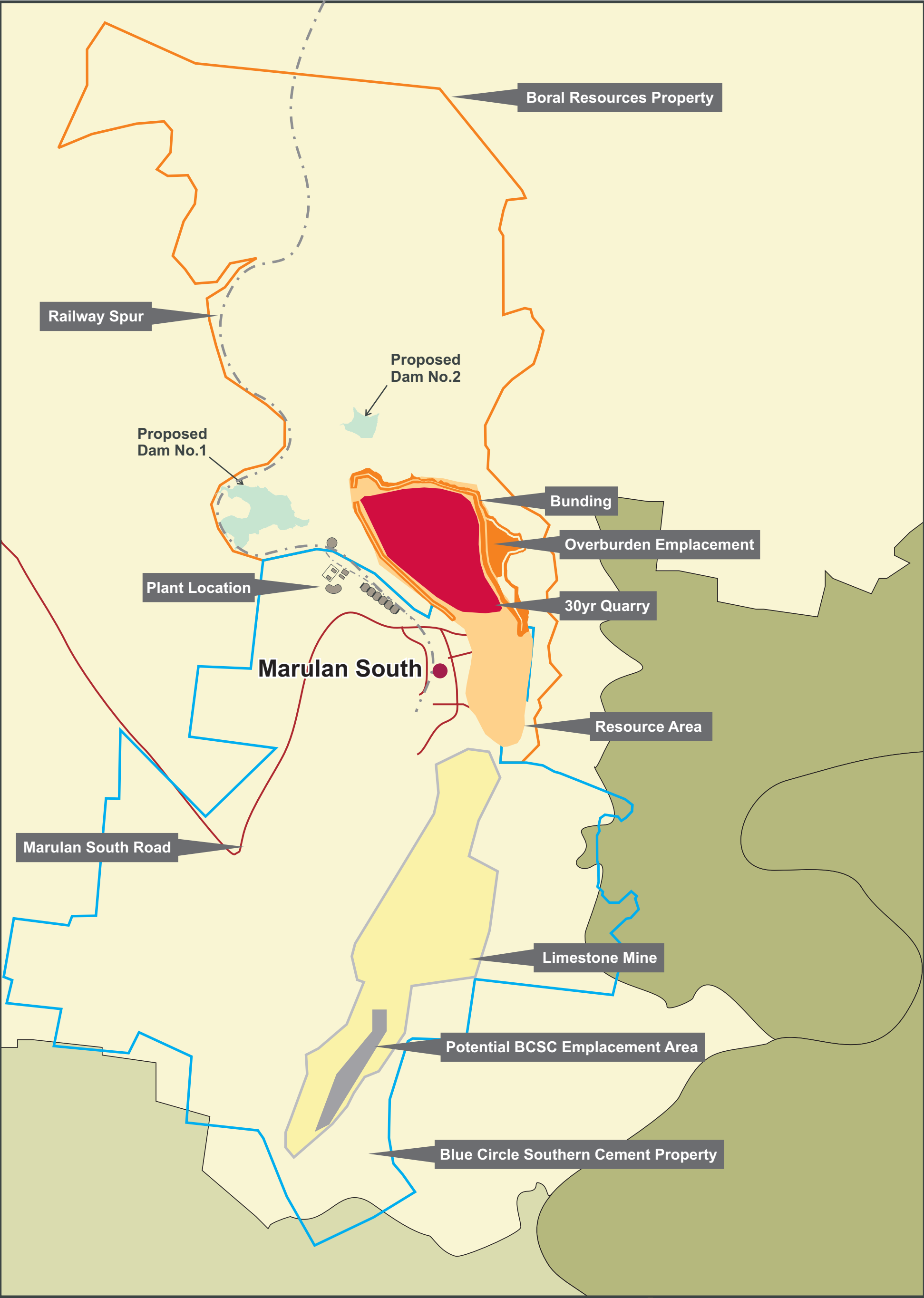
2.5.1 Overview Of Conceptual Quarry Plan

While Boral geologists have identified 250 million tonne of resource this application seeks approval for an initial 30 years of quarrying as shown in *Figure 2.4*. Quarrying will commence in the north-western corner of the 30 year quarry footprint and move in an easterly direction over a period of approximately five years. The quarry will then progress to the south over the extent of the 30 year operations.

Initial production rates of 1 to 2 mtpa are expected to increase to 3.5 mtpa saleable product as resources at Boral's current quarries diminish. *Table 2.1* provides the estimated extraction rates over the 30 year life of the quarry, but as for all quarries, rates will be dependent on sales and production efficiencies.

Table 2.1 *Estimated Extraction*

Extraction (mtpa)	Year 1	Year 2	Years 3 - 5	Years 6 - 10	Years 11 - 30
Quarry Product	0.9	1	1.5	2.5	3.5
Weathered Material	0.9	0.5	0.5	0.6	0.4
Overburden	1.2	0.6	0.5	0.5	0.5



0 1km
Approximate only

Legend

- Morton National Park
- Bungonia State Conservation Area

Figure 2.4 Marulan South Quarry Site

Marulan South Quarry

Overburden

The granodiorite resource is unweathered at depth, and is overlain by an average of ten metres of partially weathered rock, which in turn is overlain with an average of ten metres of overburden (including mostly fully weathered rock and soil). The topsoil, overburden and the limited vegetation that grows in the soil will all need to be removed to allow access to the rock.

Initial construction of bunds and dams will consume sufficient topsoil and overburden to expose weathered and unweathered rock for extraction. As quarrying progresses, further volumes of topsoil and overburden will require removal and transport to an emplacement area.

An overburden emplacement area has been identified in cleared land on the eastern side of the proposed quarry area. The overburden emplacement will be 30 metres high and form an extension of the 10 metre bund surrounding the pit.

Overburden will initially be extracted over the initial six months of the construction period to allow commencement of extraction of the identified resource. Construction of the bund wall and the eastern overburden emplacement will require approximately three and a half million cubic metres of material. Overburden and weathered material will therefore continue to be used for the construction of the bunding and overburden emplacement for up to five years dependant upon extraction rates and the quality of the weathered material influencing the potential sales of weathered material.

A number of alternatives exist for disposal of the remainder of excess overburden including extending the bund wall further south in the resource area, creating an additional emplacement area on Boral land to the north of the site, in-pit rehabilitation of the northern extent of the quarry pit or transferred to a rehabilitation area in the southern pit of the BCSC.

The BCSC south pit is expected to be available for rehabilitation by 2010 and has capacity for overburden and weathered material stripped from the Marulan South quarry for the expected life of operations.

Overburden removal will generally be by excavator and truck, with other plant required for compaction, shaping and rehabilitation. In some instances bulldozers may be used to stockpile loose material prior to loading onto trucks and to push out overburden piles.

The small volumes of vegetative debris produced from the limited clearing proposed will be either spread onto the overburden disposal areas or in areas adjacent to the quarry to provide native animal habitat.

The weathered rock is expected to be of variable strength and may either be able to be freely dug by excavators or may require blasting prior to loading. Marketable weathered material will require crushing and screening prior to transport off site.

Quarry Product

The main resource targeted at Marulan South is the fresh, unweathered granodiorite. This rock is strong and will require drilling and blasting to produce fragments suitable for crushing and screening. Traditional drill and blast methods would be used, that would require a drill rig stationed on top of each production bench. This rig will drill a series of holes that are later charged with explosives, detonators and delays. Boral would apply standard practice of limiting maximum instantaneous charge to stay within the relevant noise and vibration criteria.

The frequency and size of blasts will be determined as quarrying progresses, and by production requirements and geological constraints. At this stage, Boral expects that approximately one blast per week may be required although this may vary over time. Blasting will typically be in the middle of the day, with Saturdays and Sundays avoided. Generally the weekends and early mornings and late afternoons would be avoided, but in some instances, blasting at these times may be unavoidable due to the safe handling requirements of explosives.

In some cases blasting will produce oversized material that will not fit into the primary crusher. In these cases, an excavator with hammer may be used to break up the stone or alternatively a small explosive charge might be applied to the individual stones.

2.5.3 *Water Management*

The water supply system has been specifically designed to be self sufficient and not place additional demand on existing water supplies to the locality. Up to five potential dam locations have been identified on the Marulan South Quarry site with a total catchment area of 953 hectares.

Dams 1 and 2 are located immediately north of the proposed 30 year quarry area (refer *Figure 2.4*) and will form the main water supply for quarry operations. Dam 1 has the largest catchment area and will be constructed in the first stage of quarry development using material from overburden stripping. An off-line constructed wetland will be built upstream of Dam 1 to improve the quality of low flow runoff from the Tangarang Creek catchment and to “polish” excess water from the pit storage before it enters Dam 1. Dam 2 is expected to be constructed as production increases demand for water and it is possible that Dam 2 may not be required if demand is found to be less than anticipated.

Dams 3, 4 and 5 do not contribute significantly to the total storage or proposed water management system and are primarily designed for the management of dirty water.

During construction and operation of the quarry, drainage will convey water from areas of disturbed ground to “dirty water” storage dams and ultimately to storage basins in the pit to prevent sediment laden or contaminated runoff leaving the site. Sediment traps and settling ponds will form part of the site water management system and improve water quality at various points along both clean and dirty water drainage networks

The proposed water management system has been designed to optimise recycling within the quarry operations. Water used in all quarry activities including washing, dust suppression for stockpiles and materials handling will be collected, filtered if necessary, and recycled to minimise demand for top-up water from the clean water catchment storages and to minimise the flow of dirty water to the pit storage.

Potable water supply and sewage treatment for the offices and amenities will comprise package treatment units with minimal demand for top-up water and only a minor discharge of treated effluent to the raw water supply via the pit storage and the constructed wetland.

A schematic overview of the proposed drainage and water management network is shown in *Figure 2.5*. Details of individual elements of the proposed water management system are outlined in *Chapter 6* and *Annex D*.

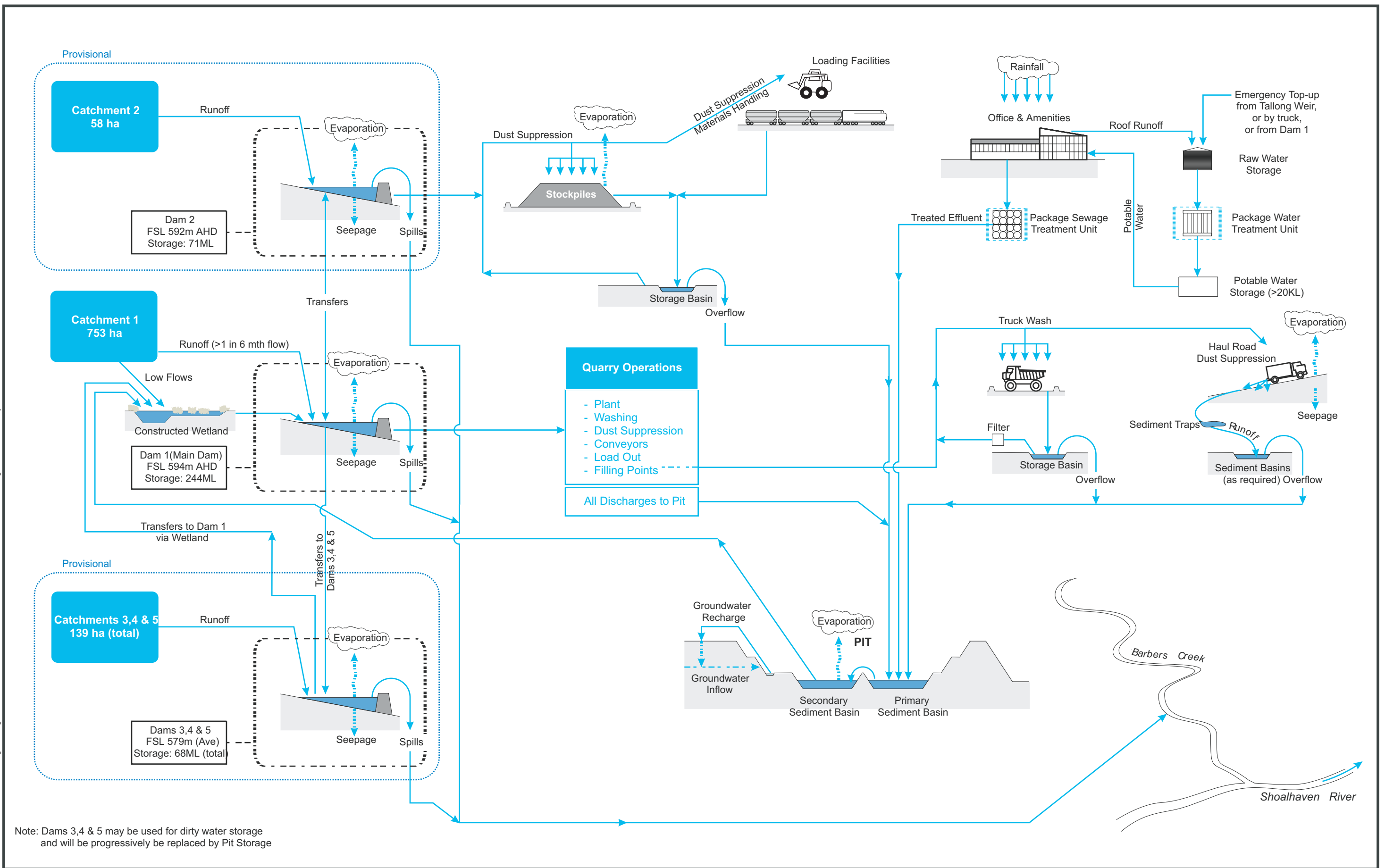


Figure 2.5 **Water Management System**

2.5.4

Processing

The raw feed from the blasted face will be either trucked or direct loaded to the in-pit crushing plant to size and screen the raw material into one of a range of desired final products. From here, the crushed rock will be conveyed to the out-of-pit tertiary plant for final crushing, shaping, screening, blending and stockpiling.

Mobile crushing plant will be positioned in-pit and will be semi-enclosed by cladding. Raw feed will either be trucked to a surge pile adjacent to the jaw crusher, or depending on the stage of quarrying, loaded direct from the face to the primary jaw crusher. The jaw crusher will size the stone, and feed a conveyor leading to the secondary crusher.

The secondary crusher will further reduce the size of the rock into a series of aggregate sizes that may or may not require further processing in the tertiary plant. During the early stages of quarrying and while the full plant and conveyor system is being commissioned, aggregates from the secondary plant may be truck hauled to the out-of-pit tertiary plant. Once fully commissioned though, production from the secondary plant will be conveyed to the tertiary plant and/or product stockpiles.

Final construction details for the final tertiary crushing and screening plant are not yet available but the building will be fully enclosed to control noise and dust emissions.

Product stockpiles will be located adjacent to the tertiary crushing and screening plant and fed by a series of conveyors. Product will be loaded to the trains from the stockpiles by front-end loader.

2.5.5

Rail Transport

At this stage, products from Marulan South Quarry will be transported by rail. Trains will traverse BCSC's spur line to the Medway Junction and onto the Main Southern Railway for transportation to Boral's Sydney rail terminals at Enfield and St Peters and perhaps other terminals. Boral and BCSC have a number of existing rail terminals serving the Sydney metropolitan market including Enfield, St Peters, Clyde and Maldon.

At peak production there will be up to four trains servicing Marulan South quarry making a daily trip between the quarry and typically the Sydney market. Each train has capacity to transport up to around 1,000,000 tonnes per annum which at full production would equate to around 3 or 4 rail trains per day. Train loading and trips will be a 24 hour operation to enable trips to be scheduled away from peak commuter times on the Main Southern Railway.

Advice from the Australian Rail Track Corporation Ltd (ARTC) indicates that they have reviewed capacity on the main southern corridor and there is adequate capacity to accommodate the rail haulage forecasts of the proposed Marulan South Quarry (refer *Annex B*).

2.5.6 *Road Haulage*

Road haulage along Marulan South Road has been identified as a key issue in the local community. To minimise pressure on the local road network, Boral proposes to use rail as its primary method of transportation and currently only seeks approval for road usage during construction and for employees and maintenance vehicles once operational. Delivery of sand from Penrose Quarry for blending with quarry products is expected to occur through the backloading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period of time.

2.5.7 *Facilities And Services*

Administrative offices, amenities, laboratory, workshop, washdown station, refuelling, parking and other facilities may be provided within the plant area to accommodate both employees and visitors.

Country Energy was consulted regarding the provision of electrical power to the quarry and has advised that Marulan South Zone Substation has sufficient capacity for the initial stage of the project. Future stages of the project will require minor upgrades to the substation and the installation of additional powerlines linking the Boral and BCSC plants. All explosives and detonators will be delivered as needed direct to the face.

Distillate will be stored in above ground tanks near the tertiary plant, and all mobile plant refuelling will be carried out either on an adjacent concrete pad, or by mini-tankers in the pit.

The staff facilities will be supplied with potable water, package sewage treatment plant, electricity and telephone.

2.5.8 *Operating Hours and Workforce*

A construction workforce of approximately 20 people will be required. Infrastructure construction will typically take place between 7 am and 6 pm Monday to Friday and 7 am and 1 pm Saturday.

The expected workforce for the operational quarry is up to 30 full time, on-site employees with 2-3 shifts with additional opportunities created in transport and support industries.

Boral seeks approval for operation of the quarry 24 hours a day, 7 days a week. In-pit activities will be restricted to the hours of 7am to 7pm to minimise potential noise issues.

2.6 *PROJECT TIMING*

Construction is planned to commence soon after the application is determined. The quarry is planned to begin initial operations in 2008 and will continue operation for 30 years.

2.7 *ENVIRONMENTAL MANAGEMENT*

An environmental management strategy will be put in place to mitigate the potential social and environmental impacts addressed throughout this EA. The strategy will detail the following:

- environmental issues;
- management objectives;
- performance indicators;
- mitigation measures;
- monitoring requirements;
- responsibilities and timing;
- incident management; and
- reviewing and reporting.

2.8 *REHABILITATION AND FINAL LANDUSE*

Along with vegetation removal, topsoil stripping will occur in any areas to be disturbed including areas for the installation of infrastructure, overburden removal and extraction. The most recently stripped topsoil will be used to dress emplacement areas and bunds to achieve the greatest benefits from the seedbank and soil structure. Topsoil unable to be used immediately will be stockpiled for later rehabilitation of disturbed areas. These stockpiles will be kept to a limited size and seeded taken to ensure stabilisation and preservation of topsoil quality.

Due to the restricted size of the 30 year pit and the longer term intention to gain approval for a southern continuation of quarrying, rehabilitation will be limited to the northern terminal faces, perimeter bunding and overburden emplacement.

Rehabilitation will include shaping of the bund and emplacement areas to provide drainage and irregular features for integration with the surrounding landscape. Topsoil and vegetation stockpiled from the most recent stripping process will be deposited over the bunds and emplacement areas to a depth equal to the average depth of topsoil across the site. Habitat features such as fallen trees and rocks will be provided and revegetation with endemic seed stock undertaken.

Revegetation and rehabilitation adjacent to the remaining woodland near Dam 1 will offset loss of native habitat from the clearing of the endangered Box-Gum Woodland. Details of this revegetation will be formulated in liaison with DEC.

The Marulan South Quarry site has an important strategic reserve of granodiorite with existing strategic infrastructure (most particularly the spur line to the Main Southern Railway) and as consequently the intended land use at the end of 30 year is a continuation of quarrying. Accordingly, no detailed rehabilitation plans have been prepared and any non-quarry landuse proposal would sterilise future extraction.

Boral is committed to rehabilitation and development of the best end use for their quarry operations. Development of the most appropriate end use for a quarry is best done within the last 5 to 10 years of the quarry's operational life within the context of market, environmental and land uses in the region at the time. If in the event that Boral chooses not to extend quarrying at the end of 30 years, the following conceptual rehabilitation principles would be expected to be implemented:

- benches will be restricted to twenty metres high;
- all out-of-pit runoff will be directed away from the pit;
- final benches will be capped with a layer of overburden and topsoil, and planted with trees shrubs and groundcovers of species found in the adjacent Box-Gum Woodland; and
- all ancillary infrastructure (apart from dams) will be removed and the land rehabilitated.



Part B

Planning Framework and
Issues Identification

3.1 INTRODUCTION

The following chapter assesses the proposed development against the relevant planning controls which affect the site. The proposal is not considered to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or trigger any other Commonwealth environmental legislation. Therefore, the assessment concentrates on the state planning controls.

There are a number of relevant NSW planning controls which affect the development proposal for the site, including:

- Environmental Planning and Assessment Act 1979;
- Environmental Planning and Assessment Regulations 2000;
- State Environmental Planning Policy - Major Projects (SEPP – MP) 2005;
- State Environmental Planning Policy No. 11 – Traffic Generating Development;
- State Environmental Planning Policy No. 33 – Hazardous and Offensive Development;
- State Environmental Planning Policy No.44 – Koala Habitat Protection;
- SEPP No. 58 – Protecting Sydney’s Water Supply; and
- Mulwaree Shire Local Environmental Plan (LEP) 1995 –as amended.

3.2 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979, AND REGULATIONS 2000**3.2.1 Part 3(A) of the EP&A Act**

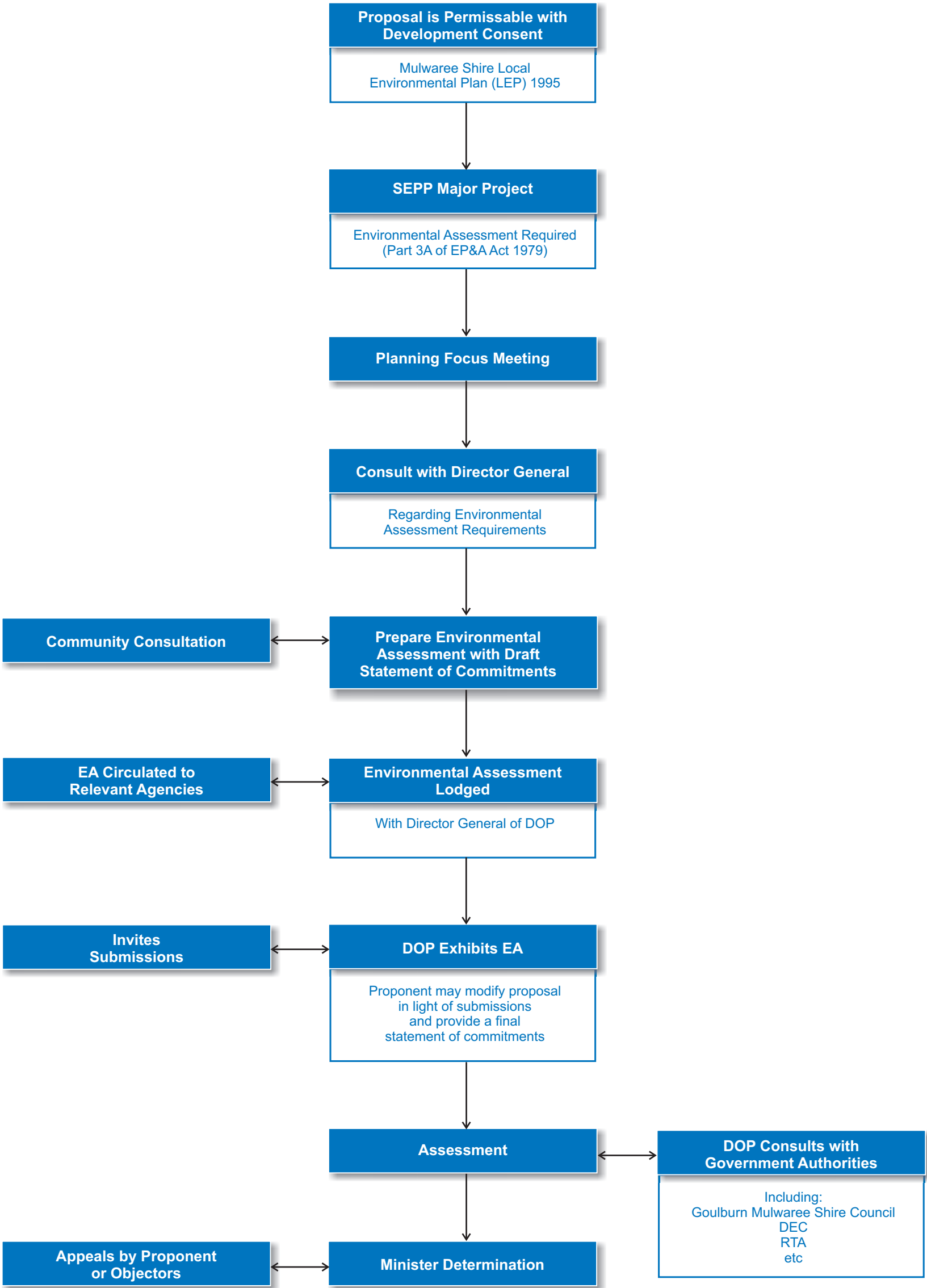
The proposed development will be assessed in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act), and the *Environmental Planning and Assessment Regulations 2000*.

The EP&A Act has been amended to include Part 3(A) which provides a streamlined assessment and approval process for development that is defined as a major project. The new Part 3(A) applies to development that previously was classified as State Significant Development. The proposed development is identified as being a 'Major Project' in Clause 75 (b), Part 3(A) of the EP&A Act which states that:

“(1) This Part applies to the carrying out of development that is declared under this section to be a project to which this Part applies:

a. by a State Environmental Planning Policy”

The proposal is identified as a Major Project in SEPP-MP 2005 (further details of this SEPP are provided below in *Section 4.3.1*). The requirements for a 'Major Project' under Part 3(A) therefore apply to the site. This EA has been prepared in relation to the environmental assessment requirements as discussed below. Pursuant to Part 3(A) the Minister for Planning is the determining authority. *Figure 3.1* illustrates the environmental assessment process under Part 3(A).



3.2.2 *Environmental Assessment Requirements*

Prior to the preparation of the EA, the Director-General of the Department of Planning (DoP) was consulted to determine the issues that were to be addressed within the EA (Clause 75(f)). The key requirements raised by the Director-General (DGRs) are presented in *Annex B*. A summary of the DGRs is included in *Chapter 4* with a table cross referencing the requirements against sections of the EA.

A project under Part 3A does not require the referral and approval from other relevant authorities prior to the planning approval determination in accordance with Clause 75(U) of the EP&A Act. However, a licence in accordance with the *Protection of the Environment Operations Act 1997* (POEO Act) will be required for the operation of the quarry as *extractive industries* are identified under Schedule 1.

Under Part 3(A) Clause 75(R), environmental planning instruments other than SEPPs, do not apply to a 'Major Project'. However, the zoning of the land is applicable in accordance with Clause 75(J)(3)(b) of the EP&A Act. This clause states that the Minister can approve applications for development that are not wholly prohibited. The zoning of the site as defined within the Mulwaree Shire LEP is discussed in *Section 3.4* of this Chapter. A discussion of the SEPPs applicable to the proposed development will follow in *Section 3.3*.

3.3 *STATE ENVIRONMENTAL PLANNING POLICIES*

A number of SEPPs may be triggered by the proposed development. Relevant SEPPs have been considered in the following sub-sections.

3.3.1 *State Environmental Planning Policy (Major Projects) 2005*

The State Environmental Planning Policy - Major Projects (SEPP-MP) 2005 identifies development to which the assessment and approval process of Part 3(A) of the EP&A Act applies. The policy establishes the Minister for Planning as the approval authority for any development at a 'Major Project'. Clause 6(1) of the SEPP identifies projects under Part 3(A) as development that, in the opinion of the Minister, is development of a kind listed in either Schedule 1, 2 or 3 of the policy. Schedule 1 includes *extractive industries* as a 'Major Project' under Part 3(A) in Clause 7(1)(a) and (b) as follows:

Extractive Industries

(1) *Development for the purposes of extractive industry that:*

- a. Extracts more than 200,000 tonnes of extractive materials per year, or*
- b. Extracts from a total resource (the subject of the development application) of more than 5 million tonnes.*

The proposed Marulan South Quarry is anticipated to produce approximately 150 million tonnes of the total resource with a per annum extraction rate of up to 3.5 mtpa. Consequently, the project is subject to the requirements of SEPP-MP and Part 3(A) of the EP&A Act as described in *Section 4.2.1* of this report.

3.3.2 *State Environmental Planning Policy No. 11 – Traffic Generating Developments*

State Environmental Planning Policy No. 11 – Traffic Generating Developments (SEPP 11) requires development proposals considered as traffic-generating developments to be referred to the NSW Roads and Traffic Authority (RTA). Traffic generating developments are identified in Schedule 1 and 2.

Extractive industries are listed in Schedule 1, thus classifying the proposal as a traffic-generating development. The application will be referred to the RTA as required. A traffic assessment is included in *Chapter 12* in this EA.

3.3.3 *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development*

State Environmental Planning Policy No. 33 - Hazardous and Offensive Development (SEPP 33) provides definitions for ‘hazardous industry’, ‘hazardous storage establishment’, ‘offensive industry’ and ‘offensive storage establishment’. The new definitions enable decisions to approve or refuse a development to be based on the merit of the proposal. The approval authority must carefully consider the specifics of the case, the location and the way in which the proposed activity is to be carried out. This policy also requires specified matters to be considered for proposals that are ‘potentially hazardous’ or ‘potentially offensive’ as defined in the policy.

The objective of this section is to establish whether the proposed development would fit within the definition of ‘potentially offensive industry’ and hence, come under the provisions of the policy. A proposal cannot be considered to be an offensive industry unless it is first identified as potentially offensive industry. Under SEPP 33, potentially offensive industry is defined as follows:

“potentially offensive industry means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would emit a polluting discharge (including for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land, and includes an offensive industry and an offensive storage establishment.”

SEPP 33 also ensures that appropriate measures are taken to reduce the impact of the development on the environment. All reasonable and feasible mitigation measures will be employed on site and activities and emissions will be within Environmental Protection Authority (EPA) licensing requirements. SEPP 33 states that “in most cases compliance with the EPA (now the Department of Environment and Conservation (DEC)) requirements should be sufficient to demonstrate that the proposal is not an offensive industry.

Another prescription of SEPP 33 is to ensure that the Minister through DoP as the approval authority is provided with sufficient information to assess whether the development is hazardous or offensive. The information provided throughout this EA satisfies these requirements and demonstrates that the proposal is not considered a potentially offensive industry.

3.3.4 State Environmental Planning Policy No. 44 – Koala Habitat Protection

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.

The State Environmental Planning Policy – Koala Habitat Protection (SEPP 44) applies to those areas of vegetation where koala feed trees constitute at least 15 % of the total number of trees in the upper or lower strata of the tree component as a measure of conserving and managing potential koala habitat and preventing further koala population decline.

Detailed flora and fauna investigations were undertaken as part of this EA which determined that there was a lack of the required density of primary food trees and there was no evidence of Koalas during the site inspection. SEPP 44 is therefore not considered to apply to the proposal.

3.3.5

State Environmental Planning Policy No. 58 – Protecting Sydney's Water Supply (SEPP 58)

The State Environmental Planning Policy No. 58 – Protecting Sydney's Water Supply (SEPP 58) applies to the land within the hydrological catchment of Warragamba, Upper Nepean, Woronora, Blue Mountains and Shoalhaven, including Mulwaree local government area (LGA) in which the proposed quarry is situated. SEPP 58 is a means to ensure that developments within Sydney's drinking water catchments do not have detrimental impacts to the quality of drinking water.

A full assessment of the impact on water resources through a water cycle management study (required under SEPP 58 Clause 11(4)(a)(i-v)) is detailed in *Chapter 6*. A summary of how each matter under Clause 11(4)(a) has been addressed is provided in *Appendix D* of *Annex C*.

A draft Regional Environmental Plan (REP) "Sustaining the Catchments" has been developed by the Sydney Catchment Authority (SCA) to provide direction to ensure the health of Sydney's drinking water catchments. The draft plan was initially exhibited in October 2000 by the then Planning NSW and subsequently re-exhibited in March 2004.

A key aspect of the draft plan is for new development in the catchment to have a neutral or beneficial effect on water quality. The assessment undertaken within this EA demonstrates that the proposal will not have any identifiable impact upon receiving waters and may improve catchment water quality through the construction of a wetland upstream from the major clean water storage.

3.4

MULWAREE SHIRE LOCAL ENVIRONMENTAL PLAN (LEP) 1995 – AS AMENDED

The majority of the site is zoned 1(a) General Rural zone under the Mulwaree Shire LEP 1995. Extractive industries are permissible in this zone with consent. The relevant aims and objectives of the 1(a) zone include the following:

"to promote the proper management and utilisation of resources by;

- (a) promoting, enhancing and conserving:*
 - (iv) valuable deposits of mineral, coal, petroleum, and extractive materials controlling the location of development for the purposes in order to ensure the efficient extraction of those deposits."*

The proposal is consistent with this objective.

A small portion of the total resource area falls within the boundary of the former Marulan South Village Zone 2(v). The village was built to service the existing limestone mine and has subsequently been abandoned and the majority of premises demolished. Community and civic buildings such as the Marulan South Country Club have been retained but are only irregularly used by Boral and BCSC. The village zoning is therefore redundant.

The former Mulwaree Council has previously adopted a Settlement Strategy for the overall LGA including Marulan South. The Settlement Strategy has subsequently been adopted by the new Goulburn Mulwaree Council who is currently undertaking a planning study to gain information to refine the strategy and undertake Local Environmental Studies.

Verbal advice from Goulburn Mulwaree Council indicates that the existing zoning is proposed to be amended within the LGA wide LEP currently in preparation. Extractive industries are prohibited in the 2(v) zone. Notwithstanding the prohibition to quarry development in zone 2(v), pursuant to Clause 75(J)(3)(b) of the EP&A Act the Minister may approve development for quarrying or associated activities in zone 2(v) if the amendments to the zoning are not gazetted by the time of the approval.

The proposed Marulan South Quarry is consistent with the Mulwaree Settlement Strategy, by promoting the development of a resource and minimising environmental and social impacts.

The project is also consistent with the Sydney to Canberra Corridor Strategy (Department of Planning, 1995), which outlines the strategic direction for the corridor of land along the Hume Highway and Federal Highway including land-use patterns and resource management. The strategy sets a framework for those with responsibility for planning decisions within the corridor and highlights the importance securing resources of extractive materials and the need to provide employment opportunities in the corridor.

4 *STAKEHOLDER CONSULTATION*

4.1 *IDENTIFICATION OF KEY STAKEHOLDERS*

A consultation strategy was formulated as a part of the EA process to assist in the identification of key stakeholders and issues for consideration by Boral and the EA project team. Consultation with a range of government and community stakeholders was incorporated into the strategy to both inform the stakeholders of the project and to allow any issues of concern to be raised at an early stage of the planning process and incorporated into the EA.

4.2 *CONSULTATION WITH GOVERNMENT AUTHORITIES*

4.2.1 *General*

Throughout the EA process, regular consultation has been maintained with State government agencies and the Goulburn Mulwaree Council. Consultation has been both formal and informal and has been used to refine the proposal and develop the assessment methodology.

Consultation was also undertaken with service providers such as Country Energy and the operators of infrastructure such as ARTC to ensure the proposal could be adequately serviced through the existing services to Marulan South.

4.2.2 *Local Council*

A meeting with key Goulburn Mulwaree Council staff and the Mayor was held on the 13th of October, 2005. Council indicated they would like to be kept informed with the progress of the EA. Council officers also attended the planning focus meeting (PFM) and the second community information session as described below.

4.2.3 *Planning Focus Meeting*

A (PFM) was held at the former Marulan South Country Club on the 3rd of November, 2005. The PFM is an essential component of the EA process, facilitating information exchange between relevant government agencies and the proponent relating to the details of the proposal and potential issues relevant to each agency.

A background report was prepared and distributed to all participants prior to the meeting. The background paper provided an overview of the proposal, a summary of the planning framework, consultation strategy and likely environmental issues associated with the proposal.

Agencies invited to the meeting included:

- Department of Planning;
- Department of Environment and Conservation;
- Roads and Traffic Authority;
- Sydney Catchment Authority;
- Goulburn Mulwaree Council; and
- Department of Primary Industries (DPI).

The Director General's Requirements for the preparation of this EA were developed from the issues raised at the PFM and subsequent agency consultation. A copy of the requirements and associated agency submissions is provided in *Annex B*. A summary of key issues raised in the DGRs and the section of the EA where they are addressed is provided in *Table 4.1*.

Table 4.1 *Director General's Requirements*

Issue Raised	Section addressed in EA
<i>General Requirements</i>	
The Environmental Assessment should include:	
• an executive summary;	Exec Sum
• a detailed project description including need for the project; alternatives considered; and various components and stages of the project;	Chapter 2 and 18
• consideration of any relevant statutory provisions;	Chapter 3
• an overview of all the environmental impacts of the project (including an environmental risk analysis) and identification of the key issues for further assessment, taking into consideration the issues raised during consultation;	Chapter 5
• an assessment of the key issues specified below and significant issues identified in the environmental risk analysis including:	Part C – Chapter 6 to 16
• a description of the existing environment;	
• an assessment of the potential impacts of the project, including cumulative impacts that may be associated with the concurrent operation of the quarry and the adjoining limestone mine and the recently approved Lynwood Quarry; and	
• a description of the measures that would be implemented to avoid, minimise, offset, manage, and/or monitor the impacts of the project;	
• a draft Statement of Commitments, outlining environmental management, mitigation and monitoring measures;	Chapter 17
• a conclusion justifying the project, taking into consideration the environmental impacts of the proposal, the suitability of the site, and whether or not the project is in the public interest; and	Chapter 18

Issue Raised	Section addressed in EA
- a signed statement from the author of the Environmental Assessment certifying that the information contained in the report is neither false nor misleading. - the Environmental Assessment should take into account relevant State government technical and policy guidelines.	Sign off page Chapter 3
Surface and Groundwater	
- detailed modelling of surface and groundwater impacts, a site water balance, and consideration of the proposal against the relevant provisions of <i>State Environmental Planning Policy No. 58 – Protecting Sydney’s Water Supply</i>; - a description of the proposed water management system, including any creek diversions and sediment/water supply dams; - a surface and groundwater contingency strategy setting out the measures that would be implemented in some circumstances to protect the water supply of surrounding landowners and the environment; and - consideration of the relevant State Government technical and policy guidelines including, but not limited to: <i>Rehabilitation Manual for Australian Stream</i> (Land and Water Resources Research and Development Corporation); <i>Guidelines for Fresh and Marine Water Quality and Guidelines for Water Quality Monitoring and Reporting</i> (ANZECC and ARMCANZ 2000); <i>Managing Urban Stormwater; Soils and Construction Volume 1 4th Edition</i> (Landcom 2004); - the various <i>State Groundwater Policy documents</i> (DNR); <i>Approved Methods for the Sampling and Analysis of Water Pollutants in NSW</i> (DEC); and <i>Environmental Guidelines: Use of Effluent by Irrigation</i> (DEC).	Chapter 6 and Annex C
Noise, Blasting and Vibration, and Air Quality	
- detail of impacts including construction, operation, off-site road and rail noise; and - consideration of the relevant State Government technical and policy guidelines including, but not limited to: <i>NSW Industrial Noise Policy</i> (DEC); <i>Construction Site Noise and Rail Traffic Noise – Environmental Noise Control Manual</i> (DEC); <i>Environmental Criteria for Road Traffic Noise</i> (DEC); <i>Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration</i> (ANZECC and ARMCANZ 2000); <i>Approved Methods and Guidelines for the modelling and Assessment of Air Pollutants in NSW</i> (NSW); and <i>Approved methods for the Sampling and Analysis of Air Pollutants in NSW</i> (DEC).	Chapter 10 and 11 Annex F and G
Transport	
- details of road and rail traffic volumes generated by the project; - an assessment of the capacity and safety of the proposed transport route, in particular the intersection of the Hume Highway, South Marulan and Jerrara Road; and - consideration of the relevant State Government technical and policy guidelines including, but not limited to: <i>Guide to Traffic Generating Development and Road Design Guide</i> (RTA); and - relevant Austroads standards.	Chapter 12
Visual	
an assessment of the visual impacts of the project on the Morton National Park.	Chapter 13 and Annex H

Issue Raised	Section addressed in EA
Flora and Fauna	
- impacts on threatened species and endangered ecological communities; - details of any vegetation offsets to ensure that there is no net loss to the flora and fauna values of the area in the medium to long term; and - consideration of the relevant State Government technical and policy guidelines including, but not limited to: <i>Draft Guidelines for Threatened Species Assessment</i> (DEC); <i>Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities</i> (DEC); <i>Guidelines for Developments Adjoining Department of Environment and Conservation Land</i> (DEC); <i>Guidelines for Assessment of Aquatic Ecology in EIA</i> (Department of Planning); <i>Policy and Guidelines Aquatic Habitat Management and Fish Conservation</i> (DPI); and <i>State Groundwater Dependent Ecosystem policy</i> (Department of Natural Resources).	Chapter 7 and Annex D
Heritage	
- impacts on Aboriginal and non-Aboriginal heritage; and - consideration of the relevant State Government technical and policy guidelines including, but not limited to: <i>draft Guidelines for Aboriginal Cultural Heritage impact Assessment and Community Consultation</i> (DEC); <i>Assessing Heritage Significance</i> (NSW Heritage Office); and <i>NSW Heritage Manual</i> (NSW Heritage Office).	Chapters 8 and 9 Annex F
Rehabilitation and Final Land Use	
- justification for the proposed final land form and use in relation to the strategic land use objectives; - a description of how the site would be progressively rehabilitated and integrated in to the surrounding landscape; and - a description of the measures that would be put in place to ensure that sufficient resources are available to implement the proposed rehabilitation measures, and for the ongoing management of the site following the cessation of quarrying activities.	Chapter 2
Waste	
- consideration of the relevant State Government technical and policy guidelines including, but not limited to: <i>Environmental Guidelines: Assessment and Classification and management of Liquid and Non-liquid Wastes</i> (DEC).	Chapter 14

4.3

CONSULTATION WITH LANDHOLDERS AND LOCAL RESIDENTS

The following section contains information relating to the consultation with the local landholders and residents of the Marulan South Quarry proposal.

4.3.1

Preliminary Contact

The consultation program was implemented during the period October 2005 – August 2006 and comprised the following activities:

- general information on the proposed project via newsletter;
- general information on the proposed project via Boral website;
- face to face meetings with landowners close to the proposed quarry;
- two information sessions held at the former Marulan South Country Club;
- feedback forms provided at the information session;
- presentation to the neighbouring Tallong Community Focus Group;
- advertisements in the local newspaper, local magazine and distribution of flyers for the public information sessions; and
- receipt of and response to phone calls, faxes, letters and other submissions.

For a summary of the consultation with the local landowners and residents, see *Table 4.2*.

Table 4.2 *Summary of consultation activities October 2005 –August 2006*

Activity	Date Commenced	No. of inquiries/ Distribution/Attendance
Newsletter 1	Early October 2005	650 letters distributed to the residents of Marulan, Marulan South, Tallong, Big Hill and Brayton via letter box drop by Marulan Post Office
Website	Early October 2005	Established in October, information on the site was upgraded in March 2006 and will be updated when the EA is submitted to DoP
Face to face meetings with landowners	Early October 2005 and September 2006	10 neighbours contacted with five face to face meetings
Public Information Session 1	22 nd October 2005	17 attendees registered (estimated 25 attendees in total)
Feedback Forms from Information Session 1	22 nd October 2005	10 completed and returned at the session (no further forms received after the session)
Tallong Community Focus Group Presentation	23 rd March 2006	Estimated 20-25 attendees
Advertisements in Local Media for Information Session 2 and flyer distribution	28 th July 2006 (Goulburn) and 31 st July 2006 (Marulan)	The Goulburn Post has a circulation on Friday of 5000. The Marulan Magazine has a circulation of 800 to Marulan, Tallong, Brayton, with additional copies going to shops in Penrose, Wingello and Bungonia.
Public Information Session 2	10 th August 2006	33 attendees registered (estimated 37 attendees in total)
Feedback Forms from Information Session 2	10 th August 2006	10 completed and returned at the session (no further forms received after the session)
Responding to inquiries	Ongoing throughout project process	11 e-mails
		0 fax
		19 phone calls
		3 letters
		1 other submission (delivered in person at Tallong Meeting, photographs)

The following section discusses these consultation activities in detail.

4.3.2 *Newsletter*

The newsletter was prepared and distributed (via letter box drop) in early October to all houses within Marulan, Marulan South, Tallong, Big Hill and Brayton. Approximately 650 newsletters were distributed with the residents' local mail by the Marulan Post Office.

The newsletter contained information on the Boral proposal, the Environmental Assessment (EA) process, the proposed quarry's location, contact details for those seeking further information (including the website) and details of the Public Information Session on the 22nd of October. A flyer was also distributed to advertise the time and location of the community information session in August.

4.3.3 *Website*

The website located at www.boral.com.au/marulanquarry was established in October 2005 and detailed the preliminary information of the Boral proposal, including the EA process, the proposed quarry's location, and contact details for those seeking further information.

In March 2006, the website was updated to reflect the proposal's progress. In addition to the existing information, copies of the Major Projects Application form to the NSW DoP as well as the supporting March 2006 Background Report for the Marulan South Quarry were posted and available for download. The website will be further updated when the EA is submitted to the DoP.

4.3.4 *Public Information Sessions*

Two community information sessions were held during the preparation of the EA involving the distribution of information on the proposed quarry, receiving feedback from the community and providing a forum for the local community to input into the EA process.

Community Information Session 1

The first community information session was held on Saturday 22nd October 2005 at the former Marulan South Country Club. The session was held between 11am and 3.00pm in order to maximise attendance. Seventeen (17) people registered at the session, although an estimated twenty five (25) attended. A newsletter, with details of the date time and location of the information session, was distributed to the local residents approximately two weeks prior to the information session.

The information session acted as a means for disseminating information regarding the proposed quarry and the EA process to the local community and neighbouring residents. The session also provided an opportunity for the Boral and ERM community consulting team to learn of issues of concern to the local community. Several ERM and Boral representatives were available to respond to questions raised.

Additional newsletters containing project information were prepared and displayed at the session, along with maps identifying the proposed location and footprint of the quarry.

Residents attending the information session were encouraged to complete a feedback form, in order for their comments and/or concerns about both the project and the information session to be formally documented. Ten feedback forms were completed and returned to the project team. In general, those who completed the feedback form seemed happy with the format and content of the information session, but raised a number of issues that they wanted addressed. These issues are discussed in more detail in *Section 4.3.6*.

Tallong Community Focus Group Presentation

Further to the first community information session, ERM and Boral attended and made a presentation to the Tallong Community Focus Group on the 23rd of March 2006 at 7.30pm.

There were an estimated twenty to twenty five attendees at the meeting. A blank letter template containing the contact details for the project's Community Liaison Officer was provided at the meeting for those residents wanting to submit any queries or comments to the project team. Letters were received following the Tallong presentation, and these comments are detailed in *Section 4.3.6*.

Community Information Session 2

In addition to the initial community information session and Tallong meeting, a further community information session was held on Thursday 10th of August 2006. This session was again held at the former Marulan South Country Club, from 6.30 to 8.30 pm and was attended by both Boral and ERM representatives.

The format of the evening included one hour 'open house' where local residents could speak to the project team one on one, with any comments or queries they had. The remaining hour featured a presentation on the environmental assessment findings and was followed with an opportunity for attendees to ask questions. A feedback form was made available for those who wished to submit comment.

4.3.5 *Inquiries (Phone/Fax/E-Mail/Letter)*

ERM established a dedicated community e-mail address and a 1800 number that were made available as community query or feedback channels for the EA process. A fax number and reply paid address were also available.

Few comments were received during the EA process. The feedback and or queries that were received consisted of:

- 2 e-mails;
- 19 phone calls;
- 3 letters; and
- 1 other submission (photographs delivered in person at the Tallong Community Meeting)

All comments received from the community have been considered by both Boral as the proponent and the EA project team. Many of the comments have directly influenced both the design of the quarry and approach to the assessment within the EA. All communications received by letter or email were acknowledged (either by email or letter) to the submitting party by the project's Community Liaison Officer and where possible a direct response to their query was also provided.

4.3.6 *Key Community Issues*

The majority of issues raised by the local community were principally in relation to local amenity and quality of life in the locality. Key issues raised by the community are outlined in the following sections.

Noise

There is concern amongst local residents that the noise generated by the quarry operations and associated traffic (both rail and truck) will be audible at nearby properties. For many of these residents, the quiet character of the area is integral to the quality of life in the locality. The potential affect of noise on local chicken and turkey farms was also raised as a potential issue.

Noise has been comprehensively addressed within *Chapter 10* and *Annex F* of this EA. All practicable measures to ameliorate potential noise emissions were progressively incorporated into the quarry design to ensure acceptable noise impacts upon the surrounding locality. All management procedures form part of the statement of commitments for the project and therefore become part of the proposal.

Visual

Visual amenity was mentioned predominantly in relationship to local lookouts at recreation areas within Morton National Park and Bungonia State Conservation Area. The existing BCSC Blue Circle mining operations can be observed from some of these lookouts and walking tracks. It is a concern that the proposed quarry would exacerbate the visual impact of these lookouts and deter visitors to the area. Potential visibility from nearby residential properties was also raised as concern.

A detailed visual assessment was undertaken as part of the EA, incorporating 3D digital terrain modelling and visual simulations to outline the maximum extent of visibility for the proposal. Marulan South Quarry will be predominantly shielded from view from all nearby receptors due to natural topography and prominent views of the site can only be obtained from the immediate vicinity of the proposal.

The proposal will not be visible from Bungonia Lookdown and views of the quarry will be extremely limited from the spurline along the Long Point walking trail. Provision of bunding around the perimeter of the site will minimise potential views of the site from recreational areas.

Traffic

Road haulage has been identified as a key issue within the local community and siting the quarry on an existing rail spur was a critical consideration in the selection of the proposed site. To recognise community concerns and minimise potential impacts upon the local road network, Boral proposes to transport all quarry product by rail and only seeks approval for road usage during construction and for employee and maintenance vehicles during quarry operations.

Delivery of sand from Penrose Quarry and potentially other sources for blending with fines is expected to occur through the back-loading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period of time.

There was also a perception that the proposed quarry will increase freight railway movements at the expense of commuter trains, which are used by the Southern Tablelands residents.

Advice from the ARTC indicates that they have reviewed the current and projected future capacity on the main southern corridor and that there is adequate capacity to accommodate the rail haulage forecasts of the proposed Marulan South Quarry. Passenger services and high speed freight services typically receive priority scheduling with individual contracts set up with each user of the line (pers comm ARTC, 11/08/2006).

Concerns were raised in regards to recent drought conditions, local water restrictions and the proposed source of water for quarry operations.

A water management system has been developed which aims for the proposed operations to be 100% self sufficient in water use so that there are no further pressures placed upon the potable water supply system or withdrawals from Tallong Weir.

4.4 ABORIGINAL COMMUNITY CONSULTATION

The local Aboriginal community and traditional owners were identified as key stakeholders for the development. The DEC's interim guidelines for Aboriginal consultation were used to guide the Aboriginal consultation program.

Letters requesting names of Aboriginal organisations to consult and any known heritage issues were faxed on 28 September 2005 to:

- NSW Department of Environment & Conservation (DEC);
- Office of the Registrar, *Aboriginal Land Rights Act 1983* (NSW);
- NSW Native Title Services Limited; and
- Goulburn Mulwaree Council (21 October, 2005).

An advertisement for this assessment was placed in the Goulburn Post newspaper on Wednesday 28 September 2005 and in the Marulan Magazine (which comes out monthly) on Tuesday 4 October 2005. While no responses were received to these particular advertisements, initial consultation with a number of organisations including DEC and Goulburn Mulwaree Council identified a number of groups to be contacted. These groups included:

- Pejar Local Aboriginal Land Council;
- Gundungurra Tribal Council Aboriginal Corporation;
- Buru Ngunnawal Aboriginal Corporation; and
- United Ngunawal Corporation.

These groups were therefore consulted on this project. In addition, each group was asked to identify any further individuals or groups who would be interested in being consulted regarding this project. No further groups or individuals were identified through this process.

Fieldwork for the assessment was undertaken on 29 November 2005 and on 7 March 2006 to follow up the details of sites recorded in the vicinity of the proposed dam. Each Aboriginal group was invited to provide a representative for the fieldwork. Aboriginal representatives present during field survey on 29 November were:

- Justin Boney, of the Pejar Local Aboriginal Land Council; and
- Peiro Delponte and Graeme Dobson of the United Ngunawal Corporation.

Bill Hardie of the Gundungurra Tribal Council Aboriginal Corporation had previously agreed to provide a representative to participate in the field survey, but was unable to organise on the day of survey. Don Bell of the Buru Ngunnawal Aboriginal Corporation was invited to provide a representative to attend fieldwork, but did not respond.

Dean Bell, representing the Yurawang Gundana Aboriginal Corporation (this organisation is not listed on the Office of the Registrar of Aboriginal Corporations), contacted ERM on 8 February 2006 requesting to be consulted. Following consultation, a follow-up survey of the study area was undertaken on 7 March 2006 with the following Aboriginal representatives:

- Dean Bell and Karen Williams of the Yurawang Gundana Aboriginal Corporation; and
- Don Bell and Holly Horning of the Buru Ngunnawal Aboriginal Corporation.

All Aboriginal groups were provided with a copy of the draft Aboriginal archaeology technical report for comment. Comments that have been received from these groups concerning the survey and review of this report indicate that they agree with the assessment. Full details of Aboriginal consultation and a consultation log are provided within *Annex F*.

5.1

OVERVIEW OF APPROACH

The following qualitative risk analysis was undertaken at the commencement of the assessment process in order to prioritise issues for assessment and assist in formulating the assessment methodologies for the project. A risk analysis is an integral part of the Part 3A process where key issues identified within the preliminary environmental investigations and through government and community consultation can be identified for a more focussed assessment process.

The risk analysis is presented within *Table 5.1* and includes the identification of key aspects to be addressed within the EA and the proposed assessment methodologies to complete the assessment. Detailed analysis of each aspect is provided within the following Environmental Interactions section of the EA.

Table 5.1 *Project Risk Assessment*

Aspect	Sub Topic	Level of Risk	Scope of Works	Justification
Noise and vibration	Quarrying at Marulan South	Medium - A number of rural residences are located around the proposed operations. The low level of ambient noise in the predominantly rural environment increases the potential for noise impacts from the new operations.	The noise assessment will be undertaken based on DEC's Industrial Noise Policy (INP) and a range of quarrying scenarios assessed including the anticipated "worst case" scenario. This will include attended and unattended ambient noise surveys at surrounding residential locations and passive recreational areas, noise modelling and site validation of the modelling results. Noise contours for the surrounding area and project specific limits will then be derived in accordance with the INP and the EPA's Environmental Noise Control Manual.	By modelling a range of quarrying scenarios, Boral will be provided with data to allow management of operational activities to minimise potential noise impacts on the surrounding community. Determination of specific noise limits will allow for maximum flexibility of quarry operations within these limits.
Cumulative noise		Medium - The proximity to the BCSC limestone mine has the potential for cumulative impacts	A cumulative noise assessment will be undertaken to determine the impact of additional operations together with BCSC's limestone mine. This will include quarrying operations as well as the cumulative rail and road traffic along the existing rail spur, the Main Southern Line and along Marulan South Road. Assessment will be based on predicted net noise increase and absolute noise level.	A cumulative assessment of the noise generated by the proposed quarrying operations together with BCSC's Limestone Mine is required to determine potential cumulative impacts and to allow management of operational requirements while minimizing potential impacts on the surrounding community and recreational receivers.

Aspect	Sub Topic	Level of Risk	Scope of Works	Justification
Air Quality	Blasting	Low - due to distance to nearest potential receivers	Blasting impacts will be assessed in accordance with the DEC recommended ANZECC criteria. These criteria are used to assess human annoyance, discomfort and potential property impacts from blasting activities.	Assessments will identify quarrying areas that may require additional management of blasting practices to reduce potential blast and vibration impacts.
	Air quality model and assessment	Medium - number of rural residences are located around proposed operations	A of The assessment will be based on the NSW DEC's <i>Guideline on the use of Air Quality Models for Modelling Assessments</i> using the ISCST3 computer-based dispersion model to predict concentration and deposition rates of particulate matter. The assessment will cover a range of operational scenarios including realistic initial construction and potential "worst case" operational scenario. Modelling of proposed and cumulative air emissions will be undertaken by Holmes Air Sciences.	Boral will be provided with data to allow management of operational activities to minimise potential air emission impacts on the surrounding community. Determination of specific air emission limits will allow for maximum flexibility of quarry operations within these limits.
	Cumulative assessment	Medium - proximity to the BCSC limestone mine	A cumulative assessment will be undertaken based on the most likely operational scenario and include available information from assessments of the BCSC limestone mine.	A cumulative assessment is required to understand the air quality interactions of the project with those from the adjacent BCSC Limestone Mine and the impact on surrounding receivers including rural residential properties and surrounding recreation areas.
Groundwater	Greenhouse gas emissions from quarrying and transport	Low	An quantitative inventory of greenhouse gas emissions for the proposal will not be undertaken.	While extraction and processing of granodiorite consumes energy, the proposal will use conveyors where possible in place of less efficient truck haulage and the aggregate will be transported by rail rather than road truck. Therefore, greenhouse gas emissions for the operation are not highly significant.
	Hydrogeological properties	Low - number of fractured rock aquifer	Assessment of the hydrogeological properties of the fractured rock aquifer will be undertaken. This will	This level of assessment will provide sufficient information to develop a conceptual site model for

Aspect	Sub Topic	Level of Risk	Scope of Works	Justification
		bores have previously been installed on the site to assess the resource	include a desktop review of geological and hydrogeological information, determination of groundwater dependent ecosystems, and a site-specific field investigation. Water depth and quality will be sampled to interpret groundwater make and interconnectivity.	determining the impacts of quarry on the groundwater system.
	Groundwater impact determination.	Low - the fractured nature and low permeability of the granodiorite aquifer is expected to result in minimal drawdown or associated impacts upon groundwater	Conceptual site modelling will be undertaken using the determined hydrological properties to simulate the progression of quarrying over stages of quarry operation to determine the maximum potential extent of groundwater impacts. The anticipated groundwater contribution to the total water budget at the quarry will also be determined.	Initial investigations conclude that no significant impacts are expected to the groundwater system as a result of the proposed quarrying. Conceptual modelling is therefore considered an acceptable approach in defining the potential extent of impacts of quarrying on groundwater users.
Surface Water	Water balance	High	A water balance will be prepared to determine the extent to which water supply requirements can be met by on-site runoff and supply options. This balance will be determined using 112 yrs of rainfall data and the MUSJC software model to generate estimates of daily runoff. A water management plan will be developed based on a number of scenarios for quarry operations, climate change, water storage and reuse with the aim of achieving	Boral intends for the proposed quarry to be independent from external water supplies so as not place additional demands on the limited supplies within the Goulburn Mulwaree LGA. This is to be achieved through capture of water from the surrounding catchment, retention of surface runoff and recycling of water used for quarry operations. This water balance will be used by the operation to understand the risk of water shortages and

Aspect	Sub Topic	Level of Risk	Scope of Works	Justification
			100% reuse.	the potential for overflows into Tangarang creek, Barbers Creek and the Shoalhaven's receiving waters.
	Water quality	Low	The MUSiC model will be used to assess potential impacts from surrounding road, rail and other infrastructure development on water quality. Snap-shot water quality testing will be undertaken and compared to ANZECC and EPA guidelines. An ongoing water monitoring plan will be developed as part of an integrated water management plan and to ensure that any releases from clean water dams complies with secondary contact standard guidelines prior to release.	The proposed level of assessment will provide Boral with sufficient information to develop a water management plan to reduce potential impacts to water quality as a result of the proposed quarrying by identifying and managing potential sources of water pollution.
Ecology	Threatened flora and fauna species and ecological communities	Low to Moderate	A desktop assessment and literature review will be undertaken of the State and Commonwealth threatened species registers to determine threatened species previously recorded or likely to occur at the site. A field survey will be undertaken targeted towards results from this assessment.	The majority of the site has been cleared, predominately for grazing and it is considered that the level of survey proposed will provide sufficient information on which to base an impact assessment and develop mitigation measures for inclusion in a Statement of Commitments.
Aboriginal Heritage	Aboriginal Relations	High	Ensure ongoing communication with Aboriginal groups.	Will maintain or improve current relationships.
	Aboriginal Assessment	Low	Assessment will be in accordance with the NSW Department of Environment and Conservation guidelines for Aboriginal heritage surveys (National Parks and Wildlife Service 1997). Assessment will include desktop analysis, consultation and field survey focusing on landforms within the site boundary that are likely to contain Aboriginal heritage sites as based on previous heritage studies in the region. Development of management measures for heritage items within the study	Heritage sites that may be required to be destroyed will be captured. The property has experienced extensive disturbance from ploughing, farm dam construction and erosion for the past 50 years and is likely to have low archaeological significance.

Aspect	Sub Topic	Level of Risk	Scope of Works	Justification
Historical Heritage	European Assessment	Archaeological	Low	Review of European heritage lists and archived plans. area will also be undertaken.
Traffic and transport	Rail transport of aggregates	Low	An assessment will be undertaken to determine the impacts with the increased use of the rail network and cumulative impacts to noise and air quality on villages along the Main Southern Line and on residents along the existing rail spur.	This level of assessment reflects the limited evidence for historic sites within the study area and therefore the low potential for subsurface archaeological sites to be present. Rail is proposed as the primary mode of transport for aggregates. The proposal would require several train loads per day along the existing rail spur and the Main Southern Line in addition to the rail traffic associated with BCSC.
	Road transport of aggregates	High	An assessment of the proposed road transport network will be undertaken to define the likely level of impact. This will include an assessment of the existing use levels and the maximum limits of Marulan South Road. The capacity of the intersections of Bungonia Road and the Hume highway with Marulan South Road will also be assessed including the capacity of the proposed new intersection at the Hume Highway to service the Readymix proposal.	The level of assessment will reflect the level of community concern raised in regards to road haulage. Given the existing B-Double Capacity designation of the road haulage route and the intention for the majority of Boral's aggregates to be transported by rail, impacts from Boral's proposal are considered to be minimal.
	Construction phase traffic generation	Moderate	Review of construction activities associated with new infrastructure requirements including establishment of a rail siding and product handling facilities, an estimate of traffic generated by these works and an assessment of impacts on the local transport network.	Construction traffic is expected to consist of heavy vehicle movements and staff traffic movements along Marulan South Road over the 12 month construction period. Although limited weekly heavy vehicle movements are expected, this level of assessment is designed to reflect community concerns over road haulage in the region.
Visual	Visual assessment	Low	The assessment will include 3D simulations of the proposed operations from visual receivers and will describe the potential impacts to visual amenity and the	Site inspections indicate that visual impacts to identified receptors are not as excessive as initially predicted. This level of assessment is considered to be appropriate given

Aspect	Sub Topic	Level of Risk	Scope of Works	Justification
			existing rural character of the area. This will incorporate modelling of significant overburden bunding on the pit perimeter and the provision of tree screens.	current visual affect from the existing limestone mine, the expected impact of the quarry on surrounding receptors, and the proposed mitigation measures.
Socio-economic considerations	Economic benefits to local and regional communities and government from the project; potential impacts to social values; and social benefits from quarrying	Low	Document the relationship between quarrying, the socio-economic status of the community, and the social values of the community. An assessment of potential social amenity values of surrounding recreational areas will also be undertaken.	Social values of the community typically relate to quality of life and the social amenity of the region. These values, along with the proposals location adjacent to recreation and wilderness areas within Bungonia State Conservation Area and Morton National Park necessitates the need for an assessment of potential air quality, noise and visual amenity issues.



Part C

Environmental Interactions

6 WATER RESOURCES

6.1 EXISTING ENVIRONMENT

6.1.1 *Catchment Description*

The proposed Marulan South Quarry site, encompassing the 30 year quarry area, proposed processing plant area and water supply dams, occupies approximately 92 ha. The identified resource sits on an elevated undulating plateau primarily used for agricultural purposes, and is intersected by three small catchments. Two of these catchments drain north towards Tangarang Creek, an ephemeral creek with a catchment area of 753 ha above the north-western corner of the site. Tangarang Creek flows along the northern edge of the site to the deep gorge of Barbers Creek approximately 500 m to the east and into the Shoalhaven River a further 6.5 km to the south.

Surface water drains away from the centre of the resource area which is situated on a ridge of the plateau. Drainage lines within the property consist of ephemeral creeks which are either slightly eroded or lined with grass. A number of small farm dams are situated along these creek lines and appear to retain water with little seepage.

6.1.2 *Environmental Value of Receiving Waters*

Barbers Creek is the primary receiving watercourse for any discharges or runoff from the site. This waterway was considered by the Healthy Rivers Commission (HRC) (1999) to have high ecological value despite being in poor condition relative to the rest of the Shoalhaven catchment due to the effects of variable quality runoff from agricultural sub-catchments. Barbers Creek flows into the Shoalhaven River approximately 30km upstream of Tallowa Dam, which supplies raw water to the Sydney and Illawarra drinking water systems.

Environmental values for the Shoalhaven River and its tributaries, as endorsed by the HRC (1999) are:

- healthy waters – protection of aquatic ecosystems;
- recreation – protection of primary and secondary recreation and visual amenity;
- water supplies – livestock, irrigation and farmstead water; and
- protection of drinking water, within defined areas of the catchment.

Water quality objectives to achieve these environmental values are provided in terms of numerical guidelines in *Australian and New Zealand Guidelines for Fresh and Marine Waters Quality* – referred to as “ANZECC 2000 Guidelines”.

Hydrogeological Environment

Hydrogeological and hydrochemical assessments detailed in *Annex D* indicate that the granodiorite unit comprises a low-yielding fractured aquifer with groundwater occurring in localised, discrete and potentially discontinuous fracture zones. The most significant of these zones comprises the water table at the weathered horizon between the overburden and the more competent, underlying granodiorite approximately 15 to 30 m below ground.

No evidence was found for significant vertical or lateral connection between the various fracture zones. Recharge of groundwater is therefore likely to occur via direct infiltration where fractures and weathered bedrock is exposed or covered by only a thin layer of overburden. Annual average recharge rates were calculated to be 90 mm/yr.

A groundwater gradient of 0.02 m/m occurs across the majority of the site, dipping in a north-easterly direction to discharge in the gorges and creeks surrounding the resource area. The exception to this is the mound of groundwater with a steeper gradient (0.12m/m) at the south of the resource area resulting from the permeability contrast between the granodiorite and limestone formations.

Groundwater migration rates across the site were calculated at 0.95 m/yr with discharge rates of 0.013 m³/day per metre of exposed fracture zone. This is a very low rate of groundwater migration, and indicates that minimal groundwater discharge to the quarry pit can be expected. Groundwater seepage rates of 52 m³/day, or approximately 19 ML/yr are expected, although these calculations will need to be refined during quarry operations to account for the large degree of spatial heterogeneity exhibited by the fractured rock aquifers.

Current Groundwater Use

A search of the DNR database of registered bores within a 5 km radius of the proposed quarry location indicated a total of 30 registered wells. Of these, 21 wells are located between 4 and 5 km from site, and 11 wells are located on the opposite side of the Barbers Creek gorge which acts as a physical hydraulic barrier between the proposed quarry site and the wells.

Only four wells are located within 2 km of the site, one of which is within the quarry footprint and will be removed during quarry operations and two others are on the opposite side of the Barbers Creek gorge and therefore not in hydraulic connection with the proposed quarry site. One well has been identified approximately 1.5 km to the west of the site and may potentially be affected by quarry operations.

6.1.4 Rainfall And Evaporation

The majority of rainfall data for the climatic assessment was obtained from Bureau of Meteorology (BoM) Station 070063 (George St, Marulan) located approximately 5.8km from the site and with records extending back to 1894. Evaporation data was generated by repeating the 27 years of existing data (1971 to present) from BoM Station 070236 (Progress St, Goulburn) located 27.2km from the site. Results of this analysis are presented in *Table 6.1* and *Figure 6.1*.

Table 6.1 *Average Monthly Rainfall and Evaporation at Site*

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean monthly rainfall (mm)	68.8	74.6	51.9	41.6	58.8	67.6	66.3	56.6	50.6	45.7	54.6	54.3	691.3
Mean monthly evaporation (mm)	195.9	153.0	127.7	79.3	51.2	33.9	40.1	59.0	83.4	119.6	147.0	195.1	1285

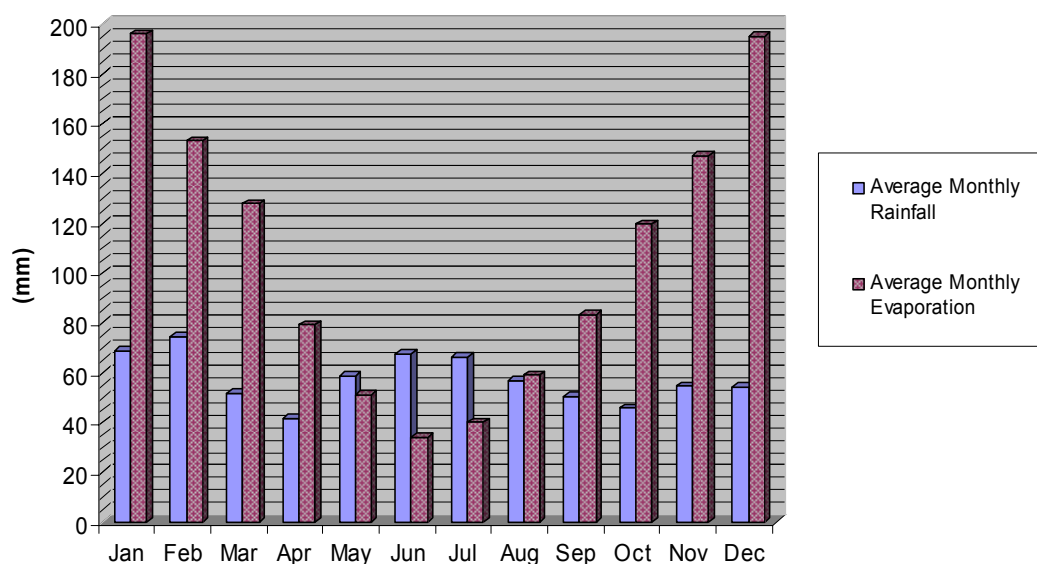


Figure 6.1 *Average Monthly Rainfall and Evaporation at Site*

Rainfall data for the local region indicates that the area experiences average monthly rainfall between 54.3 and 68.8 mm during summer and 67.6 and 66.3 mm during winter. Average annual rainfall for the station's operational years (1984-present) is 691.3 mm.

Evaporation rates in the region are high in summer (195.1 to 195.9 mm) and relatively low in winter (33.9 to 40.1 mm) with average annual evaporation rates of 1285 mm. These results indicate a generally temperate climate with warm, dry summers and cool, wet winters.

6.2 *SITE WATER DEMAND*

6.2.1 *Raw Water Demand*

Water will be required for drinking and other uses in offices and amenities for a workforce of up to 20 people in any shift. Based on a conservative usage of 170L/person/day, a potable water supply with a capacity of 3.4kL per day or 1.24ML per annum is proposed.

The expected raw water demand for the quarry operations over various stages in a proposed 30-year operational period and a 2-year rehabilitation period is given in *Table 6.2*. Because the peak demand is expected after approximately 11 years of operation, any potential future extension of the 30-year plan will not increase total demand above 255ML per annum unless production rates are increased above 3.5 million tonnes per annum (mtpa).

Table 6.2 *Raw Water Demand*

Parameters	Years 0 - 2	Years 3 - 5	Years 6 - 10	Years 11 - 30	Rehab. 1 - 2
Production (Mtpa)	0.5	0.8	2.5	3.5	0
Overburden/Spoil (Mtpa)	1.3	1	0.6	0.4	0
Total Haul Road Length (m)	800	1200	2000	3000	0
Total Stockpile Area (m ²)	20000	30000	50000	60000	0
Other Unsealed Areas (m ²)	5000	8000	10000	14000	4000
Irrigation Area (hectares)	5	10	20	20	110
Activity	Average Annual Usage (ML/year)				
Haul Road Dust Suppression (Ave 30kL/d per km)	43.8	65.7	87.6	109.5	21.9
Stockpile Dust Suppression (Ave 3L/d per m ² makeup)	21.9	32.9	54.8	65.7	0.0
Other Dust Suppression (Ave 3L/d per m ² makeup)	5.5	8.8	11.0	13.1	4.4
Plant Water (Incl. spoil) (Ave 30L/t)	54.0	54.0	93.0	117.0	0.0
Irrigation (Ave 200mm pa)	10.0	20.0	40.0	40.0	220.0
Total Demand (ML/year)	95.8	128.8	209.7	254.5	224.4

Allowance has been made for haul road dust suppression by watering for conventional quarry operations. If, as is intended, product is transferred from the pit to stockpiles by conveyor rather than truck, demand for water as indicated in *Table 6.2* is overstated and would be reduced. Similarly, demand for water may be reduced by other dust suppression methods on haul roads and unsealed access roads such as polymer based emulsions etc. Potential reductions cannot be quantified until detailed mine planning has been completed. The more conservative values of expected demand have therefore been used.

6.2.2 *Potential Water Storages*

Given recent drought conditions in the region and the extremely limited availability of dam water throughout the Goulburn Mulwaree Local Government Area (LGA), the proposed quarry is intended to be independent as far as possible from external water sources.

The maximum practical raw water storage can be developed through the construction of up to five dams on existing creeks and drainage lines within the site. The final preferred number and size of dams will be a function of environmental impacts, cost, risk of water shortages and demand management. A catchment plan showing the locations of the five potential dam sites is shown in *Figure 6.2*. The areas of these sub-catchments are given in *Table 6.3*.

Table 6.3 *Marulan Site Sub-catchments*

Location	Catchment Area (hectares)	Area Within Pit Boundary (hectares)	% of Site
Dam 1	753.0	0	0
Dam 2	58.4	0	0
Dam 3	83.7	47.6	46
Dam 4	28.6	17.0	16
Dam 5	26.3	17.1	17
Other Areas	n/a	22.0	21
TOTALS	950.0	103.7	100
Note: Dam 5 catchment area only falls within the potential future pit boundary within a 70 yr resource area.			

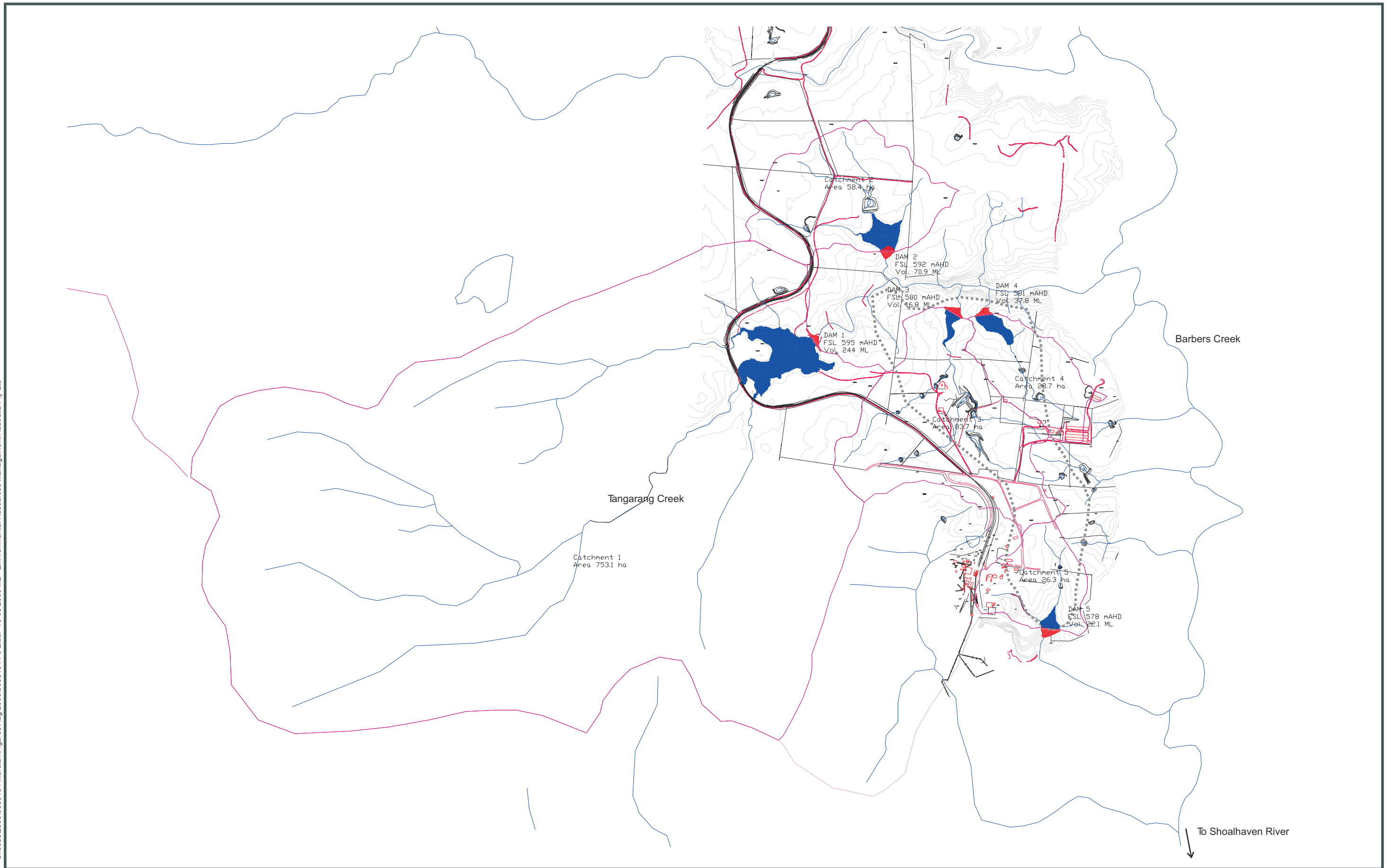
A number of scenarios were modelled to determine the extent to which water supply requirements could be met by on-site runoff. The 112 years of available rainfall records were used to generate estimates of daily runoff using the MUSIC software model. The critical parameters in determining the appropriate amount of storage required are probability of water shortages occurring and maximum duration of shortages.

Provision of Dam 1 only (244 ML capacity at 8.5m depth) would result in potential water shortages approximately 0.3% of the time over the life of the quarry with shortages extending for up to three weeks. This is considered to be an acceptable risk of water shortages. However, construction of two smaller dams (Dam 1 and Dam 2 with depths of 7.5m instead of 8.5m) will result a smaller overall storage volume with a larger catchment area resulting in the same level of risk of water shortage and greater flexibility in the operation of the quarry.

The main advantages of constructing both dams are that transfer of water will allow balancing of storages and either dam can be taken out of service for maintenance or repairs.

Dam 1 is the most practical to construct and will be the main supply dam for the quarry operations. This dam will be constructed in the first stage of quarry development using material from overburden stripping. An off-line constructed wetland will be built upstream of Dam 1 to improve the quality of low flow runoff from the Tangarang Creek catchment and to “polish” excess water from the pit storage before it enters Dam 1. Dam 2 is expected to be constructed as production increases demand for water. It is possible that Dam 2 may not be required if demand is found to be less than anticipated.

Dams 3, 4 and 5 are primarily designed for the management of dirty water on site and do not contribute significantly to the total storage or proposed water management system. Dams 3 and 4 can either initially be constructed for storage of dirty water or as in-pit sediment basins following the commencement of quarry operations. Dam 5 is located near the southern edge of the overall 70 year resource area and would be implemented if quarrying was to proceed to south of the 30 year quarry plan to manage water quality and runoff to an unnamed creek flowing southwards from the resource area.



0 300m

Legend

- Potential Dam Site
- Catchment Boundary
- Waterway
- - - - - Resources Boundary
- Contour

Figure 6.2 **Catchment Plan**

Marulan South Quarry

6.3

WATER MANAGEMENT SYSTEM

6.3.1

Overview

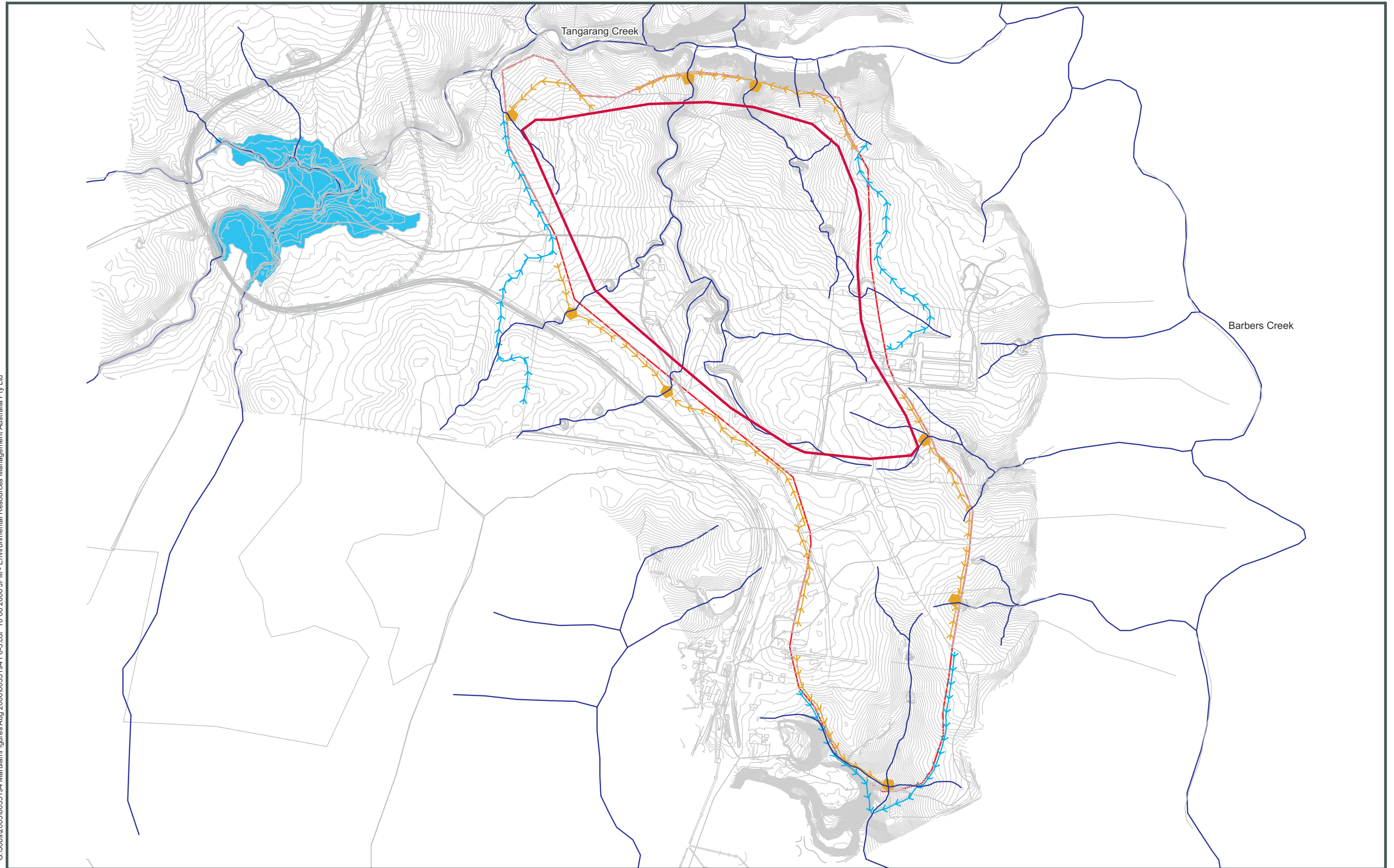
The proposed water management system at the Marulan South Quarry has been designed to optimise recycling within the quarry operations and minimise the potential for offsite impacts to local receiving waters. Water used in all quarry activities including washing, dust suppression for stockpiles and materials handling will be collected, filtered if necessary, and recycled to minimise demand for top-up water from the clean water catchment storages and to minimise the flow of dirty water to the Pit storage.

During construction and operation of the quarry, drainage will convey water from areas of disturbed ground to “dirty water” storage dams and ultimately to storage basins in the pit to prevent sediment laden or contaminated runoff leaving the site. Sediment traps and settling ponds will form part of the site water management system and improve water quality at various points along both clean and dirty water drainage networks.

Water quality will be monitored to confirm the efficiency of the drainage system. Water quality devices will be inspected and cleaned at least annually and more frequently where required

Potable water supply and sewage treatment for the offices and amenities will comprise package treatment units with minimal demand for top-up water and only a minor discharge of treated effluent to the raw water supply via the pit storage and the constructed wetland.

An overview of the proposed drainage and water management network is provided in *Figures 6.3 and 6.4*. Details of individual elements of the proposed water management system are outlined in the sections below.



0 250m

Legend

-  Clean water drains
-  Dirty water drains
-  Sediment basins
-  Water storage dams
-  Natural waterways

 30 Year Resource Boundary

Figure 6.3

Drainage Plan

Marulan South Quarry

6.3.2

Surface Drainage From Undisturbed Areas

Runoff from undisturbed areas will be diverted around areas disturbed or affected by quarry activities wherever practical. This will reduce the risk of flooding in the pit and in operational areas as well as reduce the potential for clean runoff to be polluted by quarry activities. Diversion of clean water will be effected by diversion drains, contour drains and, where necessary, bunds, levees, weirs and pipe culverts. Wherever possible, diverted clean water will be directed to clean water storage dams to augment water supplies for the quarry. Sediment traps will be installed wherever there is a risk of erosion and storages will have capacity to contain potential spills in undisturbed areas.

All permanent diversion elements will be designed with capacity to convey critical flows from a 1 in 20 year Average Recurrence Interval (ARI) storm event but may be designed for a 1 in 100 year ARI event in critical locations where risk to property, operations or life is high. Temporary drains may be designed for smaller storm events depending on their design life – typically, elements that will be in place for less than 6 months would be designed for a 1 in 5 year ARI storm. Diversions that will be in place for more than 2 years will be considered “permanent”.

Diversion drains and contour drains will be constructed as channels and/or banks depending on topography. Where practical, drains will be lined or vegetated and longitudinal gradients will be limited to 1% to minimise the risk of erosion. Check dams and sediment basins will be constructed at intervals along diversion drains where erosion is expected. At points of concentrated or high velocity flows, spreaders, lining and dissipaters will be constructed.

6.3.3

Pit Water and Runoff From Disturbed Areas

As quarrying proceeds, dirty water dams will eventually be removed and replaced by two or more storage basins in the floor of the pit. As far as possible all runoff from haul roads and disturbed areas as well as overflows from dirty water storages will be directed into the pit (refer to *Figure 6.4*).

The pit basins will act as primary and secondary settlement ponds and will alternate in function after the secondary basin is periodically desilted or either basin is relocated to accommodate new areas being quarried. Additional sediment traps will be located along the drainage network closer to disturbed areas to trap courser sediments as close to the sources as possible. Spills in disturbed areas will be contained as close as possible to potential spill sources (eg by bunding or spill basins) but can be contained in the pit basins as a backup before treatment and/or disposal.

The pit will comprise a permanent groundwater sink for the lifespan of the quarry operations. Due to the fractured nature of the groundwater system it is anticipated that the aquifer will not have a large storage and is unlikely to contribute significantly to water supplies. Major groundwater seepage is not expected as a result of the localised and potentially discontinuous nature of the fracture horizons and conservative model estimates indicate that a total groundwater seepage volume of 52 m³/day, or approximately 19 ML/year would occur on site.

Metals and major ion concentrations in groundwater will be considered before using groundwater in quarry production. Groundwater is suitable for dust suppression in and around the pit however may not be suitable for use in heavy machinery and may affect reticulation systems.

A provisional drainage plan for undisturbed and disturbed areas is presented in *Figure 6.3*.

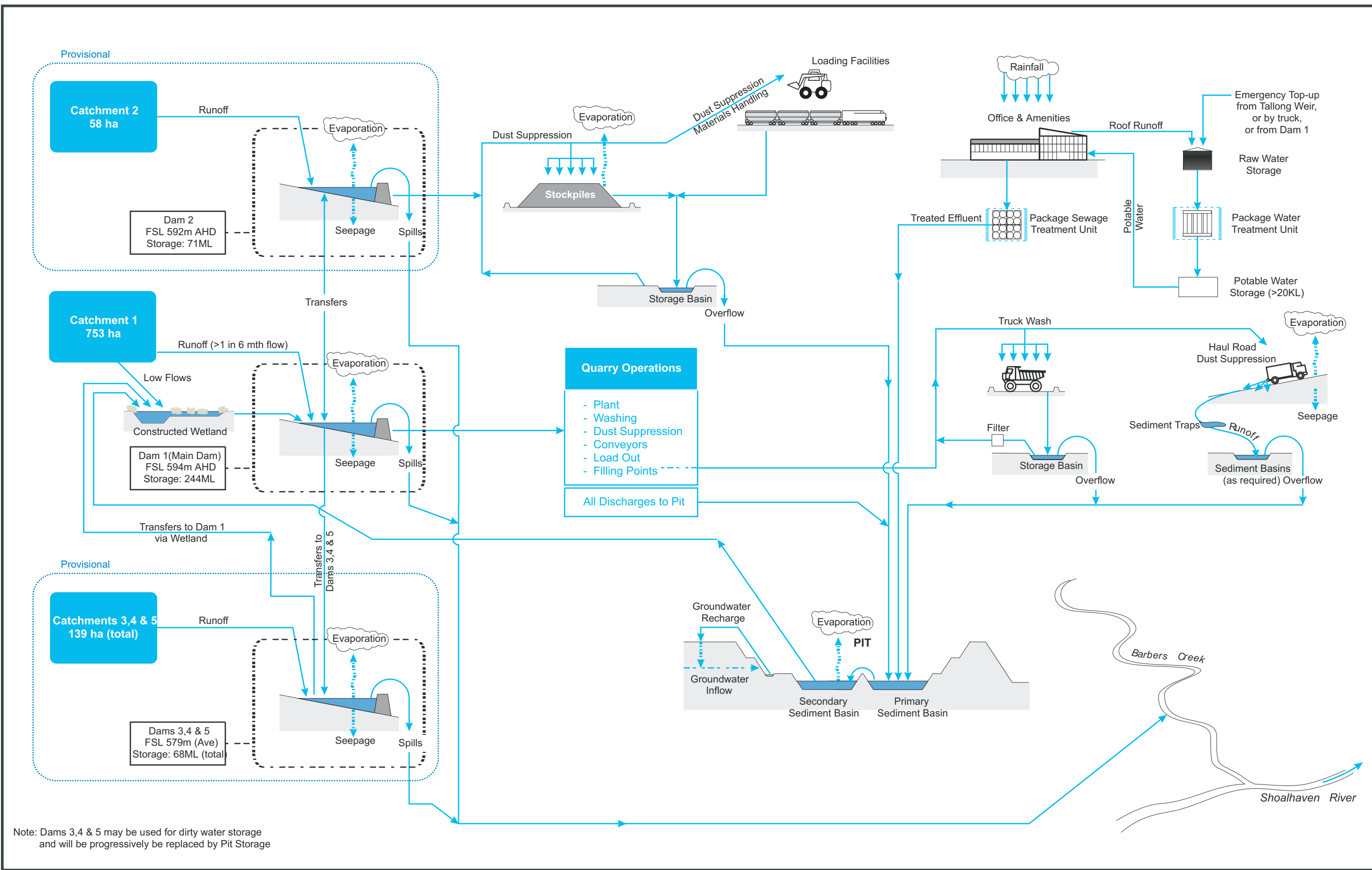


Figure 6.4 **Water Management System**

6.3.4 *Stockpile and Haul Road Dust Suppression*

Dust suppression for stockpiles and materials handling areas will utilise a closed circuit watering system with a collection basin at the lowest point in each area. Top-up water will be supplied from the main clean water dams or from the pit basin as required. Overflows will be directed wherever possible to the pit or, where this is not possible, will be eliminated by providing sufficient overflow storage from which water can be pumped to the pit or other storages.

Dust will be suppressed by watering haul roads and unsealed access roads as needed. Runoff from haul roads will be directed to the pit or to storage dams.

6.3.5 *Potable Water Supplies*

The potable water supply system will store rainwater runoff from clean surfaces (roofs, clean pavements etc); treat to drinking water standards using a small package treatment unit (eg Veolia continuous microfiltration unit 2M10C or similar); and store at least 6 days supply (20kL) of treated water. Clean water from dams can also be used when rainwater tanks are depleted.

6.3.6 *Sewage Effluent and Recycling*

A small package treatment plant is proposed to treat up to 150L/person/day (3kL/day) of sewage to secondary standard with disinfection (either UV treatment or chlorination). Treated effluent will be diluted with water in the pit storage before being used for dust suppression or other uses only in areas that drain to the pit. Excess pit water will be “polished” through a small constructed wetland before flowing into the main storage dam (Dam 1). The water quality in the pit storage and in the receiving dam will be monitored to ensure it meets minimum standards for secondary contact.

No sewage, treated or otherwise, will be discharged from the site. The treatment plant and storage will be located so that any emergency overflow will be directed into the pit.

6.3.7 *Spills and Discharges*

It is important that all potentially contaminating materials used or stored on the site during quarrying activities should be protected from entering the groundwater or surface water systems. This will be achieved through storage in designated bunded areas.

Provision of spill kits and training of site personnel in their use will ensure that in the event of any spills appropriate action can be taken rapidly to prevent and minimise impacts to surface waters or groundwaters. Wherever possible activities that have potential for spills will be located in areas that drain to the pit; otherwise appropriate safeguards and spill containment facilities will be installed.

6.3.8 *Rehabilitation Drainage*

Contour drains will be installed on rehabilitated slopes to minimise the potential for scouring. Runoff will be directed to sediment traps and settling ponds before flowing to Tangarang and Barbers Creeks. Where necessary, scour protection and dissipaters will be installed where flow velocities exceed 1 m/s or the scour velocity for soil in the vicinity. Rehabilitated slopes will be vegetated to reduce surface erosion. Rock batters will be benched so that flows collected on each bench will be directed to contour drains or natural waterways.

Depending on the final use of the pit, rehabilitation drainage for areas that drain into the pit will need to consider the stages of future development. Surface runoff will continue to flow into the pit and water levels are expected to stabilise when equilibrium is reached with seepage outflows.

6.4 *POTENTIAL WATER RESOURCES IMPACTS*

6.4.1 *Water Supply*

The water supply system has been specifically designed to be self sufficient and not place additional demand on existing water supplies to the locality. There may also be potential to incorporate future synergies with the adjacent BCSC Limestone Mine to supply the existing operation with a supplementary water source.

Marulan South is currently supplied with water via an existing pipeline from the Tallong weir, approximately 10 km to the north of the site on Barbers Creek. There are potential risks of water shortages from the weir, particularly as a result of the recent drought conditions in the region.

The proposed quarry will require up to 255 ML per annum of water at maximum production for haul road and stockpile dust suppression, material processing, wash-down and irrigation.

Water balance modelling indicated that construction of Dam 1 with a depth of 8.5m would have sufficient capacity to service the water demand for the proposed quarry operations with minimal potential for water shortages during dry weather. Construction two smaller dams (Dam 1 and Dam 2 with depths of 7.5m instead of 8.5m) will result a smaller overall storage volume with a larger catchment area resulting in the same level of risk of water shortage and greater flexibility in the operation of the quarry.

Surface water run-off from within the pit will also be collected and incorporated into the water management system to maximise recycling and minimise the potential for off-site transport.

The use of existing water supplies from the Tallong Weir or use of local groundwater wells was not considered to be sustainable over the operation of the quarry and have not been incorporated into the proposed system.

There may also be potential to incorporate future synergies with the adjacent BCSC Limestone Mine to supply the existing operation with a supplementary water source.

6.4.2 *Alteration to Catchments and Yields*

Alterations to the existing catchments will have some impacts on water quality and on the quantity of runoff. Clearing of land for agriculture over a large proportion of the Tangarang Creek catchment is already expected to have increased flows and pollutant loads in the creek. Approval is being sought for 30 years of operation of the quarry over 92 ha, reducing total runoff from Tangarang Creek into Barbers Creek by approximately 9% as a result of the reduction in catchment area.

Withdrawal of up to 255 ML of water per annum when operations reach full production, will reduce the total flows to Barbers Creek and consequently to the Shoalhaven River by a corresponding amount. This is relatively insignificant (<0.1%) in terms of total flows in the Shoalhaven River, which averaged approximately 250,000 ML per annum at Tallowa Dam between 2001 and 2005.

Storage reservoirs themselves will have mixed impacts on the environment by inundating existing grazing land and creating new habitat. There may be some beneficial impacts during floods as these storages will attenuate flood peaks. They will also act as sediment basins, reducing suspended solids in downstream flows and providing a slight reduction in nutrient levels.

6.4.3 *Diversions and Downstream Drainage*

Clean water will be diverted around disturbed areas in contour drains or modified channels. This will affect local flows and may have the potential to increase the risk of erosion in some locations. Appropriate design and management of contour drains will prevent significant erosion as well as offsite transport of suspended sediments.

6.4.4 *Water Quality*

Appropriate management of the proposed water storage dams will prevent any potential detrimental impacts upon water quality. Storage dams have the potential for negative impacts on water quality by depleting dissolved oxygen and providing a potential source of algal blooms and undesirable habitat.

Discharges from the pit and other disturbed areas have the potential for negative impacts on water quality unless the water is adequately treated. It is intended to retain all water from disturbed areas so that there would be no discharges to local receiving waters and therefore no adverse impacts on water quality in receiving waters. All excess water from the in-pit storages will initially be passed through the constructed wetland prior to release into Dam No. 1. The effectiveness of the dam in removing pollutant loads from runoff has been modelled using the MUSIC model which indicates that the dam has the capacity to remove 89% of the total suspended solids load, 75.5% of the total phosphorous load and 68% of the total nitrogen load.

6.4.5 *Environmental Flows*

Environmental flows will be maintained for Tangarang Creek to prevent any potential impacts upon downstream ecology. There will be occasional spills from clean water dams during floods and environmental flow releases will be made, equivalent to 10% of average daily flows. Flow regimes will be developed that mimic natural flows in terms of frequency and variation with a minimum number of releases each year equivalent to the number of rainfall events in the catchment and to suit the downstream ecosystem.

6.4.6 *Groundwater Level Drawdown in the Vicinity of the Quarry*

Quarrying is proposed to commence in the northern section of the resource area. Due to the fractured nature of this system it is anticipated that the aquifer will not have a large storage but the initial release of hydraulic pressure may result in a larger initial flux of groundwater into the pit than would be expected. However, considering the low permeability of the granodiorite aquifer, it can be assumed that a steep groundwater gradient will develop adjacent to the quarry pit as a result of groundwater drainage from truncated fracture zones, with significant drawdown limited to the immediate vicinity of the pit.

A conservative analytical “Theis” drawdown calculation was performed to approximate the extent of drawdown surrounding the quarry pit as a result of dewatering for the duration of quarry activities. The Theis drawdown equation is an analytical solution describing drawdown in a confined aquifer at a given radius from a pumping from a well. In this case, the quarry pit is represented by a pumping well with a discharge rate equal to the total estimated groundwater seepage volume calculated as 52 m³/day. Significantly, the Theis equation incorporates the conservative assumption that there is no source of recharge to the aquifer, which results in an overestimation of drawdown expected in the field.

The results of drawdown calculations for 5, 10 and 30 years of quarry operations are presented in *Figure 6.5*.

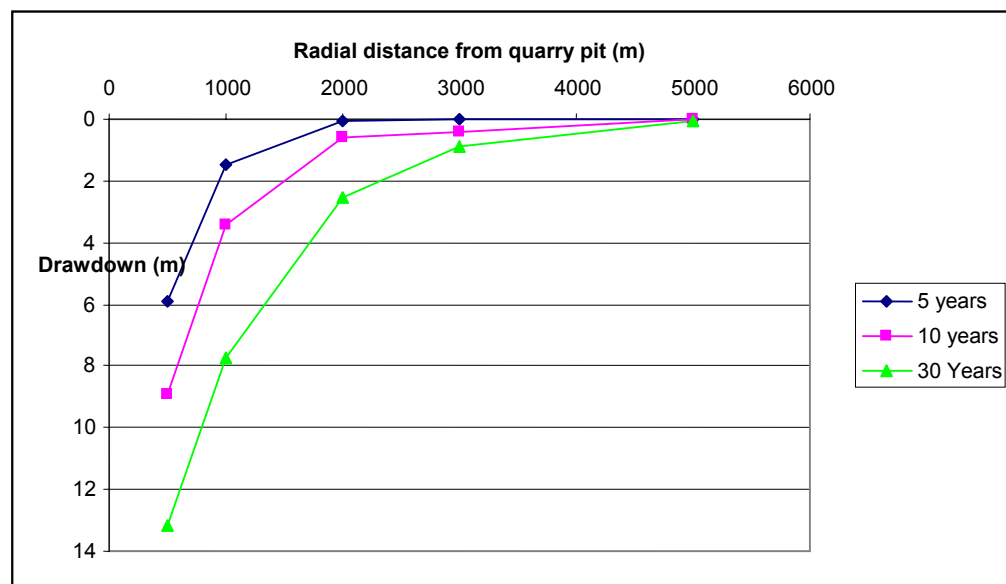


Figure 6.5 *Estimated Drawdown with Radial Distance from the Quarry Pit*

6.4.7 *Potential Impacts to Local Groundwater Users*

The quarry pit would comprise a permanent groundwater sink and reduce groundwater levels in the immediate vicinity of the quarry. However, the limited extent of water level drawdown that is anticipated should have a negligible impact on neighbouring groundwater users, especially considering that the closest registered well to the site is located approximately 1.5 km from the proposed pit footprint. Conservative Theis drawdown calculations indicate that up to 5 m of drawdown may be realised after 30 years of quarry operations at the closest registered well.

It must be re-emphasised that because the Theis solution does not account for recharge to the aquifer, a considerable overestimation of drawdown within 2 km of the quarry is observed. In reality, surface recharge to the aquifer will reduce the effect of drawdown at the well and the well is located beyond the zone of significant water level drawdown.

Groundwater monitoring at the well will determine the extent of the predicted drawdown and if an impact is identified, the properties water supply can be supplemented by a piped connection to the proposed new Dam No. 1.

6.4.8 *Groundwater Dependent Ecosystems*

Investigations to date have not identified the presence of groundwater dependent ecosystems in the vicinity of the proposed quarry area. With regards to the adjacent Barbers Creek gorge, considering the low permeability and discontinuous nature of the fracture zones it is considered unlikely that sufficient natural discharge occurs from truncated fracture zones to support a groundwater dependent ecosystem.

6.5 *MONITORING OF WATER RESOURCES*

6.5.1 *Overview*

Operational environmental management procedures for the quarry will include an ongoing monitoring program which will provide a mechanism to:

- develop a detailed understanding of water requirements at the quarry;
- optimise water use;
- manage water storages to meet demand;
- ensure the quarry is operating as anticipated with respect to water quality protection;
- assess the effectiveness of site water management strategies in protecting downstream water quality;
- identify any unforeseen impacts from the quarry operations;
- implement measures to prevent any as yet unforeseen impacts from the scheme; and
- verify that the scheme is achieving its environmental objectives.

The monitoring program will be refined where necessary based on the results of previous monitoring and current quarry operations.

Surface Water Quality Monitoring

Surface water quality monitoring will comprise sample collection and testing by a National Association of Testing Authorities (NATA) registered laboratory.

Sampling Locations and Frequency

Monitoring will be undertaken at the supply dams to ensure that water is of suitable quality for its intended use. Monitoring should also be undertaken in Tangarang Creek downstream from any disturbed areas and areas of any site discharge to confirm that site operations are not impacting receiving waters.

Water quality monitoring will commence prior to site establishment and/or any quarrying activities to develop background information on water quality in the existing waterways. Sampling will then be undertaken on a quarterly basis with additional monitoring following rainfall events and/or known discharges from the site. After quarry operations are established the frequency may be extended to half yearly, provided water quality meets the performance criteria.

Monitoring will be undertaken of the quantity of water both being supplied (through rainfall within the catchment areas) and used at the quarry. A gauge will be located at the site to gain daily rainfall and evaporation data to predict water supply balances and to manage dust suppression. Water levels in each of the storages will be monitored at least weekly to confirm available supply and to alert operators to impending water restrictions. Meters will be installed to monitor the quantity of water being used across the site for dust suppression, within the plant operations and for all other uses. Environmental flows and flood spills to Tangarang Creek will also be recorded.

Monitoring Parameters And Performance Criteria

A comprehensive suite of water quality parameters will be monitored initially to assist in gaining a comprehensive understanding of existing water quality conditions and to determine critical site water quality parameters for regular monitoring. These are expected to include pH, electrical conductivity (salinity), total suspended solids, total dissolved solids (TDS), oil and grease (hydrocarbons).

Results will be compared to guideline values provided in *Australian and New Zealand Guidelines for Fresh and Marine Waters Quality* (ANZECC, 2000). Should any sample fail to meet these guidelines, quarry management will be required to initiate action to determine the cause and remediate the problem. Additional testing may be required to confirm the effectiveness of remedial actions.

6.5.3

Groundwater Monitoring

Groundwater conditions will be monitored throughout the life of the quarry operations. A monitoring network will be established using up to eight selected exploration boreholes around the periphery of the quarry pit and at potentially affected receivers to assess the actual extent of groundwater drawdown over time. Monitoring of water levels will occur quarterly prior to commencement of quarrying and over the life of the quarry.

Water quality monitoring will be undertaken to sample major ion chemistry, TDS and dissolved metals on an annual basis and will include monitoring of pit seepage water. This will assist in determining the suitability of groundwater for use in quarry processes in the event that sufficient groundwater volume is encountered. Potential inflows of groundwater into the pit are likely to be saline. This water will not be able to be discharged to surface waters without treatment.

In the event that trends in water levels vary significantly, or if drawdown effects are observed a significant lateral distance from the quarry pit, the monitoring data should be reviewed by a qualified hydrogeologist to verify the impacts and suggest mitigation measures.

6.6

SEPP 58 MATTERS OF CONSIDERATION

In the absence of a regional environmental plan, the NSW SEPP No. 58 – Protecting Sydney’s Water Supply – was put in place as a means to ensure that developments within Sydney’s drinking water catchments do not have detrimental impacts to drinking water quality. This Policy applies to the land within the hydrological catchment of Warragamba, Upper Nepean, Woronora, Blue Mountains and Shoalhaven, and includes the LGA of Goulburn-Mulwaree in which the proposed quarry is situated.

Water quality is not anticipated to be negatively affected by the proposed quarry at Marulan South. Water quality in the local catchment of Tangarang Creek is currently affected by recent agricultural landuse practices. The proposed development will provide a slight beneficial effect on water quality in terms of reducing suspended solids and nutrient loads during flooding. This is due to the effect of sediment settling in the dams and of the filtration provided by the constructed wetland upstream of Dam 1.

Design of the water management system was based on achieving an efficient internal supply and reuse scheme given the acute state of water availability in the Goulburn Mulwaree LGA. This system is intended to be fully self reliant and utilises the catchment area of Tangarang Creek and limited expected groundwater seepage into the pit. Water balance modelling indicates that the proposed water management system has capacity to supply water demands for dust suppression, process and potable water, and release of environmental flows throughout the 30 year life of the quarry.

Receiving waters for the proposed development include Barbers Creek and the Shoalhaven River downstream which contributes to storages for Sydney and Illawarra drinking water. Environmental values sanctioned by the HRC (1999) are outlined in *Section 6.1.2* and are achieved by compliance with numerical guidelines given in ANZECC and ARMCANZ 2000 Guidelines. Measures to mitigate impacts to water quality are detailed throughout this chapter and their performance will be monitored regularly to ensure the environmental performance of the proposed quarry.

The requirements under SEPP 58 specify that a water cycle management study be prepared in accordance with Clause 11(4)(a)(i-v). A summary of how each matter under Clause 11(4)(a) has been addressed is provided in *Appendix D of Annex C*.

6.7 CONCLUSIONS

This chapter provides an outline of the potential impacts upon surface water and groundwater resources in the vicinity of the proposed Marulan South Quarry. A water management system has been developed to ensure that the proposed operations are self sufficient in terms of water use and there are no further pressures placed upon the potable water supply system or withdrawals from Tallong Weir. This system has also been designed to optimise recycling within the quarry operations and minimise the potential for offsite impacts to local receiving waters.

Mitigation measures include the diversion of clean water run-off to clean water-storages; retention and treatment of “dirty water” to prevent sediment laden or contaminated runoff leaving the site; and the recycling and treatment of all water used in quarrying activities to minimise demand for top-up water from the clean water dams and to minimise the flow of dirty water to the Pit storage. Construction of a wetland upstream of the primary water storage dam is expected to improve the quality of run-off entering Dam No. 1 and act as a filter for excess flows from the in-pit storages. Environmental flows are also to be maintained, equivalent to 10% of average daily flows, through the occasional spills from clean water dams during floods and allocation environmental flows.

Groundwater at the proposed quarry site occurs in discrete fracture zones, the most significant of which is the interface between the overburden the underlying granodiorite. The hydrogeological and hydrochemical assessment indicates that there is limited hydraulic connection between fracture zones, both vertically and laterally across the site, suggesting that groundwater occurs in localised and potentially discontinuous fracture horizons. As such, significant water level drawdown caused by quarrying is expected to be constrained to the immediate vicinity of the pit, and as such is not anticipated to result in a significant impact to either local groundwater users or potential groundwater fed ecosystems in the gorge.

Water quality and quantity will be monitored to confirm the efficacy of the proposed water management system and ensure there are no detrimental impacts upon groundwater systems or surface receiving waters.

7.1 INTRODUCTION

The proposal includes the development of a 30 year quarry and the construction of plant infrastructure and several dams as shown on *Figure 7.1*. The 'site' therefore consists of the 30 year quarry area, two dams (Dam 1 and Dam 2) and the area of the proposed processing plant and rail spur. These development areas all fall within the identified total resource area (referred to as the 'study area' within this ecological assessment). This chapter describes the flora and fauna at the study area, however, only impacts to flora and fauna as a result of development within the proposed '30 year' quarry area, and associated infrastructure and dams, are addressed.

Detailed flora and fauna investigations have been undertaken within the Marulan South Quarry study area and included in *Annex E*. This chapter provides a summary of the key findings of the investigation.

7.2 FLORA AND ECOLOGICAL COMMUNITIES

The majority of the study area has been previously cleared of native vegetation and has been used for grazing livestock for many decades. Vegetation over the majority of the site is predominantly pasture grasses with only small, isolated stands of trees scattered throughout. A larger patch of remnant woodland is present in the southern portion of the study area, around the abandoned township site of Marulan South. Footings of demolished buildings, old roads and now-wild exotic ornamental plants and rubbish lie within the patch of woodland. More trees grow at the southern and northern fringes of the study area including a patch of remnant woodland at the proposed location of Dam 1.

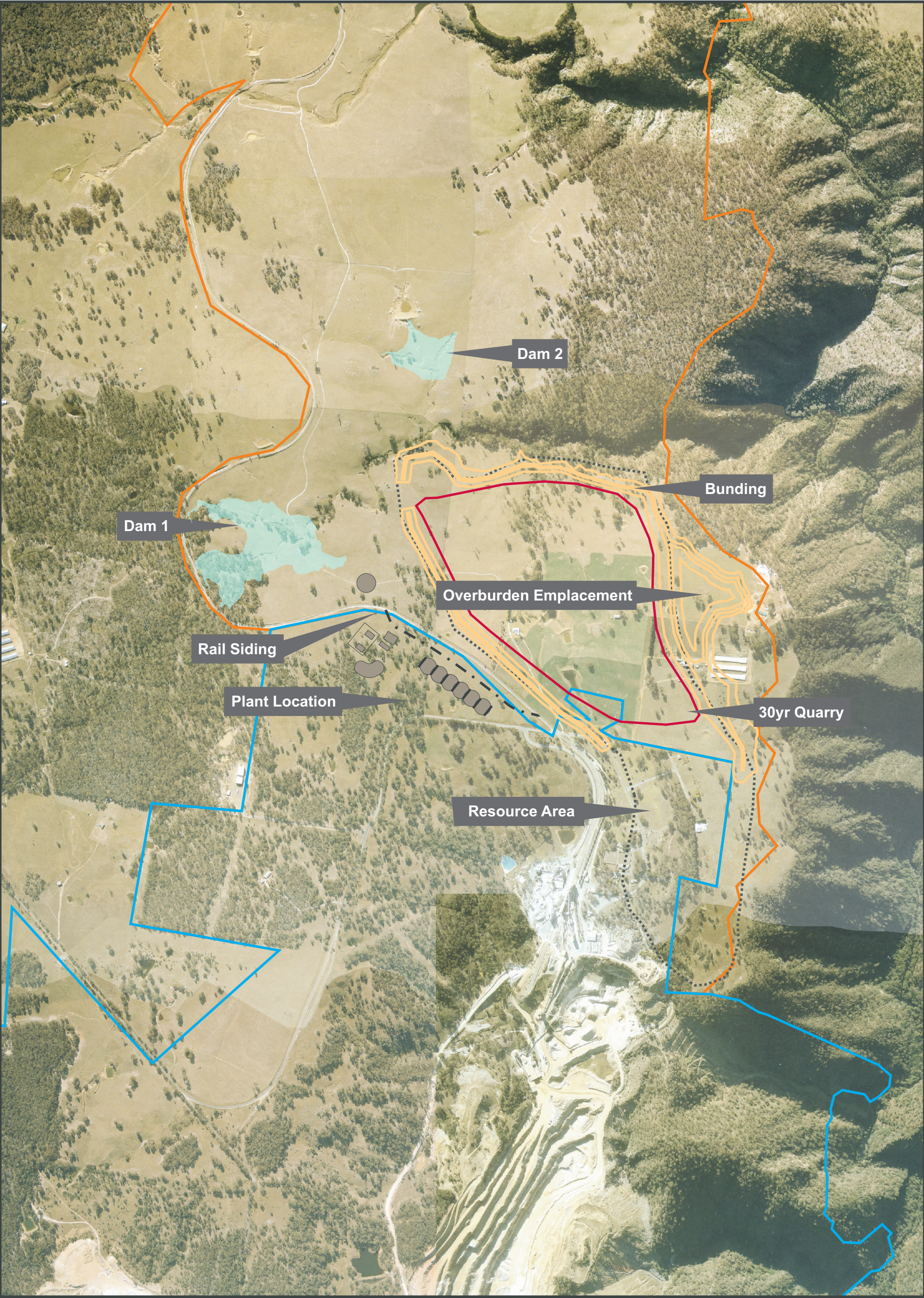
There are no known groundwater dependant ecosystems on or near the site (NSW Department of Infrastructure Planning and Natural Resources and the DEC pers comm. October 2005).

Seventeen threatened flora species listed under the *Threatened Species Conservation Act 1995* (TSC Act) were identified from the database searches as occurring or predicted to occur in the locality. Three of these are also listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A full consideration of the habitat requirements of these species and their likelihood of occurring in the study area is given in *Annex E*.

One threatened plant, *Solanum celatum*, was recorded immediately to the south of the total resource area, close to the boundary of the Blue Circle Southern Cement limestone mine (see Figure 7.2) and approximately 500 metres south of the 30 year quarry area. *Solanum celatum* is listed as Endangered under Schedule 1 of the TSC Act (1995). It is a recently described species, endemic to NSW and has been recorded within a restricted area from Wollongong to just south of Nowra, and west to Bungonia. It is known from a range of different habitat types including wet and dry sclerophyll forests and rainforests. There is very little information regarding its distribution and abundance and its essential habitat requirements are unknown. At Bungonia SRA it grows in open woodland on limestone. At the study area, the plants were found amongst small rocky outcrops and a few trees in open pasture woodland on the edge of dry sclerophyll forest. The proposed quarry is on granodiorite rather than limestone.

Database searches revealed that the two threatened ecological communities, White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland), and Natural Temperate Grasslands, may occur. Two small woodland areas occur on the study area; one in the south and one in the north-west (Figure 7.2). The woodland in the south has a canopy dominated by Blakely's Red Gum, with Coast Grey Box (*Eucalyptus bosistoana*) and Yellow Box. The soil is substantially disturbed and the ground cover is dominated by exotic species including many garden escapes. The woodland area measures approximately 2.8 ha and is relatively isolated from other woodland. As native shrubs and ground covers are largely absent, it is likely that the soil seedbank is depleted. As a result, this woodland area is unlikely to respond to natural or assisted regeneration. This area does not constitute a viable remnant of the threatened White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland).

The second isolated area of trees covers approximately 6.3 hectares near the location of the proposed Dam 1 and is separated from a much larger area of woodland by the railway spur line to the limestone mine. The canopy is dominated by mature Blakely's Red Gum, with a few Narrow-leaved Stringybarks present. The ephemeral drainage lines are dominated by exotic species, namely Blackberry and *Cyperus eragrostis*, with numerous mature eucalypts and *Acacia mearnsii* present. Regenerating and immature eucalypts were present throughout and this area has a relatively high diversity and abundance of native grasses. In contrast to the rest of the study area, native grasses comprised at least 70% of the ground-layer vegetation. Grass species included Kangaroo Grass (*Themeda australis*), Red Leg Grass (*Bothriochloa macra*), Wallaby Grass (*Austrodanthonia* sp.), Poa Tussock Grass (*Poa sieberiana*) and Spear Grass (*Austrostipa* sp.). The native Bluebell (*Wahlenbergia gracilis*) was also present in this area. These species, together with Blakely's Red Gum, are characteristic of the grassy woodland community Box-Gum Woodland. This Box-Gum Woodland has also recently been listed as critically endangered under the EPBC Act after a recommendation from the Scientific Committee (Scientific Committee, 2006).



- Legend**
- Proposed Dam Locations
 - Boral Resources Property Boundary
 - Blue Circle Southern Cement Property Boundary
 - Resource Boundary
 - 30 Year Resource Boundary
 - Proposed Bunding and Overburden Placement

Figure 7.1 **Location of the Proposed Development**

Marulan South Quarry



  0 500m
Approximate only

Legend

-  Box Gum Woodland
-  Disturbed Woodland
-  Morton National Park
-  Resource Boundary
-  30 Year Resource Boundary
-  Creeks
-  Solanum Celatum

Figure 7.2 **Location of Threatened Species and Ecological Communities within the Site**

Marulan South Quarry

Common Wallaroos, Eastern Grey Kangaroos, the Common Wombat and Sugar Glider were confirmed to be in the study area and Red-necked Wallabies and Swamp Wallabies were suspected from scats.

The two bat species positively identified from call recordings were the White-striped Mastiff Bat (*Tadarida australis*) and Gould's Wattled Bat (*Chalinolobus gouldii*), neither of which are threatened. The recorded calls of three species were most likely to be those of the Chocolate Wattled Bat (*Chalinolobus morio*), Large Forest Bat (*Vespadelus darlingtonii*) and the Little Forest Bat (*Vespadelus vulturnus*), none of which are threatened. The calls of a sixth species could not be confirmed but may be those of the Eastern Bentwing-bat (*Miniopterus schreibersii*), which is listed as vulnerable on Schedule 2 of the TSC Act (1995).

Four different frog species were heard calling within the drainage line at the northern end of the study area. The two that could be identified from their calls were the Common Toadlet (*Crinia signifera*) and Peron's Tree Frog (*Litoria peronii*). Threatened frog species recorded from the general locality include the Green and Golden Bell Frog and the Stuttering Frog, however, the species that were heard calling are unlikely to be either of these species as the calls did not resemble that of the Green and Golden Bell Frog and the area did not support suitable habitat for either of these species.

Twenty three bird species were observed within the study area. The majority of these were characteristic woodland species with the exception of the Masked Lapwing (*Vanellus miles*) and the Wood Duck (*Chenonetta jubata*) which were observed near farm dams. A Gang-gang Cockatoo was heard calling from the woodland to the north of the study area. Gang-gang Cockatoos are listed as vulnerable on Schedule 2 of the TSC Act (1995). A Wedge-tailed Eagle was also observed flying just to the north-east of the study area. Wedge-tailed Eagles are listed as migratory under the EPBC Act, however, they are not in danger of extinction (Morcombe 2000).

The Masked Lapwing and Wood Duck, also listed as migratory under the EPBC Act, were recorded on the study area, however, these are common and relatively abundant (Morcombe 2000).

Three non-threatened reptile species were observed: the Lace Monitor (*Varanus varius*), the Water Dragon (*Physignathus lesueurii*) and a species of skink. The Water Dragons were in Targarang Creek and the Lace Monitors in the adjacent woodland. The skink was found within the disturbed open grassland within the northern portion of the study area.

Rabbits, cattle and sheep graze throughout the study area.

No threatened nocturnal birds or arboreal mammals were observed during the call-playback and spotlighting searches.

Given that the majority of the study area has been cleared of native vegetation and used for grazing, there is only limited habitat for native fauna. Fauna habitat is primarily isolated or scattered small stands of mature eucalypts which may provide nesting, shelter and foraging habitat.

The majority of vegetation is retained within the two remnant woodland stands in the south and northwest of the study area which contain 14 and 28 hollow-bearing trees respectively. The size of the tree hollows was generally quite small (5-15 cm) and thus unsuitable as roosting/ nesting habitat for the larger threatened nocturnal birds and arboreal marsupials (such as the Powerful Owl, Masked Owl and Yellow-bellied Glider). Crimson Rosellas and Striated Pardalotes were observed nesting in tree hollows within the woodland areas. A Sugar Glider was also observed emerging from a small hollow in a Stringybark within the northern section of the 30 year quarry area. Six species of microchiropteran bats were recorded in the woodlands indicating that these areas are likely to provide foraging and or roosting habitat.

There are 20 farm dams in study area, most of which had little or no emergent, trailing or surrounding vegetation or shelter. For these reasons they are unlikely to provide suitable habitat for threatened frogs, although they do provide habitat for ducks such as the native (but not threatened) Wood Ducks that was recorded on the study area.

Scattered rocky outcrops that may provide basking sites for reptiles, were common throughout the study area. However, these areas were generally very exposed within the open pastures. Due to the exposed and disturbed nature of these areas, they are unlikely to be significant habitat for native reptiles. There were rocky areas within the drainage line in the northern section of the 30 year quarry area that were more wooded and which provided some leaf litter and bark ground cover. These sites provide better reptile habitat.

Leaf litter, ground debris, logs or fallen trees that may provide shelter and foraging habitat for ground-dwelling native reptiles and mammals and foraging habitat for insectivorous birds were relatively abundant within the woodland area of Dam 1. However, apart from the area within Tangarang Creek and Dam 1 there was little to no habitat for native ground-dwelling fauna across the study area.

7.5.1

Construction And Clearing

Development of the proposed Marulan South Quarry and associated infrastructure would remove 90 hectares of grassland and pasture with scattered and isolated trees and 2.6 hectares of the endangered White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland). Vegetation south of the proposed quarry, but within the total resource area, will not be impacted within this project application (including the 2.8 ha stand of remnant woodland trees within south-west of the total resource area). An Assessment of the Significance of the impact on the Box-Gum Woodland is provided in *Appendix D* of *Annex E*.

Less than 5% of the pre-European extent of Box-Gum Woodland remains in the south of its range and 10% in the north (NPWS). Approximately 12,900 hectares remain in the Southern Tablelands and 250,000 hectares in the whole of NSW (TSSC, 2001). The proposal would remove approximately 0.02 % of the regional extent of this community and 0.001 % of the NSW extent respectively.

While removal of any portion of a threatened community can impact the survival and persistence of a threatened community in some instances, mitigation measures outlined in *Section 7.7* will offset and mitigate these impacts. The key mitigation measure is the planting of endemic tree species characteristic of Box-Gum Woodland in an area equal to twice the area of Box-Gum Woodland to be cleared. Seed will be sourced from the woodland near Dam 1 and if needed, the area will be fenced to prevent human, stock and vehicular access. These actions, together with the retention of least 60% of the existing community will avoid significant impacts to this community.

The Box-Gum Woodland has recently been included under the critically endangered category after recommendation from the Scientific Committee under the EPBC Act (Scientific Committee, 2006). While the proposal will require the removal of 2.6 hectares of this community, retention of 60 % of the extent on the site and replanting will minimise the potential impact. The significance of impacts to this community was assessed under the assessment of significance guidelines for impacts to TSC Act listed as described above. The criteria for assessing significant impacts under Part 3A are similar to those for assessing under the EPBC Act (Significance Guidelines 1.1). The assessment concluded that impacts to this community would not be significant.

The habitat value of much of the area has been severely diminished due to past land clearing and grazing. However, the small isolated stands of trees, some of which have small hollows, provide nesting and foraging habitat for birds and arboreal mammals. The site is adjacent to Morton NP and Bungonia State Conservation Area, which together have 195,000 hectares of undisturbed and continuous eucalypt woodland. Therefore substantial potential foraging habitat is available immediately adjacent to the site and the loss of the relatively small area of potential foraging habitat within the 30 year quarry area is not expected to limit foraging for mobile species. The removal of hollow-bearing trees and stags may have an immediate impact on the roosting and nesting habitat of individual animals (including the Sugar Gliders), however, there is abundant suitable foraging and nesting habitat available in the surrounding area.

The lack of suitable habitat at the site and lack of impact resulting from the very small amount of habitat to be cleared relative to surrounding available habitat, suggested that a formal “assessment of significance” was not necessary for the majority of species identified from database searches as occurring within the locality. For the same reasons, it is also unlikely that species listed as migratory under the EPBC Act and identified with the potential to occur in the locality would be impacted by the proposal. Thus a referral to the Commonwealth Department of Environment and Heritage to assess the significance of any impacts to listed species is not necessary.

An assessment of significance was carried out for the threatened Eastern Bentwing-bat, possibly identified within the 30 year quarry area. Details of the impact assessment are provided in *Annex E* and the assessment concluded that, given known roosting habitat, maternity caves and foraging habitat within the adjacent Bungonia State Conservation Area and Morton NP, that clearing within the proposed 30 year quarry is unlikely to have a significant impact on the survival and welfare of this species.

7.5.2 *Operation*

Operation of the quarry and associated dams will restrict natural water flows, however, a 10% allocation will be reserved for environmental release, while major floods are expected to run their natural course. As detailed in *Chapter 6*, Tangarang Creek feeds into Barbers Creek, which was considered to have high ecological value despite being in poor condition relative to the rest of the Shoalhaven catchment due to the effects of variable quality runoff from agricultural sub-catchments. Clearing of land for agriculture over a large proportion of the Tangarang Creek catchment is already expected to have increased flows and pollutant loads in the creek.

The creek immediately upstream of the area to be flooded by Dam 1 consists of at least three ephemeral drainage lines that were dry at the time of the site inspection. Large concrete pipes (culverts) are located within these drainage lines where the train line crosses the creekline. These culverts present significant barriers to the potential movement of fish within Tangarang Creek. Thus, in terms of potential impacts of the proposed dam on fish passage within the creek, the impact is likely to be minimal due to the fact that significant barriers to fish passage already exist upstream of the proposed development.

The reduction in non-flood water flows may result in the drying up of small natural water pools and the consequent loss of aquatic habitat for species such as frogs and Water Dragons. The new dams themselves though will compensate for this loss as they will provide almost permanent aquatic habitat. Native vegetation such as the trees within the creek are also likely to be dependant on the natural water flows for survival, and therefore may be negatively impacted as a result of changes to water flows in the creek. Measures to mitigate impacts to native flora and fauna as a result of changes to natural water flows down the creek are outlined in *Section 7.7*.

Potential downstream impacts resulting from alterations to the quality and quantity of water flows are addressed in detail in *Chapter 6*. The assessment indicates that the 9% reduction in the quantity of water flowing into Barbers Creek resulting in <0.1% reduction in flows to the Shoalhaven River is insignificant relative to the water received from the greater catchment area. Furthermore the dams will attenuate flood peaks and act as sediment basins, reducing suspended solids in downstream flows and providing a slight reduction in nutrient levels. As such, the dams may have a beneficial impact to downstream environments.

Therefore the downstream aquatic and riparian environments of Barbers Creek and the Shoalhaven River, which have the potential to support threatened species such as the Macquarie Perch and Adam's Emerald Dragonfly, are unlikely to be significantly affected by changes in water flow as a result of this proposal.

Implementation of the quarry water management and monitoring system described in *Chapter 6* will appropriately mitigate potential impacts to downstream environments and on-site aquatic and riparian flora and fauna.

Operation of the quarry will involve blasting, crushing and movement of materials, machines, and personnel to and from the site by rail and road. These activities generate noise and vibration that has the potential to disturb native fauna that may use the site and surrounding area. It is difficult to predict how the various types of noise will affect local fauna, but it is likely that the response to noise is variable between species.

The large BCSC limestone mine immediately south of the proposed quarry site has for many decades generated noise of a type and level similar to that predicted from the proposed quarry. Therefore, it is most likely that nearby native animals are already habituated to the predicted noise environment. Nonetheless noise from the proposed quarry might affect animals that were previously unaffected by the noise from the limestone mine. Noise might cause these animals to relocate from the quarry area, but the long-term impact to these species is likely to be minimal due to the abundance of foraging, roosting, nesting and shelter habitat available in the surrounding area.

Dust from quarrying may have physical and/or chemical effects on plants that reduce their ability to photosynthesise respire and transpire. Due to differences in susceptibility of different species to dust, it can ultimately change the structure of plant communities (Farmer 1993). One threatened plant species (*Solanum celatum*) occurs locally in two groups, the closest approximately 500 metres south of the 30 year quarry extent. Dust modelling has predicted dust deposition rates in the area of this plant at less than 0.5 grams per square per month due to proposed quarrying. Mentor Consulting (1993) prepared a literature review of the impacts of mine generated dust on agriculture that cited Yang (1988), who noted that there would be no adverse effects on plant production unless dust deposition exceeded 22 to 45 grams per square metre per month. Accordingly the proposed quarry is not expected to affect the groups of *Solanum celatum* plants.

7.6 SUMMARY OF IMPACTS

Development and operation of the proposed Marulan South Quarry and associated infrastructure will result in the removal of 90 ha of disturbed open grassland (dominated by exotic pasture species) with scattered and isolated trees and the removal of 2.6 hectares of the endangered White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland).

Clearing and indirect impacts from operation of the quarry and associated infrastructure is not expected to have a significant impact on individual species or ecological communities.

7.7 MITIGATION MEASURES

Guidelines for the formulation of strategies to offset environmental impacts from development state that offsets must result in net environmental improvement and they must offset the impacts on a 'like for like or better' basis (DEC 2005).

To mitigate and offset the loss of habitat for native flora and fauna and reduction of the identified endangered ecological community, the following measures will be undertaken:

- 40 fauna boxes will be installed in mature trees (25 adjacent to the quarry and 15 within the section of Box-Gum Woodland to be retained) to mitigate the removal of existing hollow-bearing trees. The boxes will be installed prior to any trees being removed;
- pre-clearance surveys of all trees to be removed will be undertaken by an appropriately qualified person, to ensure that no animals are in the trees. An appropriately qualified person will be on site while trees are removed so that any fauna inhabiting the trees can be captured and relocated;
- an area equal to twice the area of Box-Gum Woodland to be cleared will be planted with endemic tree species characteristic of Box-Gum Woodland. Seed will be sourced from the woodland near Dam 1 and if needed, the area will be fenced to prevent human, stock and vehicular access;
- where feasible, clearing within the area of Dam 1 will be timed for after flowering and seed-set by the native grasses (spring-summer) to maximise stores of seed in the soil;
- where feasible, topsoil from the area of woodland near Dam 1 will be preferentially stripped and used for prompt rehabilitation;
- revegetation around the dams and the addition of semi-submerged rocky areas around the perimeter of the dams will be designed to create habitat for native frogs and reptiles species;
- weed management will suppress the growth and prevent the spread of weeds throughout the quarry and associated infrastructure areas; and
- environmental releases of water will occur periodically (timed to natural rainfall events where possible) rather than constantly, to avoid water soaking away in the upper reaches of the creek only and maximise delivery of water to downstream communities.

7.8

CONCLUSION

Most of the quarry and associated infrastructure site was cleared many decades ago for agriculture, and only scattered native trees and isolated patches of woodland remain. The value of the quarry area as habitat for native fauna has been severely diminished by this past land clearing and agriculture.

Investigations identified one threatened plant, *Solanum celatum*, and one threatened ecological community, the White Box Yellow Box Blakely's Red Gum Woodland within the site and one threatened plant species, *Solanum celatum*, adjacent to the site. Calls possibly belonging to the vulnerable Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) were recorded on the proposed quarry site, while both the vulnerable Gang-gang Cockatoo and migratory Wedge-tailed Eagle were observed nearby. The common and relatively abundant Masked Lapwing and Wood Duck, listed as migratory under the *Environmental Protection and Biodiversity Protection Act 2000* were recorded on the quarry site.

The site is adjacent to Morton NP and Bungonia SRA, which together support approximately 195,000 hectares of undisturbed and continuous eucalypt woodland with similar native vegetation and habitat resources as the quarry site. Potential foraging habitat is available immediately adjacent the quarry site and the small loss of foraging habitat within the quarry area is not expected to limit relatively mobile animals. The removal of 28 hollow-bearing trees may have an immediate impact on the roosting and nesting habitat of individual animals, however, there is abundant replacement foraging and nesting habitat available within the surrounding area.

To reduce the minor ecological impacts that would be caused by the Marulan South Quarry proposal, fauna boxes will be installed in trees adjacent to the quarry, all hollow bearing trees will be checked for animals prior to clearing, the perimeter bund will be planted with local endemic plants and Boral will establish a revegetation zone, twice the size of the area of White Box Yellow Box Blakely's Red Gum Woodland proposed to be cleared.

Development and operation of the proposed Marulan South Quarry and associated infrastructure will result in the removal of 90 hectares of disturbed open grassland (dominated by exotic pasture species) with scattered and isolated trees and the removal of 2.6 hectares of the endangered White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland). Clearing and indirect impacts from operation of the quarry and associated infrastructure is not expected to have a significant impact on species or ecological communities.

8.1 INTRODUCTION

This assessment identifies Aboriginal archaeological sites within the proposed Marulan South Quarry site incorporating the 30 year quarry area, dams and associated infrastructure. The assessment includes an analysis of the significance of the recorded sites and presents mitigation measures. This chapter summarises the findings of the Aboriginal heritage assessment further details of which can be found in *Annex F*.

8.2 METHODOLOGY OVERVIEW

Effective assessment of potential Aboriginal archaeological sites necessitated the following elements:

- consultation with the representatives of the local Aboriginal community;
- review of local environmental information (topographic, geological and soil descriptions) to determine the likelihood of archaeological sites and specific site types;
- review of previous Aboriginal cultural heritage investigations in and around the study area to provide specific information regarding the extent of archaeological investigation in the wider area and archaeological patterns observed;
- review of relevant statutory registers and inventories for Aboriginal cultural heritage such as the NSW DEC Aboriginal Sites Register and the Register of the National Estate;
- development of a predictive archaeological statement based on data searches and literature review;
- field survey in conjunction with Aboriginal representatives;
- presentation of the results of the survey and significance assessments of Aboriginal heritage items identified within the application area; and
- development and presentation of management mitigation measures.

The DEC has issued interim guidelines for Aboriginal consultation in relation to any study that might be used to support an application under Part 6 of the *National Parks and Wildlife Act 1974* (i.e. Section 90 consents and Section 87 permits to collect/investigate). The guidelines set out a process of inviting Aboriginal groups to register interest as a party to consultation, seeking responses on proposed assessment methodology, and seeking comment on proposed assessments and mitigation measures. Proponents are required to allow ten working days for Aboriginal groups to respond to invitations to register, and 21 days for registered Aboriginal parties to respond to a proposed assessment methodology.

This project is being assessed under Part 3A of the *Environmental Planning and Assessment Act, 1979* and therefore S87 and S90 permits are not applicable to the project. However, the consultation guidelines are considered good practice and applicable to the Part 3A assessment process and have been adopted.

Identified groups representing the Aboriginal community in the region, and other individuals or groups who would be interested in being consulted regarding the project were consulted with on the cultural significance assessment and management recommendations. These groups were invited to provide a representative for the fieldwork undertaken in November 2005 and March 2006. Representative included:

- Justin Boney, of the Pejar Local Aboriginal Land Council (November 2005 survey);
- Peiro Delponte and Graeme Dobson of the United Ngunawal Corporation (November 2005 survey);
- Dean Bell and Karen Williams of the Yurawang Gundana Aboriginal Corporation (March 2006 survey); and
- Don Bell and Holly Horning of the Buru Ngunnawal Aboriginal Corporation (March 2006 survey).

Fieldwork methodology and mapping information was provided to Aboriginal groups prior to fieldwork and was also discussed with each Aboriginal community representative in the field prior to beginning survey. Further details of the Aboriginal consultation are provided in *Appendix B* and *D of Annex F*.

8.4.1 *Summary of Previous Heritage Reports*

Sufficient evidence of Aboriginal occupation has been identified across the Southern Tablelands to provide information on Aboriginal subsistence and settlement patterns in the region. In addition, twelve local archaeological surveys have been undertaken in which a variety of sites have been found. A review of these earlier heritage reports suggests the following conclusions relevant to this study:

- the majority of recorded Aboriginal archaeological sites present are likely to be artefact scatters or isolated artefacts;
- stone artefact scatters are most likely to be close to water, such as creek lines. They may occur up to one hundred metres away from the creek line in some cases;
- low density artefact scatters may occur on well drained sandy ground, such as ridge tops, creek flats, and the lower slopes of hills;
- as distance from environmental foci increases, archaeological evidence is likely to become more dispersed, and concentrations of artefacts are less likely;
- geologically associated site types, such as rockshelters, rock art and quarries, are unlikely to be found in the study area due to the lack of exposed suitable rock; and,
- scarred trees are present in the region, but are not likely to be present in the study area due to past land clearing and the lack of mature trees.

8.4.2 *NSW DEC Aboriginal Sites Register*

A search of the NSW DEC Aboriginal Heritage Information Management System (AHIMS) revealed that 12 Aboriginal sites are recorded within an area 10 x 10 km surrounding the proposed quarry, although no sites are within the application area. Recorded sites consist of stone artefact scatters and a shelter with art. Although the AHIMS is not a comprehensive listing of all Aboriginal sites, items or places in NSW, the sites identified are represented in *Figure 8.1*. Further details of these sites are available in *Annex F*.

No places in the local area have been listed on the Register of the National Estate.

Stone artefact scatters are the most common site type in the local area and are likely to be present in the application area. Representing Aboriginal subsistence and knapping, these sites comprise archaeological remains such as stone artefacts and sometimes hearths. These sites are usually identified as surface scatters of artefacts in areas where ground surface visibility is increased due to lack of vegetation. Erosion, agricultural events (such as ploughing) and access ways (ie. dirt tracks) can also expose surface scatters.

An isolated artefact is defined here as a single artefact, situated more than 50 metres from any other artefact. Isolated artefacts may be the result of limited knapping activity or represent artefact discard. Their presence may be an indication of a more extensive buried deposit concealed by low ground visibility. Although no isolated artefacts have previously been recorded in or near the study area, there is potential for these sites to be found as they are closely related to stone artefact scatters (being one stone artefact found rather than more than one).

The following site types are present in the local region, but are unlikely to be found in the current study area:

- scarred trees;
- quarries;
- burials;
- rockshelters; and
- rock art.

A review of landform, soil characteristics and established pattern of local Aboriginal site occurrence suggests that stone artefact scatters or isolated artefacts are likely to occur within the study area. Stone artefact scatters are the most common site type in the area and are most likely to be present within 100 m of water, on well drained sandy ground, including landforms such as ridge tops, creek flats, and the lower slopes of hills. Isolated artefacts may also occur, particularly adjacent or close to watercourses, on flats and on hill slopes. Major artefact concentrations were anticipated along Tangarang Creek, which is a fairly reliable water source that would have attracted more intensive occupation use leading to development of larger archaeological sites from “overprinting” of occupation and activity. In contrast, the other parts of the proposed quarry footprint would have been subject to low-intensity activity dispersed over a wide area, due to the difficulty of access to reliable water sources. In other words, as distance from environmental foci in the study area increases, archaeological evidence is likely to become more dispersed, and concentrations of artefacts less likely to be present.

Past and current stock grazing, land clearing and cultivation has resulted in an extensively disturbed landscape across the majority of the study area. In particular, a long history of ploughing and grazing within the proposed quarry area has resulted in extensive subsurface disturbance.

Tangarang Creek has experienced less disturbance through tree clearing and trampling by stock along creek banks, both in the past and ongoing. Aboriginal artefacts are more likely to be present below the surface, and the archaeological deposit is likely to be relatively intact.

Scarred trees, quarries, grinding grooves and engravings are not likely to occur in the study area due to the lack of suitable trees or stone outcrops. Stone arrangements, bora grounds and earth circles are unlikely to be present in the study area due to its past history of clearing and agricultural disturbance. Burials in the region are generally located on hill tops and in soft sand (Lance and Koettig 1986), but are no more likely to occur in the study area than in any other area within the Southern Tablelands, which has low potential for burials.

8.5

FIELD INVESTIGATION

Fieldwork for the assessment was undertaken in November 2005 with a follow-up inspection in March 2006 to clarify site details in the vicinity of proposed Dam 1 along Tangarang Creek.

Eighteen Aboriginal heritage sites were identified during the survey. The locations of these sites are illustrated in *Figure 8.2* (see *Appendix C of Annex F* for Photographs of each site context and artefacts). In general terms, the findings can be grouped according to their landscape location either in the main quarry site, Dam 1 or Dam 2.

The area of the proposed 30 year quarry and associated bunds and overburden emplacements has been disturbed by the construction of fences, vehicle tracks, farm dams, farm buildings, grazing and cultivation. Despite the significant disturbance, very few artefacts were found (eight sites). Significant subsurface archaeological deposit is not likely and the extensive subsurface disturbance would not have left any original subsurface artefact patterning intact, so each of the sites in this area has low archaeological potential. Therefore, even though it contains sensitive landforms and sites were found on these landforms, the area has low archaeological importance. *Annex F* details the types of stone artefacts found in the eight sites.

The area of the proposed Dam 1 has undergone limited disturbance and contains the greatest number of Aboriginal sites (ten sites), each having high potential for subsurface archaeological deposit. *Annex F* details the types of stone artefacts found in the ten sites.

No archaeological sites or artefacts were observed in the area of the proposed Dam 2. The area has experienced impacts from clearing, extensive water erosion, stock activity and rubbish dumping. Further, the landforms in this area comprise steep, rocky simple slopes associated with an ephemeral second order creek that feeds into Tangarang Creek to the south. As such, it is unlikely that any subsurface cultural material is present, hence the area has low archaeological potential.

Previous research in the region has indicated that a widespread low density distribution of artefacts may be present up to several hundred metres away from archaeologically sensitive landforms. Given the presence of several such landforms, it is likely that a general background scatter of isolated artefacts is present across the study area. Such isolated artefacts are likely to comprise silcrete, indurated mudstone and quartz artefacts reflecting Holocene backed artefact and utilitarian technologies. Scientific data on these types of isolated artefacts are well documented in other Southern Tablelands archaeological reports, and will add little, if anything to the body of archaeological research in the region, however the scatter and patterning of artefacts in the area of proposed Dam 1 may make a contribution to this research.





Approximate only

Legend

- Resource Boundary
- 30 Year Resource Boundary
- Creeks
- ◆ Aboriginal Survey Sites
- Dams

Figure 8.2

Aboriginal Sites identified During the Field Surveys

Marulan South Quarry

The heritage value of sites, objects and places to the Aboriginal community are summarised in this assessment of significance. The nature of these values is an important consideration when deciding how to manage a heritage site, object or place and balance competing land-use options.

Research and consultation with the Aboriginal community has been conducted to determine whether any heritage value relates specifically to the study area regardless of the archaeological evidence. No information has been received that identifies specific heritage value unrelated to the Aboriginal sites. However, Aboriginal heritage sites with archaeological evidence are all of value to the Aboriginal community through the tangible connection that it represents with pre-European Aboriginal land use.

Scientific value of a heritage site, object or place is assessed according to its research potential, representativeness and rarity. Research potential is considered as the potential of the site, object or place to contribute to present understanding of human society and the human past. Issues affecting a site's assessment for research potential include the intactness and integrity of a site, the connectedness of the site to other sites across the landscape and the potential of a site to provide dating (NSW NPWS 1997:27). Site representativeness refers to the extent to which a class of sites demonstrates the archaeological record as a whole (NSW NPWS 1997:27) whereas the comparative rarity of a site demonstrates a "*...distinct way of life, custom, process, land-use, function or design no longer practised, in danger of being lost, or of exceptional interest*" (Register of the National Estate (RNE) criterion B2).

The integrity of a site is also considered in determining scientific significance as disturbance limits the research questions that may be addressed in that area. Key research issues in south eastern Australia revolve around the chronology of Aboriginal occupation, variability in stone artefact manufacturing technology and settlement pattern.

Aboriginal cultural assessment can only be made by the relevant community groups, which include:

- Pejar Local Aboriginal Land Council;
- Gundungurra Tribal Council Aboriginal Corporation;
- Buru Ngunnawal Aboriginal Corporation;
- United Ngunawal Corporation; and
- Yurawang Gundana Aboriginal Corporation.

Comments that have been received from these groups concerning the survey and review of this report indicate that they agree with the assessment (refer *Appendix B and D of Annex F*).

Most of the Aboriginal sites within the study area are of low scientific significance and representative of open stone artefact sites in the local area and region. The locations and densities of sites in the proposed 30 year quarry and the area adjacent to Tangarang Creek and Dam 1 conformed to the predictive model of Aboriginal archaeological site patterning for the region for open archaeological deposits. These sites are not distinct and are therefore not rare. No sites were located adjacent to Dam 2 and any potential subsurface sites are expected to conform to the same conclusions.

While the level of disturbance over most of the study area is high, disturbance over the proposed area of Dam 1 is fairly low and this area has moderate archaeological research potential. The assessment of low significance for many of the sites does not imply that the sites are devoid of all value; rather it suggests that the current site recording, and a salvage program focussed on the area proposed for Dam 1, would be sufficient to mitigate the impact on Aboriginal social values.

8.7 *IMPACTS*

The impact on sites in the proposed quarry area will be the loss of all eight sites within the quarry footprint while ten sites in the area of proposed Dam 1 will be lost by inundation. The remaining three sites are outside of the proposed quarry and dam zones and hence will not be affected by the proposal.

8.8 *STATUTORY CONTEXT*

Aboriginal cultural heritage in NSW is protected by the *National Parks and Wildlife Act 1974*. Land managers are required to consider the affects of their activities or proposed development on the environment under several pieces of legislation, principally the *Environmental Planning and Assessment Act 1979* (EP&A Act). Cultural heritage, which includes Aboriginal heritage, is subsumed within the definition of "environment". Commonwealth legislation protecting Aboriginal heritage may also apply to Aboriginal heritage places in NSW in certain circumstances. Key legislation is summarised below but as this project is being assessed under Part 3A of the EP&A Act much of the legislation is not specifically applicable, but has been considered.

8.8.1 *National Parks and Wildlife Act 1974 (NSW)*

All Aboriginal objects within the state of New South Wales are protected under Section 90 of the *National Parks and Wildlife Act 1974*.

Under Section 90, a person who, without first obtaining the consent of the Director-General, knowingly destroys, defaces or damages, or knowingly causes or permits the destruction or defacement of or damage to, an Aboriginal object or Aboriginal place is guilty of an offence.

The DEC is the responsible authority for this Act, with the Director-General of that department the consent authority. However, this project is being assessed under Part 3A of the EP&A Act (see *Section 8.1.3*) and therefore Section 87 permits to investigate/collect and S90 consents to destroy sites are not applicable.

8.8.2 *Heritage Act 1977 (NSW)*

The *Heritage Act 1977* protects the natural and cultural history of NSW with emphasis on non-Aboriginal cultural heritage through protection provisions and the establishment of a Heritage Council.

The *Heritage Act 1977* provides protection for subsurface relics and for heritage items of state significance listed on the State Heritage Register. The Act defers to local planning instruments under the EP&A Act for the protection of items of local significance ('items of the environmental heritage'). As this project is being assessed under Part 3A of the EP&A Act the *Heritage Act 1977* does not apply.

8.8.3 *Environmental Planning and Assessment Act 1979 (NSW)*

The EP&A Act requires that environmental impacts are considered in land-use planning, including impacts on Aboriginal and non-Aboriginal heritage. Various planning instruments prepared under the Act identify permissible land use and development constraints.

The NSW DEC provides guidelines for Aboriginal heritage assessment, including those conducted under the EP&A Act. Guidelines for Aboriginal heritage assessment under Part 3A of the EP&A Act refer to the existing DEC Guidelines (NPWS 1997) for both heritage assessment and Aboriginal consultation (DEC 2004). These guidelines have been followed in this investigation.

8.8.4

Aboriginal And Torres Strait Islander Heritage Protection Act 1984 (Commonwealth)

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* protects areas and/or objects which are of significance to Aboriginal people and which are under threat of destruction. The Act can, in certain circumstances, override state and territory provisions, or it can be implemented in circumstances where state or territory provisions are lacking or are not enforced. A significant area or object is defined as one that is of particular importance to Aboriginal people according to Aboriginal tradition. The Act must be invoked by or on behalf of an Aboriginal or Torres Strait Islander or organisation.

8.9

MITIGATION MEASURES

Mitigation measures are provided based on the results of the background research, archaeological predictive models, field survey, consultation and assessment of cultural significance.

Due to the low significance of the broad background scatter of artefacts within the area of the proposed 30 year quarry and most of its ancillary infrastructure, no mitigation measures are warranted for this area. Similarly, no further Aboriginal heritage work is required in the area of Tangarang Creek Dam 2 given the unfavourable landform conditions and the high level of disturbance in the area.

The archaeological survey has refined the predictive model to limit areas of higher archaeological value to those more intact areas immediately adjacent to proposed Dam 1. Archaeological deposit is present close to the creek and in those areas indicated by surface sites. Given the lack of information about these archaeological aspects of Aboriginal heritage in the local area, archaeological salvage recovery is warranted prior to impact by excavation and inundation. Therefore, as a condition of approval under part 3A of the EP&A Act, a program of Aboriginal site salvage is proposed to be undertaken, comprising collection of surface stone artefacts from all surface sites in a controlled manner with recording of location details and lodging of records with the DEC Aboriginal site register. This will be undertaken in a program of fieldwork by archaeologists working with representatives of the Aboriginal groups registered for this assessment.

In addition to the surface salvage, Aboriginal sites within the confluence of Tangarang Creek in Dam 1 area would be subject to a program of salvage excavation. The initial stage of the salvage excavations would most likely comprise a series of 1 m x 1 m test pits dug across a number of sites to gain a reasonable sample of spatial patterning across these landforms.

Following this first stage of exploratory excavation, the site(s) with the highest potential to allow recovery of representative archaeological features such as knapping floors and hearths (if present) will be further excavated.

8.10

CONCLUSION

This Aboriginal heritage assessment was undertaken to identify, and determine the heritage value of Aboriginal archaeological sites, objects and places within the proposed application area. The assessment included a review of previous Aboriginal cultural heritage investigations, predictive modelling of archaeological potential, field survey in consultation with representatives of the local Aboriginal community.

Eighteen sites were found within the study area, the majority of which were of low scientific significance. Sites within the proposed area of Dam 1 are the exception and are of sufficient scientific value to warrant salvage prior to development impact.

9.1 BACKGROUND

9.1.1 *Land Use and Disturbance*

The site proposed for quarrying and most of the adjacent land has been extensively disturbed by agricultural practices such as clearing, grazing, pasture improvement and fodder cropping since European settlement of the area. Aerial photographs dating from 1946 to 1991 confirm a long history of agricultural use.

The BCSC limestone mine is immediately south of the identified resource area and the site of the former village of Marulan South is close to the western boundary of the resource area. The study area referred to here is the full extent of the identified resource and areas of infrastructure ancillary to the 30 year quarry. Items of potential industrial heritage occur at and near the mine, such as defunct buildings and aerial ropeways.

A long-abandoned dimension stone quarry, reportedly used to cut granodiorite building footings, was found immediately east of the resource area, on the edge of the gorge.

9.1.2 *Heritage Database Searches and Literature Reviews*

The Register of the National Estate (RNE) was searched on 2 February 2006 and no items on the register are in or near the study area.

The Commonwealth Heritage List was searched on 2 February 2006 and no items on the list are in or near the study area.

The State Heritage Register and Inventory was searched on 2 February 2006 and no items on the register or inventory are within the study area. Old Marulan Town, which is approximately ten kilometres west of the proposed quarry, is registered. Readymix has recently gained consent for the Lynwood Quarry, and as part of this development, Readymix proposes to build a grade separated interchange on the Hume Highway near the site of Old Marulan. The consent conditions for Lynwood Quarry require further assessment and excavation at this site.

Various heritage reports in the Marulan area have been reviewed, including Brayshaw 1982, 1984; Drew 1995; ERM 2004, 2006; Haglund 1986; International Environmental Consultants 1997; Kelton 1997; McDonald and Brayshaw 1983; McIntyre 1993; Mills and Wilkinson 1994; Navin 1990; Paton 1989; Sefton 1995; Sinclair Knight Merz 1994; Umwelt 2005; Williams 1992. These reports identify no historical heritage within or associated with the study area.

The survey was carried out on 19 November 2005 and concentrated on potentially historically sensitive places within the resource area, although other areas were also sampled. Pedestrian transects were used for this sampling and copies of aerial photographs and topographic maps were used to guide the survey.

No historical sites, relics or areas of potential historical subsurface deposit were identified within the 30 year quarry and ancillary infrastructure area or the larger resource area. The area occupied by the former township of Marulan South and the old dimension stone quarry are outside the 30 year quarry area and the identified resource area.

The process of heritage assessment is outlined in the Heritage Assessment Guidelines, NSW Heritage Manual, published by the NSW Heritage Office. The guidelines establish six evaluation criteria under which a place can be evaluated in the context of State, regional or local historical themes. The heritage significance criteria are:

Criterion (a) – an item is important in the course or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (b) – an item has strong or special association with the life or works of a person or group, of importance in NSW's cultural or natural history (or the cultural or natural history of the local to area);

Criterion (c) – an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area);

Criterion (d) – an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons;

Criterion (e) – an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (f) – an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (g) – an item is important in demonstrating the principal characteristics of a class of NSW's or the local area's cultural or natural places or environments.

The resource area does not contain any known or identifiable archaeological evidence and no specific historical connection has been identified.

The resource area meets none of the criteria of historical significance and therefore the quarry proposal will not have a significant impact on historical heritage of the resource area.

10.1 INTRODUCTION

A detailed noise and vibration assessment has been undertaken as part of this EA and is included in *Annex G*. This chapter provides a summary of the key elements of the assessment, which was prepared in accordance with the EPA's Industrial Noise Policy (INP) 2000, Environmental Noise control Manual (ENCM), Environmental Criteria for Road Traffic Noise (ECRTW) and the ANZECC guidelines.

10.2 EXISTING BACKGROUND NOISE

Assessment of the environmental noise impact from the proposal requires the quantification of ambient and background noise at receiving locations, including any existing industrial noise where relevant. Distant noise sources at some of the existing residential areas include industrial noise from Blue Circle South Cement limestone mine and traffic noise from Marulan South Road and the Hume Highway.

Assessable locations surrounding the quarry include the six nearest private residences as shown in *Table 10.1* and *Figure 10.1*.

Table 10.1 *Surrounding Representative Properties*

Receiver Location	ISG Coordinates		Location from Quarry	
	Easting	Northing	Compass Point	Distance in metres
1	230394	6149983	E	1780
2	226825	6148376	SW	1730
3	226574	6148989	SW	1540
4	226253	6150502	NWW	1480
5	226475	6152336	NW	2520
6	226127	6152946	NW	3230

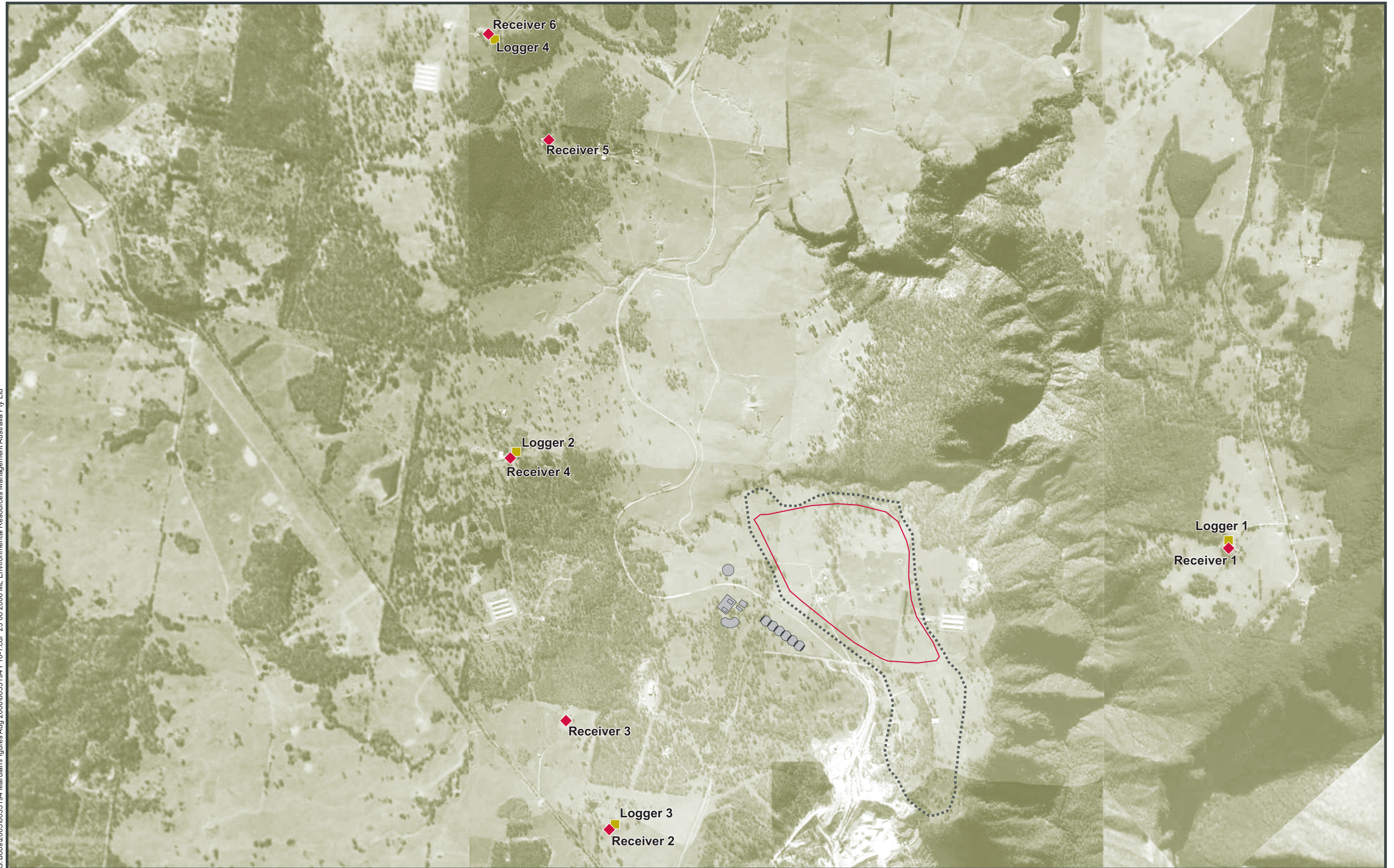
The existing acoustic environment was measured by both short-term attended and long-term unattended noise monitoring, the latter used to establish the level of ambient noise at residences surrounding the site. This was supplemented by attended noise monitoring to document and quantify the existing industrial and road traffic noise at potentially affected receivers.

A background ambient noise survey was developed and implemented for this study and was conducted in accordance with the EPA's INP using four representative sites (Refer to *Figure 10.1*).

The results of the background noise monitoring are listed in *Table 10.2*.

Table 10.2 *Summary of Measured Background Noise Levels*

Receiver Location	Rating Background Level, dB(A)			Ambient Noise Level, dB(A) L_{eq} period			Comments
	Day	Evening	Night	Day	Evening	Night	
1	31	30	30	47	44	38	Location is typical of rural settings, with little or no influence from existing industrial or traffic noise.
2	34	38	35	47	49	44	Location is typical of rural setting, but with some influence from existing industrial and local traffic noise. Attended noise measurements confirm the BCSC industrial noise is 34dB(A) at this location when averaged over a given period (day or night).
4	31	32	31	46	46	45	Location is typical of rural setting with occasional rail traffic noise.
6	30	32	30	43	42	36	Location is typical of rural setting with some influence from distant highway noise.
1. Data affected by rain and wind speeds of above 5m/s was excluded. 2. Noise levels below 30 dB(A) are presented as 30 dB(A) as stipulated by the INP 3. BCSC – Blue Circle Southern Cement Limestone Mine							



Legend

- ◆ Noise Assessment Receiver Locations
- Noise Logger Locations

Figure 10.1

Receiver Locations and Noise Logger Locations

Marulan South Quarry

10.3 NOISE CRITERIA

10.3.1 Construction Noise

Construction noise is excluded from the EPA's INP, however, recommended noise criteria for construction operations are defined in the EPA's Environmental Noise Control Manual, 1994 (ENCM).

The relevant daytime construction criteria are specified in *Table 10.3*. ENCM time limits for construction activities where construction noise is audible at residential premises, apply to the proposal as outlined below:

- Monday to Friday, 7:00 am to 6:00 pm;
- Saturday, 8:00 am to 1:00 pm, otherwise 7:00 am to 1:00 pm if inaudible at residential premises; and
- No construction on Sundays or public holidays.

Table 10.3 Daytime Construction Noise Criteria

Receiver Location	Construction noise criteria, $L_{10,15\text{minute}}$ dB(A)		
	≤ 4 weeks (b/g +20)	> 4 weeks- 26 weeks (b/g +10)	> 26 weeks (b/g +5)
1	51	41	36
2	54	44	39
3	54	44	39
4	51	41	36
5	50	40	35
6	50	40	35

1. Criteria are based on the Existing Background Noise levels presented in *Table 10.2*

10.3.2 Operational Noise

Guidelines for assessing industrial facilities are outlined in the EPA's INP with assessment criteria dependant on the existing amenity of areas potentially affected by a proposed development. Criteria for sensitive receivers near industry include:

- Intrusiveness criteria for the protection of the community from excessive intrusive noise. This criterion requires that $L_{Aeq,15\text{min}}$ (applicable over 15 minutes in any period) noise levels from a newly introduced source during the day, evening and night do not exceed the existing Rating Background Levels (RBL) by more than 5dB.

- Amenity criteria for the preservation of amenity for specific land uses. This strategy is a holistic approach to noise, where all industrial noise (existing and future) received at a given receptor does not exceed the recommended goals over the entire assessment period (day, evening and night). Where ambient noise is already high, the acoustic environment should not be deteriorated significantly.

For extractive industries, noise emissions are generally considered to be consistent (i.e. $L_{eq,15min}$ is approximately equal to the $L_{eq,period}$). Therefore, a single noise goal may be defined for each assessment period taking typical equipment downtime into consideration. Based on discussions with operators and their input into typical mobile plant operations, this is likely to result in the average noise level for a given day (11 hr) or night (9 hr) period being lower than the predicted worst case $L_{eq,15minute}$ noise level.

Project specific noise goals are the lesser value of the amenity and intrusiveness criteria. The intrusiveness goals were found to be the limiting goals in all instances and are presented in *Table 10.4*.

Table 10.4 *Project Specific Noise Limits*

Receiver Location	$L_{eq,15min}$ Project Specific Criteria, dB(A)		
	Day	Evening	Night
1	36	35	35
2	39	43	39
3	39	43	39
4	36	37	36
5	35	37	35
6	35	37	35

The higher evening RBL values are reasonable on the basis of likely increases in road traffic on Marulan South Road and the Hume Highway.

Location 3 has a similar noise environment to Location 2 due to their proximity to one another and the Blue Circle Southern Cement (BCSC) facility. Based on ERM's observations both these locations are similarly influenced by the BCSC Operations. Similarly, Location 5 and Location 6 have comparable noise environments.

10.3.3 *Cumulative Noise*

Adjoining industrial activity also influences the noise climate at residences potentially exposed to the proposal. The only other industrial noise in the area is the noise generated by the Blue Circle Southern Cement (BCSC) plant which is located approximately one kilometre south of the proposed quarry.

However, for most residences, the influence of the BCSC plant is relatively low and the proposal is likely to be the main source of industrial noise during the daytime. For the night period, noise levels from the proposal are lower due to the limited operations of the quarry. Only the tertiary plant and rail loading facility operate during the night period and in particular, only the tertiary crusher and the screens are expected to emit relatively consistent noise throughout the night period (10pm to 7am).

Residence locations 2 and 3 are the only residences exposed to measurable BCSC operations. The BCSC plant's noise levels were inaudible and immeasurable at all other residences during ERM site visits. Hence, only residences 2 and 3 were analysed in detail for cumulative noise.

10.3.4 *Sleep Disturbance*

Given the transient nature of some operations, the L_{eq} noise level alone would not adequately describe all the potential impacts of the noise in question, hence an additional approach to the project specific L_{eq} criteria used above is required.

The most important impact of transient noises would be to disturb the sleep of nearby residents. While the EPA's INP does not specify a criterion for assessing sleep disturbance, its Environmental Criteria for Road Traffic Noise (EPA 1999) indicates that levels below 50 to 55 dB(A) inside residences are unlikely to wake sleeping occupants.

If bedroom windows are open, this corresponds to an external maximum noise level of approximately 60 to 65 dB(A) at a residence. The likely number of noise events per night should also be considered.

However, in this case, this is considerably less stringent than the EPA's previous position on sleep disturbance as presented in the ENCM, which recommends that $L_{1,1\text{minute}}$ noise from a source should not exceed the existing background noise by more than 15 dB. Depending on the measured background noise, the sleep disturbance criteria for the quietest location could be as low as 45 dB(A) L_1 .

The latter more conservative sleep disturbance criterion was adopted for this study.

10.3.5 *Rail Traffic Noise*

Rail traffic noise goals are recommended by the ENCM. These apply to rail traffic on non-private track, and in this case the Main Southern Railway. Rail traffic on the private spur line was assessed as part of the site operational noise as required by the INP.

Noise criteria for residential receivers are specified as a $L_{Aeq,24hr}$ level of 60dB(A) and as a maximum pass-by level, L_{Max} of 85dB(A).

Recommended criteria for the assessment of noise and vibration from blasting are provided by the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration. Where ground vibration peak particle velocities that comply with these criteria would also be below levels that may cause structural damage to buildings.

Noise Overpressure

The ANZECC guidelines specify that air-blast overpressure should not exceed 115 dB(L_{peak}) for more than 5 % of the total number of blasts over a period of 12 months. However, the maximum level should not exceed 120 dB(L_{peak}) at any time. The dB(L_{peak}) unit of sound measurement considers the low frequency sounds which are not audible to the human ear but can be 'felt'.

Ground Vibration

The ANZECC guidelines specify that the peak particle velocity (ppv) from ground vibration should not exceed 5 mm/s for more than 5 % of the total number of blasts over a period of 12 months. However, the maximum level should not exceed 10 mm/s at any time. The ANZECC guidelines also recommend that a level of 2 mm/s be considered as the long-term regulatory goal for the control of ground vibration.

Time and Frequency Of Blasting

The ANZECC guidelines state that blasting should generally be limited to the hours from 9.00 am to 5.00 pm Monday to Saturday and should not take place on Sundays or public holidays. The ANZECC guidelines recognise that under some circumstances, blasting cannot always be restricted to general working hours and achieve compliance with blast level limits. This may be due to prevailing winds being less favourable during these periods.

The guidelines recommend that when a temperature inversion is known to exist, blasting should be avoided if practical. These restrictions do not apply where the effects of blasting are not perceived at noise sensitive locations.

In addition to the above criteria, general good practice procedures can be used to effectively minimise noise impacts.

10.4 NOISE MODELLING

10.4.1 Construction Noise Sources

Major construction activities that will act as sources of noise include overburden stripping, road construction, and building construction.

The sound power levels emitted by construction equipment for these activities were compiled from previous ERM experience and are specified in *Table 10.5*.

Table 10.5 *Representative Sound Power Levels for Construction Equipment*

Plant Item	SWL, L _{10,15minute} dB(A)
Concrete Truck	106
Concrete Pump	105
Concrete Vibrator	103
Dozer	114
Grader	108
Compactor	114
Road Truck	101
Crane	106
Grinder	98
Welder	104
Drill	86
Articulated Dump Truck	113
Excavator	110

1. Sound Power Levels reflect the expected L₁₀ from 15 minutes practical operation of such equipment. The levels are also generally consistent with sound power levels presented in AS2436.

10.4.2 Construction Noise Modelling

Given that construction activities will vary over a 12 month period, a number of scenarios were modelled to gain an understanding of the maximum noise and the potential variation of noise during construction. Scenario concentrates on a potential day during the construction period when construction noise might be expected to be high. Scenarios and plant items use are included in *Table 10.6*.

Table 10.6 *Plant Items in Construction Noise Model*

Scenario number	Construction Noise Model Scenario	Included Plant Items
1	Overburden Stripping	2 Articulated Dump Trucks, 2 Excavators, a Truck and a Dozer
2	Road Construction, overburden stripping and 10m bunding	2 Concrete Trucks, a Concrete Vibrator, a Dozer, a Grader and a Compactor
3	Building Construction, overburden stripping and 10m bunding	2 Road Trucks, a Crane, a Grinder, Welder and a Drill

The Environmental Noise Model (ENM) was used to predict noise levels from the construction equipment at representative receiver locations. ENM accounts for the effects of distance, ground affects, air absorption and weather. ENM also takes account of any shielding that may be present, either from natural features or from buildings and barriers.

Each scenario is expected to occur for a period of less than 26 weeks. Overburden stripping is expected to be undertaken progressively over the life of operations. Overburden from the initial six months of stripping will be used to construct the 10 m earth bund around the perimeter of the pit, which will shield surface activities for the remainder of operations.

10.4.3 *Operational Noise Sources*

Typical equipment used and indicative sound power levels are for earth-moving and associated operations in the pit, tertiary operations and overburden stripping areas are listed in *Table 10.7*.

Table 10.7 **Equipment Sound Power Levels for Operational Equipment**

Plant Item	Representative Freefield $L_{eq,15\text{minute}}$ Sound Power Level, dB(A) (unmitigated)
Primary Crusher	118
Secondary Crusher	116
Drill Rig	116
Excavator	107
Primary to Secondary Crusher Conveyor	99
Bulldozer	107
Grader	107
Re-fueller	98
Train Locomotive	100
Front-End Loader(2)	107
Water Cart	98
Tertiary Crusher(2)	109
VSI Crusher	109
Screen(4)	112
Road Truck(2)	98
Reclaimer	99
Transfer point	95
Conveyor(8)	99 per 100m
ADT(2)	110
Excavator(2)	107
Road Truck	98
Dozer	107

1. Refer to *Appendix D of Annex G* for spectral data used for noise modelling.
2. L_{eq} levels are for each individual source.

10.4.4 **Operational Noise Modelling**

Environmental Noise Model (ENM) noise prediction software was used to predict noise emissions during the progressive quarry operations under various weather conditions. Modelling incorporated several noise mitigation measures that form part of the quarry design and are outlined in the Statement of Commitments (*Chapter 17*). These measures were introduced progressively throughout the noise modelling process to ensure emissions from the quarry are acceptable during all stages of operation. Mitigation measures are further detailed in *Section 10.6*.

The following scenarios were selected for modelling:

- 1) 20m deep pit under calm conditions during the day.
- 2) 20m deep pit under INP weather conditions during the day.
- 3) 20m deep pit under INP weather conditions during the night.
- 4) 40m deep pit under calm conditions during the day.
- 5) 40m deep pit under INP weather conditions during the day.
- 6) 40m deep pit under INP weather conditions during the night.

These scenarios were based on the assumption that all plant and equipment operate simultaneously. In practice, such an operating scenario would be unlikely to occur and the results are therefore conservative.

There is a premise that if the criterion is met under calm weather conditions (defined as no wind and standard temperature gradients), higher noise under strong winds ($>3\text{m/s}$) is generally acceptable. This is because the ambient noise at properties also increases during such weather conditions and quarry noise is masked (for example, by wind induced vegetation noise). However, at wind speeds below 3 m/s and under temperature inversions, noise levels are assessable under the EPA's INP. These conditions are labelled *INP weather conditions* as mentioned previously.

10.4.5 Noise Model Validation

ENM is typically conservative when used to predict noise under adverse weather conditions and therefore requires site specific validation to ascertain its accuracy under such conditions. This involved generating a known noise source and measuring noise levels at various locations under varying weather conditions. Conditions were replicated in the ENM noise model and a comparison of results undertaken. The validation factor upon post-field analysis was determined to be -1.4 dB(A) , which indicated that the ENM model over predicted noise levels under positive wind conditions. This validation factor was then applied to modelled noise levels under positive wind conditions for both day and night.

10.5 IMPACT IDENTIFICATION

10.5.1 Construction Noise Model Predictions

The results of the construction noise modelling for representative receiver locations are shown in *Table 10.8*.

Table 10.8 Construction Noise Modelling Results

Receiver Location	Construction Scenario Noise Level, L ₁₀ , 15minute dB(A)						Criterion, L ₁₀ dB(A)	
	Overburden Stripping		Overburden Stripping & Road Construction		Overburden Stripping & Building Construction		< 26 weeks	> 26 weeks
	Calm	Adverse Wind	Calm	Adverse Wind	Calm	Adverse Wind		
1	20	29	29	41	24	32	41	36
2	17	37	19	38	18	28	44	39
3	21	43	27	47	24	37	44	39
4	20	26	33	48	27	33	40	35
5	13	16	28	39	22	30	40	35
6	11	13	25	35	18	26	40	35
1. All three scenarios are likely to occur within 26 weeks.								

The results demonstrate that all the residences except for Location 3 and 4 may experience construction noise levels greater than the target criteria during the loudest of the works under adverse wind conditions. The construction period is temporary, with completion occurring within 12 months. All reasonable noise mitigation measures outlined in this document will be included in a Construction Noise Management Plan (CNMP). These measures, along with the general construction mitigation measures outlined throughout this EA, will be adopted throughout construction to ensure that noise amenity of surrounding residences is not significantly affected.

The results also demonstrate that noise level criteria are met for all locations during calm weather conditions.

10.5.2 Operational Noise Model Predictions

Calm Weather Conditions

Noise modelling results for calm weather conditions are summarised in *Table 10.9*. Given that only the tertiary plant is expected to operate during the night, noise levels at the receivers will be significantly lower than these calm day scenarios as evidenced by *Table 10.9*.

Table 10.9 *L_{eq,15minute} Noise Under Calm Conditions, Mitigated dB (A)*

Receiver Location	20m Pit		40m Pit		Project Specific Noise Criteria	
	Day	Night	Day	Night	Day	Night
1	23	16	26	12	36	35
2	22	19	24	19	39	39
3	25	21	28	21	39	39
4	26	23	26	23	36	36
5	22	17	20	17	35	35
6	19	14	17	14	35	35

It is clear that daytime and night time quarry operations will satisfy EPA noise goals during calm weather conditions at all the receiver locations.

Prevailing Weather Conditions

The predicted levels for mitigated noise emission under day INP weather conditions are given in *Table 10.10* below. Noise contours for this scenario are given in *Figures 10.2* and *10.3*.

Table 10.10 *L_{eq,15minute} Noise Under Day INP Weather Conditions, Mitigated dB (A)*

Receiver Location	20m Pit	40m Pit	Project Specific Noise Criteria
1	31	32	36
2	37	39	39
3	44	43	39
4	37	34	36
5	35	25	35
6	25	23	35

1. For Day INP Weather Conditions refer to the wind speeds and wind directions given in *Table 2.4* of *Annex G*. The results above correspond to the highest modelled noise level of all winds for a given receiver.
2. Validation factor of -1.4dB(A) has been applied to the modelled levels (for positive winds only).

Under day INP weather conditions, the project specific criteria are met at most locations for both a 20m pit and a 40m pit. The exception is Location 3, with a predicted exceedance of up to 5dB demonstrated against the INP recommendations.

At Location 1 and Location 2, noise levels for a 40m pit scenario are higher than for a 20m pit despite the in-pit equipment moving deeper. This is due to the presence of a truck and dozer on top of a 30m high mound at the east of the quarry.

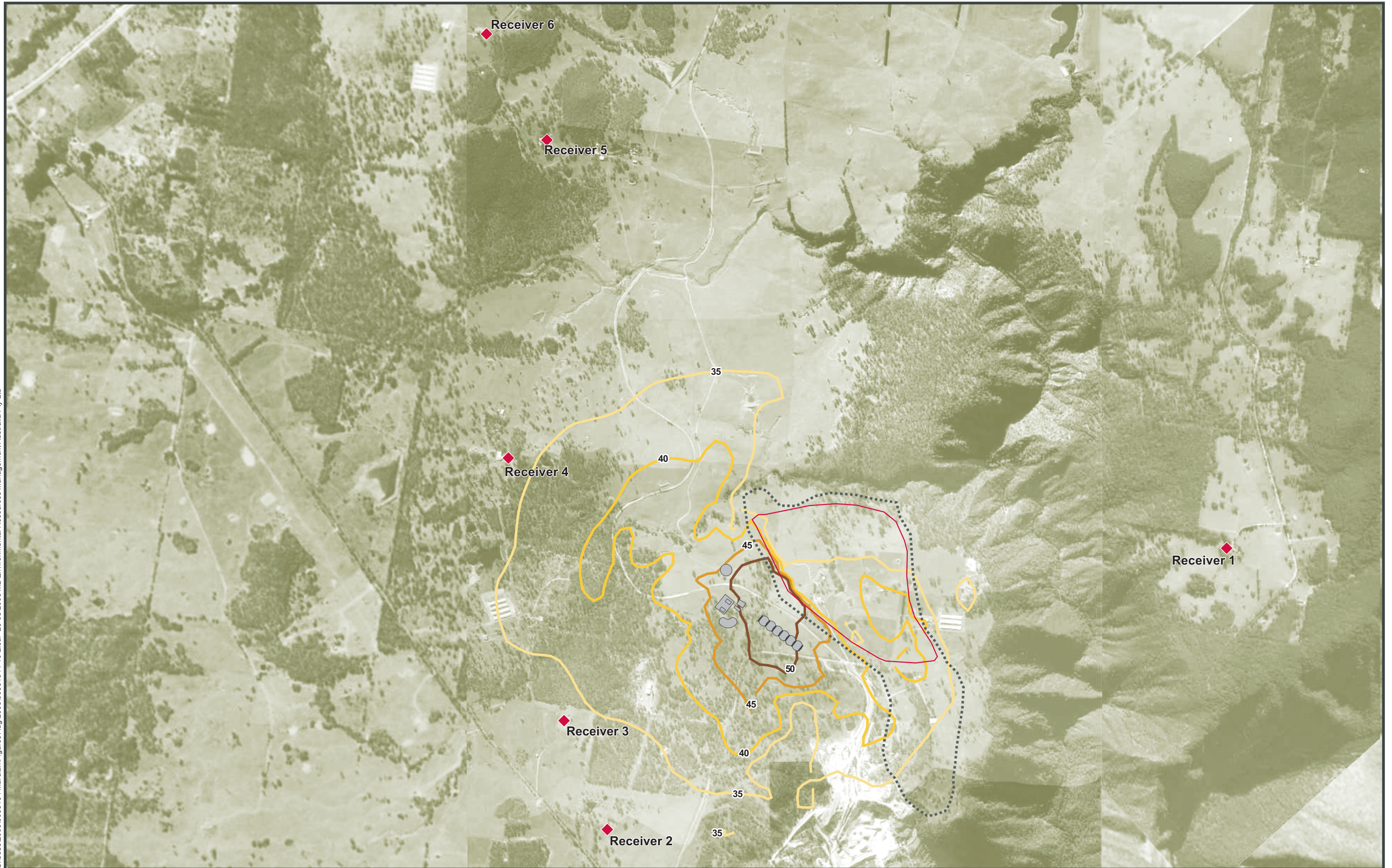
The predicted levels under INP weather conditions during the night are given below in *Table 10.11*. Noise contours for this scenario are given in *Figures 10.4* and *10.5*.

Table 10.11 *L_{eq,15minute} Noise Under Night INP Weather Conditions, Mitigated dB (A)*

Receiver Location	20m Pit		40m Pit		Project Specific Noise Criteria
	Adverse Wind	TI	Adverse Wind	TI	
1	28	21	25	19	35
2	29	24	29	24	39
3	33	28	33	28	39
4	34	31	34	31	36
5	25	24	25	24	35
6	22	21	22	21	35

- for night INP Weather Conditions refer to the Adverse Wind Speeds and Wind Directions given in *Table 2.4* of *Annex G*. The results above correspond to the highest modelled noise level.
- for night INP Weather Conditions refer to the Adverse Wind Speeds and Wind Directions given in *Table 2.4* of *Annex G*. The results above correspond to the highest modelled noise level.
- TI = Temperature Inversion of 3 °C/100 m.
- Validation factor of -1.4dB(A) has been applied to the modelled levels

During night INP weather conditions, the project specific criteria are met under all scenarios. This is due to the fact that only the tertiary plant (which is on the surface) operates at night and the noisier in-pit equipment is inactive during this period. Hence, the depth of the pit is rendered irrelevant in terms of noise levels received at the residences. For Location 1, the presence of a 30m high dump for the 40m pit scenario provides some shielding and results in slightly reduced noise levels.



Legend

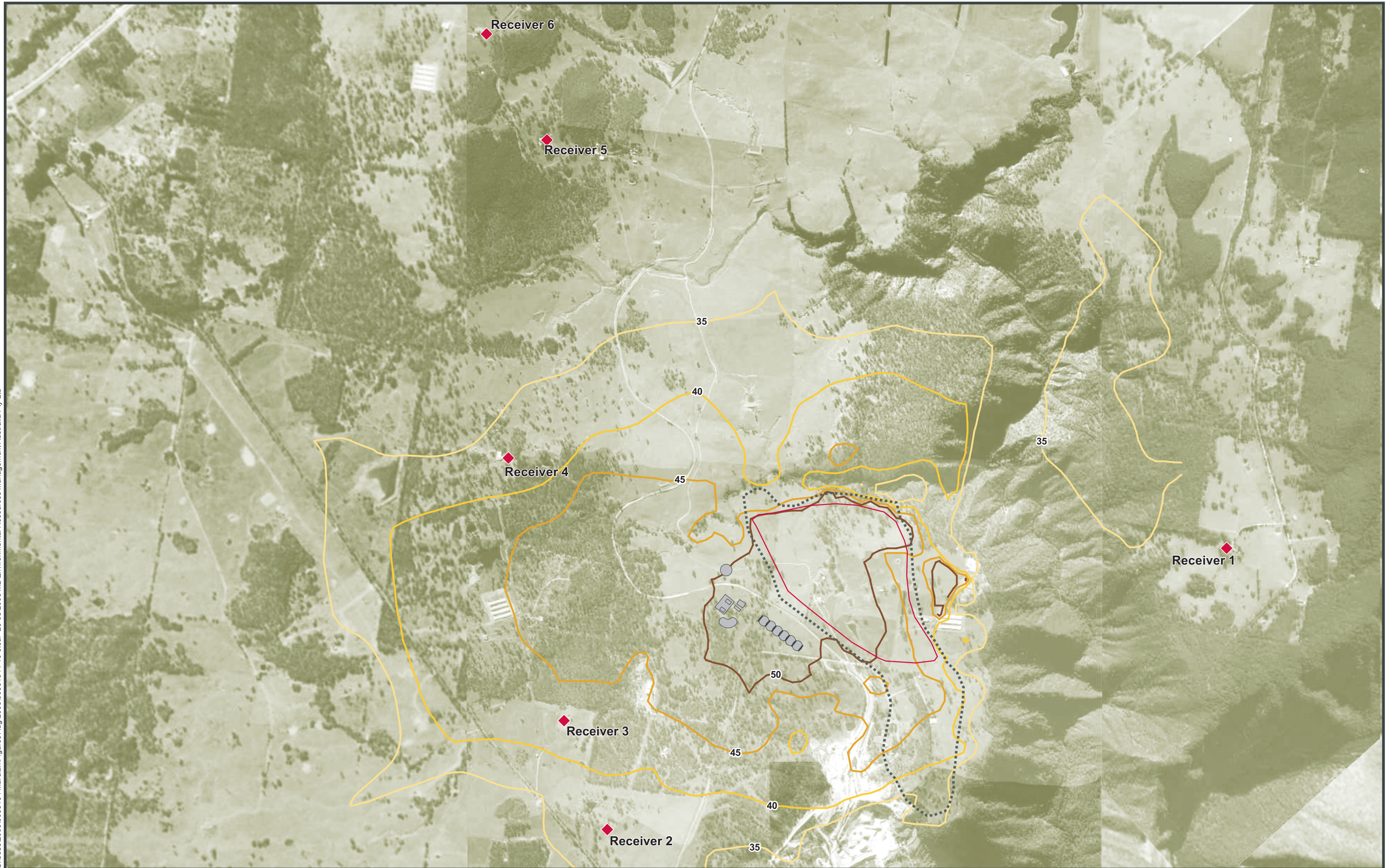
- 50 dB(A)
- 45 dB(A)
- 40 dB(A)
- 35 dB(A)
- ◆ Noise Assessment Receiver Locations

Figure 10.2

20m Pit Day Leq(15min) Operational Noise Levels - INP Weather Conditions, dB(A)

Marulan South Quarry





Legend

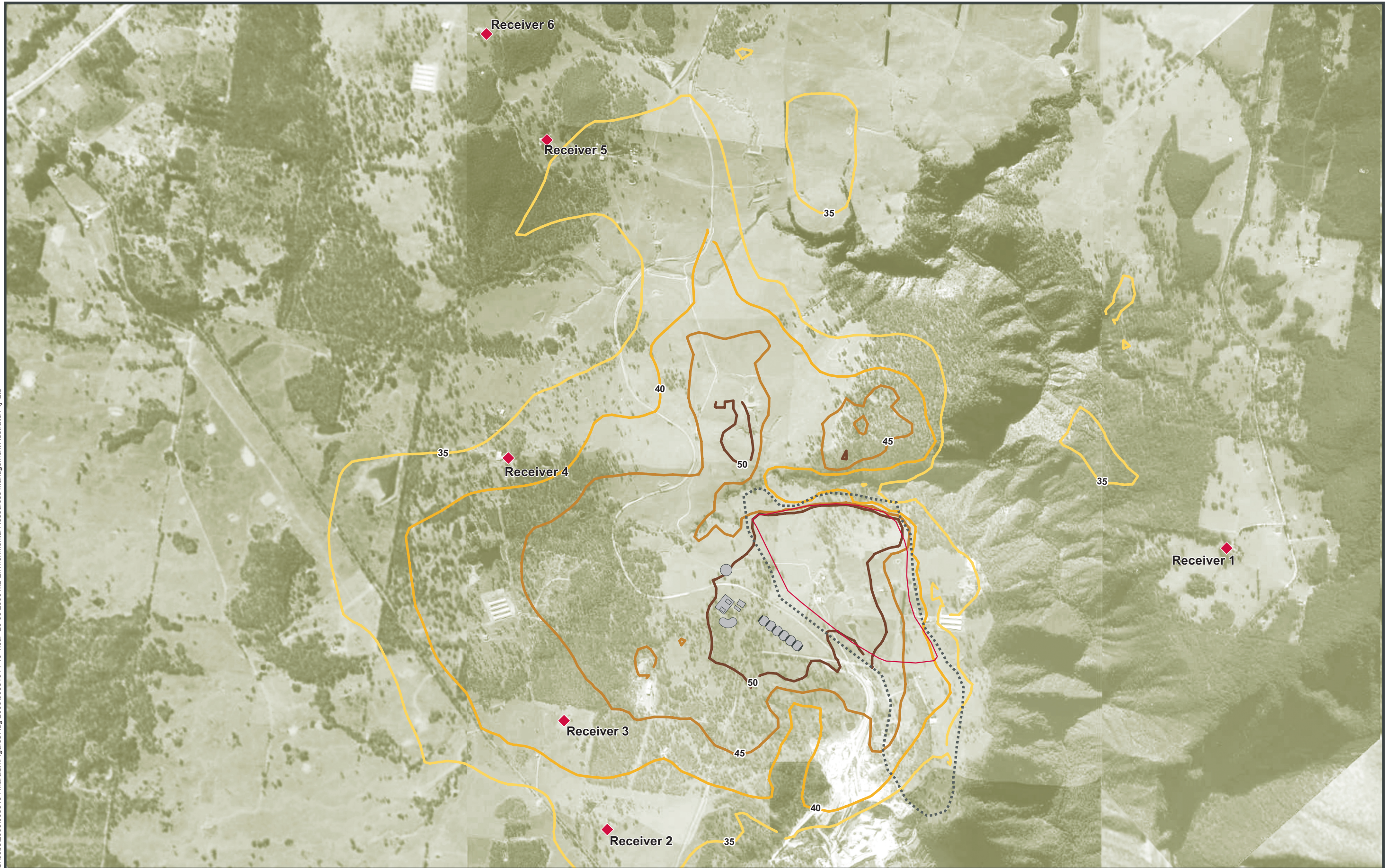
- 50 dB(A)
- 45 dB(A)
- 40 dB(A)
- 35 dB(A)
- ◆ Noise Assessment Receiver Locations

Figure 10.3

40m Pit Day Leq(15min) Operational Noise Levels - INP Weather Conditions, dB(A)

Marulan South Quarry





Legend

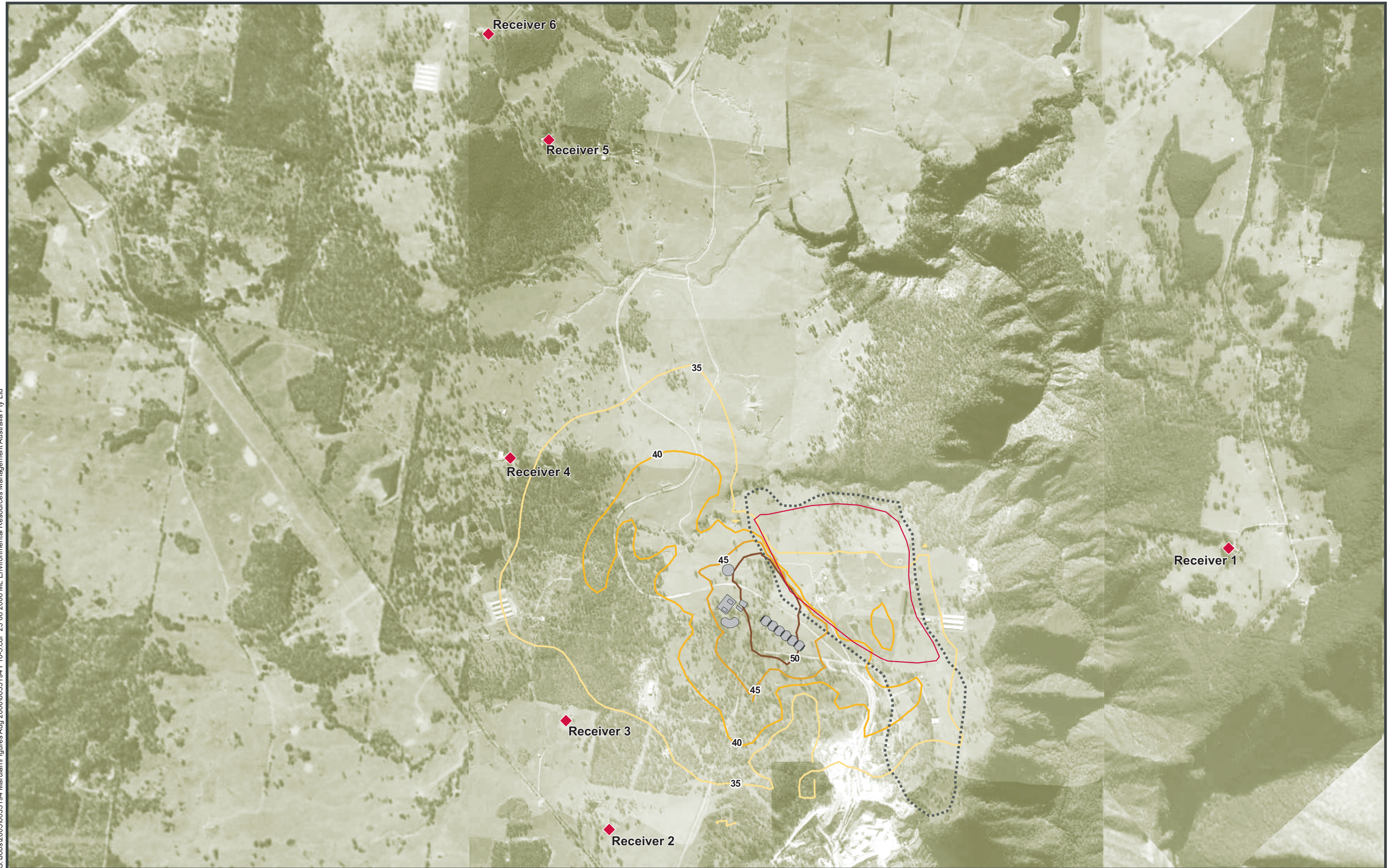
- 50 dB(A)
- 45 dB(A)
- 40 dB(A)
- 35 dB(A)
- ◆ Noise Assessment Receiver Locations

Figure 10.4

20m Pit Night Leq(15min) Operational Noise Levels - INP Weather Conditions, dB(A)

Marulan South Quarry





Legend

- 50 dB(A)
- 45 dB(A)
- 40 dB(A)
- 35 dB(A)
- ◆ Noise Assessment Receiver Locations

Figure 10.5

40m Pit Night Leq(15min) Operational Noise Levels - INP Weather Conditions, dB(A)

Marulan South Quarry

10.5.3 *Blasting Noise and Vibration*

Blasting is expected to occur on average around once per week though this may vary over the life of the quarry. The distance from the pit boundary to the residences is the minimum blast separation distance, as presented in *Table 10.12*.

Table 10.12 *Blast Locations*

Receiver Location	Minimum Blast Separation Distance, metres
1	1780
2	1730
3	1410
4	1480
5	2520
6	3230

The blast design, and hence corresponding air blast overpressure and ground vibration, is within the control of operators. A blast management strategy will be used to ensure appropriate charge masses are used. Such charge masses (or maximum instantaneous charge, MIC) are presented in *Table 10.13*. These were derived from 95% formulae delivered from monitoring as published in Blastronics Pty Limited (1994).

Table 10.13 *Blasting Assessment*

Blast to Location Distance, m	MIC _{8ms} to Satisfy ANZECC 95 % Overpressure Limit of 115 dB(Lin), kg	MIC _{8ms} to Satisfy Maximum Allowable Overpressure Limit of 120 dB(Lin), kg	MIC _{8ms} to Satisfy ANZECC 95% Ground Vibration Limit of 5 mm/s (ppv), kg	MIC _{8ms} to Satisfy Maximum Allowable Ground Vibration Limit of 10 mm/s (ppv), kg
1000	48	207	331	862
1500	163	699	745	1938
2000	386	1658	1325	3446
2500	754	3238	2070	5384
3000	1303	5595	2981	7754
3500	2069	8885	4057	10554

Given that all residences are more than 1.4km from blast locations, blast ground vibration impacts from the proposal are unlikely if the MIC masses above are used.

Blasting will occur between the hours of 7.00 am to 6.00 pm. This will provide the quarry with flexibility to blast during meteorological conditions that will result in the least impact on its neighbours.

10.5.4 Road and Rail Traffic

Main Southern Railway

Rail traffic noise has been assessed for rail movements on the Main Southern Line. Typically, 30 freight train and 16 passenger train movements per day are currently recorded on the Main Southern Railway. During the weekend, the rail traffic decreases to 20 freight train and 10 passenger train movements per day. During the wheat harvesting season, 4 more freight train movements per day may be expected.

At maximum production, the proposed quarry is expected to contribute 4 trains to the existing rail traffic which implies that there will be an addition of 8 rail movements to the existing 46 rail movements during a typical weekday.

Rail noise levels due to rail traffic generated by the proposal at different distances to the railway line are presented in *Table 10.14*.

Table 10.14 Rail Traffic Noise from Main Southern Railway Line

Distance from railway line, m	Noise Level, dB(A)			Rail Noise Criteria, dB(A)	
	Existing Rail Noise	Existing + Proposal Rail Noise			
	Leq(24h)	Leq(24h)	Lmax	Leq(24h)	Lmax
25	61	62	77	60	85
50	55	56	71	60	85
100	49	50	65	60	85
200	43	44	59	60	85
500	35	36	51	60	85
1000	29	30	45	60	85

In a 24 hour period, a residence set back more than 25m from the railway line is unlikely to exceed the stipulated Leq(24h) criteria. It can also be seen from the results that the proposal only marginally increases (1dB) the existing Leq(24h) rail noise levels. This is due to the fact that the increase in rail traffic is not substantial.

The L_{max} criterion assesses instantaneous noise from a single train pass-by. Hence, the existing and future L_{max} rail noise levels are not expected to differ. The L_{max} levels due to a train pass-by from the proposal are below the stipulated criteria as near as 25m away from the railway line.

BCSC Rail Spur

Noise from the local rail spur was considered part of the site operational noise as required by the INP. However, it is analysed separately due to its relatively infrequent nature.

The proposal is expected to generate 8 railway movements per 24 hours along the rail spur during maximum production. The calculated rail noise of proposed traffic on the spur is shown in *Table 10.15*.

Table 10.15 Rail Spur Noise

Receiver Location	Distance, m	Noise Level, dB(A)	
		Leq(15min)	INP Night Criteria
1	2280	23	35
2	1340	28	39
3	820	32	39
4	800	33	36
5	960	31	35
6	1220	29	35

1. Distance refers to the distance from the residence to the closest point on the rail spur.

The combined effect of the local railway spur and the quarrying operations of the proposal does not add significantly to noise levels at any receiver locations.

Train pass-bys will essentially dominate the $L_{eq}(15min)$ during a worst-affected period at night but will not result in a breach to the INP's night criteria.

10.5.5 Cumulative Impacts

The cumulative noise effects of the proposed quarry and the existing BCSC plant on residences 2 and 3 during adverse weather conditions are summarised in *Table 10.16*. Only these residences are exposed to measurable BCSC operations are included in the results.

Table 10.16 Cumulative Night-time L_{eq} Noise Levels

Receiver Location	$L_{eq}(9h)$ Noise Level, dB(A)			Amenity Criteria, dB(A)
	Proposal	Existing BCSC Plant	Total	
2	18	34	34	40
3	24	34	34	40

1. Modifications applied to the amenity criteria according to the INP.

The EPA's INP recommends an acceptable amenity goal of 40 dB(A) $L_{eq,9hour}$ applicable for a rural residence. Results in *Table 10.16* demonstrate that cumulative industrial noise is expected to be within the INP Amenity targets.

10.5.6 *Sleep Disturbance*

During the night period, only the out-of-pit processing plant and rail loading facility is expected to operate. Assessment was required to determine the potential for sleep of residents to be disturbed by transient noise such as loading of wagons by front-end loaders, starting of truck engines and vehicle reversing alarms. The noise generated by a front-end loader dumping into an empty rail carriage was identified to be the noisiest event. Based on ERM's database of previous similar measurements, the sound power level of a front-end loader dumping 20mm aggregate into an empty truck or a train carriage in a controlled manner was calculated to have an L_{max} Sound Power Level of 124dB(A). The results may increase by up to 10 dB(A) at the receivers if less control is used in dropping the load.

Maximum noise levels for the operation of single plant items were calculated under calm and INP weather conditions for each location during the night period as shown in *Table 10.17*. The criteria used to assess sleep disturbance are based on the EPA's background plus 15 dB for the $L_{1,1min}$ noise level (which in this case is conservatively approximated by the maximum noise level (L_{max})). Calculated noise levels under prevailing weather conditions are within the EPA's conservative sleep disturbance criterion at all the residences during calm and INP weather conditions.

Table 10.17 *Sleep Disturbance Impact – Calm and INP Weather Conditions*

Receiver Location	External L_{max} Noise Level From Tertiary Plant, dB(A)		$L_{1,1min}$ Criteria, dB(A)
	Calm Weather	INP Weather	
1	25	37	45
2	35	43	50
3	36	46	50
4	36	46	46
5	30	38	45
6	24	33	45

10.6

NOISE MITIGATION AND MANAGEMENT

Several noise mitigation measures were included in the quarry design and will form part of the project's overall Statement of Commitments. All feasible mitigation measures were introduced progressively throughout the noise modelling process to ensure acceptable emissions from the quarry. These measures were introduced based upon their functionality in noise amelioration and practicality in terms of quarry operations, and include:

- construction of a 10m earth bund spanning the pit boundary facing the residences to the east, west and the north;
- construction of an enclosure to house the tertiary plant, west of the quarry. The enclosure will be designed to provide adequate attenuation;
- using a drill rig with a suitable sound power level emission;
- limitation of in-pit operations to the day period (7am- 7pm) only;
- limitation of blasting to the hours of 7.00 am to 6.00 pm;
- partial cladding of the in-pit crushers to achieve an adequate reduction in their sound power levels;
- selection a dozer with lower sound power level;
- cladding of the conveyors to achieve a reduction in their sound power levels; and
- the overburden stripping fleet will be limited to an excavator, trucks and a dozer.

10.7

CONCLUSIONS

This study considers the potential noise impacts of the proposal. The acoustic assessment included modelling of all major quarrying equipment at representative operational locations. The study had the following features:

- long term ambient noise survey at four representative locations in accordance with the EPA's INP;
- noise criteria derived in accordance with the EPA's INP;
- site-specific hourly meteorological data analysed in accordance with the EPA's INP;
- noise modelling addressing the EPA's INP with regard to weather effects; and

- validation of the noise model to produce site-specific and more accurate results.

The noise assessment has shown that under calm weather conditions all receiver locations experience noise levels below the EPA's noise goals.

The assessment has also shown that under worst case INP derived weather conditions, noise at most properties is below EPA noise goals. The only exception is daytime noise levels at Receiver 3. The night time operational noise levels are predicted to meet EPA goals at all receivers. Given the concerted effort applied to mitigate noise and the level of residue impact (up to 5dB(A)), negotiation with the resident and the regulator is proposed. This will involve demonstration by the proponent that all feasible and reasonable noise mitigation has been considered and will be applied as part of the Statement of Commitments. This negotiation process will be undertaken in accordance with *Chapter 8* of the INP.

Sleep disturbance and cumulative noise impact due to the proposal are not considered likely. Rail traffic noise due to the proposal was also found to be within relevant criteria.

Blast design will incorporate control on the MIC (maximum instantaneous charge) as described in this study and ensure acceptable limits are maintained. This will also be addressed through monitoring.

11.1 INTRODUCTION

Holmes Air Sciences quantitatively assessed the air quality impacts of the proposed Marulan South Quarry. This chapter summarises the assessments as detailed in *Annex H*.

The assessment is based on a conventional approach following the procedures outlined in the NSW DEC guidelines “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW” (DEC, 2005). The assessment used a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the quarry under reasonable worst-case operational scenarios. Dispersion model predictions have been compared to relevant air quality goals and mitigation methods provided to reduce dust emissions and associated impacts.

11.2 AIR QUALITY ASSESSMENT CRITERIA AND METHODS

11.2.1 Assessment Criteria

Air quality goals relate to the total dust burden in the air, including impacts from the project and background levels. Relevant assessment criteria stipulated by the DEC are summarised in *Table 11.1* and *Table 11.2*.

Table 11.1 Assessment Criteria for Particulate Matter Concentrations

Pollutant	Averaging Period	Concentration ($\mu\text{g}/\text{m}^3$)	Agency
TSP ^I	Annual mean (including cumulative sources)	90	National Health & Medical Research Council
PM ₁₀ ^{II}	24-hour maximum	50	DEC
	Annual mean (including cumulative sources)	30	DEC long-term reporting goal
	(24-hour average, 5 exceedances permitted per year)	50	National Environment Protection Council

Source: DEC

Notes: ^I TSP = total suspended particulate

^{II} PM₁₀ = particulate matter with aerodynamic diameters less than 10 μm

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by deposition on surfaces. The maximum acceptable increase in dust deposition over the existing dust levels, and the maximum acceptable total dust deposition due to the quarry and other sources are shown in *Table 11.2*. These criteria for dust fallout levels are set to protect against nuisance impacts (DEC, 2005).

Table 11.2 *DEC Criteria for Dust Fallout*

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust (insoluble solids)	Annual	2 g/m ² /month	4 g/m ² /month
Source: DEC			

11.2.2 *Methods*

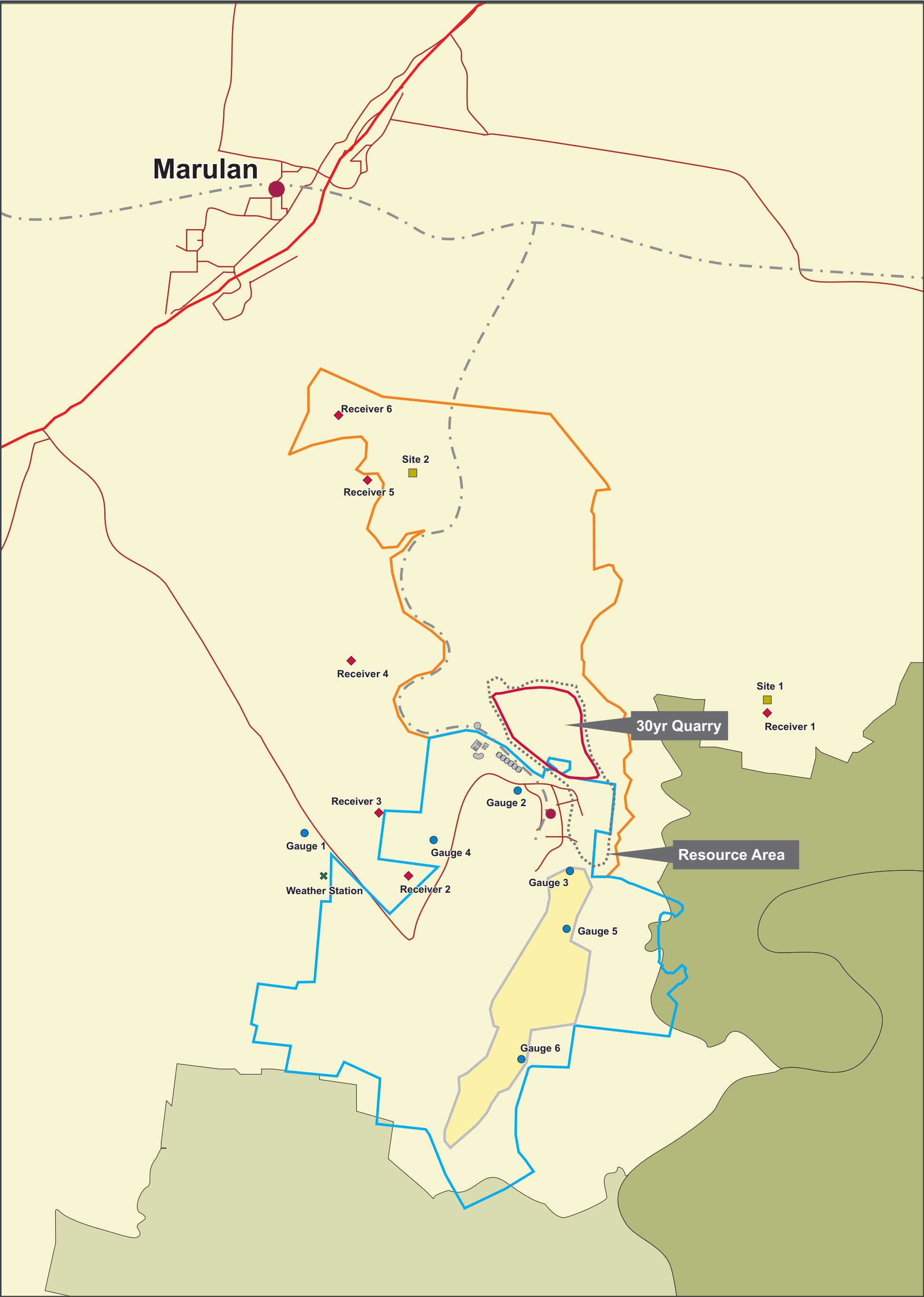
This assessment follows the DEC Guidelines for the Assessment of Air Pollution Sources Using Dispersion Models (DEC, 2005), which specify how assessments based on the use of air dispersion models should be undertaken. This includes the preparation of meteorological data to be used in dispersion models; 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.

11.3 *DISPERSION METEOROLOGY*

The United States Environment Protection Agency (US EPA) Gaussian dispersion model ISCST3 has been used for this air quality assessment. This model requires information about the dispersion characteristics of the area, particularly wind speed, wind direction, atmospheric stability class and mixing height (see *Annex H* for further detail).

An automatic meteorological monitoring station installed on the Boral property (see *Figure 11.1*) has provided hourly records of temperature, wind speed, wind direction and sigma-theta (used to calculate stability). Data from May 2004 to April 2005 was used in the dispersion model and represents 100% data capture where DEC requirements state that meteorological data used for dispersion modelling should contain at least 90% of one year. Similar wind patterns are experienced at the site from year to year.

Mean annual wind speed was recorded as 2.5 m/s. with percentage of calms at 9.6%. Annually, the most common winds are from the WSW, W and ENE with winds predominately from the east in summer and from the west in winter. Modelling of dispersion conditions indicate that dust emissions would disperse rapidly for a significant proportion of the time.



11.4 EXISTING AIR QUALITY

11.4.1 Existing Monitoring

Monitoring has measured the existing dust concentrations and deposition levels in the project area. This includes the measurement of both total suspended particulates (TSP) and those dust particles with a diameter less than ten micrometres (PM₁₀) using high volume air samplers at two locations as shown in *Figure 11.1*. This monitoring program is inclusive of dust emissions from the existing BCSC mining activities and other activities. Other sources of particulate matter in the area include traffic on unsealed roads, local building and construction activities, animal grazing activities and to a lesser extent traffic from the Hume Highway

11.4.2 Concentration

Twenty-four hour TSP and PM₁₀ samples were recorded every three days for a 42 day period and then every six days for 66 day period from November 2005 to late February 2006.

Average and maximum concentrations for PM₁₀ and TSP are shown below in *Table 11.3*. The highest 24-hour average PM₁₀ concentration since monitoring began was from Site 1 with 34 µg/m³ on 27 December 2005. This is below the 50 µg/m³ DEC 24-hour maximum goal. Average PM₁₀ concentrations for the data period were below the DEC's annual average PM₁₀ goal of 30 µg/m³. Also, average TSP levels were below the 90 µg/m³ goal.

Table 11.3 *Dust Concentration Data for Marulan South Quarry*

Date	Site 1 PM ₁₀	Site 1 TSP	Site 2 PM ₁₀	Site 2 TSP
Maximum (µg/m ³)	33.8	45.8	29.1	58.8
Average (µg/m ³)	16.4	25.2	13.9	24.9
Source: Holmes Air Sciences 2006				

An estimate of 16 µg/m³ has been taken to be the annual average PM₁₀ background level to apply at the nearest residential receptors. The annual average for TSP has been taken to be 25 µg/m³. While it is desirable to have a full year of monitoring data to record seasonal variations in dust concentrations, the captured summer period represents that portion of the year in which dust concentrations tend to be highest. Therefore, these estimated averages for the monitoring period can be considered conservative estimates of the annual averages.

11.4.3 *Deposition*

BCSC has operated six dust deposition gauges within and around the perimeter of the limestone mine since February 2001 as shown in *Figure 11.1*. Dust deposition gauges measure the rate at which dust settles onto the surface over periods approximating one month and include the effects of all background sources relevant to that location.

Dust deposition data from gauge 4 was selected to represent existing fallout levels at the rural residences around the proposed quarry site. This gauge was chosen based on its proximity to the residences that would be closest to the quarry, however, BCSC operations may have contributed to the measured levels at gauge 4. A value of 3 g/m²/month has been taken to be the likely annual average dust deposition at each of the residential receptors shown in *Figure 11.1*.

The assumed background concentrations and deposition rates applicable at the nearest residential receivers are:

- annual average TSP of 25 µg/m³;
- annual average PM₁₀ of 16 µg/m³; and
- annual average dust deposition of 3 g/m²/month.

In addition, the DEC guidelines require an assessment against 24-hour PM₁₀ concentrations. This assessment adopts the approach that the predicted 24-hour average PM₁₀ concentration from the development should be less than 50 µg/m³ at the nearest residences. The potential for short-term cumulative impacts to arise from the simultaneous operations of the quarry along with the BCSC mine have also been investigated.

11.5 *ESTIMATED EMISSIONS*

Emissions from the proposed quarry were modelled using the US EPA ISCST3 model. Emission rates of TSP have been calculated using emission factors developed both within NSW and by the US EPA as detailed in *Appendix B of Annex H*.

The modelling has been performed using the dispersion meteorology and the dust emission estimates from *Sections 11.3 and 11.4*. Dust concentrations and deposition rates have been predicted over an area 10 km by 12 km with the quarry site located approximately in the centre. Modelling has been undertaken for 102 discrete receptors, including residential locations, located in the study area and assumes the following:

- overburden stripping and emplacement will take place between 7 am and 7 pm;
- handling of materials into dump trucks or in-pit crusher via front end loader (FEL) will place between 7 am and 7 pm; and
- final crushing, screening, blending and transportation will take place 24 hours per day.

11.5.1 Emissions From Quarry

The main sources of dust associated with the operation of the quarry would be as follows:

- drilling and blasting of rock within the active extraction areas;
- vehicles travelling on unpaved surfaces;
- crushing and screening of rock;
- loading and unloading of material to crushers, stockpiles, trains and trucks; and
- wind erosion from stockpiles and unpaved exposed areas.

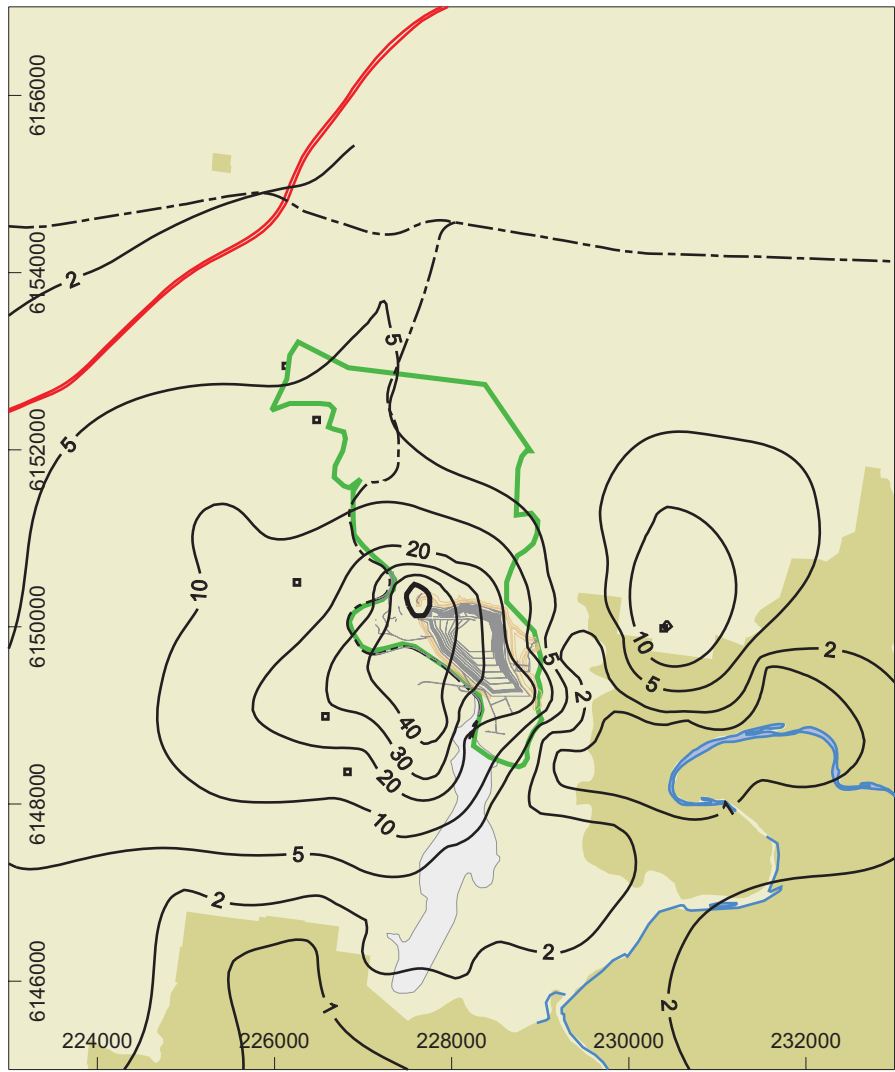
The assessment of total dust emissions has considered two operational scenarios to capture the worst-case air quality impacts of the project on neighbouring residential properties. Key assumptions include requirements for drilling and blasting, truck sizes, haul road distances and routes, conveyors, facility layout, stockpile and pit areas, operating hours and other details that are necessary to estimate dust emissions. These assumptions and the resulting dust emission estimates for each activity are detailed in *Annex H*. These worst-case operational scenarios have been developed to assess the maximum extents of air quality impacts. Scenarios modelled are as follows:

- year 1 operations with overburden emplaced on the surrounding bund wall and the eastern emplacement area; and
- maximum production (3.5 mtpa) operations with overburden transported and emplacement to a stockpile in the BCSC limestone mine.

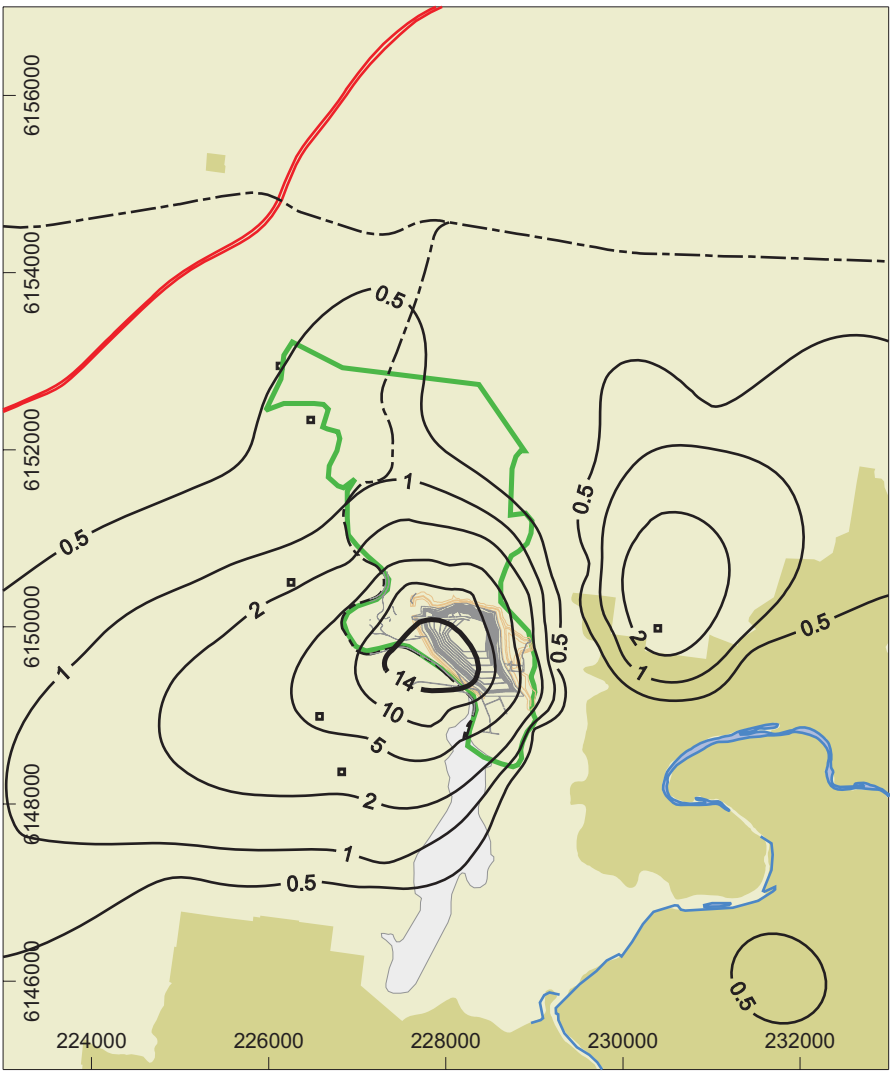
Dust concentrations and deposition rates due to the operational scenarios have been presented as isopleth diagrams (contour plots) in *Figures 11.2 and 11.3* for:

1. Predicted maximum 24-hour average PM₁₀ concentration
2. Predicted annual average PM₁₀ concentration
3. Predicted annual average TSP concentration, and
4. Predicted annual average dust deposition.

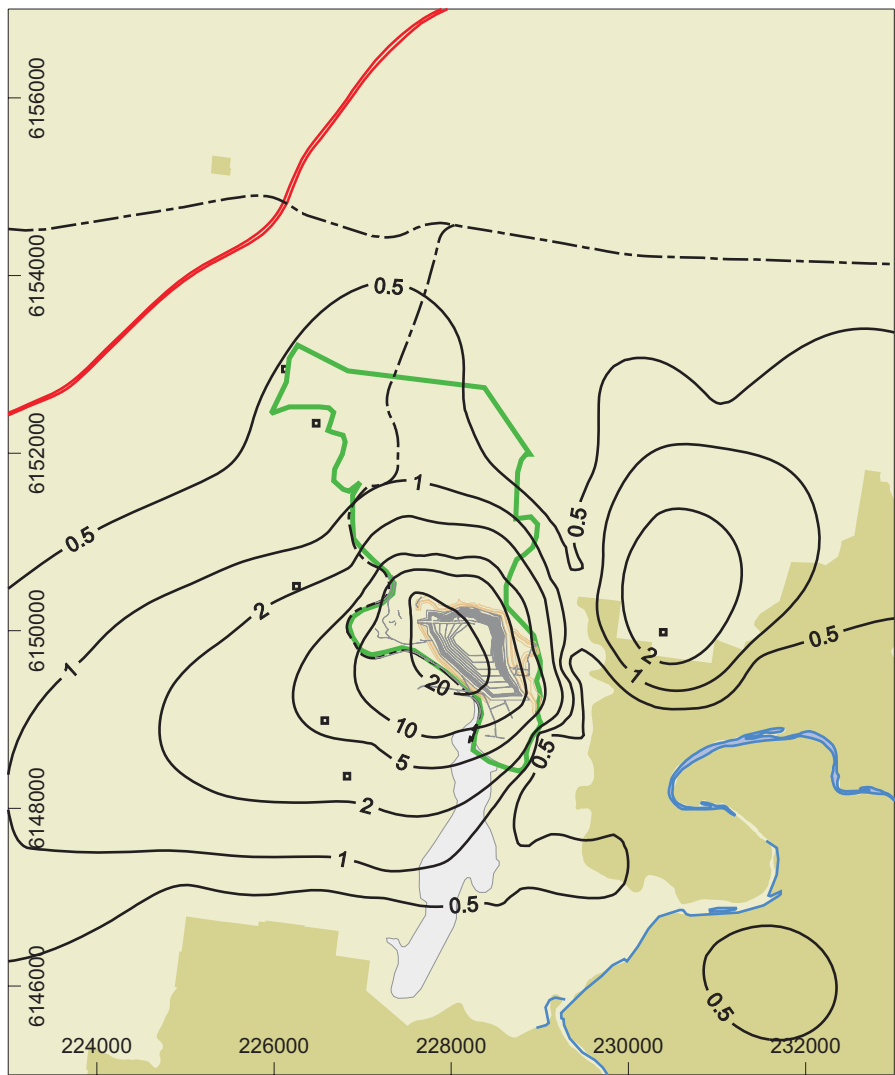
The maximum 24-hour average contour plots show the highest predicted 24-hour average concentration that occurred at each location regardless of when it occurred.



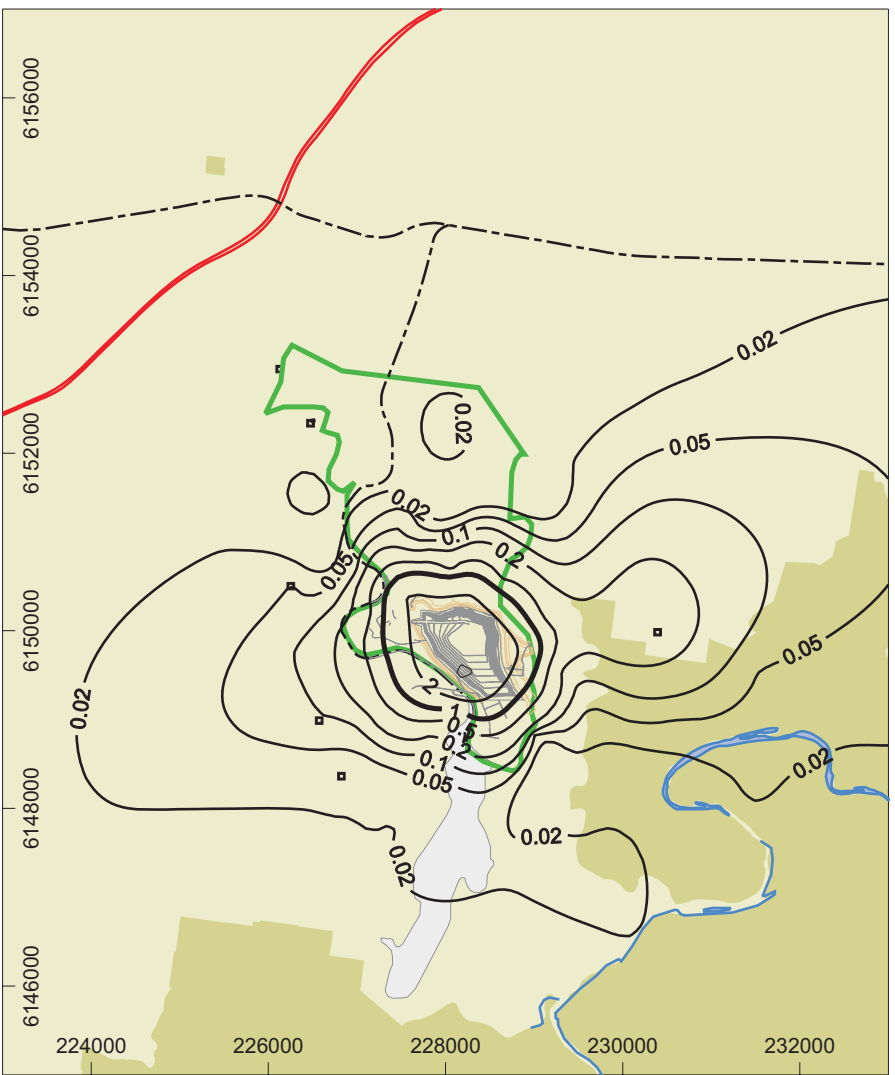
Maximum 24-hour average PM₁₀ (µg/m³)



Annual average PM₁₀ (µg/m³)



Annual average TSP (µg/m³)

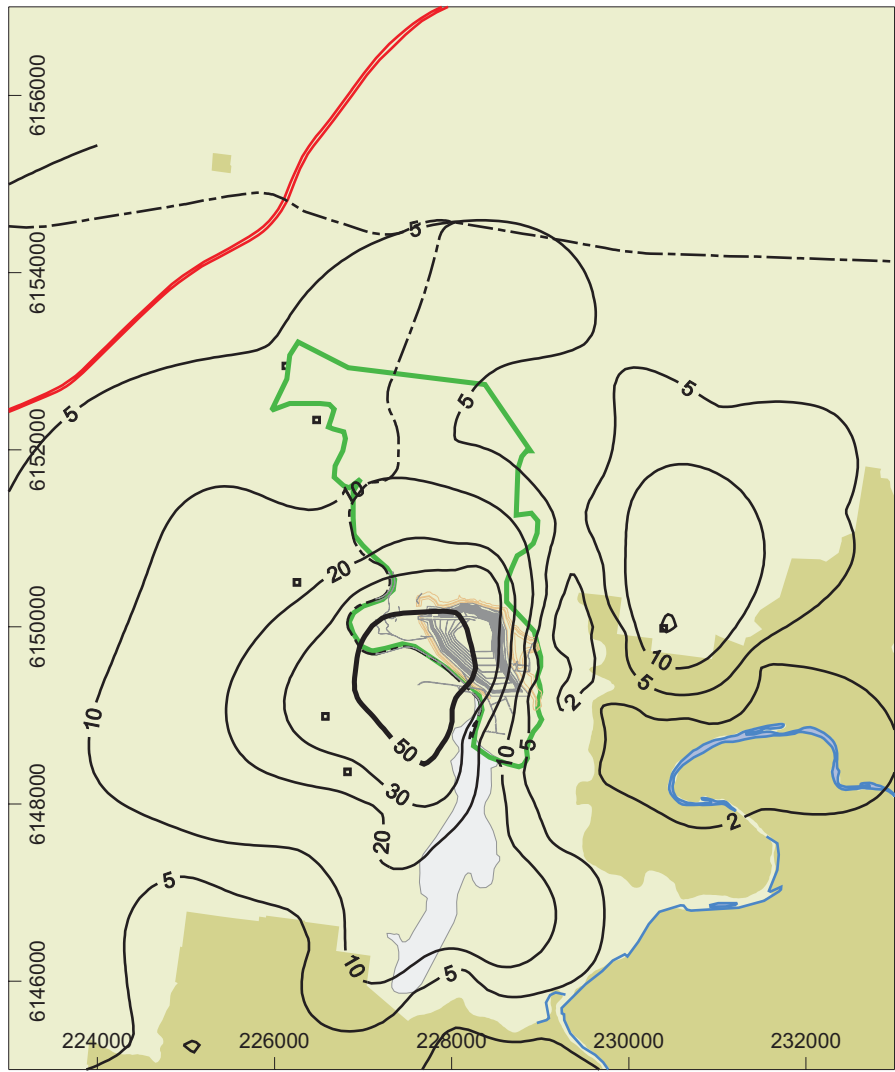


Annual average dust deposition (g/m²/month)

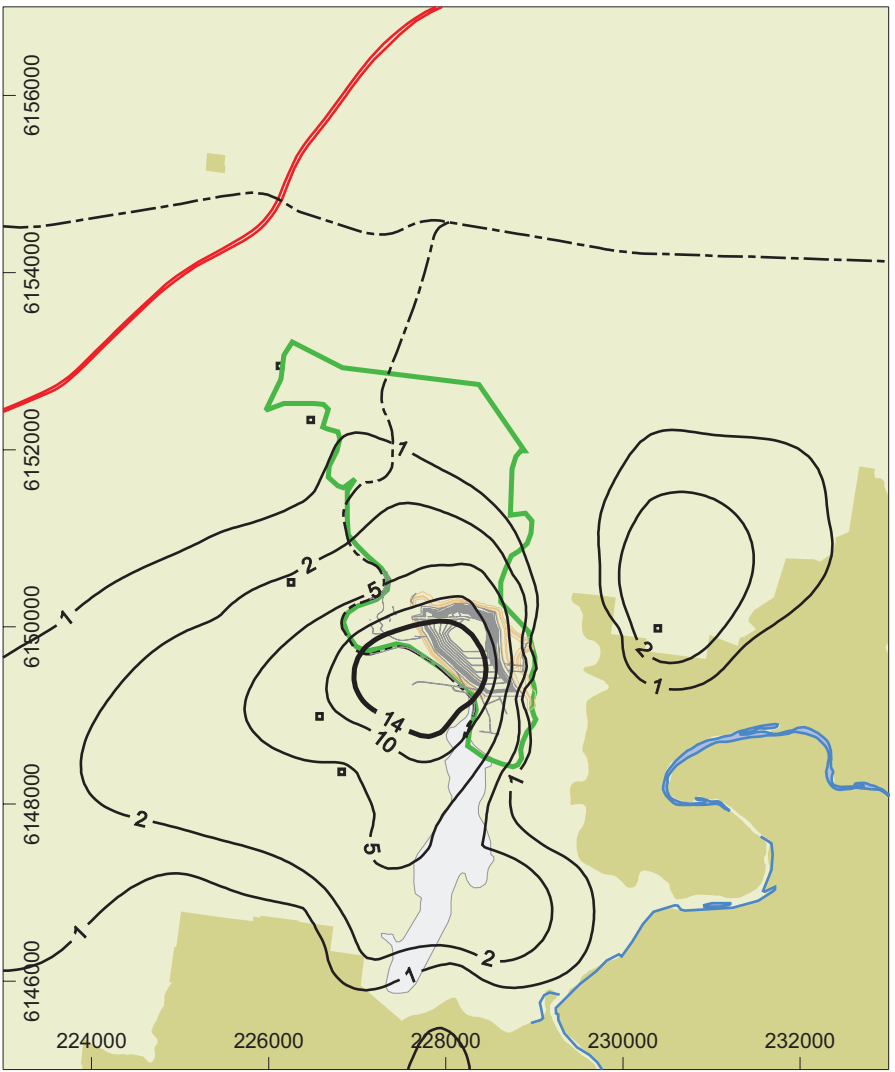
The enhanced contour lines represent the relevant air quality criteria, including the addition of background levels where relevant.

Source: Holmes Air Sciences

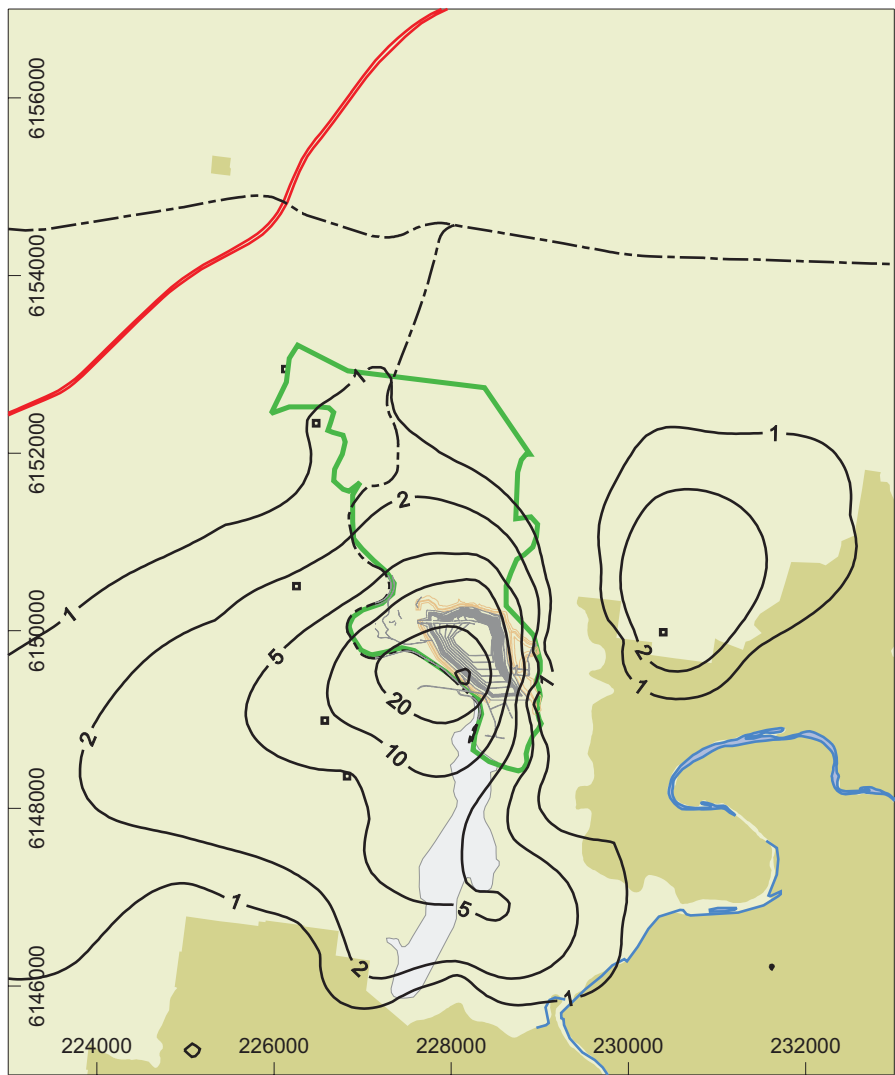




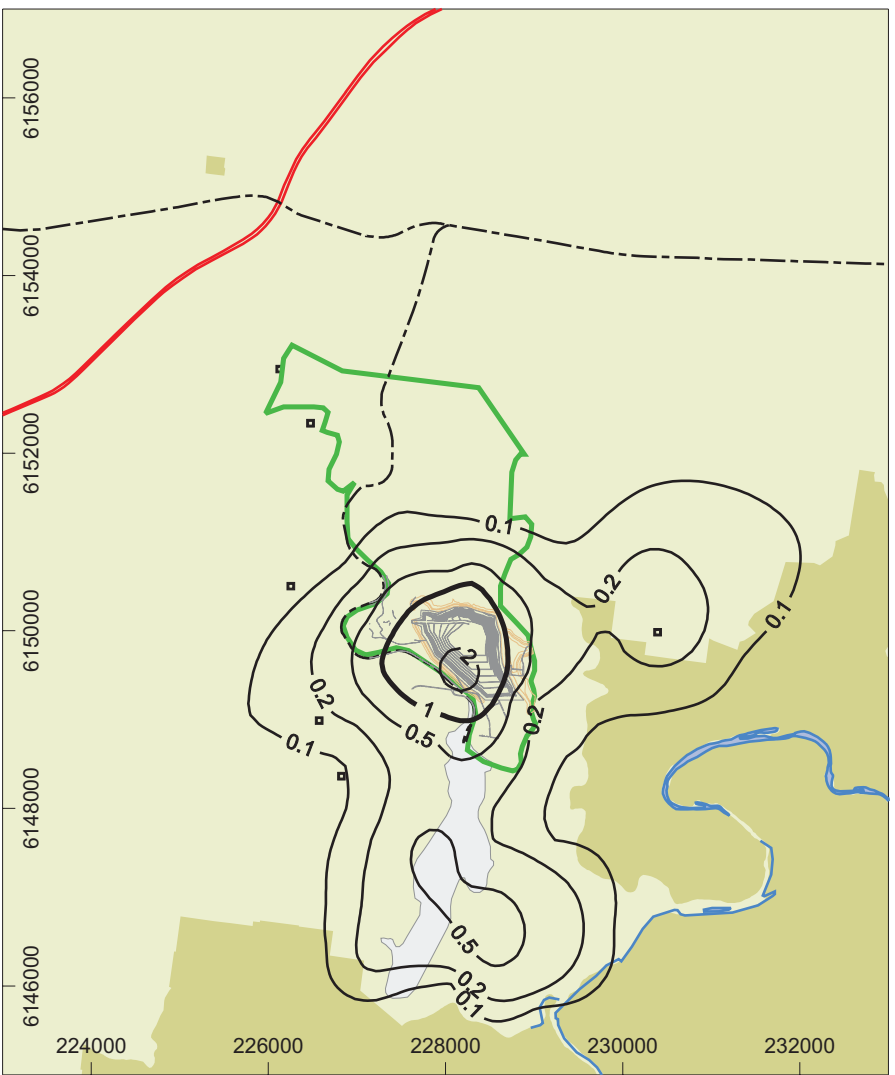
Maximum 24-hour average PM₁₀ (µg/m³)



Annual average PM₁₀ (µg/m³)



Annual average TSP (µg/m³)



Annual average dust deposition (g/m²/month)

The enhanced contour lines represent the relevant air quality criteria, including the addition of background levels where relevant.

Source: Holmes Air Sciences



Figure 11.3 Dispersion Model Results for Quarry Operations at 3.5 Mtpa
Marulan South Quarry

These dispersion model predictions for the each stage of the quarry operations are summarised in *Table 11.4* for the nearest residences. Cumulative effects are represented by the addition of the background monitoring data which represents all existing sources, including the BCSC operations to some extent. However, explicit modelling of the project with BCSC operations has also been carried out to capture the highest potential cumulative impacts due to the BCSC operations at the residences closest to the quarry.

Table 11.4 *Model Predictions at Residential Properties*

ID	Easting (m)	Northing (m)	Due to Project only		Due to Project and other sources*	
			Year 1	3.5 Mtpa	Year 1	3.5 Mtpa
Maximum 24-hour average PM ₁₀ concentrations (µg/m³)						
Goal = 50 µg/m³ due to Project only						
1	230394	6149983	21.6	22.0	-	-
2	226824	6148362	14.2	25.6	-	-
3	226574	6148989	28.9	41.3	-	-
4	226253	6150502	12.6	16.8	-	-
5	226475	6152336	6.0	7.0	-	-
6	226127	6152946	4.5	5.3	-	-
Annual average PM ₁₀ concentrations (µg/m³)						
Goal = 30 µg/m³ due to Project and other sources						
1	230394	6149983	3.4	4.0	19.4	20.0
2	226824	6148362	2.6	4.4	18.6	20.4
3	226574	6148989	5.9	8.7	21.9	24.7
4	226253	6150502	1.7	2.2	17.7	18.2
5	226475	6152336	0.7	1.0	16.7	17.0
6	226127	6152946	0.5	0.7	16.5	16.7
Annual average TSP concentrations (µg/m³)						
Goal = 90 µg/m³ due to Project and other sources						
1	230394	6149983	3.7	4.3	28.7	29.3
2	226824	6148362	2.7	4.7	27.7	29.7
3	226574	6148989	6.1	9.1	31.1	34.1
4	226253	6150502	1.8	2.4	26.8	27.4
5	226475	6152336	0.7	1.1	25.7	26.1
6	226127	6152946	0.5	0.8	25.5	25.8
Annual average dust deposition (µg/m²/month)						
Goal = 2 g/m²/month due to Project only and 4 g/m²/month due to Project and other sources						
1	230394	6149983	0.31	0.31	3.31	3.31
2	226824	6148362	0.03	0.10	3.03	3.10
3	226574	6148989	0.10	0.16	3.10	3.16
4	226253	6150502	0.05	0.08	3.05	3.08
5	226475	6152336	0.02	0.03	3.02	3.03
6	226127	6152946	0.01	0.02	3.01	3.02

* where other sources are represented by the air quality monitoring data

* where other sources are represented by the air quality monitoring data

11.5.2 *Impact Identification*

The model predictions were compared with the air quality goals, resulting in the following conclusions:

- maximum 24-hour average PM₁₀ concentrations due to Year 1 and maximum operations are below the 50 µg/m³ goal at all selected residences;
- annual average PM₁₀ concentrations due to Year 1 and maximum operations are below the 30 µg/m³ goal at all residences, including the addition of background levels;
- annual average TSP concentrations due to Year 1 and maximum operations are below the 90 µg/m³ goal at all residences, including the addition of background levels; and
- dust deposition levels due to Year 1 and maximum operations are below the 2 g/m²/month criteria at all residences. Model predictions at the nearest residences are also below the 4 g/m²/month goal when an existing background dust deposition level of 3 g/m²/month is added.

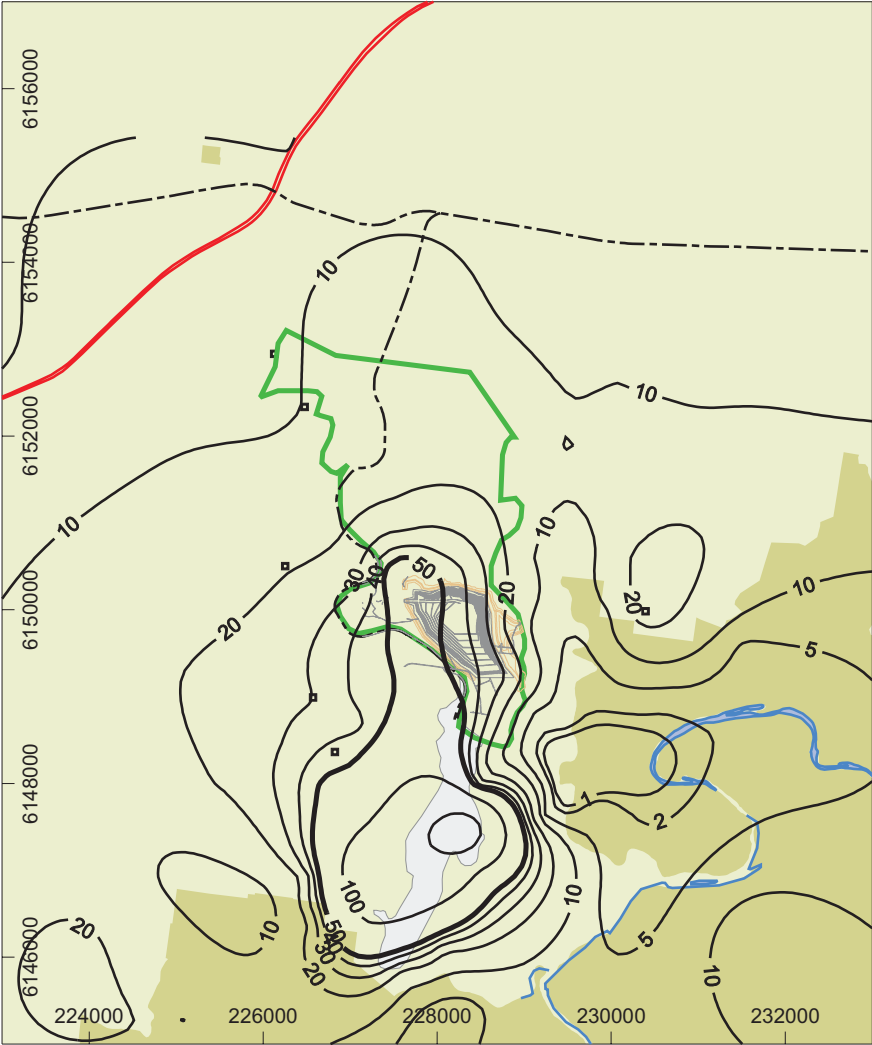
Concentrations and deposition levels are generally predicted to be highest at east and west of the site, consistent with the prevailing wind patterns. For maximum operations, the assumption that all overburden will be transported to the BCSC mine is evident by the extension of contours in this direction.

11.5.3 *Cumulative Emissions*

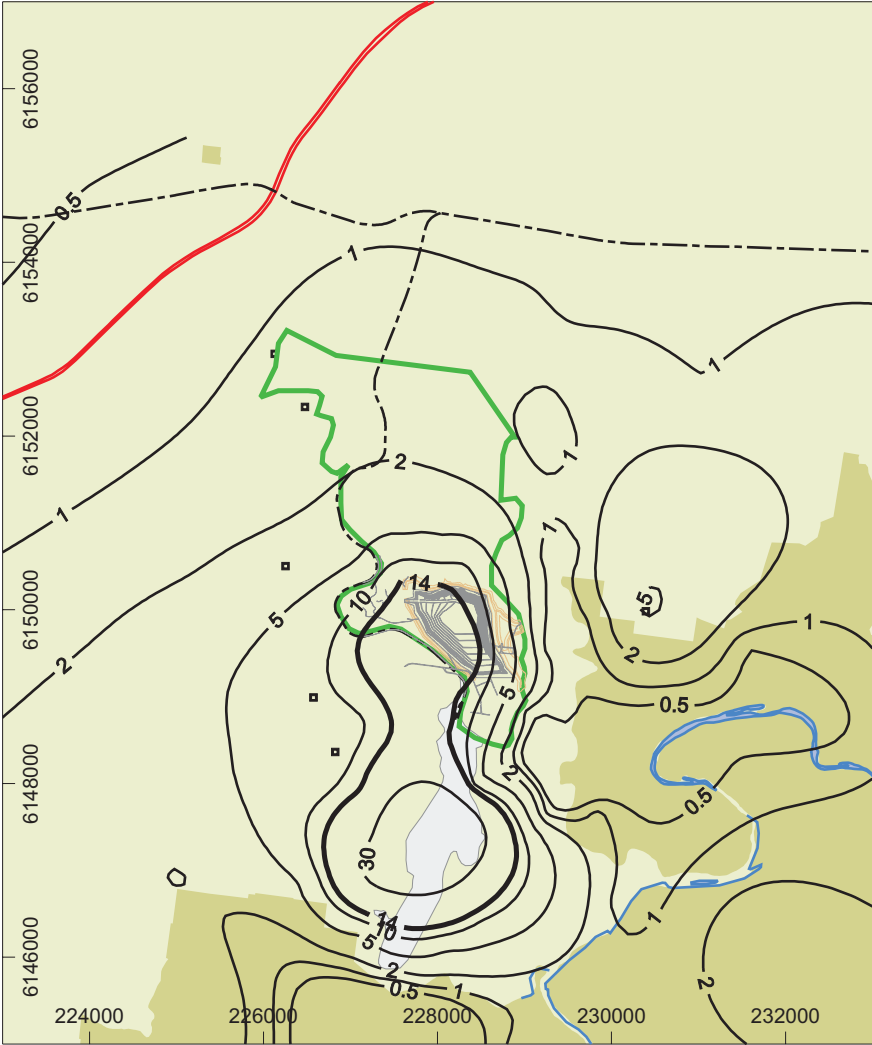
Continued operation of the BCSC limestone mine and ongoing agricultural and industrial activities will contribute to PM₁₀, TSP concentrations and to dust deposition in the local area. Monitoring carried out for this project will have captured some of these effects, however, there is a potential for the combined effects of the BCSC operations to be higher in areas closer to the BCSC site; namely near residences 2 and 3. The potential for cumulative impacts to be higher than those presented for the quarry emissions alone was assessed by the cumulative affects of the proposed quarry with the existing BCSC operation plus background monitoring data. Due to background monitoring data containing some contribution from the BCSC operations, this approach will result in an overestimate of an unknown extent.

Dust emissions from BCSC operations were approximated at 4 mtpa of product per year, resulting in TSP dust emission equal to that of the proposed quarry, i.e. of 0.31 kg of TSP per tonne of product.

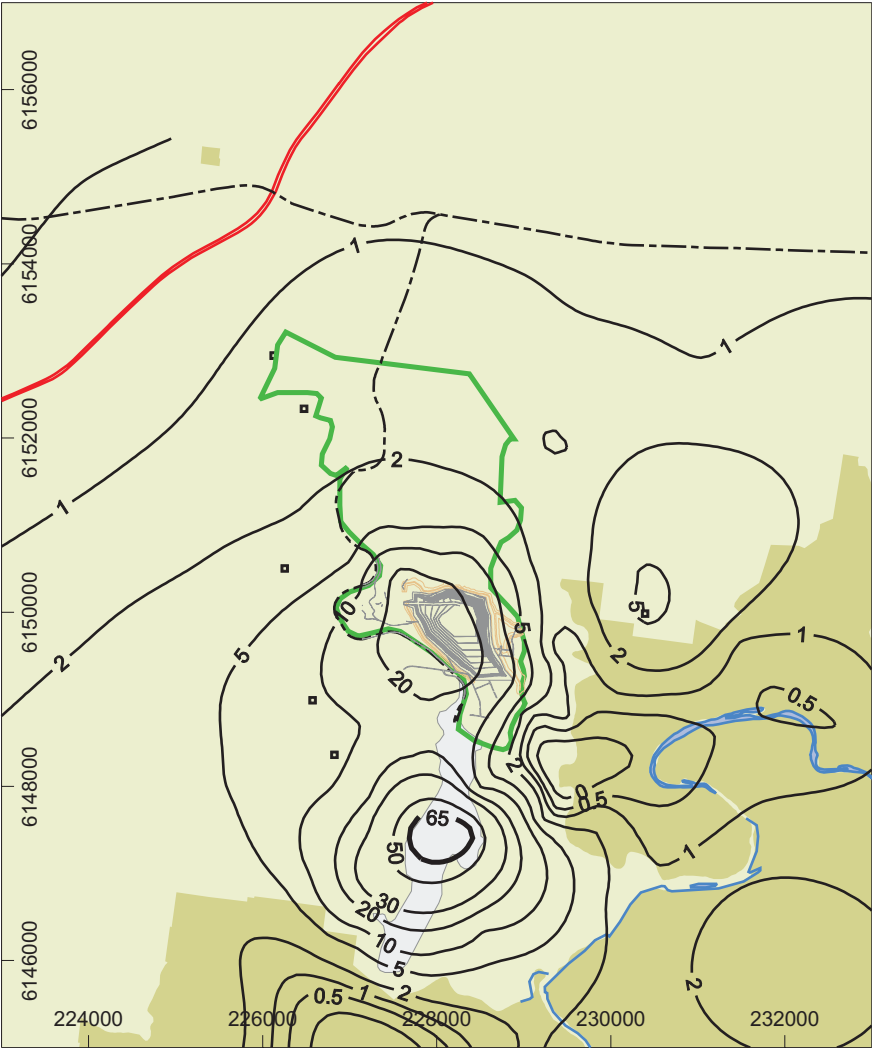
Model results for the cumulative impact assessment are presented both as contour plots (*Figures 11.4 and 11.5*) and in tabular form (*Table 11.5*) for each residence.



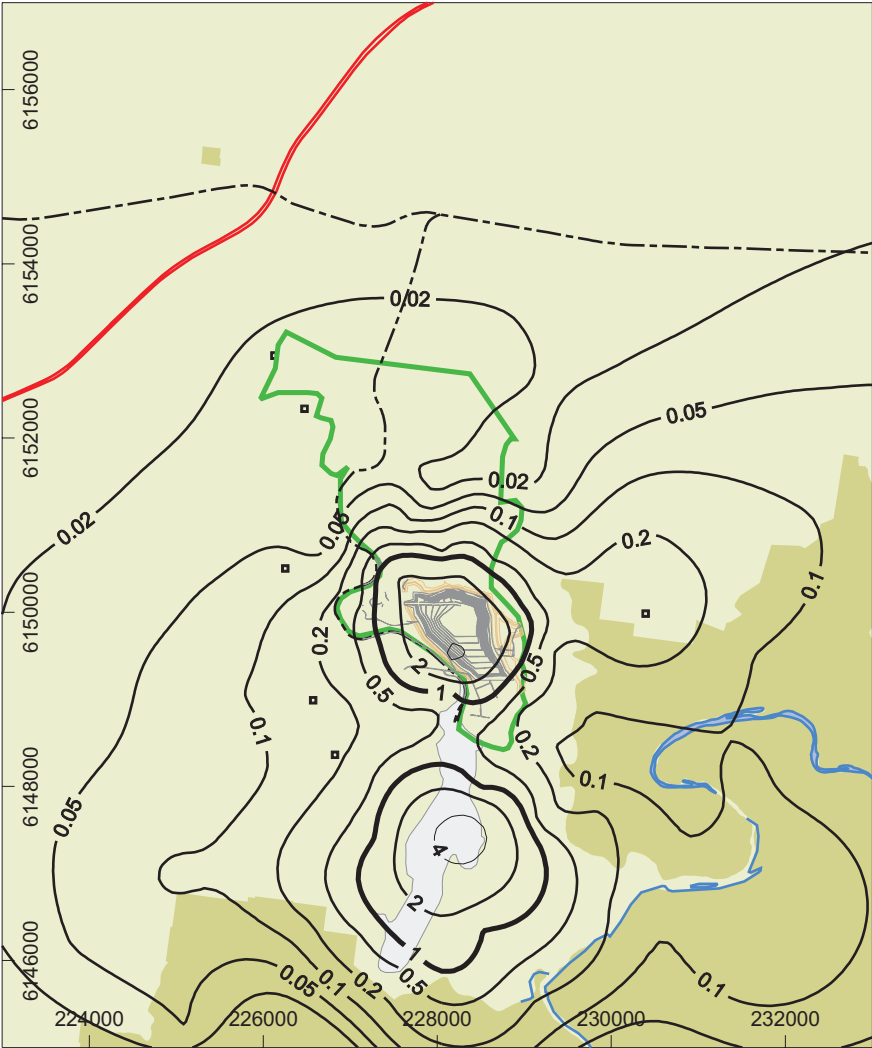
Maximum 24-hour average PM₁₀ (µg/m³)



Annual average PM₁₀ (µg/m³)



Annual average TSP (µg/m³)



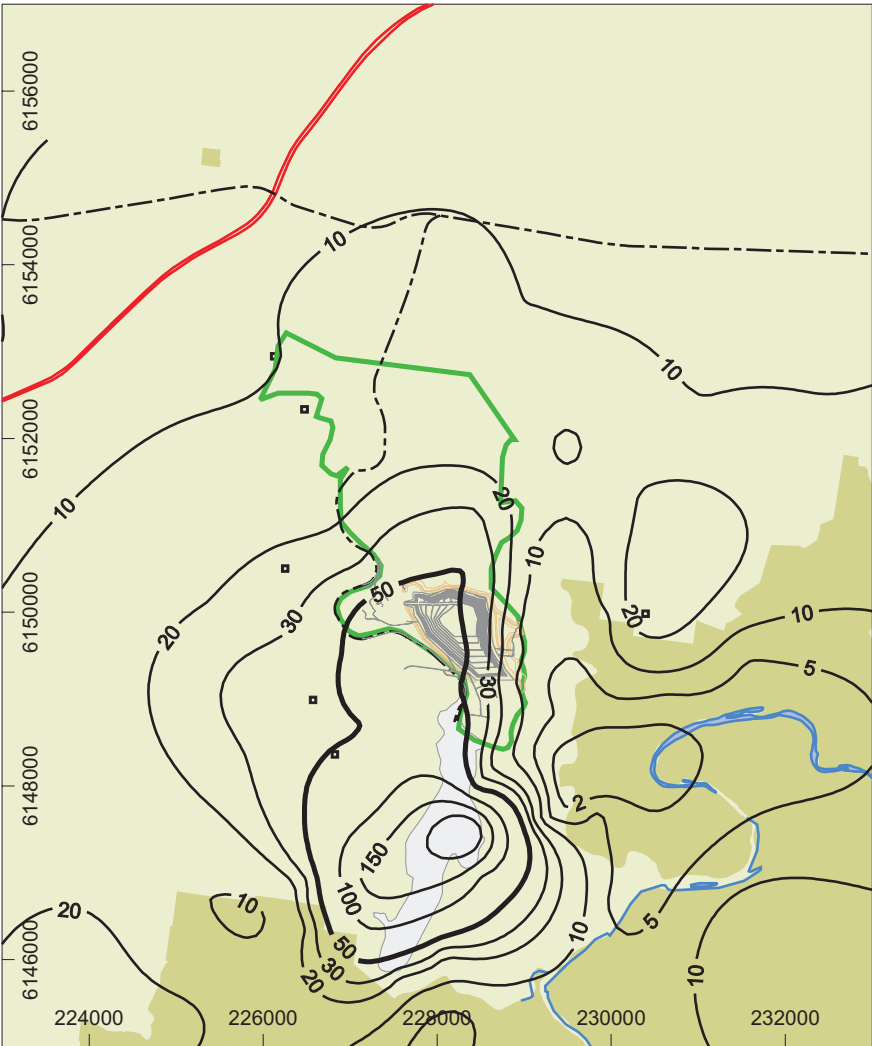
Annual average dust deposition (g/m²/month)

The enhanced contour lines represent the relevant air quality criteria, including the addition of background levels where relevant.

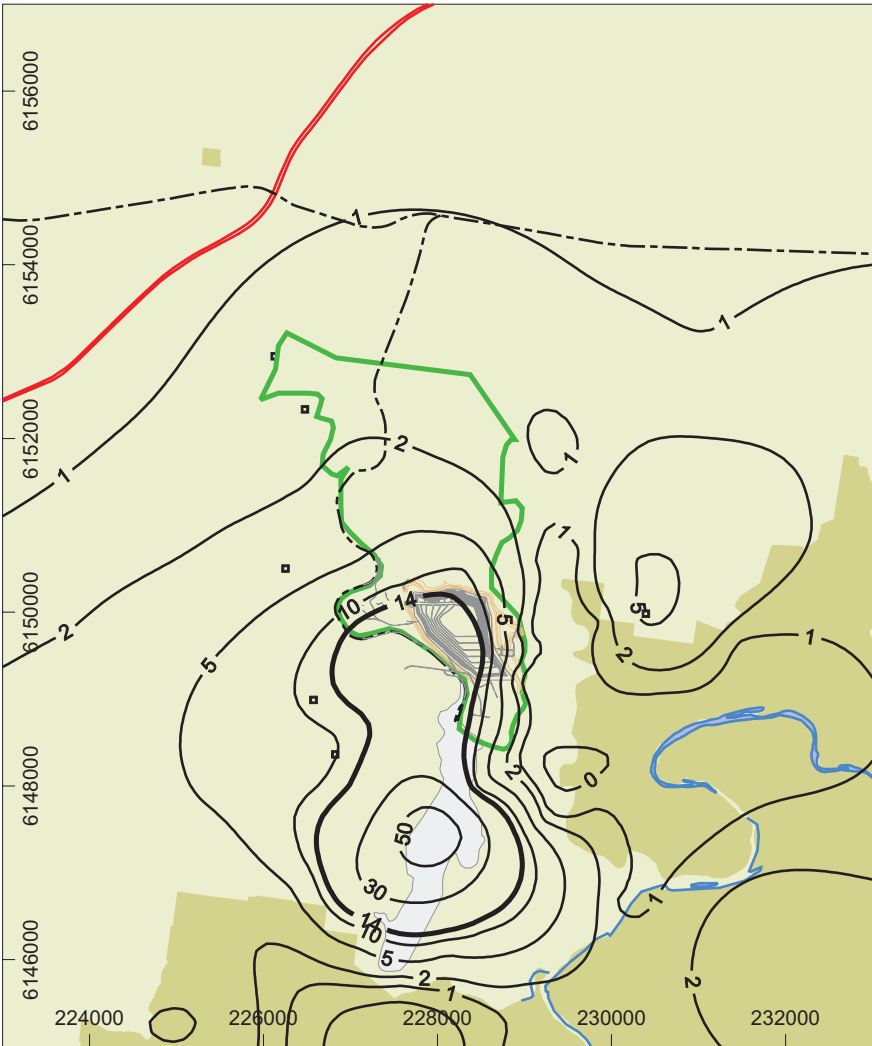
Source: Holmes Air Sciences



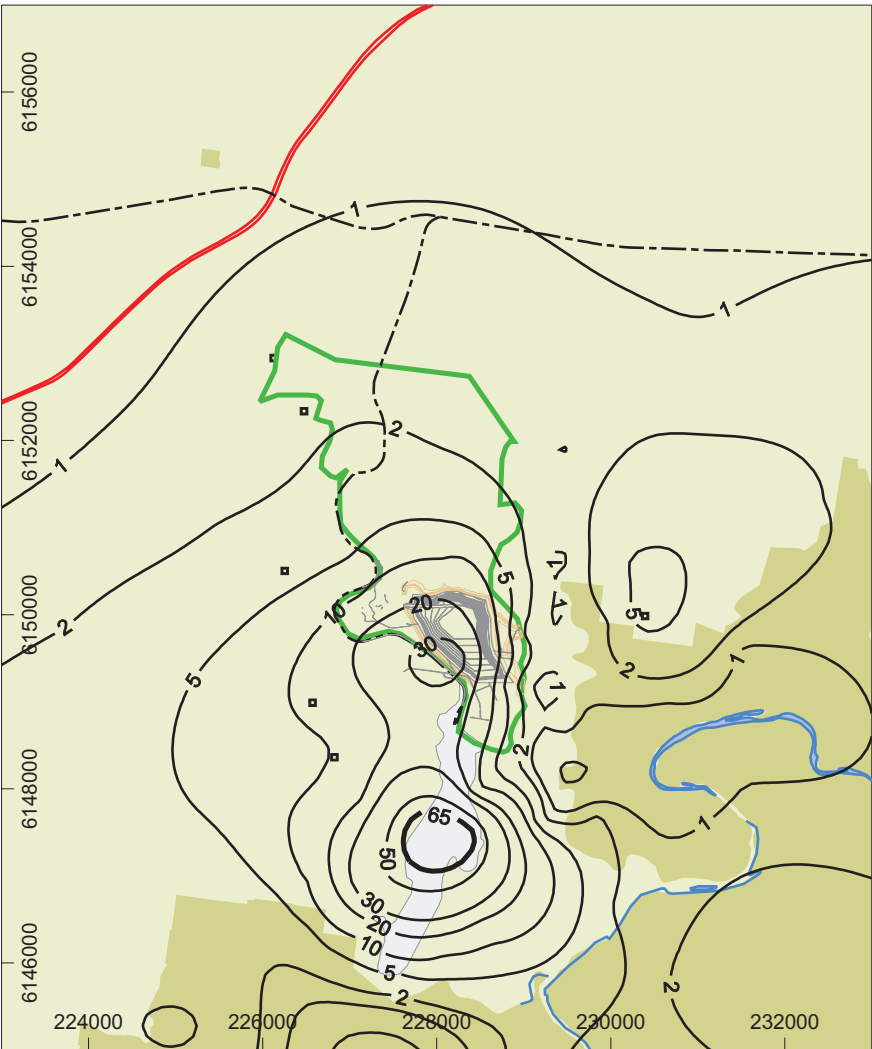
Figure 11.4 Dispersion Model Results for Year 1 Quarry Operations Including BCSC Operations at 4 Mtpa
Marulan South Quarry



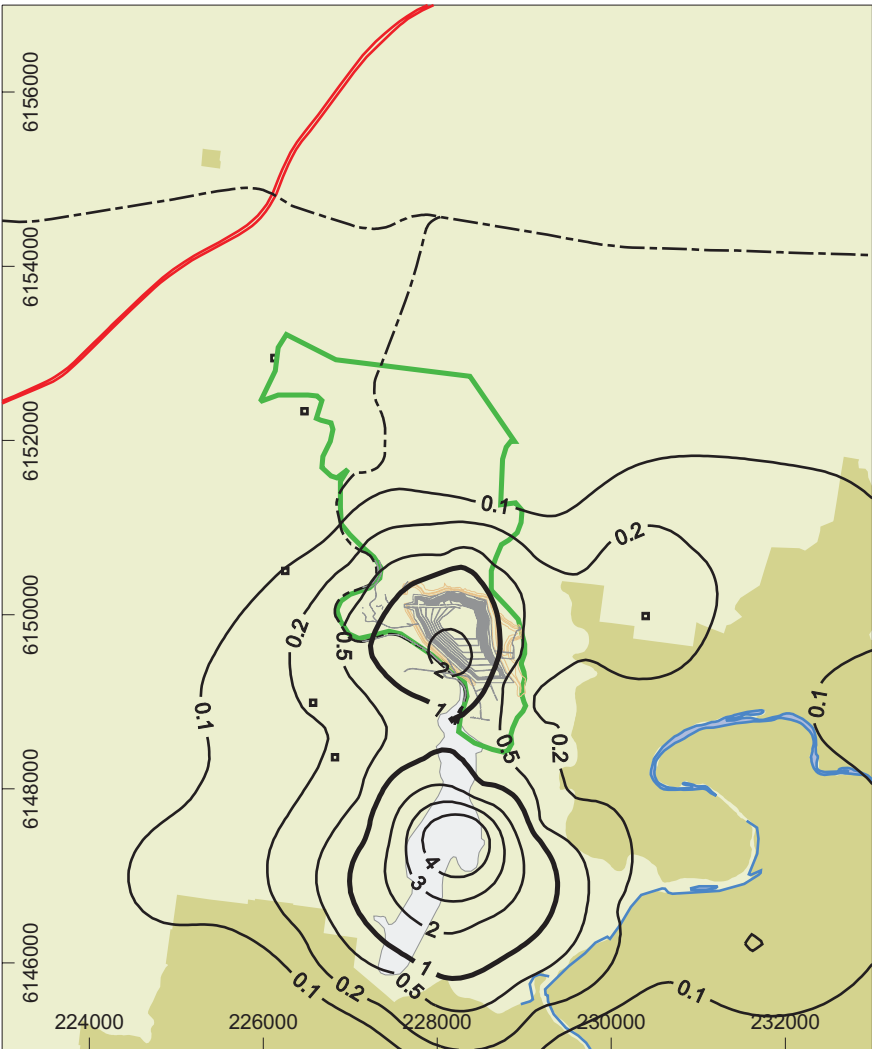
Maximum 24-hour average PM₁₀ (µg/m³)



Annual average PM₁₀ (µg/m³)



Annual average TSP (µg/m³)



Annual average dust deposition (g/m²/month)

The enhanced contour lines represent the relevant air quality criteria, including the addition of background levels where relevant.

Source: Holmes Air Sciences



Figure 11.5 Dispersion Model Results for Quarry Operations at 3.5 Mtpa Including BCSC Operation at 4 Mtpa
Marulan South Quarry

Table 11.5 Predictions at Residential Properties Including Modelled Effects of BCSC

ID	Easting (m)	Northing (m)	Due to Project and BCSC sources		Due to Project, BCSC and other sources*	
			Year 1	3.5 Mtpa	Year 1	3.5 Mtpa
Maximum 24-hour average PM ₁₀ concentrations (µg/m³)						
Goal = 50 µg/m³ due to Project only						
1	230394	6149983	26.2	29.7	-	-
2	226824	6148362	44.3	52.3	-	-
3	226574	6148989	29.6	41.3	-	-
4	226253	6150502	19.3	23.8	-	-
5	226475	6152336	10.1	11.8	-	-
6	226127	6152946	8.3	9.5	-	-
Annual average PM ₁₀ concentrations (µg/m³)						
Goal = 30 µg/m³ due to Project and other sources						
1	230394	6149983	5.5	6.1	21.5	22.1
2	226824	6148362	7.8	9.7	23.8	25.7
3	226574	6148989	8.7	11.6	24.7	27.6
4	226253	6150502	3.0	3.5	19.0	19.5
5	226475	6152336	1.4	1.7	17.4	17.7
6	226127	6152946	1.1	1.3	17.1	17.3
Annual average TSP concentrations (µg/m³)						
Goal = 90 µg/m³ due to Project and other sources						
1	230394	6149983	5.9	6.5	30.9	31.5
2	226824	6148362	8.3	10.3	33.3	35.3
3	226574	6148989	9.1	12.1	34.1	37.1
4	226253	6150502	3.2	3.8	28.2	28.8
5	226475	6152336	1.5	1.8	26.5	26.8
6	226127	6152946	1.2	1.4	26.2	26.4
Annual average dust deposition (µg/m²/month)						
Goal = 2 g/m²/month due to Project only and 4 g/m²/month due to Project and other sources						
1	230394	6149983	0.36	0.36	3.36	3.36
2	226824	6148362	0.17	0.24	3.17	3.24
3	226574	6148989	0.16	0.23	3.16	3.23
4	226253	6150502	0.08	0.10	3.08	3.10
5	226475	6152336	0.03	0.05	3.03	3.05
6	226127	6152946	0.02	0.03	3.02	3.03

* where other sources are represented by the air quality monitoring data

* where other sources are represented by the air quality monitoring data

Results show that annual average PM₁₀ and TSP concentrations and annual average dust deposition would be below relevant air quality criteria at the nearest residences due to the combined effects of the quarry, the BCSC mine and other local sources of dust.

This assessment does highlight the potential for the 24-hour average PM₁₀ goal to be slightly exceeded at residence 2 (52 µg/m³ where the criterion is 50 µg/m³). This result is based on the conservative model calibration and is likely to indicate the maximum tolerable dust production rates at the quarry. At maximum production, the quarry will need to operate at a level to ensure that air quality criteria are not exceeded at the nearest residences as demonstrated through the implementation of mitigation measures and monitoring program described below.

The operational scenarios chosen for this assessment were selected to capture the maximum extents of air quality impacts due to the proposed operations. This was to allow some flexibility in quarry operations within the determined limits of the worst-case scenario.

The following range of dust control measures have been adopted for the project and will ensure that a high level of dust control is maintained at the quarry. Dust control measures taken into account in the modelling of dust emission estimates include enclosing the crushing, screening and transfer points, and using water sprays as required on haul roads and exposed areas.

Engineering Controls

- covering of conveyors;
- enclosing of crushing and screening plant with dust extraction system fitted;
- fitting of scraper for cleaning conveyor belts;
- dust suppression sprays on the primary crusher;
- fitting drills with either water sprays or dry dust collection devices; and
- controlling stockpiles of fine material with water sprays etc.

Operational controls

Operational controls are used to vary operations when adverse meteorological conditions occur. These include:

- Traffic confined to identified haul road routes;
- removal and rehabilitation of unnecessary roads;
- exposed areas kept to a minimum;
- watering of haul roads;
- cleaning of areas which could become sources of wind erosion dust due to build-up of settled fine material;
- reviewing meteorological conditions prior to blasting to minimise the exposure of residences to dust emissions; and
- daily assessment of meteorological conditions to identify wind conditions that may be conducive to excessive dust generation – for example, very high winds.

Planning Controls

Planning controls are generally implemented prior to the commencement of a project. Planning controls for the Marulan South Quarry include the purchase of land to act as buffer zones between dust sources and sensitive receptors.

11.7 MONITORING

The dispersion model predictions indicated that some increases to off-site dust concentration and dust deposition levels would be detectable due to operation of the quarry. Changes to air quality beyond the boundary of the site and at residential locations that may arise from the operation of the quarry will be monitored through a comprehensive air quality monitoring program once the quarry commences operation.

A suitable air quality monitoring program may consist of the following:

- Short term dust concentration monitoring using a high volume air sampler (or similar) located at or near the closest residential receptor;
- three or four dust deposition gauges located around the boundary of the quarry; and
- additional dust deposition gauges at or near the closest residential receptors, perhaps at the same locations as the high volume air samplers.

11.8 CONCLUSION

Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to emissions from the quarry. Two operational scenarios were selected to capture the maximum extents of air quality impacts due to the proposed operations.

The dispersion modelling was based on conservative assumptions about the way in which the quarry will operate and therefore results are conservative. These results suggested that annual average dust concentrations and deposition levels would be below relevant air quality criteria at the nearest residential properties. Short-term (24-hour average) air quality impacts due to the quarry alone are predicted to be within the air quality criteria and appropriate management practices would ensure that this is the case.

There is some potential for minor adverse short-term air quality impacts to be observed at residence 2 due to the combined effects of the quarry at 3.5 mtpa with the adjacent BCSC limestone mine at 4 mtpa. However, the model prediction was very close to the air quality goal and given the conservative nature of the dust emission estimates, adverse air quality impacts at the nearest residential locations would not be expected.

12.1 INTRODUCTION

This chapter examines potential impacts associated with the construction and operation upon the local and regional transport networks. The assessment is based upon a technical study completed by Christopher Stapleton Consulting Pty Ltd which assessed access and transport issues to the Marulan South Quarry site based upon transporting up 750,000 tonnes per annum (tpa) of quarry product by road.

Road haulage has been identified as a key issue within the local community and siting the quarry on an existing rail spur was a critical consideration in the selection of the proposed site. To recognise community concerns and minimise potential impacts upon the local road network, Boral proposes to transport all quarry product by rail and currently only seeks approval for road usage during construction and for employee and maintenance vehicles during quarry operations.

Delivery of sand from Penrose Quarry and potentially other sources for blending with fines is expected to occur through the back-loading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period of time.

The technical assessment completed by Christopher Stapleton Consulting Pty Ltd included analysis of haulage of a considerable proportion of quarry product by road and is therefore not directly applicable to the current proposal and has not been included in the EA. This chapter is based upon information from the study related to the existing use and capacity of the road network and potential impacts associated with construction, operational, maintenance and delivery vehicles.

12.2 EXISTING TRANSPORT NETWORK

12.2.1 Local Road Network

Road access to the Marulan South Quarry site is available via Marulan South Road, which extends from an intersection with the Hume Highway and services the existing limestone mine and a number of rural properties including poultry farms and lime processing industries.

The Hume Highway at Marulan is a separated dual carriageway and forms the major north-south transport corridor between Sydney and Canberra and subsequently Melbourne. Marulan South Road runs to the east from the Hume Highway for approximately 8.5 km to the former village of Marulan South and the existing BCSC Limestone mine.

The intersection of the Hume Highway and Marulan South Road is an at-grade junction with a protected “seagull like” junction design. The intersection provides acceleration and deceleration lanes of approximately 150 metres and provides excellent sight distance in each direction. An intersection of Marulan South Road with Jerrara Road which extends towards Bungonia, is located immediately adjacent to the Hume Highway intersection.

Marulan South Road is an existing B-Double approved access route which currently operates at a high level of service. The road has been previously assessed by the RTA and Mulwaree Shire Council in 1998 in regards to its suitability to accommodate restricted access vehicles including B-Doubles.

The RTA assessment was completed in accordance with the RTA’s *Route Assessment Guidelines for Restricted Access Vehicles (RAGRAV)* and confirmed that the route was of a standard to accommodate daily traffic flows of up to 2,000 vehicles per day (vpd) which included the following requirements:

- minimum lane widths of 3.0m;
- minimum additional shoulder widths of 1.0m; and
- gradients and sight distances suitable for these vehicle flows and types (i.e. up to and including restricted access vehicles such as B-Doubles).

While the RTA classification provides restricted access status for Marulan South Road, it has been raised in stakeholder consultation that there are concerns over the quality of Marulan South Road and improvements could be made to increase road safety along some sections of the road. The local road network is illustrated on *Figure 12.1*.

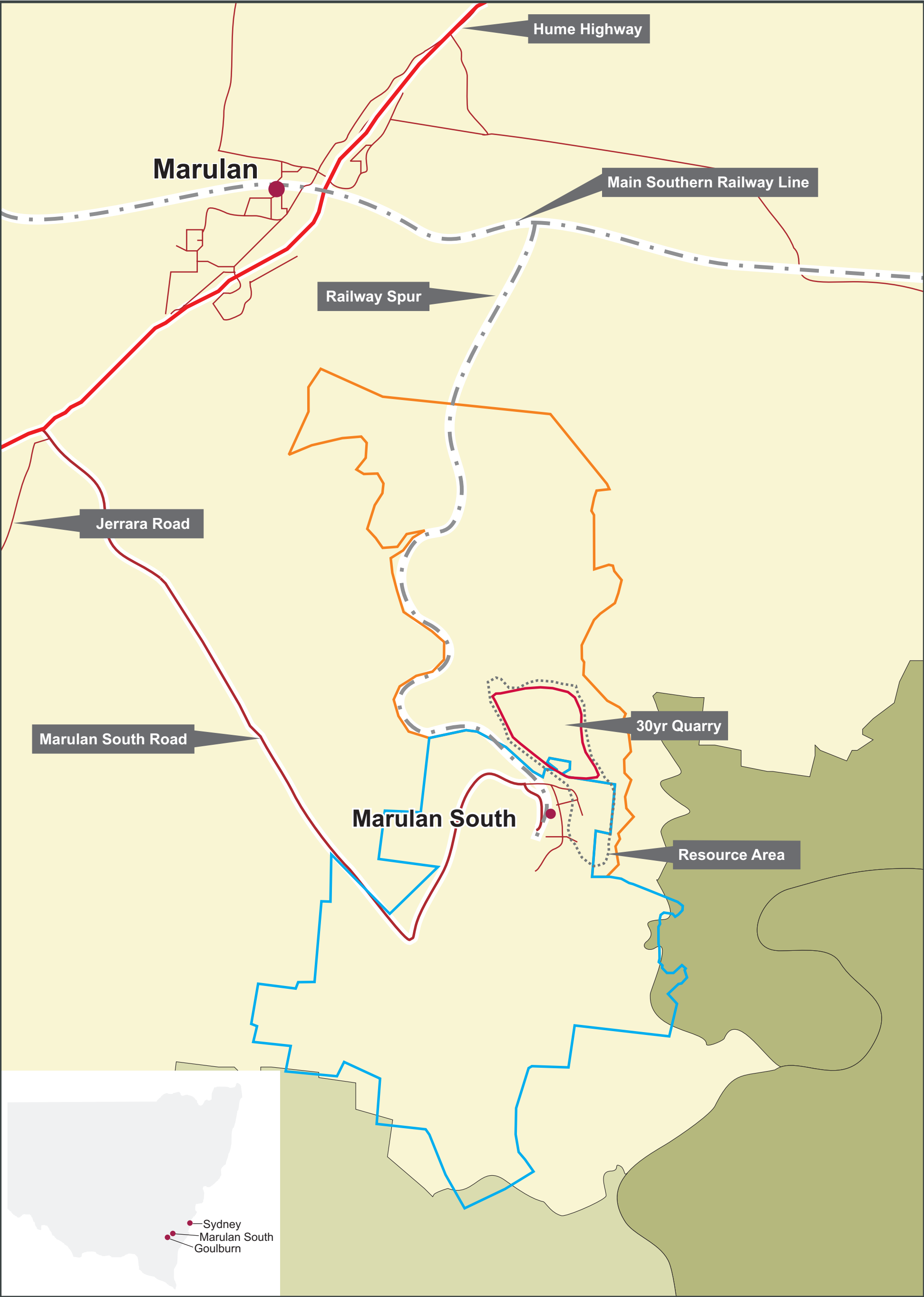
12.2.2 *Existing Vehicle Numbers*

To gain a better understanding of the capacity of the local road network, classified counters and direction surveys were undertaken in the locality and included:

- classified counter in Marulan South Road east of Jerrara Road;
- classified counter in Jerrara Road south of Marulan South Road; and
- direction flow surveys of the Hume Highway & Marulan South Road, and Marulan South Road & Jerrara Road intersections;

The direction flow surveys were completed to identify the general distribution of trips through the 'combined' intersection.

Marulan South Road (east of Jerrara Road) has an average weekday two-way flow of 443vpd, comprising 297 light vehicles (67%); 49 small trucks (11%); 4 medium trucks (1%); and 93 large trucks (21%) including B-Doubles and truck & trailers. A peak hourly flow of 53 vehicles was recorded in Marulan South Road east of Jerrara Road between 6:00am and 7:00am.



Jerrara Road (south of Marulan South Road) has an average weekday two-way flow of 468vpd, comprising 395 light vehicles (84%); 28 small trucks (6%); 7 medium trucks (2%); and 37 large trucks (8%), also including B-Doubles and truck & trailers. A peak hourly flow of 37 vehicles was recorded in Jerrara Road south of Marulan South Road between 3:00pm and 4:00pm.

Additional Annual Average Daily Traffic (AADT) data for the Hume Highway indicates an average daily flow of approximately 18,000vpd at Marulan South Road.

With an existing RTA classification for up to 2000 vpd, Marulan South Road has considerable spare capacity over the existing average of 443 vpd without compromising the operational capacity of the Marulan South Road.

12.2.3 *Intersection Capacity*

While Marulan South Road is expected to be able to accommodate a number of additional vehicle movements without compromising its existing operation, the RTA classification does not provide explicitly for an increase in vehicles flows at the intersection of the Hume Highway and Marulan South Road.

In order to determine the existing performance of the intersection at Marulan South Road and the Hume Highway, peak hour traffic flows were modelled using INTANAL based upon the existing intersection geometry.

INTANAL provides assessment criteria for the evaluation of intersection performance. The key criteria is level of service, which is calculated with reference to average and maximum delays as provided in *Table 12.1*.

Table 12.1 *Intanal Level of Service for Give Way and Stop Signs*

Average Delay (seconds)	Level of Service
0 to 14	A - Good
15 - 28	B - Acceptable delays and spare capacity
29 - 42	C - satisfactory but accident study required
43 - 56	D - near capacity and accident study required
57 - 70	E - At capacity and requires another control mode
> 70	F - Unsatisfactory and requires another control mode
Note: The Level of Service for the relevant control mode is shown based upon average delay in seconds per vehicle	

The results of the INTANAL analysis are presented in *Table 12.2* and indicate that intersection operates at an acceptable Level of Service ("B"), with low average delays and a minor peak delay to the right hand turn movement from Marulan South Road to the Hume Highway (northbound). The intersection is currently operating at only a fraction of available capacity, however it is acknowledged that the acceleration and deceleration lane lengths provided at the intersection do not conform to the strict guidelines of the RTA's Road Design Guidelines.

Table 12.2 *Existing Hume Highway and Marulan South Road Intersection Performance*

	Level of Service	Average Delay	Maximum Delay	Degree of Saturation
AM Peak Hour	B	14	21	< 0.10
PM Peak Hour	B	15	22	< 0.10
Business Peak Hour	B	15	22	< 0.10

There has also been a recent proposal to upgrade the intersection of Marulan South Road and the Hume Highway, primarily to service the proposed Lynwood Quarry west of the intersection which has been recently approved under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Lynwood proposal incorporates the construction of a grade separated intersection incorporating a new approach from the west and also access to Jerrara Road. The new intersection will need to be designed to accommodate the approved vehicle capacity on Marulan South Road of up to 2000vpd.

12.2.4 *Existing Rail Network*

Freight access to the site is available via rail on an existing rail spur which currently services the adjacent BCSC limestone mine. The rail spur connects with the Main Southern Railway at Medway Junction approximately seven kilometres north of the site.

The BCSC currently operates up to five or six trains per day along the rail spur for transport north to Sydney. An average of 30 freight and 16 passenger services per day operate on the Main Southern Railway through Medway Junction including daily train movements from the limestone mine. Rail movements are subject to seasonal variation with additional 5 or 6 rail movements experienced during wheat harvest season en route to Port Kembla. Passenger services and high speed freight services typically receive priority scheduling with individual contracts set up with each user of the line (pers comm ARTC, 11/08/2006).

Advice from the ARTC Ltd indicates that they have reviewed the current and projected future capacity on the main southern corridor and there is adequate capacity to accommodate the rail haulage forecasts of the proposed Marulan South Quarry (refer *Annex B*) .

12.3

CONSTRUCTION PHASE TRAFFIC GENERATION

Marulan South Road will be used by the construction workforce of up to 20 staff expected at the Marulan South Quarry site over a period of approximately 12 months.

Construction vehicles are expected to have minimal impact upon the capacity of Marulan South Road or the existing Marulan South Road and Hume Highway intersection. Assuming a worst case scenario of up to 10 heavy vehicle movements per day for delivery of materials and equipment and 40 individual construction contractor vehicle movements, the construction vehicles would constitute less than 12% of the average daily traffic flows. Total traffic flows would remain less than 25% of the total approved vehicle movements for Marulan South Road and construction vehicle movements would be difficult to distinguish from average daily variation.

The additional vehicle movements are expected to have minimal impact upon the operation of the existing intersection at Marulan South Road and the Hume Highway. Additional traffic flows were modelled using INTANAL and found minimal change in the level of service for the existing intersection.

The timing of construction at the proposed Marulan South Quarry has the potential to coincide with construction for the proposed grade separated intersection to service the Lynwood Quarry proposal. During the interchange construction phase, access to the local road network including Marulan South Road and Jerrara Road will need to be maintained. The small number of additional construction vehicles for the Marulan South Quarry will utilise the temporary arrangements as required.

12.4 OPERATIONAL TRAFFIC GENERATION

12.4.1 Road Haulage

Boral proposes to transport all quarry product by rail and currently only seeks approval for road usage for employee, maintenance and delivery vehicles during quarry operations.

Delivery of sand from Penrose for blending with quarry products is expected to occur through the back-loading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period of time.

The Marulan South Quarry will employ up to 30 staff with two to three shifts per day. A shuttle bus currently operates between Goulburn and the BCSC limestone mine to accommodate a number of staff movements. Conservatively assuming that all staff drove independently to the quarry site, an increase of approximately 12% would be expected over existing traffic flows along Marulan South Road. The majority of movements would consist of passenger vehicles and not impact upon the safety or capacity of the road network.

Additional heavy vehicles would be restricted to maintenance and delivery vehicles, which could be expected to result in up to ten vehicle movements per week for the life of the quarry operations. Heavy vehicles for the operation of the site are expected to be easily accommodated within the existing road network.

12.4.2 Rail Haulage

All extracted material from Marulan South Quarry is currently proposed to be transported by rail. A rail siding will be built to facilitate rail loading from Marulan South Quarry with minimal interruption to BCSC operations. The rail siding will be constructed approximately parallel and at grade to the existing rail spur, minimising the need for major civil construction and earthworks.

Trains will traverse the BCSC's spur line to the Medway Junction and onto the Main Southern Railway for transportation to Boral's Sydney rail terminals at Enfield and St Peters and perhaps other terminals. Boral and BCSC have a number of existing rail terminals serving the Sydney metropolitan market including Enfield, St Peters, Clyde and Maldon. It also has a number of other sites that are being investigated and separate applications to increase the capacity of the rail depots will be made within the next 12 months.

At peak production there will be up to four trains servicing Marulan South quarry making a daily trip between the quarry and typically the Sydney market. Each train has capacity to transport up to around 1,000,000 tpa which at full production would equate to around 3 or 4 rail trips per day. Train loading and trips will be carried out during a 24 hour day period to enable trips to be scheduled away from peak commuter times on the Main Southern Railway.

Advice from ARTC indicates that there is sufficient capacity on the main southern line to accommodate the additional rail movements. A conservative assumption of up to eight train movements per day on the Main Southern Line would result in an increase of approximately 17% over existing train movements. A cumulative noise assessments associated with the additional rail movements is included in *Chapter 10*.

12.5 *MITIGATION MEASURES*

The following safeguards will be implemented to minimise the extent of impacts associated with traffic and access requirements in the surrounding area:

- a traffic management plan (TMP) will be prepared for the construction period of the project;
- vehicle movements will be restricted to the minimum necessary to complete the works;
- materials and equipment will be delivered during standard working hours;
- construction vehicles will be required to stay on formed roads or designated laydown areas;
- vehicle / plant movements will be confined to areas previously cleared of vegetation; and
- materials and equipment will be stored securely on site to minimise the required vehicle movements.

12.6 *CONCLUSIONS*

Boral proposes to transport all quarry product by rail and currently only seeks approval for road usage during construction and for employee, maintenance and delivery vehicles during quarry operations. The site is serviced by Marulan South Road, which is a dedicated restricted access haulage route which is considered to have ample capacity to accommodate the small number of additional movements associated with the proposal.

Delivery of sand from Penrose for blending with quarry products is expected to occur through the back-loading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period of time.

All extracted material from Marulan South quarry is currently proposed to be transported by rail via the existing private rail spur and the main southern line. An average of three or four train loads per day will be transported from the site at full production, resulting in a small incremental increase in rail movements on the Main Southern Line. Advice from ARTC indicates that there is adequate capacity on the railway corridor to accommodate the additional movements.

13.1 INTRODUCTION

A visual assessment of the proposed Marulan South Quarry has been undertaken by Site Image and Virtual Ideas. The complete report is presented in *Annex I* and includes an assessment of the visibility of the proposed quarry from surrounding viewpoints using three-dimensional digital terrain modelling. This chapter is based upon the findings of the visual assessment report and presents a summary of the likely visual impacts associated with the proposal.

The visual assessment used a common assessment methodology based on the determination of likely viewpoints, a photographic recording, and a visual assessment from each of these locations.

The assessment included an analysis of a range of criteria including view type and context in relation to vegetation types and landform, visual absorption capacity, view quality, and the significance of impact. These assessment criteria allowed a definitive determination of the views impact from the proposal, as well as recommendations to limit or minimise visual impacts.

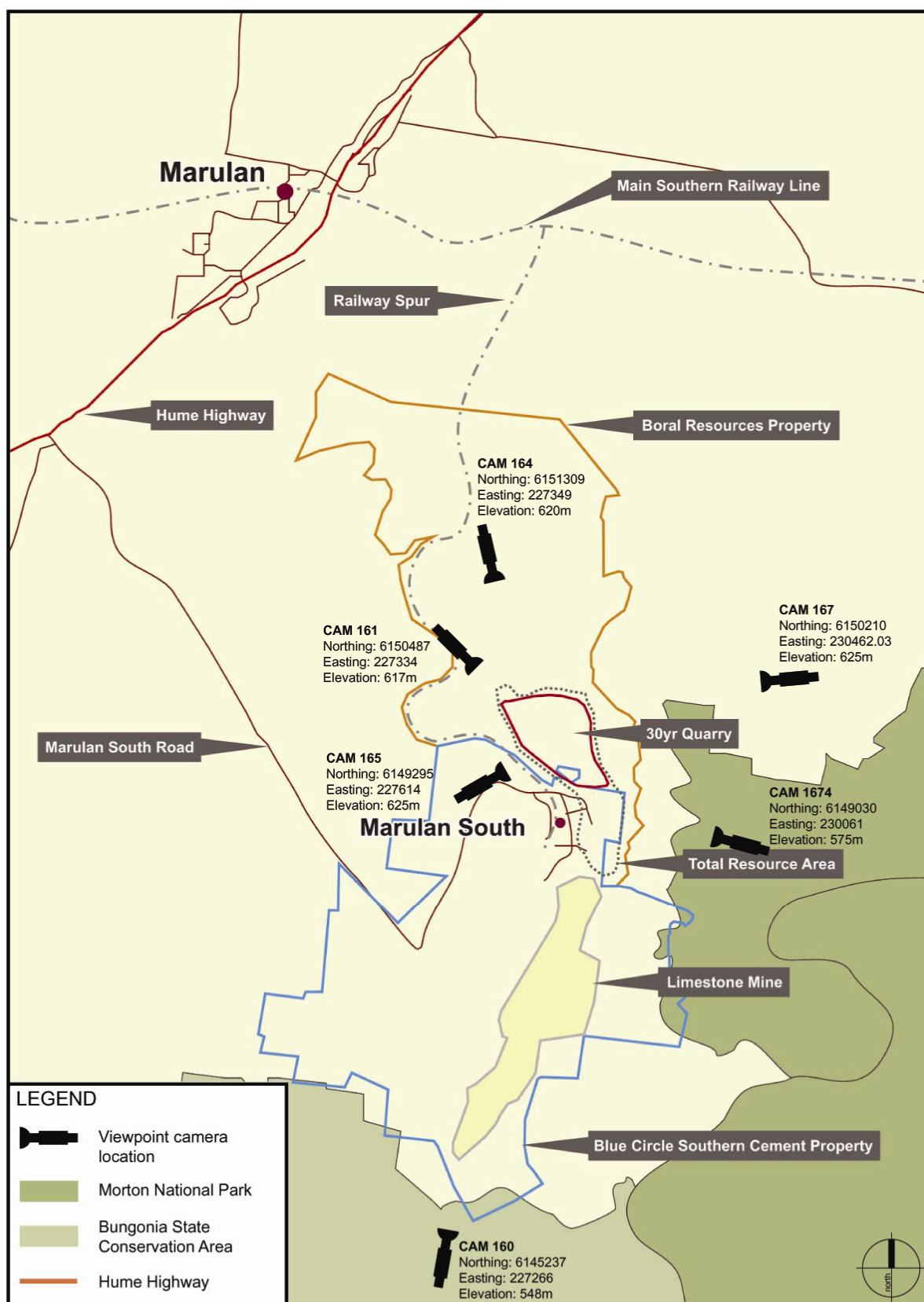
13.2 VISUAL ASSESSMENT CRITERIA

13.2.1 Viewpoint Assessment Locations

Viewpoints for the assessment were selected from the gathering of photographic information from a site visit on the 25th November 2005. Selection of the assessment points took into account the nature of the landscape, topography and view distance, and the potential of being a view point. Through this criterion, six assessment points were chosen due to the potential visibility. All of the chosen assessment points are where views into the project site might occur from an access road, surrounding properties or designated lookout in Morton National Park or Bungonia State Conservation Area.

The selected viewpoints generally represent the worst case scenarios in terms of visibility of potential impacts associated with the proposal. The small number of private residences on Marulan South Road are not expected to have views to the proposed quarry. Viewpoints were chosen on the edge of the rail spur, Marulan South Road and on the Boral property to represent the maximum extent of visibility associated with the proposal. Natural terrain will limit any potential visibility with increased distance from the quarry. *Figure 13.1* shows the proposed quarry with the view assessment point locations.

Figure 13.1 Proposed Quarry with View Assessment Point Locations



Viewpoint 1 was selected from Bungonia Lookdown located to the south of the site (refer Camera 160) as the area receives a high number of visitors for tourist and recreational pursuits. The existing BCSC Limestone mine is highly visible and dominates the view from the scenic lookout. The steep Bungonia and Barbers Creek gorges can be seen from the lookout with natural bushland extending into Morton National Park and Bungonia State Conservation Area.

Viewpoint 2 (refer Camera 1674) was selected from the spurline along the Long Point walking trail to the east of the site. The main scenic lookout at Long Point has an easterly aspect, with views in the direction away from the site, towards the Shoalhaven River. A spurline with a rough walking trail extends to the south from the lookout and picnic area for approximately 500 m prior to descending down into the Bungonia Creek Gorge. The proposed quarry was expected to be visible from this spurline and therefore was included as a viewpoint. Badgerys Lookout is located approximately a further 3.5 km east and will be shielded from views of the quarry by the Long Point spur.

Viewpoint 3 (refer Camera 167) is taken from the closest residential location on Long Point Road (Receiver Location No 1) which currently has views across Barbers Creek Gorge towards the proposed quarry site. The property has scenic views dominated by a rural setting with cleared grazing land in the foreground and bushland within the surrounding Morton National Park. Due to the existing rural and bushland setting the owners are likely to be sensitive to any visual change.

Viewpoint 4 (refer Camera 164) was selected to represent the extent of potential views from the north of the proposed quarry site. The viewpoint is actually taken from within Boral's owned land. The viewpoint represents the maximum potential visibility from this aspect as the terrain dips further north towards privately owned land. Receiver Location No. 5 and No. 6 are located approximately 500m and 800m north of this viewpoint.

Viewpoint 5 (refer Camera 161) is located on the edge of the existing private rail-spur to the limestone mine. The viewpoint was included to represent the maximum extent of potential visibility from private properties located north-west of the site, rather views from the private rail spur servicing the BCSC limestone mine and the proposed Marulan South quarry. Residential Receiver No. 4 is located approximately 500 m west of this viewpoint and is not expected to have views of the quarry due to intervening terrain.

Viewpoint 6 (refer Camera 165) is located on Marulan South Road immediately adjacent to the proposed quarry site. The viewpoint represents the maximum extent of potential views from Marulan South Road. The section of the road is only used to service the existing limestone mine and the proposed quarry and therefore road users are expected to have a low sensitivity to the development.

13.2.2 *View Type and Context*

View type and context relates to how and why the view is relevant, as well as defining the current view in relation to vegetation and topography. The view context influence the visual absorption capacity of the view, due to the ability of a landscapes ability to absorb the proposed change.

13.2.3 *Visual Absorption Capacity*

Visual absorption capacity is an estimation based on the view type and context of the landscape to absorb development without creating a significant change in visual character or significant reduction in scenic quality. A major factor influencing visual absorption capacity is the level of contrast between the proposed development and the existing elements in that landscape. Due to the location of the existing limestone mine, the capacity of the landscape to visually absorb the proposed quarry is higher than that of a landscape with a completely natural, undeveloped character.

13.2.4 *Existing View Quality*

View quality rates the view's existing aesthetic quality's base on its relationship with the landscape setting and with its visual interest and contrast. This is done though a rating system of 1 to 3, with 1 having the highest existing view quality.

13.2.5 *Significance of Impact*

Significance of impact from the viewpoints has been semi-quantified though a rating system of 1 to 5, with 1 having the highest impact. This has been determined by computer modelling the level of change, taking into consideration the nature of the landscape, topography, the distance between the receptor and the new quarry site, as well as the type of view experienced.

13.3

VISUAL ASSESSMENT RESULTS

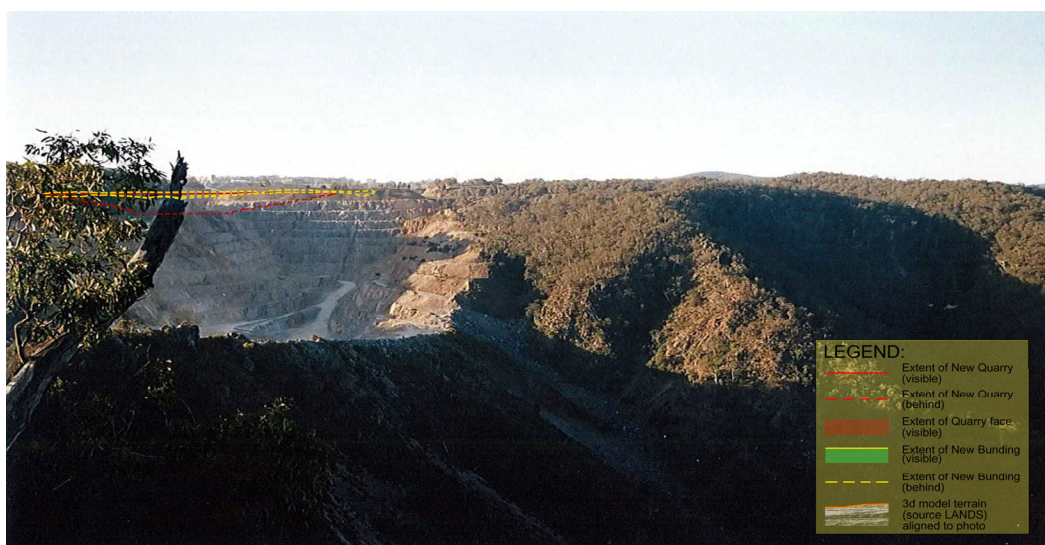
13.3.1

Viewpoint 1 – Bungonia Lookdown

Viewpoint Location:	Bungonia Lookdown (Camera 160).
View Type and Context:	Pedestrian view from the lookout to the south of the site. The existing mine dominates this viewpoint, with the Morton National Park and Bungonia State Conservation Area surrounding.
Visual Absorption Capacity:	High due to the new quarry not being visible from this location, although the existing mine does dominate this viewpoint.
Existing View Quality:	2 (medium).
Significance of Impact:	Low impact of 1, due to the new quarry not being visible.



Photograph 13.1 Existing View from Bungonia Lookdown



Photograph 13.2 Expected Future View from Bungonia Lookdown

13.3.2

Viewpoint 2 – Long Point Walking Track

Viewpoint Location:	Longpoint Walking Track (Camera 1674).
View Type and Context:	Pedestrian view from walking track to the east of the proposed quarry. Morton National Park including cliffs, valleys and bushland occupy the foreground, with open grazing land behind the natural bushland and the BCSC mine appearing slightly on the left.
Visual Absorption Capacity:	High due to distance and the existing vegetation, with only the bunding (which is to be planted) having any impact.
Existing View Quality:	1 (high).
Significance of Impact:	Low impact of 2, due to the distance and terrain and vegetation. The bunding will be visible, however this incorporates new vegetative planting.



Photograph 13.3 Existing View from Longpoint Walking Track



Photograph 13.4 Expected Future View from Longpoint Walking Track

13.3.3

Viewpoint 3 – Long Point Road

Viewpoint Location:	Residence 1 on Long Point Road (Camera 167).
View Type and Context:	View from private property to the north-east, and over valley of the Morton National Park. The foreground belongs to the property and incorporates open grazing land, with bush towards the cliff edge.
Visual Absorption Capacity:	High due to distance, terrain and scattered vegetation adding contrast and interest.
Existing View Quality:	1 (high).
Significance of Impact:	Low impact of 1, due to terrain and vegetation. Only a small section of the bunding will be visible, which is to incorporate new plantings.



Photograph 13.5 Existing View from Residence 1 on Long Point Road



Photograph 13.6 Expected Future View from Residence 1 on Long Point Road

13.3.4

Northern Properties

Viewpoint Location:	Northern properties (Camera 164).
View Type and Context:	View from properties to the north. The foreground and midground contains open grazing land with no significant canopy vegetation, whilst in the distance the background contains some thick vegetation.
Visual Absorption Capacity:	Medium due to terrain and the lack of vegetation in the foreground, although the quarry is proposed behind the foremost ridgeline and incorporates new vegetated bunding.
Existing View Quality:	3 (low).
Significance of Impact:	Low impact of 1, due to terrain, with the proposed quarry behind the ridgeline.



Photograph 13.7 Existing View from Northern properties



Photograph 13.8 Expected Future View from Northern properties

13.3.5

Railway spur

Viewpoint Location:	Railroad tracks (Camera 161).
View Type and Context:	Vehicle view from railroad track and parallel along access road. An open grazing field context with scattered trees and thick vegetation to the background.
Visual Absorption Capacity:	Low due to proximity and lack of foreground vegetation. Existing View Quality: 3 (low).
Significance of Impact:	Medium-low impact of 4, due to proximity and terrain, although this view is from within the Boral property itself. The back face of the quarry will be visible, however planting of the bunding surrounding the quarry will help reduce this impact, and additional planting in the grazing land in the foreground would provide additional screening.



Photograph 13.9 Existing View from Railroad tracks



Photograph 13.10 Expected Future View from Railroad tracks

13.3.6

Marulan South Road

Viewpoint Location:	Marulan South Road (Camera 165).
View Type and Context:	Vehicle and pedestrian view from Marulan South Road. An open woodland with grazing field in the foreground and midground, and canopy vegetation in the background.
Visual Absorption Capacity:	Medium due to terrain and the lack of vegetation in the foreground, although the quarry is proposed behind the foremost ridgeline and incorporates new vegetated bunding.
Existing View Quality:	2 (medium).
Significance of Impact:	Medium impact of 2, due to proximity and terrain. A small section of the back of the quarry will be visible as well as the surrounding bunding, however planting of this bunding will help reduce this impact, and additional planting in the grazing land in the foreground would provide additional screening.



Photograph 13.11 Existing View from Marulan South Road



Photograph 13.12 Expected Future View from Marulan South Road

The visual assessment impacts from the proposed hard rock quarry at Marulan South have been examined from several viewpoints. These viewpoints had varying impacts due to the main factors of distance, vegetation amount and topography. The existing context around the proposed quarry varies in character from open woodland to cleared open grazing rural lands.

The proposed Marulan South Quarry is predominantly shielded from view from all potential nearby receptors due to natural topography. The viewpoints were selected to represent the maximum extent of potential views of the proposed quarry. The viewpoint from Marulan South Road represents the only locations where prominent views of the quarry can be obtained. It should be noted that this section of Marulan South Road is only used to service the BCSC limestone mine and the proposed new quarry and do not represent sensitive viewpoints.

Viewpoints 4 and 5 were also selected to represent the maximum extent of visibility from properties to the north and west of the site. The locations were selected on the edge of Boral property to represent the maximum extent of visibility from each aspect as the terrain dips towards private properties, restricting any views of the site. Residential receivers in proximity to these viewpoints will be predominantly shielded by existing terrain.

The proposal will not be visible from Bungonia Lookdown and its views of the quarry will be extremely limited from the spurline along the Long Point walking trail. Provision of bunding around the perimeter of the site will minimise potential views of the site from recreational areas.

The assessment has found that landscape around the proposed development, generally has a high visual absorption capacity due to the existing terrain and scattered vegetation. The high visual absorption capacity corresponds directly with the generally low significance of visual impacts to views from the proposal.

14.1 INTRODUCTION

This chapter examines the wastes generated during the operation of the proposed Marulan South Quarry. Opportunities for waste recycling and reuse are examined and methods of waste disposal are outlined for wastes that cannot be beneficially reused.

Resource NSW is a state government organisation charged with the role of initiating strategies for waste avoidance and resource recovery throughout NSW as a means of promoting ecological sustainability.

The aims of these strategies are to:

- minimise the consumption of natural resources;
- encourage resource recovery, including reuse, recycling and energy recovery;
- provide for the continual reduction in waste generation; and
- minimise the final disposal of waste.

The NSW Waste Management hierarchy will be incorporated into waste reduction and resource recovery strategies for the operation of the proposed quarry. This hierarchy is on the principles: avoid, re-use, recycle/reprocess, dispose.

14.2 IDENTIFIED WASTE STREAMS

The proposed quarry operations are described in *Chapters 1* and *2*. Quarrying will involve the stripping and emplacement of topsoil and overburden; the blasting and crushing of raw feed in-pit; crushing, screening and stockpiling out-of-pit; and product loading and distribution.

This development will involve the handling and production of waste from a limited number of sources, including:

- small volumes of vegetative matter from progressive clearing of the 30 year quarry footprint and infrastructure areas;
- topsoil and overburden;
- fines from crushing;

- waste water from runoff and plant processing;
- used oils, filters and machinery parts;
- sewage waste; and
- general office and administrative waste.

14.3 *MANAGEMENT PROCEDURES*

14.3.1 *Non Liquid Waste*

General Construction Waste

Waste material generated during construction will comprise scrap building material including piping off-cuts, metal and concrete. This waste stream is classified as non-liquid inert waste in accordance with EPA Guidelines (EPA 1999) and will be disposed of off-site by quarry staff or a licensed contractor.

Excavated Material

Excavated materials will include soil from the construction of water storage dams, drainage systems and the rail siding, and soil and weathered rock waste from the removal of topsoil and overburden during quarry operations.

Soil-based materials are intended to be re-used in construction such as in the construction of dam walls, earth bunds or drainage diversions. Appropriate site management will be implemented to prevent sediment escaping into local drains or waterways during construction activities.

Overburden is an inert waste if deposited on-site as it is considered a 'virgin excavated natural material not mixed with any other waste that has been excavated from an uncontaminated area' as classified by Environmental Guidelines: Assessment, Classification and Management of Liquid and Non Liquid Wastes (EPA, 1999).

Topsoil and overburden stripped during quarry operations will be used to construct earth bunding around the quarry perimeter as a measure to reduce noise and impacts to the visual amenity of the surrounds.

Processing Waste

All non-liquid products from quarry processing are intended for market, including the fines which have traditionally been considered a waste. Fines from the Marulan South Quarry will be blended with sand from Boral's sand quarries to produce a marketable manufactured sand while reducing the demand for natural sand. The remaining aggregates of a range of shapes and sizes will be used in concrete, asphalt and other building materials.

Domestic Waste

'Domestic' waste is classified as non-liquid inert waste in accordance with EPA Guidelines (EPA 1999) and comprises everyday waste such as paper, aluminium cans, plastics, packaging and other material generated by on-site staff. Where practical, collection bins will be provided for recyclables (including paper, cardboard, glass bottles and aluminium cans). General domestic waste such as food and paper generated by on-site staff will be collected in separate waste bins and disposed of off-site by quarry staff or a licensed contractor.

Green Waste

Vegetation stripped during clearing may be re-used to rehabilitate different areas of the property including as a vegetative cover on stockpiles.

Both putrescible waste such as food scraps and green waste are classified as non-liquid solid waste under the EPA Guidelines (EPA 1999).

14.3.2 *Liquid Waste*

Effluent

Staff amenities will be constructed within the processing plant area during the initial 12 month construction phase. Package treatment units requiring minimal water top-ups and resulting in minor effluent discharges will be installed for office and amenity sewage treatment. Treated effluent will be recycled in-pit as a means of maximising on-site water recycling and avoiding off-site effluent disposal.

Portable toilets may be used on site prior to the establishment of the above amenities. These toilets will require effluent collection and disposal by a sub-contractor who will remove the effluent under their own liquid trade waste agreement.

Lubricants

Greases and lubricants are classified as Group B liquid wastes under the EPA guidelines (EPA, 1999). Small quantities of these wastes may be generated during construction and operation of the quarry. To prevent these waste types from posing a potential risk to the environment, any waste of this type will be collected and stored in designated drums for off site disposal or re-use wherever possible.

Any waste oils accumulated during on-site maintenance of heavy machinery will be disposed of by the contractor under their license agreement. Waste oil contractors and maintenance and refuelling contractors will be required to have spill response protocols in place. Spill response equipment will be stored at the site in the event of unforeseen spills due to hose breaks and similar exceptional events.

Water

The water supply of Marulan South Quarry is intended to be self-sufficient and will optimise water recycling within the quarry operations. This will ensure that no additional demands on the locality's existing water supply and that the potential for offsite impacts to local receiving waters is minimised. Measures will be implemented to ensure necessary water demands are met and that all water leaving the site is of a quality acceptable for release into the surrounding catchments. These include the construction of five provisional water storage dams, construction of an off-line wetland, diversion of clean runoff and the retention and filtration of all dirty water from materials handling, washing and dust suppression of stockpiles.

Details of individual elements of the proposed water management system can be found in *Chapter 6* and *Annex C*.

14.4 MITIGATION MEASURES AND SAFEGUARDS

Mitigation measures to be implemented to minimise wastes generated during quarry operations are outlined below:

- wherever possible wastes will be separated into recyclable and non-recyclable materials and stored in appropriate containers;
- containers will be collected by a licensed waste contractor, as appropriate, or removed by quarry staff on a regular basis and transported off-site for disposal to a licensed landfill or recycling facility;

- all waste disposal will be in accordance with the *Protection of the Environment Operations Act 1997* (POEO Act) and the guidelines recommended in the EPA (1999) *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*; and
- waste management will be incorporated into the EMP which will outline measures to avoid waste generation and promote reuse, recycling and reprocessing of waste where possible during construction and operation.

14.5

CONCLUSION

Wastes will be generated during both construction and operation of the proposed Marulan South Quarry. These materials will be recycled wherever possible or disposed of in an environmentally acceptable manner in accordance with the appropriate operational or construction Environmental Management Plan.

Granodiorite aggregates constitute the main resource generated as part of this project. All aggregates and fines produced from the quarry will be saleable with the associated topsoil and overburden intended for use in bund construction.

15.1 INTRODUCTION

The Marulan South quarry proposal will result in considerable social and economic benefits at both the local and state level. The main economic benefit of the proposal is related to the security of supply of construction materials for the Sydney construction market. Local economic benefits include employment opportunities during the construction and operation of the quarry and subsequent flow on effects to the local economy.

Potential social issues primarily relate to social amenity and the quality of life in the surrounding locality. Detailed noise, air and visual assessments have been undertaken as part of this EA to outline potential issues to surrounding areas. This chapter will provide a summary of the findings of these studies to the amenity values of the surrounding locality including potential impacts upon the values of the surrounding national parks and recreation areas.

15.2 ECONOMIC CONSIDERATIONS

The major economic benefit for the proposed Marulan South Quarry is to provide surety in the supply of construction materials to meet the demand from the Sydney Metropolitan Region. The NSW construction industry is of vital economic importance to both NSW and Australia as a whole. The construction industry is the fourth largest industry in NSW and employs around 8% of the state's workforce (ABS, 2004). The ongoing supply of construction materials to the Sydney Metropolitan market is necessary to ensure continued affordability of construction projects including residential homes, and continued contribution to the state and federal economies.

Boral currently operates four quarries that supply the Sydney market with construction and building materials, including Peats Ridge, Dunmore, Emu Plains (within the Penrith Lakes scheme) and Prospect. With the latter two quarries ceasing operation within the next six years, Boral has proposed Marulan South Quarry to meet current and future market demands in the Sydney Metropolitan Region.

The estimated cost for the establishment of the Marulan South quarry is \$150 million, much of which will occur in the initial construction phase of the proposal. The operation of the quarry will continue to contribute to the local economy through ongoing operational expenditure and employment.

A construction workforce of approximately 20 people will be required for the establishment of the quarry. The expected workforce for the operational quarry is up to 30 full time, on-site employees with 2-3 shifts with additional opportunities created in transport and support industries. While some workers are expected to transfer from Boral's Emu Plains and Prospect operations, the employment opportunities are still considered significant for the for the Goulburn Mulwaree region. Flow on and multiplier effects can also be expected to occur as a result of the additional expenditure which will be injected into the regional economy.

15.3 *SOCIAL AMENITY*

15.3.1 *Local Amenity Values*

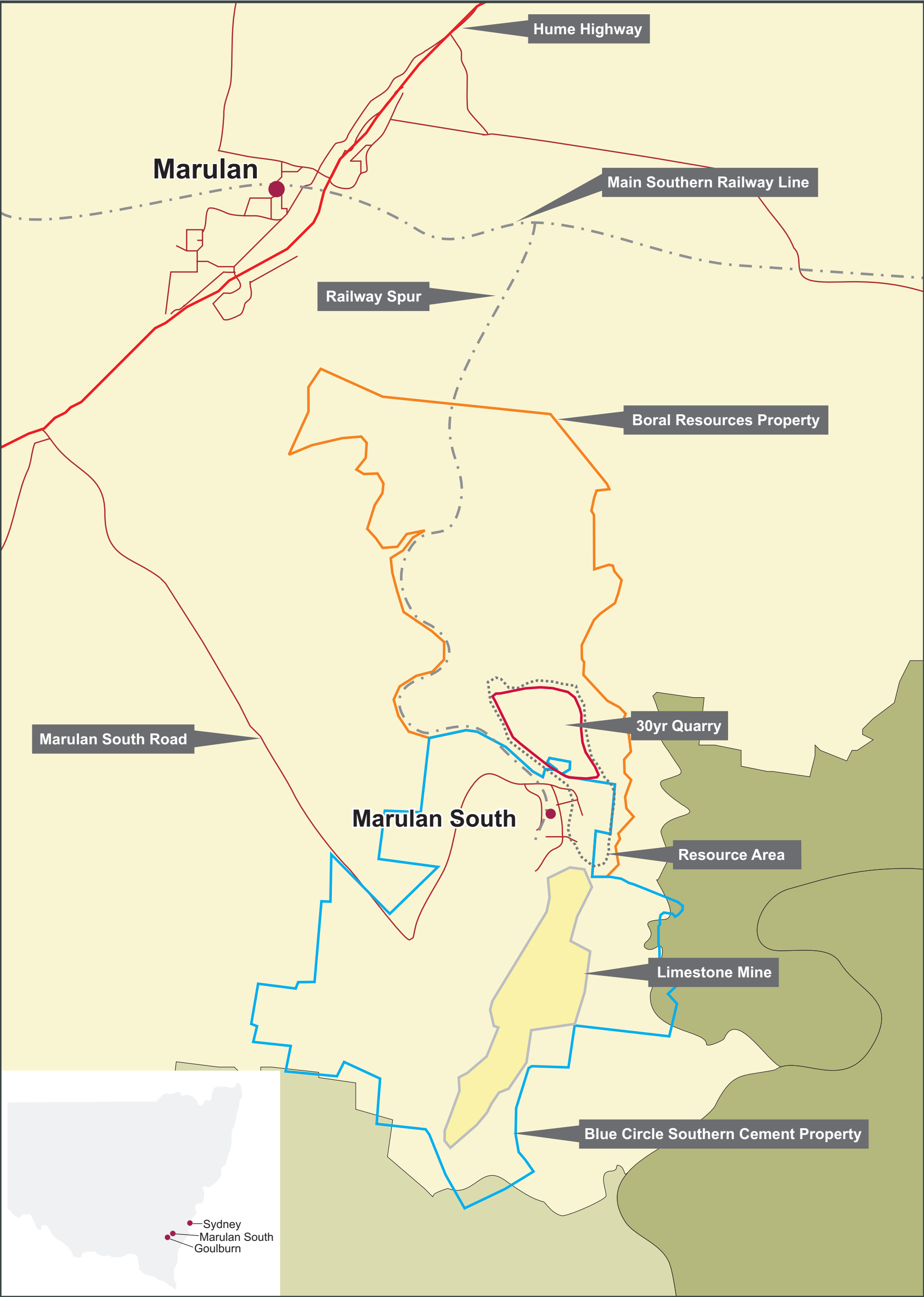
The proposed Marulan South quarry site is located approximately 10km southeast of Marulan in a region currently dominated by mining and agricultural activities. The proposed quarry will be situated immediately north of the existing BCSC limestone mine so will not result in the introduction of a completely new land-use to the region. The site is bordered by a steep gorge to the east that extends towards Morton National Park. A small number of rural properties are located to the north and west of the site and the Bungonia State Recreation Area is located south of the BCSC limestone mine on the edge of Bungonia Gorge.

Boral owns approximately 650 hectares (ha) which includes the proposed quarry site together with additional granodiorite resources and surrounding buffer land. The location of proposed quarry with respect to the local setting is shown in *Figure 15.1*.

The surrounding area is typical of a rural setting with agricultural properties adjoining bushland within the protected reserves. Rural residents typically place value on the quality of life in terms of amenity issues including noise, dust and visual amenity.

Morton National Park and Bungonia State Recreational Area are jointly managed by the NSW National Parks and Wildlife Service which from part of the DEC. Social values of the park and SRA are associated with the extensive declared wilderness areas and with recreational, tourism and educational values.

The area provides protection of relatively pristine areas and natural processes and self reliant recreational opportunities in a scenically spectacular setting within close proximity to the major population centres of Sydney, Wollongong and Canberra. While several areas within Morton National Park (e.g. Fitzroy Falls, Bundanoon and Pigeon House Mountain) receive heavy tourism, a variety of other recreational activities are undertaken. These include scenic lookouts, nature study, camping, walking, cycling, car touring, canoeing, caving and other adventure training activities.



Bungonia State Recreation Area receives the greatest number of visitors to locality surrounding the Marulan South Quarry proposal for tourist and recreational pursuits. Bungonia Lookdown is a popular local tourist attraction and contains scenic lookouts, picnic and camping facilities, marked bushwalking trails and a series of limestone caves which are frequently explored. The existing limestone mine is highly visible and dominates the view from the scenic lookout. The steep Bungonia and Barbers Creek gorges can be seen from the lookout with natural bushland extending into Morton National Park and Bungonia State Recreation Area.

Morton National Park is located to the east of the Marulan South Quarry and receives fewer numbers of visitors than Bungonia Lookdown, with principle values associated with the wilderness values of the area. Long Point is located on the ridge on the opposite side of Barbers Creek Gorge and has a scenic lookout and rough picnic facilities. The main scenic lookout has an easterly aspect with views in the opposite direction towards the Shoalhaven River. A spurline with a rough walking trail extends to the south from the lookout and picnic area for approximately 500m prior to extending down into the Bungonia Creek Gorge.

15.3.2 *Potential Impacts*

Detailed assessment of potential impacts upon local amenity values has been previously outlined in visual, noise and air-quality chapters.

The proposed Marulan South Quarry is predominantly shielded from the view of all potential nearby receptors due to natural topography. A range of viewpoints were selected to represent the maximum potential visibility of the site from potential private residences and concluded that there will be minimal visual intrusion associated with the proposal.

The proposal will not be visible from Bungonia Lookdown, which is the major tourist destination in the locality. The proposal will have extremely limited visibility from the spurline along the Long Point walking trail. This section of the walking trail is used relatively infrequently, predominantly for access to the adjoining wilderness areas. Bushwalkers will receive passing views of the proposal and the existing limestone mine for a short section of the trail either at the commencement or conclusion of the trail which are not expected to significantly reduce the overall wilderness experience.

Badgerys Lookout is located approximately a further 3.5 km east of Long Point and any potential views of the quarry will be shielded by the intervening terrain including the Long Point spurline. Provision of bunding around the perimeter of the site will further minimise potential views of the site from recreational areas.

Potential noise impacts on the surrounding locality has been modelled and show that the potential emissions from the quarry meet site specific noise criteria at all residential receivers. The results of the noise modelling has been presented as both direct calculations at the nearest residential receivers and through the use of contour plots which illustrate the extent of noise impacts upon the surrounding region. The noise contours illustrate that there will generally be minimal change to the background noise levels in the surrounding recreational areas.

Air quality modelling has also been undertaken to assess the impact of dust on surrounding areas. Again the results were presented in terms of direct calculations at the closest residences and through the use of contour plots to represent the worst case scenario for dust concentration and dispersion to surrounding areas. The results indicate that the proposal is within the EPA prescribed air quality goals for all nearby receivers and is not expected to impact upon the value of surrounding recreational areas.

Boral's decision to use rail for all product transport from the quarry means that the amenity of properties on Marulan South Rd will not be altered by substantially increased heavy vehicle traffic.

15.3.3 Conclusion

The proposed Marulan South quarry is expected to have considerable economic and social benefits in terms of securing the supply of construction materials to the Sydney market and in local expenditure and employment opportunities.

Potential social issues relate to the affect of the proposal on the quality of life and social amenity in the locality. The location of the proposal adjacent to recreation and wilderness areas within Bungonia State Recreation Area and Morton National Park strengthened the need for a thorough assessment of potential air quality, noise, vibrational and visual impacts to the recreational values of the above areas.

Modelling of cumulative impacts with the adjoining BCSC Limestone quarry under worst case scenarios indicates that receptors such as nearby residents and passive recreational users will receive no significant impact to air quality, noise or vibration. The assessment outlined visual impacts to limited areas of Morton National Park along the Long Point spurline. The site will have minimal visibility and is not considered to significantly detract from the surrounding wilderness values.

16.1 CUMULATIVE IMPACT SETTING

In order to fully determine the impacts associated with the proposed Marulan South Quarry, it is necessary to assess the proposal in the context of the cumulative affect of the proposal together with existing or proposed mines, quarries and other industries in the locality. This is particularly important for issues associated with public amenity, including noise and air quality, where perception of cumulative effect is often greater than the sum of the individual components.

Cumulative impact assessments have been included within the assessment process for each environmental aspect assessed within this EA. Potential cumulative impacts have been assessed principally in regards to the concurrent operation with the BCSC limestone mine located immediately south of the quarry proposal.

The recently approved Lynwood Quarry is located approximately eight kilometres north-west of the proposed site near Marulan. Due to the distance from the Marulan South Quarry proposal and the predominant wind directions in the locality there is expected to be minimal interaction associated with cumulative operations.

The following sections provide a summary of the cumulative assessments undertaken throughout the EIS. Detailed information on the cumulative impacts is also presented in the relevant chapters and technical studies included within the EA.

16.2 NOISE

The only other major industrial noise in the area is the noise generated by the Blue Circle Southern Cement (BCSC) plant which is located approximately one kilometre south of the proposed quarry.

For the majority of residences the influence of the BCSC plant is relatively low and the proposal is likely to be the main source of industrial noise during the daytime. For the night period, noise levels from the proposal are lower due to the limited operations of the quarry. Only the tertiary plant and rail loading facility operate during the night period and the tertiary crusher and screens are expected to emit relatively consistent noise throughout the night period (10pm to 7am).

Background noise monitoring has indicated that only residence locations 2 and 3 are exposed to measurable BCSC operations. The BCSC plant's noise levels were inaudible and immeasurable at all other residences during ERM site visits. Residence location 2 and 3 were therefore analysed in detail for cumulative noise.

Cumulative noise effects of the proposed quarry and the existing BCSC plant are summarised in *Table 16.1* for adverse INP weather conditions.

Table 16.1 *Cumulative Night-time L_{eq} Noise Levels*

Receiver Location	$L_{eq}(9h)$ Noise Level, dB(A)			Amenity Criteria, dB(A)
	Proposal	Existing BCSC Plant	Total	
2	18	34	34	40
3	24	34	34	40
1. Modifications applied to the amenity criteria according to the INP.				

EPA's INP recommends an acceptable amenity goal of 40 dB(A) $L_{eq,9hour}$ applicable for a rural residence. The results indicate that cumulative industrial noise is expected to be within the INP Amenity targets for Residence Location 2 and 3. There is not expected to be any cumulative affect of concurrent operations at any of the other identified receiver locations. The L_{eq} noise levels from the proposed Marulan South Quarry average over 9 hours of night operations will not be discernable over the existing background noise incorporating the BCSC operations.

16.3 AIR QUALITY

The BCSC limestone mine is expected to contribute to PM₁₀, TSP concentrations and to dust deposition in the local area. Cumulative impacts were assessed using monitoring data captured using high volume air samplers and dust deposition gauges together with modelling of concurrent operations with the BCSC limestone mine.

This is considered a conservative modelling approach as the as the monitoring carried out for the project will have captured some of the effects of the operation of the limestone mine upon existing dust levels. However, to ensure a conservation approach was adopted for the properties in closest proximity to the existing limestone mine, cumulative impacts were also assessed by explicitly modelling the concurrent operations. The modelling results therefore assess the cumulative impacts of the proposed Marulan South Quarry together with BCSC operations and background monitoring data providing a conservative approach with an element of double counting to an unknown extent.

For emissions estimation it has been assumed that the BCSC operations produce 4 Mtpa of product per year and that the TSP dust emission is in the same ratio of dust to production determined for the quarry – that is, 0.31 kg of TSP per tonne of product. This is an approximate way of determining the BCSC dust emissions in the absence of detailed activity information.

In this cumulative modelling work the BCSC mine has been treated as a number of volume sources. These sources have been located at the apparent points of major emission as estimated from the known location of the pits and/or major dust sources on the mine.

The model results are presented as contour plots in *Figures 11.4 and 11.5* and calculated results at receiver locations in *Table 16.2*.

Table 16.2 Predictions at Residential Properties Including Modelled Effects of BCSC

ID	Easting (m)	Northing (m)	Due to Project and BCSC sources		Due to Project, BCSC and other sources*	
			Year 1	3.5 Mtpa	Year 1	3.5 Mtpa
Maximum 24-hour average PM ₁₀ concentrations (µg/m³)						
Goal = 50 µg/m³ due to Project only						
1	230394	6149983	26.2	29.7	-	-
2	226824	6148362	44.3	52.3	-	-
3	226574	6148989	29.6	41.3	-	-
4	226253	6150502	19.3	23.8	-	-
5	226475	6152336	10.1	11.8	-	-
6	226127	6152946	8.3	9.5	-	-
Annual average PM ₁₀ concentrations (µg/m³)						
Goal = 30 µg/m³ due to Project and other sources						
1	230394	6149983	5.5	6.1	21.5	22.1
2	226824	6148362	7.8	9.7	23.8	25.7
3	226574	6148989	8.7	11.6	24.7	27.6
4	226253	6150502	3.0	3.5	19.0	19.5
5	226475	6152336	1.4	1.7	17.4	17.7
6	226127	6152946	1.1	1.3	17.1	17.3
Annual average TSP concentrations (µg/m³)						
Goal = 90 µg/m³ due to Project and other sources						
1	230394	6149983	5.9	6.5	30.9	31.5
2	226824	6148362	8.3	10.3	33.3	35.3
3	226574	6148989	9.1	12.1	34.1	37.1
4	226253	6150502	3.2	3.8	28.2	28.8
5	226475	6152336	1.5	1.8	26.5	26.8
6	226127	6152946	1.2	1.4	26.2	26.4
Annual average dust deposition (µg/m²/month)						
Goal = 2 g/m²/month due to Project only and 4 g/m²/month due to Project and other sources						
1	230394	6149983	0.36	0.36	3.36	3.36
2	226824	6148362	0.17	0.24	3.17	3.24
3	226574	6148989	0.16	0.23	3.16	3.23
4	226253	6150502	0.08	0.10	3.08	3.10
5	226475	6152336	0.03	0.05	3.03	3.05
6	226127	6152946	0.02	0.03	3.02	3.03

* where other sources are represented by the air quality monitoring data

The model results shown above suggest that annual average PM₁₀ and TSP concentrations and annual average dust deposition would be below relevant air quality criteria at the nearest residences due to the combined effects of the quarry, the BCSC mine and other local sources of dust.

However, this assessment does highlight the potential for the 24-hour average PM₁₀ goal to be slightly elevated at Residence Location 2 where the model result of 52 µg/m³ is slightly above the 50 µg/m³ goal for emissions from the proposal. The result is dependent on the very conservative model assumptions adopted for the study and the maximum PM₁₀ 24 hour average criteria, which relates specifically to the operation of Marulan South Quarry is not expected to be exceeded in practice. However, it does indicate that the assumed operating scenario is approaching the maximum tolerable dust production rate at the quarry and the operating procedures must ensure that dust generation is minimised to comply with relevant goals.

16.4

VISUAL ENVIRONMENT

An assessment of visual impacts associated with the proposal was undertaken from a range of viewpoints in the surrounding locality. The proposal is predominantly shielded from view of all nearby receptors by natural topography.

Prominent views of the site can only be obtained from areas in close proximity to the proposal including the northern extent of Boral's property and the section of Marulan South Road which is predominantly used to service the existing limestone mine.

The proposal will not be visible from Bungonia Lookdown and its views of the quarry will be extremely limited from the spurline along the Long Point walking trail. Provision of bunding around the perimeter of the site will minimise potential views of the site from recreational areas. Careful quarry planning will ensure the intrusiveness of the development is minimised and the proposal is sympathetic to all potential viewer locations.

The Marulan South quarry is located immediately north of the existing BCSC Limestone Mine and therefore does not introduce a new landscape element into the rural setting. The limestone mine is a prominent visual element from a number of viewpoints including the Bungonia Lookdown and sections of Morton National Park. There will be negligible cumulative visual impacts associated with the development of the Marulan South Quarry due to the minimal visibility of the proposal. There may be potential in the future to assist with rehabilitation activities within the BCSC south pit through the emplacement of excess overburden from the Marulan South proposal.

Road access to the Marulan South Quarry site is available via Marulan South Road, which extends from an intersection with the Hume Highway and services the existing limestone mine and a number of rural properties including poultry farms and lime processing industries.

Road haulage has been identified as a key issue within the local community and siting the quarry on an existing rail spur was a critical consideration in the selection of the proposed site. To recognise community concerns and minimise potential impacts upon the local road network, Boral proposes to transport all quarry product by rail and currently only seeks approval for road usage during construction and for employee and maintenance vehicles during quarry operations.

There will therefore be minimal cumulative impact upon traffic numbers along Marulan South Road. Average daily traffic flows are expected to increase by approximately 12% during both the construction and operations phase of the proposal. The majority of the additional movements are expected to be attributed to staff passenger vehicle movements and are not expected to impact upon the capacity or safety of Marulan South Road.

Rail access to the site is available via rail on an existing rail spur which currently services the adjacent BCSC limestone mine. The rail spur connects with the Main Southern Railway at Medway Junction approximately seven kilometres north of the site.

The BCSC currently operates up to five or six trains per day along the rail spur for transport north to Sydney. Typically around 30 freight and 16 passenger services per day operate on the Main Southern Railway through Medway Junction, although rail movements are subject to seasonal variation with additional 5 or 6 rail movements experienced during wheat harvest season.

At peak production there will be up to four trains servicing Marulan South quarry making a daily trip between the quarry and typically the Sydney market. Each train has capacity to transport up to around 1,000,000 tpa which at full production would equate to around 3 or 4 rail trips per day.

Advice from ARTC indicates that there is sufficient capacity on the main southern line to accommodate the additional rail movements. A conservative assumption of up to eight train movements per day on the Main Southern Line would result in an increase of approximately 17% over existing train movements.

A cumulative noise assessment for additional rail movements was also undertaken as part of this assessment. The results indicate in a 24 hour period, a residence set back more than 25m from the railway line is unlikely to exceed the stipulated Leq(24h) criteria. It can also be seen from the results that the proposal only marginally (1dB) increases the existing Leq(24h) rail noise levels.

16.6

WATER SUPPLY

Marulan South is currently supplied with water via an existing pipeline from the Tallong weir, approximately 10 km to the north of the site on Barbers Creek. There are potential risks of water shortages from the weir, particularly as a result of the recent drought conditions in the region.

The water supply system has therefore been specifically designed to be self sufficient and not place additional demand on existing water supplies to the locality. There may also be potential to incorporate future synergies with the adjacent BCSC Limestone Mine to supply the existing operation with a supplementary water source.

The proposed quarry will require up to 255 ML per annum of water at maximum production for haul road and stockpile dust suppression, material processing, wash-down and irrigation. Water balance modelling indicated that construction of Dam 1 with a depth of 8.5m would have sufficient capacity to service the water demand for the proposed quarry operations with minimal potential for water shortages during dry weather. Construction two smaller dams (Dam 1 and Dam 2 with depths of 7.5m instead of 8.5m) will result a smaller overall storage volume with a larger catchment area resulting in the same level of risk of water shortage and greater flexibility in the operation of the quarry.

Withdrawal of up to 255 ML of water per annum at full production, will reduce the total flows to Barbers Creek and consequently to the Shoalhaven River by a corresponding amount. This is relatively insignificant (<0.1%) in terms of total flows in the Shoalhaven River and the proposal is not expected to have any cumulative impacts to the Sydney water supply system.



Part D

Environmental Management and
Project Justification

17.1 ENVIRONMENTAL MANAGEMENT STRUCTURE

17.1.1 *Environmental Management Context*

Under section 75F of the *Environmental Planning and Assessment Act 1979* (EP&A Act), the EA must include a description of measures to “avoid, minimise, mitigate, offset, manage, and/ or monitor the impacts of the project”.

These measures will be incorporated within site specific Construction and Operational Environmental Management Plans (collectively referred to as EMP’s), which will provide an overall framework for the management of environmental impacts that could potentially arise from the proposed Marulan South Quarry. All mitigation measures identified throughout this EA and the following Statement of Commitments will be incorporated into the EMP’s.

The EMP’s will:

- act as an environmental operations manual for Boral staff and contractors throughout construction and operation of the quarry;
- identify potential impacts of the proposed quarry and the measures proposed to mitigate these impacts as described in the preceding chapters of this EA;
- detail how environmental safeguards are to be implemented;
- detail the timing of the implementation of the mitigation measures;
- clearly define allocations of environmental responsibilities of all staff and contractors;
- outline monitoring and reporting requirements to demonstrate compliance with licensing and approval requirements; and
- provide procedures for review and updating of the EMP’s.

Preparation of these EMP’s complies with the requirements of the NSW Government Environmental Management Systems Guidelines and Boral’s overall approach to environmental management. The EMP’s will be prepared in accordance with the relevant environmental Acts and Regulations, principles of Ecologically Sustainable Development and good practice environmental procedures (including the “Guideline for the Preparation of Environmental Management Plans” NSW Department of Planning, 2004).

Adherence to the EMP's will enable environmental safeguards and mitigation measures to be effectively implemented and sustainable work practices adopted throughout the duration of the project. This will demonstrate Boral's intent to comply with relevant environmental legislation, prevent environmental pollution and minimise the impact of the proposal on the environment.

17.1.2 Boral's Approach to Environmental Management

Boral is committed to responsible environmental practices and the management of impacts associated with the proposed Marulan South Quarry will be in accordance with Boral's Environmental Policy.

Specifically Boral is committed to:

- *conducting our operations to minimise environmental risk and, wherever practicable, eliminate adverse environmental impacts;*
- *continual improvement of our environmental performance including regular review and the setting of rigorous environmental objectives and quantified targets – particularly with regards to:*
 - *efficient use of energy (including appropriate use of alternative fuels);*
 - *conservation of water;*
 - *minimisation and recycling of wastes;*
 - *prevention of pollution; and*
 - *effective use of virgin resources and supplemental materials;*
- *open, constructive dialogue with communities surrounding our operations;*
- *reducing the greenhouse gas emissions from our processes and facilities;*
- *complying with environmental legislation, regulations, standards and codes of practice relevant to the particular business as the absolute minimum requirement in each of the communities in which we operate;*
- *conducting business with suppliers and contractors who have a commitment to the values and objectives contained in this environmental policy;*
- *remediating our contaminated sites to standards internationally acceptable for the site purpose.*

At Marulan South Quarry, these commitments will be supported through Boral's implementation of the Environmental Management Plan(s) (EMP).

17.2

STATEMENT OF COMMITMENTS

The following Statement of Commitments has been prepared in accordance with the Director General Requirements and Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). These commitments outline the management, mitigation and monitoring measures to be adhered to by Boral throughout construction and operation of the proposed Marulan South Quarry to manage potential environmental impacts arising from the proposal.

17.2.1

General

Boral will:

- carry out the proposal in accordance with the systems, plans and mitigation measures identified throughout this Environmental Assessment;
- bring any matter that arises and requires further assessment by the Director General to the Director General's attention and will comply with all requirements received; and
- obtain and maintain all permits, licenses and approvals required throughout the life of the project. This Statement of Commitments does not replace any obligations Boral has to these statutory requirements.

17.2.2

Environmental Management Strategy

Prior to the commencement of operations at Marulan South Quarry, Boral will prepare and implement an Environmental Management System (EMS) based on the AS/NZA ISO 14001:2004 - Environmental Management Systems.

The EMS will:

- incorporate construction and operational EMPs;
- detail potential environmental risks due to construction and operation of the proposed quarry;
- provide measures for the prevention, minimisation and management of these impacts to within acceptable limits; and
- provide a means for the project to improve environmental performance and move towards environmental sustainability.

17.2.3 *Construction And Operation*

Construction and operation will be limited by:

- production will not exceed 3.5 mtpa;
- the tertiary crushing and screening plant immediately to the south of the rail siding will be enclosed;
- the in-pit crushing plant will be semi-enclosed;
- a 10 m high earth bund will be built around the perimeter of the 30 year quarry plan;
- the eastern overburden emplacement will be restricted to 30 metres high;
- construction will typically take place between 700 am and 600 pm Monday to Friday, and 700 am and 100 pm Saturday;
- operation of the quarry will take place 24 hours a day, 7 days a week. In-pit activities will be restricted to the hours of 7am to 7pm to minimise noise.

17.2.4 *Community Consultation*

Community liaison will continue to be provided throughout the approvals process through the following channels:

- the community email address;
- 1800 number;
- fax number; and
- reply paid address.

The operational EMP will detail ongoing community involvement, by way of a complaints line, and if there is sufficient interest, a community consultative committee.

17.2.5 *Rehabilitation*

The following general rehabilitation procedures will apply:

- the most recently stripped topsoil will be used to topdress emplacement areas and bunds to a depth equal to the average depth of topsoil across the site to achieve the greatest benefits from the seedbank and soil;
- topsoil unable to be used immediately will be stockpiled for later rehabilitation of disturbed areas. These stockpiles will be kept to a limited size and seeded to ensure stabilisation and preservation of topsoil quality; and
- rehabilitation will include shaping of the bund and emplacement areas to provide drainage and irregular features for integration with the surrounding landscape;

If in the event that Boral chooses not to extend quarrying at the end of 30 years, the following conceptual rehabilitation principles would be expected to be implemented:

- benches will be restricted to twenty metres high;
- all surface runoff will be directed away from the pit;
- final benches will be capped with a layer of overburden and topsoil, and planted with trees, shrubs and groundcovers indicative of species found in the adjacent Box Gum Woodland; and
- all ancillary infrastructure (apart from dams) will be removed and the land rehabilitated.

17.2.6 *Water Resources*

Water resources will be managed through a management system designed to target 100% self-sufficiency in water supply, provide environmental flows equivalent to 10% of average daily flows, optimise recycling within the quarry operations and minimise impacts to receiving waters.

Boral will monitor the potential impacts of the project on surface and groundwater quality, to ensure water is suitable for intended use and that operations are not impacting on receiving waters. Water quantity will also be monitored to manage water supply balances and assess groundwater drawdown impacts from the project.

The water management system will include:

- installation of a permanent drainage network to divert clean and dirty water flows to appropriate storages. These diversions will have capacity to convey critical flows of at least a 1 in 20 year average recurrence interval (ARI) storm event, and up to a 1 in 100 year ARI event in critical locations;
- installation of erosion control devices including sediment traps, check dams, spreaders, dissipaters, lined or vegetated drains, and the limitation of longitudinal gradients of drains to 1%;
- diversion of all dirty water from haul roads, disturbed areas and overflow from dirty water storages to in-pit dirty water storages. All dirty water is to be filtered or treated prior to release;
- package treatment unit for potable water supply to treat rainwater runoff to drinking water standards. This will store at least 20kL (six days supply) of treated water;
- package treatment plant with capacity to treat 3kL/day of sewage to secondary standard with disinfection prior to release;
- filtration of all excess pit water through a constructed wetland prior to release into Dam 1;
- provision of bunding and spill kits, and the locating of any activities with potential for spills within the pit drainage area; and
- release of environmental flows to Barbers Creek equivalent to 10% of average daily flows.

A water quality monitoring program will be implemented including:

- monitoring of surface water quality in supply dams and downstream of Tangarang Creek to ensure water is suitable for intended use and that operations are not impacting on receiving waters. Baseline monitoring will be followed by quarterly monitoring with additional sampling following rainfall events and/or known discharges from the site. Results will be compared to ANZECC 2000 guidelines;
- monitoring of supply quantity and quarry use to manage water supply balances;
- recording of environmental flows and flood spills to Tangarang Creek;
- at least annual inspection and cleaning of water quality devices;
- monitoring of water in pit storage and Dam 1 to ensure water meets secondary contact criteria;
- monitoring of storage dams for algal blooms;
- baseline and quarterly monitoring of groundwater around the quarry boundary to assess local drawdown impacts; and
- annual groundwater quality monitoring.

17.2.7

Ecology

Key mitigation measures designed to offset the loss of habitat, native flora and fauna, and endangered ecological communities during the project include:

- installation of 40 fauna boxes in mature trees (25 adjacent to the quarry and 15 within the section of Box-Gum Woodland to be retained) to mitigate the removal of hollow-bearing trees. The boxes will be installed prior to any trees being removed;
- a pre-clearance survey of all trees to be removed by an appropriately qualified person, to ensure that no animals are in the trees. An appropriately qualified person will be on site while trees are removed so that any animals inhabiting the trees can be captured and relocated;
- planting of an area equal to twice the area of Box-Gum Woodland to be removed with endemic tree species characteristic of Box-Gum Woodland. Seed will be sourced from the woodland near Dam 1 and if needed, the area will be fenced to prevent human, stock and vehicular access;
- where feasible, clearing within the area of Dam 1 will be timed for after flowering and seed-set by the native grasses (spring-summer) to maximise stores of seed in the soil;
- where feasible, topsoil from the area of woodland near Dam 1 will be preferentially stripped and used for rehabilitation;
- revegetation around the dams and the addition of semi-submerged rocky areas around the perimeter of the dams will be designed to create habitat for native frogs and reptiles;
- weed management will occur throughout the quarry and associated infrastructure areas; and
- release of environmental flows to Barbers Creek equivalent to 10% of average daily flows.

17.2.8

Archaeology

The Aboriginal cultural heritage value of those areas immediately adjacent to proposed Dam 1 will be managed through an archaeological salvage recovery prior to impact by excavation and inundation.

This will include salvage excavation testing of the confluence of Tangarang Creek in Dam 1 followed by further excavation of the site(s) with the highest potential to allow recovery of representative archaeological features. Salvage will be undertaken by archaeologists and representatives of the Aboriginal groups registered for this assessment. Records of location details and will be lodged on the DEC Aboriginal site register.

Several noise mitigation commitments include:

- construction of a 10m earth bund spanning the pit boundary facing the residences to the east, west and the north;
- construction of an enclosure to house the tertiary plant, west of the quarry. The enclosure will be designed to provide adequate attenuation;
- using a drill rig with a suitable sound power level emission;
- limitation of in-pit operations to the day period (7am- 7pm) only;
- limitation of blasting to between the hours of 7.00 am to 6.00 pm. A blast management strategy will be used to ensure appropriate charge masses are used to avoid excessive air blast overpressure and ground vibrations;
- partial cladding of the in-pit crushers to achieve an adequate reduction in their sound power levels;
- selection of a dozer with lower sound power level;
- cladding of the conveyors to achieve a reduction in their sound power levels;
- the overburden stripping fleet will be limited to an excavator, trucks and a dozer;
- air-blast overpressure will not exceed 115 dB(L_{peak}) for more than 5 % of the total number of blasts over a period of 12 months with a maximum level of 120 dB(L_{peak}) at any time; and
- peak particle velocity (ppv) from ground vibration will not exceed 5 mm/s for more than 5 % of the total number of blasts over a period of 12 months. The maximum level will not exceed 10 mm/s at any time.

Noise limits will be maintained at the closest residential receivers are outlined in *Table 17.1*.

Table 17.1 Noise Limits

Receiver Location	Leq,15minute Project Specific Criteria, dB(A)		L1,1minute (Night), dB(A)	
	Day	Evening	Night	
1	36	35	35	45
2	39	43	39	49
3	39-44	43	39	49
4	36	37	36	46
5	35	37	35	45
6	35	37	35	45

17.2.10 Air Quality

Measures to minimise and mitigate dust emissions will be put in place to ensure that no significant air quality impacts occur to surrounding residential and recreational receivers as a result of the proposed operations. These include:

- covering of conveyors;
- enclosing the tertiary crushing and screening plant and installing a dust suppression system;
- fitting of scraper for cleaning conveyor belts;
- operating dust suppression sprays on the primary crusher;
- fitting drills with either water sprays or dry dust collection devices;
- watering stockpiles of fine material;
- confining traffic to identified and watered haul roads;
- removal and rehabilitation of unnecessary roads;
- keeping exposed areas to a minimum;
- cleaning of areas which could become sources of wind erosion dust due to build-up of settled fine material;
- reviewing meteorological conditions prior to blasting to minimise the exposure of residences to dust emissions; and
- daily assessment of meteorological conditions to identify wind conditions that may be conducive to excessive dust generation – for example, very high winds.

Air quality monitoring will determine changes to air quality beyond the boundary of the site. This will determine whether mitigation measures are effective in ensuring that annual average dust concentrations and dust deposition levels, and short-term (24-hour average) air quality impacts remain below relevant air quality criteria at the nearest residences.

17.2.11 *Traffic and Transport*

Boral proposes to transport all quarry product by rail and currently only seeks approval for road usage during construction and for employee and maintenance vehicles during quarry operations. Delivery of sand from Penrose Quarry for blending with fines is expected to occur through the back-loading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period of time. Safeguards will be implemented to minimise the extent of impacts associated with these traffic and access requirements including:

- preparation of a traffic management plan for the construction period;
- restriction of vehicle movements to the minimum necessary to complete the works;
- delivery of materials and equipment during standard working hours;
- confinement of construction vehicles on formed roads and designated laydown areas;
- confinement of vehicle and plant movements to areas previously cleared of vegetation;
- secure storage of materials and equipment on site to minimise the required vehicle movements;
- loading of trains and train transportation will be carried out during a 24 hour day period to enable trips to be scheduled away from peak commuter times on the Main Southern Railway; and
- road haulage of sand to the quarry for blending with fines is only to occur through the backloading of trucks travelling to BCSC.

17.2.12 *Visual Amenity*

Limited visual impacts to residential receivers and recreational users of the Long Point Walking trail will be further minimised through the following:

- provision of bunding around the perimeter of the site; and
- planting the outer face of bund wall with native vegetation.

Wastes generated during both construction and operation of the proposed Marulan South Quarry will be recycled wherever possible or disposed of in an environmentally acceptable manner in accordance with the *Protection of the Environment Operations Act 1997* (POEO Act) and the guidelines recommended in the EPA (1999) *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*. Waste management measures to avoid waste generation and promote reuse, recycling and reprocessing of waste will be incorporated into the Environmental Management Plan for the project. This plan will detail waste management practices including storage, recycling, reuse and waste reduction measures.

18.1 INTRODUCTION

Boral is Australia's leading quarry operator with over 100 quarries producing sand, concrete aggregates, crushed rock, asphalt and sealing aggregates and road base materials. In managing its quarry businesses, Boral regularly reviews the most sustainable and cost efficient ways to continue to meet market demands for construction materials.

In Sydney, Boral has supplied the market from its Dunmore, Prospect, Peats Ridge and Penrith Lakes quarries and its recycling operations at Wetherill Park and St Peters. With Prospect Quarry due to cease operations by 2008 and Penrith Lakes by 2012, alternative supplies need to be found.

This chapter provides an overview of the alternatives considered in the development of the proposed Marulan South Quarry and throughout the EA process. The reasons for justifying the final proposal are presented, having regard to biophysical, economic and social considerations and the principles of ESD.

18.2 PROJECT ALTERNATIVES

18.2.1 *Alternative Locations*

Boral has investigated other greenfield locations for the establishment of a quarry, none of which are able to provide the quality, quantity and environmental outcomes that can be achieved with Marulan South. The option of expanding Boral's other hard rock quarries (Dunmore and Peats Ridge) has been considered and both quarries have recently received approvals to increase production. These increases at existing operations however, are insufficient to meet market demands indicating that a third quarry is required.

18.2.2 *Alternative Materials*

The option of using alternative materials has also been pursued. Boral is a major producer of recycled quarry products through its Boral Recycling business. Boral currently has 3 sites in Sydney and Newcastle currently producing approximately 600,000tpa from construction and demolition waste. This supplements but cannot replace the market intended for the proposed Marulan South quarry.

Overview

Almost all hard rock quarries drill and blast a face to produce raw material. Dimension stone quarries use alternative methods such as rock saws or drilling close spaced holes that are filled with low yield explosive, a chemical expanding agent, or in cold climates with water that then freezes, expands and splits the rock. These methods can only produce large stone at relatively low rates. There are few current alternatives to drill and blast if the object is to produce high volumes of relatively uniformly sized material for subsequent crushing, and none of these alternatives have proved to be economically feasible. However, there is substantial flexibility in the way broken rock is moved, processed and transported. These alternatives are discussed in following sections.

Quarry Plans

Various options were considered to optimise the quarry plan within the constraint of the identified reserves within the resource area. These alternatives included:

- where to commence quarrying;
- where to limit the 30 year quarry area; and
- to what depth to limit the quarry.

The limits of the 30 year quarry area and the commencement point were to a large extent determined through the selection of the processing and transport options. The optimum location for the out-of-pit processing plant, rail siding and rail loading area drove the location of the pit to commence in the northern portion of the resource area.

A southern pit layout and start point were initially considered, however, the northern area proved more attractive due to its separation from the BCSC rail operation and because more flat land which is relatively unconstrained by native woodland was available.

The depth of the proposed quarry was determined simply by likely economies of extracting and transporting raw material from depth. The geological limit to the resource is well below the proposed depth of quarrying. Even at full depth within the 30 year quarry extent, there is more than sufficient pit floor space to quarry to a depth of approximately 135m. Should technology progress, it may well become cost effective to extract raw material lower than the currently proposed pit depth.

Various permutations of the bunding and overburden storage were considered. The overall height and location of the bund was determined by the available overburden and the requirement for visual and acoustic screening. A nominal ten metre high bund was selected to provide a suitable level of acoustic and visual shielding of the quarry operations.

Several sites were considered for separate overburden emplacement of the excess overburden that was not required for the proposed earth bund or dam wall construction. The proposed 30m emplacement forms an extension of the bund on cleared land on the eastern side of the quarry area. Construction of the bund wall and the eastern overburden emplacement will require approximately three and a half million cubic metres of material. Overburden and weathered material will therefore continue to be used for the construction of the bunding and overburden emplacement for up to five years dependant upon extraction rates and the quality of the weathered material influencing the potential sales of weathered material.

A number of alternatives exist for disposal of the remainder of excess overburden including extending the bund wall further south in the resource area, creating an additional emplacement area on Boral land to the north of the site, in-pit rehabilitation of the northern extent of the quarry pit or transfer to a rehabilitation area in the southern pit of the BCSC limestone mine.

The BCSC south pit is expected to be available for rehabilitation by 2010 and has capacity for overburden and weathered material stripped from the Marulan South Quarry for the expected life of operations.

Additional overburden emplacement sites were identified, most notably north of Tangerang Creek. These sites were all relatively cleared of native trees, were outside likely foci of past Aboriginal activity and were well distanced from residences and were therefore reasonable locations for emplacements.

Processing Methods And Layout

Quarries generally use truck based load and haul to transport raw materials both to and between crushing and screening plants. The most common alternative to this traditional load and haul method is conveyor haulage. Load and haul typically has a lower initial capital cost but higher ongoing operating cost, particularly with the rising price of fuel, oils and consumables such as tyres. Conveyor systems will involve an initial capital outlay but then have significantly lower operating costs. Conveyor systems generate considerably less emissions and are economically attractive for larger quarries with a high extraction rate and a long operational life.

The other major alternative consideration is where the raw material (broken rock) receives its primary, secondary and tertiary processing ready for market. This processing can feasibly be either in-pit, out-of-pit, or a combination of the two.

At a large resource such as Marulan South, a traditional load and haul and out-of-pit crushing operation would use the following fixed and mobile plant:

- an overburden stripping fleet;
- one face loading machine such as a face shovel or large excavator;
- up to four large haul trucks producing a total power of approximately 3,000 kW and consuming up to 1 million litres of diesel per year;
- a fixed electrically powered primary, secondary and tertiary crushing and screening plant consuming approximately 750 kW;
- two plant dedicated front end loaders; and
- one grader for haul road and pit floor maintenance.

By comparison, this same quarry operating a conveyor system for all raw feed would use the following fixed and mobile plant:

- an overburden stripping fleet;
- one face loading machine such as a face shovel or large excavator and perhaps one medium haul truck;
- a mobile electrically powered primary and secondary in-pit crushing and screening plant consuming approximately 350 kW;
- a long conveyor from the in-pit plant to the out-of-pit tertiary crushing and screening plant consuming approximately 300 kW;
- one front end loader for material handling and pit floor maintenance; and
- a tertiary crushing and screening plant consuming approximately 200 kW with one dedicated front end loader.

There is a substantial difference in the energy consumption between the traditional load and haul option, and the conveyor option, owing mainly to the inherent efficiencies in conveyors over large haul trucks. The conveyor option would negate diesel consumption of approximately one million litres every year at the cost of a small increase in electricity consumption. This is a significant saving in greenhouse emissions, even without allowing for hydrocarbons used in truck servicing and lubrication.

Other advantages of conveyor haulage versus load and haul include a reduction in dust emissions, a reduction in noise emissions and safety. Haul trucks run on unsealed haul roads and while watering reduces dust, it cannot totally control it. A conveyor system produces considerably less dust, particularly if covered and if transfer points are minimised. Minimising the need for truck movements also means the need for water carts is reduced, thereby again reducing fuel and water consumption.

Haul trucks by necessity have very powerful engines, which, even with careful design, produce noise. Conveyors on the other hand produce far less noise per tonne of rock moved. Placing the primary and secondary crushing and screening plant in-pit will reduce noise emissions by pit wall shielding.

A significant proportion of safety incidents within quarries are related directly or indirectly to mobile equipment: this risk can be reduced with the reduction of mobile equipment.

18.2.4 *Alternative Transport*

Road and rail transport networks currently service Marulan South and the existing BCSC limestone mine operations. Road transport is available via Marulan South Road and rail transport via the existing rail spur from the Main Southern Line.

Road transport provides additional flexibility and reduces the need to double-handle at the receiving end of the supply chain. Truck fleets are readily available, they can be loaded quickly and easily, and can transport products directly to the final user. Trucks require far less capital investment but have relatively high environmental operating costs.

Rail transport is efficient for moving large volumes of material over long distances with relatively low environmental operating costs. Rail haulage uses less fossil fuel, causes no damage to road pavements and is safer for road users. However, operation of trains is considerably less flexible, requires dedicated sidings or rail loops and cannot generally deliver to the end user.

In early project planning, Boral considered both road and rail haulage options for the proposal and siting the location of the proposed quarry on an existing rail spur was a key consideration in site selection.

RTA classification provides a restricted access status for Marulan South Road, which allows for heavy vehicles including B-doubles. This road is currently operating at less than 25% of its approved capacity. However, it has been raised in stakeholder consultation that there are concerns over the use of Marulan South Road.

The existing at grade intersection with the Hume Highway is operating at an adequate level of service with acceptable delays and spare capacity, but does not include an adequate length of acceleration and deceleration lanes to strictly comply with RTA design guidelines.

Potential alternative haulage routes were investigated to minimise the number of additional vehicle movements on Marulan South Road. Two alternative intersections with the Hume Highway were assessed for the capacity to service the Marulan South Quarry proposal including sites at the RTA's Heavy Vehicle Checking Station (HVCS) at Marulan and the BP Service Centre located approximately 3.5 km and 2 km north of Marulan South Road respectively.

The HVCS site intersection provides RTA approved deceleration and acceleration lanes, but does not specifically cater for northbound movements from the eastern side of the Hume Highway. The service centre site has adequate acceleration and deceleration lanes for southbound trips, but does not provide an alternate access for vehicles travelling northwards, either to or from the site. Both alternatives would also require the construction of new access roads to service the quarry and involve traversing private land and railway crossings. Neither option provides a suitable alternative road access to the Marulan South Quarry site.

To minimise cumulative impacts on the local road network, Boral proposes to use rail as its primary method of transportation and currently only seeks approval for road usage during construction and for employees and maintenance vehicles once operational. Delivery of sand for blending with quarry products is expected to occur through the backloading of trucks that are already travelling to the limestone mine. Road haulage of product will only be considered as an emergency if the rail network becomes unavailable for an extended period.

Trains will traverse BCSC's spur line to the Medway Junction and onto the Main Southern Railway for transportation to Boral's Sydney rail terminals at Enfield and St Peters and perhaps other terminals.

18.3 FINDINGS OF THE EA

18.3.1 Overview

The EP&A Regulation states that an environmental assessment should include:

"the reasons for justifying carrying out the development or activity in the matter proposed, having regard to biophysical, economic and social considerations and the principles of ecologically sustainable development."

The following sections provide an overview of the main findings of the EA having regard to the biophysical, social and economic considerations and the principles of ecologically sustainable development (ESD).

Water Resources

A water management system has been developed to aim for the proposed operations to be self sufficient in terms of water use and there are no further pressures placed upon the potable water supply system or withdrawals from Tallong Weir. The water management system has been designed to incorporate the diversion of catchment run-off to clean water dams and the retention, treatment and recycling of all water used in quarrying activities to minimise demand for top-up water from the clean water dams and to minimise the flow of dirty water to the pit storage.

Construction of a wetland upstream of the primary water storage dam is expected to improve the quality of run-off entering Dam No. 1 and act as a filter for excess flows from the in-pit storages. Environmental flows will be maintained, equivalent to 10% of average daily flows, through the occasional spills from clean water dams during floods and allocated environmental flows.

Groundwater at the proposed development site occurs in discrete fracture zones, the most significant of which is the interface between the overburden the underlying granodiorite. Significant water level drawdown caused by quarrying is expected to be constrained to the immediate vicinity of the pit, and as such is not anticipated to affect either local groundwater users or potential groundwater fed ecosystems in the gorge.

Water quality and quantity will be monitored to confirm the efficiency of the proposed water management system and ensure there are no detrimental impacts upon groundwater systems or surface receiving waters.

Ecology

The majority of the site has been previously cleared for agriculture, and only scattered native trees and isolated patches of woodland remain. Development and operation of the proposed Marulan South Quarry and associated infrastructure will remove 2.6 hectares of the endangered White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland), while the remainder of the site is cleared grassland and pasture with scattered and isolated trees. Clearing and indirect impacts from operation of the quarry and associated infrastructure is not expected to have a significant impact on species or ecological communities.

The removal of 28 hollow-bearing trees may have an immediate impact on the roosting and nesting habitat of individual animals, however, there is abundant replacement foraging and nesting habitat available within the surrounding area.

To reduce the minor ecological impacts that would be caused by the Marulan South Quarry proposal, fauna boxes will be installed in trees adjacent to the quarry, all hollow bearing trees will be checked for animals prior to clearing, the perimeter bund will be planted with local endemic plants and a revegetation zone will be established, twice the size of the area of Box Gum Woodland proposed to be cleared.

18.3.3 Social Considerations

Heritage Considerations

Aboriginal and historic heritage assessments were undertaken to identify, and determine the heritage value of archaeological sites, objects and places within the proposed application area. The assessment included a review of previous Aboriginal cultural heritage investigations, predictive modelling of archaeological potential and field survey in consultation with representatives of the local Aboriginal community.

Eighteen Aboriginal sites were found within the study area, the majority of which were of low scientific significance and representative of open stone artefact sites in the local area and region. Sites within the proposed area of Dam 1 are of sufficient scientific value to warrant salvage prior to initial quarry development.

No items of European heritage will be impacted by the proposal.

Noise And Vibration

The noise assessment has shown that under calm weather conditions all receiver locations experience noise levels below the EPA's noise goals. Under worst case weather conditions, noise at most properties is below EPA noise goals, with the exception of Receiver 3. Given the concerted effort applied to mitigate noise and the level of residue impact (up to 5dB(A)), negotiation with the resident and the regulator is proposed. This will involve demonstration by the proponent that all feasible and reasonable noise mitigation has been considered and will be applied as part of the Statement of Commitments.

Sleep disturbance and cumulative noise impact due to the proposal are not considered likely. Similarly, rail traffic noise due to the proposal was also found to be within relevant criteria.

Blast design will incorporate control on maximum instantaneous charge which will ensure acceptable overpressure and vibration limits are maintained.

Air Quality

Dust dispersion modelling was based upon conservative assumptions and indicates that the annual average dust concentrations and deposition levels would be below relevant air quality criteria at the nearest residential properties. Short-term (24-hour average) air quality impacts due to the quarry operations are also predicted to be within the air quality criteria.

There is some potential for minor adverse short-term air quality impacts to be observed at residence 2 due to the combined effects of the quarry at 3.5 mtpa with the adjacent BCSC limestone mine at 4 mtpa. However, given the conservative nature of the dust emission estimates, adverse air quality impacts at the nearest residential locations would not be expected.

Transport And Traffic

Boral proposes to transport all quarry product by rail and currently only seeks approval for road usage during construction and for employee, maintenance and delivery vehicles during quarry operations. The site is serviced by Marulan South Road, which is a dedicated restricted access haulage route which is considered to have ample capacity to accommodate the small number of additional movements associated with the proposal.

All extracted material from Marulan South Quarry is proposed to be transported by rail via the existing private rail spur and the main southern line. An average of three or four train loads per day will be transported from the site at full production, resulting in a small incremental increase in rail movements on the Main Southern Line. Advice from ARTC indicates that there is adequate capacity on the railway corridor to accommodate the additional movements.

Visual

Marulan South Quarry will be predominantly shielded from view from all potential nearby receptors due to natural topography. A series of viewpoints were selected for the assessment to represent the maximum extent of potential views of the proposed quarry. Prominent views of the site can only be obtained from the immediate vicinity of the proposal, typically on Boral property.

The proposal will not be visible from Bungonia Lookdown and views of the quarry will be extremely limited from the spurline along the Long Point walking trail. Provision of bunding around the perimeter of the site will minimise potential views of the site from recreational areas.

The assessment has found that landscape around the proposed development, generally has a high visual absorption capacity due to the existing terrain and scattered vegetation. The high visual absorption capacity corresponds directly with the generally low significance of visual impacts to views from the proposal.

18.3.4 *Economic Considerations*

The major economic benefit for the proposed Marulan South Quarry is to provide surety in the supply of construction materials to meet the demand from the Sydney Metropolitan Region.

The estimated cost for the establishment of the Marulan South quarry is \$150 million, much of which will be expended on initial construction. The operation of the quarry will continue to contribute to the local economy through ongoing operational expenditure and employment.

A construction workforce of approximately 20 people will be required for the establishment of the quarry. The expected workforce for the operational quarry is up to 30 full time, on-site employees with 2-3 shifts with additional opportunities created in transport and support industries.

18.4 *ECOLOGICALLY SUSTAINABLE DEVELOPMENT*

The broadest meaning of ESD is:

“using, conserving and enhancing the community’s resources so that the ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased” (Commonwealth of Australia 1992).

The main thrust behind ESD is that current and future generations should leave a natural environment that functions as well or better than the one inherited. This proposal addresses meeting society’s needs through the provision of a valuable resource, while maintaining a balance with the potential impacts on the physical and social environment of the Marulan South area. Each of the principles of ESD is considered in the following sections.

18.4.1 *Precautionary Principle*

Interpretation

According to the *Protection of the Environment Administration Act 1991*, the precautionary principle means that if there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

This principle was developed in response to one of the great difficulties of interpreting scientific data. The scientific method produces results based on confidence limits. These are controlled by the scope of data acquisition, interpretation methods and general understanding within a particular scientific discipline of a particular phenomenon. This has been used as a way of validating a lack of response to a potential threat of serious or irreversible environmental degradation.

In the application of this principle:

- careful application should always be undertaken to avoid serious or irreversible environmental damage; and
- an assessment of consequences of various options should be undertaken in formulating a proposal.

ESD requires that uncertainty and the associated risk level be considered in decision making.

Justification

The environmental consequences of the proposed Marulan South Quarry have been assessed as accurately as possible using appropriate specialists in relevant disciplines where required. The assessment process involved computer modelling, field validation, scientific analysis and interpretation of the individual and cumulative environmental impacts of the proposed development. This process has enabled the impacts of the proposed quarry to be predicted with a reasonable degree of certainty. All predictions, however, contain a degree of uncertainty, which reflects the variable nature of the environment. Where there has been any uncertainty in the prediction of impacts throughout the assessment process, a conservative approach was adopted to ensure the worst case scenario was predicted in the assessment of impacts.

The proposal is consistent with the precautionary principle to the extent that all potential threats to the environment have been identified and appropriate mitigation measures have been developed to minimise such impacts. All management procedures form part of the statement of commitments as outlined in *Chapter 17* and will be implemented as part of the project application.

The environmental investigations undertaken during the preparation of this EA have identified potential impacts with adequate scientific certainty to justify proceeding with the proposed development. The proposal therefore meets the objectives of precautionary principle of ESD.

Interpretation

Social equity involves value concepts of justice and fairness so that the basic needs of all sectors of society are met and there is a fair distribution of costs and benefits to improve the well-being and welfare of the community, population or society. Social equity does not imply equality but that there should be equal access to opportunities for improved welfare, with a bias towards advantaging the least well-off sectors of society.

Social equity includes intergenerational equity, which requires that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

Justification

The proposal is consistent with the principles of social equity and intergenerational equity through the efficient use of a resource that provides a number of fair and wide ranging benefits to society.

The proposed Marulan South Quarry has an identified granodiorite resource of approximately 250 million tonnes. This resource area has a potential operational life span of over 70 years and with two of Boral's quarries currently nearing completion, will supply the ongoing market demand for construction materials in the local and the Sydney metropolitan areas. The proposed 30 year initial operation detailed in this assessment will ensure that the resource is extracted efficiently and sustainably and that the existing benefits afforded to the community are maintained or enhanced providing both intra and intergenerational equity.

Social and economic benefits to the local community are expected through the production of local employment opportunities, the transfer of technical and commercial skills to local industry, the development of local capacity; and positive multiplier effects in the region.

At this stage there are no fixed plans for the end use of the quarry. Given the life of the quarry (70+ years) it would be premature to make decisions around its end use. Boral is committed to sustainable end-use planning of its quarries and to this end has a specific business unit charged with that responsibility. Decisions around the end-use are better made in the final 5-10 years of a quarry.

18.4.3 *Conservation Of Biological Diversity And Maintenance Of Ecological Integrity*

Interpretation

Biological diversity refers to the diversity of genes, species, populations, communities and ecosystems, and the linkages between them. Biological resources provide food, medicines, fibres and industrial products. They are also responsible for vital ecological services such as maintaining soil fertility and the supply of clean and fresh water. Maintaining biological diversity safeguards life support functions and can be considered a minimal requirement for intergenerational equity.

Justification

A comprehensive assessment of the likely impacts of the proposal on flora and fauna is detailed in *Chapter 7* and *Annex E*. The majority of the site has been previously cleared of native vegetation and retains minimal habitat value.

Potential impacts from the proposed activities will be restricted to birds and arboreal mammals nesting and foraging in isolated trees, an area of the endangered Box-Gum Woodland (TSC Act) and aquatic habitat downstream of the water storage dams. Provision of fauna boxes, compensatory habitat and retention of environmental flows will minimise impacts associated with the proposal.

The native habitat value over the remainder of the site has been severely diminished due to prior landuse. Therefore, the additional clearing of a very small amount of habitat is not expected to result in any significant impact, particularly given the abundance of roosting, nesting and foraging habitat in the nearby Morton National Park. Overall the proposal is expected to counter effects from the unavoidable loss of habitat. Mitigation measures aim to conserve, enhance and manage habitat within the study area, so that local populations can be maintained ensuring adherence to the principles of conservation of biological diversity and ecological integrity.

18.4.4 *Improved Valuation And Pricing Of Environmental Resources*

Interpretation

This principle is a component of intergenerational equity. The principle relates to the need to determine proper values for services provided by the natural environment, such as the atmosphere's ability to receive gaseous emissions, cultural values and visual amenity.

Applying standard methods of valuation and pricing to environmental resources is a difficult process. This is largely due to the intangible nature of much of the natural environment. The environment has conventionally been considered a free resource, with the true cost to the environment not factored into cost of production or use of that resource.

This principle involves placing a monetary or social value on the environment that ultimately increases its value so as to decrease future exploitation.

Pollution and future exploitation can be controlled under the polluter pays principle, whereby polluters who degrade the natural environment are responsible and accountable for returning it to its previous condition.

Justification

This EA examined the environmental consequences of the project and has identified a number of mitigation measures for adverse impacts associated with the proposal and have been included in the statement of commitments. The mitigation measures have been developed concurrently with the environmental assessment and have been incorporated directly into the quarry design. The proposal has therefore been refined and involves a higher initial capital expenditure (i.e. use of conveyors, enclosing the tertiary plant, excluding road haulage) to ensure a sustainable outcome. The cost of these measures can be used as an indirect indication of the value of environmental resources.

18.5

CONCLUSION

This EA has assessed the potential environmental impacts associated with the Marulan South Quarry proposal. The proposal has an identified resource of approximately 250 million tonnes which, depending upon extraction rates, would allow quarrying for 70 years or more over an area of approximately 104 ha. Project approval is being sought for an area sufficient for 30 years of quarrying, commencing in the northern portion of the resource area with an area of approximately 72 ha.

The EA was prepared having regard to biophysical, economic and social considerations and the principles of ESD. There were no significant environmental impacts identified during the preparation of the EA that cannot be mitigated by appropriate mitigation measures and management strategies.

The environmental assessment process has been used to drive the development of the quarry and ensure operations will be sustainable and create minimal disruption to the local community. Quarry operations have been designed to be self sufficient in water use, minimise truck movements on Marulan South Road, ensure acceptable noise and dust emissions and to minimise the visibility of the operations. All mitigation measures and management practices identified in the EA form part of the statement of commitments for the proposal and will be incorporated into the environmental management plans for construction and quarry operations.

The quarry will provide a long term viable supply of construction material to the Greater Sydney Metropolitan area. The proposal can be implemented with minimal adverse environmental impacts as demonstrated throughout this assessment and is justified in terms of the overall economic benefits to both the local, state and national economies.



Part E

References, Glossary and Abbreviations

REFERENCES

ANZECC (Australian and New Zealand Environment and Conservation Council) (1990), **Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration**. Australian and New Zealand Environment and Conservation Council, Canberra.

ANZECC & ARMCANZ (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand) (2000), **Australian and New Zealand Guidelines for Fresh and Marine Waters Quality**. Canberra. Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand.

Blastronics Pty Ltd (1994), **Drill & Blast Study, Mount Pleasant**, Prepared for CNA.

BoM (Bureau of Meteorology) (2004) **Climatic Averages Australia**, Bureau of Meteorology website, www.bom.gov.au

Brayshaw, H. (1982) **Berrima Colliery: Archaeological Survey of Proposed Surface Facility Expansion**. Consultancy report to Sinclair Knight & Partners Pty Ltd.

Brayshaw, H. (1984) **Archaeological Investigation near Goulburn**. Consultancy report by Brayshaw & Associates.

Churchill, S. (1998) **Australian Bats** Reed New Holland Sydney.

Cogger, H. C. (2000) **Reptiles and Amphibians of Australia** Reed New Holland Sydney.

DEC (Department of Environment and Conservation) (2004) **National Parks & Wildlife Act 1974: Part 6 Approvals – Interim Community Consultation Requirements for Applicants**, Department of Environment and Conservation NSW.

DEC (Department of Environment and Conservation) (2004) **Threatened Biodiversity Survey and Assessment: Guidelines for developments and activities**, Working Draft, Department of Environment and Conservation NSW.

DEC (Department of Environment and Conservation) (2005), **Approved Methods for Dispersion Modelling**. Department of Environment and Conservation NSW.

DEC (Department of Environment and Conservation) (2005) **BioBanking – A Biodiversity Offsets and Banking Scheme** Conserving and restoring biodiversity in NSW Working Paper, Department of Environment and Conservation NSW.

DEC (2005) **Threatened Species Profiles in Threatened Species: species, populations and ecological communities of NSW**
<http://threatenedspecies.environment.nsw.gov.au/tsprofile/>

DEC (2006) **Threatened Species Profiles in Threatened Species: species, populations and ecological communities of NSW**
<http://threatenedspecies.environment.nsw.gov.au/tsprofile/>

DMR (Department of Mineral Resources) (1999) **State Structural Geology (1:1,000,000)**.

Drew, J. (1995) **Environmental Summary Statement: Telstra's Proposed Optic Fibre Cable Route Marulan to Bungonia**. Prepared for Telstra Network Design and Construction NSW.

Dwyer, P. D. (1995) **Common Bent-wing Bat**. In Strahan, R. (ed.), *The Australian Museum Complete Book of Australian Mammals*. Angus & Robertson, Sydney.

Eddy, M. (1985) **Marulan; "A Unique Heritage"**. Marulan 150, Marulan.

EPA (Environment Protection Authority) (2000), **Industrial Noise Policy**. NSW EPA.

EPA (Environment Protection Authority) (1994), **Environmental Noise Control Manual (ENCM)**, NSW EPA.

EPA (Environment Protection Authority) (1995) **Best Practice Environmental Management in Mining Rehabilitation and Revegetation**, NSW EPA.

ERM (Environmental Resources Management) (2004) **Lots 1 & 3 Simpson and Wilson Drive, Marulan – Heritage Study**. Prepared for Tailored Properties.

ERM (Environmental Resources Management) (2006) **Marulan South Continuation of Operations: Aboriginal Cultural Heritage Assessment**. prepared for Blue Circle Southern Cement.

Farmer, A. M. (1993) **The effects of dust on vegetation – a review** *Environmental Pollution* 79: 63-75.

Haglund, L. (1986) **Archaeological Survey of Areas within Bungonia State Recreation Area likely to be Affected by Present and Future Recreational Activities and Associated Development**. Prepared for Bungonia State Recreation Area Trust.

Harden, G. (2000) **Flora of New South Wales**, University of New South Wales Press Ltd Sydney.

HAS (Holmes Air Sciences) (2002) **Air Quality Assessment: Warkworth Mine**, Holmes Air Sciences, NSW.

HAS (Holmes Air Sciences) (2003) **Air Quality Impact Assessment : Proposed Concrete Batching Plant at Kellog Road, Rooty Hill**, Prepared for National Environmental Consulting Services.

HAS (Holmes Air Sciences) (2006) **Air Quality Impact Assessment: Bengalla Mine - Mine Plan Modifications**. Prepared for Hansen Consulting Pty Limited.

HRC (Healthy Rivers Commission) (1999) **Independent Inquiry into the Shoalhaven River System**, HRC.

International Environmental Consultants Pty Ltd (1997) **Proposed Clayshale Extraction Marulan Quarry: Environmental Impact Statement**. Prepared for Blue Circle Southern Cement.

Kelton, J. (1997) **Proposed Clayshale Extraction Marulan Quarry EIS**. Prepared for Blue Circle Southern Cement.

Koettig, M. (1981) **Hoddles Crossing to Alpine**. Prepared for Department of Main Roads.

Koettig, M. (1983) **Goulburn Freeway By-Pass**. Prepared for Department of Main Roads.

Koettig, M. (1987a) **Wingello State Forest: Assessment of Archaeological Sites in a Proposed Gravel Quarry, near Wingello in the Southern Tablelands of NSW**. Prepared for Wingecarribee Shire Council.

Koettig, M. (1987b) **Soapy Flat Reserve: Assessment of the Archaeological Resources within the Reserve**. Prepared for Crown Lands Office, NSW.

Koettig, M. (1988) **Survey for Aboriginal Sites in the Proposed Rural Subdivision at Tallong, NSW**. Prepared for MJS Keys Young Planners Pty Ltd.

Lance, A. and M. Koettig (1986) **An Aboriginal Resources Planning Study for the City of Goulburn, NSW**. Prepared by ANUTECH for Goulburn City Council.

Lance, A. (1984) **An Archaeological Survey of Proposed Water Supply Pipeline between Sooley Dam and Rossi Weir, Goulburn, NSW**. Prepared for P.W.D.

McDonald, J. and H. Brayshaw (1983) **Archaeological Survey of Proposed Extension to Hard Rock Quarry near Bowral, NSW**, Brayshaw & Associates.

McIntyre, S. (1993) **Archaeological Investigation of Sensitive Areas along the Marulan to Goulburn 132 kV Transmission Line**. Prepared for Pacific Power Services.

Mentor Consulting (1993) **Literature Review on the Impacts of Mine Generated Dust on Agricultural Production**, Prepared for Peabody Resources.

Mills and Wilkinson (1994) **Archaeological Survey of the Proposed Extensions to the Limestone Quarry at South Marulan**. Prepared for Sinclair Knight Merz.

Navin, K. (1990) **Archaeological Survey of a Proposed Hard Rock Quarry Site near Marulan NSW**. Prepared for Quarry Technology Pty Ltd.

NPWS (NSW National Parks and Wildlife Services) (1997) **Aboriginal Cultural Heritage: Standards and Guidelines Kit**, NSW National Parks and Wildlife Services.

NPWS (NSW National Parks and Wildlife Services) (1998) **Bungonia State Recreation Area Plan of Management**, NSW National Parks and Wildlife Services.

NSW Mineral Council (2000), **Technical Paper, Particulate Matter and Mining Interim Report**. NSW Minerals Council.

Paton, R. (1989) **Archaeological Excavations at site G17, Goulburn, NSW**. Report prepared for the NSW Roads and Traffic Authority.

Pizzey and Knight (1999) **Field guide to the Birds of Australia** Angus & Robertson Australia.

RTA (NSW Roads and Traffic Authority) Technology, **Environmental Noise Model (ENM)**, Windows Version 3.06.

RTA (NSW Roads and Traffic Authority) (2002) **Route Assessment Guidelines for Restricted Access Vehicles (RAGRAV)**, NSW Roads and Traffic Authority.

Sefton C (1995) **Archaeological Survey of the Marulan Water Supply Augmentation** Consultancy report to Public Works, South Coast Region.

Sinclair Knight Merz 1994 **Marulan White Clay Quarry Environmental Impact Statement**. Consultancy report to Blue Circle Southern Cement Limited.

Slater and Slater (1995) **The Slater field guide to Australian Birds**, Landsdowne Publishing Pty Ltd.

Smith, J. (1992) **Aborigines of the Goulburn District**. Publication of the Goulburn and District Historical Society.

SPCC (NSW State Pollution Control Commission) (1983) **Air Pollution from Coal Mining and Related Developments**, Published by NSW State Pollution Control Commission (now EPA).

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

Speight, J. G. (1990 "Landform". In McDonald, R. C., Isbell, R. F., Speight, J. G., Walker, J. and Hopkins, M. S. (Eds) **Australian Soil and Land Survey Field Handbook: Second edition**. Inkata Press.

Thackway and Cresswell (1995) **An interim biogeographic regionalisation for Australia: a framework for setting priorities in the National Reserves System Cooperative Program Version 4.0** Australian Nature Conservation Agency Canberra.

TSSC (Threatened Species Scientific Committee) (2001) Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the List of Ecological Communities under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Umwelt (2005) **Environmental Impact Statement: Proposed Lynwood Quarry, Marulan**. Report to Readymix Holdings Pty Ltd.

US EPA (United States Environment Protection Agency) (1985 and updates) **AP-42 Compilation of Air Pollutant Emission Factors, Fourth Edition** United States Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards.

US EPA (United States Environment Protection Agency) (1986) **EPA-450/2-78-027R Guideline on air quality models (revised)**, United States Environmental Protection Agency, Office of Air Quality Planning and Standards.

US EPA (United States Environment Protection Agency) (1995) **User's Guide for the Industrial Source Complex (ISC3) Dispersion Models - Volume 1 User's Instructions and Volume 2 Description of Model Algorithms**, US Environmental Protection Agency, Office of Air Quality Planning and Standards Emissions, Monitoring and Analysis Division.

Williams, D. (1992) **An Archaeological Investigation of the Proposed Route of the Optus Fibre Cable between Goulburn and Campbelltown, NSW**. Consultancy report to Landscan Pty Ltd.

GLOSSARY OF TERMS AND ACRONYMS

Term	Description
3D	Three dimensional
AADT	Annual Average Daily Traffic
ABL	Assessment Background Level (ABL) is defined in the <i>INP</i> as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{90} statistical noise levels.
ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AMG	Australian Map Grid
ANZECC	Australian and New Zealand Environment Conservation Council
ARI	Average Recurrence Interval
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ARTC	Australian Rail Track Corporation
BATEA	Best Available Technology Economically Available
BMP	Best Management Practice
BCSC	Blue Circle Southern Cement
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(LinPeak)	The peak sound pressure level (not RMS) expressed as decibels with no frequency weighting.
DEC	Department of Environment and Conservation
DEH	Department of the Environment and Heritage
DGRs	Director-General's Requirements
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DPI	Department of Primary Industries
DoP	Department of Planning
EA	Environmental Assessment
EAR	Environmental Assessment Report
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
ENM	Environmental Noise Model
EPA	Environmental Protection Authority
ERM	Environmental Resources Management (Australia) Pty Ltd
ESD	Ecologically Sustainable Development
FEL	Front End Loader
glc	Ground level concentration
HAS	Holmes Air Sciences
HRC	Healthy Rivers Commission
HVCS	Heavy Vehicle Checking Station
INP	Industrial Noise Policy
INTANAL	Intersection Analysis of signals
ISC	Industrial Source Complex Dispersion Model
ISO	International Standards Organisation
L1	The noise level exceeded for 1 % of a measurement period.
L10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.

Term	Description
L90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
Leq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LEP	Local Environment Plan
LGA	Local Government Area
Lmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
LoS	Level of service
MIC _{8MS}	Maximum Instantaneous Charge (with a minimum 8 milli-sec delay).
MSQ	Marulan South Quarry
mtpa	Million tonnes per annum
NATA	National Association of Testing Authorities
NP	National Park
NPWS	National Parks and Wildlife Service
OEMP	Operational Environmental Management Plan
ORP	Oxidation Reduction Potential
Peak Particle Velocity	The maximum velocity of a particle of the transmission medium, used in assessment of vibration.
PFM	Planning Focus Meeting
PM _{2.5}	Particulate Matter less than 2.5 microns in diameter
PM ₁₀	Particulate Matter less than 10 microns in diameter
ppv	Peak Particle Velocity. The maximum velocity of a particle of the transmission medium, used in assessment of vibration.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
RTA	NSW Roads and traffic Authority
RAGRAV	Road Assessment Guidelines for Restricted Access Vehicles
RMS	Root Mean Square which is a measure of the mean displacement (velocity or acceleration) of a vibrating particle.
RNE	Register of the National Estate
RTA	NSW Roads and Traffic Authority
SEPP	State Environmental Planning Policy
SEPP-MP	State Environmental Planning Policy – Major Projects
SI	Still isothermal (SI) refers to calm weather conditions (defined as no wind and standard temperature gradients).
sigma-theta (σ_θ)	The standard deviation of horizontal wind fluctuation.
Sound power level	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment.
SPCC	State Pollution Control Commission
SRA	State Conservation Area
SWL	Static Water Level
TDS	Total Dissolved Solids
Temperature inversion	A positive temperature gradient. A meteorological condition where atmospheric temperature increases with altitude to some height.
TMP	Traffic Management Plan
tpa	tonnes per annum
TSP	Total Suspended Particulates
US EPA	The United State Environmental Protection Agency
vpd	Vehicles per day

ERM has over 100 offices
across the following
countries worldwide

Australia	Netherlands
Argentina	New Zealand
Belgium	Peru
Brazil	Poland
China	Portugal
France	Puerto Rico
Germany	Singapore
Hong Kong	Spain
Hungary	Sri Lanka
India	Sweden
Indonesia	Taiwan
Ireland	Thailand
Italy	UK
Japan	USA
Korea	Venezuela
Malaysia	Vietnam
Mexico	

Environmental Resources Management

Building C, 33 Saunders Street
Pyrmont NSW 2009
Locked Bag 24,
Broadway NSW 2007

T: 61 2 8584 8888
F: 61 2 8584 8800
www.erm.com

